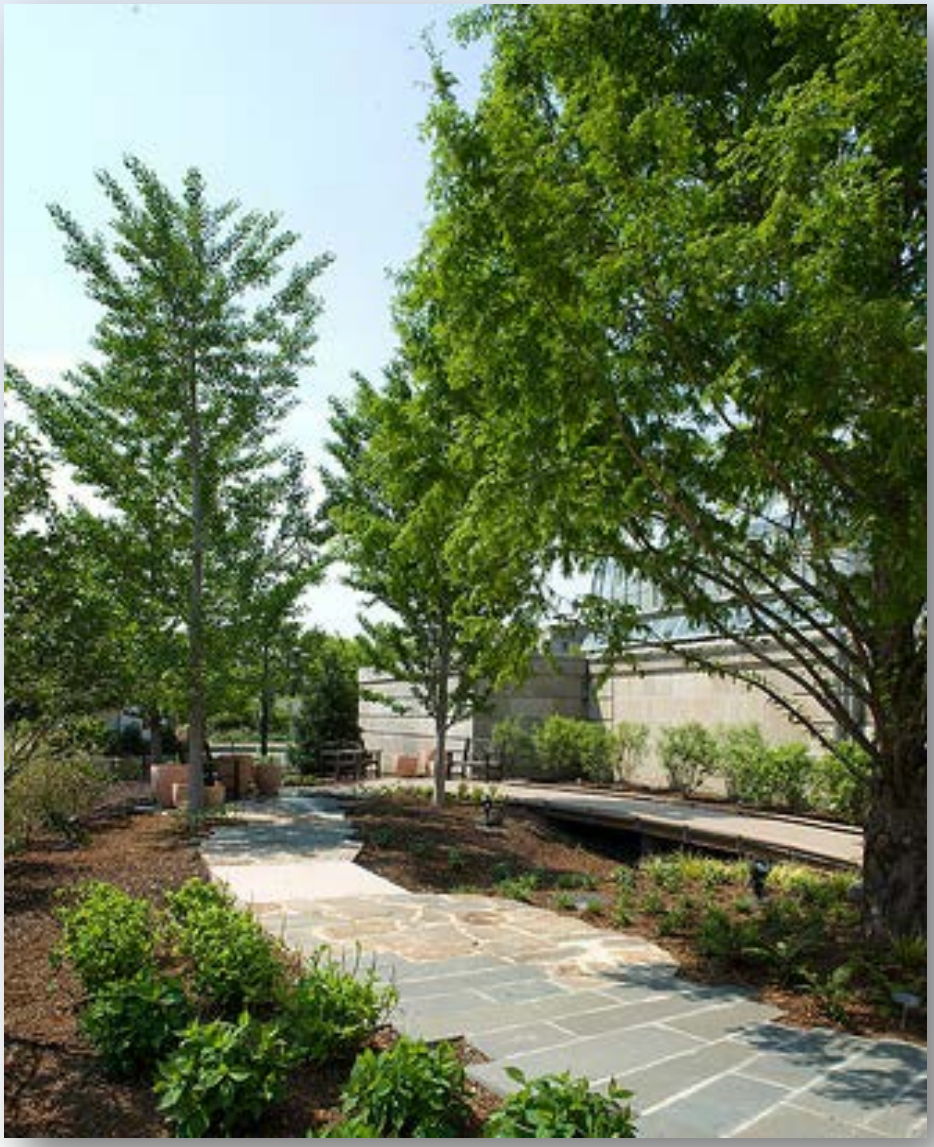
Tool-Box Approach to Wet Growth

Module 3

Green Infrastructure



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Cover: Pocket park. (Photo: U. S. Capital)

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Introduction to Green Infrastructure

As cities and urban areas continue to grow, an increasing amount of stress is placed on the environments that support them. This is a factor often over looked, however green infrastructure is an extremely important part of urban development. According to the Center for Land Use and Environmental Responsibility at the University of Louisville, green infrastructure refers to "natural and engineered ecological systems that act as living infrastructure through a variety of techniques, approaches, technologies and practices." (Arnold, Norton and Wallen, 2009).

(Photo: U.S. Department of Agriculture, National Resources Conservation Services)

One of the major functions of green infrastructure is to reduce and manage storm water runoff. Storm water management can be done in a number of different fashions. Parks, green space, and trees may be introduced, impervious surfaces may be replaced by surfaces, green roofs, rain gardens, bio-swales and pocket wetlands can all be constructed. There are many different ways to incorporate green infrastructure and storm water management. Local governments need to plan ahead to properly prepare for these improvements in order to successfully implement them. Once green infrastructure has taken root there are numerous benefits for the community. The following section illustrates different forms of green infrastructure while highlighting what local governments should know and do to successfully promote sustainability in their communities.

Planning Goals

Each community needs to have a specific set of goals in mind before they begin to undertake the challenge to integrate green infrastructure into their already established community. Goals help maintain structure and focus during the planning process.

Examples

1. Charlottesville, VA, created a chapter in their 2007 comprehensive plan that included a chapter on the environmental impacts and methods they used to soften the impacts that their development created.

2. Erwin, NY, created an amendment to their comprehensive plan that stated the goals and processes they planned to use in the implementation of several green infrastructure undertakings.
3. McHenry County, IL, created green infrastructure network maps and trail maps to depict to the public how the new infrastructure would affect the county.
4. Nashville, TN, created a Green Infrastructure Master Plan that went into extreme detail explaining the necessity of green infrastructure, the ways it was implemented, and an analysis of the results.

Public Education and Input

When making changes that will affect the public, it is important to allow the public to either have a say in or be able to observe and understand the entire process. Important factors to note are:

1. Each community is different and the various implementations of green infrastructure in a community need to address the specific goals each community is trying to achieve. For example, if a community greatly values its water and its sources, then the community needs to focus on protecting and promoting the water and water sources. One major mistake a community can make is being too broad when tackling green infrastructure issues.
2. Research needs to be done on the implementation of these same ideas in similar areas. While no two communities are exactly alike, it is possible for two communities to be faced with the same problems. By seeing how another community tackled the same issue, a lot time could be saved
3. Research needs to be done on the areas to be affected by the planned new infrastructure. Each community needs to insure that they protect all their assets from unnecessary risks.
4. The new infrastructure needs to be mapped and strategies for implementation need to be included in the community's comprehensive plan.

The Green Infrastructure Center offers methods and tools on their web site on engaging the public (both on an individual and community level) in green infrastructure planning.

Challenges

Because it ultimately involves changing much of how the city uses and manages its resources, implementing a green infrastructure project is not without its many difficulties. The fear of an unattainable cost and performance in the long run are two of the largest fears when beginning to think about the costs and benefits of green infrastructure. The U.S. Environmental Protection Agency (EPA) addresses many of these issues to help ease worries and convince communities to try to implement green infrastructure.

Case Study

Lancaster, PA, which relies heavily on its landscapes, is trying to revitalize the green infrastructure in its area to aid the "ecosystems and landscapes" on which it depends. They created a plan for the implementation of the new infrastructure that addressed all of the challenges they faced.

Public Lands, Parks, and Facilities

Introduction

One way cities can improve their green infrastructure is by maximizing their use of parks, public lands and facilities. Preserving, restoring, and maintaining public nature areas will have positive benefits for cities. It can help manage issues like storm water and flooding, protect and preserve species and natural features, and help improve air quality among other environmental advantages. But public lands and parks have benefits beyond the environment; they improve communities by creating a common space, and can even spur economic development.

(Photo: U.S. Department of Agriculture, National Resources Conservation Services)

The following section describes what cities should know about the importance of public parks and green spaces in urban areas. It highlights how to develop public lands in ways that will have environmental, social, and economic benefits for cities. Several examples of successful parks are provided as reference, and tools are included to encourage viewers to see the benefits public lands can have on urban areas.

Types of Public Land, Parks and Facilities

There are different types of public lands and parks. They can vary from green open space, to forests, to wetlands. All of these are important to promoting green infrastructure. The following examines the different types of public landforms, illustrating the importance of each.

Urban Open Space

Open space in urban areas can come in different styles. It may be a large park with a play structure, it may be small pocket parks, or it may be preserved land set aside from development or disruption. Either way the idea of open space in downtown areas is becoming an increasingly important topic among planners and city officials. There are numerous benefits from preserving nature in urban downtowns. Parks build community, improve quality of life, provide a place for people to connect with their community, can be used to engage citizens in sustainable living, and help express the unique quality of an area (Francis, 2006).

Community Forestry and Trees

Trees are an extremely important aspect of green infrastructure. They provide air quality, climate moderation, energy, conservation, and wildlife habitat benefits. They can help manage storm water, prevent erosion, and have a positive economic effect (Arnold, et al., 2009). Often times people think of trees as being part of a large preserved forest, however community forests are just as important. A "community forest" is defined as the tree canopy within a community. This canopy is made up of trees from peoples' yards, tree that are part of landscaping in parks, trees lining streets, etc. All of these together create a community's tree canopy. Protecting and promoting tree growth can help improve the community. For more information on community forests please see Chapter 7 of the *Kentucky Wet Growth Handbook*.

Pocket Wetlands

Wetlands are critical to ecosystems. They filter and clean surface water while also holding excess water, releasing it when water levels are low. Pocket wetlands operate in this manner. They collect storm water runoff from impervious areas, often times being able to hold a large amount of water. The pollutants in the storm water runoff are filtered out and absorbed by the plants in the wetland. As new storm water runs into the wetland, the existing storm water is pushed out into the receiving body of water. Pocket wetlands are built where they can receive ground water, enabling them to not solely rely on runoff water. This allows them to be smaller in size, making them ideal for urban or developed areas (Charles River Watershed Association, n.d.). For more information on pocket wetlands please see the Charles River Watershed Association's chapter on Constructed Stormwater Wetlands.

Rain Gardens

Rain gardens are another way to help manage storm water runoff. Rain gardens are depression gardens near areas of runoff that catch the water from these impervious pavements. The soil and plants in the garden absorb the water. This can help prevent erosion, water pollution, and flooding while revitalizing the groundwater (Arnold, et al., 2009) For more information on rain gardens see the *Kentucky Wet Growth Handbook* Green Infrastructure chapter.

Implementation

In order to ensure that public lands and parks are successful in facilitating green infrastructure, their implementation must be strategically carried out. The following are suggestions of how to create vibrant parks and public spaces that will have a positive effect on green infrastructure.

Interconnection

Parks, forests, open spaces, or any other type of public land should be developed in an interconnected fashion. When these types spaces are created individually and separately they can't have as strong an effect on the environment as if they were connected. A system of parkways helps preserve wild life. Animals, plants, insects, and other species are better protected from disruption to the nature area because the area is larger. They can migrate, grow, and thrive. This can help protect, and potentially even rebuild biodiversity in the area. Connected park systems can also benefit humans by improving the aesthetics of a city and shaping future development around the nature preserves. Finally a connected park system can also help manage storm water and flooding (Benedict and McMahon, 2003). To learn more on this subject, go to *How Cities Use Parks As Green Infrastructure*.

Planning

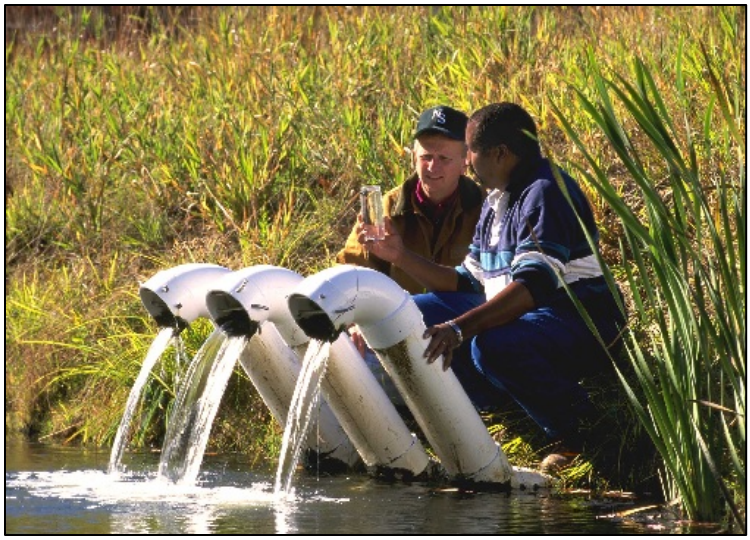
In order to have public land and parks that are interconnected, large, and healthy enough to have positive impacts, local governments need to plan ahead. Incorporating future plans for greenspace and parks into city plans has become an increasingly popular movement. An example of this can be seen in the *Nashville Open Space Plan*. The City of Nashville wanted to preserve and enhance the quality of life for future residents by creating and preserving open space. They created this plan which calls for several interconnected nodes of open space to be set aside from development. Each of these will also be connected to downtown Nashville. The plan will be carried out over the next 10 years (Nashville Open Space Plan, 2011). For more information see the *Nashville Open Space Plan*.

Create Parks Along Natural Features

Creating parks and public land around already-existing natural features such as creeks and rivers can help protect these special elements, drawing public attention to their importance, and promote an interconnected system of parks. In Montgomery County, Maryland the county bought land along its major stream corridors in the 1940s and 1950s. This helped preserve the area, most of which has now been converted into parks. In 2001, the County began buying land to add to the system in order to create a county-wide park system. Land that has been bought and protected includes farmlands, ecological reserves, greenspace, and stream valleys (Benedict and McMahon, 2003). Such unique features can now be preserved for generations to come. For more information on this project see *How Cities Use Parks for Green Infrastructure*.

Work with Local Decision Makers to Make Policies

In order to get green infrastructure implemented into towns, cities, villages, or any other community, local decision makers have to cooperate. The following are steps that local governments can take to ensure that green infrastructure is part of a community's future (Kloss and Calarusse, 2009):



(Photo: U.S. Department of Agriculture, National Resources Conservation Services)

1. Minimize future use of impervious pavement, start preserving vegetation with future projects, and start preserving green space.
2. Begin incorporating these tools into long-term storm water management plans.
3. Revise existing storm water regulations to incorporate greener infrastructure.
4. Designate funding to reward green infrastructure use of storm water management.
5. Create incentives for private and commercial use of green infrastructure.
6. Revise development ordinances to require green infrastructure.
7. Encourage wet growth development to preserve at-risk areas.
8. Preserve and work around existing trees and vegetation in new development projects.
9. Encourage community involvement.

For additional information see Rooftops to Rivers.

Provide Incentives for Community Involvement

In order to successfully promote green infrastructure, residents of these areas must be involved. The best way to get people involved is to reward them for their participation. An example of such a program can be seen in the city of Portland, OR. In order to help promote tree canopy in the urban areas, the city created the "treebate" program. Residents who plant a tree on their property get a rebate on their utility bill. Having such incentives encourages community participation which leads to greater green infrastructure (Portland Bureau of Environmental Services, n.d.). For more information on "treebates" see Portland Trees.

Mix and Match

Combining various types of low-impact development with parks can create greater benefits for the area.

Tools

Funding

Many governments are promoting green infrastructure. This means that there are various types of funding available for parks, greenspace development, and other green infrastructure investments. The following are a list of resources with links to available funding:

- http://www.greeninfrastructure.net/resources lists numerous grants and programs to assist towns and cities in becoming more green
- http://www.landpolicy.msu.edu/modules.php?name=Pages&sp_id=268 lists grants through the land policy institute and other external sources

Calculators

Calculators can be a great tool for those interested in knowing the benefits of green infrastructure. Below is a list of links to different types of calculators showing various types of green infrastructure benefits

- http://www.treebenefits.com/calculator/ Tree Benefit Calculator
- http://www.plangarden.com/app/vegetable_value/ Vegetable Value Calc
- http://greenvalues.cnt.org/national/calculator.php Green Values National Storm Water Management Calculator
- http://www.epa.gov/epawaste/conserve/rrr/greenscapes/tools/erosion.xls EPA Erosion Control Calculator in Excel

Policies, Ordinances, Regulations, Incentives

Introduction

The first step communities should take to guarantee green infrastructure is to evaluate their current land use planning programs to see if changes should be made. Communities can evaluate their codes, ordinances, regulations and policies using the following three strategies: (1) Assess current codes and ordinances for gaps and opportunities for modification; (2) Look at examples of various types of ordinances and regulations that are currently in use across the country, and use pertinent language in creation or editing of local codes and ordinances; and (3) Find ways to involve property owners that does not come from the local government. (Arnold, et al., 2009)

Use this graphic representation to help assess the local codes and ordinances in your area, or to create new ones.

Assessment of Codes and Ordinances

Local land use regulations will either (1) be supportive of green infrastructure by requiring or encouraging and facilitating land use and development practices that enable green infrastructure, (2) be neutral towards green infrastructure by allowing or authorizing land use and development practices that enable green infrastructure, or (3) stand in the way of green infrastructure by restricting or prohibiting certain land use or development practices that enable green infrastructure. Local land use regulations can require certain practices either as a legal obligation of land ownership or use or as a condition of a development approval that is otherwise restricted. (Arnold, et al., 2009)

Regulation in Communities without Zoning Ordinances

Some counties and cities in the United States have not adopted zoning as authorized by various state statutes. For these communities, although a different approach may have to be taken in order to regulation green infrastructure, regulation may still be achieved. Communities can look to other state statutes to given them the authority to regulate things like the subdivision of land. Also, communities without zoning still have the authority to regulate to protect public health and safety, natural resources or public infrastructure, which fall under the state's police power. The regulations that stem from the police power can cover actions that would threaten the public health and safety, cause a public nuisance, degrade natural resources, or harm public infrastructure, but they cannot regulate the categories of land or apply only to particular geographic areas of the local jurisdiction – this would characterize zoning ordinances. (Arnold, et al., 2009)

When reading through the example codes and ordinances below, many could be altered to be adopted as non-zoning health and safety ordinances by communities that do not have zoning.

Examples of Ordinances

Storm-water Management Ordinances

1. Fort Worth, TX
    a. Fort Worth
2. Albemarle County, VA
    a. Albemarle County
3. Rain Garden – Burnsville, MN
    a. Water Resource Management Plan
    b. Burnsville, MN
4. Planter Boxes – Portland, OR
    a. Portland

Sediment and Erosion Control Ordinances

5. Minneapolis, MN
    a. Minneapolis
6. Grand Traverse County, MI
    a. Grand Traverse County

Riparian Buffer Zones

7. Baltimore County, MD
    a. Baltimore County
8. Buffalo, MN
    a. Buffalo

Groundwater, Aquifer, Wellhead and Sinkhole Protections

9. Lexington, KY
    a. Lexington
10. Hernando County, FL
    a. Hernando County
11. Stratham, NH

a. Stratham

12. Weston, WI
    a. Weston
    b. Weston Overlay Districts

Open Space Zoning, Cluster Development and Conversation Subdivision

13. Louisville, Kentucky
    a. Louisville
14. Hamburg Township, MI
    a. Hamburg Township

Tree Preservation Ordinances

15. A Guide to Developing a Community Tree Preservation Ordinance
    a. Guide
16. Fairfax County, VA
    a. Fairfax County
17. Northbrook, IL
    a. Northbrook
    b. Tree Protection Agreement

Forest Conservation Ordinances

18. Frederick County, MD
    a. Frederick County
19. Fayetteville, AR
    a. Fayetteville

Water Conservation Ordinances

20. Dallas, TX
    a. Dallas
21. St. Johns River Water Management District, FL
    a. St. Johns River

Including Private Property Owners

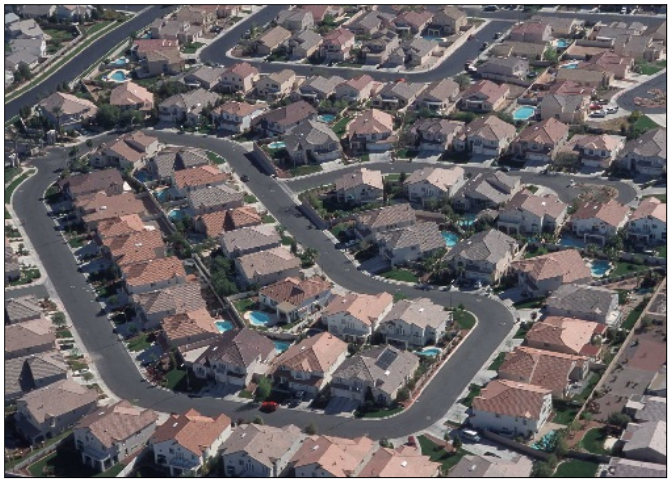
Although local cities and governments have the ultimate control over the creation and amending of city codes and ordinances, involving private property owners in the process creating and implementing green infrastructure is vital. In April 2012, the District of Columbia Department of Environment launched the first web-based tool to incentivize private property owners in implementing green infrastructure measures on their property. The tool will be used to help private property owners use and understand their property's energy usage and storm water discharge. To see and use this interactive tool, click here. To learn more about how to use the tool and about its implementation, reading this blog article will prove informative.

Projects like the *GreenUp DC* initiative are imperative to breaking down information to make it more accessible for private property owners and help them to understand why green infrastructure betters whole communities.

Transportation Infrastructure and Wet Growth

Introduction

Transportation-related land cover (streets, parking and driveways) make up as much as 70 percent of the impervious footprint in most urban watersheds. A myriad of information exists on the relationship between these systems and wet growth. This section provides excerpts, references and examples from the specific sites referenced to streamline research on this topic.



(Photo: U.S. Department of Agriculture, National Resources Conservation Services)

Implementing linear green infrastructure projects and retrofits (which are storm water management measures inserted in an urban or developed landscape where little or no prior storm water controls existed) are often faced with the following challenges:
:

- Limited number of "acceptable" practices
- Multiple watersheds
- Offsite run-on
- Lack of space in the right-of-way
- Utility conflicts
- Code constraint

- Retrofitting objectives
- Restoration of ecosystem/watershed processes
- Addressing past mistakes and maintenance problems
- Fixing flooding problems
- Reducing runoff
- Trapped trash and floatables
- Reduction of pollutants
- Erosion reduction
- Education and demonstration of best management practices

The State Environmental Resource Center website provides extensive information on effects of sprawl on natural resources including press releases, talking points, policy issues, and multiple links to related sites. A good resource the Center provides are fact sheets for areas across the U.S.; these can be found at http://www.serconline.org/grInfrastructure/fact.html.

The *Playbook for Green Buildings and Neighborhoods* is also a very user-friendly and in-depth tool. This was produced to help promote the goals set out in the U.S. Conference of Mayors Climate Protection Agreement. More than 600 mayors, representing more than 50 million U.S. residents, have signed the agreement, which commits communities to reducing greenhouse gas emissions to the targets set in the Kyoto Protocol. Highlights include an overview and detailed information including manuals and calculators from building to neighborhood to infrastructure scale, and data provided by consortium of more than 20 local governments, non-profit organizations, government agencies, and utilities. The playbook can be found at http://www.greenplaybook.org/.

Sample Green Street Projects

Seattle

The Seattle Street Edge Alternatives (SEA) Streets projects are designed to provide storm drainage that more closely mimics drainage in the undisturbed natural landscape than do traditional piped systems. General methods employed to achieve this goal include reduction of impervious surfaces in the public rights-of-way, provision of surface detention in swales, additional planting in the public rights-of-way (Seattle Public Utilities, n.d.). For more information visit:
http://www.seattle.gov/util/About_SPU/Drainage_&_Sewer_System/GreenStormwaterInfrastructure/NaturalDrainageProjects/StreetEdgeAlternatives/CommunityCostBenefits/index.htm

San Francisco

San Francisco's effort to move from status quo, grey infrastructure to utilizing green practices for new and retrofitted transportation infrastructure can be seen by reviewing the city's ordinance and planning document amendments over a four year period. On Feb. 28, 2006, San Francisco passed Ordinance 33-06, their *Better Streets Ordinance* as an amendment to their Administrative Code, and requested that a General Plan amendment be created to incorporate *Better Streets* policies and principles (SFBS). An excerpt reads:

> *"Major new developments, both public and private, often include the rebuilding of portions of public right-of-ways and should serve as models of the Better Streets Policy. Special efforts should be made to ensure that such new developments lead by example. Public projects should establish model street and open space designs and private projects should incorporate stronger street design and landscaping standards. The City should encourage local residents, businesses, and other stakeholders to collaboratively develop such designs and standards in order to foster the community's active use and sense of ownership of these spaces over time."*

In December 2010, San Francisco adopted the *Better Streets Plan* and updated their planning code with requirements of the *Better Streets Ordinance and Plan*. In addition to place-making and multi-modal transportation considerations, the San Francisco plan includes sections requiring that urban forest and storm water management techniques be used in new and retrofit street designs. In early 2011, San Francisco also began developing a comprehensive website and user guide, explaining in greater detail the requirements and guidelines of the Plan (San Francisco Transit Authority, n.d.).

Additional examples include:

- Conservation Fund green infrastructure site with an array of projects across the country: http://www.greeninfrastructure.net/content/projects
- Idaho examples of storm water retrofit with excellent photos of grey storm water basin retrofit into green infrastructure; results shown in five different stages over several growing seasons: http://itd.idaho.gov/pdc11/docs/Stormwater%20Retrofitting%20Along%20Linear%20Projects.pdf
- The Green Topeka website is a good, practical example of what could be adapted for other cities, including a link to a parking lot retrofit to incorporate a bio-retention basin: http://www.greentopeka.org/Projects/?category=5. The website provides a variety of green infrastructure projects; sewer, buffer and landscape ordinances; and details of a partnership that includes state agencies, Kansas State University, local government, nonprofit organizations, private stakeholders, and the U.S. Department of Agriculture's

National Agro-forestry Center (NAC). The partnership is working to develop and implement a Stormwater Master Plan.

- "Knitting Green Infrastructure into the Urban Fabric: An Overview of Municipal Policies" by Annie Kline, APA Planning and Law Newsletter, Spring, 2012, page 6: This article reports on Green Infrastructure accomplishments in NYC, Philadelphia and Portland, OR.

Regulatory Drivers for Green Transportation Infrastructure

The referenced sites listed below have links and often webcasts which can be used for inter-departmental and community education sessions regarding the community-wide commitment required for successful Green Infrastructure implementation.

Sustainability Mandates

The EPA's Green Infrastructure site provides basics, tools, case studies and EPA contacts across the U.S., research, and a library link to non-EPA websites for more information Site provides resources to show how Green Infrastructure, unlike single-purpose gray storm water infrastructure which uses pipes to dispose of rainwater, uses vegetation and soil to manage rainwater where it falls, storm water management, flood mitigation, air quality management, and much more.

Phase I and Phase II NPDES MS4 Permits

Storm water runoff is generated when precipitation from rain and snowmelt events flows over land or impervious surfaces and does not percolate into the ground. As the runoff flows over the land or impervious surfaces (paved streets, parking lots, and building rooftops), it accumulates debris, chemicals, sediment or other pollutants that could adversely affect water quality if the runoff is discharged untreated. Because of the continued use of the traditional street gutter to storm drain to river/lake/creek methods of storm water management, these centralized system discharges are considered point sources and require coverage under a National Pollutant Discharge Elimination System (NPDES) permit. By implementing Green Infrastructure Best Management Practices (BMP) the primary methods to control stormwater will be supplemented by decentralized methods discussed in Low-Impact Development, such as bio-retention basins, pervious surfaces, green roofs, water harvesting, etc. Source: http://cfpub.epa.gov/npdes/home.cfm?program_id=6

404 Permitting –Streams and Wetlands

A 404 permit is required for the discharge of dredged or fill material into waters of the United States, which include wetlands, rivers/streams/drainages, ponds and lakes (fill material is the trigger). Typical activities requiring Section 404 review include grading, widening and resurfacing, culvert extensions, bridge/culvert replacements, rip-rap and/or flood emergency

repairs, new construction on new alignment, and any construction in or around streams or wet areas, including clearing and grubbing.
Source: http://water.epa.gov/type/oceb/habitat/cwa404.cfm

TMDLs: Total Maximum Daily Loads

(Nutrients, sediment, bacteria, trash)

Under section 303(d) of the Clean Water Act, states, territories, and authorized tribes are required to develop lists of impaired waters. These are waters that are too polluted or otherwise degraded to meet the water quality standards set by states, territories, or authorized tribes. The law requires that these jurisdictions establish priority rankings for waters on the lists and develop Total Maximum Daily Loads (TMDLs) for these waters. A TMDL is a calculation of the maximum amount of a pollutant that a waterbody can receive and still safely meet water quality standards. Source: http://water.epa.gov/lawsregs/lawsguidance/cwa/tmdl/index.cfm

Threatened and Endangered Species

The EPA Endangered Species Protection Program (ESPP) is a program designed to determine whether pesticide use in a certain geographic area may affect any listed species. Unfiltered run-off from areas with high percentages of impervious surfaces and pesticide use, such as for lawns and landscapes in urban and suburban areas, often flows directly into street gutters and storm drains contributing to this problem. If limitations on pesticide use are necessary to protect listed species in that area, the information is relayed through Endangered Species Protection Bulletins. Under the Endangered Species Act (ESA), the government protects endangered and threatened plants and animals (listed species) and the habitats upon which they depend. The ESA requires federal agencies to ensure that any action they authorize, fund, or carry out, will not likely jeopardize the continued existence of any listed species, or destroy or adversely modify any critical habitat for those species. Source: http://www.epa.gov/espp/

The Center for Watershed Protection, Urban Sub-watershed Restoration Manual Series:

Under an EPA grant, the Center developed an 11-manual series on practical techniques to restore urban watersheds; these manuals include sub-watershed issues relating to Green Infrastructure. The manuals cover the seven major practices used to restore urban watersheds: stormwater retrofits, stream repair, riparian management, discharge prevention, pollution source controls, watershed forestry and municipal operations. In addition, the series outlines new methods for desktop and field assessment and stakeholder management to develop effective small watershed restoration plans, and presents an integrated framework for urban watershed restoration. Source: http://www.cwp.org/categoryblog/92-urban-subwatershed-restoration-manual-series.html#Manual3

Manual 1: An Integrated Framework to Restore Small Urban Watersheds

Manual 2: Methods to Develop Restoration Plans for Small Urban Watersheds

Manual 3: Urban Stormwater Retrofit Practices

Manual 4: Urban Stream Repair Practices

Manual 8: Pollution Prevention Practices
Manual 9: Municipal Pollution Prevention/Good Housekeeping Practices
Manual 10: Unified Stream Assessment: A User's Manual
Manual 11: Unified Subwatershed and Site Reconnaissance: A User's Manual

Funding

The EPA's Four Pillars Approach to promote Sustainable Water Infrastructure provides a comprehensive foundation to approach new and retrofit Green Infrastructure (GI) transportation projects. These pillars are 1) better management, 2) full cost pricing, 3) water efficiency and 4) water shed approach, and are used here as a framework for organizing additional information from multiple sources. To download a copy of EPA's "Sustaining our Nation's Water Infrastructure" go to http://water.epa.gov/infrastructure/sustain/upload/2009_05_26_waterinfrastructures_brochure_sisustainingournationswaters.pdf

Collaboration through intergovernmental, interdepartmental and community wide input is assumed in all areas. The EPA Smart Growth webpage provides multiple links to GI topics and funding sites http://www.epa.gov/smartgrowth/partnership/tools.html#fundresources

Better Management

Green Infrastructure Knowledge and Leadership

Expertise will be needed to go beyond relying on guidelines which "allow" Green Infrastructure's use to "ensuring" consistent design and implementation, assuming full cost/benefits calculators have been used and support it.

- EPA National Menu of Storm water Best Management Practices (BMP's) http://cfpub.epa.gov/npdes/stormwater/menuofbmps/
- Center for Watershed Protection comprehensive website http://www.cwp.org/
- Values of Green Infrastructure guide; Center for Neighborhood Technology and American Rivers publication http://greenvalues.cnt.org/national/calculator.php
- National NEMO (Nonpoint Education for Municipal Officials) Network with programs in over 30; goal is to provide decision makers with the skills and resources that they need to identify local water quality problems and to adopt effective pollution controls. We offer training in the science, management, and regulation of water resources for community leaders and volunteer board members. Source: http://nemonet.uconn.edu/
- The Citizens' Guide to Groundwater Protection outlines citizen and community roles and responsibilities relative to Clean Water Act and Federal and State Laws and programs.

http://water.epa.gov/infrastructure/drinkingwater/sourcewater/upload/2006_08_28_sourcewater_guide_citguidegwp_1990.pdf

- U.S. Green Building Council LEED-ND provides educational material, fact sheets, webcasts and power point which provide opportunities to incorporate Green Infrastructure. Source: http://www.usgbc.org/DisplayPage.aspx?CMSPageID=2509
- SAFETEA-LU; DOT/FTA funding provides an opportunity for communities to incorporate GI into designs for multi-modal systems (link to SAFETEA-LU)
- According to ARRA (American Recovery and Reinvestment Act) a partial list of funds spent since 2009: transportation 33.8 billion, infrastructure 26.3 billion, energy and environment 23.9 billion, energy incentives to residences 10.8 billion, energy 12 billion. (author's note: These are funds that could have been used to incorporated GI water infrastructure projects related to transportation infrastructure, however these projects will not required to have Green Infrastructure water resource management in designs; it continues to be the responsibility of leaders and communities to ensure that Green Infrastructure design techniques are incorporated into these designated funding streams. http://www.recovery.gov/Transparency/fundingoverview/Pages/fundingbreakdown.aspx#ContractsGrantsLoans
- Institute of Transportation Engineers; design fact sheets provide opportunities for the integration of green water infrastructure techniques. (author's note: once again leadership is key in requiring that these green practices are implemented. Source: www.ite.org/css or
- www.contextsensitivesolutions.org

Asset Management

EPA and the U.S. Department of Transportation's Federal Highway Administration (USDOT-FWA) have worked together to develop case studies and the following information to support communities that are considering multi-sector or "*whole of government"* asset management (AM) strategies. The communities studied were Calgary, Alberta, Canada; Hamilton, Ontario, Canada; Henderson, Nevada; Portland, Oregon; and Saco, Maine.

For each case study, FHWA/EPA representatives interviewed city transportation, water, wastewater, and planning staff and compiled the information. City representatives reviewed the resulting material. Each case study presents background information on the city's infrastructure, history of, and reasons for applying AM tools; lessons learned to date; and benefits of AM. These case studies also assess how far along each city is with applying *best practices* within each sector (transportation, water, and wastewater). The activities generally regarded as the steppingstones to effective AM programs include the following:

- Develop an asset inventory (a list of assets and their principal components).
- Assess asset condition and failure modes (quantifying the deterioration rate and remaining useful life of an asset).

- Determine residual lives (what is the remaining useful life of the asset?).
- Evaluate life cycle and replacement costs/economic evaluation (the sum of all costs throughout the life of an asset, including planning, design, acquisition, construction, operation, maintenance, rehabilitation/renewal, and disposal costs).
- Set a target level of service (a defined standard against which the quality and quantity of service can be measured). A level of service can include reliability, responsiveness, environmental acceptability, customer values and cost.
- Determine business risk exposure/criticality (the chance of something happening that will have an effect on objectives). Risk is measured in terms of likelihood and consequences.
- Optimize operations and maintenance investment (keeping an asset operating as designed or preventing it from deteriorating prematurely).
- Optimize capital investment strategies.
- Determine funding strategies.
- Build an AM Plan (AMP) which is an enterprise-wide plan that includes AM for multi-sectors (U.S. Environmental Protection Agency and the U.S. Department of Transportation, Federal Highway Administration, n.d.).

Finance Charrettes

- University of Maryland Environmental Finance Center (EFC) has developed a charrette model for environmental finance problem solving to provide a direct mechanism for ensuring meaningful, constructive two-way communication, in this case between higher levels of government and local communities. Case Study Reports online from University of Maryland EFC Website: www.efc.umd.edu/charrette.html.
- Combine centralized and decentralized water infrastructure solutions in planning:
    - EPA info on Decentralized Systems: National Decentralized Water Resources Capacity Development Project (DWRC) managed by Water Environment Research Foundation (WERF) and others since 2001 funded by EPA; www.werf.org/decentralizedoutreach.
- Tetra Tech, an engineering and architecture firm provides a great site with multiple downloadable articles and guides for planning and all areas of Green Infrastructure; http://www.tetratech.com/us/about-tetra-tech.html.

Full Cost Pricing

The Center for Neighborhood Technology's The Value of Green Infrastructure: A Guide to Recognizing Its Economic, Environmental and Social Benefits is a manual with economic valuation methods and tools (equations and explanations) for GI techniques to be used by communities in order to make informed economic decisions regarding conventional grey infrastructure vs. GI. Also, the manual's appendix has several other calculators for green roofs, street trees and urban forests, Low Impact Development calculations, etc.

An associated tool from the Center for Neighborhood Technology is The National Green Values™ Calculator (GVC). This tool is very user friendly and is the current standard calculator being referenced for GI estimating purposes. The National GVC is meant for a single site or a campus of buildings contained on a single site. The site states that if you are interested in looking at the performance and cost/benefit analysis of Green Infrastructure BMPs applied on a neighborhood or watershed scale, consider using the original GVC. The calculator is a tool for quickly comparing the performance, costs, and benefits of Green Infrastructure or Low-Impact Development (LID), to conventional storm water practices, focusing on runoff volume reduction. The GVC is designed to take you step-by-step through a process of determining the average precipitation at your site, choosing a storm water runoff volume reduction goal, defining the impervious areas of your site under a conventional development scheme, and then choosing from a range of Green Infrastructure Best Management Practices (BMPs) to find the combination that meets the necessary runoff volume reduction goal in a cost-effective way.

Water Efficiency

Education and Behavior Change

In addition to educated, committed and empowered leadership, a bottom-up approach to providing water resource planning, operation and management of GI water resource systems will require community education and involvement.

Low Hanging Fruit

- Educating and empowering private property owners and developers to install, manage, operate and report on GI issues on personal and city properties may result in reduced storm water volumes and velocities during extreme wet weather events. EPA offers models for documents to be approved at the site design phase to plan and measure storm water control devices to be used, and to identify responsible parties for routine and non-routine maintenance, as well as for maintenance scheduling and inspections. For more information go to http://www.epa.gov/owow/NPS/ordinance/mol4.htm
- The Context Sensitive Solutions (CSS) for transportation planning website offers guidance, webinar registrations and educational videos. Non-profits provide another alternative for GI guidance.
- The Green Infrastructure Center, Inc. (GIC) was formed in 2006 to help local governments, communities, and regional planning organizations, land trusts and developers evaluate their green infrastructure assets and make plans to conserve them.
- Private and public property runoff controls and education are essential to preventing polluted runoff from gravel, roads, highways and bridges from reaching surface waters. Multiple fact sheets, guidance documents, manuals and BMPs for construction,

operations and management for these areas are available at this EPA website: http://water.epa.gov/polwaste/nps/roadshwys.cfm.

Watershed Approach

Regional Intergovernmental and Community Collaboration

Broad collaborative efforts are essential to prevent "upstream" and regional water resource management issues from defeating "downstream", local and site specific goals. See the Watershed Module for more information on this fourth pillar.

Financial Tools Overview

Many Financial Mechanisms (Tools) are available regarding construction and maintenance of sustainable water infrastructure and related water quality protection initiatives. EPA offers extensive guidance and descriptions of all of the mechanisms listed in the summary below, as well as the EPA Financing Alternatives Comparison Tool (FACT) and EPA Municipal Handbook on Funding Options. These can be found at: http://water.epa.gov/infrastructure/sustain/upload/WATERINFRA2007.pdf.

State Financial Assistance:

The Safe, Accountable, Flexible, Efficient Transportation Act: A Legacy for Users (SAFETEA-LU) authority has been extended to all states to establish State Infrastructure Banks (SIBS) as well as multi-state SIBS, providing Federal and State matching startup funding for transportation projects for both public and private sector borrowers.

Department of Transportation Office of Innovative Program Delivery (IPD): Provides a one-stop source for expertise, guidance, research, decision tools, and publications on program delivery innovations; go to http://www.fhwa.dot.gov/ipd/pdfs/fact_sheets/2_tfi_sibs_1_19_12.pdf for more information.

Institutional Arrangements

Contacting one of the following universities who constitute the EPA's Environmental Finance Center Network is an important first step in the funding process in order to expeditiously navigate the sea of information available online. To find your local environmental finance center, visit http://www.epa.gov/envirofinance/.

Electronic Services

The main page of EPA's Green Infrastructure website and software programs provide up to date assistance and links to myriad GI finance data and tools.

In addition to EPA, helpful detailed descriptions of the following financial tools (fees, bonds, grants, loans, unconventional financial tools and tools for brown field, coastal, tribal and local and regional funding models) are available at Indiana University-Purdue University Indianapolis website for Green Infrastructure financial assistance.

Fees

Protection area fees, connection fees, septic fees, well fees, inspection fees, user fees, permitting fees, NPDES fees, professional certification fees, water rights applications fees, public water withdrawal fees, navigable waters fees.

Bonds

Advance refunding bonds, appropriations-backed bonds, capital appreciation and zero coupon bonds, double barrel bonds, general obligation bonds, mini/baby bonds, moral obligation bonds, private activity bonds, revenue bonds, short-term municipal bonds, special assessment bonds, special tax bonds, state revolving funds revenue bonds, tax increment bonds.

Other

Anticipation notes, asset backed securities, certificates of participation, derivatives, exactions, co-funding, cooperatives, cost share programs for non-point source pollution controls, demand-side management pricing, conservation pricing, capital improvements programs, point source/non-point source trading, tax increment financing, special districts, community development financial institutions.

Grants and Loans

Rural Areas

- Rural Communities Assistance Corporation (nonprofit assistance, below 50,000 pop.)
- U.S. Department of Agriculture; Rural Business Enterprise Grants
- U.S. Department of Agriculture; Rural Utility Service Technology Assistance and Training Grants

- U.S. Department of Agriculture; Water and Waste Water Loans
- U.S. Department of. Agriculture; Hospitals, Fire, Safety and other community based initiatives
- Appalachian Regional Commission Grants

Brownfields

- EPA State Revolving Funds for Brownfield Loans

Coastal

- NOAA Community Based Restoration Program; to inspire and sustain local efforts regarding coastal habitat restoration and to encourage local participation.
- The EPA's Office of Wetlands, Oceans, and Watersheds Nonpoint Source Pollution website describes nonpoint source pollution, discusses different categories of nonpoint sources, and provides information for the public, students, and educators about nonpoint sources. It also includes information about funding opportunities, Section 319 of the Clean Water Act, and Section 6217 of the Coastal Zone Act Reauthorization Amendments.

Regional

- U.S. Economic Development Agency (EDA); encourages programs that promote job growth regionally through intergovernmental, public and private collaboration.
- Clean Water Act Non-point Source Grant (EPA sect 319); for states, territories, tribes; technical assistance, financial assistance, education, training, technology transfers, demonstration projects, monitoring existing/new projects.

Local and Project Based

- HUD Community Development Block Grants (CDBG); flexible funding for communities; opportunity for creative integration of water solutions in community planning and design.
- HUD Sustainable Communities Regional Planning Grants; support metro and multi-jurisdictional planning efforts that integrate housing, land use, economics, workforce, transportation and infrastructure with a focus on triple bottom line of economics, social, and energy/environment.
- FHWA Eco-logical Grant Program; projects integrating planning with eco-systems approaches.
- Environmental Work Force Development and Job Training Grants; train local unemployed in jobs in environmental fields.
- C.A.R.E. Community Action for Renewed Environment; supports community based partnerships at local level for governments, tribes and NGO's.

Tribes

- EPA Pollution Prevention Grant Program (P2 grants, CFDA 66.708); matching funds to states and tribes; to give capabilities to assist business and industry to develop better strategies to meet federal and state environmental regulations; to improve business competitiveness through tech assistance, training, outreach, education, regulatory integration, data collection, research, demonstration projects, and recognition projects.
- EPA Tribal Funding supports The National Tribal Water Council to build participation to address water issues.

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