Green Streets

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M.1 Introduction

The Alameda Countywide Clean Water Program (ACCWP) developed Example GI Typical Details that may be used to design green infrastructure (also known as green stormwater infrastructure) facilities for projects located in the street right of way, subject to local jurisdiction approval (see Attachment M-1). To design future GI facilities that will provide stormwater treatment for runoff from existing streets, please refer to the Green Infrastructure Plan of the jurisdiction in which the project will be located for additional guidance, including guidance for sizing for GI facilities in street projects. Streets can represent 80% of a municipality’s public property and typically occupy 25% of all the impervious surfaces in the jurisdiction. Therefore the planning, designing, construction and maintenance of streetscapes is an important aspect of a jurisdictional stormwater program. “Green streets” suite of BMPs is a sub-category of the larger sphere of systems described by the term “green infrastructure”. According to the EPA:

“Green infrastructure uses vegetation, soils, and natural processes to manage water and create healthier urban environments. At the scale of a city or county, green infrastructure refers to the patchwork of natural areas that provides habitat, flood protection, cleaner air, and cleaner water. At the scale of a neighborhood or site, green infrastructure refers to stormwater management systems that mimic nature by soaking up and storing water.”

1 water.epa.gov/infrastructure/greeninfrastructure/gi_what.cfm
Implementation of a green infrastructure program in a municipality includes retrofit of impervious areas in streets, parking lots and other public property with the LID measures discussed in this C.3 Technical Guidance. Green infrastructure also includes urban forestry, gardens, parks and other places of vegetation that have purposes and benefits other than stormwater management.

In the San Francisco Bay Area, green streets most often use bioretention facilities to “slow, spread and sink” roadway runoff removing pollutants before the typical release back into the storm drain system via an underdrain. Stormwater curb extensions, sidewalk flow-through planters and tree filters are the most common types of BMPs used (see Attachment M-1 for ACCWP’s Example GI Typical Details). Green streets also provide other eco-system services, such as habitat and temperature moderation, to the streetscape. Guidance from the City of Portland, Oregon describes their function in this way:

“Green streets transform impervious street surfaces into landscaped green spaces that capture stormwater runoff and let water soak into the ground as plants and soil filter pollutants. Green Streets convert stormwater from a waste directed into a pipe, to a resource that replenishes groundwater supplies. They also create attractive streetscapes and urban green spaces, provide natural habitat, and help connect neighborhoods, schools, parks, and business districts.”

Green street design elements such as stormwater curb extensions can be integrated with bicycle and pedestrian projects to achieve multiple benefits such as traffic calming and increased safety, which can lead to more active transportation and better community health.

M.2 Green Street Pilot Projects Summary Report

The previous Municipal Regional Stormwater NPDES Permit (MRP, Order No. R2-2009-0074) included a requirement that ten green street projects be completed by the permittees during the permit term and that a report summarizing the results of the projects be submitted to the Water Board by September 15, 2013. The report, entitled “Green Street Pilot Projects Summary Report”, describes the ten projects that were substantially completed, and an additional ten projects that were in varying stages of planning and design. Of the twenty projects described in the report, seven are in Alameda County. The report concluded that:

“Implementation of green streets (or “green infrastructure”) can best be furthered not through permit provisions requiring development of green streets, but rather by facilitating grant funding, providing appropriate incentives in related sections of permits, and perhaps most importantly, working collaboratively with Permittees, transportation agencies, and state and federal agencies that provide water quality-related funding to better integrate green street objectives with transportation programs. Green street projects are most likely to occur in situations where a transportation project is already planned. Trying to acquire supplemental funding for green street features through grant solicitations that are not in sync with transportation funding programs and calendars is extremely challenging, at best.”

Lessons learned from the completed projects include the following:

2 www.portlandoregon.gov/bes/article/209685
Siting of treatment areas in streets is difficult due to limited space in the right-of-way and utility conflicts;

Sizing treatment systems can be challenging with hard-to-define catchment areas;

Curb cut design needs careful attention so that significant bypass does not occur;

Strreets with low cross slopes allow for more effective treatment area;

Monitoring of the facility should be considered during the design phase so that the appropriate infrastructure can be built;

Outreach to residents and property owners in the project area is effective not only for obtaining approval, but also for education, understanding concerns, and receiving feedback;

A maintenance period following construction should be incorporated into the schedule.

M.3 Green Street Projects in Alameda County

Member agencies of the Alameda Countywide Clean Water Program are leaders in green streets development and implementation. With projects completed or in process in Albany, Berkeley, Emeryville, Fremont, Livermore, Oakland, Union City and Unincorporated County, green streets are becoming a common sight. Union City alone has over $6 million in Proposition 84 grant funding slated for two green streets projects.

<table>
<thead>
<tr>
<th>Project Name</th>
<th>Jurisdiction</th>
<th>Street</th>
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<tbody>
<tr>
<td>Cordonices Creek Restoration Project</td>
<td>Albany/Berkeley</td>
<td>6th &amp; 8th Str.</td>
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<tr>
<td>Stanley Blvd Safety &amp; Landscape Improvement</td>
<td>Unincorporated Alameda County</td>
<td>Stanley Blvd.</td>
</tr>
<tr>
<td>Derby Street Stormwater Curb Extension</td>
<td>Berkeley</td>
<td>Derby Street</td>
</tr>
<tr>
<td>Park &amp; Hollis Stormwater Curb Extension</td>
<td>Emeryville</td>
<td>Park Avenue</td>
</tr>
<tr>
<td>Green Street Tree Filter</td>
<td>Fremont</td>
<td>Various</td>
</tr>
<tr>
<td>Residential Green Street Bioswales</td>
<td>Livermore</td>
<td>Various</td>
</tr>
<tr>
<td>Broadway &amp; Keith Avenues Bike Safety Project</td>
<td>Oakland</td>
<td>Broadway Ave</td>
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<tr>
<td>Decoto Green Streets Projects</td>
<td>Union City</td>
<td>C St., H St., other streets</td>
</tr>
<tr>
<td>San Pablo Avenue Stormwater Spine</td>
<td>Albany, Berkeley, Emeryville, Oakland</td>
<td>San Pablo Ave.</td>
</tr>
</tbody>
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M.4 Resources

There are many excellent resources for Green Street planning, design, construction and maintenance. Some are listed below:

- San Mateo County - Sustainable Green Streets and Parking Lots Design Guidebook
  flowstobay.org/greens
treets

- Portland - Stormwater Manual (see Green Streets Details section)
  www.portlandoregon.gov/bes/64040

- Los Angeles County - Model Design Manual for Living Streets
  www.modelstreetdesignmanual.com

- Seattle - Right of Way Improvements Manual
  www.seattle.gov/transportation/rowmanual/manual/6_2.asp

- Washington D.C. - Green Infrastructure Standards
  ddot.dc.gov/node/818592

- San Francisco - Better Streets Plan
  www.sfbetterstreets.org/

- Boston - Complete Streets Manual
  bostoncompletestreets.org/

- Philadelphia - Green Streets Design Manual
  www.phillywatersheds.org/what_were_doing/gsdm

- City of San Mateo Green Streets Manual
  www.cityofsanmateo.org/2738/Plans-and-Policies
Attachment M-1

Example Typical Details

The Alameda Countywide Clean Water Program’s Example Typical Details for designing green infrastructure facilities for projects located in the street right of way are listed below and provided on the following pages. Please note that the use of these details is subject to local jurisdiction approval.

<table>
<thead>
<tr>
<th>Sheet No.</th>
<th>Title of Drawing/Standard Specifications</th>
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<tbody>
<tr>
<td>GI-2A</td>
<td>Bioretention Area: Plan view with street parking</td>
</tr>
<tr>
<td>GI-2B</td>
<td>Bioretention Area: Bulbout plan view</td>
</tr>
<tr>
<td>GI-2C</td>
<td>Bioretention Area: Street Median</td>
</tr>
<tr>
<td>GI-3A</td>
<td>Bioretention Area: Sloped Sides Cross Section</td>
</tr>
<tr>
<td>GI-3B</td>
<td>Bioretention Area: Vertical Side Wall Cross Section</td>
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<tr>
<td>GI-4</td>
<td>Bioretention Components: Outlet Detail</td>
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<td>GI-5</td>
<td>Bioretention Components: Edge Treatment Detail</td>
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<td>GI-6A</td>
<td>Bioretention Components: Gutter Curb Cut Inlet Detail</td>
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<tr>
<td>GI-6B</td>
<td>Bioretention Components: Trench Drain Curb Cut Inlet Detail</td>
</tr>
<tr>
<td>GI-6C</td>
<td>Bioretention Components: Curb Cut At Bulbou Inlet Detail</td>
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<tr>
<td>GI-7</td>
<td>Bioretention Components: Check Dam Detail</td>
</tr>
<tr>
<td>GI-8</td>
<td>Bioretention Area: With Bike Lane Plan View</td>
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</tbody>
</table>
The American Recovery and Reinvestment Act (ARRA), Green Reserve of 2009, provides funding for a wide variety of qualifying projects in the categories of: green infrastructure, energy efficiency, water efficiency, and other innovative projects. For more information on ARRA, to find out if your current or future planned project meets the necessary criteria, and how to apply, visit www.Recovery.gov.

Green Streets

A Green Street is a street that uses natural processes to manage stormwater runoff at its source.

Green Street designs provide better environmental performance while creating attractive, safer environments.

Streets comprise a significant percentage of publicly owned land in most communities, and thus offer a unique opportunity to manage for environmental outcomes. A Green Street uses a natural systems approach to reduce stormwater flow, improve water quality, reduce urban heating, enhance pedestrian safety, reduce carbon footprints, and beautify neighborhoods. Through various combinations of plants and soils, these objectives—and several others—can be met on different types of streets in many settings. Green Street features include vegetated curb extensions, sidewalk planters, landscaped medians, vegetated swales, permeable paving, and street trees. This guide provides an overview of different strategies that can be employed in transportation rights-of-way at the local or neighborhood scale.
Residential streets offer the greatest potential for building Green Streets in new neighborhoods or retrofitting existing streets because the streets are typically slower, less trafficked, and likely to already have some landscape elements.

These days, it is fairly common for homes to have rain gardens incorporated into their landscaping to collect and store stormwater runoff from rooftops, driveways, and patios. “Rain garden” is the general term used to describe stormwater strategies that use plants and soils to filter, absorb, and slow rainwater on the landscape surface.

Similar types of rain gardens can take various forms within the street right-of-way itself—the edges of the street can be built to allow stormwater to flow into a landscape area, or space within the paved area of the street can be converted to landscape, increasing permeability. Additionally, permeable paving that is durable, load-bearing, and built with an underlying reservoir can temporarily store water prior to infiltration.

In new construction situations, Green Streets can be designed to handle significant volumes of water. In retrofit situations, they can typically handle all of the rain from small storms, while excess water from large storms can overflow into existing storm sewer systems.

Rain gardens are beautiful landscape features that naturally filter runoff and require less maintenance than turf grass.

STORMWATER CURB EXTENSIONS

Conventional curb extensions (also known as curb bulb outs, chokers, or chicanes) have been used for decades to enhance pedestrian safety and help in traffic calming.

A stormwater curb extension simply incorporates a rain garden into which runoff flows.
PERMEABLE PAVING

Permeable paving (pavers, or porous asphalt and pervious concrete) in the parking lane converts impervious surfaces to allow stormwater to absorb into the ground, which reduces the amount of runoff without any loss of parking on the street.

The aesthetics of permeable paving can also give the illusion of a narrower street and therefore help calm traffic.

VEGETATED SWALES

Swales are long, shallow vegetated depressions, with a slight longitudinal slope. As water flows through the swale, it is slowed by the interaction with plants and soil, allowing sediments and pollutants to settle out. Water soaks into the soil and is taken up by plants, and may infiltrate further into the ground if the soil is well-drained.
Commercial streets in most urban areas need to accommodate a wide range of users and uses including pedestrians, drivers, bikers, transit riders, on-street parking, outdoor seating, lighting, trees, etc. Because of all these demands, finding space to collect and manage stormwater can at first appear challenging. There are, however, several design options that towns and cities can consider when integrating stormwater management into even their most active streets.

The key is thinking creatively in finding space that can accommodate multiple purposes in one space, such as a street tree pit designed to collect runoff, or the curb extensions (also known as “pedestrian bulb outs”) at the corners designed to reducing crossing distances for pedestrians that can also contain a rain garden. These design options are more easily accommodated in new streets where the location of underground utilities is considered from the start. More strategic design is necessary for streets with existing utilities. The pay-off of these efforts, though, is a more attractive, walkable street that considerably reduces polluted runoff.

A community’s identity is often most evident on its commercial streets. Green Street techniques not only achieve environmental goals but can greatly improve the look and feel of a community.

**STORMWATER PLANTERS**

Planters are long, narrow landscaped areas with vertical walls and flat bottoms, typically open to the underlying soil. They allow for more storage volume than a swale in less space.

Water flows into the planter, absorbs into the plants and topsoil, fills to a predetermined level, and then, if necessary, overflows into a storm sewer system. If desired, planters can accommodate street trees.
**STORMWATER CURB EXTENSIONS**

Stormwater curb extensions on commercial streets are similar to those on residential streets. They are rain gardens typically located near the corners that can also provide the pedestrian with a more comfortable crossing.

Curb extensions can also be located mid-block by converting one or more parking spaces.

**PERMEABLE PAVING**

Permeable paving on commercial streets can be incorporated into sidewalks and parking lanes.

Recent advances in permeable paving technologies now make many appropriate for higher speeds or where large, heavy vehicles are expected to be parked—areas such as loading zones and bus stops.
Arterial streets in towns and cities are often characterized by wide expanses of pavement, little greenery, and little to address pedestrian needs. Should an arterial street already have landscape areas adjacent to the roadway or within grassy medians, then retrofitting these areas to accommodate rainwater will significantly reduce runoff and help protect water quality.

Where adjacent landscape space does not exist, a process of “road dieting” can be undertaken. This involves determining just how much paved surface is necessary to safely manage travel, and how much can be converted to green space. In addition to managing runoff, this is also an opportunity to retrofit the functionality of arterial streets, making them more “multi-modal” by incorporating sidewalks, on-street bike lanes, or landscape-separated bike greenways.

Again, as with residential and commercial streets, though it is easier to plan and design all of these uses into a roadway from the beginning, most arterials present opportunities to incorporate Green Street features, and can be highly successful.
In many towns and cities, alleys comprise a significant amount of impervious surface and are sometimes prone to flooding because they are often not connected to the sewer system. Green Street techniques like vegetated swales and permeable paving effectively reduce and treat runoff, alleviate flooding, and are far less expensive than installing connections to sewers.

**PERMEABLE PAVING**

Alleys are typically low-speed and low-trafficked streets and therefore suitable locations for using permeable paving. The entire surface could be permeable, or if heavier vehicles are anticipated for loading and unloading, or the alley is "reversed crowned" (sloping toward the center line), then only the middle section needs to be permeable.

**VEGETATED SWALES**

If the alley is crowned in such a way that water flows to the side, then stormwater can be accommodated by simply greening edges of the alley with swales and planters. If necessary, water can flow through pipes or covered trenches to allow vehicle access to garages and driveways.

Illustrations and photographs used in this brochure are from the EPA publication *Stormwater Management Handbook—Implementing Green Infrastructure in Northern Kentucky Communities* and were created by Nevue Nagan Associates of Portland, Oregon.

This handbook, as well as other valuable resources, are available at both [www.epa.gov/smartgrowth](http://www.epa.gov/smartgrowth) and [www.epa.gov/greeninfrastructure](http://www.epa.gov/greeninfrastructure).