Chapter 6. Green Streets

Description

Green streets are designed in a holistic manner that minimizes impervious surfaces, emphasizes landscaped elements, includes measures for enhancing water quality, while also potentially including aspects that increase "live-ability" and/or promote alternative transportation modes. Water quality enhancement within green streets is achieved with landscape elements and/or pervious pavement systems that capture, slow, filter, and potentially infiltrate stormwater runoff into the ground. Green streets often include individual LID elements such as pervious pavement, vegetated swales, bioretention (in the form of curb extensions, rain gardens, and sidewalk planters), interceptor trees, and many others that are commonly associated with traditional development sites.

Design the site to drain stormwater runoff on the landscape's surface and minimize underground piped infrastructure. "Green" the right of way corridor by adding new trees and preserving any existing mature trees.

Applicability

- All roadway projects involving 5 acres of newly created or replaced impervious surfaces (not including overlays or routine maintenance)
- Other roadway projects involving less than 5 acres of newly created or replaced impervious surfaces seeking the following environmental benefits:
  - Mitigation of impacts from aged or inadequate storm drain infrastructure within right of way area
  - Reduction of pollutant concentration and pollutant load to receiving waters, particularly with respect to oils and grease, metals, trash, and other common roadway constituents of concern
  - Achieving aesthetic benefit and enhanced community environment
  - Air quality benefits from settlement of aerial particulate matter and reduction of low level ozone
  - Reduction of heat island effects
  - Volume reduction

Potential Elements of Green Street Design

- ✓ Maximized Landscaping
- ✓ Minimized Impervious Area
- ✓ Significant Tree Canopies
- ✓ Runoff Reduction and Stormwater Treatment Elements
- ✓ Focus on Alternative Transportation Modes
- ✓ Combined Management of Public and Private Drainage

Design Process Overview

The design procedure for green streets should follow the steps described below. In many instances, runoff reduction and stormwater treatment elements have additional detailed design procedures described within fact sheets in Chapter 5 of this manual. The reader should refer to those sections as applicable.

Design Procedure

Step 1 – Address Site Layout Issues

- Minimize travel lane width to the extent permissible based upon traffic safety
- Consolidate travel lanes and on street parking areas wherever feasible
- Convert unused or oversized asphalt areas next to the traveled way into landscaped stormwater management elements
- Consider the appropriateness of angled parking in lieu of traditional parallel parking spaces
- Avoid over-allotment of parking. Keep parking space count balanced with respect to landscaping area (balance number of street parking spaces and landscape planters).
- Wherever feasible, utilize vegetated elements on the surface such as vegetated swales, filter strips, or "green curbs" to convey drainage.
- Wherever feasible, incorporate trees with significant canopy area into the design. Consider canopy heights for trees near walkways, bike paths, street, drive lanes, and other features that could be adversely impacted by tree canopies.

Step 2 – Incorporate Alternative Transportation Options

- Consider inclusion of alternative transportation elements such as bicycle lanes, bicycle racks, and preferred parking areas for carpool/vanpool participants.

Step 3 – Choose Stormwater Facilities

Vegetated Swales

Good Places for Vegetated Swales:

- New residential and commercial streets
- Arterial streets and boulevards
- Within street medians on new streets

Vegetated Swale, Colonia San Martin, County of Sacramento

Why Choose Vegetated Swales?

- Widely-accepted stormwater strategy
- Simple to construct
- Relatively low-cost to implement
- Replaces underground conduits which may reduce sanitary quality

Potential Constraints:

- Need long, continuous spaces which can be difficult to find in retrofit conditions
- Difficult to incorporate other streetscape elements within swales (lighting, signage, etc.)
- More difficult to provide good pedestrian circulation through swales
- Often designed to be “too deep” and, as a result, are not aesthetically pleasing

Refer to Vegetated Swale BMP Fact Sheet in Chapter 5 for additional information.

Bioretention within Sidewalk Planter

Good Places for Sidewalk Planters:

- Streets where space is constricted

Why Choose Sidewalk Planters?

- Are best landscape solution for ultra-urban conditions
- Can be used with or without on-street parking depending on available space
- Can fit between other streetscape elements (trees, utilities, signage, etc.) and are highly versatile in shape and size
- Can provide both volume and flow stormwater benefits

Sidewalk Planter - Folsom Historic District Parking

Potential Constraints:

- Are generally more expensive than swales
- May only be contextually appropriate in high density urban settings
- For unlined systems, the depth to groundwater should be at least 10’ below the bottom of the facility
- Liner and underdrain are required for soil types C and D

Refer to Bioretention Planter BMP Fact Sheet in Chapter 5 for additional information.

Bioretention within Curb Extension Area

Good Places for Curb Extensions:

- Parking zones along commercial street
- Residential settings where on-street parking is under-used

Why Choose Curb Extensions?

- Can significantly “green” a street with minimal investment
- Can be inexpensive to build depending on the local land use context

- Can be flexible in both shape and size to conform to site conditions
- Can act as a "backstop" to capture stormwater flow on steep streets
- Can narrow portions of a street and provide traffic calming benefits
- Increased cooling from landscaping and reduced heat from asphalt

Potential Constraints:

- Generally requires the removal of on-street parking
- Can sometimes conflict with bike travel if adequate space is not allowed between edge of curb extension and a street's travel lane
- For unlined systems, the depth to groundwater should be at least 10' below the bottom of the facility
- Liner and underdrain are required for soil types C and D
- Vegetation must not impede sight distance

Bioretention within curb extension area - Freedom Park, County of Sacramento

Refer to Bioretention Planter BMP Fact Sheet in Chapter 5 for additional information.

Pervious Paving, Permeable AC and Permeable Concrete

Good Places for using Pervious Paving, Permeable AC and Permeable Concrete:

- Low-volume streets
- Parking stalls (streets and parking lots)
- Alleys
- Residential driveways
- Sidewalks (depending on material and ADA-compliance)

Why Choose Pervious Paving?

- Reduces the size of stormwater treatment measures
- Can be the only viable option in ultra-urban conditions

Potential Constraints:

- Requires well-drained native soil, or other associated mitigation measures such as impervious liners and subdrain systems.
- Higher installation cost than traditional pavement

Pervious Paving, Fair Oaks Promenade - Fair Oaks

- Can be difficult to maintain and difficult to repair in small batches if using porous concrete and asphalt.
- Has limited infiltration effectiveness on street slopes over 5%. This effect can be mitigated to some extent be leveling and terracing the sub-excavation area.

Refer to Porous Pavement BMP Fact Sheet in Chapter 5 for additional information.

Green Gutters

Good Places for Green Gutters:

- Residential, commercial, and arterial street frontages that have oversized wide travel lanes or "dead space" between travel lanes and the sidewalk zone

Why Choose Green Gutters?

- Can often significantly "green" a street with minimal investment
- Can be inexpensive to build depending on the local land use context
- Can help create a more walkable street environment by providing a green buffer between auto traffic and the sidewalk

Potential Constraints:

- Require a long, continuous space to effectively slow and filter stormwater pollutants
- Are very shallow and do not retain large amounts of runoff
- Can sometimes conflict with bike travel if adequate space is not allowed between edge of green gutter and a street's travel lanes

Bioretention (as Rain garden)

Good Places for Rain Gardens

- Underutilized space adjacent to streets
- Left over spaces created by angled street intersections

Why Choose Rain Gardens?

- Can often significantly "green" a space that would otherwise be leftover asphalt area
- Can be inexpensive to build depending on the amount of hardscape and pipe system used
- Can provide the greatest stormwater flow and volume benefit because of their large size
- Can provide an opportunity to incorporate small trees or large shrubs in site design
- Offer versatility in shape

Potential Constraints:

- Often more maintenance required because of their large size
- Can be difficult to find large spaces for rain gardens in ultra-urban or retrofit conditions

Refer to Bioretention Planter BMP Fact Sheet in Chapter 5 for additional information.

Table 6-1 Summary Table of LID Incorporation within Green Streets

	Vegetated Swale	Bioretention (within Sidewalk Area Planter)	Bioretention (within curb Extension Area)	Pervious Pavers/Permeable AC/Permeable Concrete	Green Gutters	Bioretention (as a Rain Garden)
Residential	✓	✓ (Site Dependent)	✓	✓	✓	✓
Commercial Main Street	✓ (Site Dependent)	✓	✓	✓	✓ (Site Dependent)	✓ (Site Dependent)
Arterial and Boulevard	✓	✓	✓		✓	

Step 4 – Perform Final Sizing of Stormwater Facilities and Implement Detailed Design Strategies

Sizing of Stormwater Facilities

- Roadway projects consisting of 5 acres or more of new or replaced impervious surface (not including overlays or routine maintenance) should size vegetated swales, bioretention areas, and permeable pavement in accordance with the formal LID and treatment sizing standards discussed within Chapter 5 of this manual.
- Green gutters do not provide numeric credit towards the formal LID and treatment sizing standards discussed within Chapter 5 of this manual.
- For roadway projects consisting of less than 5 acres of new or replaced impervious surface, the sizing of LID stormwater and treatment facilities is at the discretion of the designer within the limits of what is practical for the individual project. However, compliance with standards discussed within Chapter 5 of this manual is encouraged.

Maintaining Pedestrian Circulation within the Right of Way

Adequate provision for pedestrian circulation should always be a major consideration of green streets. A number of typical strategies should be considered to the extent feasible and allowable by local standards. In all instances, the capture and conveyance strategy should be reviewed for compliance with the Americans with Disabilities Act (ADA).

- When on-street parking is provided adjacent to a stormwater facility, maintain a minimum 3' clear egress zone to allow drivers and passengers to enter and exit their cars safely.
- Stormwater facilities should include reasonably frequent crossings, or "breaks" in the layout. Wherever grade differential exceeds 12" between the pedestrian circulation areas and the adjacent stormwater facilities, pedestrian safety rails should be provided based upon local agency standards. Grade differentials between 6" and 12" can be demarcated using low profile railings, low profile shrubs, raised curbs, and/or detectable warning strips.

- Separation can be provided from sidewalk planter areas through the use of raised curbs or low profile rail systems. Reasonable caution should be taken to avoid creation of tripping hazards.

Control of Unintended Lateral Migration of Groundwater

Unintended lateral flow of groundwater is a design challenge. If it is not handled in a suitable manner, the possibility to damage surrounding infrastructure (such as pavement areas, utility trenches and vaults, etc.) becomes greatly increased. In all instances, close coordination and consultation with the project geotechnical engineer should occur during the design process. The following strategies can be used to inhibit the flow of water in unintended directions:

- Impermeable liners (such as visqueen) at the sub-excavation limits of vegetated swales, bioretention areas, and permeable pavements.
- "Deepened" curbs
- Clay plugs or concrete cutoff walls within the rock portion of utility trench lines
- Various combinations or all of the above

Utility Conflicts

Utility location and maintenance needs constitute one of the greatest physical constraints in the design of green streets. The design must consider maintenance access needs, minimum cover requirements, prevention of lateral groundwater migration (discussed above), and appropriate spatial allocation for valves, vaults, and other appurtenances. The utility conflict strategy should consist of the following prioritized measures:

- Avoidance of facilities - through strategic selection and siting of stormwater facilities.
- Acceptance – when avoidance cannot be accomplished, but construction of the stormwater facility does not preclude proper function and maintenance of the utility. This approach may warrant that maintenance of the utility necessitate temporary impact, and reconstruction of the stormwater facility. For example, gas and water valve boxes have successfully been incorporated into the design of bioretention areas by protecting them within riser boxes. However, should the utility line controlled by the valve need service, temporary encroachment and restoration of the bioretention area would be needed.
- Relocation/replacement of the utility – typically a resort of last measure due to the design complications and generally cost prohibitive nature. However, this approach may be suitable in the case of aged infrastructure already identified for replacement. Incorporation of such work into a green street project may provide an opportunity to cost effectively leverage multiple objectives into one effort.

Alternatives for Capture and Conveyance of Stormwater

There are strategies that can be evaluated to capture and direct stormwater in the manner necessary to function within the context of the overall project layout. The stormwater collection strategy should consider the following to the extent feasible and allowable by local agency roadway and drainage design standards:

- Wherever feasible, priority should be given to capture stormwater in a sheet flow condition by utilizing "curbless" streets or curbs installed at an elevation flush with the edge of pavement. Flush mounted curb should be sloped towards the receiving stormwater facility.
- When a "curbless" design is not feasible, cuts in a raised curb (i.e. "curb cuts") should be provided at the greatest possible frequency, with an 18" minimum length for each. The minimum distance between curb cuts should be calculated hydraulically based on the street slope and the size of the opening to ensure that flow will not bypass the openings. On steep streets, a low profile AC or concrete berm can be in conjunction with a longer curb cut to prevent bypass. The bottom of curb cuts should be sloped towards the stormwater facility. The outlet of curb cut areas should be stabilized with suitably sized gravel or cobbles to prevent localized scour.
- A minimum 2" drop should be provided between the roadway elevation (either at the curb cut or "curbless" edge condition) and the finished grade of the stormwater facility. This will help ensure proper performance in the event of sediment accumulation.
- Consider the use of check dams and weirs at 25' maximum intervals to convey runoff wherever longitudinal gradient exceeds 4%

The stormwater conveyance strategy should consider the following to the extent feasible and allowable based upon local agency roadway and drainage design standards:

- Use of "non-traditional" roadway cross sections (i.e. not crowned at the center) such as "inversed crowns", side-shed sections, and flat cross sections (well suited for permeable pavements systems)
- Using speed bumps to direct runoff in a strategic manner
- Using shallow trench drains to direct runoff in a strategic manner

Other Strategies

- For project sites with hydrologic Class "C" or Class "D" soils, stormwater facilities can be sub-excavated and backfilled with select import material, gravel, and suitably designed perforated sub-drains to prevent prolonged ponding of water and associated vector hazards.
- In situations where flow enters a stormwater facility in a concentrated manner, or where the roadway generates a high volume of leaves or debris, consider use of a forebay to facilitate ease of maintenance.

Maintenance Issues

Determination of long term maintenance responsibility is necessary to ensure optimal performance of stormwater control measures. Installation of green street stormwater control measures within the public right of way is subject to approval by the local permitting agency. Green street stormwater control measures may be subject to a maintenance agreement and/or the establishment of a maintenance funding mechanism such as Home Owners Association (HOA), Landscape and Lighting (L&L) District, or Community Facilities District (CFD). Check with the local permitting agency on the siting and long-term maintenance options.

Refer to individual LID element fact sheets in Chapter 5 for detailed inspection and maintenance procedures regarding the use of vegetated swales, vegetated strips, bioretention, and permeable pavement.

References

- San Mateo Countywide Water Pollution Prevention Program, *San Mateo County Sustainable Green Streets and Parking Lots Design Guidebook*, January 2009. http://www.flowstobay.org/documents/municipalities/sustainable%20streets/San%20Mateo%20Guidebook.pdf

THIS PAGE LEFT INTENTIONALLY BALNK