EXPLORING ROLES FOR COMMUNITIES IN GREEN INFRASTRUCTURE PROJECTS

A thesis submitted by

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In partial fulfillment of the requirements

For the degree of

Master of Arts

In

Urban and Environmental Policy and Planning

Tufts University

August 2017

Advisory Committee:

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ABSTRACT

Why do green infrastructure projects fail? A lack of public engagement in green infrastructure development, installation, and maintenance can limit the project's success. Meanwhile, increasing public participation has been shown to have a positive effect on green infrastructure programs. Through a series of interviews with green infrastructure experts in eleven different programs across the United States, this thesis explores stakeholder roles in a variety of green infrastructure programs, and considers strategies for improving outreach and overcoming community engagement barriers. Governments can take responsibility for increasing community access to programs, being flexible to a community's needs, and ensuring the project is maintained and promoted. Non-profits can raise awareness and bridge communication gaps between government agencies and communities. Finally, community groups and individuals can start their own programs, volunteer, educate others, and work with governments and non-profits to develop successful, sustainable green infrastructure programs.

ACKNOWLEDGEMENTS

This thesis would never have been completed without the patience, guidance, and encouragement of my advisor, Julian Agyeman. Thank you for helping me to build this thesis and continually nudging me in the right direction. I likewise wish to thank my reader, Christine Cousineau, for her ongoing advice and support. Special thanks also to Barbara Parmenter for advising me on thesis scheduling and degree completion.

Thank you to the staff at the following agencies and organizations who consented to interviews for this thesis, and for their invaluable insights into the field of green infrastructure: NYC DEP, NYC Parks, Portland BES, Seattle Public Utilities, RainWise Rebates, the 12,000 Rain Gardens Campaign, the Philadelphia Water Department, the City of Atlanta Department of Watershed Management, the Long Creek Watershed Management District, the City of Dover's Public Works Department, the University of New Hampshire Stormwater Center, the Worcester Tree Initiative, the Greenway Conservancy, the Charles River Watershed Association, the Chelsea Collaborative, Land Escapes Design, and the Fairmount-Indigo Line CDC Collaborative.

A very special thanks also to the Environmental Protection Agency's New England Regional Office in Boston, where I had the pleasure of interning during my composition of this thesis. Their support and encouragement has been invaluable to me, and working with them on green infrastructure and stormwater management projects greatly informed my research. Many of the case examples selected for this thesis I discovered in the course of my work at EPA.

Finally, thank you to my friends and family for supporting me in my pursuit of my graduate degree. Your love and patience has seen me through.

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I. INTRODUCTION

In the summer of 2016, I attended the annual board meeting of a local non-profit. We gathered at an affordable housing development to check up on two rain gardens they had installed the previous year. It was a warm summer day, and our troupe of ten environmental do-gooders trekked excitedly into the rear parking lot, where one rain garden covered the end of a parking median, and the other edged against a stone wall.

Those of us expecting a riot of colorful flowers were disappointed; with only a year's growth behind it, the landscaper explained, the first rain garden had not yet come into its own. We spent a few minutes squinting to discern the scattered young plantings from the weeds, and then embarked on a spontaneous ten-minute weeding session. Proud of our work and optimistic that the little grassy mulch patch would look much hardier given another year to grow, we went to perform the same act on the second rain garden.

We were surprised to find that the second rain garden was covered in uprooted weeds. The tenders of the community garden, bulging with lettuce and tomato leaves over an adjacent fence, had mistakenly begun using the second rain garden as their compost pile. Disheartened, we relocated the rubbish pile, resuscitated any crushed plants, and left the rain garden in peace, hoping the incident would not be repeated.

This was most likely not a shot across the bow in some imagined war between the community gardening movement and green infrastructure development. My immediate impulse was to question why there was no fence protecting the young rain garden, or at least a little sign marking the space for what it was and asking residents for their assistance in protecting it from harm as it grows (the answer: the grant had not included funding for a sign). I later wondered to myself if it was we who were the interlopers: perhaps that spot had been the community garden's compost pile

for some years, and we had mistakenly impinged on their own unlabeled space. Regardless, it was clear that this was a case of green infrastructure rendered invisible, and of a community unaware.

So what went wrong? Engaging and educating the affordable housing community about the many benefits of these two rain gardens being installed in their backyard was one of the main goals of the program, and yet engagement efforts had apparently been ineffective. One apparent culprit was time: the limited timeline of the grant-funded program meant there was only enough time (and funding) allocated to the non-profit for one visit to a neighborhood school board meeting. Related offenders were the absence of trust and clear communication, which could not be developed adequately between the non-profit and the community during the single community engagement event. The grant itself was directed at rain garden installation and not community outreach; there wasn't funding available for multiple outreach meetings or educational signage. There was also a technical barrier to engagement: the sites best suited for a rain garden according to the community would not work from an engineering perspective.

Green infrastructure projects are first and foremost intended to serve as a technical mechanism for improving water quality and providing other environmental benefits, particularly in an urban space lacking in green or natural areas. However, the absence of an engaged community can be the death knell of a green infrastructure program, severely limiting the efficacy and sustainability of any green infrastructure installation. Poor design standards, lack of maintenance, and an inability to relate to or obtain support from the community are cited as key factors in a green infrastructure installation's failure (Rainer, 2017). Some residents of New York City neighborhoods have complained that their city-installed rain gardens are an eyesore: poorly installed, under-maintained, and above all "built without community consultation" (Nir, 2017). Bad publicity from failed projects (see Figure 1) can make it difficult for future projects to garner adequate support.

Figure 1. Rain Garden in Queens. Residents unhappy with the appearance of poorly-maintained rain gardens installed by the city. (Source: New York Times, March 23, 2017.)

Meanwhile, studies have shown that citizen participation and support can make green infrastructure installations more effective and environmental programs more successful: "when community groups are given an opportunity to lead and own an environmental stewardship project, everyone wins" (Shandas & Messer, 2008, pg. 416). The role of the community in a green infrastructure program is crucial to that program's success.

Green infrastructure projects across the country have faced this dilemma: how to implement green infrastructure installation programs to the benefit of the urban environment while still promoting community awareness and participation to ensure the program is supported in the long-term? Which elements of the program – site selection, design, installation, or maintenance – should be handled by the city, and which should be left to the initiative of the community? What steps can a city-wide, institutionalized green infrastructure program take to achieve a level of community engagement on par with small-scale, grassroots initiatives? Are current outreach and engagement

strategies effective, and how can they be improved? What is the role of a community in the universe of green infrastructure programs, and how can it be expanded or improved?

My search for answers to these questions led me to Seattle and New York and Atlanta, to an urban watershed in Maine and a bus shelter in Dorchester, Massachusetts. Through a series of interviews with community engagement specialists and experts in green infrastructure projects at a variety of scales and situations across the country, I sought to examine the capacity for communities to take a more active role in green infrastructure programs. I looked for spaces where municipal planners, non-profit program managers, and academics can welcome and encourage community participation, and for mechanisms communities can use to initiate green infrastructure in their neighborhood. Finally, I considered the power dynamics of a green infrastructure project: how do the stakeholders in a green infrastructure project negotiate the shape of the program so that all voices are heard and respected, and the programs can flourish?

Chapter II of this thesis examines existing literature on two major topics: a review of green infrastructure technology, including benefits of and barriers to its implementation; and an exploration of community and stakeholder access to and engagement in green infrastructure projects. In Chapter III, I explain my methods of research, including interviews with representatives of eleven different green infrastructure programs across the United States; I have arranged these programs and the results of these interviews by scale and geography in Chapter IV. The resulting observations and recommendations are discussed in Chapters V and VI.

II. THE STORY OF GREEN INFRASTRUCTURE

Definition: What is Green Infrastructure?

Opinions differ on how to define green infrastructure (GI), as the term is relatively new and has been applied in myriad contexts and scales (Dunn, 2010; Rowe & Bakacs, 2017). The American Society of Landscape Architects defines GI as a broad approach to sustainable development and climate change mitigation, which includes green energy, alternative transportation, habitat restoration, and stormwater management (Moon, 2011). One of the first books to coin the term directly referred to it more narrowly as an "interconnected network of natural areas and other open spaces that conserves natural ecosystem values and functions" (Benedict & McMahon, 2006, p. 1). The second definition expresses the environmental benefit of integrating organic matter into any urban, suburban, or rural landscape, be it a row of urban street trees or a forest reserve around a waterbody.

Most commonly, GI refers to the practice of using organic matter (soil and vegetation) and natural processes to collect, absorb, and filter stormwater where it falls in order to reduce or offset the negative environmental impacts of urban or suburban development (Clean Water America Alliance [CWAA], 2011; Dunn, 2010; Rowe & Bakacs, 2017; United States Environmental Protection Agency [US EPA], 2015b). Traditional stormwater management, or "grey infrastructure," uses city pipes and sewer systems to carry water underground to the nearest water body; GI is an alternative or supplement to this practice, based on the idea that it is more economically and environmentally sound and healthy to treat polluted stormwater on-site through natural processes.

In conventional urban planning, open space is a surface layer; GI, on the other hand, is part of a city's "organizing framework," creating a healthier and better-functioning urban system (Eisenman, 2013, p. 288). In GI, green spaces are part of an integrated and comprehensive city or regional

plan, rather than an afterthought added wherever funding and space allows (Benedict & McMahon, 2006). Although GI projects can operate at multiple scales -- a single residence or business, a neighborhood, or an entire city or town -- ultimately a GI installation is meant to serve the health of an entire watershed, and so is often part of a larger plan for an entire city or region (Benedict & McMahon, 2006; US EPA, 2015b).

History: Where Does Green Infrastructure Come From?

Although the term is most commonly associated with the 21st century, the concept of green space integrated into an urban fabric for environmental and human health purposes dates back to mid-19th century urban planning (Newell et. al., 2013). Frederick Law Olmsted, the 19th-century landscape architect responsible for New York City's Central Park, saw green space as a crucial element of urban design, capable of improving human physical, mental, and social health and wellbeing (Eisenman, 2013). One of the crown jewels of Olmsted's Emerald Necklace park system in Boston was the Back Bay Fens, the first known example of a wetland constructed to manage a city's sewage and water pollution, which has been identified as a clear predecessor to modern GI (Eisenman, 2013).

The concepts behind GI were part of an evolving philosophy around green space and environmental conservation throughout the 20th century. Landscape architect Ian McHarg, for example, advocated for designing with, rather than against, natural systems; his 1970s neighborhood design for The Woodlands in Houston, which focused development on less-permeable land and used calculated preservation of permeable open space to match the natural hydrology of the landscape, survived 100-year storms in 1979 and 1994 with less property damage than nearby areas (Yang & Li, 2013). Anne Spirn's *The Granite Garden* (1984) further explored the idea that a city and its population will be happier and healthier when the city is designed in keeping with its natural processes, such as wind direction and waterflow.

According to Firehock (2010), the actual words "GI" were first used in a Florida Governor's report in 1994 in order to elevate the importance of green space and land conservation as a crucial land use rather than an afterthought in town planning. In the early 2000s, GI referred to large-scale watershed management, including natural land preservation and greenway corridors (Benedict & McMahon, 2006; Firehock, 2010). Since 2007, the USEPA has used the term to refer to technologies engineered to manage stormwater onsite, which can include both vegetated installations (e.g. green roofs, rain gardens) and non-vegetated techniques (e.g. permeable pavement, rain catchment barrels); these technologies help developers, homeowners, and cities achieve "low-impact development," or lessen the environmental impacts of their infrastructure (Firehock, 2010; US EPA, 2015b). Because of how the term has evolved over time and been applied in different contexts, sources still differ on what does and does not qualify as GI today, but all generally agree it refers to an installation (watershed or site specific) designed to improve stormwater management (Benedict & McMahon, 2006; Firehock, 2010; US EPA, 2015b).

Typology: What Does Green Infrastructure Look Like?

Figure 2a, b, and c: Examples of Green Infrastructure. From left to right: a planter box (bioretention), permeable pavers, and a green roof. (Source: US EPA, 2015b.)

The technical elements, or building blocks, of a GI installation include rain barrels, green roofs, permeable pavement, rain gardens, bioswales, and street trees (Figure 2a-c). A single installation of one of these elements could be considered GI. These elements can also be combined or expanded to create large-scale city or watershed-based GI networks, such as green streets, urban forests, or riverside greenways (Rowe & Bakacs, 2017; US EPA, 2015b). Table 1 lists the most common types of GI according to the US EPA, Rutgers University, and the United Nations Environment

Programme (UNEP); these types may go by different names based on the source, program, or geographic region.

Table 1: Common Types of Green Infrastructure

Green Infrastructure Type	Description
Rainwater Harvesting and Downspout Disconnection	Rain barrels and cisterns collect and store rainwater runoff from rooftops for future use in irrigation, toilet flushing, or household purposes other than consumption. Alternatively, a downspout can be re-routed directly to a nearby lawn or garden.
Green Roofs and Roof Gardens	Vegetated rooftops are highly technical and carefully engineered to capture and reduce stormwater, combat the urban heat island effect, reduce energy use and increase building efficiency, and provide social green space, garden space, or natural habitats in dense urban areas.
Permeable Pavement	Porous pavers, concrete, or asphalt allows rainwater to sink through a road, alley, or parking lot and be absorbed directly into the ground or into a catchment basin.
Bioretention Cells, Planter Boxes, and Rain Gardens	These shallowly depressed or walled basins use soil and vegetation to collect, store, and filter stormwater runoff along roadsides or parking lots, filtering pollutants from stormwater and providing opportunities for groundwater recharge and evapotranspiration. Unlike constructed wetlands, they are dry except during storm events.
Vegetated Swales and Bioswales	Similar to rain gardens, swales are planted, depressed channels along roadsides or parking lots that slow and filter stormwater runoff as it travels toward a waterbody.
Street Trees and Urban Forests	Shade trees improve air quality and lessen CO2 in the atmosphere while also absorbing and filtering stormwater through evapotranspiration, especially when trees are planted in planter boxes. Trees also improve neighborhood mental and social health.
Green Streets, Alleys, and Parking Lots	Bioswales, rain gardens, permeable pavement, and street trees integrated into overall street or lot design as a comprehensive system reduce street flooding and air pollution, mitigate the urban heat island effect, and improve overall street health, accessibility, and walkability.
Greenways, Parkways, Riparian Buffers, Constructed Wetlands, Wet Ponds, Forests, and Parks	Natural areas, parks, and green areas near or around waterways can protect waterways from contamination, while also providing opportunities for outdoor recreation. Wetlands and buffers can protect towns from flooding. Forest preserves and parks around reservoirs can protect sources of drinking water.

(Sources: Rowe & Bakacs, 2017; UNEP, 2014; US EPA, 2015b)

Benefits: Why Green Infrastructure?

The primary benefit of GI is its ability to improve the overall hydrological health and function of a watershed (Rowe & Bakacs, 2017; US EPA, 2015c). A GI installation collects, filters, and slows the flow of water, thereby reducing the risk of flooding or combined sewer overflow (CSO) events during storms (Rowe & Bakacs, 2017; US EPA, 2015c). GI can also improve river flow, watershed health, and wildlife habitat by increasing groundwater recharge (CWAA, 2011; UNEP, 2014). Plants and soils used in GI improve water quality and protect waterways from pollution by absorbing and filtering oils, sediments, nutrients, chemicals, and metals from roads, cars, buildings, and farms (Dunn, 2010; Rowe & Bakacs, 2017; US EPA, 2015c). Trees and plants also improve air quality by absorbing ozone (smog), pollutants, and CO2 in the atmosphere, thereby mitigating the urban heat island effect (Rowe & Bakacs, 2017; US EPA, 2015c). Because of the proven positive environmental impacts, GI has been identified as a key strategy for climate change mitigation (Roseen, Janeski, Houle, Simpson, & Gunders, 2011; US EPA, 2015c).

GI and urban green space have also been shown to improve human physical, mental, and social health. In terms of physical health, GI reduces human exposure to extreme urban heat and polluted air and water (Rowe & Bakacs, 2017; US EPA, 2015c). Green streets, greenways, and parks provide opportunities for outdoor recreation and exercise as well as social gatherings or encounters (Rowe & Bakacs, 2017; Wolch, Byrne, & Newell, 2014). GI improves the overall community aesthetic, and by extension community pride and engagement, leading to vibrant, healthy communities and social cohesion (CWAA, 2011). Studies of "civic ecology," or community-based environmental stewardship, have shown that active participation in GI installation and maintenance has a positive effect on cultural, social, and community health (Krasny, Russ, Tidball, & Elmqvist, 2014). Dunn (2010) argues that GI can be especially beneficial to low-income communities: rooftop urban farms and gardens promote food security in "food desert" neighborhoods, while just the presence of trees in a neighborhood has been shown to reduce neighborhood crime.

In addition to clear environmental, social, and physical health benefits, GI is a cost-saving strategy for urban infrastructure development. As old infrastructure wears out across the country, there will be an increased need for more cost-effective solutions to stormwater management; the US EPA (2015c) estimated in 2008 that nationwide stormwater infrastructure repairs would cost $42.3 billion, and identified GI as a cost-saving option. Dunn (2010) estimates that a $10 billion investment in GI would create 150,000-220,000 green jobs, save 6.5-10 trillion gallons of water, and produce a $25-28 billion output.

In fact, GI is so cost-effective compared to conventional stormwater management that Jaffe (2010) recommends focusing exclusively on direct, measurable economic savings when promoting GI policies and practices, claiming that the indirect environmental benefits are more difficult to measure or demonstrate persuasively. In addition to reducing stormwater infrastructure construction and maintenance costs, GI increases property values and reduces building heat and cooling costs by improving urban energy efficiency and mitigating the urban heat island effect (CWAA, 2011; Dunn, 2010). Several sources identify perceptions of the costs of GI installation and maintenance as being much higher than reality (Baptiste, Foley, & Smardon, 2015; CWAA, 2011; Dunn, 2010; USEPA, 2015c).

Obstacles: It's Not Easy Being Green[1]

A study by the National Resource Council in 2008 identified institutional, technological, and perceptual barriers as the major impediments to GI projects (Baptiste et. al, 2015). Though there are concrete elements preventing GI installation, such as inadequate zoning or lack of stormwater financing, sources indicate that the biggest barrier may be hesitance from municipal staff, business owners, developers, and the general public who are unaware of or unfamiliar with the concept (CWAA, 2011; Dunn, 2010). One landscape architect cites poor design standards, improper

[1] From the song *It's not easy being green*, composed by Joe Raposo, first sung by Jim Henson in 1970

maintenance, and unattractive installations as key barriers, and cites a failure to consult with plant experts as the source of these issues (Rainer, 2017).

A comprehensive web-based survey by the Clean Water America Alliance (CWAA) in 2011 carefully examined the common obstacles to GI implementation, and sorted these barriers into four categories: regulatory, financial, technical, and community-based. From a regulatory perspective, CWAA (2011) and Dunn (2010) both found a lack of incentives, performance standards, or GI requirements in state, local, and EPA permits. According to these sources, not only is there limited regulatory guidance to help cities implement these principles, but many codes and regulations, such as water harvesting laws and zoning for street widths, prevent GI outright. Limited institutional understanding of GI has created a nationwide regulatory system that does not empower or even enable GI projects (CWAA, 2011; Dunn, 2010).

Another common concern about GI is perceived costs and financial uncertainty. Unlike conventional stormwater financing, GI net costs can be difficult to quantify because of unpredictable environmental benefits and differences in price depending on site-specific environmental factors (Montalto, Behr, & Yu, 2011; "MA Smart Growth Toolkit," 2007). A lack of financial data on or understanding of both upfront and long-term installation costs and benefits leads to limited grant funding, political support, or overall coordination for GI programs (CWAA, 2011; US EPA, 2015c). Many developers, residents, and municipal agencies are skeptical of GI's cost, feasibility, and performance despite ample evidence regarding GI's capacity to create jobs, conserve resources, increase property values and tourism, save money on stormwater infrastructure, increase building efficiency, and stimulate the local economy (Dunn, 2010; Firehock, 2015; US EPA, 2015c).

The CWAA (2011) survey also cites lack of institutional knowledge of or familiarity with GI as a source of widespread hesitance from engineers, developers, public works department and other agency workers, and other field experts to pursue GI projects. Though studies of GI procedures

and impacts have been documented (Roseen et. al, 2011; USEPA, 2015b and c), insufficient outreach and poorly-articulated design standards that are only applicable in certain geographic regions or climates have led to institutional confusion and reluctance to embrace this new technology (CWAA, 2011). The CWAA (2011) survey also finds that training of the GI maintenance workforce has been limited or inadequate: one municipal staffer reported to the CWAA that "it is not uncommon to find that the installations are damaged by well-meaning maintenance crew who may mow or weed out native plants or systems" (p. 27).

Community-based obstacles to GI primarily involve limited community awareness or engagement in the project, which leads to an installation that does not match community needs or aesthetic preferences and is not accepted or understood by the receiving neighborhood (CWAA, 2011; Yang & Li, 2013). Residents in Ian McHarg's 1970s GI development in The Woodlands, Houston, disliked the appearance of the GI installations, preferring "American manicured lawns" to the "natural vegetation and unmaintained understory" they received; the lack of community support led to the complete abandonment of the installation in favor of conventional piping by the late 1990s (Yang & Li, 2013). As one commenter said in the CWAA (2011) survey, "some people think the facilities like rain gardens are ugly" (p. 28). A receptive and engaged community is key to effective GI implementation, and sources indicate that an installation that does not fit the community can be rejected (Baptiste et. al, 2015).

Communities can have a variety of reasons for objecting to GI. An LA community's biggest concerns about a green alley project were long-term maintenance and the danger of attracting strangers to the neighborhood (Newell et. al 2013). Residents surveyed in Portland, Oregon were also concerned about bioswale maintenance, and were unclear about the purpose or efficacy of the installations (Everett, Lamond, Morzillo, Matsler, & Chan, 2016). While Dunn (2010) argues that GI can be used to address environmental injustice, Wolch et. al (2014) counters that communities may express wariness about GI due to concerns about gentrification and displacement, as green

spaces tend to raise housing values and neighborhood affluence. Increased public awareness, understanding, and engagement in the project process can lead to improved public acceptance (Baptiste et. al, 2015; CWAA, 2011).

The common thread in the CWAA (2011) survey of GI barriers is a universal lack of adequate outreach and engagement of the GI community, including municipal staff, developers, engineers, and the general public. In fact, the most common theme in survey responses was that "the quality and scope of education efforts need to improve" (p. 26). CWAA ultimately concluded that improved stakeholder outreach and community engagement were key to raising awareness and support of GI projects (2011).

III. GREEN INFRASTRUCTURE & THE COMMUNITY

The Network: Players and their Parts

Federal and State

Federal and state government agencies can set up environmental and land use laws and regulations that require, incentivize, or fund green infrastructure (GI) projects (Dunn, 2010). For example, while the 1996 Massachusetts Stormwater Policy encourages GI through its Stormwater Management Standards (MassDEP, 2008), the Boston Water and Sewer Commission (BWSC, 2017) began exploring GI as a strategy to improve water quality only after entering into a consent decree settlement with the Commonwealth of Massachusetts and US EPA in 2012. Large-scale GI programs that cover entire watersheds can be more effective than individual, uncoordinated installations (Yang & Li, 2013). State and federal agencies are also well-positioned to provide educational resources, such as US EPA New England's Soak Up the Rain Initiative, which offers customizable outreach tools (R. 01, 2015).

The federal government is also a key funding source, particularly through the Environmental Protection Agency (US EPA), whose website provides a long list of funding resource manuals, links to grants at other federal departments, and information on US EPA's own grant programs (2017). Plans under the Trump Administration to significantly reduce funding for the EPA may severely limit the capacity of the federal government to continue supporting crucial environmental programs, including GI projects (Dwyer, 2017).

Cities and Towns

For regulatory, financial, planning, outreach, implementation, and maintenance purposes, municipalities play a key role in making GI possible and pushing these projects forward (US EPA, 2015a). A town or city can also inhibit GI programs by not allowing for GI in local codes, land use

plans, or municipal budgets (Dunn, 2010; US EPA, 2015a). It often falls to the municipality to initiate, pursue, and maintain a GI project, while also building community engagement and support (Roseen et. al, 2011; US EPA, 2015a).

Organizations and Institutions

Organizations can lead their own GI programs and help communities in need of GI support. For example, the Charles River Watershed Association's Blue Cities Program (2014) works with community groups to install green streets throughout Greater Boston. The Worcester Tree Initiative (2017) helped the City of Worcester, MA revitalize its much-mourned urban forest following its destruction by the Asian Longhorn Beetle. Academic institutions can also support GI programs: Portland State University graduate students help with Portland's Community Watershed Stewardship Program by providing technical and logistical assistance for installations (Shandas & Messer, 2008). The University of New Hampshire Stormwater Center research hub (2017) supports GI projects through technical knowledge, experimentation, and data collection and analysis.

The Community: Residents and Businesses

To support GI, communities can form or join environmental collaboratives, watershed groups, and stormwater coalitions, in which community stakeholders work together to solve environmental problems (Dukes, Firehock, & Birkhoff, 2011). These groups can build community trust, encourage environmental engagement, improve communication between a community and municipality, and potentially solve environmental conflicts (Dukes et al, 2011; Sink, D., 1996).

Individual developers and landowners can install GI on private or commercial parcels of land; building permit requirements, property tax incentives, and stormwater fee credits can help motivate this action (Dunn, 2010). Some agencies and groups will even help residents install private GI through "installation financing," or the provision of funds, materials, and training: the Philadelphia Water Department, for example, provides installation and maintenance resources

online; hosts rain barrel workshops and giveaways; and compensates homeowners for 80% of installation costs through the Rain Check Program (US EPA, 2012).

Residents can also support GI programs by volunteering to plant trees or maintain local rain gardens, which promotes physical and mental health as well as an improved connection with nature and the community, a concept referred to as "civic ecology" (Krasny et al, 2014). However, community participation in GI maintenance is limited when most citizens view maintenance as the city's responsibility (Moskell & Allred, 2013). Co-production, or the reliance on "active citizenship" to "fill in gaps" in government programs, can be seen as a response to government deficiency, an opportunity for stakeholder collaboration and agency-community partnerships, or a sign of an active and involved community; some citizens and public agencies resist co-production as a risk or burden, while others see it as an opportunity to empower communities, improve relationships, and increase efficiency (Kleinhans, 2017).

Access: The Building Blocks of Green Infrastructure

The US EPA (2015a) recommends updating local laws and codes, identifying and establishing funding mechanisms, and setting up an installation and maintenance workforce training plan as a support system for GI programs. These essential building blocks aid municipalities, communities, organizations, or individuals in accessing and pursuing GI installation opportunities (Dunn, 2010).

Policies and Codes

Dunn (2010) details how federal, state, and local laws and regulations can help or hinder GI development. In some western states where water is scarce, water use is still regulated by "prior appropriation" laws, under which some GI installations are seen as illegally appropriating water meant for other users (Cooney-Mesker, 2013; Dunn, 2010). Antiquated local zoning and building codes can unintentionally discourage GI installations by requiring certain street widths, building setbacks, and stormwater drain pipe connections (Dunn, 2010). Recent zoning reform efforts have made it easier to integrate GI into modern developments; Maryland's 1997 Smart Growth

Initiative, for example, prioritized the preservation of green space as a tenet of its zoning policy (Benedict & McMahon, 2001). Zoning overlay districts can also allow for watershed-based land management without significantly changing the current zoning (Roseen et. al, 2011).

Federal environmental regulations can motivate town and city GI programs. Over the past few years, the EPA has promoted GI as an effective stormwater management strategy in permits and "Best Management Practice" (BMP) manuals (US EPA, 2015b). The 1972 Clean Water Act authorizes the EPA to regulate state and local stormwater management through the National Pollutant Discharge Elimination System (NPDES) permit program; municipalities are required to meet certain regulatory requirements to qualify for an NPDES permit, and can use GI as a BMP to meet those requirements (US EPA, 2015b). In response to a water pollution reduction requirement in their NPDES permit, the City of Portland, OR's Bureau of Environmental Services (2010) established the Grey to Green (G2G) Initiative, which implements GI as a replacement or supplement for their overloaded traditional stormwater piping system.

Municipalities can also encourage GI through zoning, other regulations, and permits; for example, some city regulations require impervious surface minimization or on-site stormwater treatment in new developments (Dunn, 2010). Seattle's Green Factor Ordinance and 2016 Stormwater Code require commercial and residential developments over a certain size to incorporate GI (Dunn, 2010; Seattle Public Utilities, 2015). Construction permits can also require runoff minimization and on-site stormwater management; due to budget and time constraints, developers often won't prioritize a site's greenscaping unless required to do so (Dunn, 2010).

Financing and Fees

Unpredictable environmental costs and benefits make it challenging to accurately budget for GI programs (Montalto et. al, 2011; "MA Smart Growth Toolkit," 2007). Because of this, Environmental Finance Centers have developed resources to help communities with the complicated financing of GI projects; for example, the University of Maryland (UMD, 2014) has

assembled a story map of financing mechanism case studies to inform those initiating their own programs.

The US Federal Government is a key source of funding for GI projects. The American Recovery and Reinvestment Act of 2009 dedicated $1.2 billion to state grants for GI (Dunn, 2010). Federally-backed state grants can help towns develop their own local GI programs (US EPA, 2009). The EPA allocates grants directly to local governments, tribes, communities, and organizations; their website provides funding resource manuals, links to grants at other federal departments (e.g. Department of Energy, Department of Transportation, etc.), and information on EPA's own Nonpoint Source (319) grants, Clean Water State Revolving Fund, and Office of Wetlands, Oceans, and Watersheds grants (US EPA, 2017).

Local government voluntary incentive programs are an effective mechanism for funding GI projects (Dunn, 2010). Local governments can offer development incentives, such as permit fee waivers or requirement exemptions, to developers who include GI in the site design; Philadelphia's Stormwater Management Incentives Program awards GI installation grants to commercial developers (US EPA, 2012). Portland, OR and Chicago's "eco-roof" incentives encourage green roof installations in exchange for funds or increased site density (Dunn, 2010). Increased property values from GI recognition and award programs can be enough to incentivize GI development (USEPA, 2012).

Another type of voluntary incentive program is "installation financing," or the provision of grants, rebates, tax breaks, materials, or technical assistance to homeowners who wish to install their own rain garden, rain barrel, or other GI technology (US EPA, 2012). The City of Portland, OR, for example, installs rain gardens on residential properties for free (Robben, 2014), while the Seattle RainWise Program offers grants and rebates so homeowners can hire a contractor to install a rain garden ("RainWise Rebates," n.d.). A 2016 study indicated that the average Washington-Baltimore area resident's willingness to pay (WTP) for a rain garden is only $6.72 per square foot, or ¾ of

the actual installation cost; installation financing and rebate programs are therefore essential in promoting voluntary programs on private land (Newburn & Alberini, 2016).

A stormwater utility fee is a sustainable economic system for providing consistent stormwater management funding, and can fund as well as incentivize GI installations (Dunn, 2010). Landowners are charged a quarterly or yearly fee, similar to a drinking water or electric utility fee, based on the percentage of the property's land area that is impervious (Riordan, 2017; US EPA, 2009). This practice creates a specific, reliable fund for public stormwater management, while also incentivizing residents and businesses to minimize impervious surfaces on their land in order to lessen their fee (Dunn, 2010; Riordan, 2017; US EPA, 2009). Portland, OR's Clean River Rewards Program offers a rebate on the stormwater utility fee for residents who install GI (Dunn, 2010). Instead of a utility, some towns simply distribute a portion of existing property taxes to a stormwater fund (Dunn, 2010; US EPA, 2009). However, Riordan (2017) notes that a utility fee is more equitable than a tax program, which puts the burden on residents over tax-exempt nonprofits and commercial areas.

Communities who do not feel directly responsible for stormwater management sometimes resist stormwater utilities as an unnecessary "tax" and express concerns that it will be increased or misappropriated (Riordan, 2017; US EPA, 2009). Sources recommend earning community support for stormwater utility fees through public education, advocacy through local leaders, and a clear plan with a 5-year infrastructure cost estimate (Firehock, 2015; Riordan, 2017; US EPA, 2009).

Maintenance: Training the Workforce

A lack of sustained project maintenance post-installation, which results primarily from a lack of continued funding coupled with a lack of a trained workforce, is cited by multiple sources as a major barrier to effective GI development (CWAA, 2011; Everett et. al, 2016; Roseen et. al, 2011). The current lack of a trained GI workforce is mostly due to minimal market demand and training opportunities in a relatively nascent field (Center for Watershed Protection [CWP], 2016).

The National Green Infrastructure Certification Program (Water Environment Federation, 2016), for example, only had its first pilot class in late 2016. However, Dunn (2010) argues that more visible GI programs, such as green roofs on public buildings, will increase demand for a trained workforce to install and maintain GI. The Center for Watershed Protection (2016) has initiated a workforce development program to help bridge the gap between the growing number of available jobs and the still-small number of skilled workers or training opportunities.

While most programs make GI maintenance the city's responsibility, supplemental volunteer maintenance programs can help citizens feel invested in local installations, increasing the likelihood that the installation will remain functional (Everett et. al, 2016; Roseen et. al, 2011). Programs that increase resident volunteering can also build community understanding of and demand for GI, creating a market for a maintenance workforce in turn (Krasney et al., 2016; CWP, 2016).

Engagement: The Public in the Public Park

The Importance of Being Engaged

The late 20th century saw a shift in planning policy and practice from top-down decision-making to an increased value being placed on citizen-driven policies and social justice programs. Sherry Arnstein's Ladder of Citizen Participation (1969) laid out the levels of citizen power and participation in urban planning, and the importance of genuine community empowerment in planning projects. Programs powered and supported by the community are not only socially just but also more effective: a street tree, for example, is more likely to be cared for if planned and planted by a community initiative rather than a government program (Herzele, Collins, & Tyrväinen, 2005).

The environmental movement reflects this general rise in support for community empowerment. Growing awareness of environmental pollution and toxic waste dumps, found disproportionately in disempowered low-income communities and communities of color, gave rise to the environmental justice movement in the 1980s as well as President Clinton's Executive Order 12898 in 1994 (Cole

& Foster, 2001). President Clinton also signed the Clean Water Action Initiative in 1998, requiring state and local governments to collaborate with the public on watershed management strategies; in the same year, 40 European and Asian Countries joined the Aarhus Convention, which protects the rights of citizens to be informed of environmental issues (Shandas & Messer, 2008). The 1990s also saw an upsurge in Community-Based Collaboratives (CBCs), where community members work together to solve environmental issues or develop land use strategies with minimal to no government assistance (Dukes et. al, 2011).

Some critics have questioned whether citizen participation actually hinders watershed management, due to a community's probable lack of environmental knowledge, experience, or technical skill (Shandas & Messer, 2008; Sink, 1996). Additionally, local governments have raised concerns about community groups impeding fair and democratic process or underrepresenting certain stakeholders due to lack of group diversity (Dukes et. al, 2011; Shandas & Messer, 2008). Though co-production, or active citizenship, can be seen as empowering for interested communities and necessary for underfunded public agencies, other public officials see a risk in depending on potentially unskilled or unreliable citizens for city programs (Kleinhans, 2017).

Others argue that that citizen awareness, active interest, and initiative in a GI project is crucial to the project's success (Baptiste et. al, 2015; Shandas & Messer, 2008). Researchers have found that public participation and leadership can improve decision-making, innovation, and equitable stakeholder representation, while also generating community trust and investment in the project (Barclay, 2016; Shandas & Messer, 2008; Sink, 1996). The Clean Water America Alliance (2011) survey found that lack of awareness or understanding was a major barrier to GI projects, and that improved outreach could mend this gap. A study of urban forestry projects even found that a high level of community engagement makes up for a lack of project funding (Young, 2011).

Shandas & Messer (2008) argue that community input can actually improve rather than detract from a GI installation's technical efficacy. Because community members have local environmental

knowledge, they may be able to see problems or solutions that an expert would miss (Firehock, 2015). Stormwater is therefore no longer just an engineering problem; it is a part of a larger system that necessitates stakeholder collaboration to resolve (Barclay, 2016).

Community participation is also beneficial to the health of the community itself, as it builds positive relationships within the community and with nature (Krasny et. al, 2014). Community engagement can raise resident awareness of and interest in their neighborhood and environment while also building trust between the community and the government (Firehock, 2015; Shandas & Messer, 2008). Community advocacy can also bring GI to sometimes-overlooked low-income communities who are most in need of increased green space (Dunn, 2010).

Outreach and Community Engagement Strategies

Consulting with community leaders, attending community meetings, and encouraging community participation before and during a project fosters increased community trust, interest, and investment in the program (Firehock, 2015; Shandas & Messer, 2008). Early community surveying also makes it possible to tailor project outreach and engagement strategies to community interests (Firehock, 2015). Innovators and leaders in the community should be approached first to adopt and model GI programs in order to raise larger community awareness of and interest in GI (Houle, 2016).

Direct community engagement also improves program success during implementation. The Portland, OR Watershed Stewardship Program has been successful in part due to Portland State University graduate students who provide time and resources to interact with community members directly (Shandas & Messer, 2008). Online mapping tools, open-house meetings, training workshops, and community charrettes are recommended strategies for community engagement during the planning and design process (Barclay, 2016; Firehock, 2015).

Different types of visible media can act as outreach and educational tools to support GI. On-site awareness-raising strategies include rain garden installation days, adopt-a-rain-garden programs, tree-planting events, and other volunteer opportunities (Everett et. al, 2016; Krasny et. al, 2014). The Portland, OR Green Streets Program increases installation visibility through informational signs and art installations that increase resident awareness of bioswales in their neighborhoods (Church, 2015). In a survey, Portland residents also said they would like to be actively involved in bioswale maintenance and plant selection in order to feel connected to the installation (Everett et. al, 2016).

Off-site outreach strategies include TV and radio ads, newspaper articles, and social media. In a 1999 survey, the Center for Watershed Protection determined that TV was the most effective outreach strategy, ahead of radio, brochures, trainings, demonstration projects, and the internet. However, times have changed: a recent webinar by the Environmental Finance Center Network posited that online presentations, videos, and social media were more effective avenues for reaching a modern audience base, especially for the millennial generation (Diefendorf, 2017). A diverse range of media outlets can help the project be more socially inclusive and reach a larger portion of the community (Johnston & Shimada, 2004). However, simple presentation of facts is not sufficient; careful framing of outreach messaging to match the needs and values of the community is crucial to effectively engaging their interest and increasing awareness (Firehock, 2015).

Obstacles to Community Engagement

Obtaining active citizen participation in a GI project can be challenging, especially when outreach efforts are hindered by project cost and time limitations (Barclay, 2016). Community meetings and city-initiated forums encouraging citizen participation are often poorly attended and do not adequately represent the entire community (Arnstein, 1969; Barclay, 2016; Dukes et. al, 2011). Demographic factors can negatively affect community participation, leading to underrepresentation

from environmental justice communities (Barclay, 2016; Dunn, 2010). Vocal community members and community sub-groups can dominate or drown out other voices, impeding social equity; it can be challenging for program implementers to sort through the multiple conflicting perspectives and find genuinely useful input (Barclay, 2016; Dukes et. al, 2011; Firehock, 2015; Sink, 1996). Cities especially struggle with effective social inclusion as the population becomes increasingly diverse and multicultural, as there are more groups and sub-communities to represent (Firehock, 2015; Johnston & Shimada, 2004).

There are several examples of community outreach strategies failing or missing the mark. A 1999 survey of Chesapeake Bay residents by the Center for Watershed Protection found that community engagement strategies employed by watershed education programs were largely ineffective, while the outreach strategies identified as most effective by residents were underutilized due to limits on funding, staff time, and resources. In a survey of MillionTreesNYC, volunteers were found to have limited knowledge about the importance of urban forestry despite the organization's attempts to educate volunteers through regular outreach and communication (Moskell, Allred, & Ferenz, 2010). A survey of residents in Portland, OR showed that residents were most resistant to neighborhood bioswales because of maintenance and cleanliness concerns, while few voiced the expected complaints about parking availability (Everett et. al, 2016).

Negative attitudes about environmental stewardship and disbelief in GI's environmental impact can make residents unwilling to engage in discussions about GI opportunities (Everett et. al, 2016). Residents are sometimes distrustful of government's ability to manage or maintain an installation as intended (Everett et. al, 2016; Moskell & Allred, 2013). The Clean Water America Alliance 2011 survey indicates that the major barrier to community involvement in GI is not any actual community resistance, but rather a lack of understanding or awareness due to ineffective outreach and community engagement approaches.

IV. RESEARCH METHODS

In pursuing this thesis, I intended to examine the role of the community in green infrastructure (GI) and discern recommended strategies for improved community access to and engagement in GI projects. I compiled the final results - best practices for improved community outreach and engagement in GI - based on research, interviews with GI project officials, and careful examination of eleven relevant cases.

Preliminary research included a review of academic work, media publications, and government agency materials related to GI projects. I then selected eleven GI programs that provided unique lessons in community engagement and involvement for interviews and in-depth analysis. With IRB approval, I interviewed public agency officials, community and organization leaders, GI project managers, and other professionals in the field about community involvement in their GI initiatives, asking questions such as:

- What was the role of the community in your project or program?
- What was the community response? Did interest in GI increase as a result of your project or project outreach?
- Were there elements of your project that were community-initiated?
- Was outreach most prominent before, during, or after installation? What outreach strategies were most effective?
- What steps have you or the community taken to continue maintenance of the installation? What is the community's current relationship to the project?

The full list of questions is available in Appendix A.

The "case study" research strategy is well-suited for the topics of GI and effective community engagement, as it can be used to address contemporary issues that have not yet been studied thoroughly, as well as complicated situations that are highly reliant on context (Yin, 1981; Yin,

2003). Purposeful GI is a relatively new urban practice, and there is not yet sufficient data about its role in the community for significant quantitative analysis. Additionally, GI projects and community engagement initiatives are heavily tied to the contexts in which they are enacted – breaking the data down into numbers would yield less relevant information than considering these cases as a whole. Because of the diversity of each project, it became necessary to adapt the "case study" approach into a broader qualitative analysis; rather than analyzing a few cases in-depth, I investigated eleven different case examples in order to paint a clearer picture of the variety of GI program types, scales, and approaches across the United States.

I considered the following criteria in selecting cases for this thesis (results detailed in Appendix B):

1. Identity - Conspicuously framed as a GI project
2. Engagement - Includes significant community involvement
3. Relevance - Could serve as a learning model, as it includes a serious commitment to outreach, communication, and research
4. Sustainability - players are aware, engaged, and committed to project maintenance and longevity
5. Replicability - Outreach model could be applied in other places and contexts
6. Plausibility - there is someone available to interview who was significantly involved with the project

The eleven programs examined for this thesis fall into three categories. First, I selected five US cities with comprehensive, city-wide programs to provide a snapshot of diverse engagement contexts in large-scale projects across the nation:

- New York City, New York
- Portland, Oregon
- Seattle, Washington

- Philadelphia, Pennsylvania
- Atlanta, Georgia

Second, I narrowed my geographic focus to three smaller-scale New England programs in small cities and towns: an urban forestry initiative, a watershed program in a commercial district, and a watershed-based public-academic partnership:

- Long Creek Watersged Management District, Portland, ME
- Berry Brook Watershed, Dover, NH (with University of New Hampshire)
- Worcester Tree Initiative, Worcester, MA

Finally, I focused in on the City of Boston for individual GI projects. Boston is only just starting to develop a widespread GI program, but stormwater is a major issue due to the City's climate; Boston is therefore a good place to explore the efficacy of individual GI projects without the context, support, or constraints of a larger, city-wide initiative:

- Rose Kennedy Greenway, Boston, MA
- Charles River Watershed Association in Allston, MA
- Bus Shelter Green Roof Project, Dorchester, MA

I evaluated these case studies' community involvement strategies, successes, and lessons learned, and compiled them with other academic research and interviews to generate a list of recommendations for community involvement in GI, described in detail in Chapter VI.

V. STORIES FROM THE FIELD: A SURVEY OF THE GREEN INFRASTRUCTURE LANDSCAPE

As I mentioned earlier, green infrastructure (GI) projects vary widely in scope and scale. I therefore conducted interviews with city officials and non-profit program managers at the national, regional, and project-specific levels in an attempt to encapsulate a variety of program types. I have divided these eleven case examples below into three geographic categories: five US cities with comprehensive programs; two watershed-based initiatives and an urban forestry program in New England; and finally, three independent projects within the City of Boston, which has not yet developed a comprehensive GI program.

I started with comprehensive network programs in large US cities, which usually develop in response to state and federal regulatory authority under the Clean Water Act; as such, they are required to improve their watershed's health and permeability by a certain amount and within a certain timeframe. They are therefore somewhat restricted in their ability to engage or respond to city residents due to limited time, high deliverable demands, and program inflexibility.

Narrowing my focus to the New England Region, I next looked at watershed and urban forestry programs in smaller cities and towns, where the capacity for community engagement and public participation was greater due to a smaller, narrower audience.

Finally, I looked at three individual GI projects within the City of Boston. Boston is in a transitional period, on the cusp of developing a city-wide GI initiative. The Mayor's 2016 Climate Action Plan calls for GI as a strategy to control flooding and mitigate sea level rise in the face of climate change; the Boston Water and Sewer Commission (2017) has spent the past few years developing GI pilot projects in response to a 2012 water quality consent decree from the state and US EPA. Boston today provides an opportunity to explore individual GI projects implemented without the support

of a larger program. This is also an opportune moment for the city to learn from both its own local programs and other large city programs across the US about effective and ineffective GI engagement strategies; the results of this thesis may be relevant to future Boston planning.

Comprehensive Network Programs: Major US Cities

A Collaborative Effort: New York City, NY

Figure 3: New York City, NY. A public rain garden on a New York City green street. (Source: New York City Department of Environmental Protection, 2017.)

In 2010, New York City released its GI plan in order to comply with state requirements to decrease water pollution from combined sewer overflows (CSOs) during storm events. The City's Department of Environmental Protection (NYC DEP) manages several city-wide GI projects in pursuit of this goal, including a rain barrel giveaway program, "Green Street" rain garden installations, and grant programs for installations on private property. Over 4,000 GI installations are currently in development or completed, and all are mapped for resident information on the city website (NYC DEP, 2017).

Due to the massive scale and scope of this city-wide program, NYC DEP has limited time or flexibility to engage with or respond to community interests. It is also necessary to prioritize the environmental needs of the watershed and technical parameters of the installation over a community's site selection or design preferences. As such, the primary focus of engagement is education and notification of installation plans through community meetings, brochures and door

hangers, local press, social media, and community liaisons, who field neighbors' questions about construction logistics.

However, NYC DEP still strives to involve the community to the extent possible. Educating and engaging the public in participatory GI planning through a variety of forums, including community meetings, public surveys, and paper and electronic communication tools, is part of NYC DEP's 2012 Long Term Control Plan for CSOs (NYC DEP, 2012). For example, in response to a negative response from a Queens community to their proposed GI designs, NYC DEP is currently developing three different rain garden designs so that the community can choose the design that most matches their community aesthetic and identity. While the City is responsible for maintenance, they have also considered paying communities to maintain their own rain gardens, in order to build homeowner familiarity with and connection to the project. As one official said: "Where we can get community involvement leverage we want to do that, though we are limited in that capacity" (Youngerman & Adgate, 2017).

Early attempts to engage with and support individual community groups initiating their own GI projects proved inefficient, as the City was operating at a larger scale and needed to move fast to meet program targets (up to 600 installations at a time). Instead, the City partners with non-profits and community groups to fill community engagement gaps and increase community awareness and support. For example, NYC DEP partners with the Trust for Public Land, who have the resources for "more intense community engagement," to include GI in their playground retrofit programs. NYC DEP is currently funding 33 active GI Grant Projects (Youngerman & Adgate, 2017).

NYC Parks, a public/non-profit joint program, is uniquely positioned to act as a bridge between the city and the community: "we are able to get in to the community in a way the city can't and work with the city in a way the community can't" (Bambridge, 2017). When community groups approach them for assistance with park projects, NYC Parks advises them on funding and logistics, provides resources and information, and works with the community to develop a GI plan and

design over several community meetings. They also encourage community members to get involved in park planning, design, and maintenance. At the same time, NYC Parks can assemble useful feedback and identify interested communities for NYC DEP, and facilitate city-community collaboration.

In this way, NYC Parks helps communities initiate their own GI and green space programs, while also helping the city achieve the trust and community connection that they lack the capacity to establish on their own. This 3rd-party approach increases efficiency for the entire GI process by building city-wide understanding and support on a neighborhood-by-neighborhood basis, which makes it possible for the City to protect public health and water quality in partnership with the communities they wish to serve.

Table 2: New York City Key Takeaways

Barriers to Engagement	Outreach Strategies	Key Takeaways
Scale and scope of program Environmental and technical needs Limited time for pilot projects and early engagement	Provide design options Community Liaisons Engage early and through various community groups Brochures and door hangers Social Media	Grants for voluntary private installations Work with community as early & as much as possible Rely on organizations and community groups to help community and city connect Build trust and a reputation

Civic Ecology: Portland, OR

Figure 4: Portland, OR. Installation day with Portland Green Streets Program. (Source: Museum of the City, 2017.)

Portland, Oregon's Bureau of Environmental Services (BES) began their Grey to Green (G2G) Initiative in 2006 in response to federal stormwater regulations (NPDES permit under the Clean Water Act), with the intention of not only reducing and improving the quality of stormwater runoff but also providing benefits to "community livability, health, and energy" (BES, 2010, pp. 1-1). For over 10 years, BES has promoted and installed GI across the city through several programs, including Green Streets, Downspout Disconnect, % for Green, and Private Property Retrofits. In the latter three programs, the city provides assistance to communities or homeowners who wish to implement their own GI installations (City of Portland, 2017).

For the Private Property Retrofit Program, BES targets outreach (letters) to homeowners in key areas of the watershed. Interested residents can give the city permission to install a rain garden on their property using public dollars. Though initiated and funded by the City, this project is entirely voluntary; the homeowner signs up for the program, works with the city on site design, and takes

on maintenance responsibility post-installation (the city supplies a manual and onsite training). Though the city has an active role and some control over site selection, the key participant is the homeowner; the approach is not purely top-down, but instead allows GI to grow in the community.

The Green Streets program, by contrast, installs bioretention cells on public streets according to environmental and technical needs. BES engages and educates each community about these projects, respects negative feedback, and works with communities to find solutions to any objections. Though BES accommodates community preferences wherever possible, such as altering proposed rain garden placement in response to concerns about parking infringement, ultimately rain gardens are installed where they are needed for stormwater management: "it's about what the community needs, not what the community wants" (Pell, 2017). Due to the constraints of the tech-based installation plan, communities that ask for Green Streets do not always receive one (Pell, 2017).

In 2010, BES found an opportunity to bring more community engagement to their Green Streets: a resident approached them about volunteering to maintain their local rain garden. BES responded with the Green Stewards Program, where residents, business owners, and non-profits can sign up via an online map to "adopt" a neighborhood rain garden. The BES-run program currently hosts 150 volunteers, who water, weed, and clean trash out of 350 adopted Green Street rain gardens (Pell, 2017).

BES uses bus advertisements, flyers in city bills, and presentations at town or community meetings to inform people of the program and GI in general. Connecting one-on-one and face-to-face with residents is "always best" for successfully engaging the community; outreach is the most challenging in communities with knowledge or language barriers (Pell, 2017). BES also installs signs in rain gardens seeking adoption; informational signs in Portland Green Streets build visibility and stormwater awareness (Church, 2015).

The City still takes ultimate responsibility for each installation. BES provides on-site training to each volunteer, and is available for additional maintenance questions or assistance. While the Steward can replace up to 25% of the plantings, they are not yet allowed to add their own plants. The City checks on each rain garden every quarter to perform heavier maintenance, such as sediment removal. While encouraging volunteer maintenance is seen as an avenue for building community interest in and connection to GI installations, the City also views city responsibility for maintenance as key to building community trust and support (Pell, 2017).

Academic research supports Portland's view of GI maintenance as a pathway to civic engagement. A study of Portland BES' Community Watershed Stewardship Program found that community stewardship programs "have the potential to increase citizen trust in government, improve the biophysical environment, and foster participants' ecological understanding," and can increase project efficacy overall (Shandas et. al, 2008). A 2016 survey of Portland residents found that littering, over-growth, insufficient watering, poor plant choice, and other installation and maintenance issues negatively affect resident opinion of Green Street bioswales, and that well-maintained and aesthetically-pleasing installations were more likely to be well-received by a community (Everett et. al, 2016). Joint City responsibility for and citizen involvement in maintenance can improve resident knowledge of, interest in, and support for their neighborhood Green Street.

Table 3: Portland, OR Key Takeaways

Barriers to Engagement	Outreach Strategies	Key Takeaways
Need to follow an installation plan Environmental and technical needs Lack of knowledge or understanding	"Face-to- face outreach is best" Direct mailings, flyers, bus ads Sign-up website map Signs in installations Follow and support individual or	Incentivize residential voluntary programs (target audience) Respond to and encourage community initiative Connecting the community to its Green Street builds acceptance

Reaching everyone in multilingual areas	community interest Maintenance as engagement	and support Visibility builds education and acceptance

The Green Street Network: Seattle, WA

Figure 5: Seattle, WA. Promotion for RainWise, Seattle's rain garden rebate program. (Source: Sustainable Ballard, 2017.)

Seattle Public Utilities (SPU)'s Green Stormwater Infrastructure (GSI) program started in 1998 with a "roadside bioretention," or green street, project known as SEA-street, which became a template for other green street installations across the city's three watersheds. This initial project relied on community initiative: neighborhood advocates who generated the most responses to a citywide survey "won" the privilege of being the first green street. The city-wide program and stormwater code, developed in 2009 in response to a US EPA CSO consent decree, revolves around a public green street program and a voluntary private installation program called RainWise (City of Seattle, 2017).

SPU green street installations often run in partnership with other departments and projects, such as where road construction is already planned, which cuts costs but sometimes impedes community involvement in the planning process. As is often the case with city-scale projects, the environment and the larger GI plan can take priority over engagement efforts: "Sometimes we don't have a lot of options for which streets we choose, as there are a lot of technical constraints and we are trying to reduce costs, which makes it harder to pay attention to what the community wants" (Mills, 2017). However, SPU ultimately prefers to work in places where the community is largely in support of the project: "technical constraints can be hard to resolve with community needs, but one of our goals is to take in information from residents and fulfill those needs" (Mills, 2017).

Pushing a project too fast can also lead to community distrust; SPU feels they are more successful when they devote time to reaching an agreement with the community, clarifying their message and intentions, assuaging any fears, and giving the community a chance to feel heard. Though residents are excited about GI projects, they do not always fully understand them; it is important to dedicate time to education and trust-building (Mills, 2017). Extra time also makes it easier to manage expectations and communicate clearly about the project, so community members won't be confused or disappointed by the results, and trust won't be broken (Mills, 2017).

Residents who can advocate for GI in a neighborhood on a city's behalf are seen as an incentive to bring GI to that neighborhood, as SPU can more easily develop a close and trusting relationship with that community. However, SPU has to be careful that the message remains consistent through 3rd-party (and sometimes multi-lingual) outreach; SPU wants to be clear and transparent about the project in order to maintain trust in the community. SPU also worries that relying on community advocates can lead to equity issues if some communities who would benefit from GI lack awareness or agency to advocate for themselves (Mills, 2017).

Advocates can also help develop and diversify outreach strategies: "we are always adapting modes of outreach, because no matter how many times you say something, sometimes it doesn't sink in, and

one tactic does not fit all needs" (Mills, 2017). SPU advocates for tailoring an outreach strategy to the needs of the community and starting with the audience rather than the outreach tool; this necessitates developing close partnerships with community stakeholders. SPU also hosts community block meetings and "walk and talks" in order to meet with community members face-to-face.

One place where SPU does not attempt to engage the community is through participatory maintenance, as early attempts at a volunteer program were not successful. SPU has gradually taken maintenance responsibilities back from the community in order to make sure the facility is functional and aesthetically appealing: "the idea of community involvement is wonderful, but the reality is a harder logistical problem" (Mills, 2017). Maintenance is instead a critical part of the initial city budget and planning process.

The RainWise program, a partnership between SPU and King County, started in 2010 as a rebate program for landowners who disconnected and diverted their drainpipes to a water barrel or rain garden. Homeowners who sign up receive a credit on their stormwater utility fee. Today, a landowner can hire a contractor through RainWise at a discounted price to build a rain garden on their property. RainWise also provides maintenance training materials. This initiative to "let the residents be part of the solution" now has 58,000 customers, with 250-300 new GI installations each year (Spencer, 2017). RainWise sends postcards to residents every 8-12 weeks, puts up advertising signs on installations, and encourages residents to spread the word to their neighbors; currently most residents participate out of altruism or love of environment, rather than an appreciation of the aesthetic, but RainWise is working on a messaging angle that will appeal to a different audience (Spencer, 2017).

The RainWise program has illuminated another sector of the community where outreach is lacking: landscaping contractors. RainWise has trained over 600 contractors, but only about 50 actually install rain gardens for RainWise at any one time (Spencer, 2017). RainWise only has funding to

provide basic installation training, and most contractors do not see enough profit or benefit in starting a full-fledged green business, while others lack the interest or know-how. RainWise is working with the Seattle Office of Economic Development to develop strategies for green workforce development to encourage more contractors to get on board with green businesses (Spencer, 2017).

Seattle also benefits from partnerships with non-profits who help promote the benefits of GI. Non-profit Stewardship Partners' 12,000 Rain Gardens campaign, developed in partnership with Washington State University, maintains a GI resource library and offers grants, trainings, and workshops to spread the word about Seattle's GI programs. In an effort to increase equity in the GI world, Stewardship Partners provides rain garden grants to low-income communities. Where SPU has limited capacity for on-the-ground engagement, Stewardship Partners is able to help bridge the gap by giving communities agency to implement their own GI projects. In addition to the resource library, Stewardship Partners also provides an online sharing platform where rain garden owners can share their stories online and be part of self-guided GI neighborhood walking tours. Non-profits like this can help large-scale agencies like SPU generate interest in and access to GI, increasing receptiveness to SPU's GI installations (Bahr, 2017).

Table 4: Seattle, WA Key Takeaways

Barriers to Engagement	Outreach Strategies	Key Takeaways
Environmental, technical, and cost constraints Preserving trust and clarity of message Education gap/lack of knowledge or awareness Lack of engaged	Postcards & direct mailings Blogs & social media Press coverage (newspapers, radio, blogs) Online resource library (i.e. maintenance training) Online GI project sharing platform and mapping tool for self-guided	Incentivize residential voluntary programs Stakeholder Partnerships Target communities based on their interest Encourage community advocacy and peer-to-peer promotion Tailor the message to the

workforce Ensuring equity Sufficient time for early engagement	tours Community/stakeholder meetings, conferences, summits Community advocates do door-to-door canvassing, peer-to-peer networking Outdoor block meetings and neighborhood walk-and-talks	audience Engage and train contractors; build the green workforce Design for maintenance Provide online resource library & sharing platforms

Trust & Participation: Philadelphia, PA

Figure 6: Philadelphia, PA. Students designed artwork for Philadelphia's Wrapped Rain Barrel Program, which gave free rain barrels to qualifying organizations. (Source: Philadelphia Water Department, 2017.)

The Philadelphia Water Department (PWD) adopted the Green City, Clean Waters plan in 2011 in response to a water quality consent order from the US EPA. The main goal of the plan is to reduce stormwater pollution in the city's combined sewer system by 85% in 25 years using GI (PWD, 2017). Five years into the program, the City has already completed 441 GI site installations, greened 837.7 acres, and reduced pollution by 1.5 billion gallons, surpassing their five-year target (PWD, 2016a). The program involves three main approaches: projects on public land, such as green streets and public park retrofits; stormwater regulations requiring GI components in

development and redevelopment projects; and an incentive program to encourage the voluntary installation of GI on private property.

The PWD prefers to install public projects where there is community interest and support, but is somewhat limited by the large scope and strict timeline of the program. Public GI installation sites are chosen according to the environmental parameters of a GIS site selection tool, and PWD has to stay on-schedule in order to complete the required number of installations per year. PWD believes in the importance of responding to community needs and enjoys connecting with community members face-to-face to hear their feedback, but the parameters of the program can be a limiting factor: "we will always respond where there is demand because if there is community support it makes our project easier and of course we want to go there, but we have to prioritize technical needs over community support" (Ledesma, 2017).

In order to ensure that there is space for community participation in the process, the PWD shows up at community meetings with a pre-approved plan but no completed design, so that the community can choose between different GI types and weigh in on design styles and plant choices (Ledesma, 2017). Because the top-down approach to planning and urban development has historically generated government distrust, PWD endeavors to build and maintain community trust through early and sustained engagement, education, and open, transparent communication. Once communities understand the benefits of the program and trust the government to maintain the installations, they are generally supportive and accepting of the installations: "We hear anecdotes all the time that people are happy with the program" (Ledesma, 2017).

PWD also gives residents opportunities to initiate GI programs on their own land. Under the voluntary Raincheck incentive program, landowners can obtain free rain barrels and funding for rain garden installations. Residents can also attend city workshops and trainings to learn how to maintain their installations. Though started by PWD, Raincheck is in many ways a community-based program: program participation is voluntary, residents learn to install and maintain the GI

themselves, and residents even promote the program to each other by word-of-mouth (Ledesma, 2017).

PWD partners with schools, businesses, and non-profits on individual GI projects, and encourages residents to promote GI projects as volunteer "outreach ambassadors." While the City takes responsibility for GI maintenance as a strategy for preserving a trusting city-community relationship, PWD's Soak It Up Adoption mini-grant program allows non-profits to maintain installations through City grants. Community members can volunteer with these non-profits, which PWD sees as an opportunity for community members to connect with and become champions of GI (Ledesma, 2017).

A key element of PWD's GI program is engaging the Philadelphia community through interactive GI installations. PWD has designed and is in the process of installing interpretive signage that complements and explains GI installations to passersby. Additionally, several agencies, non-profits, and other city stakeholder groups have contributed to public art projects in concert with GI installations around the city. Installations include benches, gazebos, murals, student art displays, and festivals to celebrate the revitalization of vacant lots into green space (Ledesma, 2017). Interactive GI provides opportunities for residents to learn about and build relationships with installations, so that they feel connected to and invested in the projects. Educating and engaging the community is a big part of what moves the project forward; making GI community-relevant and accessible helps sustain a trusting relationship between the community and the City.

Table 5: Philadelphia, PA Key Takeaways

Barriers to Engagement	Outreach Strategies	Key Takeaways
Environmental needs, technical parameters, and installation plan & schedule Scope Limitations: Large project scale/lack of time to engage Education gap/lack of knowledge or awareness Ensuring clear communication; building and preserving trust	Fliers and direct mail Collaborate with partners Community & stakeholder meetings In-person meetings Peer-to-peer and word-of-mouth promotion Social Media (facebook, blogs, etc.) Press for large events Public art and installation signs	Incentivize residential voluntary programs Engage early to build trust; get feedback on plan before design stage Target communities based on their interest Build trust & support through transparency, open communication, & education City takes responsibility for maintenance to build community trust Volunteer maintenance can build trust, interest, and understanding

The First Steps: Atlanta, GA

Figure 7: Atlanta, GA. Sign on rain garden at Adair Park. (Source: City of Atlanta Department of Watershed Management, 2017.)

Atlanta is unique among the five large US cities chosen for this thesis in that it does not have an established, comprehensive stormwater program or sufficient funding for a city-wide initiative. Though the City manages a 2,000-acre protected stream buffer (Greenway) under a wastewater consent decree, there is no regulatory mechanism, permit order, or stormwater utility fee to mandate or fund a city-wide stormwater program. As such, GI initiatives in the City have been cobbled together creatively through grants and inter-agency partnerships.

The city's Green Infrastructure Task Force, formed in 2012 by multiple city agencies and partner organizations, seeks opportunities to raise awareness and integrate GI technology into City infrastructure repair projects. Their work includes 10 GI projects and a progressive Post-Development Stormwater Management Ordinance, adopted in 2013. This ordinance has allowed the city to permit nearly 2,000 GI construction projects, which are projected to reduce polluted runoff by 350 gallons per year (City of Atlanta, 2016). Their 2016 Strategic Action Plan promotes GI through policy changes, installation projects, outreach, and inter-agency collaboration. At the time of this writing, they are in the midst of developing a Communications Plan to increase program visibility and "engage not inform" the Atlanta community in GI projects: "We want to help facilitate more meaningful community involvement" (Rutherford, 2017).

The Task Force's primary strategy in promoting GI has been to educate and engage stakeholders throughout the city. City staff have spoken to community associations, church groups, and watershed stewardship councils, and have relied on informed stakeholders to raise awareness amongst their peers in turn. Several of their non-profit partners are moving forward with small, awareness-raising GI demonstration projects. While the City does distribute handouts and send letters, their chief outreach strategy is to speak with business owners, residents, and non-profit staff face-to-face (Rutherford, 2017).

Perhaps the greatest challenge for the Task Force has been raising awareness and interest in GI within the City government itself. Because GI impacts multiple departments, it requires intense

and somewhat-unprecedented interdepartmental collaboration: "The issue with GI is it has so many benefits and involves so many things that it changes the way the city does its projects, requires a different style of project management, demands information-sharing and coordination that we're not used to" (Rutherford, 2017). The Atlanta Public Works Department has recently started taking the initiative in recommending GI projects; this relationship is crucial, as the Task Force will be relying on Public Works to take on responsibility for GI project maintenance as they develop an official maintenance program in the coming years (Rutherford, 2017).

While the lack of a comprehensive, city-wide GI plan creates challenges, such as a lack of reliable support or funding for installation projects, Atlanta also has the flexibility to follow the initiative of individual communities over the demands of an established installation schedule. In the summer of 2017, the City of Atlanta will install a 1.2-mile Green Street in northwest Atlanta as a result of the initiative shown by two Atlanta neighborhoods. The Boone Boulevard Green Infrastructure and Capacity Relief Project, designed through a 2012 EPA Technical Assistance Grant, includes bioretention cells, permeable pavement, improved sidewalks, and a bike lane.

Boone Boulevard residents approached the non-profit organization Park Pride in 2010 to help them design neighborhood park space. Working with the community, Park Pride developed "Proctor Creek/North Avenue Watershed Basin: A Green Infrastructure Vision," a plan to help the community increase green space while also addressing neighborhood stormwater issues (US EPA, 2014; City of Atlanta, 2014). In response to the proposal, the City conducted a feasibility study and survey, which revealed that 33% of neighborhood residents considered stormwater flooding to be a major neighborhood issue (Rutherford, 2017). In response to community interest, the City obtained an EPA grant to complete the project (City of Atlanta, 2014).

Since there is no stormwater utility fee or other GI funding mechanism in place, Boone Boulevard is funded solely by an EPA grant with a deadline. While the grant has provided a great opportunity to the City, the nature of the grant has also limited the City's ability to engage the community in

the design process: "all these factors conspire to make a short timeline between the design and construction" (Rutherford, 2017). Though the City spoke at meetings and sent letters informing less-engaged residents of the project, a few community members began objecting when construction began in the Spring of 2017. Though the minority, these residents felt they had not been engaged in the project and were concerned about the planned lane reduction. This highlights the challenge of ensuring complete and equitable engagement, a common challenge faced by city planners. However, the city feels confident that they have engaged the community majority, and that the lane diet will improve access for cyclists and pedestrians and life for the neighborhood overall (Rutherford, 2017).

Table 6: Atlanta, GA Key Takeaways

Barriers to Engagement	Outreach Strategies	Key Takeaways
Lack of funding mechanism, regulations, institutionalized programs, or incentives Time and grant funding constraints Reaching the whole community Lack of education in the community or amongst City staff Requires a different, cross-agency approach to project management	Letters, handouts, website posts Educate and form relationships with stakeholders first Rely on stakeholders to open doors to the community, and visit their group meetings One-on-one and face-to-face interactions Build interagency interest, awareness, and involvement	Look for and follow community demand and initiative Find funding sources and regulatory mechanisms Train, build relationships, and collaborate with communities, organization leaders, and City staff Promote buy-in and sustainable project support; build DPW investment in maintenance

Urban Forests and Watersheds: The New England Region

A Community Service: Long Creek Watershed, ME

Figure 8: Long Creek Watershed, South Portland, ME. Blanchette Brook Stream Restoration. (Source: Long Creek Watershed Management District, 2016.)

In 2009, the EPA and Maine Department of Environmental Protection (ME DEP) exercised their authority under the Clean Water Act to require all property owners within the Long Creek Watershed, a 3.5 square mile commercial/retail area covering four cities around South Portland, ME, to obtain a stormwater discharge permit if they owned one or more acres of impervious land. This action came in response to the watershed's failure to meet water quality standards. In response, the four affected municipalities joined forces to establish a special purpose district and non-profit corporation, known as the Long Creek Watershed Management District. The District developed a Watershed Plan and applied for an EPA/ME DEP grant to fund the Long Creek Restoration Project, with the goal of reaching water quality standards by 2020 ("Long Creek Watershed Management District" [LCWMD], 2016).

By working together, the District was able to obtain and implement a Long Creek General Permit on behalf of 89 participating landowners who own 98% of the watershed's impervious cover (LCWMD, 2016). Rather than each landowner having to apply for permit coverage individually, this collaborative approach allowed landowners to pay an annual fee to the district in return for permit coverage and compliance assistance: "The General Permit, and implementation of the Plan, is premised on the notion that the watershed restoration project is more efficiently and effectively implemented as a cooperative project" (Carney, 2017).

While a permit is required, participation in the District's general permit program is voluntary. The District conducts direct outreach to a target audience through mailings, factsheets, and face-to-face interactions. The participating landowners, who are targeted based on their eligibility for the general permit, pay $3,000/acre annually to the District; in return, they are covered under the general permit and exempt from the challenge of meeting individual permit requirements. The District also provides assistance in planning, designing, installing, and maintaining the GI installations on landowner property. They conduct annual inspections and site visits in order to ensure that each landowner meets the permit requirements, as well as to monitor the installations, maintain stakeholder relationships, and conduct ongoing outreach to help resolve common maintenance issues.

Maintenance is a shared responsibility between the District and the participating landowner. During annual site visits, the District representative inspects the installation, tests the site's water quality, and provides training, advice, or factsheets to the landowner as needed to help them improve their maintenance strategy or resolve any issues. The landowner is, in turn, responsible for day-to-day maintenance, and the District offers a credit on the annual fee to incentivize proper maintenance (Carney, 2017).

Although the program is voluntary and relies on community and landowner initiative, this program is unique in that it largely revolves around the idea of *not* engaging the community. Participating

landowners are encouraged to join the District Board and participate in the District process if they want to, but "one of the main draws of the District is it handles design, maintenance, permit compliance on behalf of Participating Landowners – they can make decisions, but they are paying the District to make decisions so they don't have to worry about it" (Carney, 2017). The District hosts an annual landowner meeting, but only 16 of the 89 participating landowners are on the District Board (Carney, 2017). While landowners have an active role in planning, installation, and maintenance, one of the program's greatest incentives is the freedom to be less engaged in the watershed management process.

Similarly, the larger community is not generally aware of the program because "they do not need to be," since they are not eligible for the permit; however, the District has begun conducting outreach to retail property leasers, who could support landowners, and to non-impacted landowners, who can still have an impact on watershed health (Carney, 2017). The District hopes to start installing signage and engaging the larger community; in 2016, The District hosted their first annual volunteer clean-up day with USM students to clean garbage out of catch basins and raise awareness about the project (Carney, 2017).

Table 7: Long Creek Watershed, ME Key Takeaways

Barriers to Engagement	Outreach Strategies	Key Takeaways
Overwhelming variety of information Finding the right strategy for the community Need for flexibility in plan to adapt to project changes over time	Group collaboration to increase ease of participation Priority outreach to target audience (one-on-one engagement, direct mail) Media coverage – press releases, website news Volunteer maintenance days and planned signage to engage non-target public	Power of incentives and regulatory mechanisms Incentivize voluntary participation and maintenance (fee credits) Encourage ongoing participation through sustained engagement: provide assistance post-installation Maintenance as shared responsibility Be flexible; change project as needed

Learning Together: Berry Brook Watershed, NH

Figure 9: Berry Brook Watershed, Dover, NH. US EPA staff with Bill Boulanger and Jamie Houle. (Source: Amy Miller, US EPA Blog, 2016.)

Bill Boulanger, Director of Public Works at the City of Dover, New Hampshire, never expected to become an innovator and inventor of GI technology. In 2006, when Dover's Berry Brook watershed was deemed "impaired" by the US EPA, Jamie Houle of the University of New Hampshire's Stormwater Center approached Boulanger with grant funding and a plan to improve the city's water quality through GI (UNH Stormwater Center [UNH], 2016). Boulanger, however, was immediately concerned that the proposed designs did not match the community's aesthetic, and more importantly that traditional rain garden plantings were not suited to the DPW's maintenance budget, equipment, or training (Boulanger, 2017). What followed was nine years of negotiations, conversations, and adaptations in pursuit of a community-relevant, environmentally-effective, and sustainable GI program for the Berry Brook Watershed.

From Boulanger's perspective, UNH staff were more focused on engineering principles than on what would actually work in the field, both in terms of community reception and the likelihood that the installation would be maintained (Boulanger, 2017). When UNH presented their initial rain garden and GI designs, Boulanger's immediate and largest concern was how Dover would continue to maintain them after grant funding ran out and UNH moved on to another project: "We had to do a design that would fit the neighborhood since it's the neighborhood that will manage it down the line" (Boulanger, 2017). If it was going to be up to Dover to maintain these installations in the long term, then UNH would have to bring installations that Dover had the knowledge, equipment, and resources to maintain. Working together, Dover and UNH created and implemented a new design plan that included catch basins for easy maintenance, grasses that could be mowed with Dover's equipment, and the "Boulanginator," a network of catch basins and subsurface filtration mechanisms that mimics permeable pavement without requiring the purchase of special pavement maintenance equipment (UNH, 2016). Dover residents have been very supportive of the installations, and have begun requesting rain gardens and catchment barrels in their neighborhoods (Boulanger, 2017).

Collaborative design is not a quick, smooth, or simple process; UNH and Dover DPW come from different perspectives and realms of understanding, and there was "a lot of back-and-forth" as they learned from each other and developed a plan that would work for both the community and the environment (Boulanger, 2017; Houle, 2017). However, UNH was focused not just on installing GI for the sake of the environment, but on raising community and municipal awareness and support so as to promote GI sustainably through widespread behavior change (Houle, 2017). According to Jamie Houle of UNH (2017), GI has been thoroughly developed and studied, but has not fully emerged as common practice due to lack of awareness: "we don't really have any technical barriers, the real barrier is the human dimension, and getting people to start doing it."

UNH was able to overcome the "human barrier" and reach the community effectively by abandoning the "top-down" GI installation approach in favor of collaborating with local advocates like Boulanger to develop and implement a plan together. In his dissertation, Houle argues: "agents of change who want to move innovations through a broad municipal population should focus their efforts on working with innovators and early adopters that have status within relevant peer networks and who have capacity to evaluate the strengths and weaknesses of innovations" (Houle, 2015, xi). Through a long-term process of collaboration, knowledge-sharing, and trust-building, UNH was able to depend on Boulanger to bring the concepts of GI to the community sustainably as an "early adopter" and advocate.

A crucial element of this knowledge-sharing process is that it wasn't just UNH sharing knowledge. Instead of UNH bringing GI education to Boulanger and Dover, the two groups were able to learn and adapt together. Traditionally, rain gardens have been planted with specific plant species; through work with Dover, UNH began studying the plausibility of improving water quality through plantings of mowable grass, which is seen as easier to maintain; according to Houle (2017), these new GI inventions are also compatible with water quality improvements. Top-down "forced community engagements," like factsheets or rain garden demonstrations, are not as effective as working with a community to develop adaptive GI technologies that the community can and will use over time: "if they reinvent the technology for themselves, they demonstrate true buy-in and project longevity" (Houle, 2017).

True behavior change is critical to the maintenance and longevity of a GI project. Both Boulanger and Houle identify maintenance as the most important component, and often the greatest barrier, to the success of GI projects. Houle tells the story of a permeable pavement installation on a city street five years ago: the pavement was not adequately vacuumed or maintained, and so after five years the street was actually worse in terms of stormwater impacts than neighboring streets where no action had been taken (Houle, 2017). If a community is not aware and invested in a project, it

will not be maintained after project funding runs out, and the project will fail. That is why Houle and UNH recommends adapting GI technology to fit the needs and interests of the community: "let them invent the solutions that work, rather than forcing technology/solutions on them," so they will have both the capacity and the initiative to keep a project going (Houle, 2017). Boulanger notes that the nine-year collaborative process has changed the way his team thinks: "now, my highway crew wants to think about what we can do in projects that don't have stormwater in the plan" (UNH, 2016).

Table 8: Berry Brook Watershed, NH Key Takeaways

Barriers to Engagement	Outreach Strategies	Key Takeaways
Large Project Scope and Scale interferes with community engagement Knowledge gaps and lack of common understanding Building trust and understanding takes time Maintenance needs, including labor, time, cost, equipment, and training Lack of knowledge, trust, or understanding "There are no technical barriers, only human barriers"	Community meetings "collaboration is key" "Peer-to-peer conversations are more effective than factsheets" Understand and adapt outreach to your audience Emails, website postings, newsletters Spread the word/serve as model to others Engage maintenance staff early in process	Building trust is a priority and takes time Promote learning and behavior change Promote buy-in and behavior change Get them to take ownership of concepts and reinvent technology for themselves Design for and adapt to community needs Design for maintenance

Being Present: Worcester Urban Forest, MA

Figure 10: Worcester Tree Initiative, Worcester, MA. Volunteer and student tree planting programs. (Source: Worcester Tree Initiative, 2017.)

The Worcester Tree Initiative was founded in 2009 in response to the removal of 30,000 trees from Worcester, Massachusetts and surrounding neighborhoods due the invasion of the Asian Longhorn Beetle. City residents, especially those in the hardest-hit neighborhoods, were "emotionally devastated" by their removal, as the trees were highly valued and "integral to neighborhood identity," says Executive Director Ruth Seward (2017). In anticipation of the upset, Congressman James P. McGovern and former Lt. Governor Tim Murray set up the Initiative through a combination of public-private funding, with the goal of replanting 30,000 trees in 5 years (Worcester Tree Initiative [WTI], 2017). The programs initiated to accomplish this goal have included tree giveaway programs, school and group tree planting projects, young adult forestry programs and internships, and a volunteer maintenance program.

The Initiative, led by just two staff members, relies on public grants and private/non-profit support; rather than establishing themselves as an official non-profit, they have maintained non-profit status through a partnership with the Tower Hill Botanic Gardens. "Partnership is the biggest thing," says Seward (2017). The Initiative reaches out to residents and builds awareness of their

programs primarily by speaking at community meetings and events. Their earliest initiative involved partnering with Worcester-area schools to start 10 different school planting and education projects. Partnering with local organizations, including public housing projects and the Boys and Girls Club, have helped them to reach, educate, and bring trees to more people in the community.

Being present and approachable is the most important outreach tactic for the initiative. Staff and volunteers spend time not only at community meetings but also walking the streets of Worcester neighborhoods, monitoring and maintaining planted trees, canvassing with door hangers in multiple languages, and having one-on-one, face-to-face conversations with area residents: "we were out in the community constantly and people would come out and talk to us" (Seward, 2017). Being visible helps raise community awareness of and interest in the project, while their attention to tree maintenance builds trust in the community. The Initiative has also built its reputation by being approachable and responsive to feedback; residents are encouraged to write, call, or approach volunteers on the street with any requests or maintenance concerns. While the response to the Initiative has been very positive, as trees are still highly-valued by the community, the Initiative is also attentive to residents who express anger: "they are frustrated the trees were cut in the first place and want to vent" (Seward, 2017).

The Initiative believes strongly in maintenance and volunteering as a community engagement and nature-connection-building tool, and views tree maintenance as a joint responsibility held by the Initiative and the people. The Initiative plants street trees, but also hosts tree giveaways for residents to plant and care for trees on their own property. While residents are encouraged to call the initiative about maintaining a street tree or to ask advice about a tree on their property, they are also encouraged to care for their own trees, learn about tree maintenance, and volunteer with the initiative to maintain their neighborhood street trees (Seward, 2017). The Initiative's Neighborhood Tree Stewards Program provides residents with the opportunity to volunteer to

maintain trees and engage more closely with their natural environment because "it is essential to reconcile urban people with the natural environment" (WTI, 2017).

The Initiative is especially committed to nature-engagement for urban youth and communities of color. "Part of Worcester Tree Initiative's mission to Rebuild Worcester's Urban Forest is to ensure that a large, diverse group of people will continue to care for the forest" (WTI, 2017). In addition to school planting projects, the Initiative also manages high school internships, a young adult forestry program for high school and college students and disadvantaged youth, and a Green Club to "get urban kids engaged with the environment" and interested in forestry and other green jobs (Seward, 2017). The Initiative is also committed to "bringing diversity to the forestry workforce," by providing opportunities for diverse urban youth to engage with the natural environment and become interested in environmental careers (Seward, 2017). This not only ensures the longevity and maintenance of Worcester trees but also increases overall awareness of and interest in nature and green spaces in urban places.

Table 9: Worcester, MA Tree Initiative Key Takeaways

Barriers to Engagement	Outreach Strategies	Key Takeaways
Need time and patience to develop reputation Importance of urban connection to nature Need for green jobs training	Partnerships, stakeholder meetings Door-hangers (multi-lingual materials) One-on-one talks (get to know the people) Community Presence (door-to-door, visibility)	"partnership is the biggest thing" Build reputation, awareness, and trust over time Be visible, approachable, and present in community Multicultural nature engagement and green jobs training Maintenance as engagement

Neighborhood Projects: Boston, MA

Connecting Communities: The Rose Kennedy Greenway

Figure 11a, b, and c: Rose Kennedy Greenway, Boston, MA. From top to bottom: The North End; Chinatown; Public Art on the Greenway. (Source: The Greenway Conservancy, 2017.)

The Rose Kennedy Greenway (RKG) was founded and built by the Massachusetts Department of Transportation (MassDOT) in 2008 as part of Boston's Big Dig project to lower Routes 93 and 90 below ground and open the former highway space for alternative uses. In place of the former elevated highway system, MassDOT installed a string of parks on top of the new highway tunnel network; the entire site is technically a green roof, though it is not generally advertised as such (Purcell, 2017). In 2009, the public-non-profit Greenway Conservancy took over maintenance and management of the RKG, which stretches across multiple Boston neighborhoods (Rose Kennedy Greenway, 2017).

Because the RKG is built over a highway, there are some technical constraints in terms of what can be done in each parcel. For example, it is challenging to plant trees in shallower parcels, where the highway tunnel is close to the surface, while avoiding the risk of roots breaking through the waterproofing layer. However, technical challenges do not severely limit the design of the space: "engineering makes design challenging but doesn't define it - we still try to work with the

community" (Jazinski, 2017). The Greenway generally follows the will of the surrounding neighborhood, stepping in where "there is risk of communities not knowing what they want" (Purcell, 2017), such as a community favoring a plant species that won't grow well in Boston's climate.

The Greenway seeks to balance uniformity in its signage and park amenities with making each park segment relevant to its neighborhood: "Different cultures in one corridor is interesting but lacks cohesion" (Jazinski, 2017). The RKG serves a variety of audiences, including residents of the North End and Chinatown, tourists, and residents of the larger metro area who are drawn to the park by food trucks and events (Purcell, 2017). Considering the predominant audience in each park parcel necessitates partnering with community groups, welcoming community feedback and participation, and trying to design each parcel based on community interests and aesthetic. Four years ago, The Greenway received some bad press; they addressed the problem by increasing community engagement, outreach and transparency, which included staffing their 21-person board with community representatives. Their mission has shifted to speak to the needs of each community: "Community engagement should ask rather than tell" (Purcell, 2017).

One of RKG's most outspoken communities is Boston's North End. Because of the community's Italian roots, community members originally advocated for Italian plants that do not grow in Boston's climate. The Greenway helped the North End merge community interests with environmental constraints: "We can match their aesthetic preferences by hearing why they want something and doing something similar rather than just saying no" (Jazinski, 2017). Over the years they have added a larger variety of plants to improve the look of the site according to community aesthetic, without consulting the community directly: "We need to consult them on the big design decisions, not the technical decisions – they aren't experts on plants, so we provide the horticulturalists" (Purcell, 2017). In terms of big decisions, the original designers of the parcel added a pergola that was meant to serve as a gate to the North End. The Greenway found that

residents did not have a use for a gate, and instead wanted to add wisteria and benches to create a shaded seating area; though the original design did not address the community's needs, the Greenway was able to adapt the space to make it relevant to them (Jazinski, 2017).

Chinatown is another Boston neighborhood that is prominent in The Greenway's engagement efforts. Chinatown residents prefer to leave their parcel of the RKG open for festivals and events, and The Greenway's focus has been on improving communication so the community can easily request use of the space whenever needed (Jazinski, 2017). Because of the necessarily flexible nature of the space, Chinatown's parcel has become an ideal site for placemaking and temporary installations: in 2016, a museum donated some moveable playcube structures to the Greenway, who put the play structures in Chinatown's parcel as a one-year experiment; residents responded positively to the temporary addition, so the Greenway has left the play structures there for their use (Jazinski, 2017; Purcell, 2017). The Greenway also partners with local groups to increase engagement and improve communication between the Greenway and Chinatown; for example, they have provided Asian-American students from the local group AVOICE with supplies to do their own placemaking in the space (Jazinski, 2017; Purcell, 2017). The Greenway has also relied on local advocates to help promote the cessation of smoking in the park through peer-to-peer networking (Purcell, 2017).

The mission of the RKG is to be "active, beautiful, and engaging" (Purcell, 2017). The RKG displays public art exhibits and demonstration gardens (including a rain garden), and the Greenway regularly rents park space out to communities and businesses for festivals and other events. In addition to its horticultural staff, the Greenway also hosts a volunteer maintenance program to engage park visitors; this popular program is generally booked through the summer, and 46% of participants in "volunteer days" say they would implement what they have learned in their own yards (Purcell, 2017).

Laura Jazinski (2017) designed a carousel for the RKG based on drawings from school children in five Boston schools; upon request of the carousel donor, Jazinski visited Boston schools and invited students to draw local animals that they would like to see on the carousel. Jazinski also incorporated universal design elements, such as non-moving animals that are more enjoyable for autistic children, in order to make the carousel more accessible and interactive; carousel staff are trained to inform parents of these amenities (Jazinski, 2017). This is one example of how the Greenway ensures that the RKG is accessible, interactive, and relevant to the variety of users who visit.

Table 10: Rose Kennedy Greenway, Boston Key Takeaways

Barriers to Engagement	Outreach Strategies	Key Takeaways
Cohesive vision vs. diverse communities	Community meetings	Respond to multiple audiences
Technical needs vs. community interests	One-on-one/personal stakeholder relationships	Volunteering (education & maintenance) as engagement
Lack of trust/transparency	Education through Park Staff and Volunteers	Respond to feedback; be transparent, preserve open communication
Open communication, clarity, and education	Website postings, e-news, social media, and press	Design for community
Concerns about preserving equity	Adapt outreach to community	Interactive spaces
	Placemaking, events, public art	

Figure 12a and b: Charles River Watershed Association, Boston, MA. Everett Street Pilot Project, Allston-Brighton. (Source: CRWA, 2014.)

The Charles River Watershed Association (CRWA)'s Blue Cities initiative has been designing and installing GI demonstration projects with Boston-area communities since 2005 (CRWA, 2014). Their first GI demonstration project involved a park installation at Peabody Square in Dorchester, which they completed with grant funding in collaboration with the state; from this initial process, CRWA learned a great deal about one-on-one community engagement and collaboration, while the state began to see the value in an institutionalized program instead of a case-by-case approach (Bowditch, 2017). Other projects have included a porous alley in Boston, apartment complexes in Waltham and Chelsea, and a town hall in Blackstone, MA (CRWA, 2014). CRWA manages the funding, planning, design, and installation of each project, while partnering with local non-profits and community groups to cover neighborhood outreach and communication because "that's not what CRWA does" (Bowditch, 2017).

CRWA's largest community-engagement GI project started ten years ago when residents of North Allston, a Boston neighborhood abutting the Charles River, asked for CRWA to assist them in negotiating land development decisions with Harvard University. Harvard had purchased a significant portion of North Allston land in preparation for an expansion of their Cambridge campus, and the community was concerned about how their development plans would affect the watershed and community. Harvard agreed to work with the North Allston community on a master plan for the neighborhood, and North Allston asked for CRWA to have a role in the process in

order to protect their watershed: "they were open to the idea because they wanted our help in the negotiations with Harvard, though they didn't know what the content of that help would be – once we explained, they were very supportive" (Bowditch, 2017). Because North Allston and CRWA had "complementing interests," they were able build trust and work together relatively easily; "no one was actively against it" (Bowditch, 2017).

Though CRWA and North Allston started on good footing, there was still an adjustment and learning process – most residents had not heard of GI and were unfamiliar with the terminology, so CRWA started with community awareness-raising while using "lay terms" in the meantime (Bowditch, 2017). CRWA hosted design charrettes and community meetings, went door-to-door in North Allston neighborhoods, and spent time getting to know and be known by the community: "the main thing that works is face-to-face communication…it is not enough to have demonstration plots, you need to get more in depth" (Bowditch, 2017). Trust and understanding do not develop quickly or easily:

> "people are often suspicious of outsiders they don't know getting involved…you have to take the time to understand and communicate why you are there and find ways for your goals to align, and over time people get used to the ideas and language you use, you build up trust…now people just know who we are." (Bowditch, 2017)

The reward for an intensive, long-term relationship between a watershed group and a community is an effective, supported, and community-sustained environmental improvement program. North Allston is still working on GI projects, including a grant application for a neighborhood green street, a tree planting project, and a school education program; they are also working with Harvard to increase river access and green space as part of a highway improvement project (Bowditch, 2017). Ten years in, CRWA is still working with them to help them green their neighborhood. Thanks to the recession, Harvard is just now getting ready to implement their new campus plan; the push for GI development never ends.

CRWA and North Allston may have had a taller hill to climb together ten years ago than watershed associations and community groups would have today, since communities are generally more familiar with green design concepts than they were a decade ago (Bowditch, 2017). However, GI concepts are still not considered general knowledge, and generating genuine community support for GI is still a time-consuming process, just as awareness-raising and trust-building takes time and patience no matter what the subject. CRWA acknowledges that this creates an interesting conundrum:

> "the big challenge is how to scale up – North Allston is just one neighborhood, and it's hard to find the right methods to use to engage them…the amount of work needed to be this in-depth in one community, we don't have the resources to work at this depth in the whole watershed, so how do we scale up to cover multiple cities?" (Bowditch, 2017)

Boston does not yet have a city-wide program like the ones in Seattle or Philadelphia; neighborhood-specific projects like this are the norm. Like the cities discussed at the start of this chapter, Boston will face the challenge of maintaining in-depth engagement should they ever start a comprehensive GI program.

Table 11: Charles River Watershed, Boston Key Takeaways

Barriers to Engagement	Outreach Strategies	Key Takeaways
Lack of knowledge; language/lingo barrier Building trust, awareness, and open communication Cohesive vision vs. reaching diverse communities Need time and funding for early and long-term engagement	Community meetings, design charrettes Door-to-door canvassing "the main thing that works is face-to-face communication" Do more than one-day demonstration plots	Take time to develop reputation & trust by being visible & approachable Work with the community Take the time to understand and respond to feedback Engage early and in the long term Maintenance is community responsibility

Sustainable Buy-in: The Bus Shelter Green Roofs, Dorchester

Figure 13: Bus Shelter Green Roofs, Boston, MA. A living roof on a Dorchester bus shelter. (Source: Dorchester Reporter, July 31, 2014.)

In 2014, the Fairmount-Indigo CDC collaborative, a community development coalition that seeks equitable development and sustainable improvements for Boston neighborhoods along the Fairmount-Indigo rail line, obtained a US EPA grant to install eight green roofs on existing neighborhood bus shelters. Every step of the project was focused on raising awareness and engaging the community. Project leaders Trevor Smith and Michael Chavez hosted school and community workshops pre-installation to teach the community about green roofs. Project collaborators, including the City of Boston, the US EPA, Land Escapes Design, and the Massachusetts Bay Transit Authority (MBTA), gave speeches at a green roof "installation day," which was covered by some local journals. The roofs themselves were highly visible to bus riders; the US EPA's Soak up the Rain campaign even provided bus shelter ads to teach bus riders about the green roof over their heads (Ecological Landscape Alliance, 2014).

Smith and Chavez also trained local youths through YouthBuild Boston and the TNT Eco-Teens Program to install, maintain, and monitor the bus shelter green roofs. One of the goals of the project was to grow the green workforce by training young adults in GI technology skills. While it remains to be seen if they will enter and remain in the green jobs sector in the future, the participants were very engaged and interested in the project at the time (Chavez, 2017). The teens would test each green roof to gather data on stormwater retention, pollution filtration, and impacts on the urban heat island effect, in order to generate significant data about green roof efficacy in support of future projects.

The general community reaction to the project was very positive: "There were times YouthBuild would go there to maintain it, and people would be there saying they didn't want it taken down, were starting to get protective of them" (Chavez, 2017). Media coverage helped spread the word, though coverage was limited and focused on the installation day photo opportunity rather than sustaining long-term interest in the project (Smith, 2017). The City was also excited about the project, as it was a step toward fulfilling Boston's climate resiliency goals (Ecological Landscape Alliance, 2014). However, once grant funding for the project ran out, none of the many stakeholders involved in the project was willing or able to take responsibility for maintenance, and so in 2016 the green roofs were all taken down. Without a built-in plan and funding mechanism for green roof maintenance, the project was ultimately unsustainable: "the major challenge in all green infrastructure is maintenance; no one really knows how to make a long-term budget for these programs" (Chavez, 2017).

The major issue at the heart of the project's ending was a lack of buy-in or trust in GI technology. Because bus shelter green roofs are a new concept with minimal data to support them, there were liability and safety concerns as well as a lack of evidence that the shelters would have a rewarding long-term impact. When the green roofs went up, Boston had just suffered through one of the highest snowfall seasons on record; the City and the MBTA were worried that the shelters would

not be able to hold the weight of both a green roof and heavy winter snows, and so it was determined that the roofs would be taken down in winter and replaced in the spring. A structural engineer was brought in to confirm that the shelters were robust enough to safely hold a green roof and several feet of snow and ice, but various stakeholders were still unwilling to take the risk. According to Smith (2017), once the green roofs had been established for a couple years, the plants were no longer in need of significant maintenance; the only significant labor cost in the long-term would have been the cost of installing and removing the roofs each year. If there had been more trust in the green roof technology or data to support green roof bus shelters, the roofs could have stayed.

From the beginning, Smith and Chavez viewed this project as a learning experience – both an opportunity to engage and educate the city, the community, and especially the young adults of the neighborhood, and also a chance for them to learn what does and does not work in a GI project. Through this process, the Fairmount-Indigo CDC accumulated data to support future projects, generated community interest, and built connections with various organizations and agencies: "we are looking for the next door to open," says Smith (2017). A temporary pilot project is a great opportunity to raise awareness and support in the City and community, but Chavez and Smith (2017) now advocate for a long-term plan, including a city-wide regulatory device to build a sustainable program and reliable funding mechanism, such as a stormwater utility, to incentivize GI development.

Table 12: Bus Shelter Green Roofs, Boston Key Takeaways

Barriers to Engagement	Outreach Strategies	Key Takeaways
Need regulatory incentive and funding mechanism Lack of data/evidence of success Liability concerns - distrust in the technology due to unfamiliarity Obtaining & sustaining commitment & support from collaborative partners and media Finding long-term buy-in and funding to ensure maintenance and sustainability of project Top-down approach lessens ability to engage community on the ground Lack of knowledge; language/lingo barrier "The major challenge in all green infrastructure is maintenance"	School workshops and community meetings Talking to people one-on-one and face-to-face Visible installations Posters/signs at installations Media coverage (papers and online) Youth engagement through job training	Community needs to be involved & aware to ensure the project is used & maintained Increase buy-in, trust, and understanding through education and engagement Develop a long-term commitment to maintenance from community partners Maximize media coverage Maintenance as workforce development Monitor installations, obtain efficacy data for future projects Engage community through maintenance trainings; more than a one-off installation day

VI. DISCUSSION & RECOMMENDATIONS

Several common themes, including goals, barriers, and strategies for community engagement, were revealed in the course of these interviews. These themes are shown in Figure 14 and detailed in Appendix C. Common barriers to effective community engagement include: project scope and time constraints; the prioritization of environmental and technical specifications for installations; the need to follow a schedule, plan, or grant parameter; lack of widespread agency or organizational support or understanding; distrust of government or development programs; and limited funding. Voluntary programs for landowners are common, but agencies are sometimes limited in their ability to respond to widespread community demand. Grants, incentives, and regulatory mechanisms can encourage or limit community involvement in different ways.

Figure 14: Common Themes. Extracted from interview notes and displayed in wordcloud format. (Source: www.wordclouds.com)

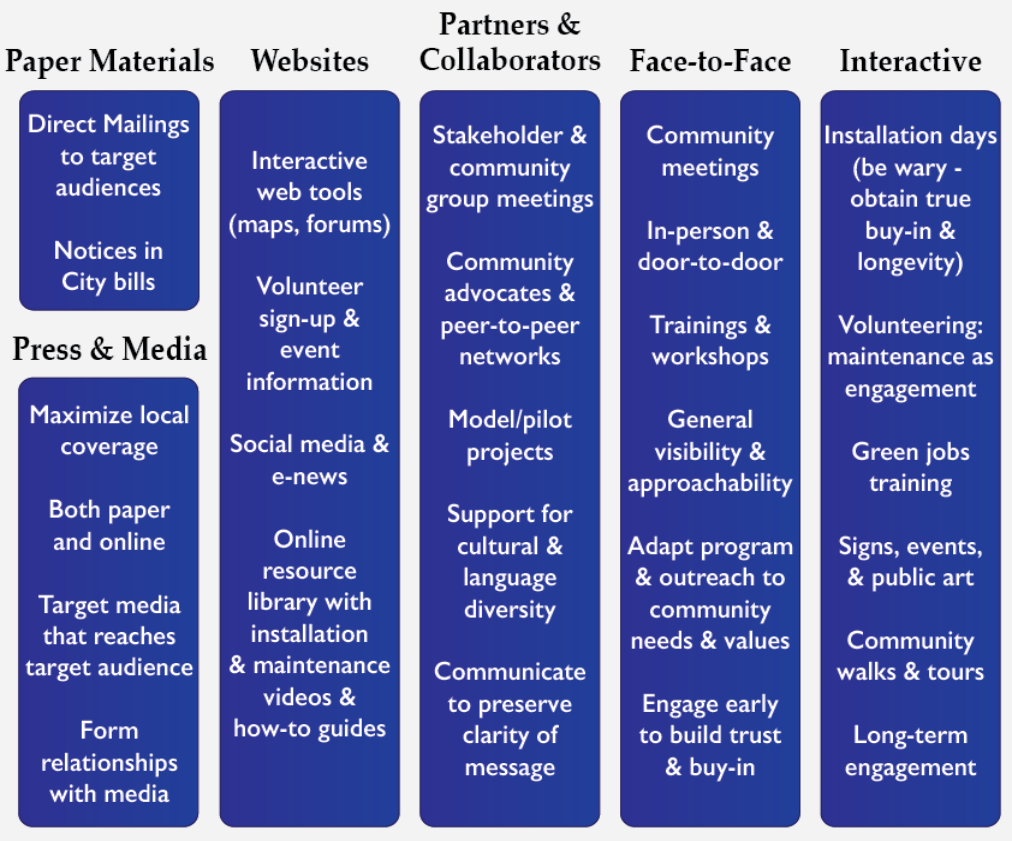

***Figure 15*: Recommended Outreach Strategies for Building Public Participation in Green Infrastructure. (Source: Elise Simons, created in Adobe Illustrator)**

Community outreach and engagement strategies are summarized in Figure 15 and detailed in Appendix D. Some strategies are considered more effective than others. Paper materials are valued most when targeted to a specific audience, and less than other forms of direct outreach tailored to a specific community. Interactive online forums, blogs, and installation site maps are more popular. Several interviewees noted that "Installation Day" rain garden demonstrations make a good photo opportunity for media outreach, but are not memorable enough to properly engage or sustain interest.

Several interviewees noted the importance of community advocacy and person-to-person communication in amplifying a project. Face-to-face conversation, either at meetings or one-on-one, receives praise across the board, as does reliance on community advocates and neighborhood peers to spread knowledge by word-of-mouth. Residents interacting with green infrastructure (GI)

through maintenance, walking tours, public art festivals, signage, or general use of the space is seen as a positive. Above all, collaborative partnerships between governments, non-profits, businesses, homeowners, community and environmental advocacy groups, academic institutions, and other stakeholders is crucial to improved project promotion, support, funding, and longevity.

A Resolution of Themes

A Race against Time

Of the eleven GI program interviews I conducted, six interviewees were concerned about time constraints or acknowledged a limited timeline as a barrier to thorough community engagement in GI programs. Seven emphasized the importance of engaging a community early and sustaining that engagement over the long term, regardless of whether their own program was able to accomplish that goal. The University of New Hampshire, for example, worked with the Dover Public Works Department for ten years to develop a trusting relationship and a sustainable GI program suitable to both the community and the environment. The Worcester Tree Initiative (WTI) and the Charles River Watershed Association (CRWA) have likewise relied on a decade of community visibility and engagement to build an effective GI program. While interviewing the CRWA, we discussed the benefit of a small-scale, neighborhood-based program that leaves enough time for thorough community engagement: while a city-wide program has many benefits, including reliable funding and support, it would be challenging to achieve such thorough, in-depth, and effective engagement with a larger-scale program.

For some, the issue of time constraints is caught up in an issue of funding: Atlanta's Boone Boulevard project, for example, faced some community engagement constraints as a grant-funded project, which allotted a limited amount of time for outreach, planning, design, and implementation of the green street installation before the grant timeline expired. A federal consent decree can also lead to a rushed watershed improvement program, with community engagement to some degree neglected in the shuffle. Five programs covered in this thesis exist as a result of a

regulatory authority executed by the state or US EPA under the Clean Water Act, requiring the city to improve the quality of their watershed. The four largest of these programs noted that they worked on a strict installation timeline (and followed strict site selection parameters) based on legal and environmental factors, which left limited time for community engagement despite their best efforts (and to be fair, these four cities do make a concerted effort). The fifth example, Long Creek in Portland, ME, overcame the lack of time for engagement by using it as a selling point: landowners who join their program no longer have to worry about their water quality, and are given the flexibility to choose how engaged they will be.

It would be remiss of me not to mention another element in this race against time, though it was not addressed in my thesis research: the growing threat of climate change. In coastal cities in particular, the threat of rising sea levels, increased riverflows, and disrupted weather patterns makes the issue of improved management of city environments all the more urgent and relevant. Whether dealing with a historic urban neighborhood with an over-taxed combined sewer system or an environmental justice community rife with brownfields and toxic landscapes, there may be moments in our future when protecting the public health of our neighborhoods supersedes any concerns about whether the community was adequately consulted before action was taken. In an ideal world, there would always be time for the community to be engaged in the GI process; however, environmental history has demonstrated that our species rarely acts to better the health of our environment until the last possible moment, at which point the time for long-term and in-depth engagement may have passed.

The People vs. the Environment

Seven interviewees felt the scale of their project and the environmental needs of the watershed limited their ability to spend time on individual communities. Interviewees whose programs operate under a Clean Water Act consent decree are required to improve watershed health by a certain amount within a specified timeframe, which means a certain number (or square acreage) of

installations need to be installed each year in specific, environmentally significant portions of the watershed. That being the case, a community's stated interest (or lack thereof) in a GI installation often runs second tier to the requirements of the city's GI plan. Each of these cities stated a genuine interest in following community demand and welcoming community input wherever possible, and have made substantial efforts to be flexible to community needs; they simply acknowledged that they were sometimes limited in that capacity due to higher-priority environmental and logistical factors.

Despite limitations on their ability to cater to community needs, large-scale, institutionalized programs offer programmatic, financial, and environmental benefits over individual, small-scale programs. The City of Atlanta, which relies on community-based initiatives rather than an official, regulated program, expressed interest in a stormwater utility fee as a funding mechanism for future GI and stormwater management projects. Neighborhood-specific projects, such as the Fairmount-Indigo Bus Shelters and the CRWA in North Allston, allowed time for valuable, in-depth engagement, and yet interviewees also expressed interest in a city-wide, institutionalized program in order to build a reliable and sustainable funding and support mechanism for project maintenance. When I interviewed CRWA's Kate Bowditch (2017), she voiced concern about translating and maintaining that degree of depth on the larger scale. Can our environment wait for us to spend a decade engaging every community?

Jamie Houle of UNH also worked on his GI program in the Berry Brook watershed for over a decade. Houle noted in his interview (2017) that the last remaining real barrier to GI is getting people on board. I likewise noted in my reading of the CWAA 2011 survey of obstacles to GI that failure to engage government officials, contractors, and the general public was the greatest recurring theme. Shandas & Messer (2008) concluded that community input and local knowledge can actually complement and improve an installation's environmental impact. Perhaps it is not a matter of choosing between the people and the environment, but of acknowledging that truly

reaching the people and increasing public participation is the last true barrier to making the environment better.

Houle (2017), likewise concluding that a project without community participation and support would fail, worked with the Dover Public Works Department to invent entirely new GI technologies based on soil and grass rather than ornamental plants, in line with community aesthetics and local maintenance capacity. He chose to adapt to rather than impose on the community. This is an argument in favor of the idea that we don't have to choose between the people and the environment after all; the two are complementary, not oppositional. Furthermore, in testing these new technologies, Houle has concluded that they are just as effective as traditional GI at improving water quality (2017). This finding has massive ramifications for the future of GI as a widespread development tactic, as it opens the door to GI installations in large-scale, low-maintenance projects, such as along the edges of highways. Following community interest can actually make a program better not only for the community or program but for the environment as a whole.

On the other hand, landscape architect Kate Kennen, who works in the related field of phytoremediation – the use of plant biology to remove toxins from contaminated soils and water sources – has argued in her latest book that plant choice is crucial to maximizing the environmental health benefits of any green installation (Kennen & Kirkwood, 2015). In cases where soil and water contamination is high, densely and deliberately planted rain gardens are likely to be more effective than turf lawn because of the benefits of plant life. Ornamental rain gardens may be more effective and appropriate in certain contexts, whereas lawn-and-soil-based GI technologies are better suited in places where maintenance is a debilitating limitation.

Depending on the degree of environmental contamination, it may be worthwhile to install a rain garden with plants a community dislikes, if it will make a difference in soil and water health, rather than sacrifice environmental health to please the community. In most cases, however, accounting

for community interest and aesthetic preferences is key to ensuring the installation lives up to its environmental potential. A willingness to design for and invite participation from a community not only ensures the installation will match community interest but also increases community interest in GI succeeding. In the end, there is a cautionary tale to be found in Ian McHarg's Houston Woodlands, where GI installations were ultimately dismantled because the community did not like the look of them: while sometimes the environment comes first, without community approval there may be no sustainable environmental improvement at all.

Trust: Building Relationships

Community trust was one of the most-repeated topics in my interviews. This is not surprising given urban planning's sometimes-spotty history, which includes urban renewal, redlining, and other projects lacking community consent or approval (Arnstein, 1969), and government efforts to overcome and improve that reputation. One of if not the major goal of Philadelphia's 25-year city-wide GI program, which includes volunteer programs, public art, and festivals in GI project areas, is to raise awareness and promote trust in the community. CRWA went in to their 10-year North Allston project expecting some distrust and prepared to work on building relationships over time. Lack of trust in the technology from various stakeholders may have been the dominant factor in why the Dorchester living roof bus shelters were ultimately dismantled and removed. Many also see city responsibility for GI maintenance as a mechanism for maintaining trust.

The most common observation among interviewees was that connections and partnerships with community stakeholders and non-profits are key to a successful, collaborative program. New York City DEP, for example, relies on non-profits to help bridge the communication gap between the needs of the community and the goals of their government program. Partnerships are also opportunities to increase funding and pool resources. While there is a risk of crucial information being lost or misconstrued through a third party (and loss of clarity can lead to distrust), ultimately

a message about GI or a GI program has more power delivered through a trusted 3rd party in the community, such as a local official, community board member, or even a friendly neighbor.

Interviewees also generally agreed on the importance of in-person, face-to-face interactions for raising awareness, interest, understanding, and trust in GI. This could include speaking at community meetings and events, going door-to-door to visit neighbors, hosting neighborhood block meetings and walking tours, or encouraging neighbors to advocate their own GI installation or volunteer work to their peers. Volunteers at WTI spend a great deal of time working in the neighborhood, both to monitor and maintain tree plantings and to increase their visibility, making them a familiar and approachable tenant of the neighborhood. At12,000 Rain Gardens in the Seattle area, online maps and forums help residents who are considering GI installations on their own property to visit and learn about their neighbors' installations.

The Long Haul: Maintenance & Project Longevity

One of the greatest challenges of any GI project keeping it effective in the long-term; this means sustaining community interest, public involvement, government support, and funding. Above all else, it means providing a lasting mechanism for maintenance.

A successful GI project means educating and training public works staff, contractors, the general public, and the green workforce of tomorrow (CRWAA, 2011). YouthBuild Boston, for example, trained Dorchester teenagers to install, maintain, and monitor the Dorchester Bus Shelters as a means to provide green workforce training. WTI similarly has several youth volunteer programs for forestry workforce development and engagement of disadvantaged youth. Alternatively, UNH opted to increase buy-in not by teaching GI maintenance techniques, but by adapting and designing GI technology to match Dover's current maintenance equipment, skills, and training. Either way, GI needs to be planned and designed with maintenance needs and capabilities in mind. If the project cannot be maintained, it will not succeed.

Project longevity and awareness-raising also depends on project visibility. Philadelphia's public art project and interactive installations are focused on making residents aware of and interested in their GI program. The Rose Kennedy Greenway also hosts public art exhibits, festivals, and farmers markets, while using signage to inform and engage their multiple publics. The Dorchester green roofs were placed on bus shelters in large part to increase their visibility, since traditional green roofs are often isolated from view.

WTI maintains project visibility not through signs and art but through volunteer programs and the presence of volunteer maintenance crews in the community. While a city should take some responsibility for maintenance to show the community they are reliable and committed to the project, supplemental community maintenance creates opportunities for public participation and civic ecology, or connection with one's environment and community (Krasny et. al, 2014). Portland, Oregon's volunteer maintenance program, for example, helps residents develop interest in and a relationship with neighborhood rain gardens.

To work, voluntary maintenance programs require both a willing public and a government willing to allow citizen maintenance while still taking responsibility for larger maintenance tasks. Reliance on an active citizenry to supplement government work, referred to as co-production, won't work for every neighborhood. Some community members resent co-production, perceiving it as an abdication of government responsibility, while some governments perceive great risk in trusting the public with maintenance responsibility (Kleinhans, 2017). When it is possible and contextually appropriate, however, shared maintenance responsibility can build a positive relationship between the government agency and community, provide opportunities for public participation, and increase capacity for GI maintenance overall.

Ultimately, the key to maintaining a project in the long term is maintaining relationships between installations and GI stakeholders. This means continually raising awareness, encouraging public participation, and gathering data and evidence to build trust in GI as a solid investment. It means

convincing governments to institute stormwater utilities or other mechanisms for continued funding. It means having a maintenance plan and training program, and providing opportunities to learn and engage. It means when you put in a rain garden, put a sign on it.

Stepping into our Roles

When I started this project, I set out to explore the various roles of government, non-government, and community stakeholders in GI projects. I wanted to analyze the power balance between these parties, while acknowledging that a GI project is not necessarily a struggle for power: if executed correctly, it can and should be a collaborative process for the benefit of our communal health and happiness. If a stakeholder does not play their role – if a government does not provide GI program access or listen to community concerns about an installation plan, if a community refuses to learn about GI or participate in a collaborative process due to distrust or unjustified concerns – then the project, whether it moves forward or not, will ultimately sit unmaintained and fail to provide the expected environmental benefits. Table 13 and the following pages explore potential roles in GI projects for government agencies, organizations, and community groups and individuals.

Table 13: Roles for Community Stakeholders in GI Projects

Players	Their Parts
Public Agency	Change laws; set up funding mechanisms and voluntary incentive programs; train workforce; provide and plan for maintenance; engage public face-to-face and through community stakeholders; be flexible and invite community input; encourage public participation through interactive installations, signage, and volunteer opportunities
Non-profits, organizations, community groups	Advocate and educate; attend and provide trainings; set up volunteer maintenance programs; apply for grants and install projects; engage municipality and community
Academia	Research and monitor installations; assist agencies and organizations with outreach, planning, installation, and maintenance; provide or assist with workforce trainings

Commercial/private businesses	Attend trainings; sign up for grants and incentive programs for private installations; join watershed groups
Community/residents	Go to town meetings; advocate and educate; attend trainings; volunteer and participate in programs; sign up for grants and incentive programs for private installations; share information with peers; join watershed groups

The People of the Neighborhood: Residents, Landowners, and Community Groups

Although the decision to initiate GI programs often falls to the town or city due to technical, financial, and large-scale planning requirements, communities can and should advocate for and participate in GI projects. Communities can initiate or influence programs through social and political will by petitioning governments for GI-friendly regulations, funding, and programs. They can start or join environmental collaboratives and advocacy groups. Portland, OR's Green Street Stewards rain garden adoption program started because a community member asked the city government if they could volunteer to maintain a local rain garden. The Boone Boulevard project in Atlanta was ultimately planned and implemented by the city government with grant funding and assistance from the US EPA, but it was a few vocal community groups who took the step of initiating the project, and it was the Boone Boulevard neighborhood that drove the process forward. Without fail, every person I interviewed for the large, institutional programs said they preferred to install GI where a community requested or showed interest in GI as it made the program more sustainable. Regardless of whether they are empowered to respond to that interest, it is clear that community enthusiasm and initiative are well-received and powerful factors in GI program decisions.

Although public investment in and support of GI is key to a successful project, municipal planners sometimes overlook public opinion during the planning and design process (Baptiste et. al, 2015). This may be in part due to concerns about the project being hindered by negative public opinion. Residents, like other stakeholders in GI development, are sometimes distrustful or unsupportive of

GI, especially when they don't feel engaged in the process (Nir, 2017; Rainer, 2017). However, the CWAA found that public acceptance improved as education and awareness increased (CWAA, 2011). While governments and non-profits can provide educational trainings, events, and materials, community members can choose to learn about GI, participate actively in the planning process, and volunteer to educate others. CRWA attributes its success in North Allston in part to the community's receptiveness; while they didn't know much about GI, they were enthusiastic about CRWA's participation and willing to collaborate. Similarly, the Dover Public Works Department did not say no outright to UNH's GI initiative; instead, they voiced their concerns, and worked with the university to find a solution.

Where programs exist, communities can show support by getting involved. Landowners can sign up for voluntary incentive programs (rebates, fee and tax reductions, installation assistance, material giveaways, etc.) and install GI on their property. They can go a step further by posting information about their installation on GI forums, telling their neighbors about their installation, and hosting interested landowners and neighborhood GI tours. Peer-to-peer networking was praised as one of the most effective outreach techniques during my interviews; people are more likely to believe a program is a good thing if they hear it from someone they know and trust, especially if it is someone who has already tried the program and seen it succeed.

Community members can also participate by volunteering. They can join tree planting and installation programs, park maintenance and clean-up days, or "adopt a rain garden" maintenance programs; these actions are good for the environment and also for the person in question, who can benefit from developing a deep and positive relationship with their local environment and community (Krasny et. al, 2014). Volunteer maintenance programs help community members build and maintain a connection to the installation and the environment, while also improving the GI installation's health.

The level and nature of community engagement in a GI program post-installation may vary depending on the type and location of the installation. Greenways, for example, are highly visible and interactive, as they can include biking and walking paths or be sites for volunteer maintenance. City rain barrel giveaways in Philadelphia, adopt-a-rain-garden programs in Portland, OR, and tree-giveaways in Worcester, MA, have encouraged direct community participation in GI projects (Dunn, 2010; USEPA, 2012; WTI, 2017). Green roof incentives encourage privately owned GI, while green roofs used as urban gardens, interactive park spaces, or bus shelter rooftops can build awareness and invite community participation (Dunn, 2010). Urban forests provide ample opportunities for community engagement, and draw a great deal of neighborhood attention: some communities, like Worcester, MA, greatly value their trees (Seward, 2017); others, such as one community in Brooklyn where trees were improperly planted in the 1950s and tore up the sidewalk, are wary of tree planting projects (Bambridge, 2017). A community's ability and willingness to trust the agency behind their GI program is also a factor in whether they will accept, participate in, and support a GI project.

Groups and Organizations

Non-profit organizations play a key role in GI projects: they can act as an intermediary or connector between the public and the public sector. NYC Parks, for example, acts as a communication bridge between New York City and neighborhood residents. Other organizations in New York obtain grants from the city for GI projects, and are allocated time to more thoroughly engage with neighborhoods where they work. Park Pride in Atlanta provided Boone Boulevard neighborhoods with a GI plan that became the inspiration for an EPA-funded city installation program. The12,000 Rain Gardens campaign in Seattle provides trainings, grants, a resource library, GI project mapping and walking tours, and other community resources. This is a common trend repeated across projects: non-profits can support and educate communities, assist cities in community outreach, and even obtain grants for their own community GI projects.

Where no government program exists, non-profits and non-government agencies can take the lead in GI projects. The Fairmount Collaborative brought together neighborhood non-profits, the City of Boston, the US EPA, and other stakeholders to fund and be a part of the Dorchester Green Roof Bus Shelters Project. The Charles River Watershed Association united the North Allston community, Harvard University, and the Boston Planning and Development Agency in a GI program. Universities are also crucial to GI programs; the University of New Hampshire not only led a program in Dover, New Hampshire, but also monitored and tested new GI technologies as they were being developed in order to provide data to support and justify the program.

Non-profits are sometimes created by public agencies to play a unique role in maintaining an installation and engaging the community. MassDOT set up the Greenway Conservancy to manage and maintain the Rose Kennedy Greenway . The Long Creek Watershed Management District and Worcester Tree Initiative are both non-profit programs initiated by public entities to provide GI directly to the public. Where a city may lack the time and a community may lack the know-how (and both may lack the funding), a non-profit can step in as a unifier of stakeholders and resources.

The Government

Government-led GI programs are most successful when flexible enough to accommodate public participation and community leadership (Shandas and Messer, 2008). The key role of the government at every level is therefore to make GI programs accessible to the public. Federal and State governments can issue consent decrees under the Clean Water Act, pass or amend regulations, and set up GI funding programs (Dunn, 2010). Cities and towns are often responsible for running GI programs in response to a combination of federal and state regulations, community pressure, and environmental necessity. Local government voluntary incentive programs, where the government offers money, training, and resources to landowners who install GI on their property, are a common mechanism for promoting GI projects; these targeted programs give community

members control over individual installations while helping the local government to educate the community and increase the environmental health of the watershed.

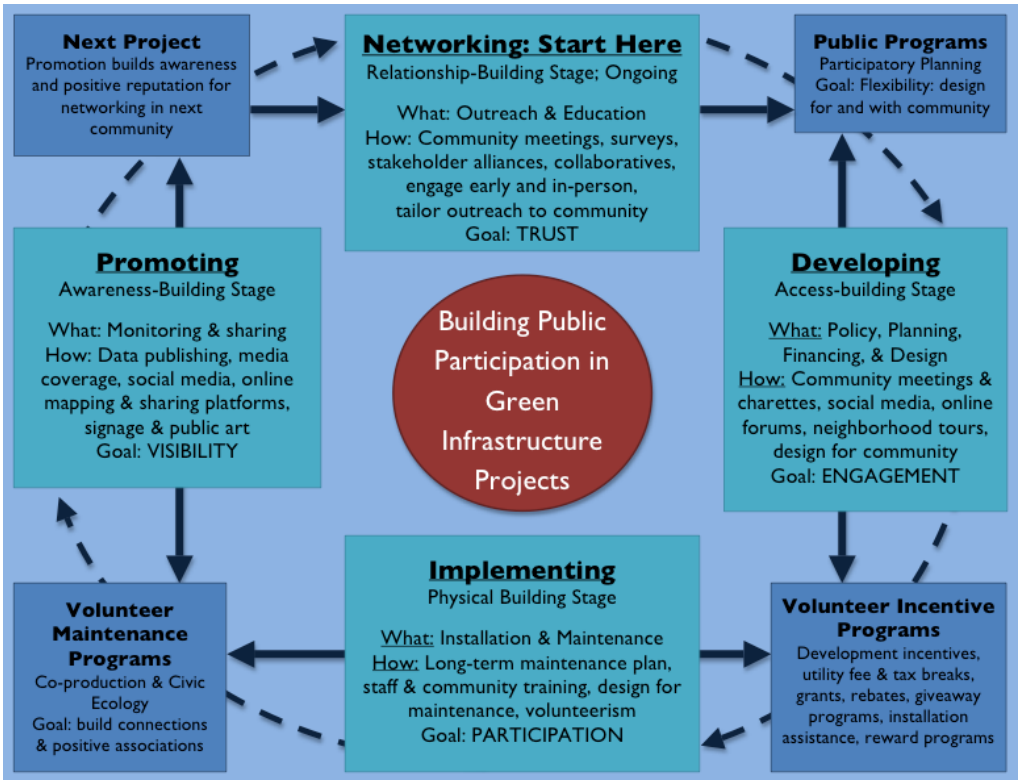

Figure 16: Recommended Strategies for Engaging the Public in Green Infrastructure Projects. (Source: Elise Simons; heavily influenced by interviews and literature reviewed for this thesis, including: Firehock, 2015)

Figure 16 shows the general process of a GI installation project, with recommendations for improved outreach and public participation included. This diagram is the result of my research and interviews; it is especially influenced by Karen Firehock's 2015 book, *Strategic Green Infrastructure Planning*. As the diagram shows, networking is an important starting point for GI, though this relationship-building activity never really stops. Public programs require a great deal of networking as well as a strong community role in project development. Voluntary incentive programs are created during the development stage, and give community members control over the development and implementation of their own GI installation. Volunteer maintenance programs also invite community participation in the implementation process, while contributing to overall

promotion of the installation. Promotion, the final stage, is a very important and sometimes-overlooked part of the GI process: it is through data collection and information sharing, increased visibility and interactivity, and improved signage and maintenance that a completed GI project garners attention and starts the networking process for the next GI project.

It is important for a government agency to adapt its outreach strategy to whatever suits the community. This means taking the time to learn about the community and being flexible to its needs, interests, and values. Small-scale projects are well-suited to this in-depth approach, but often lack the funding and support to be sustainable in the long-term; large-scale projects are more efficient, but often struggle to slow down and adapt to an outreach style and message that fits the community in question. Partnerships, funding structures that encourage community engagement, long-term maintenance plans, and a willingness to adapt are key to a municipal agency finding the balance between efficient installation procedures and sustainable, community-engaged projects.

My research and interviews with experts across the country have highlighted to me the massive influence of the federal government, and the US EPA especially, in environmental management generally and GI in particular. Many city-wide GI programs are responses to state or federal consent orders under the Clean Water Act. Since 2011, when the US EPA began promoting GI, the number of federal grants from the US EPA for GI projects has increased astronomically. In my studies, I had difficulty finding a GI program or document that didn't refer to, involve, cite, or even attribute credit to the US EPA in some form. There is a plethora of EPA resources available, including case studies, how-to guides, efficacy and cost data, analysis and planning tools, and outreach materials.

There is concern in the environmental community about the future of these resources in the current political climate: President Donald Trump has promised to abolish the EPA, proposed to cut EPA funding and programs by 34%, and appointed climate change denier Scott Pruitt to lead the agency (Milman, 2016; Dennis & Elperin, 2017; Davenport & Lipton, 2016). Even the recently

introduced House Bill, which reduces the EPA budget by $1.9 billion less than Trump's proposal, still calls for a massive reduction in staff, programs, and regulations (Siciliano, 2017). What sort of void would be left if the EPA were disbanded or stripped of all funds and power? Will state and local governments, non-profits, academic institutions, and community collaboratives be able to rally enough momentum, funds, and resources to maintain fledgling GI programs without the powerful backing of the US government? States will have to set up regulatory and funding programs; non-profits will have to take a more active role in promoting projects. Communities will have to organize and fight for environmental programs and legislation. The void left by the US EPA in the next few years could be an opportunity for more grassroots, community-engaged GI and environmental programs; at the same time, a new priority in the environmental movement will be rallying knowledge and support around GI and other climate resiliency programs to ensure they are sustained.

Who has the power in a GI Project?

I was unsurprised to conclude that the government calls the shots in most GI programs, and that from an environmental standpoint this may at times be necessary. However, I was surprised to find how large a role non-profits play in GI projects when government support is lacking or absent, and how much they can improve government programs by assisting in communication with and advocating for communities. A community itself has the hidden power: if they do not know about, understand, support, connect to, or appreciate a GI installation, there are less likely to be funds or volunteers for maintenance, and the project will fail. Their political will and local knowledge can be a starting point for a GI program. A community, then, is immensely powerful in deciding whether a GI program succeed. The question is whether they are aware of GI as a tool they can control. Until then, GI will continue to come from government initiatives and federal and state watershed protection mandates.

The Way Forward: Recommendations

For Municipal Governments

Pave the way for green infrastructure. Make it possible and profitable for non-profits, developers, and landowners to do their own GI programs. This could mean adjusting current regulations and zoning requirements to allow for GI, or (in the case of federal and state agencies) executing authority under the Clean Water Act to require GI and other stormwater pollution mitigation mechanisms. It also means setting up grants, stormwater utility fees, and other funding mechanisms for GI – especially voluntary incentive programs, which help landowners fund and maintain GI on their property.

Engage early & often. Before you start planning a program or designing an installation, begin forming relationships with community stakeholders and learning about the neighborhood's needs, interests, and environment. Educate stakeholders and the community about GI and your program, and promote it widely. Be visible, accessible, and familiar in the community, and communicate clearly in order to build trust.

Adapt to the community. The community knows what is best for their neighborhood, and sometimes even what is best for their environment. Give the community power and ownership over GI placement and design, and be prepared to adapt to their needs and recommendations. Also adapt your outreach and engagement strategies to your audience: what sort of message framing or medium will they respond to best? When in doubt, in-person, direct communication is generally the most effective tactic.

Have a maintenance plan. A well-maintained installation will be more effective, and residents will have a more positive response to a GI project if it is taken care of and if they are involved in its upkeep. The city taking responsibility for maintenance breeds trust in both the agency and the

program. Meanwhile, volunteer maintenance programs help residents connect to and care about GI in their neighborhood.

Promote it. A GI project doesn't end with its installation. Educational signs, visible installations, public art, events and festivals, data collection and publishing, news articles and media attention, online project display and discussion forums, neighborhood GI installation tours, residents encouraged to show their rain gardens to their neighbors – all these opportunities to engage the public and raise general awareness of, familiarity with, and interest in future GI programs are valuable and should not be wasted!

For Non-profits & Institutions

Be the bridge. Work with agencies to help them understand and engage with communities. Help residents learn about GI and develop strategies for working with their government agency.

Raise awareness. Obtain grants to start pilot projects and demonstration plots in visible locations. Put up signs and hold workshops to build familiarity with the technology. Provide educational resources and events. Train students and the future green workforce, as well as agency employees.

Build knowledge and support. Build trusting relationships with agencies and communities. Test and collect data on GI installations (their cost, environmental impacts, etc.) to encourage investment in future projects. Schools can provide student volunteers to help with outreach, education, and installation monitoring.

For Communities

Get organized and involved. Attend town meetings and petition for GI zoning amendments, regulations, and programs, including voluntary incentive programs and stormwater utility fees. If a program already exists, participate – show up to meetings and get involved in the planning, design, installation, and maintenance process. Volunteer for maintenance programs or events; sign up for an installation rebate or giveaway program.

Start local programs. Form or join environmental collaboratives. Encourage diversity and strive for the inclusion of all neighborhood residents, beyond the most vocal. Reach out to non-profits for support when there is a stormwater or green space issue in your community. Where a city-wide program exists, petition and work with the government agency to start that program in your neighborhood.

Spread the word. Self-educate on GI technology, programs, and resources. Bring your local knowledge to the table with agencies running GI programs; it is as valuable to the success of their project as their environmental knowledge and technical skills. Share knowledge and start conversations about GI with your neighbors.

Do it yourself. If you are a landowner or developer, you can install GI on your own property. Voluntary incentive programs can help fund installation and maintenance through rebates, tax breaks, permit or stormwater fee reductions, lower material and labor costs, and material giveaways. Where there is a program in your neighborhood, you can volunteer to help with outreach, education, and/or maintenance. Spread the word about your and other GI installations in your neighborhood. Be a part of the movement.

Final Thoughts: Project Limitations

This thesis is by no means a comprehensive analysis of all GI programs; it is a sample survey of the GI landscape. It is intended to represent a variety of GI programs, from the grassroots neighborhood project to the large-scale institutionalized program, but does not account for or examine variability within a program type or scale. There are many types of green infrastructure projects, including public programs and private installations, and many types of green infrastructure technology, from highly technical installations (e.g. bioretention cells, greenroofs) to nature-based landscapes (e.g. river buffers, forests). It would be interesting to compare outreach strategies within a GI type, or to look at which GI types are best suited to community engagement.

I also was not able to explore programs outside the U.S. Internationally, GI is an influential field; there would be a great deal to learn from GI around the world.

For the sake of simplicity, this thesis does not delve too deeply into the "community" concept, and instead groups a variety of community types, shapes, and sizes under one umbrella term. In reality, each community is different, and an individual can be a part of multiple communities at once; the idea of "community" is much more complicated than it is presented here. As I reach the close of my research, I find myself wondering: are environmental justice communities more, less, or equally engaged in GI projects in their neighborhood? Are there differentials in engagement tactics, efforts, or efficacy in low-income communities, immigrant communities, communities of color, suburban or urban or rural communities, or any other demographic group? Dunn's article (2010) on the potential benefits of GI in low-income communities indicates that increased access to information about and funding for GI programs would be valuable to these communities. Whether low-income communities are actually receiving GI programs, or being adequately engaged in the process when they do, is another question, to be explored at another time.

VI. CONCLUSION

My last interview for this thesis was with Roseann Bongiovanni (2017), who led a project with the Chelsea Collaborative and the Charles River Watershed Association to install rain gardens at the Mace Apartments Complex in Chelsea, Massachusetts. Together with her team, she went door-to-door throughout the housing complex inviting residents to a community meeting to "design their own parkland." Residents were able to decide what plants they wanted and where. Rather than focusing on the water quality benefits of GI, they framed it as an opportunity to create their own green open space – something that is in short supply in urban environmental justice communities such as this one. The in-person outreach approach, the community benefits angle, and the focus on resident voice and power in the process were key elements of the planning and design process. "Start really basic, get people engaged, and have them help design it," says Bongiovanni (2017). "The goal is to get them connected to the environment…they have a lot of buy-in/support because they were involved from the beginning and got to create a green space that is right for them" (Bongiovanni, 2017).

One element of the project, however, could not be left to community preference: residents had begun an informal community garden at the edge of the river, and the Chelsea Collaborative and Charles River Watershed Association were concerned that the soil could be contaminated and unfit for growing food. Instead of telling residents to stop gardening there, they built a new raised-bed community garden nearby, and encouraged people to garden there. They then put GI near where the gardening had been taken place, which deterred gardening in the area, created a new and community-approved park space, and contributed to improving the quality of the soil and river. "They have come to appreciate the GI because it gives them something to look at and enjoy the view," says Bongiovanni (2017).

What makes a green infrastructure project successful? Some of it may be luck of the draw – in the introduction, I described a similar rain garden project that hit a roadblock in large part due to unsuccessful community engagement. However, that was by no means a failure of effort or intention, but a matter of logistical error and a failure to connect. There are similarities between that project and this one, in terms of goals, context, and techniques, and yet the results were quite different. The community's initial receptiveness and willingness to collaborate matters: in New York City, community responses to GI projects are as diverse as the city's population. The flexibility of the group in charge also matters: not merely whether they are willing to engage the community, but whether they have the time, funding, and social connections to do so.

One thing I can say for certain: a green infrastructure project is more than a group of plants filtering sediments, absorbing nitrogen, or protecting our streets from flooding. As Jamie Houle of the University of New Hampshire and Bill Boulanger of Dover have proven, there is more than one peg that can fit in this hole. There is more than one green and sustainable solution to our stormwater problem, our water quality and flooding problem, our urban heat island problem, and our climate change problem. And the Green Infrastructure installed by our towns and communities of tomorrow serve more than one purpose: while cleaning our air and water, they can also protect pedestrians from cars, provide shade from the heat for elderly residents, get us out of our houses and back into the community, provide jobs for the green workforce, give us all something pleasant to look at, and teach children that there is value in the natural world. Or as Bongiovanni said: "we are looking to improve quality of life, rather than just environmental quality."

APPENDICES

Appendix A: Interview Questions

1. **Set-up:** How are you today? Is now still a good time to talk? Did you receive the interview consent information, and do you have any questions? Is there anything you'd like to know about the thesis project or me before we get started?
2. **Background:** What drew you to green infrastructure? How long have you worked in the field/at your agency? What projects are you working on now?
    a. What were/are the goals of your green infrastructure project?
    b. What was your project process? Where did you turn for funding, planning, implementation, maintenance, etc? Are there project elements of note which you would like to discuss?
3. **Community Engagement:** Who were the players in the project (community, public, private, etc.)?
    a. What was the role of the community in your project? Did they become adequately engaged, and if so how?
    b. What was the response of the community to your proposed ideas?
    c. Were there elements of your project that were community-initiated? Did they come to you with the need for green infrastructure, or did you approach them, or a combination?
    d. Does your city have policies, zoning codes, financial incentives, or grants to encourage community interest and involvement in green infrastructure? What works, and what doesn't?
    e. Did community interest in or demand for green infrastructure projects increase as a result of your project or project outreach?
    f. What are some of the challenges faced in achieving community awareness and buy-in from the community, government, and/or private sector?
4. **Outreach:** Was outreach most prominent before, during, or after the plan/installation?
    a. What strategies did you use to increase community awareness of or interest in your project initially?
    b. What outreach strategies were most effective, and why?
    c. What training or engagement, if any, was pursued during the project? What was the role or purpose of any continued outreach during/after the project?
5. **Project Longevity:** Maintenance and long-term buy-in can be major issues in green infrastructure projects. Post-installation, what steps have you or the community taken to continue maintenance, build continued momentum/interest in the project?
    a. Do you think your green infrastructure installation has longevity? Who will maintain it? Does the community still know about it/what is their current relationship to the project?
    b. If you were to repeat this project, what would you do differently? What recommendations would you have for future green infrastructure projects?

Appendix B: Case Criteria/Suitability Table

The following Green Infrastructure programs and projects were selected based on their fulfillment of the following criteria (marked with "y" for "yes"): engagement capacity, relevant commitment to outreach, project sustainability and longevity, potential for learning from or replicating project techniques and experiences, and interviewee responsiveness.

Region	Case Name	Org type	GI Type	Size/Scope	Engagement: Is Community Involved?	Relevance: Commitment to Outreach?	Sustainability: Project has Longevity?	Replicability: What is there to learn, what makes it unique?	Plausibility: Someone to interview?
Major US Cities	New York City	public/ non-profit	Green Streets/ Parks	City-wide	y	y	y	Scope/scale, partnerships, community/city bridges	y
	Portland, OR	public	Green Streets	City-wide	y	y	y	Maintenance as engagement, community initiative	y
	Seattle, WA	public/ non-profit	Green Streets	City-wide	y	y	y	Community interest targeting, community liaisons, tailored outreach	y
	Philadelphia, PA	public	Green Streets	City-wide	y	y	y	Trust-building, public art	y
	Atlanta, GA	public/ non-profit	Green Streets	City-wide	y	y	y	New initiative, community-initiated	y

New England	Worcester Tree Initiative	non-profit	Urban Forest	Community/City-wide	y	y	y	community support, maintenance as engagement	y
	Berry Brook Watershed/ UNH	academic/public/watershed group	Watershed/ study center	Watershed	y	y	y	adapt the technology to the community, peer-to-peer education, design for maintenance	y
	Long Creek Watershed	public/ watershed group	Watershed/ Green Streets	Watershed	y	y	y	Commercial area, collaboration for efficiency	y
Boston	Rose Kennedy Greenway	public/ non-profit	Interactive Green Roof	Community	y	y	y	multiple uses and communities, interactive, adapt to community needs	y
	Boston Bus Shelter Project	non-profit	Demonstration green roofs	Community	y	y	N	visibility, workforce training, maintenance issue	y
	CRWA Blue Cities Program	Watershed group	Green Streets	Community/Watershed	y	y	y	Long-term, in-depth engagement	y

Appendix C: Interview Themes

The following concepts and concerns, barriers and opportunities, techniques and recommendations, potential community roles, and approaches to sustainable installation maintenance were repeated by multiple interviewees during the interview process. They have been sorted by theme category and marked where a theme was mentioned or discussed ("y" = "yes"). Boxes marked in green were especially emphasized by interviewees. Note that this list is not exclusive or definitive; a project or program may consider one of these themes a priority, but it would not be marked as such in the table merely because it did not come up in the course of the interview.

		New York City, NY	Portland, OR	Seattle, WA	Philadelphia, PA	Atlanta, GA	Long Creek Watershed	Berry Brook Watershed	Worcester Tree Initiative	Rose Kennedy Greenway	CRWA	Bus Shelter Green Roofs
Mechanisms	Regulatory authority (has or wants)	y	y	y	y		y				y	y
	Funding concerns					y						y
	Provides grants or incentives	y	y	y	y		y					
Barriers/Priorities	Time (lack of, importance of, need for)	y		y	y	y		y			y	
	Project Size & Scale (systems vs. individual approach)	y	y		y			y		y	y	y
	Plan/technical needs vs. community	y	y	y	y			y		y		
	Visibility & Approachability	y			y			y	y	y	y	y
	Trust/Reputation	y		y	y			y	y	y	y	y
	Clarity/Transparency			y	y					y	y	

	Design for Community (Adaptability/Flexibility)						y	y		y	y	
	Equity Concerns			y						y		
	Build Awareness & Understanding (education)	y		y	y	y		y		y	y	y
	Early/Long-term Engagement	y	y	y	y			y			y	y
Community Role	Group Collaboration/Partnerships	y	y	y	y	y	y	y	y	y	y	y
	Stakeholder/Community Advocates	y		y	y	y	y	y		y		
	One-on-one/in-person		y	y	y	y	y	y	y	y	y	y
	Tailor Message/Project to the community	y		y				y		y		
	Community Demand/interest	y	y	y		y		y	y	y	y	y
	Community initiative/voluntary program	y	y	y		y	y	y	y		y	
	Limitiations on following community interest	y	y	y	y	y						
Post-Installation	Interactive installations (Signs/Art)		y	y	y					y		y
	Workshops/training	y	y	y	y				y			y
	Maintenance as city responsibility	y	y	y	y	y	y	y	y	y		y
	Maintenance as engagement/volunteerism	y	y		y		y		y	y	y	y
	Design for Maintenance			y				y				y
	Buy-in/Sustainability/Behavior Change		y	y		y		y	y	y	y	y

Appendix D: Outreach & Engagement Strategies

The following outreach techniques and engagement strategies have been currently or previously used, planned, or recommended by interviewees during the interview process. They have been sorted by outreach type and marked where an outreach format was cited or discussed ("y" = "yes"). Highlighted boxes represent strategies that were especially emphasized or endorsed by interviewees. Note that this list is not exclusive or definitive; a project or program may use or support an outreach strategy that was not mentioned in the course of the interview.

		New York City, NY	Portland, OR	Seattle, WA	Philadelphia, PA	Atlanta, GA	Long Creek Watershed	Berry Brook Watershed	Worcester Tree Initiative	Rose Kennedy Greenway	CRWA	Bus Shelter Green Roofs
Paper Materials	Flyers, Brochures, Handouts	y			y	y						
	Door Hangers	y							y			
	Training manuals, factsheets, videos, other resources		y	y		y	y					
	Direct mailings (target audience)		y				y					
	Postcards/letters			y	y	y						
	Inserts in bills/city notices		y									
	Bus ads/posters		y									y
Online Resources	Website	y	y	y	y	y	y	y	y	y	y	
	Website posts					y	y	y	y	y		
	Newsletters/emails/enews						y	y		y		
	Interactive Mapping Tools		y									
	Interactive Forums			y								
	Social Media (facebook, twitter, instagram, etc.)	y		y	y					y		
	Online Resource Database			y								

Media	Press Releases/newspapers	y		y	y		y			y		y
	Publications (reports, newsletters)							y				
	Websites/Onlne Papers (blogs, op-eds, webpostings, etc.)			y	y			y				y
	TV/online videos, webinars	y						y				
	Radio			y								
Face to Face	Community meetings, planning/design charrettes	y	y		y	y	y	y		y	y	y
	Conferences/Summits	y		y								
	In-person meetings, interacting one-on-one/face-to-face		y	y	y	y	y	y	y	y	y	y
	Going door-to-door			y							y	
	Pre-installation site visits: outdoor block meetings, community walk-and-talks			y								
	Installation/maintenance trainings/workshops (on or off-site)	y	y	y	y				y			y
	Post-installation site visits: inspections, monitoring, maintenance support						y					y
	Visibility & Approachability	y			y			y	y	y	y	y
	Early Engagement	y	y	y	y			y			y	y
	Tailor outreach to community	y		y				y		y		
	Listen/respond to feedback	y	y	y				y	y	y	y	
	Flexibility, adapt to community						y	y		y	y	
	Build trust, reputation, transparency	y		y	y			y	y	y	y	y
Partnerships & Collaborators	Promote at Stakeholder group meetings or events		y	y	y	y			y		y	
	Community partnerships/stakeholder collaboration	y	y	y	y	y	y	y	y	y	y	y
	Stakeholder board						y			y		
	Community advocates/liaisons in the field	y		y	y	y		y		y		
	Word of mouth/peer-to-peer conversations			y	y			y				
	Current participants/existing projects as models			y	y							
	Multilingual support/representation		y						y			

Interactive	Demonstration/Installation days											y
	More than an installation day/photo opportunity							y			y	y
	Volunteering/Maintenance as engagement	y	y		y		y		y	y	y	y
	Signs		y	y	y					y		y
	Public art				y					y		
	Community walking tours			y								
	Festivals/events				y					y		
	Connection to space		y		y					y		
	Long-term engagement & Community Buy-in		y	y		y		y	y	y	y	y
	Green jobs/workforce training			y					y			y

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