Stormwater Best Management Practice

Street Design and Patterns

Minimum Measure: Post Construction Stormwater Management in New Development and Redevelopment
Subcategory: Innovative BMPs for Site Plans

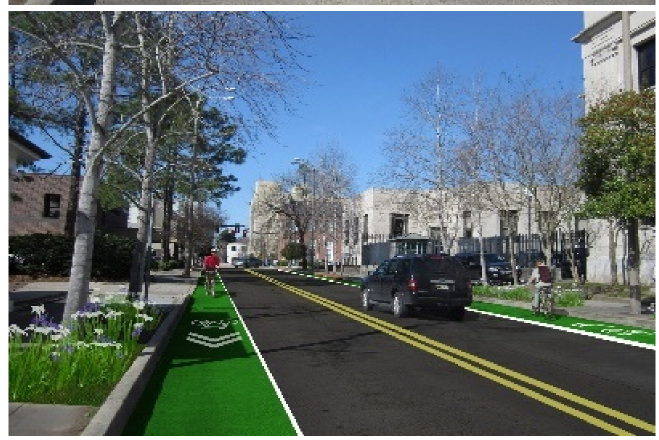
Description

Streets make up a third or more of all land and half of impervious surface in many cities (NACTO, 2017). Traditionally, they collect and convey stormwater directly into storm sewer systems that lead to nearby waterways. As such, they present both a barrier to natural hydrology and an opportunity for municipalities to improve stormwater management. Streets that capture and infiltrate stormwater back into the urban ecosystem can generate ecological, economic and public health benefits.

The design of an individual street (e.g., cross-sectional layout, length, intended use) and the layout of a network of streets in a community both impact stormwater because they affect the total amount of impervious surface, neighborhood connectivity and overall development patterns in a region. Streets that follow a "smart growth" approach are well connected, support multiple transportation modes and provide a range of community benefits—from stormwater management to greenhouse gas reduction and enhanced livability.

Alternative street design resources:

- Institute of Transportation Engineers' list of Complete Streets Resources
- Federal Highway Administration's Eco-Logical Annual Reports
- Strategic Highway Research Program 2
- EPA's Smart Growth and Transportation Web site



Artistic rendering of a street redesign to include narrower lanes, bike lanes, and planters.
Credit: Photo by Spackman Mossop Michaels on USEPA's Flickr

Applicability

Conventional street layouts tend to follow a hierarchy. Many smaller roads, serving residential areas, feed into larger roads and arterials; these in turn funnel traffic onto regional roads and highways. This funneling of traffic creates congested chokepoints, with few (if any) alternative routes from place to place. This system was a result of a highly separated and dispersed land use system (e.g., sprawling suburban residential areas surrounding concentrated urban economic and cultural centers).

A connected street system does not need to be a formal grid of streets. Often, links among activity centers (e.g., schools, jobs) define the connections as much as the street layout. Many local governments and states are realizing the need for better-connected, multimodal street networks. As municipalities develop regional master plans or capital improvement plans, municipal leaders should identify all available opportunities to redesign streets following smart growth practices, including addressing stormwater management at the forefront. States should enact policies that support a connected streets approach so that new residential or mixed-use development projects have more than one connection to neighboring retail, commercial or transportation centers. Urban areas can add streets around transportation hubs to enhance circulation and multimodal connections. Examples of policies include New Jersey's Future in Transportation program and Virginia's Secondary Street Acceptance Requirements.

Smart growth street designs support more intense development on a smaller footprint. These designs can help make streets safer and more inviting for pedestrians, bicyclists, transit users and drivers while also incorporating stormwater management. A smart growth street layout can result in less impervious coverage and reduce sprawl. In addition, concentrating growth and development in certain parts of the watershed can help protect more sensitive areas, such as headwaters. To the extent that street designs can reduce vehicular traffic, running vehicles will sit for shorter periods, releasing less pollutants onto the road surface for stormwater to pick up.

Siting and Design Considerations

Standard road design practice has been to design post-construction stormwater controls after already designing the roadway. This not only limits options, but often focuses attention on end-of-pipe treatment controls rather than in-line measures or preventive measures, which are generally less expensive to build and maintain and more effective at protecting water quality. For new development or redevelopment of any part of a transportation system, stormwater management features should be an integral part of the design, not add-on features. EPA's Green Streets handbook and Green Streets resources provide guidance on how to implement such a holistic approach. The complete Green Streets concept is to make streets functional and safe for all users (i.e., pedestrians, bicyclists, vehicles and users of public transportation).

Another approach, context sensitive solutions and design, uses a collaborative, interdisciplinary decision-making and design approach involving all stakeholders. Designing streets to meet or exceed transportation, environmental and stakeholder needs will create lasting value to the community. (The Federal Highway Administration, which created this approach, offers several case studies at the site linked above.)

Street Design in New Projects

For new projects, smart growth street designs are typically part of an overall site design that seeks to meet transportation, economic and multimodal objectives. Though one set standard does not exist, street designs should meet the following objectives:

- Support mixed uses.
- Develop green parking plans to optimize the number of spaces and layout for multimodal connections.
- Incorporate features such as boulevard islands, rotary islands, parking lot islands, alternative turnarounds, right-sized streets, grassed swales, sidewalk trees and groundcover planters that capture, filter and infiltrate stormwater. Planners often already incorporate these features as aesthetic amenities and for traffic-calming purposes; they can also manage stormwater.
- Integrate sidewalks, crosswalks and traffic-calming approaches to support bicycling, walking and automobile traffic.
- Design streets with shorter block lengths.
- Engineer right-sized streets to facilitate pedestrian crossings and moderate automobile speed while meeting the needs of emergency responders.
- Provide access lanes, on-street parking and turning lanes to complement the land development design, sidewalks and building setbacks.

Additionally, EPA provides guidance for communities in two *Essential Smart Growth Fixes* documents, covering rural and urban planning, zoning and development codes. These guides cover topics such as right-sizing streets, density planning, parking and fostering walkability.

Modification of Existing Streets

Where possible, a street retrofit should take advantage of opportunities to improve the drainage system or add structural and non-structural stormwater controls to reduce the flow of stormwater or filter pollutants. This will require a new approach to street repair and retrofits. Departments of public works and stormwater engineers should consult with land use planners and site designers to find ways to reduce volume and treat stormwater before entering the public conveyance system. Organizations like the *Clean Water America Alliance* and the University of Wisconsin's *Sea Grant Program* provide guidance on how to reinvent design code to include green infrastructure.

Local governments can use several methods to incorporate smart growth features and stormwater benefits into existing streets. Some of these strategies include:

- Connecting disconnected streets, lanes and cul-de-sacs.
- Adding paths to link housing and other uses in areas where a new street is impossible.
- Converting unused streetscapes into green parking or using them to introduce bike lanes.
- Replacing traditional curbs and gutters with site stormwater design features like tree planters and vegetated bulb-outs.

Limitations

At the regional level, many different agencies control street and road designs. State departments of transportation typically control the design and operations of highways and larger arterial streets, while local governments control smaller streets. Interagency coordination and cooperation is necessary for successful implementation of smart street designs.

Limitations to innovative street designs might also occur within stormwater regulations themselves. Blanket regulations that require land set-asides, mandatory infiltration or swales can create barriers to better site design. For example, sizing requirements for swales might consume land needed for connections to a higher-intensity transit district. To address this limitation, regulators can create incentives for alternative street designs by modifying stormwater management requirements in targeted areas. And, even in densely developed, highly impervious areas, communities can achieve very low stormwater generation rates through reasonable, low-maintenance measures. The following documents provide examples of how various communities have overcome implementation barriers:

- *Implementing Living Streets: Ideas and Opportunities for the City and County of Denver*
- *Green Infrastructure Opportunities and Barriers in the Greater Los Angeles Region*
- *Flexible Design of New Jersey's Main Streets*

Finally, the street system alone will not bring about stormwater benefits. Integration among the street layout, the development plan and existing activity centers is crucial for obtaining stormwater benefits.

Maintenance Considerations

Separate stormwater sewers typically discharge water into receiving bodies with little or no treatment. Thus, maintenance considerations for curb and gutter designs include street sweeping, cleaning catch basins, clearing blocked sewer lines, repairing and replacing failed pipes, and conducting other aspects of buried/hard infrastructure maintenance. Maintenance of aboveground bioretention and bio-infiltration features—such as swales and infiltration trenches—largely entails maintaining established vegetation. Depending on locations and designs, removal of accumulated sediment and debris is also typically necessary. Porous or pervious surface materials generally need little maintenance aside from periodic cleaning with a vacuum truck. In-line and end-of-pipe commercial swirl separators or filter devices need regular clean-out.

In northern climates, storing plowed snow from streets is a major consideration. Narrower streets translate into less on-street snow, though multi-use streets (e.g., with parking on each side and frequent intersections) need advanced planning for snow storage. Like stormwater, snowmelt can carry pollutants and water volume, so techniques to filter pollutants and reduce the velocity of melting snow are also important. Some communities plan storage by designating park areas or infiltration strips to handle and eventually release collected snow from streets.

Communities should inspect all system types regularly to ensure they are functioning properly.

Effectiveness

Smart growth street design can be effective at the street, neighborhood and watershed levels. In addition, smart growth street designs benefit both redevelopment and new development by absorbing development demand on a smaller footprint. Furthermore, less land disturbance during initial construction results in less exposure and risk of sedimentation.

The Atlantic Station redevelopment project in midtown Atlanta, Georgia, is a good example of a project that considered streets, the development plan and stormwater control in an integrated fashion. The 138-acre former steel mill site holds a mix of residential, office and retail space, all designed around better mobility and reduced environmental impact. The site designers used high-density development concepts, separated the combined sewer system serving the site and installed pretreatment controls for stormwater within the site. To assess the regional environmental benefits of the site, the designers considered an alternative “greenfield” (or previously undeveloped land) development scenario that reflected the prevailing development and street patterns of the outlying area. Owing to its smaller footprint than the greenfield scenario, Atlantic Station resulted in fewer vehicle miles traveled, fewer greenhouse gas emissions and substantial reductions in the amount of stormwater discharge generated annually.

Cost Considerations

Cost considerations for implementing alternative street designs and patterns depend on factors that differ for individual projects. The most basic costs to consider are for street construction itself. Alternative street designs and patterns may cost more to build, per unit, than traditional design because they incorporate multiple infrastructure components (e.g., streets, utilities, drainage infrastructure, stormwater controls, green spaces, bike lanes) in a smaller footprint. However, they create benefits for the community by coordinating transportation and environmental planning, which is not possible with traditional design. Planners should take these benefits—including reduced stormwater discharge generation, improved mobility and increased property values—into account when considering the cost-effectiveness of alternative street designs and patterns. The following reports provide resources and a range of case studies to outline those costs and benefits:

- EPA’s *Managing Wet Weather with Green Infrastructure*
- Naturally Resilient Communities’ Green Streets Web page
- EPA’s *Reducing Stormwater Costs through Low Impact Development (LID) Strategies and Practices*

Additional Information

Additional information on related practices and the Phase II MS4 program can be found at EPA’s National Menu of Best Management Practices (BMPs) for Stormwater website

References

National Association of City Transportation Officials (NACTO). (2017). *Urban street stormwater guide*. Island Press.

Disclaimer

This fact sheet is intended to be used for informational purposes only. These examples and references are not intended to be comprehensive and do not preclude the use of other technically sound practices. State or local requirements may apply.