

GREENING THE GREY

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Greening the Grey:

An Institutional Analysis of Green Infrastructure for Sustainable Development in the US

This report was prepared for green infrastructure professionals and sustainability leaders by the Center for Leadership in Global Sustainability (CLiGS) at Virginia Tech with support from the National Association of Regional Councils (NARC)

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Acronyms

ACE	US Army Corp of Engineers
ACEC	American Council of Engineering Companies
ASCE	American Society of Civil Engineers
ASIWPCA	Association of State and Interstate Water Pollution Control Administrators (became APWA - Association of Public Works Administrators)
BLM	US Bureau of Land Management
CLiGS	Center for Leadership in Global Sustainability
CWA	Clean Water Act of 1977
DOI	US Department of Interior
DOT	US Department of Transportation
EPA	US Environmental Protection Agency
EPA OW	EPA Office of Water
EU	European Union
FWS	US Fish and Wildlife Service
GI CoP	Green Infrastructure Community of Practice
HHS	US Department of Health and Human Services
HUD	US Department of Housing and Urban Development
LID	Low Impact Development
LIDC	Low Income Development Center
MAGICOP	Mid-Atlantic Green Infrastructure Community of Practice
NACWA	National Association of Clean Water Agencies
NARC	National Association of Regional Councils
NOAA	National Oceanographic and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System
NPS	US National Park Service
NRDC	Natural Resources Defense Council
TCF	The Conservation Fund
TMDL	Total Maximum Daily Load
UNEP	United Nations Environmental Programme
USFS	US Forest Service
WRI	World Resources Institute

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Preface

Infrastructure supports our lives and livelihoods. It manages our access to food, water, energy, transportation, communication, waste disposal, and other critical services. It provides the foundation on which our communities, economy, and security are built and thrive or falter. The strength and resilience of our infrastructure systems are directly correlated to the strength and resilience of the places we live, now and into an uncertain future. Most of us take the infrastructure, and its resilience, for granted – until something fails or the cost of repair becomes exorbitant.

“Grey” infrastructure has traditionally attracted the most attention – e.g., roads, power grids, piped sewer and water systems – but the “green” infrastructure, the natural systems and features that provide valuable ecosystem services, is just as critical. We need both to support resilient and vibrant places. In the past, these green infrastructure systems were often left out of the planning calculus, with the value of the services they supplied unaccounted for as a positive externality. But with mounting investments required to repair and maintain the aging stock of grey infrastructure systems, and increasing environmental pressures from expanding urbanization, the value of ecosystem services that have otherwise been “free” are entering more prominently into town, city, and regional planning and management equations. Compounded by increasing regulatory pressure to address water and air quality, the need to anticipate and adapt for localized (if yet uncertain) impacts of climate change, and the drive for economic competitiveness, all with ever more constricted finances, communities, cities, and regions across the US are increasingly assigning higher priority to their green infrastructure systems.

Green infrastructure is a concept that entered the sustainability discourse in the last decade among a wide range of agencies, organizations, companies, community groups, and planners. It elevates natural systems as infrastructure to a level of importance similar to “grey” systems and provides a common language for discussing these systems. But as is often the case when new organizing concepts emerge, its definition, application, and implication must be negotiated at all levels. Its role, function, and measures of effectiveness must be defined relative to other infrastructure systems; to the entities that regulate, build, operate, and maintain them; and, to the services they provide and the quantification or qualification of those services. As is true in most negotiation, some interests prevail over others. While green infrastructure is becoming a more mainstream element of city and regional planning discussions in the US, it is running the risk of being narrowly defined in a way that does not capture the full range and value of ecosystem services it provides.

In this report, we make the case that

Green infrastructure is more than a bioswale or a green roof or a forested corridor – it’s a different way of thinking about infrastructure. Understood as a multi-scale network of ecological features and systems that provide multiple functions and benefits, it provides a systems approach to planning and development that recognizes the value of ecosystem services and strives to integrate and enhance those ecosystem services within our built environment. Green infrastructure is not limited to a particular type of technology or feature

doing a specific job; it's the result of a wide network of institutions, organization, agencies, businesses, and citizens bringing ecosystem services back into planning and development. It's ultimately about people and organizations making that choice. Realizing green infrastructure's full potential requires coordination and collaboration across multiple boundaries – political, jurisdictional, agency, organizational, sectoral, disciplinary, professional, to name just a few. The most significant challenge for advancing a robust and integrated form of green infrastructure may be one of leadership and collective action.

Planning and decision making for vibrant and environmentally sustainable communities requires a systems perspective that integrates green and grey infrastructure: watershed and stormwater management; hubs and corridors for automobile, bus, rail, bicycle, pedestrian, and wildlife “traffic”; efficient energy grids and mature tree canopies to reduce carbon footprints and minimize urban heat island effect; city and regional land use plans that account for wastesheds, habitat, open spaces, working landscapes, riparian corridors, and more. A robust infrastructure system that supports sustainable development is essential to national prosperity, personal and public health, community vitality, and economic competitiveness. Green infrastructure systems, in their most robust sense, are a critical element of sustainable development.

This report is one outcome of a multi-year project funded by the US Forest Service in cooperation with the National Urban and Community Forestry Advisory Council, with the goal of mapping and evaluating the support system for green infrastructure planning in the US – a system that has changed dramatically over the study period and continues to evolve. The primary audience for this study was originally the National Green Infrastructure Community of Practice, an entity that has since ceased activities. So, while the target audience has shifted, the purpose of the project and this report remains the same: to provide green infrastructure practitioners and sponsors with a valuable reflection on how the concept emerged, how it has evolved, and where it is heading. In fact, in the same month this preface was written, the EPA released a new strategic agenda for green infrastructure in the US, and the World Resources Institute released an extensive guide to natural infrastructure investment, both of which reflect many of the same observations and recommendations that emerged from this study.

Two key questions guided this study:

- *What are strategic scales, policies, programs, and partnerships for implementing green infrastructure in the US?*
- *What is and could be an effective institutional support system for green infrastructure in the US?*

Part I of the report responds to these questions based largely on empirical fieldwork from 2011 to 2013 and is reflective of the path green infrastructure has taken from its introduction into the discourse in the late 1990s to the present. Part II offers reflections on what green infrastructure *can* be as a strategy for sustainable development, what an effective institutional support system for a more holistic form of green infrastructure *could* look like, and some promising lessons to support these opportunities and recommendations for sustainable development.

Introduction

The stated goal of this project was to map the institutions supporting green infrastructure in the United States in order to 1) better understand the interests and activities of stakeholders at multiple scales and 2) identify opportunities for coordination and improvement.

Our approach to this project was guided by two overarching questions:

- **What are the *strategic* scales, policies, programs, and partnerships for implementing green infrastructure?**
- **What is and could be an *effective* institutional support system for green infrastructure?**

The first step in evaluating any system is to identify its components, trace their linkages, and in turn, map the system. But as green infrastructure has been an evolving concept with shifting definitions and practical applications, its support system has also been changing, with a stable, much less final, arrangement yet to be determined. So while federal agencies started as the primary unit of analysis in this study and do play a central role in supporting green infrastructure efforts and practice, we approached them as one in a series of interdependent actors operating as part of a larger network. This allowed us to examine how the institutional support system was developing, and how the field of practice was evolving; and, whether they were doing so congruently.

Project Approach

In order to explore how green infrastructure was emerging in the US, we developed an iterative approach to the study, simultaneously examining activity surrounding the development of green infrastructure at the national level among agencies and organizations promoting and advancing green infrastructure as an organizing and policy strategy, and at the ground-level among practitioners applying green infrastructure planning concepts to incorporate natural assets into their planning processes. This allowed salient themes to emerge (see Figure 1) for further explanation.

Phase I of this project entailed extensive reviews of green infrastructure plans, policy documents, web content, technical reports, and academic and gray literature. Members of the research team also conducted numerous interviews and focus groups with stakeholders at various scales and attended several meetings and conferences on green infrastructure. We also conducted a survey among the membership of the National Association of Regional Councils to gain access to regional plans and to compare responses among regional stakeholders to other survey results collected from city-scale stakeholders. Phase II entailed more detailed analysis of green infrastructure plans and reports, as well as additional interviews and focus groups.

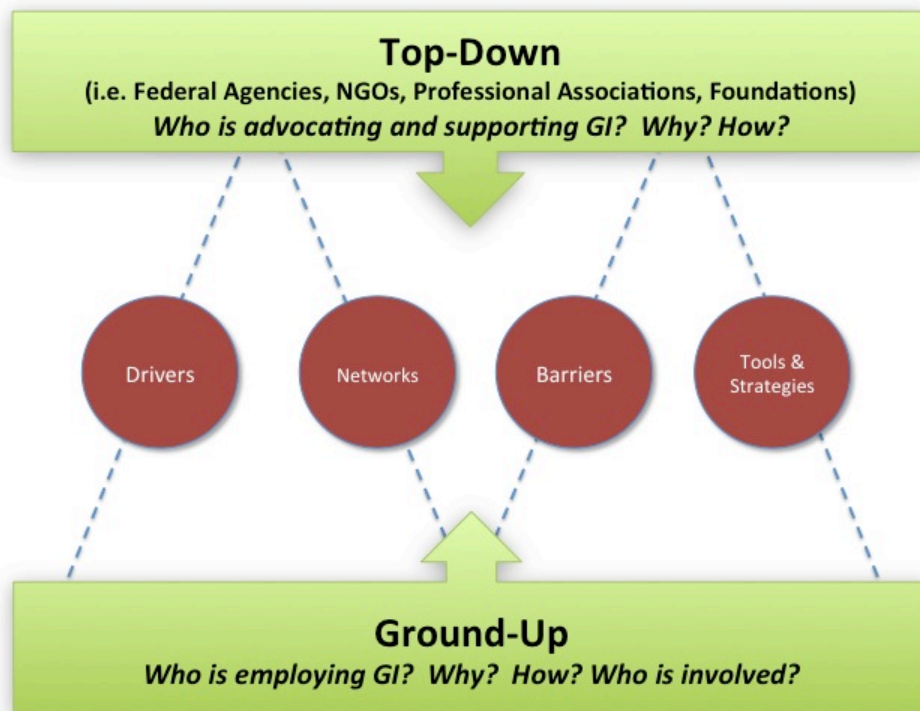


Figure 1. Research approach involved iterative process to reveal broad themes

Research Overview

In Phase I, we explored the current state of green infrastructure policy and practice in the United States from the top-down and from the ground-up, guided by the following framing questions:

- What is green infrastructure (and what is not)?
- Who is involved in promoting and supporting green infrastructure from the top-levels, and why?
- Who is involved in advancing and implementing green infrastructure on the ground and why?
- What are some of the significant impediments to green infrastructure in practice?

Through this initial phase of investigation, four themes emerged that we explored further in Phase II.

- **Drivers** – A range of issues and challenges are causing cities, communities, and regions to consider green infrastructure solutions. What are these drivers? How is green infrastructure being used to address these issues? What support is there to advance these uses of green infrastructure?
- **Networks** – Advancing and implementing green infrastructure at all scales is not the work of a single actor, but the coordinated effort of a network of actors. What networks are operating at the national level? What stakeholders are involved in local and regional scale networks? What networks exist to bridge supporting agencies and organizations at the national level with local and regional

practitioners? What opportunities exist to build or strengthen green infrastructure “communities of practice”?

- **Barriers** – There are significant barriers to implementation that must be addressed if green infrastructure is to become a readily accepted strategy for advancing sustainable development. What are the barriers at the national scale? Local and regional level? What efforts are being made to address these challenges?
- **Tools & Strategies** – There are many innovative and valuable best practices being developed and employed to support and implement green infrastructure. If the goal is to build capacity in a network or community of practice, what tools and strategies are useful? What is lacking? What do green infrastructure practitioners need?

The contents of Part I of this report provide an overview of our findings to these questions. Part II offers recommendations in response to the two guiding questions.

Part I – Institutional Analysis of Green Infrastructure in the US

Why green infrastructure?

Urbanization is a defining feature of humanity’s development trajectory: in 1800 less than 10% of people on the planet lived in urban areas, in 2000 it was 50%, by 2050 it could be 75%, in the US it is already over 80%. The world’s population is projected to increase beyond 9 billion by 2050; most of that increase will occur in cities at the rate of one million new people per week. And for good reason: Cities drive trends and opportunities that attract people, money, and political power. Cities account for over 70% of all economic growth. People living in metropolitan areas are 50% more productive than their rural counterparts. On average, per capita output increases 30% for every 10% increase in a country’s urbanization.¹ In response to these pressures and opportunities, cities will double in size by 2050, adding 400,000 square kilometers of built area and requiring an almost unimaginable amount of new utilities, roads, roofs, and markets.² Because of these trends, the battle for sustainable development will be won or lost with how cities develop, which in turn will be directed by how we design our urban infrastructure systems.

There is no shortage of calls to invest carefully in infrastructure. The American Society of Civil Engineer’s Report Card on Infrastructure details \$3.6 trillion dollars of critical investments needed for all roads, water systems, ports and such by 2020.³ America 2050 and the Regional Planning Association call for dramatic domestic investments in energy,

¹ Statistics are derived from: Edward Glaeser, “Cities, Productivity, and Quality of Life,” *Science* 333, no. 6042 (2011): 592–594; Edward L. Glaeser, *Triumph of the City: How Our Greatest Invention Makes Us Richer, Smarter, Greener, Healthier, and Happier* (New York: MacMillan, 2011).

² Amazingly that 400,000 square KM will occur mostly in developing countries, with all their limitations on resources, political stability, and markets: Hiroaki Suzuki et al., *Eco2 Cities: Ecological Cities as Economic Cities* (World Bank, 2010), <http://siteresources.worldbank.org/INTURBANDEVELOPMENT/Resources/336387-1270074782769/Eco2CitiesBookWeb.pdf>.

³ American Society of Civil Engineers, “2013 Report Card on America’s Infrastructure,” 2013, <http://www.infrastructurereportcard.org/>.

transportation, water, and waste infrastructure to sustain security and competitiveness.⁴ The Environmental Protection Agency (EPA) estimates U.S. communities are facing a total of \$106 billion stormwater management and combined sewer correction upgrades.⁵ The World Bank's Sustainable Cities program⁶ makes similar claims for international investments, as does the World Business Council for Sustainable Development's Urban Infrastructure Initiative.⁷

Until recently, "infrastructure" has been synonymous with engineered systems that support basic functions of modern industrialized society: transportation, energy, water, military, etc.⁸ These traditional infrastructure systems are "grey" in that they ignore, replace, or suppress the "green" ecological systems that preceded them.⁹ "Green infrastructure" has emerged as a holistic approach to re-integrating ecosystem services back into the developed landscape and into infrastructure development configurations.

What is green infrastructure?

Green infrastructure thinking and planning brings together planning, natural resource, ecological, and sustainable development concepts to provide a systems approach to infrastructure planning and development that recognizes the value of ecosystem services, and integrates those ecosystem services within the built environment. Most importantly and less well acknowledged is that green infrastructure is not limited to the physical outcome; it includes the process through which a broad network of institutions, organization, agencies, businesses, and citizens bring ecosystem services back into planning value systems and actively direct more sustainable development. It's ultimately about people making choices and advancing green infrastructure practice requires helping people make these choices. In practice however, there are an array of green infrastructure definitions being advocated that vary in terms of the scale of activity and the specific benefits they deliver.

Infrastructure to direct more sustainable forms of development

Before discussing the various interpretations of "green infrastructure" specifically, it's helpful to situate it within the assortment of environmentally friendly forms of "infrastructure" that are currently part of the sustainable development lexicon. Infrastructure is a powerful concept that communicates a systems approach to providing crucial services, defined in the Oxford dictionary as "the basic physical and organizational structures and facilities needed for the operation of a society or enterprise". We know that

⁴ Petra Todorovich, "Toward a 21st Century Infrastructure Investment Plan for the United States. America 2050.," *Regional Plan Association* (2008).

⁵ *Clean Watersheds Needs Survey - 2008 Report to Congress* (EPA, 2008), <http://water.epa.gov/scitech/datait/databases/cwns/2008reportdata.cfm>.

⁶ World Bank, "Sustainable Cities Initiative," accessed December 3, 2013, <http://www.worldbank.org/en/region/eca/brief/sustainable-cities-initiative>.

⁷ WBCSD, "World Business Council for Sustainable Development - Urban Infrastructure Initiative," accessed December 3, 2013, <http://www.wbcsd.org/urban-infrastructure.aspx>.

⁸ M. W. Doyle and D. G. Havlick, "Infrastructure and the Environment," *Annual Review of Environment and Resources* 34 (2009): 349-373.

⁹ Pierre Belanger, "Redefining Infrastructure," in *Ecological Urbanism*, ed. M. Mostafavi and G. Doherty (Lars Muller Publishers, 2010), 332-360.

the way we plan and build our infrastructure systems influence the way cities, communities, and regions develop. As environmental impacts of development have become more prevalent, infrastructure systems have been used in two general ways to frame sustainability solutions sets – including ecological systems into our understanding of infrastructure (i.e., green infrastructure); and using or adapting our engineered infrastructure to improve environmental performance (i.e., greening infrastructure) (see Table 1).

This broad range of green infrastructure solutions, in which the value of ecological systems and the services they provide are brought back into the planning and development process as a form of infrastructure, has been similarly described by various organizations as “ecological infrastructure”,¹⁰ “natural infrastructure,”¹¹ and ‘green infrastructure’ (specific definitions of this form of green infrastructure will be discussed in greater detail).

The second category describes various ways for ‘greening’ infrastructure by enhancing or including built systems that contribute to more sustainable communities, i.e. building for alternative transportation routes, integrating alternative energy grids, systematically improving energy and water efficiency, building grey infrastructure systems that minimize environmental footprints. These initiatives have been described variously as “sustainable infrastructure”¹², “smart infrastructure,”¹³ (referring specifically to the use of informational technology), and to add to the confusion, “green infrastructure” as a form of infrastructure that supports green energy.¹⁴

The ideas and strategies contained in each of these concepts are important elements of sustainability planning for cities and regions across the US (and around the world), and need to be considered and incorporated into sustainability plans as interdependent but distinct strategies. Unfortunately the assortment of ambiguous and overlapping terms creates confusion, a challenge that has been acknowledged in reports and assessments of green infrastructure.¹⁵

¹⁰ UNEP, *Securing a Green Economy through Ecosystem Management* (International Ecosystem Management Programme, 2011), <http://www.unep.org/ecosystemmanagement/Portals/7/Documents/Issues%20paper%20for%20Hi-level%20Forum%20on%20Ecosystem%20Management%20and%20Green%20Economy.pdf>.

¹¹ Todd Gartner et al., *Natural Infrastructure: Investing in Forested Landscapes for Source Water Protection in the United States* (World Resources Institute, 2013), <http://www.wri.org/publication/natural-infrastructure>.

¹² “Institute For Sustainable Infrastructure (ISI),” accessed December 3, 2013, <http://www.sustainableinfrastructure.org/>.

¹³ Steve Lohr, “Bringing Efficiency to the Infrastructure,” *The New York Times*, April 30, 2009, sec. Business / Energy & Environment, <http://www.nytimes.com/2009/04/30/business/energy-environment/30smart.html>.

¹⁴ Environment America, “Clean Energy, Bright Future: Rebuilding America Through Green Infrastructure,” 2009, <http://www.environmentamerica.org/reports/ame/clean-energy-bright-future-rebuilding-america-through-green-infrastructure>.

¹⁵ Clean Water America Alliance, *Barriers and Gateways to Green Infrastructure* (Washington D.C., 2011), <http://www.cleanwateramericaalliance.org/news-media/alliance-publications/barriers-and-gateways-to-green-infrastructure/>.

Table 1. Infrastructure approaches to environmental sustainability

	Meaning (as defined or inferred)	Source(s)	Examples
GREEN INFRASTRUCTURE			
green INFRASTRUCTURE (water specific)	Green infrastructure is an approach to wet weather management that is cost-effective, sustainable, and environmentally friendly. Green infrastructure management approaches and technologies infiltrate, evapotranspire, capture and reuse stormwater to maintain or restore natural hydrologies (EPA OW)	EPA Office of Water; American Rivers, Clean Water America Alliance, ASCE	Green roofs; bioswales, rain gardens, disconnected stormwater systems
green INFRASTRUCTURE (strategic conservation)	Strategically planned and managed networks of natural lands, working landscapes and other open spaces that conserve ecosystem values and functions and provide associated benefits to human populations (TCF)	The Conservation Fund, US Forest Service, NOAA, NARC, EPA (Region 3)	Hubs & corridors of natural areas
Ecological infrastructure	naturally occurring systems that provide ecosystem services	UNEP; Economics of Ecosystems and Biodiversity (TEEB); Society for Ecological Restoration	Wetlands, forests, aquifers, floodplains, watersheds, etc.
Natural infrastructure	Term used to describe natural capital or assets with regards to the services they provide, with particular emphasis on habitat creation and watershed management	EPA Region 3 (TCF definition); ASCE (uses the EPA water definition); BoozAllen uses it to describe systematic NR/ asset management; World Resources Institute	Watershed planning; landscape-scale conservation development planning
GREENING INFRASTRUCTURE			
Greening infrastructure	Infrastructure development with minimized environmental impact	Mostly international context: South Africa, New Zealand, EU	Vegetated swales, pervious paving, ???
GREEN infrastructure	Infrastructure that supports more sustainable or “green” communities	Environment America	Renewable energy sources, smart grids, infrastructure to promote conservation & efficiency
Sustainable infrastructure	Design and construction of all infrastructure systems that maximize triple bottom line benefits while still serving their intended purpose	Institute for Sustainable Infrastructure (APWA; ASCE; ACEC); Zofnass Program at Harvard (recently partnered with ISI); Academic design & engineering programs	Recycled content; energy & water efficiency; low-waste processes; material sourcing; ecologically-cognizant design
Smart infrastructure	NYT: “more efficient and environmentally friendlier systems for managing, among other things, commuter traffic, food distribution, electric grids and waterways...the crucial technological ingredients include low-cost sensors and clever software for analytics and visualization, as well as computing firepower.” (specific citation needed?)	Large technology firms; international consulting firms; major urban areas	Smart grid; technological advancements that facilitate more efficient city operation (i.e. traffic control)

Defining green infrastructure in the US

Green infrastructure has been defined differently by organizations and agencies in the United States over the last decade (see Appendix A for specific organization definitions). These definitions can generally be broken into two categories – green infrastructure as a strategy for using ecological features and processes to manage urban water, namely stormwater; and green infrastructure as an approach to protecting and enhancing connective networks of natural and open space at the landscape or regional scale. Each category has been championed by a core set of agencies and organizations; has been driven by different motivations and policies; has been supported by different government programs and financing sources; and has used different techniques and strategies at different scales to guide implementation.

The chronology of how green infrastructure has evolved in the US provides some insight into how the dominant interpretation of green infrastructure has emerged and matured. Aside from its obvious precursors in land planning concepts advanced by legendary urban landscape architects such as Fredrick Olmstead and others, the first formal mention of the concept of “green infrastructure” was in the report released in 1999 by the President’s (Clinton’s) Council on Sustainable Development, as one of five promising strategies for comprehensive sustainable community development, using it in the context of regional networks of open space and natural areas,

*The pace, extent, and intensity of human activities place great burdens on ecosystems and natural resources across the country. **Green infrastructure** is the network of open space, airsheds, watersheds, woodlands, wildlife habitat, parks, and other natural areas that provides many vital services that sustain life and enrich the quality of life. To obtain these benefits, many communities are increasingly promoting place-based approaches to conserve, protect, and restore local and regional systems of natural resources and amenities. The objectives of these green infrastructure strategies are somewhat different from those of traditional conservation efforts. While traditional conservation focuses on environmental restoration and preservation, it often neglects the pace, shape, and location of development in relationship to important natural resources and amenities. Green infrastructure strategies actively seek to understand, leverage, and value the different ecological, social, and economic functions provided by natural systems in order to guide more efficient and sustainable land use and development patterns as well as protect ecosystems.¹⁶*

To further expand on this concept of natural systems as a key infrastructure component to integrated conservation and development across an urbanizing landscape, the Conservation Fund, led primarily by Mark Benedict and Edward McMahon, and leaders from within the US Forest Service, spearheaded largely by dedicated staff such as Ruth McWilliams and Peggy Harwood, convened a working group to advance green infrastructure as an integral component of local, regional, and state planning processes. They defined green infrastructure as follows,

Green infrastructure is our nation’s natural life support system; an interconnected network of waterways, wetlands, woodlands, wildlife habitats and other natural areas; greenways, parks and other conservation lands; working farms, ranches and forests; and wilderness and other

¹⁶ <http://clinton2.nara.gov/PCSD/Publications/index.html>

*open spaces that support native species, maintain natural ecological processes, sustain air and water resources and contribute to the health and quality of life for America's communities and people.*¹⁷

For the six to seven years that followed, green infrastructure was discussed primarily in these terms – as a regional or landscape-scale approach to development that recognized and strived to protect and enhance connective natural features. Organizations and agencies including the Conservation Fund, the National Association of Regional Councils, the US Forest Service, US Fish and Wildlife Service, and others were active supporters and promoters of green infrastructure planning as a sustainable regional planning approach. What started as a federal-agency working group to advance green infrastructure expanded to include a broader base of stakeholders that eventually formed the National Green Infrastructure Community of Practice (GI CoP). The GI CoP was very active for the first few years, with regularly held meetings hosted on a rotating basis mostly by member agencies. Meetings included policy updates, discussions of case studies and best practices, study findings, etc. In 2006, Benedict of the Conservation Fund, a leading champion of green infrastructure, passed away. Two years later, in 2008, both McWilliams and Harwood retired from service in the US Forest Service. Corresponding with the loss of three national-scale leading champions for green infrastructure as a regional-scale conservation strategy, momentum of the movement slowed.

At the same time, another definition of green infrastructure, one that was more restrictive and potentially competing, was introduced in 2007 in another part of the federal government. The “Green Infrastructure Statement of Intent” was signed in April 2007 by the Environmental Protection Agency (EPA), National Association of Clean Water Agencies (NACWA), Natural Resources Defense Council (NRDC), Low Impact Development Center (LIDC), and the Association of State and Interstate Water Pollution Control Administrators (ASIWPCA), formalizing a

*[C]ollaborative effort among the signatory organizations in order to promote the benefits of using green infrastructure in protecting drinking water supplies and public health, mitigating overflows from combined and separate sewers and reducing stormwater pollution, and to encourage the use of green infrastructure by cities and wastewater treatment plants as a prominent component of their Combined and Separate Sewer Overflow (CSO & SSO) and municipal stormwater (MS4) programs.*¹⁸

The agreement was signed by EPA Administrator Stephen Johnson, NACWA's Dick Champion, NRDC's Nancy Stoner, LIDC's Neil Weinstein, and ASIWPCA's Dana Aunkst.

In May 2007, NRDC's Stoner and NACWA's Alexandra Dapolito Dunn published an article in Environmental Forum titled “Green Light for Green Infrastructure”, defining green infrastructure as,

¹⁷ MA Benedict and ET McMahon, “Green Infrastructure: Smart Conservation for the 21st Century,” *Renewable Resources Journal* 20, no. 3 (2002): 12–17.

¹⁸ EPA, “Green Infrastructure Statement of Intent,” 2007, http://water.epa.gov/infrastructure/greeninfrastructure/upload/gi_intentstatement.pdf.

*The use of soil, trees, vegetation, and wetlands and open space (either preserved or created) in urban areas to capture rain while enhancing wastewater and stormwater treatment.*¹⁹

In 2008, a coalition of NACWA, NRDC, LIDC, EPA, American Rivers, and ASIWPCA (now Association of Clean Water Administrators (ACWA)) co-developed and released the “Managing Wet Weather with Green Infrastructure: Action Strategy”, which defined green infrastructure as,

*[M]anagement approaches and technologies that utilize, enhance and/or mimic the natural hydrologic cycle processes of infiltration, evapotranspiration and reuse.*²⁰

With increasing pressure on municipalities and cities to control urban stormwater to comply with Clean Water Act (CWA) requirements, green infrastructure was entering the urban planning and management dialogue as a cost-effective strategy to reduce stormwater runoff volume entering sewer and stormwater systems, thus reducing the number of combined sewer overflow events and the expensive CWA violations that follow. In many ways, it fit into planners’ and developers’ existing understanding of Low Impact Development (LID) strategies, so it was not a totally alien concept. National attention to green infrastructure skyrocketed in 2008, as demonstrated by an Internet survey recently conducted by The Nature Conservancy to track the number of Google searches for the term “green infrastructure” conducted since 2004 (see Figure 2).²¹

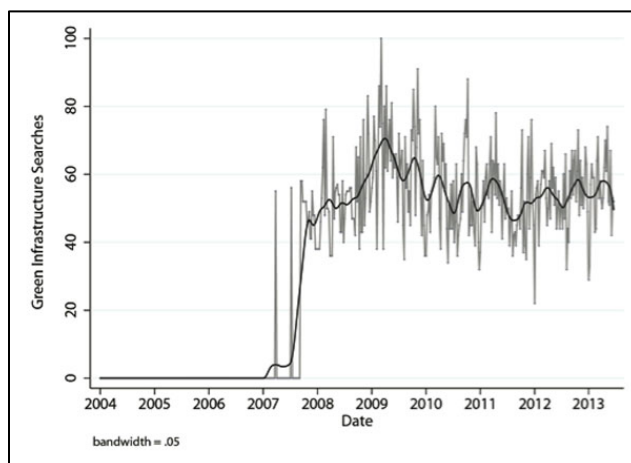


Figure 2. “Interest in “green infrastructure” measured by weekly Google searches (black line is average trend). The number 100 represents the peak search interest. Search interest is in relative terms and does not represent absolute search volumes, but rather popularity.” Source: Reddy, S. W. (2013) <http://blog.nature.org/science/2013/06/26/nature-invest-green-infrastructure/>

During the time that green infrastructure was gaining official policy recognition, Ben Grumbles was serving as the Assistant Administrator for Water at EPA. In 2010, he became the President of the Clean Water America Alliance (now the US Water Alliance); Nancy

¹⁹ A. D. Dunn and N. Stoner, “Green Light for Green Infrastructure,” *Pace Law Faculty Publications* Paper 494, Pace Law Faculty Publications (2007), <http://digitalcommons.pace.edu/lawfaculty/494>.

²⁰ EPA, “Managing Wet Weather with Green Infrastructure,” 2008, http://cfpub.epa.gov/npdes/home.cfm?program_id=298.

²¹ Sheila Walsh Reddy, “What Could Make Investing in Nature Catch On?,” *Cool Green Science - The Nature Conservancy*, June 23, 2013, <http://blog.nature.org/science/2013/06/26/nature-invest-green-infrastructure/>.

Stoner became Assistant Administrator of Water at EPA; and Alexandra Dapolito Dunn became Executive Director of the ACWA. In other words, many of the initial actors involved in brokering the initial statement of intent in 2007, all of which are accomplished environmental attorneys, had taken more influential national positions to advance water policy, and in doing so, elevated the prominence of green infrastructure as a strategic urban water management practice.

The Clean Water America Alliance, founded in 2008 and renamed the US Water Alliance in 2012, became a leading coalition organization to advance water sustainability policy with green infrastructure as a key strategy. The organization's vast membership represents a wide range of water policy and management stakeholders including public entities and agencies, private industry groups, and nonprofit organizations all dedicated to "changing the water paradigm" to advance integrated water policy and management practices. The combination of influential and savvy leadership and a member roster has raised the prominence of green infrastructure as an urban water management strategy, highlighted by the definition included on the EPA Office of Water website,

Green infrastructure is an approach that communities can choose to maintain healthy waters, provide multiple environmental benefits and support sustainable communities. Unlike single-purpose gray stormwater infrastructure, which uses pipes to dispose of rainwater, green infrastructure uses vegetation and soil to manage rainwater where it falls. By weaving natural processes into the built environment, green infrastructure provides not only stormwater management, but also flood mitigation, air quality management, and much more.²²

This coalition of organizations has been working diligently to formally incorporate green infrastructure as a recognized strategy in the EPA's revisions of stormwater regulations. Their formation of the One Water Management Network has taken this effort a step further, with almost all federal agencies represented in this group dedicated to advancing integrated and sustainable water management and policy in the US. In addition, organizations such as The Conservation Fund, which has traditionally been associated with the landscape-scale conservation interpretation of green infrastructure, have become engaged with the One Water Management Network, suggesting a bridging of the two communities.

The US Forest Service is still involved in advancing green infrastructure practice, but largely within an urban context through the National Urban and Community Forestry Advisory Council, Urban and Community Forestry Program, and as a member of the multi-agency Urban Waters Federal Partnership. The National Green Infrastructure Community of Practice that had been co-facilitated by the US Forest Service and Conservation Fund has been inactive since 2011-12.

²² Office of Water US EPA, "Green Infrastructure," Policies & Guidance, accessed December 4, 2013, <http://water.epa.gov/infrastructure/greeninfrastructure/>.

Green infrastructure is more than a bioswale or a green roof or a forested corridor – it’s a different way of thinking about infrastructure. Understood as a multi-scale network of ecological features and systems that provide multiple functions and benefits, it provides a systems approach to planning and development that recognizes the value of ecosystem services and strives to integrate and enhance those ecosystem services within our built environment.

The rise in popularity of green infrastructure as a water management strategy is not surprising when you consider multi-million and even billion dollar municipal sewer and stormwater systems upgrades towns, cities, and regions are facing to comply with water quality regulations. Green infrastructure offers a cost effective alternative for reducing stormwater volume rather than having to expand capacity of their grey infrastructure systems. The argument for cost-effectiveness is strengthened when you consider the other benefits green infrastructure features and networks provide to the communities they service.

The two interpretations of green infrastructure – (1) as a landscape-scale network of natural and open spaces; and, (2) the use of ecological features and processes to manage water – are not mutually exclusive and in fact, are arguably complementary strategies for guiding more sustainable forms of development. Green infrastructure is more than a bioswale or a green roof or a forested corridor – it’s a different way of thinking about infrastructure. Understood as a multi-scale network of ecological features and systems that provide multiple functions and benefits, it provides a systems approach to planning and development that recognizes the value of ecosystem services and strives to integrate and enhance those ecosystem services within our built environment. Green infrastructure is not limited to a particular type of technology or feature doing a specific job; it’s the result of a wide network of institutions, organization, agencies, businesses, and citizens bringing ecosystem services back into planning and development. It’s ultimately about people and organizations making that choice. Realizing green infrastructure’s full potential requires coordination and collaboration across multiple boundaries – political, jurisdictional, agency, organizational, sectoral, disciplinary, professional, to name just a few. The most significant challenge for advancing a robust and integrated form of green infrastructure may be one of leadership and collective action.

Guiding Principles of Green Infrastructure

Green infrastructure, like the broader concept of sustainable development, is inherently contextual and will take different forms and follow different processes according to local and regional values and norms. As much as an inclusive definition would provide clarity, it would do little to guide its contextual planning, adaptation, and implementation. Rather than recommending a single definition, we observed three key guiding principles across

many of the definitions, as well as in practice, which embody green infrastructure in its most robust sense.

Principle 1: Green infrastructure as a systems approach to integrating ecosystem services into the landscape at multiple scales

Central to the idea of green infrastructure is the recognized value of ecosystem services to society, and the desire formally incorporate them into planning and development considerations. Ecosystem services are broadly defined as the benefits people derive from functioning ecosystems and are traditionally classified into four categories²³:

- Provisioning services that include the production of tangible products and materials such as food, fresh water, fiber, etc.
- Regulating services that perform beneficial processes such as climate regulation, water regulation and purification, pollination, etc.
- Cultural services that provide nonmaterial and often intrinsic value such as aesthetic quality, emotional and spiritual significance, cultural heritage, recreational and touristic value, etc.
- Supporting services that facilitate and support all ecosystem service production including nutrient cycling, soil formation, primary production processes, etc.

We recognize these services as critical to human existence and within the context of urban development, as incredibly important for vibrant and sustainable places, but because their value is generally not reflected in the market, they are largely left out of the development budgeting process. We don't pay for them now, but most estimates suggest that we could not afford to replace them.²⁴ Cities, town, and regional planners and managers are increasingly aware of the importance of ecosystem services, but have lacked a compelling argument for incorporating them as a critical service to the urbanizing environment. Green infrastructure provides a politically and economically salient organizing framework to accomplish that.

However, a lone stretch of road or a single phone pole, disconnected from a larger network, are not considered infrastructure. Likewise, a single green roof or a random scattering of street trees are not going to produce the level of ecosystem services required to support vibrant and sustainable cities. Like (and at times unlike) its grey counterparts, green infrastructure is fundamentally a systems-based approach, occurring at multiple nested scales, creating a connective network of features building on each other to provide essential ecosystem services to the communities it serves. Scales of green infrastructure can and do include site-scale projects, city or community-wide networks and policies of implementation, and regional plans and networks of open and natural spaces. State and national scale networks also exist. Connectivity in this sense can take the form of linear networks (i.e. hubs and corridors), inter-scalar networks (i.e. site to city to regional scale plans and projects), or even programmatic/ policy networks (i.e. implementation is

²³ Joseph Alcamo et al., *Ecosystems and Human Well-Being: A Framework for Assessment*, 2003.

²⁴ Robert Costanza et al., "The Value of the World's Ecosystem Services and Natural Capital," *Nature* 387, no. 6630 (1997): 253-260.

coordinated through a strategic plan such as homeowner incentive programs) (see Figure 3).

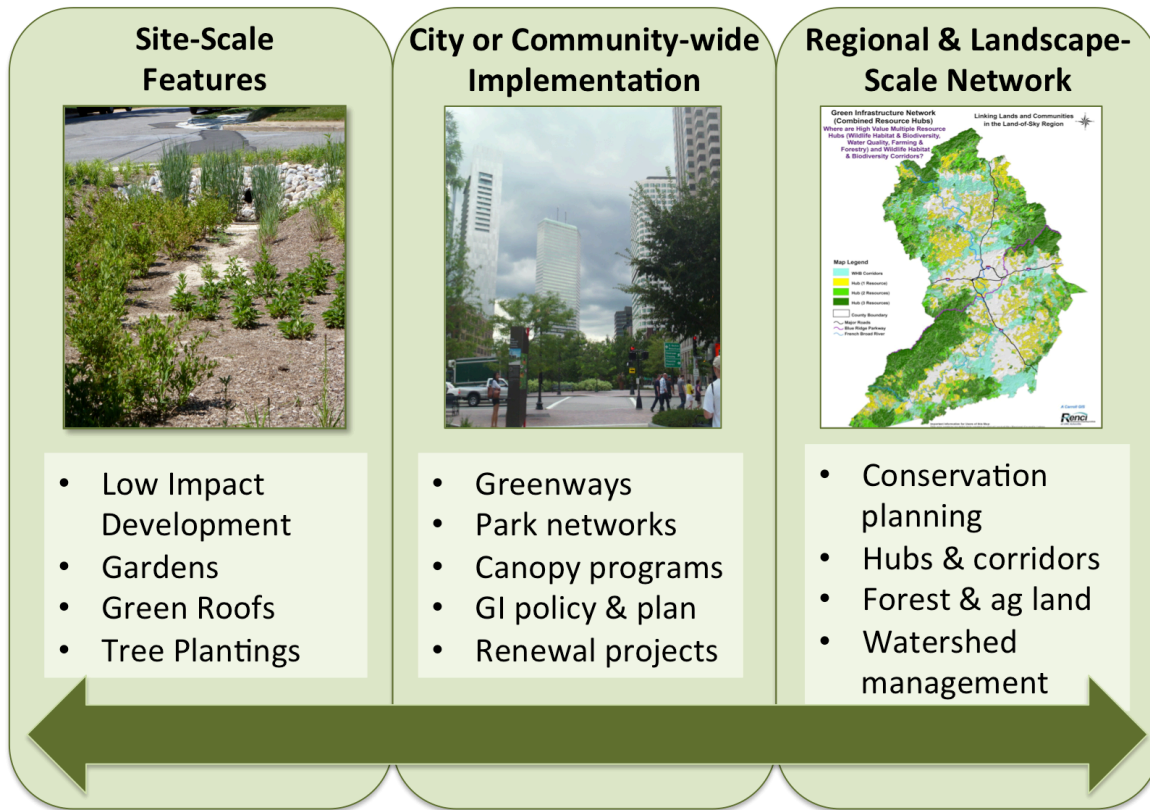


Figure 3. Nested scales of green infrastructure include site-scale projects, community or city-wide implementation plans as part of regional-scale network.

Leading proponents of green infrastructure are not suggesting replacing all grey infrastructure systems with ecological or natural alternatives. Concrete, polymers, fiber optics, pumps, and the multitudes of synthetic materials and technologies provide critical public safety, public health, and efficiency solutions. These materials will continue to play an essential role in sustainable development, ideally integrated seamlessly with ecological systems in a mutually supportive design.

Principle 2: Green infrastructure is multifunctional and provides a range of environmental, social, and economic benefits

Green infrastructure, whether we are talking about an urban forest, a park, a green roof, or a regional greenway, provides several ecosystem services simultaneously, or is multifunctional. The multifunctionality of green infrastructure arguably creates efficiencies in urban planning and development investments.²⁵ For example, a network of green roofs, bioswales, urban forests, and rain gardens can capture, infiltrate, filter, and

²⁵ Environmental Finance Center - UMD, *Encouraging Efficient Green Infrastructure Investment* (University of Maryland, 2012).

store rain, and thus reduce the investment required in engineering storm water treatment systems. At the same time, this green infrastructure network is reducing energy consumption by shading and insulating, improving public health by providing open space access to underserved populations, sequestering carbon, creating habitat for wildlife, birds and insects, and improving property values of adjacent lots.

Investing in green infrastructure projects can also provide jobs. Scoping studies for Philadelphia's impressive and aggressive green infrastructure efforts, for example, estimates the potential for a significant green infrastructure industry cluster of more than 2,400 firms employing more than 32,000 people and generating in excess of \$7.4 billion in sales.²⁶ This study further argues that public investments in green infrastructure provide one of the more effective policy strategies to promote job growth, especially among less skilled workers and providing public investment in green infrastructure can create a viable workforce and economic development trajectory. In fact, the report estimates that investments in green infrastructure "...create over 16 percent more jobs dollar-for-dollar than a payroll tax holiday, nearly 40 percent more jobs than an across-the-board tax cut, and over five times as many jobs as temporary business tax cuts."

Principle 3: Green infrastructure is boundary spanning and requires inter-agency and cross-sector collaboration

By virtue of the fact that green infrastructure systems and networks span traditional spatial, functional, and governance boundaries, advancing its practice requires an array of stakeholders working collaboratively at all scales. To reiterate, green infrastructure is more than a physical system; it's the outcome of a series of decisions to integrate ecosystems back into the built environment. This cannot happen in silos; it requires many different actors thinking holistically and proactively about the future of a place. Just as green infrastructure provides several simultaneous benefits, its design, implementation, and management requires simultaneous engagement by a variety of stakeholders at multiple spatial and organizational scales. For example, just at the local level, a park system that concurrently provides stormwater benefits as well as recreational opportunity, alternative transportation access, and habitat falls under the purview of several city or county departments. How these departments or agencies choose to work together will determine the long-range integration and management of green infrastructure as a viable system-wide solution.

Drivers of Green Infrastructure

More than definitions or abstract principles, green infrastructure's power comes from illustrations of its utility in addressing real world challenges. We examined more than seventy green infrastructure projects and initiatives in the US to identify the predominant drivers or motivations for pursuing green infrastructure initiatives.

Six dominant drivers emerged from the case examinations (see Figure 4):

- **Regulatory Compliance** - namely Clean Water Act with some instances of Safe Drinking Water Act, and Endangered Species Act

²⁶ Green for All, *Water Works: Rebuilding Infrastructure, Creating Jobs, Greening the Environment*, 2011, <http://greenforall.org/focus/water/water-works-rebuilding-infrastructure-creating-jobs-greening-the-environment/>.

- **Climate Adaptation & Mitigation** - including flood and drought mitigation, carbon sequestration, and reducing urban heat island effect
- **Ecologically Responsive Growth Management** – regional and state scale planning efforts to guide development towards non-critical habitat and ecological areas
- **Habitat Conservation** – plans with a specific conservation goals
- **Asset & Risk Management** – holistic planning efforts that recognize the economic and competitive value of natural assets, as well as their role in mitigating risk
- **Community & Economic Development** – the use of green and natural features to enhance the livability and economic competitiveness of an area.

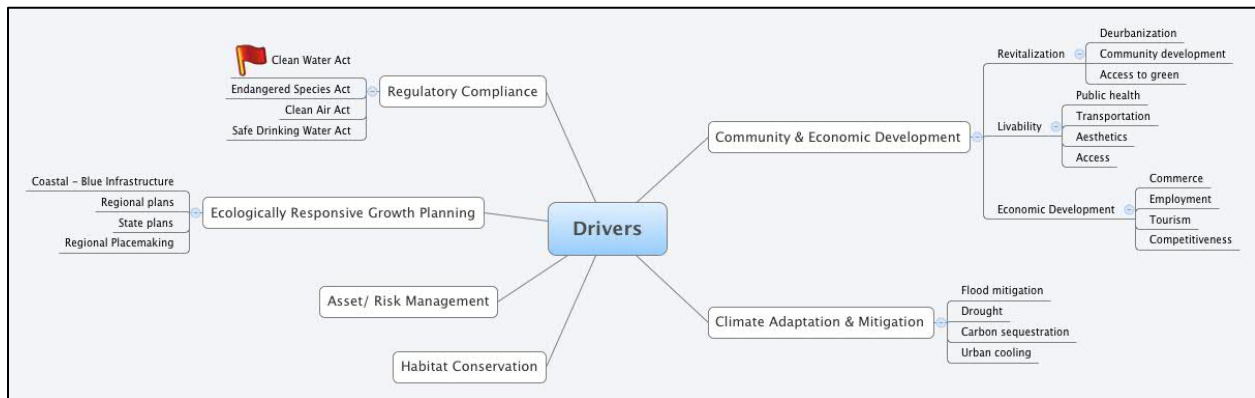


Figure 4. Predominant drivers of green infrastructure planning and implementation initiatives in the US

Regulatory Compliance

The most common driver for green infrastructure adoption and implementation among cities and regions is to comply with federal regulations, chiefly the Clean Water Act (there are a few cases of citing the use of green infrastructure strategies to comply with Endangered Species Act, Clean Air Act, and Safe Drinking Water Act requirements, but Clean Water Act compliance is by far the most common). Under the Clean Water Act, municipalities are facing increasingly rigorous standards with regards to water pollutant discharge, either as part of Total Maximum Daily Load (TMDL) implementation plans or as part of National Pollutant Discharge Elimination System (NPDES) permitting programs. The goal of both of these programs is to reduce and restrict stormwater discharge in terms of pollutant loads and volume into local tributaries, which many cases entails huge investments in water infrastructure upgrades. Green infrastructure solutions have emerged as a cost effective way to reduce the volume of stormwater by enhancing natural infiltration processes. Rather than investing in all grey infrastructure upgrades to expand capacity, an increasing number of cities and regions are looking to green infrastructure as a viable way to meet their stormwater reduction goals while also benefiting from the other functions and values green infrastructure provides.

Climate Adaptation & Mitigation

Numerous cities and regions across the US are working to reduce their impacts on the atmosphere (mitigation) and to prepare for anticipated impacts of future climatic conditions (adaptation). Green infrastructure is one in an array of urban sustainability strategies being employed for achieving these goals. As a mitigation strategy, green infrastructure can help reduce urban heat island effect by increasing green areas and moisture that naturally cools the air, and in turn, reduces energy consumption to maintain cooler temperatures.²⁷ Soils and trees also serve to sequester carbon. As an adaptation strategy, green infrastructure can provide a number of benefits depending on the context of the situation. Restored and conserved floodplains and wetlands help absorb storm surges and protect against flooding events²⁸; foliage and green space in the place of asphalt and concrete reduces storm water run-off. Some cities are also re-evaluating and adapting their existing green infrastructure plans and programs to reflect future conditions; for example, Chicago is planting southern climate adapted sweet gums and swamp oaks instead of white oaks that have traditionally thrived in northern climates.²⁹

Ecologically Responsive Growth Management

Particularly at regional, landscape, and even state scales, green infrastructure plans can guide development in ecologically responsive directions. Maintaining connective networks of green space (e.g., forests, riparian buffers, meadows, working landscapes) provides important ecosystem services to surrounding communities and contributes to the regional character: sometimes framed as placemaking and economic competitiveness. Organizations such as The Conservation Fund and Trust for Public Land emphasize this driver as the foundation for green infrastructure, providing training and assistance to regions to inventory and map the natural assets of the region as a comprehensive green infrastructure layer for regional comprehensive plans. Regional councils and governments are often engaged in employing this form of green infrastructure, though their specific drivers may vary. This approach to green infrastructure relies more heavily on land conservation and proactive planning to direct growth rather than retrofitting existing built space. Maryland provides a good example of comprehensive state-scale green infrastructure planning that has been expanded to include coastal “blue infrastructure” assets and resources in its development plans.³⁰

Habitat Conservation

Often coupled with ecologically responsive growth management, regulatory compliance (namely the Endangered Species Act), and/or more urban ecology motivations such as conserving pollinator and bird populations, there are a variety of cases across the US where green infrastructure has been used as a strategy to conserve habitat for indigenous species.

²⁷ Office of Atmospheric Programs EPA, *Reducing Urban Heat Islands: Compendium of Strategies*, 2008, <http://www.epa.gov/heatisland/resources/pdf/TreesandVegCompendium.pdf>.

²⁸ The Conservation Fund, “Flood Management,” accessed December 5, 2013, <http://www.conservationfund.org/our-conservation-strategy/focus-areas/flood-management/>.

²⁹ Leslie Kaufman, “With Eye on Climate Change, Chicago Prepares for a Warmer Future,” *New York Times*, May 22, 2011, sec. Science.

³⁰ Maryland Dept of Natural Resources, “Maryland’s Green Infrastructure Assessment,” accessed December 5, 2013, <http://www.dnr.state.md.us/greenways/gi/gi.html>; National Oceanic and Atmospheric Administration, “Using Green Infrastructure Planning to Prioritize Coastal Resources in Maryland,” accessed December 5, 2013, <http://www.csc.noaa.gov/digitalcoast/stories/greenmaryland>.

Drawing on principles of landscape ecology and conservation biology, the idea behind this approach to green infrastructure is to conserve hubs of intact green space as islands of habitat and maintain their connectivity through a network of corridors. This physical manifestation is the basis for The Conservation Fund's interpretation of green infrastructure, though other places have taken a more holistic approach to integrating green infrastructure into the landscape in order to improve overall environmental quality. Portland, Oregon is one example where green infrastructure is employed as a water quality strategy for maintaining habitat quality in the Columbia River for the endangered fish species.³¹

Community & Economic Development

Reflected in its multifunctionality, green infrastructure also provides a range of ecosystem services that contribute to improving quality of life. As such, green infrastructure is being used in an increasing number of cities and regions to contribute to community and economic development efforts. In urban centers such as Denver, Minneapolis, and Boston, green infrastructure has been employed as a strategy to restore river corridors and greenways for recreation, alternative transportation routes, drawing commerce and tourism, and celebrating heritage. Cleveland has applied green infrastructure as an approach for reclaiming delinquent and contaminated properties, and restoring them as green assets to the community to improve property values, provide employment opportunities, offer social spaces, and restore pride in communities.

Asset & Risk Management

Green infrastructure does not serve a single purpose; it can provide a full range of benefits proportionate to scale of implementation and coordination of actors. One of the most holistic cases of green infrastructure planning and implementation we observed was in Portland, Oregon, where green infrastructure thinking and practices was formally integrated into city-wide planning and operations as an asset and risk management strategy.³² In this case, there was wide recognition and agreement of the value of investing in green infrastructure solutions to address stormwater management, habitat protection, climate adaptation and mitigation, as well as community and economic development. In formalizing it at this level, green infrastructure became a central consideration in city planning and management.

Green Infrastructure Stakeholders at the National Scale

At the national level within the US context, there are many agencies, organizations, and industries working to build support for green infrastructure solutions through influencing policy and dedication of resources (see Figure 5). These actors can generally be delineated into two distinct networks segregated by different interpretations of the principal goals of

³¹ Jim Robbins, "With Funding Tight, Cities Are Turning to Green Infrastructure," *Yale360*, August 23, 2012, http://e360.yale.edu/feature/with_funding_tight_cities_are_turning_to_green_infrastructure/2564/; ENTRIX, Inc., *Portland's Green Infrastructure: Quantifying the Health, Energy, and Community Livability Benefits* (CITY OF PORTLAND BUREAU OF ENVIRONMENTAL SERVICES, February 16, 2010), www.portlandonline.com/bes/index.cfm?a=298042&c=52055.

³² City of Portland, *City of Portland Asset Status and Conditions Report*, 2007, <http://www.portlandoregon.gov/bps/article/233289>.

green infrastructure, namely stormwater management, and ensuring connected and continuous networks of green space.

Within the federal government, the two agencies that have been most involved with advancing the two distinct interpretations of green infrastructure have been the Environmental Protection Agency (specifically the Office of Water) and the USDA Forest Service (specifically the community and urban forestry program), respectively, though other agencies have been involved in varying capacities. As discussed earlier, the network formed around stormwater management, driven in large part by regulatory compliance pressures under the Clean Water Act, has had significant influence in directing the discourse in recent years. The 2007 formal Statement of Intent initiated by the coalition of EPA, NRDC, LIDC, NACWA, and ASIWPCA garnered over 100 signatories including municipalities, industry groups, and NGOs, (see Appendix B).

Beyond the dichotomy: Federal stakeholders in green infrastructure functions

If we consider the functions and benefits of green infrastructure systems aside from specific definitions, the list of federal agencies that support green infrastructure types of policy and practice gets much longer (see Appendix C for a list of federal agencies and programs with a stake in green infrastructure outcomes that were most salient at the time of publication). The length of the list in Appendix C is indicative of 1) the vast federal landscape of federal agencies and programs that localities seeking technical or financial support must navigate; 2) the challenge of coordination and efficiency in supporting green infrastructure at the federal level.

It is possible that many of these agencies may not formally consider the practices they support to be “green infrastructure” per se, but this is not stopping communities and regions from tapping into the federal resource pools for help implementing their green infrastructure initiatives on the ground. For example, resources from federal agencies including HUD, HHS, EPA, and DOT are being leveraged and utilized to increase and improve access to networks of green space for public health and community development. Resources from HUD, NOAA, EPA, USFS, FWS, ACE, and DOT are helping cities and regions use green infrastructure strategies to mitigate urban heat islands and floodplain functionality in the face of changing climatic conditions. Federal programs such as the USDA, NPS, DOI, BLM, EPA, USFS, DOD, and FWS are all contributing to landscape scale green infrastructure that provides valuable ecosystem services at the local level. Green infrastructure is a strategy that can contribute to many federal goals, including creating employment³³, improving the economic competitiveness and resilience of cities and regions, providing access to recreational space for public health, protecting environmental quality, and helping communities and regions comply with federal regulations. There is an opportunity for much greater coordination at the federal level to efficiently and effectively support green infrastructure.

³³ <http://www.greenforall.org/resources/water-works>

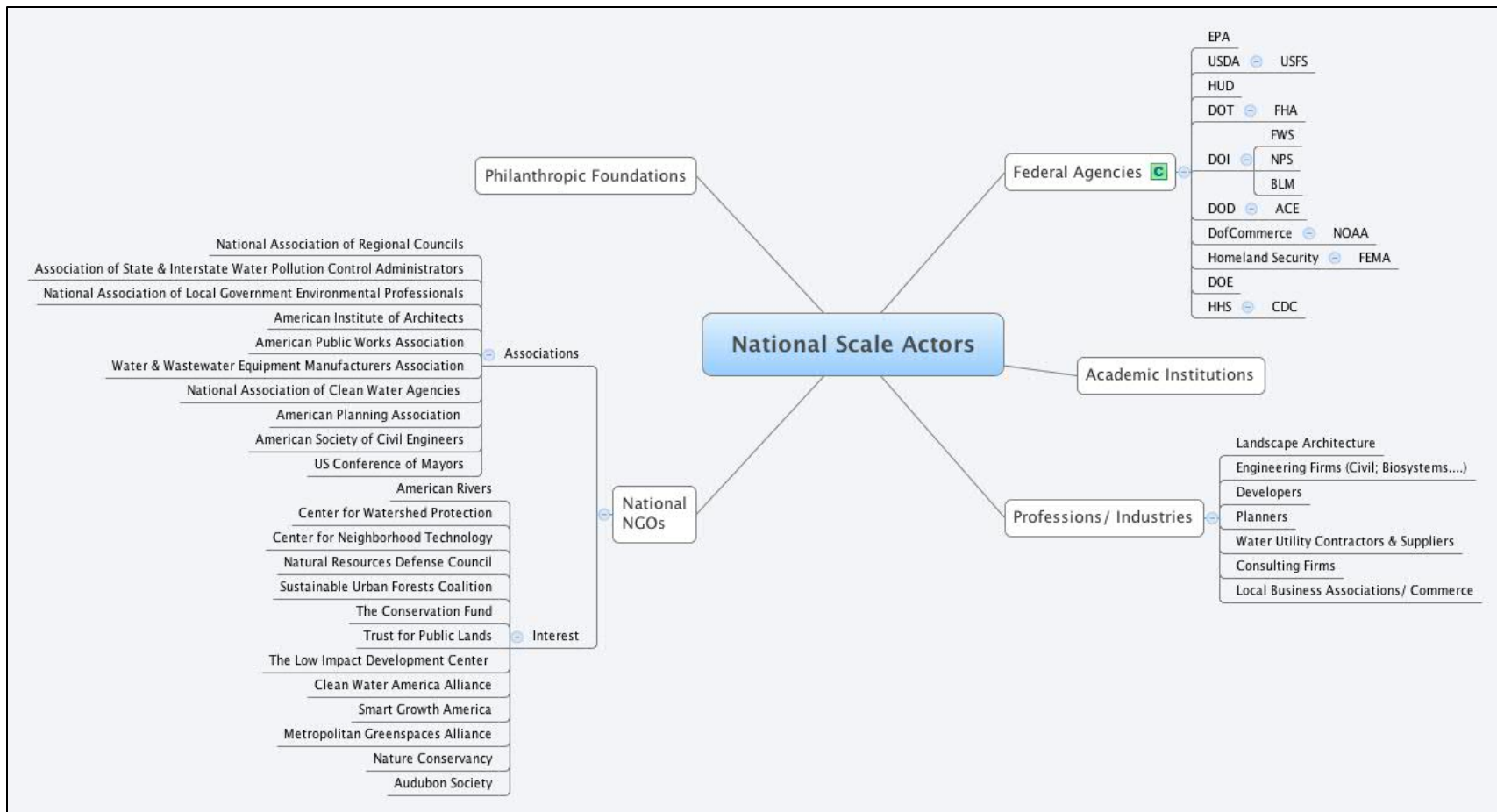


Figure 5. National scale actors supporting the advancement of green infrastructure in the US.

As with many other such initiatives, the challenge is fostering greater cooperation across agencies to support green infrastructure in practice. While multifunctionality is touted as an advantage to green infrastructure, that same benefit can be met as a barrier to implementation in a highly segmented and compartmentalized governance system. Cross-linkages on agency websites suggest that there is at least tacit awareness of other agency's green infrastructure initiatives, even if its not being actively coordinated. This lack of coordination translates to inefficiency at the top levels and confusion at the ground level.

In an effort to organize the different federal agency programs according to the benefit areas of green infrastructure they support through technical and financial support, our project team of Virginia Tech's Center for Leadership in Global Sustainability and the National Association of Regional Councils, in partnership with the Environmental Finance Center at the University of Maryland, created a web-based "roadmap" to green infrastructure the programs that are most appropriate for the drivers they are responding to (see Figure 6). Each of the green dots are linked to a page describing the green infrastructure relevant programs maintained by the agency, and a link to current opportunities. This "roadmap" is hosted on the NARC website³⁴ with links available on the CLiGS site.

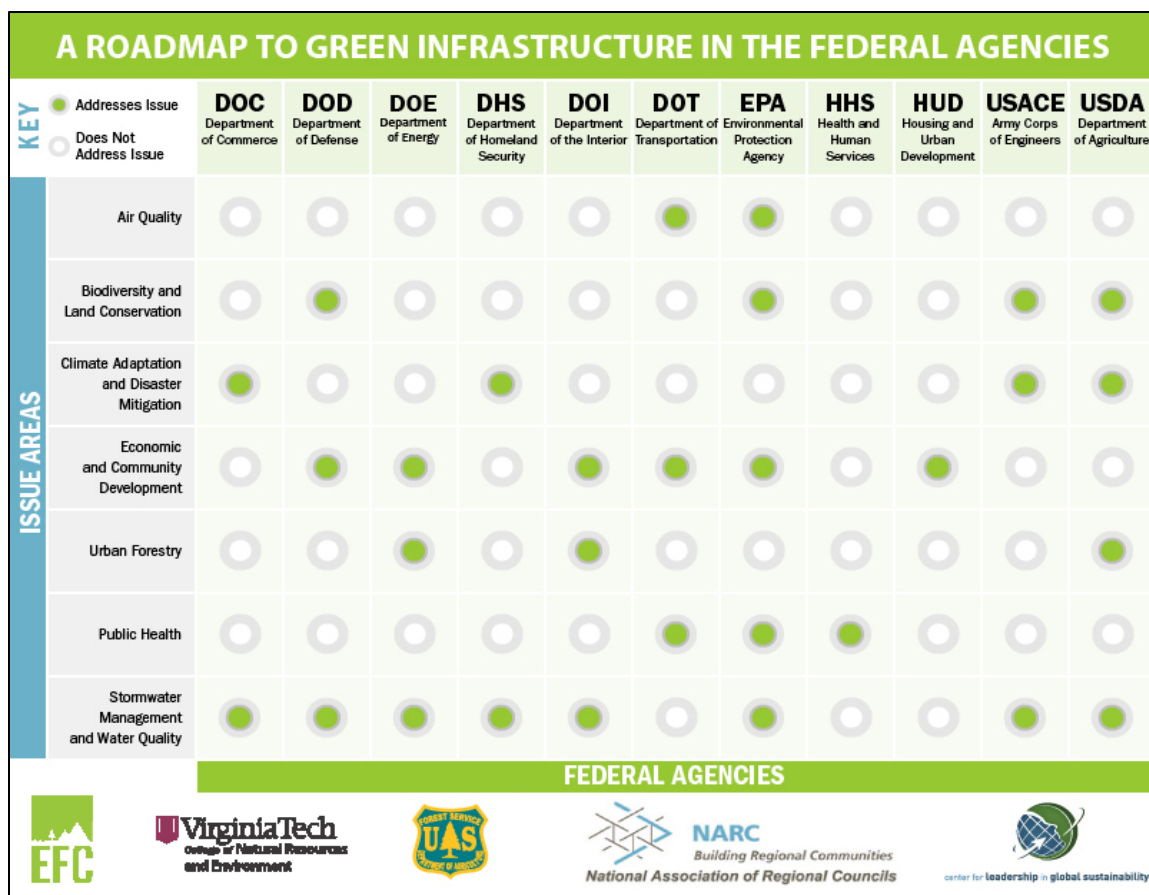


Figure 6. "Roadmap" tool designed to help communities and practitioners sort through the federal agency programs supporting green infrastructure work

³⁴ <http://narc.org/issueareas/environment/areas-of-interest/green-infrastructure-and-landcare/roadmap/>

Green Infrastructure in Practice

The motivations of external (i.e. national scale) actors in supporting green infrastructure tells us a lot about the value of green infrastructure in theory, but only by examining green infrastructure in practice do we begin to see its practical value, as well as the opportunities and challenges communities, cities, and regions are facing in bringing it into reality. We were warned early and wisely not get trapped by trying to be exhaustive. Our goal was not to identify and examine every green infrastructure project and initiative in the US, but rather to examine a range of cases to get a general sense of the trends of green infrastructure practice in the US. We examined more than 70 cases in varying levels of detail to derive the information presented here. Though there are a few statewide plans in existence, namely in Maryland and Florida, we focused primarily on regional, city, and community scale initiatives. The focus was on the institutions, the motivations, actor networks, strategies, successes, and challenges.

Green Infrastructure Networks

Regions, cities, and communities across the US are considering and implementing green infrastructure strategies in response to the variety of issues and drivers discussed earlier, and there are often a wide range of actors associated with the place that have a stake in the outcome. From what we observed, these stakeholders often form a network that collectively engage in the planning, design, and implementation of green infrastructure initiatives. The composition and diversity of network actors, the processes the network goes through, the efficacy of networks vary widely, but we did observe some consistencies and best practices.

Green infrastructure is often not the rallying point for the formation of the networks – finding a solution to a shared problem is what draws stakeholders in, and green infrastructure becomes part of the solution set.

Network Formation

The agencies, organizations, people, businesses, etc. that engage in the network is often determined (at least initially) by the precipitating issue that the region, city, or community is trying to address. In other words, green infrastructure is often not the rallying point for the formation of the networks – finding a solution to a shared problem is what draws stakeholders in, and green infrastructure becomes part of the solution set. This is an important distinction for supporting agencies and organizations to recognize in framing green infrastructure.

The range of network actors and the timing of their engagement appear to make a difference in terms of the degree to which green infrastructure is integrated as a systematic solution, as well as the level of commitment to the outcomes. For example, in situations where the driver has been complying with Clean Water Act regulations and only water utilities were engaged in the network, the green infrastructure solutions have been relatively narrowly defined, maintained, and utilized. In other situations where green infrastructure has been proposed as an integrated solution with a broad range of actors

engaged early in the planning stages, the result has been city-wide implementation of green infrastructure to address a broad set of goals.

Network Roles

Catalyst: The first steps in forming a network are often initiated by an agency, organization, or high-profile individual with a direct stake in the issue at hand and how it is addressed. This **catalyst** serves as the champion of green infrastructure as part of the solution set, and engages other stakeholders in the process. We identified a variety of types of actors playing this critical role including local NGOs, elected officials, public agencies, and regional planning commissions (see Figure 7). Though the actions of the catalyst are often in the name of an organization or agency, in reality, it's often a few select individuals embedded within these groups that provide this energy, or a high-profile champion that has credibility across stakeholder groups. This can create a challenge if the individual exits the scene and momentum has not been institutionalized.

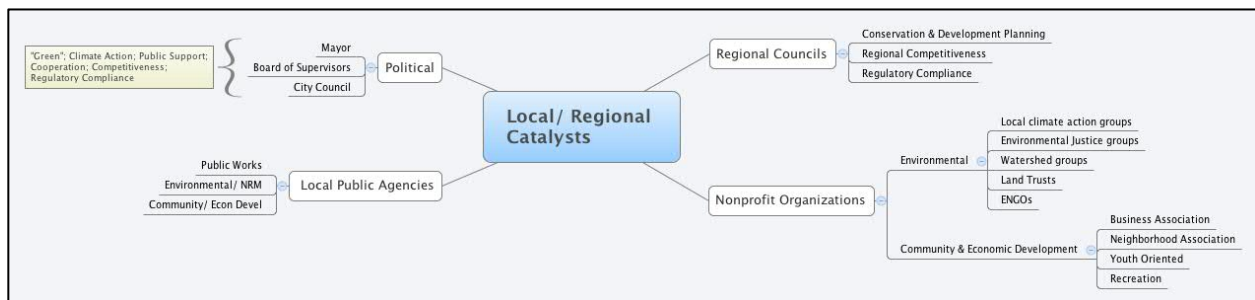


Figure 7. Types of local scale actors that serve as catalysts for green infrastructure initiatives.

Broker: Once the catalyst has initiated the process of considering green infrastructure as part of the solution to the prevailing issue, the network broker identifies and engages the appropriate stakeholders in the discussion. Sometimes the catalyst plays this role; sometimes it's a different actor (group or individual), but it's often a dedicated part of someone's job. The broker provides a vital function in ensuring that the right stakeholders are involved and in coordinating the interactions and activities of the network. The long-term success of green infrastructure initiatives has a lot to do with the work of the broker.

Supporting Roles: In addition to the facilitating roles played by the catalyst and broker, successful green infrastructure implementation networks require engagement by a number of other stakeholder groups that can support the following elements of planning and implementation:

- Political – gaining political support for green infrastructure initiative, or at least serving as a political liaison to keep local officials informed
- Education & Engagement – facilitating public engagement process and activities; serving as the liaison between public interest and initiative development
- Planning & Design – working within local codes and ordinances and with the best available science to plan and design green infrastructure projects that respond to identified goals

- Policy – working within the local policy framework to facilitate the development of compliant green infrastructure projects or to negotiate for their approval
- Financing – developing and facilitating a financing strategy for green infrastructure implementation and maintenance
- Operations & Management – brings an understanding of the unique considerations and constraints of managing a dynamic ecological system; informs the budgeting process for maintaining green infrastructure; trains workforce.

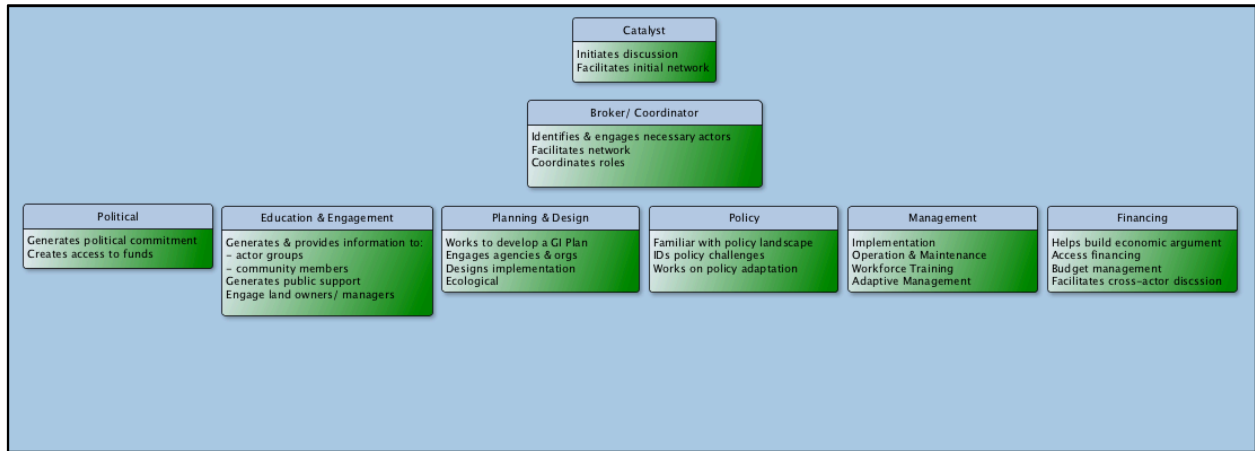


Figure 8. Green infrastructure network roles

Barriers to Implementation

There has been no shortage of reports and conference discussions articulating and working to address some of the most common barriers to green infrastructure implementation. In 2011, the Clean Water America Alliance conducted a nation-wide survey of mostly water utility professionals to gauge the most prevalent barriers to implementation³⁵. Though the responses they received were largely referring to green infrastructure driven by stormwater management and Clean Water Act compliance, in our review of the data, we found that the broad categories of barriers were consistent across scales of implementation. We expand on those categories of barriers here.

Community & Institutional

Despite its promise as a cost effective, multi-beneficial strategy for delivering valuable ecosystem services to society and efficiently contributing to a range of goals, green infrastructure faces challenges to implementation; top among them is simply deviating from the status quo. Gray infrastructure solutions have become the norm for managing issues such as stormwater, transportation, and energy; landscape-scale conservation has been seen as a luxury or inhibiting growth. Making the case for green infrastructure and

³⁵ Clean Water America Alliance. 2011. <http://www.cleanwateramericaalliance.org/news-media/alliance-publications/barriers-and-gateways-to-green-infrastructure/>

gaining widespread support requires a compelling vision, innovative thinking, extensive outreach, and interdisciplinary and inter-sectoral cooperation.

- **Communications** – Green infrastructure is fundamentally about investing in the provision or protection of ecosystem services. However, as largely unmeasured and unpriced services, the value of doing so can be difficult to communicate. This communications and values challenge creates barriers in gaining political and community (e.g., tax payer) support. This communications challenge is increased as a result of definitional confusion.
- **Risk aversion** – We have come to expect and rely on engineered solutions to fix infrastructure problems. Using green infrastructure in place of grey solutions can be seen as a risk, open to uncertainties and potential failure. This view is seen among engineering firms and planners facing data gaps, politicians investing in solutions, and interestingly, by environmental groups unwilling to compromise the performance standards of proven grey solutions for the potential benefit of other ancillary benefits.
- **Cooperation** – As a network of multifunctional features across the city or region, green infrastructure cannot be designed, implemented, and managed in a vacuum. Multifunctionality should be seen as a benefit and efficiency, but operationally, it creates challenges, as it is an inherently cross-agency and cross-sectoral undertaking that requires cross-boundary cooperation and coordination. Public-public (or inter-agency) cooperation is necessary as green infrastructure cross-cuts traditional infrastructure systems and areas of responsibility. Public-private cooperation is necessary because green infrastructure entails a different approach to planning, implementation, and maintenance that ideally should not be isolated to public entities.

Budgeting & Financing

The financial barriers to green infrastructure are substantial. A parallel study was done by the Environmental Finance Center based out of the University of Maryland to address these challenges in greater depth. The highlights of their findings are summarized and included here.

- **Life-cycle costs** – A frequently cited challenge to green infrastructure is that it is perceived as expensive, but that perception may simply reflect a sense of uncertainty in terms of performance and long-term maintenance costs. There is limited data to demonstrate the life-cycle costs of many green infrastructure practices or their cost relative to other strategies that provide comparable services.
- **Demonstration of benefits** – The multifunctionality of green infrastructure often includes tangible and intangible benefits, which can be difficult to measure or illustrate. This complicates the process of demonstrating cost-benefit ratios and return on investment projections for green infrastructure.

- **Budgeting & Accounting** – Green infrastructure is a different type of system than traditional grey infrastructure because it's a dynamic, living system that requires adaptive management to maintain its functionality. This creates challenges for traditional budgeting and accounting processes as the life-cycle of different features vary: some features (e.g., trees) appreciate over time rather than depreciate; projects may not fall into traditional capital improvement project categories; maintenance costs may vary over; etc.
- **Financing** – Availability of resources to plan, design, implement, and maintain green infrastructure is a fundamental challenge to communities, cities, and regions. Federal funds are available to support some green infrastructure initiatives depending on the driver and outcomes, but these almost always need to be leveraged with other sources of financing.
- **Cost of conservation** – Green infrastructure at the regional and state-wide scale relies on the strategic permanent conservation of land, which can be prohibitively expensive at a large scale. This barrier is increased by the fact that land conservation does not count towards water management goals, as it does not result in a net runoff reduction, thus creating a negative incentive for some locations to invest in this form of green infrastructure.

Policy & Governance

Rules and regulations at all levels of government can present barriers to pursuing green infrastructure strategies as a viable part of the solution set.

- **Local level** – At the local level, zoning, building, road, and even health codes and ordinances can restrict the ways in which green infrastructure can be designed and installed on the landscape. The duration of the permitting process for green solutions (rather than grey) has also been cited as a barrier.
- **State level** – States policies and laws can also present confines on how green infrastructure is realized. For example, strict technical requirements or design standards for particular solutions may preclude the use of green infrastructure solutions. Lack of inter-agency coordination and integration can result in conflicting guidance. Also, in different states, water and land use and access policies can impede implementation of green infrastructure strategies, as well as their maintenance.
- **Federal level** – Particularly with regards to using green infrastructure for stormwater management in order to comply with Clean Water Act requirements, there are significant policy barriers to incorporating green infrastructure as part of the solution set, though there are substantial efforts underway to address these issues. These barriers include whether green infrastructure can and should count as part of compliance strategies, and in turn, what impact does that have on the

timeline for compliance, and the availability of federal resources to implement it. Data gaps to demonstrate performance of green solutions, particularly urban forests and natural areas (as opposed to site-specific bioengineered technologies) is a significant limitation for federal policy recognition.

- **Accountability** – Green infrastructure is a networked, and thus fundamentally decentralized system of features and spaces across the landscape that performs a variety of valuable services. Spatial decentralization (including potentially private property) and cross-agency coordination raises concerns for accountability. If a green infrastructure element is part of a public park that also serves stormwater management services and is maintained by a neighborhood organization, who is accountable to ensure it is performing the functions it was designed for?
- **Incentives** – At all levels, there is a perceived lack of incentives to take the “perceived risk” of pursuing green infrastructure as part of the solution set, specifically as part of a regulatory compliance plan.

Technical & Information

Insufficient information about the performance, short and long-term costs, benefits, and management strategies for green infrastructure elements and systems is a fundamental barrier to its widespread adoption and implementation; but this is an area that is seeing a lot of activity and is improving.

- **Demonstration of benefits** – The multifunctionality of green infrastructure often includes tangible and intangible benefits, which can be difficult to measure or illustrate. This complicates the process of demonstrating cost-benefit ratios for green infrastructure, particularly as its physical form will depend heavily on the context in which it's being applied.
- **Design standards** – Green infrastructure essentially integrates dynamic ecological features and functions into existing systems, creating additional design variables and thus potentially changing the performance of the system. In some situations, the lack of design standards for green infrastructure precludes them from implementation. In other situations, it presents a perceived risk and liability for engineers to go outside of the industry standard.
- **Performance data** – Hand in hand with design standards, there is a gap (though it is shrinking) in terms of performance data to support the use of green infrastructure to deliver anticipated benefits, namely stormwater infiltration and filtration services.
- **Operations & maintenance** – Green infrastructure is a dynamic system that requires monitoring and a more adaptive form of management. This presents a

barrier to many local, city, or regional governments for how to budget for operations and maintenance, and how to train or employ maintenance staff.

Part II - Advancing Green Infrastructure Practice

The goal at the outset of this project was to examine and map the institutional landscape supporting green infrastructure in the US in order to identify opportunities to build capacity among practitioners and policymakers at the local to national level. We have the opportunity to (re)conceptualize what a “community of practice” could and should look like in the context of the current state of green infrastructure as a concept and practice in the US. As this concept has been shifting and the institutional landscape supporting it has been evolving throughout the course of the study period, we have had a unique opportunity to observe trends. We have also had an opportunity to compare the emergence and operationalization of green infrastructure and the comparable concepts of ecological and natural infrastructure in different parts of the world.

We articulated the goals of this project by asking two guiding questions, which have held up throughout the course of the study, and help frame our recommendations:

- *What are strategic scales, policies, programs, and partnerships for implementing green infrastructure in the US?*
- *What is and could be an effective institutional support system for green infrastructure in the US?*

What are the strategic scales, policies, programs, and partnerships for implementing green infrastructure?

Developing a strategic plan for advancing and implementing green infrastructure needs to start with how it is framed, presented, and perceived. Just as other types of infrastructure systems provide an unambiguous service and value, green infrastructure needs to be framed as a solution, not an end unto itself. Road systems are crucial because we demand transportation services; electrical grids are important because we depend on reliable supplies of electricity to power our society. Likewise, green infrastructure systems provide ecosystem services that are vital, to our communities and economy. The concept of ecosystem services has gained traction because it communicates the value and utility of environmental systems and processes to humans. Green infrastructure is a systematic strategy for reintegrating these services back into planning and decision-making processes as a way to achieve sustainable development goals.

Numerous studies and tools have been released in the past few years to attempt to quantify the value of ecosystem services. Many of the methods embedded in these studies and tools have received criticism that is inevitable when taking on the task of valuing what has otherwise not been quantified or assigned value. But articulating the value of the services green infrastructure provides, and demonstrating the costs versus benefits of 1) not having these services or 2) having to replace these services with technocratic solutions will be key to advancing the rate of green infrastructure adoption and implementation in the US. Two key framing concepts that resonate with regards to climate change and can be inferred for green infrastructure at both the place-scale (towns, cities, and regions), as well as at the

national scale, are *risk management* and *public health*.³⁶ The terms ‘resilience’, ‘security’, ‘health’, ‘efficiency’, etc. communicate the idea of mitigating against risks that threaten the stability and competitiveness of place, and accurately depict value green infrastructure provides, particularly for decision-makers. Likewise, emphasizing the co-benefits of green infrastructure for improving air quality, reducing urban heat, as well as the range of cultural ecosystem services relating to human health and well-being, (See Tzoulas et al. (2007)³⁷ for full review) would likely increase the support for green infrastructure among citizens.

Scale:

Green infrastructure features and practices range from site-scale projects (e.g., bioswales; green roofs; rain gardens), to city or community wide programs (e.g., green streets; urban forestry programs; greenways), to landscape scale connective networks of open and natural spaces (e.g., Green Prints; regional GI plans; blue infrastructure plans). In some cases, these different scales of practice are seen as independent from each other. Site-scale green infrastructure practices are popular among stormwater regulators, engineers, and public works departments being pushed by regulatory compliance drivers because they are discrete units where performance can be measured and accountability can be assigned. In isolation, these practices are valuable, but unless implemented in a holistic and systematic way, the multifunctionality benefit is reduced.

Rather than framing these as competing scales, they should be framed, planned, and depicted as a nesting of scales, where site scale projects are networked spatially and programmatically at the neighborhood, community, and city scales, extending out into the surrounding region. This approach requires regional cooperation, which depends on developing a common vision for the future of that place, and aligning leadership and decision-making to operationalize that vision.

In some cases, the regional definition might be a watershed, where green infrastructure provides water regulation and purification services to meet regulatory and municipal drinking water protection goals, as is advocated in WRI’s concept of “natural infrastructure”.³⁸ In other cases, it might be an interstate region where a common planning district is serving as the catalyst and broker for facilitating regional development. In yet other cases, the most strategic scale of green infrastructure implementation might be limited to a particular city or community where drivers are spatially limited to that place, such as the case with Cleveland’s “Re-Imagining Cleveland” program that is using green infrastructure practices as an urban renewal strategy (see Appendix D for case study).³⁹

³⁶ “Yale Project on Climate Change Communication,” accessed December 8, 2013, <http://environment.yale.edu/climate-communication/>.

³⁷ K Tzoulas et al., “Promoting Ecosystem and Human Health in Urban Areas Using Green Infrastructure: A Literature Review,” *Landscape and Urban Planning* 81, no. 3 (2007): 167–178.

³⁸ Gartner et al., *Natural Infrastructure: Investing in Forested Landscapes for Source Water Protection in the United States*.

³⁹ “Reimagining Cleveland,” *Neighborhood Progress Inc.*, accessed December 5, 2013, <http://www.npicle.org/places/urban-greening/about-reimagining-cleveland/>.

The temporal scale of green infrastructure is another challenge that must be considered in advancing the concept and practice. Unlike its grey counterpart, green infrastructure is not a stable and static system. As a living and dynamic system, it grows and matures as opposed to depreciating like typical grey infrastructure systems, requiring different management and accounting processes and metrics. Green infrastructure requires an adaptive management approach occurring slowly over time as the system and its surrounding conditions change. This must be taken into account in municipal and regional management plans and budgets.

Policies & Programs:

In a parallel study conducted on green infrastructure financing strategies, the Environmental Finance Center at University of Maryland⁴⁰ identified pervasive challenges relating to coordination, financing mechanisms and processes, and cohesion across federal agencies impeding the larger-scale development of green infrastructure networks, which are consistent with our observations and recommendations for program and policy change. In short, the fragmentation of definitions, policies, funding streams, government programs, even data and communications, is the green infrastructure movement's weakest link at this time. Over the course of this study period, we observed some shift towards greater coordination and cohesion at the national and federal level. For example, the EPA Office of Water's official definition of green infrastructure has recently been modified to better reflect the multi-functional and multi-scalar nature of the approach, better aligning with other federal programs and priorities in the process.

In 2011, the definition posted on the EPA website read:

Green infrastructure is an approach to wet weather management that is cost-effective, sustainable, and environmentally friendly. Green Infrastructure management approaches and technologies infiltrate, evapotranspire, capture and reuse stormwater to maintain or restore natural hydrologies.

In December 2013, the definition is much more explicit about the multiple benefits green infrastructure provides and is much less technical, while still emphasizing its application to water management,

Green infrastructure is an approach that communities can choose to maintain healthy waters, provide multiple environmental benefits and support sustainable communities. Unlike single-purpose gray stormwater infrastructure, which uses pipes to dispose of rainwater, green infrastructure uses vegetation and soil to manage rainwater where it falls. By weaving natural processes into the built environment, green infrastructure provides not only stormwater management, but also flood mitigation, air quality management, and much more.

Programmatically, it's important for federal agencies to recognize the challenges they pose to local implementation by creating overlapping and at times conflicting definitions and programs that support green infrastructure. Greater coordination among these programs is necessary. Three major inter-agency partnership programs that support green infrastructure initiatives as a multifunctional and networked approach to urban

⁴⁰ Environmental Finance Center - UMD, *Encouraging Efficient Green Infrastructure Investment*.

sustainability are a promising step in this direction. The Urban Waters Federal Partnership⁴¹, with representation from most of the major federal agencies, supports local green infrastructure initiatives through its mission is to,

Reconnect urban communities, particularly those that are overburdened or economically distressed, with their waterways by improving collaboration among federal agencies and collaborating with community-led revitalization efforts to improve our Nation's water systems and promote their economic, environmental, and social benefits.

The Partnership for Sustainable Communities⁴² is a partnership between HUD, DOT, and EPA to “coordinate federal housing, transportation, water, and other infrastructure investments to make neighborhoods more prosperous, allow people to live closer to jobs, save households time and money, and reduce pollution.” This partnership offers mostly knowledge and technical support to communities, but also provides a platform for a member agencies to better coordinate their sustainable community development goals and funding programs.

Eco-Logical is a third inter-agency program geared mostly towards coordinating intra-governmental planning and data collection and sharing around ecosystem-based mitigation for major infrastructure development projects. Facilitated by the Federal Highway Administration within the US Department of Transportation with seven other major federal agencies as signatories, the Eco-Logical program

Encourages Federal, State, tribal and local partners involved in infrastructure planning, design, review, and construction to use flexibility in regulatory processes...and puts forth the conceptual groundwork for integrating plans across agency boundaries, and endorses ecosystem-based mitigation - an innovative method of mitigating infrastructure impacts that cannot be avoided.

In September 2012, the White House Council on Environmental Quality and EPA sponsored an invitation only conference with key federal agencies and national-scale stakeholders to discuss the multiple benefits that green infrastructure provides, identify barriers to implementation, and evaluate options for better coordinating programs and funding. This conference led to a statement issued by the White House in January 2013, issued specifically from the Chairman of the Council on Environmental Quality and Director of Intergovernmental Affairs, indicating a commitment from the Administration to work with federal agencies to “align their resources to make it easier for municipalities to build and invest in green infrastructure,” and to “support efforts to leverage federal funding programs, green infrastructure set-asides, and other resources to mobilize private financing.”⁴³ In October 2013, the EPA released their 2013 Strategic Agenda for advancing green infrastructure, emphasizing the multifunctionality of green infrastructure and listing better federal coordination as a top priority

Green infrastructure is a distributed approach to water management that advances many community priorities – from air quality management to urban renewal. As a holistic approach

⁴¹ Office of Water EPA, “Urban Waters Federal Partnership,” accessed December 5, 2013, <http://www.urbanwaters.gov/>.

⁴² EPA, HUD, and DOT, “Partnership for Sustainable Communities,” accessed December 5, 2013, <http://www.sustainablecommunities.gov/index.html>.

⁴³ White House Council on Government, “Building the Future: Innovative Water Infrastructure,” January 18, 2013, <http://www.whitehouse.gov/blog/2013/01/18/building-future-innovative-water-infrastructure>.

that crosses traditional boundaries between federal programs, green infrastructure can most effectively be implemented by aligning the priorities and investments of relevant federal agencies.⁴⁴

Partnerships:

Green infrastructure is not simply its physical form; it is the outcome of a wide network of institutions, organization, agencies, businesses, and citizens actively choosing to bring ecosystem services into planning and development processes as a way to solve problems and provide vital services. This requires coordination at the federal level, as described above, as well as greater collaboration across the wide range of stakeholders at the local and regional scales. We elaborate on our recommendations for partnerships strategies and arrangements in the following section on effective institutional support systems.

What is and could be an effective institutional support system for green infrastructure?

To more effectively support green infrastructure as a robust, multifunctional system of natural and ecological features embedded into the urbanizing landscape requires the coordination and collaboration of a wide range of actors and stakeholder groups working toward a shared vision of what can achieve on the ground. This must happen at both the national scale across agencies and organizations supporting green infrastructure, as well as at the local/ regional scale among place-based stakeholder groups involved in implementation and affected by the outcomes.

Horizontal Structure: National Scale

At the national level, there must be greater horizontal coordination across federal agencies and programs, with the support and in cooperation with the major national non-governmental actors. This has already started to occur under the leadership of the EPA Office of Water, with a particular emphasis on urban water management, which was confirmed in the statement released by the White House in January 2013⁴⁵ and the EPA's Strategic Agenda for Green Infrastructure released in October 2013.⁴⁶ The US Forest Service is included in this White House statement as a federal agency that maintains existing programs in support of green infrastructure and we recommend aligning with this emphasis on green infrastructure primarily as a stormwater management strategy with co-benefits, but with an emphasis on (re)incorporating urban forests and tree canopy as among the green infrastructure features that contributes to water management. The National Association of Regional Councils and Center for Leadership in Global Sustainability are currently engaged in follow-up study of communities and regions that have successfully established green infrastructure programs with a robust urban forestry component to identify the barriers to incorporation of trees as part of the suite of practices, and to identify best practice for including them.

⁴⁴ Office of Water EPA, *Green Infrastructure Strategic Agenda 2013* (EPA, October 2013), http://water.epa.gov/infrastructure/greeninfrastructure/upload/2013_GI_FINAL_Agenda_101713.pdf.

⁴⁵ White House Council on Government, "Building the Future."

⁴⁶ EPA, *Green Infrastructure Strategic Agenda 2013*.

Another initiative that offers promise for greater horizontal coordination at the national scale is the establishment of the One Water Management Network in 2012, which includes representatives from more than twenty research foundations, national trade associations, federal agencies, and NGOs to support and advance integrated water management policy in the US. The last meeting held in June 2013 included more than 60 attendees from the full range of organizations and agencies that have supported green infrastructure in its many interpretations, including The Conservation Fund and the US Forest Service, suggesting a bridging between and among the various interpretations of the concept.

Horizontal Structure: Local/ Regional

As this report has reiterated, one of green infrastructure's greatest strengths is its multifunctionality, particularly when implemented as part of a systematic, multi-scalar plan and network. At the local and regional scale, green infrastructure is implemented relative to context – in other words, the motivations for pursuing green infrastructure and its consequent planning and design are often in response to a specific driver, as we discussed in Part I of this report. Whether this driver is regulatory compliance or neighborhood revitalization, green infrastructure presents a slightly different paradigm in urban planning and development that requires engaging and getting buy-in for this strategy as part of the solution set from the full range of stakeholders. We contend that the process and structure for this engagement effort is directly related to the extent to which stakeholders are able to cooperate and collaborate across boundaries, and in turn, the degree to which green infrastructure can be implemented as a multi-scalar network and formally recognized for its full range of benefits and functions.

Structurally, we found that institutional arrangements that support and sustain implementation of multi-scalar and multifunctional green infrastructure systems at the local and regional scale generally include a diverse range of stakeholders that share a common vision for how to respond to the driver. These stakeholders collaborate from an early stage on how to coordinate their efforts towards that common vision using green infrastructure. This is reflective of the *collective impact* organizational framework, in which a group of key actors from different sectors, disciplines, professions, organizations, etc. commit to a common agenda for solving a specific problem.⁴⁷ The concept of collective impact emerged from the social innovation literature, which recognizes that complex problems that demand social change (i.e. attitudes, behaviors, norms, standards) across a diversity of actor groups cannot be accomplished through processes and strategies that target isolated impacts. Collaboration across these actor groups is required to affect simultaneous and systematic change.

According to John Kania and Mark Kramer⁴⁸, the leading scholars on collective impact initiatives, what sets this apart from other types of collaborative arrangements such as multi-stakeholder initiatives or public-private partnerships is the presence of five conditions that foster long-term commitment:

⁴⁷ John Kania and Mark Kramer, "Collective Impact," *Stanford Social Innovation Review* 1, no. 9 (2011): 36–41.

⁴⁸ John Kania and Mark Kramer, "Embracing Emergence: How Collective Impact Addresses Complexity," *Stanford Social Innovation Review* (2013).

- **Common Agenda** – All participants have a shared vision for change including a common understanding of the problem and a joint approach to solving it through agreed upon actions
- **Shared Measurements** – Collecting data and measuring results consistently across all participants ensures efforts remain aligned and participants hold each other accountable
- **Mutually Reinforcing Activities** – Participant activities must be differentiated while still being coordinated through a mutually reinforcing plan of action
- **Continuous Communication** – Consistent and open communication is needed across the many players to build trust, assure mutual objectives, and create common motivation
- **Backbone Support** – Creating and managing collective impact requires a separate organization with staff and a specific set of skills to serve as the backbone for the entire initiative and coordinate participating organizations and agencies.

We have not observed these conditions in many cases of green infrastructure implementation in the US, particularly where green infrastructure is being applied as a technical solution to address stormwater management challenges without much concern or recognition for the broader impacts it can provide. While this narrow interpretation of green infrastructure for isolated impact may not require broad stakeholder engagement, it also may not maximize the value green infrastructure systems can provide for sustainable urban development. One case that does demonstrate collective impact for urban renewal using green infrastructure thinking is Cleveland, Ohio (see Appendix D and www.greeningthegrays.org for an expanded case study). The institutional support system that was formed to advance the Reimagining Cleveland agenda using green infrastructure thinking (among other strategies) provides an excellent example of how the collective impact framework can support the implementation of robust inter-scalar and multifunctional green infrastructure systems.

As mentioned in an earlier section, the same research team of NARC and CLiGS is currently engaged in a follow-up project to examine the process for how these stakeholder engagement processes result in more or less robust forms of green infrastructure system implementation, with a particular emphasis on the inclusion of urban forests as part of the system. We will be using the collective impact framework among others to examine the steps, relationships, and processes for effective collaboration to achieve green infrastructure's maximum impact. The results of this study will ideally guide local and regional scale practitioners in how to organize for collective impact using green infrastructure practices.

Vertical Structure: National & Local/Regional

In addition to structures and processes that better facilitate coordination and collaboration at the national scale and on the ground, it's important to develop institutional systems that facilitate communication and information and knowledge exchange between the two scales. In this regard, we echo the recommendations of the Environmental Finance Center report that a new forum that draws on the elements of the former National Green

Infrastructure Community of Practice (GI CoP) would be beneficial to advancing green infrastructure in policy and practice.

One of the challenges the former iteration of the GI CoP faced was that it was attempting to facilitate dialogue and exchange at all of these levels simultaneously. Though its origins were as a federal agency working group to advance the conversation about green infrastructure across federal agencies, it became a forum for federal agencies, state-level agencies, local and regional level practitioners, as well research organizations, supporting NGOs and others. Much of the agenda for GI CoP meetings was dominated by discussion taking place a mid-level bureaucratic level, which meant that while much information was shared, it was not in a form or context that could filter up to higher-level decision making, nor down to the ground where it could be practically applied. The CoP was also working across definitions at a point when the divergence in the community of practice was just recognizing the schism, which may have added to the challenge of facilitating coherent dialogue and demonstrating value to participants.

The role of a re-imagined forum should be to facilitate dialogue between an already coordinated federal level green infrastructure cross-agency program and practitioners. This forum would ideally be designed for two-way exchange, in which practitioners receive information from the federal representatives, but also have an opportunity to provide input back up to inform national scale policy and decision making. These forums could be facilitated online or through periodic meetings. Organizing the forums by region, as is the case with the active, predominantly listserv, network facilitated Mid-Atlantic Green Infrastructure Community of Practices (MAGICOP), would make the information provided through the forums more regionally and contextually applicable, thus increasing the value of participation and likely retention rate of active participants.

Conclusions

The stated goal of this project was to map the institutional landscape of green infrastructure in the United States to provide a better understanding of national scale stakeholders' efforts and coordination to support its advancement, and in doing so, identify opportunities for improvement. Evaluating the effectiveness of national scale efforts and making recommendations for improvement required a closer look at green infrastructure planning and implementation at the local and regional scales to determine if the work at the national scale was aligning with needs on the ground. Meanwhile, the institutional landscape for green infrastructure support at both national scale and local/regional scales over the duration of this study period were in rapid transition. Since the commencement of this project, green infrastructure has shifted from a concept predominantly associated with landscape scale conservation planning to a more urban focused strategy for urban stormwater management. With that definitional and functional shift came a change in dominant stakeholder groups supporting and advancing green infrastructure policy and practice, and in turn, a confusing array of programs and policies that supported different and sometimes conflicting interpretation of green infrastructure.

This shift towards emphasizing green infrastructure's utility for stormwater management, a major driver for many urban and urbanizing communities facing Clean Water Act compliance challenges, made green infrastructure a more prominent concept among urban planning and management practitioners. What was left behind in defining green infrastructure in a narrowly technical way were the broader range of ecosystem services and co-benefits that these ecological features and systems provide communities, services and benefits that had been advanced and prioritized in previous iterations of the concept. However, the pendulum is starting to swing back towards green infrastructure as a multifunctional, multiscale system of ecological features that are being championed as a cost-effective stormwater management strategy that simultaneously provides a range of co-benefits. There is also evidence that the need to coordinate federal programs across functional boundaries is starting to occur, most notably with the statement issued from the White House in January 2013 calling for inter-agency coordination. The time might now be right for the US Forest Service and aligned partners to provide renewed leadership to the green infrastructure movement through reinvigorating the national green infrastructure community of practice or similar forum for peer-to-peer learning and joint action.

At the local and regional scale, green infrastructure networks and support structures are taking very different forms, some with greater success than others. We are pleased to currently be engaged in a follow-up study to examine what processes and structures facilitate more robust forms of green infrastructure at specific local-regional scales and we look forward to sharing our findings with the burgeoning community of place-based green infrastructure practitioners and the organizations and institutions that support them across the US.

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Appendices

Appendix A. Definitions of green infrastructure as of Fall 2011

American Rivers - Green infrastructure is an approach to water management that protects, restores, or mimics the natural water cycle. Green infrastructure is effective, economical, and enhances community safety and quality of life. <http://www.americanrivers.org/our-work/global-warming-and-rivers/infrastructure/water-infrastructure-background.html#WiGI>

Center for Neighborhood Technologies - Green infrastructure is the interconnected network of open spaces and natural areas, such as greenways, wetlands, parks, forest preserves and native plant vegetation, that naturally manages stormwater, reduces flooding risk and improves water quality. <http://greenvalues.cnt.org/green-infrastructure>

Clean Water America Alliance - Green infrastructure (also known as low impact development) is a set of techniques, technologies, management approaches and practices that can be used to eliminate or reduce the amount of stormwater and nonpoint source runoff including water and pollutants that run into combined sewer overflow systems. <http://www.cleanwateramericaalliance.org/index.php>

EPA Office of Water - Green infrastructure is an approach to wet weather management that is cost-effective, sustainable, and environmentally friendly. Green Infrastructure management approaches and technologies infiltrate, evapotranspire, capture and reuse stormwater to maintain or restore natural hydrologies. http://cfpub.epa.gov/npdes/home.cfm?program_id=298

Green Cities, Great Lakes: The Green Infrastructure Report (Ecojustice Canada) - 'Green infrastructure' is a relatively new concept that uses many old techniques. Commonly thought of as the interconnected network of forests, wetlands, waterways and other areas that maintain natural ecological processes, green infrastructure also refers to engineered, human-designed systems that mimic nature in function. Integrating the conservation and enhancement of natural green spaces with engineered green infrastructure system to dramatically reduce the impacts of development and environmental damage in the urban environment. <http://www.ecojustice.ca/publications/reports/the-green-infrastructure-report>

Land Policy Institute (MSU) - Green infrastructure is the physical environment within and between our cities, towns and villages. It is a network of multi-functional open spaces, including formal parks, gardens, woodlands, green corridors, waterways, wetlands, forest, and open countryside. It comprises all environmental resources...Green Infrastructure becomes part of the persona of a place, but it is hard to create if the fixed natural assets are not present to begin with. http://www.landpolicy.msu.edu/modules.php?name=Pages&sp_id=455

Lincoln Institute of Land Policy - A network of landscaped and/or natural areas threading through a site. It includes features such as street trees, landscaped boulevards, riparian stream corridors, wetlands, or wooded areas. Green infrastructure provides residents of high-density neighborhoods with a vital connection to the natural world as well as many environmental benefits including absorption of storm water. http://www.lincolninst.edu/subcenters/visualizing-density/glossary.aspx#green_infrastructure

National Association of Regional Councils - Green Infrastructure is our Nation's natural life support system - an interconnected network of protected land and water that supports native species, maintains natural ecological processes, sustains air and water resources and contributes to the health and quality of life for America's communities and people. <http://www.narc.org/activities/environment/green-infrastructure-and-landcare.html>

President's (Clinton) Council on Sustainable Development (1998) - The pace, extent, and intensity of human activities place great burdens on ecosystems and natural resources across the country. "**Green infrastructure**" is the network of open space, airsheds, watersheds, woodlands, wildlife habitat, parks, and other natural areas that provides many vital services that sustain life and enrich the quality of life. To obtain these benefits, many communities are increasingly promoting place-based approaches to conserve, protect, and restore local and regional systems of natural resources and amenities. The objectives of these green infrastructure strategies are somewhat

different from those of traditional conservation efforts. While traditional conservation focuses on environmental restoration and preservation, it often neglects the pace, shape, and location of development in relationship to important natural resources and amenities. Green infrastructure strategies actively seek to understand, leverage, and value the different ecological, social, and economic functions provided by natural systems in order to guide more efficient and sustainable land use and development patterns as well as protect ecosystems.

Sustainable Cities Institute - by the Home Depot Foundation - The multifaceted nature of green infrastructure means that it can meet multiple municipal goals in cost-effective ways. For example, open green spaces can serve both recreational and stormwater management purposes. Effectively harnessing the power of green infrastructure systems requires appropriate planning and coordination. A strategic approach must therefore be proactive and supported by good policy articulated in local ordinances and regulations. Public awareness, public/private/nonprofit partnerships, and community buy-in are other key components to success.

http://www.sustainablecitiesinstitute.org/view/page.basic/casestudy/tag.topic/community_support;jsessionid=62ECBF1168ABACBB1CFB9AAD549689B5

The Conservation Fund - Green infrastructure is strategically planned and managed networks of natural lands, working landscapes and other open spaces that conserve ecosystem values and functions and provide associated benefits to human populations. <http://www.greeninfrastructure.net/content/definition-green-infrastructure>

US Conference of Mayors - The interconnected network of open spaces and natural areas, such as greenways, wetlands, parks, forest preserves and native plant vegetation, that provide wildlife habitat, natural drainage, recreational opportunities and help to sustain our Nation's cities. http://www.usmayors.org/urbanwater/policyres_06c.asp

http://www.usmayors.org/urbanwater/policyres_06c.asp

US Forest Service - Strategic conservation planning using a **green infrastructure** approach focuses on how to identify the best lands to conserve and the best lands to accommodate development, in order to help communities balance environmental and economic goals through strategies that lead to smarter, sustainable land uses. <http://www.fs.fed.us/ucf/subject.html>

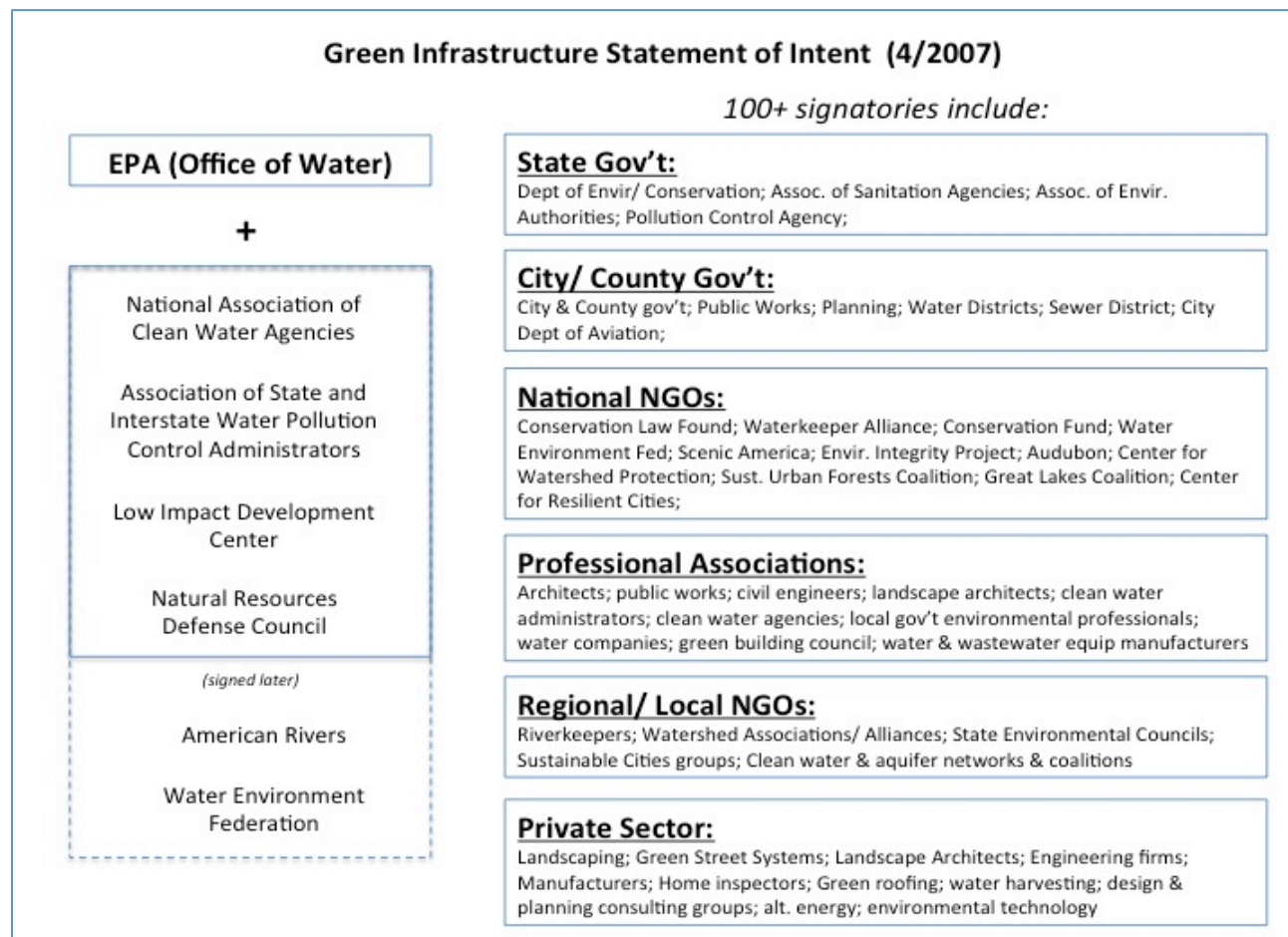
<http://www.fs.fed.us/ucf/subject.html>

495/ Metrowest Partnership (MA) - Green infrastructure is the preservation, restoration or creation of facilities that utilize natural processes or technological innovation to recycle stormwater, conserve energy and protect habitat, in a way that encourages connectivity, supports development and is environmentally and economically sustainable.

http://www.495partnership.org/index.php?option=com_content&view=article&id=39&Itemid=87

Appendix B. Signatories of Statement of Intent signed April 2007

“The purpose of this Statement is to formalize a collaborative effort among the signatory organizations in order to promote the benefits of using green infrastructure in protecting drinking water supplies and public health, mitigating overflows from combined and separate sewers and reducing stormwater pollution, and to encourage the use of green infrastructure by cities and wastewater treatment plants as a prominent component of their Combined and Separate Sewer Overflow (CSO & SSO) and municipal stormwater (MS4) programs. The Statement is intended to describe and facilitate cooperation, collaboration, coordination, and effective communication among the signatory organizations. We encourage other organizations that support green infrastructure to join us in this initiative.”



Appendix C. Federal stakeholders to green infrastructure outcomes

EPA – There are many office of the EPA involved in promoting green infrastructure, but the Office of Water is by the most visible and dominant.

- **Office of Water** - Green infrastructure features and technologies has been introduced as a strategy for reducing the volume of stormwater entering municipal stormwater systems. Municipalities that have combined sewer and stormwater systems and who are being forced to reduce their combined sewer overflow (CSO) events under the Clean Water Act are finding green infrastructure as cost-effective means of reducing volume. EPA's Office of Water has formally recognized green infrastructure as practice for addressing these stormwater issues. The Office of Water is also responsible for the protection of drinking water under the Safe Drinking Water Act, which has also been demonstrated as a utility for green infrastructure.
- **Office of Air & Radiation** - Administers the Community Action for a Renewed Environment (CARE) program, a “competitive grant program that offers an innovative way for a community to organize and take action to reduce toxic pollution in its local environment” which many communities have used to implement green infrastructure projects.
- **Office of Solid Waste and Emergency Response** – Responsible for Brownfield remediation projects, which many communities have used to implement green infrastructure projects.
- **Office of Policy** – Housed under the Office of the Administrator, OP administers three programs that have supported green infrastructure types of projects and initiatives, though not through regulatory channels – Partnership for Sustainable Communities; Climate Change Adaptation; and the Office of Strategic Environmental Management
- **Chesapeake Bay Executive Order** – As part of the action plan developed to respond to the CB EO, each state in the watershed is required to develop a Watershed Improvement Plan for meeting the permitted Total Maximum Daily Loads (TMDLs). The EPA is working with states to develop these plans, which will likely entail green infrastructure strategies.

USDA - US Forest Service - The US Forest Service is the primary agency involved with promoting the development of green infrastructure in the US. Though there appears to be great potential for the Natural Resource Conservation Service to engage in the effort, this program does not seem to be actively involved.

- **State & Private Forestry Division (?)**
 - **Urban and Community Forestry Program** – Authorized under the Community Forestry Assistance Act of 1978, this program as been a major advocate of green infrastructure planning and development as a strategy for providing systematic and strategic networks of forest and open space in both urban and rural areas. Partners with other organizations to promote and grow the green infrastructure movement.
 - **Cooperative Forestry Program** – provided initial funding for the formation of the Green Infrastructure Community of Practice in partnership with The Conservation Fund
 - **Green Infrastructure Community of Practice** – “created in 1999 to build the capacity of land conservation professionals and their partners to undertake strategic conservation activities that are proactive, systematic, well integrated and applied at multiple scales.” Currently administered by the Urban & Community Forestry Program, the GI CoP engages people from across the US on a quarterly basis to share knowledge and build capacity.
- **National Urban and Community Forestry Advisory Council** – as a separate entity within USDA reporting directly to the Secretary of Agriculture, NUCFAC was created to “synthesize the full spectrum of views into a consistent vision, as a foundation for practical policy on urban forestry.” This group offers challenges cost-share grants and other forms of support to research and build the capacity of the green infrastructure movement.

Dept. of Transportation (DOT) - Roads and transportation corridors comprise a significant portion of the nation's infrastructure system and budget. There is increasing recognition of the opportunities to integrate green infrastructure features into transportation projects at all scales. There are currently some efforts within the DOT to support and implement green infrastructure practices, though this is certainly a growth opportunity

- **Federal Highway Administration (FHWA)** – Funded under the Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU), FHWA maintains a Planning and Environment Linkages Initiative, which supports green infrastructure both programmatically and in practice.
 - Convened the Integrated Planning Workgroup (IPWG), an interagency effort that aims to more effectively link transportation system planning with natural and cultural resource planning.
 - Initiated development of "*Eco-Logical: An Ecosystem Approach to Developing Infrastructure Projects*," introducing ecosystem-based planning for infrastructure project development and mitigation of impacts. FHWA and partners are implementing the Eco-Logical concept at the national level through outreach and training.
 - Funding projects to field test Eco-Logical principals with a focus on complying with the SAFETEA-LU (current transportation bill) planning and environmental linkages provisions.
 - *Transportation, Community, and System Preservation (TCSP) Program* is a comprehensive initiative of research and grants to investigate the relationships between transportation, community, and system preservation plans and practices and identify private sector-based initiatives to improve such relationships.
- **Transportation Investment Generating Economic Recovery (TIGER)** (grant program funded by American Recovery & Reinvestment Act) - Funding provided under this grant program has been used to support green infrastructure projects and initiatives across the US, including projects to reduce area of impervious surfaces
- **DOT Inter-agency Livability Initiative** - This interagency initiative strives to better coordinate programs across DOT to support and improve 'livability' aspects of DOT projects and programs - DOT administrative partner to Partnership for Sustainable Communities with EPA and HUD.

Housing & Urban Development (HUD) – HUD's mission is "to create strong, sustainable, inclusive communities and quality affordable homes for all." Working in cities and communities across the US, HUD is supporting green infrastructure projects through two main channels

- **Office of Community Planning and Development** - Authorized under Section 104(g) of the Housing and Community Development Act of 1974, the OCPD administers the *Community Development Block Grant* program, a flexible grant program that supports community initiatives in addressing a wide range of issues. Many communities have identified or used the CDBG program to implement green infrastructure projects
- **Office of Sustainable Housing and Communities** - the mission of this office is to "create strong, sustainable communities by connecting housing to jobs, fostering local innovation, and helping to build a clean energy economy." This program is the HUD administrative partner to the Partnership for Sustainable Communities program along with EPA and DOT.

Homeland Security – Federal Emergency Management Agency – As a partner agency in implementing the Coastal Zone Management Act administered by NOAA, and responsible for flood response, we would have thought that FEMA would be more active in supporting climate change adaptation efforts, which could certainly include green infrastructure. This is not the case and is an opportunity for growth by the agency.

Dept. of Commerce – National Oceanographic & Atmospheric Administration - NOAA is tasked with managing coastal resources in the US. They are mostly involved with promoting and supporting green infrastructure projects and initiatives as they relate to coastal resources (blue infrastructure) and the effects of sea level rise.

- **Office of Ocean and Coastal Resource Management** – particularly as authorized under the Coastal Zone Management Act, the OOCRM works with coastal states to protect and manage their coastal resources.
 - National Coastal Zone Management (CZM) Program is a voluntary partnership with states and territories that takes a comprehensive approach to planning for and managing coastal resources in the face of development.
 - Coastal Zone Enhancement Grants Program encourages state and territory coastal management programs to develop program changes, or enhancements, to their Federally approved coastal management programs in one or more of nine enhancement areas: wetlands, coastal hazards, public access, marine debris, cumulative and secondary impacts, special area management plans, ocean/Great Lakes resources, energy and government facility siting, and aquaculture.
 - Coastal Nonpoint Pollution Control Program (Technical Assistance) - Congress appropriates 1:1 matching funds to help state coastal zone management programs implement their Coastal Nonpoint Pollution Control Programs.
 - Coastal Services Center - serves state and local coastal resource management organizations, providing the technology, information, and management strategies these organizations need to address complex coastal issues.
 - Partners with The Conservation Fund to offer GIS training for green infrastructure planning

Dept. of Interior

- **US Fish & Wildlife Service** – As the key administrator for the Endangered Species Act, USFWS has been involved in developing approving ESA compliance plans that have implemented a green infrastructure approach to planning and conservation. Unsure about specific funding mechanisms.
- **National Park Service** – The NPS has been engaged in several green infrastructure regional plans that have included national forests and monuments. They are also involved in efforts to link and network natural areas around the nation.
- **Bureau of Land Management** – Primarily operating in the Western US, BLM has been involved in discussions with regions developing green infrastructure plans, though specific information has not yet been identified.

Dept. of Energy – Office of Energy Efficiency & Renewable Energy - Authorized under the Energy Independence and Security Act (EISA), the OEERE administers the Energy Efficiency and Conservation Block Grant (EECBG) Program (first funded as part of ARRA 2009), which can be used for energy efficiency and conservation programs and projects communitywide. Though we have heard mention of using these funds for green infrastructure initiatives, namely urban forest projects to address urban heat island effect, we are not certain these funds have been used as such.

Dept. of Health & Human Services – Center for Disease Control & Prevention - CDC offers *Community Transformation Grants* (authorized under the Patient Protection and Affordable Care Act of 2010 (Affordable Care Act) to “support community-level efforts to reduce chronic diseases such as heart disease, cancer, stroke, and diabetes. By promoting healthy lifestyles, especially among population groups experiencing the greatest burden of chronic disease, these grants will help improve health, reduce health disparities, and control health care spending.” Green infrastructure projects have been funded using this program.

Appendix D. Reimagining Cleveland as Collective Action: A model for local scale institutional structure supporting multifunctional green infrastructure

Since the 1970's, Cleveland, Ohio has lost 46% of its population and the median household income has dropped 32%.⁴⁹ According to the 2010 US Census, vacancy rate of homes nearly doubled from 1980 to 2010⁵⁰, with 14,700 foreclosures filed in 2007-2008 alone.⁵¹ Census numbers indicate nearly 20% or more than 40,000 housing units stand vacant, with 3,300 additional vacant and mostly neglected acres (20,000 lots) spread across the city.⁵² A study conducted in Philadelphia suggests that the presence of a single abandoned or boarded-up home on a block can drop property values of surrounding properties by 15%.⁵³ Add this to foregone property taxes and a dramatically reduced industrial base and it becomes clear that Cleveland is facing a tough urban renewal challenge.

Recognizing the severity of the problem and vacant properties as being a main driver, in 2008, Neighborhood Progress, Inc., a local NGO with the mission of “foster(ing) communities of choice and opportunity throughout Cleveland” assembled a group of community stakeholders including the City Planning Commission, Kent State’s Urban Design Center and more than thirty other community stakeholders representing city and state level public agencies, community groups, local and regional NGOs, universities, and private businesses conducted a study on strategies for reclaiming and reusing vacant lands.

Based on the principles of the Lake Erie Balanced Growth Initiative (now the Ohio Balanced Growth Initiative⁵⁴), which links land-use planning to watershed management, the *Re-Imagining a More Sustainable Cleveland* initiative that emerged from this study has developed and is actively engaged in a systematic strategy for addressing the vacant land issues based on an economic and ecological evaluation for the best reuse of a property. Reuse strategies fit into three overarching categories: (1) stabilization and holding strategies for areas of the city where new development is anticipated; (2) green space expansion and green infrastructure to improve ecological systems, increase access to parks and amenities, and improve public health; and (3) productive strategies (including urban agriculture and the generation of alternative energy) as a means to extract an economic benefit from vacant land.⁵⁵

⁴⁹ Daniel Hartley, *Urban Decline in Rust-Belt Cities* (Federal Reserve Bank of Cleveland, May 20, 2013), <http://www.clevelandfed.org/research/commentary/2013/2013-06.cfm>.

⁵⁰ City of Cleveland – City Planning Commission - <http://planning.city.cleveland.oh.us/2010census/cpc.html>

⁵¹ Claudia Coulton, Michael Schramm, and April Hirsh, “REO & Beyond: The Aftermath of the Foreclosure Crisis in Cuyahoga County, Ohio,” in *REO & Vacant Properties: Strategies for Neighborhood Stabilization* (Federal Reserve Banks of Cleveland and Boston, 2010).

⁵² “Reimagining Cleveland.”

⁵³ Raymond Pianka, “Abandon Properties: Facing the Challenge,” *Cleveland Housing Court*, 2012, http://www.clevelandhousingcourt.org/hc_rd_b.html.

⁵⁴ <http://balancedgrowth.ohio.gov/>

⁵⁵ Neighborhood Progress, Inc, *[Greater] Cleveland Action Plan for Vacant Land Reclamation*, 2010, <http://www.docstoc.com/docs/132535329/Greater-Cleveland-Action-Plan-for-Vacant-Land-Reclamation>.

Following an initial round of pilot projects in which neighborhood groups, churches, schools and other community stakeholders received grants to reclaim vacant lots, the program was expanded to include all of Cuyahoga County, or the Greater Cleveland area. The signature projects of this expanded initiative were held to rigorous set of criteria:⁵⁶

- (1) Leverage partnerships and expertise of the Re-imagining initiative; BUT FOR this process, this idea would not be fully realized
- (2) Advance a VACANT LAND REUSE agenda
- (3) Weave together multiple objectives - NO SILOS
- (4) Achieve UNIQUE outcomes that are REPLICABLE
- (5) Have MEASURABLE, SUSTAINABLE impacts
- (6) Address the SCALE of the vacancy challenge
- (7) Involve MULTIPLE JURISDICTIONS, city and county
- (8) INVOLVE neighborhood stakeholders
- (9) Provide access to ECONOMIC OPPORTUNITY
- (10) Align with FUNDING OPPORTUNITIES, including NSP2 target areas
- (11) Address HEALTH IMPACTS
- (12) Change the image of Cleveland and be ICONIC
- (13) REINFORCE current and planned investments

Since 2008, ReImagining Cleveland has recruited a growing list of partners and has reclaimed more than fifty properties into pocket parks, greenways, urban orchards and gardens, rain gardens and side yard expansions, guided by the Idea to Action Resource Book developed in collaboration with Kent State University's Cleveland Urban Design Collaborative,⁵⁷ and cleared and preserved 16,000 more in the Cuyahoga County Land Bank⁵⁸ for future use.

In addition to its vacant property challenge, Cleveland as part of the Northeast Ohio Regional Sewer District (NEORS) was also looking at significant Clean Water Act violations as a result of an aging and overwhelmed combined sewer and stormwater system. In December 2010, as part of a settlement with the EPA, NEORS was ordered to reduce combined sewer overflow (CSO) events from the 4.5 billion gallons it was spilling into Lake Erie and its tributaries to 494 million gallons by 2035, to the tune of roughly \$3 billion in infrastructure improvements. Included in the consent decree was a stipulation that at least \$42 million invested in green infrastructure projects to capture an estimated 44 million gallons of stormwater runoff annually.⁵⁹

With representatives of the city water agency and the district sewer authority already engaged in the ReImagining Cleveland initiative, there was an opportunity to leverage the

⁵⁶ Ibid

⁵⁷ Kent State University's Cleveland Urban Design Collaborative and Neighborhood Progress, Inc, *Re-Imagining Cleveland: Ideas to Action Resource Book* (2011, n.d.), <http://reimaginingcleveland.org/files/2011/03/ideas-to-action-white-layout-for-printing.pdf>.

⁵⁸ <http://cuyahogalandbank.org/>

⁵⁹ Northeast Ohio Regional Sewer District, "Project Clean Lake," accessed December 10, 2013, <http://www.neorsd.org/projectcleanlake.php>.

work the initiative had been doing to identify and assess vacant properties for green infrastructure solutions, while at the same time scaling up implementation by bringing significant additional funding to the effort. The NEORS, in collaboration with the Cleveland Planning Commission, conducted a feasibility study of the most strategic locations to implement green infrastructure for stormwater control. At the same time, Neighborhood Progress established a coordinating committee to work with NEORS advisors on its green infrastructure initiative and Kent State University's Cleveland Urban Design Collaborative agreed to help ensure the project functionality.⁶⁰

In December 2011 the NEORS released their list of 20 potential green infrastructure projects to the EPA that would meet their stormwater management goals.⁶¹ Following a rigorous process for identifying 38 priority areas for stormwater management, the committee, comprised of representatives of the sewer district and ReImagine Cleveland developed project profiles for each priority areas that met the following principles:

- Provide infiltration opportunities
- Incorporate community and transformational benefits
- Repurpose vacant land
- Support viable partners

These projects were then evaluated and ranked according performance criteria (50%):

- Cost-benefit
- CSO reduction capacity (volume)

And Feasibility Criteria (50%):

- Land requirements (availability)
- Partnership opportunities (to facilitate new development or redevelopment)
- Public acceptance (potential negative social impacts or co-benefits provided to surrounding community)
- Flexibility in the use of GI measures within the project area
- Operation and Maintenance administration
- Performance reliability
- Overall feasibility

The twenty projects that ranked highest through this process would actually cost an estimated \$101,681,000, so Cleveland will begin with high-potential "Early Action Projects" anticipated to yield immediate stormwater reductions. As performance is measured, the case can be made for expanding the green infrastructure elements of the CSO consent decree.⁶² Many of the project plans involved vacant land repurposing and green street designs, but one project stands out for its ability to find win-win solutions. In the area surrounding a 23-acre "Urban Agricultural Innovation Zone", the plan would create a water

⁶⁰ Kathy Carr, "Green Infrastructure Advocates Get Hands Dirty," *Cleveland Business News*, April 18, 2011, <http://www.crainscleveland.com/apps/pbcs.dll/article?AID=/20110418/FREE/304189970>.

⁶¹ Dave Davis, "Regional Sewer District Picks 20 'Green' Infrastructure Projects for \$42 Million Program," *The Plain Dealer*, December 28, 2011, http://blog.cleveland.com/metro/2011/12/regional_sewer_district_picks.html.

⁶² Process, criteria, and cost estimates derived from NEORS, *Northeast Ohio Regional Sewer District: Green Infrastructure Plan*, April 2012, http://www.neorsd.org/I_Library.php?a=download_file&LIBRARY_RECORD_ID=5526.

capture system, which could be filtered and reused by the urban farmers, which includes an aquaculture operation.⁶³

An Example of Collective Action for Multifunctional Green Infrastructure System

The situation in Cleveland exemplifies that of a complex situation without simple solutions. A single organization working in isolation or in partnership with others on an isolated element of the situation would have an impact, but not the scale of impact needed to make a significant enough difference in the situation. Only by bringing a very broad range of stakeholder groups together to develop a shared vision for the future of their city, and then coordinating their actions through a strategic plan could actors in Cleveland hope to have a significant change. This is the thinking behind collective impact, of which ReImagining Cleveland, especially in partnership with the NEORSD provides an excellent example to implement green infrastructure in its most robust sense – as a multifunctional network of ecological features and systems providing a range of ecosystem services to the community it supports.

Collective impact⁶⁴ is distinct from traditional multi-stakeholder collaborative efforts in that it presents five core conditions:

- **Common Agenda** – All participants have a shared vision for change including a common understanding of the problem and a joint approach to solving it through agreed upon actions
- **Shared Measurements** – Collecting data and measuring results consistently across all participants ensures efforts remain aligned and participants hold each other accountable
- **Mutually Reinforcing Activities** – Participant activities must be differentiated while still being coordinated through a mutually reinforcing plan of action
- **Continuous Communication** – Consistent and open communication is needed across the many players to build trust, assure mutual objectives, and create common motivation
- **Backbone Support** – Creating and managing collective impact requires a separate organization with staff and a specific set of skills to serve as the backbone for the entire initiative and coordinate participating organizations and agencies.

In the case of ReImagining Cleveland, Neighborhood Progress emerged as the “backbone” organization, facilitating and supporting the process. Their initial step was to assemble the full range of stakeholder groups with an interest in the condition of Cleveland, including elected officials, city and regional public agencies, NGOs working on everything from arts to education to community and economic development, university programs, and some private businesses around a common concern. In this case, the concern was vacant and derelict properties that were further depressing property values and economic

⁶³ Davis, “Regional Sewer District Picks 20 ‘Green’ Infrastructure Projects for \$42 Million Program.”

⁶⁴ Kania and Kramer, “Collective Impact.”

development. So the driver for action among this group became city revitalization in the name of ReImagining Cleveland. Without the finances or tax base to support major rebuilding in the city, reclaiming these properties as green infrastructure for either the long or short term was a cost-effective and multi-beneficial option. With that common understanding, the coalition developed a shared vision of Cleveland as a vibrant, stable, green city using green infrastructure thinking.

Through their standing committees, ReImagining Cleveland member organizations kept in constant contact and developed set criteria to assess project proposals and track and evaluate progress of the projects. Particularly when the NEORSC were issued their consent decree to invest heavily in green infrastructure projects, the condition of mutually reinforcing activities took on a new life, sharing the same committees and evaluation metrics for projects across initiatives.

Robust forms of green infrastructure that are systematically integrated into the landscape to provide a full range of benefits requires significant collaboration across organization and agency goals and programs. The institutional map shown below illustrates not only the collaboration across the ReImagining Cleveland and NEORSC goals to advance green infrastructure, but also the range of stakeholder groups involved. In this case, the organizations marked as triangles were the lead organizations for each individual initiative, though Neighborhood Progress, Inc. would be considered the “backbone organization” for the advancement of green infrastructure in Cleveland. The organizations marked in blue circles are nonprofit organizations, pink are private sector businesses, yellow are public entities or agencies, and orange are academic partners. The amount of overlap between the two initiatives, both through participation in the Vacant Land Steering Committee and as members of each initiative ensures a common agenda, continuous communication, mutually reinforcing activities, and shared measures of success.

Collective Impact for Cleveland's Green Infrastructure Strategy – Stakeholder groups and relationships

