

Sustainable Streets: An Emerging Practice

THIS FEATURE PRESENTS THE CONTRIBUTIONS THAT URBAN STREET DESIGN CAN MAKE TO ACHIEVING SUSTAINABILITY GOALS. THE SUSTAINABLE STREETS PROJECT INTRODUCES THREE FOCUSES OF SUSTAINABLE STREET DESIGN: MOVEMENT, COMMUNITY AND ECOLOGY. EXAMPLES OF NEW AND REDESIGNED STREETS IN SUBURBAN AND HIGH-DENSITY CONTEXTS BUILT AND UNDER CONSTRUCTION ARE DESCRIBED.

BY ELLEN GREENBERG, AICP

FOR WELL OVER A DECADE, street design practice has been responding to changing ideas and values expressed in movements such as thinking beyond the pavement, livable communities and complete streets. The Federal Highway Administration's *Flexibility in Highway Design*, the American Association of State Highway and Transportation Officials' (AASHTO) *Achieving Flexibility in Highway Design* and ITE's *Context Sensitive Solutions in Designing Major Urban Thoroughfares for Walkable Communities: A Proposed Recommended Practice* all reflect these changing values. Together, they emphasize the need to design thoroughfares that respond to a full range of community values while providing mobility and safety for all users.

Now an additional set of priorities is emerging. Increasingly, design professionals—whether engineers, architects, product developers, landscape architects, or city planners—are hearing demands for sustainable and green design. A widely-used definition of sustainable development is “development that meets the needs of the present without compromising the ability of future generations to meet their own needs.”¹

AASHTO's “Transportation Vision and Strategy for the 21st Century” cites this definition and includes the following five goals for achieving sustainable transportation:

- Reduce carbon in the atmosphere and conserve energy.
- Coordinate land use and transportation in support of sustainability objectives.
- Achieve “better than before” outcomes for our communities and the natural environment.

- Apply innovative, sustainable practices in

the development and delivery of transportation projects and services.

- Adopt the triple bottom line as a way of advancing and as a yardstick for evaluating the sustainability of surface transportation system policies and performance.²

How should the broad concept of sustainability and these specific goals for sustainable transportation influence the design of city streets? In a project sponsored by the visiting practitioner program at the University of California at Davis' Sustainable Transportation Center, the author set out to learn how agency staff and street design professionals are responding to these emerging values.

The findings, which are sampled in this feature, provide examples and insight into how sustainable streets are being introduced in different communities and contexts. Based on the responses received as well as a review of relevant literature, the sustainable streets project introduces three aspects of sustainability that can be meaningfully addressed through street design: movement, ecology and community.

These terms are used with the following meanings, with the hope that others will help refine and improve these definitions over time. All of the definitions cover direct and indirect impacts of roadway design:

- **Movement:** the movement of both people and goods by all modes and for all trip purposes and types. Sustainable streets increase the use of least-polluting ways to connect people and goods to their destinations, through greater use of non-polluting and less-polluting modes and reductions in vehicle-miles traveled.
- **Ecology:** the resource value of landscape and natural elements within the right of way as well as the much broader set of ecological processes affected by the movement system supported by the street, such as the air, water and climate impacts of motor vehicle emissions. Sustainable streets protect and enhance natural resources and processes.
- **Community:** social, economic, public health, cultural and aesthetic considerations as well as environmental justice. Consistent with the principles of

context-sensitive solutions, sustainable streets reflect community values and support urban development patterns that reinforce movement goals.

There is considerable overlap among these three focus areas. For example, community and movement goals sometimes are linked directly, in objectives for decreased traffic-related injuries and fatalities. Community and ecology goals also are closely linked, for example, through urban forest, which offers community benefits in the form of place making, as well as environmental benefits.

MOTIVATING CHANGE

Innovations in street design are being spurred by a national regulatory framework that recognizes city streets as pollution sources, motivating change specifically in relation to the ecological dimension of street design.

In particular, the National Pollution Discharge Elimination System (NPDES), under the Clean Water Act, regulates stormwater discharges from municipal storm sewer systems. The NPDES permitting system requires many medium and large cities around the country, as well as certain large independent organizations (including some departments of transportation), to receive permits allowing the discharge of stormwater to surface waters. Those permits require stormwater management plans that establish how the permittee will control stormwater discharges.

Stormwater management plans may specifically identify best management practices to be implemented. These typically include street design strategies sometimes referred to as “green infrastructure” or “high performance infrastructure.”

Just as sustainable street design is an evolving practice, so too are the particulars of stormwater permitting and control. The U.S. Environmental Protection Agency is supporting increased use of green infrastructure as an element of pollution control, as is made clear by the recent publication of the *Managing Wet Weather with Green Infrastructure Action Strategy*.³

SUSTAINABLE STREETS IN PLACE

The 10 projects profiled in this feature were contributed by public agency

Project	City	State	Community	Movement	Ecology
Mobility Plus					
Aurora	Shoreline	WA	+	++	+
Sandy Boulevard	Portland	OR	++	+	++
Pacific Boulevard	Vancouver	BC	++	++	+
Revitalization Plus					
Riverfront Parkway	Chattanooga	TN	++	++	+
First Street	Livermore	CA	++	+	+
Neighborhood Plus					
New Columbia	Portland	OR	++	++	++
Garrison Woods	Calgary	AB	++	++	+
Stormwater Plus					
Holladay Green Street	Gresham	OR	--	--	++
Taylor Avenue	Seattle	WA	++	+	++
Josey Heights	Milwaukee	WI	+	+	++
++ = primary emphasis + = secondary emphasis -- = not an emphasis of the design					

staff, private developers and consulting designers or engineers in response to a call for projects from the sustainable streets project in summer 2007. Approximately 50 projects were submitted, illustrating a wide variety of techniques and approaches. Because most of the projects are newly-implemented, before and after safety and operational performance analysis has not been a focus of the sustainable streets research.

However, capacity, safety and, in some cases, congestion relief were important aspects of the planning processes for several of the projects. Others are on low-volume local streets where community and environmental values were central to the design process. Emergency vehicle access, pedestrian safety and network connectivity typically emerged as important considerations.

Although each of the projects presented here addresses multiple sustainability objectives, the review identified a dominant theme of each. The projects are organized according to these themes, as follows:

- Movement Plus: higher-volume streets (greater than 15,000 average daily traffic) redesigned to meet sustainability goals ranging from im-

proving bike parking to supporting high-density residential infill.

- Neighborhood Plus: two redesigned neighborhoods that seek to foster community values, reduce transportation impacts and preserve natural resources.
- Downtown Revitalization Plus: projects in older communities that are using street design as a tool to spur economic activity and support compact and infill development downtown.
- Stormwater Plus: projects designed with implementation of stormwater management features as a primary design objective.

Table 1 identifies, for each project, the primary and secondary emphasis of the design with respect to the three aspects of sustainable street design.

MOVEMENT PLUS: HIGHER-VOLUME STREETS

Aurora Avenue, Shoreline, WA, USA
(contributor: CH2M Hill)

The redesigned Aurora Avenue offers a model of a large, auto-oriented street that has been retrofitted to be more responsive to the needs of pedestrians, transit riders and bicyclists as well as to improve ecological performance (see Figure 1). This

reconstructed 1.6-kilometer portion of heavily-traveled Washington State Highway 99 features:

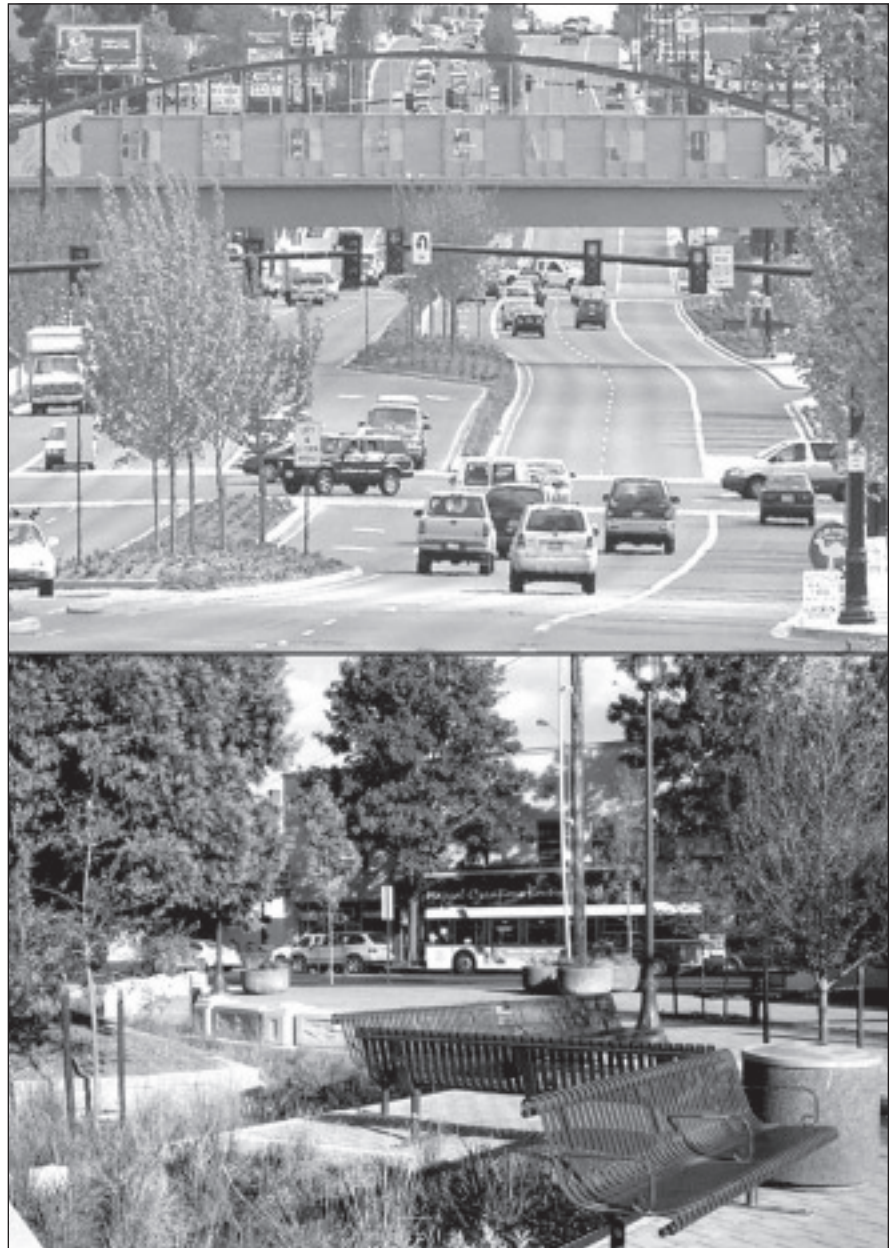
- intersection capacity improvements;
- construction of curb lanes dedicated to business access and bus movement;
- two pedestrian/bicycle bridges;
- sidewalks;
- access management;
- utility under grounding;
- landscaping;
- lighting; and
- stormwater management features.

The context-sensitive solutions process for Aurora Avenue resulted in a list of 32 points for the redesign of the street, which carries an average daily traffic volume of 45,000. These addressed concerns from providing a seven-lane cross section for adequate capacity to access management to public art. The package brings a dramatic change in the street that is in stark contrast to the unimproved segments to the north and south. These improvements—in particular, construction of continuous sidewalk on this heavily-traveled road—are essential facilities for pedestrian safety and accommodation.

Sandy Boulevard, Portland OR, USA
(contributors: City of Portland and Nevuel Nguen Associates)

Sandy Boulevard's redesign started as a streetscape project and expanded to embrace and address a full range of objectives for community, ecology and movement. With a 2007 average daily traffic of almost 30,000 vehicles, Sandy Boulevard is the first example of green street facilities being installed on a high-volume street in Portland, where a number of examples already exist on residential and smaller downtown streets.

The project incorporates five landscaped stormwater treatment areas into the right of way. Infiltration basins and landscaped curb extensions are used, achieving the dual purposes of managing stormwater and strengthening the identity of selected intersections. The city's project manager, Chris Armes, explains that: "The angle of Sandy Boulevard against the city grid provided opportunities to reduce the asphalt paved areas and create sizable vegetated stormwater facilities that also increase pedestrian safety by reducing the crossing distances at intersection."



Source: Tim Bevon

Source: Chris Armes

Figure 1. Mobility Plus projects: Top: A multimodal bridge spans Aurora Boulevard in Shoreline, WA, USA. Bottom: Pedestrian accommodations and a bioswale are shown beside Sandy Boulevard in Portland, OR, USA.

The project includes facilities for bikes, parking and wayfinding, including:

- curb extensions at some transit stops;
- median pedestrian refuges at larger intersections;
- public open spaces with gathering places;
- street trees and benches;
- wayfinding information; and
- custom-designed bike racks (70 new racks were installed).

Intersection reconfigurations also were implemented to eliminate confu-

sion and improve safety. Sandy Boulevard provides valuable examples of how "remnant" right-of-way segments can be put to use for community purposes while maintaining significant roadway capacity and serving ecological functions.

Pacific Boulevard, Vancouver, British Columbia, Canada (contributors: Elizabeth MacDonald and City of Vancouver)

This reconstruction, underway in 2008, is intended to make Pacific Boulevard "one of Vancouver's great streets and a preeminent pedestrian promenade

Source: City of Vancouver Planning Department



Source: Elizabeth Macdonald

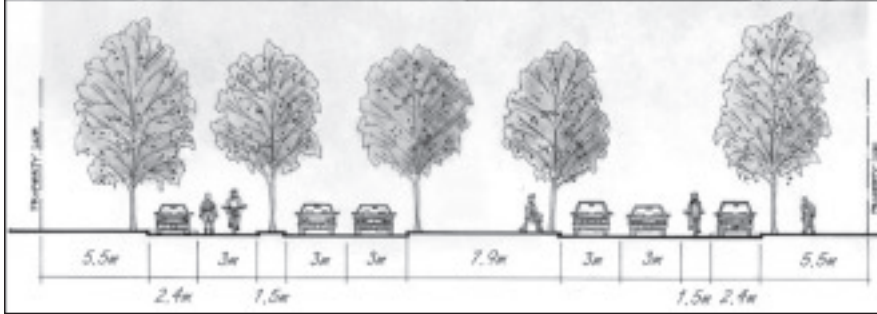


Figure 2. Top: The newly-constructed local access lane on the west side of the street adjoining residential towers on Pacific Boulevard, Vancouver, British Columbia, Canada. **Bottom:** How space is allocated in the one-sided multiway boulevard segment.

- support for pedestrian activity;
- support for compact residential development;
- heat island effect reduction and contribution to the city’s urban forest;
- bike friendly;
- support for transit; and
- stormwater infiltration through the creation of the center medians that are completely permeable.

One technique for making this street friendly for pedestrians and street-fronting land uses is creating wide separation between pedestrians, building entries and moving traffic. In some segments, this is achieved with 5.5-meter-wide sidewalks and a 4-meter shared parking and bike lane. In others, an asymmetrical design features on one side a 5.5-meter-wide side access zone adjoining a sidewalk of equal width, which allows for curbside parking and a slow-moving local access lane. Separating the shared use local access lane from two through lanes is a 1.5-meter-wide side “median” (see Figure 2).

The wide street is softened by a 6-meter-wide center median, which serves as a pedestrian refuge and can accommodate a future streetcar or waiting areas for streetcars running on inside travel lanes. The median narrows to accommodate a turning lane at intersections.

Studies conducted by the City of Vancouver prior to approving the designs indicated that capacity on the redesigned streets would be adequate through a 2021 design year and that delays would be reduced with the redesign, in part because reducing crossing distances allows for retiming signals to provide more green time for Pacific Boulevard traffic.

The project is particularly notable because it demonstrates true context-sensitive design, with variations in the cross section reflecting surrounding land uses and design character, multimodal travel demand and operational considerations. Project designers Elizabeth MacDonald and Alan Jacobs explained in a 2002 memorandum that the redesigned street will be a moderately paced public right of way that “becomes an extension of the waterfront parkway circulation system to the northwest, that in some places is wider than at present in order to better accommodate cyclists and pedestrians and is tighter at other

Source: Tony Durett, Canada Lands Company



Source: Nancy McInelly

Figure 3. Neighborhood Plus projects: Left side: An aerial view shows a park and pedestrian-way at Garrison Woods in Calgary, Alberta, Canada. Right side: A pocket swale allows for natural drainage along a street in New Columbia in Portland, OR, USA.

for downtown residents, workers and visitors.”⁴ This project stands out for its very high-density development context. Pacific Boulevard applies a number of design innovations while using time-honored methods to create a beautiful and green urban street including generous sidewalks and a wide median, both planted with

closely-spaced trees. The new boulevard design will both unify and identify the redeveloped False Creek neighborhood, one of several new high-density residential districts on former industrial land near downtown Vancouver.

Sustainability features in the project include:

places where it is currently too wide, and that caters to local neighborhood uses as well as through movement uses.”⁵

NEIGHBORHOOD PLUS (SEE FIGURE 3)

New Columbia (contributor: SERA/Urbsworks)

New Columbia, a Hope VI project initiated by the Housing Authority of Portland (HAP), transformed a 33-hectare public housing site into a mixed-use, mixed-income community. The primary objective of the redevelopment was to reduce the concentration of poverty by building a neighborhood of varied housing types for residents of different income levels. A secondary objective was to redevelop the site in the most sustainable way possible.

Features of the street plan include:

- a high degree of internal and external street network connectivity;
- multimodal design: a fine-grained pedestrian network including narrow streets, alleys and mid-block pedestrian pathways;
- sustainable stormwater management (bioswales, permeable paving in parking areas, park strips and alleys);
- high-frequency transit route incorporated into the site (with pedestrian linkages);
- safe routes to school model project; and
- tree preservation.

New Columbia illustrates a comprehensive approach to neighborhood design, addressing community, ecology and movement. The multimodal movement network and the inclusion of an elementary school and other uses deliver convenience and the possibility of reducing vehicle trips and trip length. The fact that these features are integrated into a project primarily focused on the reduction of concentrated poverty makes it an important and instructive example.

Garrison Woods, Calgary, Alberta, Canada (contributor: Tony Druett, Canada Lands Company)

Garrison Woods, a 66.7-hectare former army base within the inner ring suburbs of downtown Calgary, has been redeveloped for compact residential and mixed-use development. Key aspects of the plan are a tripling of residential density from 600 to 1,800 units, greater street connectivity and customized design of all streets. An example of customized design in the project is provided by Somme Boulevard, which has a central median designed and sized to preserve mature trees. While many streets in Garrison Woods have planted park strips, in this case the median substitutes for a park strip and offers a central walking path and benches.

Tony Druett of Canada Lands Corporation explains the customized approach

to design standards that was used in the project, noting that “most communities across Canada have design ‘standards’ which are specified to be followed by developers operating in those communities. The end result has been that suburban development has become very ‘standardized.’” Druett cites negative results as including over-design of roadways and other public infrastructure, lack of attention to aesthetics and single-issue solutions rather than creative solutions. The answer, says Druett, is to “ignore suburban standards, and to customize the design of all elements of the development to meet the requirements of each individual situation.”

Garrison Woods embodies a number of smart growth principles, from sensitive tripling of density in an inner-ring suburb to preservation of heritage trees in park strips, medians and private yards. The project also illustrates how a site’s history can be celebrated and used to enhance the community identity of a contemporary infill project—in this case, through emphasis on the military history of the property and of Canada as a whole.

DOWNTOWN REVITALIZATION PLUS

Riverfront Parkway and Downtown Streets, Chattanooga, TN, USA (contributors: City of Chattanooga and River City Company)

Supporting compact development and re-use was the overarching objective of this major civic and business effort to revitalize downtown Chattanooga using street design as a key element. This project dismissed conventional ideas about mobility “solutions” in favor of choices that were more responsive to natural and community context.

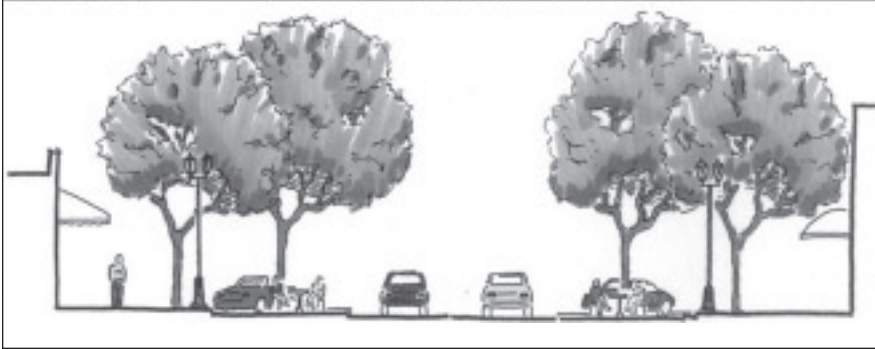
The centerpiece of the project is the reconstruction and realignment of a five-lane limited access highway as a two-lane surface street with lower posted speed, on-street parking, crosswalks and a 4-meter-wide riverfront esplanade (see Figure 4). The reconstructed roadway carries about 19,000 vehicles per day. Realignment of the roadway created new downtown housing sites. The project also included conversion of two one-way pairs of downtown streets to four two-way streets.

City staff describe the transformation and the transferability of Riverfront Parkway: “Before it felt like a highway, and



Source: River City Company

Figure 4. This construction photo shows the narrowing of the travelway and initial installation of one-sided on-street parking, walkways and street trees on Riverfront Parkway, Chattanooga, TN, USA.



Source: Freedman Tung & Bottomley

Figure 5. Top: The narrowed street and new “flexible zone” on First Street in Livermore, CA, USA. Bottom: The 5.2-meter wide sidewalk adjoins the 5.3-meter flexible zone. Each through lane is 3 meters wide.



Source: © Mithun

Source: Conservation Design Forum www.cdfinc.com

Source: Steve Fancher

Figure 6. Stormwater Plus projects: Left side: Model of Taylor Way and Taylor 28, Seattle, WA, USA. Upper right: Jolley Heights, Milwaukee, WI, USA. Lower right: Holladay Green Street, Gresham, OR, USA.

now feels like a road through a park. The example offers good transferability too, because other cities do have those ugly highways along the riverfront and the ocean-front.”

First Street, Livermore, CA, USA
(contributor: Freedman, Tung & Bottomley)

The 2006 transformation of First Street, Livermore’s downtown main street and former four-lane California State Highway 84, was essential in remaking it from an auto-dominated arterial into a slow-speed downtown spine. The project required the relinquishment of First Street from the state highway system and designation of an alternate route, a change that had been long-contemplated and was finalized during the course of a comprehensive downtown planning process. The streetscape was a “catalyst project” recommended by Livermore’s 2004 Downtown Specific Plan, which envisions a compact, livable town center and a revitalized downtown.⁶ The streetscape project works hand-in-hand with a new development code.

The redesigned First Street is particularly innovative in its flexible allocation of right-of-way space and in the construction of architectural objects (trellises) within the curb-to-curb space (Figure 5). Urban designer Greg Tung explains how designs like this support sustainability objectives at the regional scale: “Wild and agricultural land conservation is made possible when built-out urban environments and places are densely and multiply used, made highly livable and human-scaled, and are vital places to be. In particular, opportunities can be found on most existing urban streets to re-allocate space from cars to people.”

Reduction from four to two through lanes allowed the creation of 3.55-meter-wide flexible zones, paved to match the sidewalks and connected by two steps rather than a vertical curb. Spaces in the flexible zone can be used by sidewalk cafes operated by adjoining restaurants, while most of the zone is used for curbside parking to support ground floor shops. Slow speeds are an essential part of making this street successful as a gathering place as well as a thoroughfare, with a flexible use of space that is in sharp contrast to the strict separation of users that characterizes typical designs.

STORMWATER PLUS

Taylor Avenue/Taylor 28, Seattle, WA, USA (contributor: Mithun)

Redesign and reconstruction of Taylor Way is part of a mixed-use development project in Seattle's Denny Triangle area. The project, under construction in 2008, includes both green infrastructure components in the right of way and green building techniques. These multiple strategies together unify the ecological functioning of the public way and the abutting private buildings (see Figure 6).

The streetscape's natural functions are addressed through rainwater management, restoring urban tree canopy and fostering urban wildlife habitat. Prior to redesign, the street had a 17-meter-wide travel way with two 5.5-meter sidewalks. The project reclaims approximately 6 feet of the roadway as public realm for both livability and ecological functions. This strategy is of particular interest because conversion of curbside parallel parking spaces to angle parking is a frequent "solution" to overly wide streets. In contrast, this project re-establishes parallel parking, thereby creating a generously-dimensioned area that can support social interaction and quiet enjoyment as well as natural processes.

Holladay Green Street, Gresham, OR (contributor: City of Gresham)

This project combines a deliberate learning exercise with implemented stormwater management techniques on a three-block segment of a local street. Three rain gardens were constructed and a standard asphalt parking lane replaced with porous asphalt that intercepts stormwater runoff and filters it through topsoil prior to infiltration into native soils.

Gresham City staff offer the following perspective: "We can learn by experience which design 1) is more cost effective (short and long-term), 2) better protects the environment and 3) is more desired by the neighborhood citizens. The design factors that make this street more sustainable than standard streets are applicable to either new construction or for retrofitting existing streets."

Josey Heights, Milwaukee, WI, USA (contributor: Conservation Design Forum)

Integrating sustainable stormwater

management with affordable housing is a goal of the Josey Heights Development under construction in Milwaukee. Project designers, the developer and the city worked together to design a neighborhood that features an integrated stormwater system and moderate-income custom manufactured housing. When completed, this infill project will include 37 single-family and 14 townhome units. Functioning together as an integrated unit, the management practices are designed to infiltrate, convey and store rainwater runoff on site. Water storage to meet the city release rate requirements is located in gravel storage trenches under the permeable paving, biofiltration rain gardens and bioswales within the street and alley rights of way, and along lot lines. These stormwater management techniques eliminated the need for surface detention, allowing for additional residential lots.

CONCLUSION AND ADDITIONAL INFORMATION

The projects presented here and the many others documented by the sustainable streets project are innovations in practice that can serve as examples and inspiration as the practice of street design increasingly embraces sustainability goals. Performance data regarding safety and operational experience will be of particular interest as these projects mature. Readers interested in additional information about the projects highlighted here or in documentation of additional projects can visit stc.ucdavis.edu/.

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References

1. *Our Common Future, Report of the World Commission on Environment and Development*. World Commission on Environment and Development, 1987. Published as Annex to General Assembly document A/42/427, *Development and International Co-operation: Environment*, August 2, 1987.
2. American Association of State Highway and Transportation Officials Sustainable Transportation Panel, Transportation Vision and Strategy for the 21st Century Summit, "Sustainable Transportation for America," March 1-2, 2007.
3. *Managing Wet Weather with Green Infrastructure Action Strategy*. Washington, DC, USA: U.S. Environmental Protection Agency, January 2008. Accessible via www.epa.gov/npdes/pubs/gi_action_strategy.pdf.
4. Gordon, M. *Policy Report: Urban Infrastructure*. Report to Vancouver City Council, Vancouver, British Columbia, Canada, April 23, 2002.
5. Jacobs, A. and E. Macdonald. "Appendix 4: Memorandum from Cityworks" in Gordon, M. *Policy Report: Urban Infrastructure*. Report to Vancouver City Council, Vancouver, April 23, 2002.
6. *Downtown Specific Plan*. Livermore, CA, USA: City of Livermore, February 2004. Accessible via www.ci.livermore.ca.us/dsp/dsp.html.



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