Green Infrastructure in Detroit: Mapping Synergies and Gaps

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Contents

Executive Summary

Green infrastructure is gaining acceptance as a solution for managing stormwater in urban areas. Comprised of both natural and man-made water management systems, green infrastructure often provides additional benefits in the form of increasing green spaces, lower lifecycle costs relative to grey infrastructure, and carbon abatement, among others. Given the frequency and intensity of flooding across the Midwest in recent years, green infrastructure offers an increasingly attractive option for increasing city capacity for managing stormwater.

In Detroit, green infrastructure projects are seen as an opportunity to increase both the liveability and sustainability of the city. In addition to stormwater abatement, many organizations view green infrastructure as a component of broader revitalization efforts in the city by improving the environment, quality of life, and beautification of the city. Current strategies for implementation include incorporating green infrastructure into city planning and broader sustainability objectives, offering incentives to private landowners, and providing financing to project developers.

For this project, we surveyed 18 leading city departments, non-governmental organizations, and for-profit entities working on green infrastructure primarily in Detroit to determine what has happened to date, where opportunities and barriers persist, and how the various actors fit together within the Detroit green infrastructure ecosystem (see Figure 10 for an organizational mapping of these actors). The most frequently cited opportunities for expanding green infrastructure included a heightened awareness of the benefits of green infrastructure (although greater awareness

is still needed), successful partnerships among local actors, and the impending implementation of a drainage charge that will help to align incentives for greater adoption.

Yet challenges persist. While the array of organizations working on green infrastructure is a boon, it also complicates coordination of local efforts. Additionally, working around antiquated grey infrastructure presents its own unique challenges and developing sustainable financing for development and maintenance of green infrastructure projects is an ongoing challenge. Finally, there is a lack of established metrics for evaluating the impact of green infrastructure projects, which makes it more challenging to demonstrate benefits relative to gray infrastructure.

Of particular note, vacant land was frequently cited as both an opportunity and a barrier. Vacant land is common in Detroit's landscape: approximately 20 square miles of Detroit's occupiable land, 80,000 residential units, 22% of industrial zoned land and 36% of commercial parcels are vacant. While this land offers an affordable landscape for green infrastructure, ownership is highly disaggregated, making coordination difficult.

Looking forward, the organizations with whom we spoke highlighted several key opportunities for future development of green infrastructure:

- Ushering in a culture shift to incorporate green infrastructure in city planning
- Increasing accessible funding for implementation
- Updating city and state codes to prioritize green infrastructure
- Increased coordination among local organizations

Detroit organizations have made laudable progress in developing green infrastructure projects across the city. Still, there is ample opportunity to address systemic barriers to greater adoption. We hope that the findings from this project serve to illuminate opportunities to overcome the most persistent barriers to development and inspire ongoing action to take advantage of green infrastructure benefits.

Green Infrastructure in Detroit

Green infrastructure can refer to a broad array of natural and man-made water management systems, including green roofs, trees, rain gardens, and bioswales, rain barrels, permeable pavement and more. The precise definition of green infrastructure varies by locality, but generally refers to water management infrastructure that reduces the need for "gray" wastewater systems such as gutters and sewage drains. Green infrastructure is not a replacement for gray infrastructure, but rather an alternative system that works alongside and supports gray infrastructure.[1]

In this paper we defer to the definition of green infrastructure used by the Southeast Michigan Council of Governments (SEMCOG), which defines green infrastructure according to eleven elements, outlined in Table 1. This definition is consistent with a recent pollution discharge permit released by the Michigan Department of Environmental Quality that defines green infrastructure as downspouts, pervious surface, bioswales, rain barrels and gardens, tree plantings, and related man-made and natural systems designed to manage water flows.[2] Indeed, to many organizations working on green infrastructure in Detroit, the term is synonymous with stormwater management, an objective that is particularly relevant amidst the large-scale storms the Midwest has received in recent years.[3]

Figure 1. Green Infrastructure Elements in Southeast Michigan[4]

Green Infrastructure Element	Definition
Agricultural lands	Rural land used with the growing of food as the primary function, but can also provide ecological benefits
Community gardens	Urban and/or residential land used to grow food, but can also provide ecological services
Conservation easements	Public and private land designated for conservation perpetuity
Critical habitats/Regionally significant features	Areas unique to Southeast Michigan that are critical to protect and enhance, such as the Detroit River International Refuge and St. John's Marsh
Public access sites	Sites that allow access to our region's rivers and lakes
Rain gardens, bioswales, green roofs	Techniques that follow the natural water cycle. Manages rainfall by using design techniques that infiltrate, filter, store, evaporate, and detain runoff close to its source
Recreational land	Public and private land designated for recreation such as parks, forests, hunting preserves, etc.
Riparian Corridors	Land that exists between water bodies (lakes, rivers, streams, and wetlands) and higher dry upland areas (forests, fields, cities, and suburban property)
Trails (land and water trails)	Designated trails designed for walking, hiking, biking, cross-country skiing, snowmobiling, canoeing, kayaking, and other recreational activities
Wetlands, floodplains	Floodplains, Michigan-designated wetlands, and constructed wetlands or other natural features that provide similar functions
Woodlands, trees, street trees, urban forests	Areas of tree canopy cover that exist in multiple forms such as woodlots, private landscapes, street trees, and urban forests

figure 1

Benefits of Green Infrastructure
Green infrastructure provides a number of benefits to ecological systems and local residents, including improved water quality, flood mitigation, increased water supply, landscape aesthetics, recreational opportunities, higher property values, traffic calming, improved natural habitat, better air quality and health, reduced lifecycle costs for man-made infrastructure like roads, lower energy bills and carbon abatement.[5] Although the flood abatement benefits of green infrastructure are perhaps the main driver of investment, the ecological benefits are significant. For instance, green infrastructure reduces energy waste twofold. First, infrastructural elements such as green roofs reduce cooling loads in commercial buildings, reducing energy bills and associated carbon emissions from electricity generation. Second, the energy required to manage and treat wastewater is reduced when less water runs into sewerage systems.[6]

In Detroit, green infrastructure projects are seen as an opportunity to increase both the liveability and sustainability of the city. From a liveability perspective, green infrastructure would help alleviate flooding, an increasingly prominent issue that is largely attributable to three factors.[7] First, the last few years have seen increasing intensity of storms. Exacerbating the impact of this increase in water flow, the percentage of impermeable surfaces in Detroit grew exponentially over the past decades, yet the sewerage system has not changed in light of increasing storm intensity, rendering it obsolete from the perspective of stormwater abatement.[8]

In addition to stormwater abatement, many organizations see green infrastructure as a component of broader revitalization efforts in the city by improving the environment, quality of life, and beautification of the city.[9] Some organizations point to evidence that green infrastructure has a stabilizing effect on communities by bringing multiple parcels of land together to create larger, communal green spaces.[10] This reconstruction of vacant land into spaces desirable for existing residents is known as place-making. See page 27 for more about the place-making potential of green infrastructure in Detroit.

Most major cities and many smaller cities have adopted plans to expand green infrastructure to manage wastewater and meet broader sustainability goals. Typically, municipal departments and local NGOs spearhead such efforts, with little if any involvement from national parties, aside from funding. However, the disaggregated nature of experience with green infrastructure leaves open the opportunity for national players to disseminate best practices and help local groups implement projects. In this section we detail lessons learned from implementing and financing green infrastructure in cities across the country.

City Planning
Like Detroit, many cities along the rust belt have aging, combined sewerage systems. A number of these cities are currently investing in green infrastructure programs and pilot projects to decrease reliance on gray infrastructure, which is often capacity-constrained during heavy rain events, resulting in overflow of contaminated water into rivers and lakes. One strategy to expand green infrastructure is to include these projects in broader city-wide sustainability initiatives. For example, Chicago officials delegated authority for implementing green infrastructure to the Department of the Environment as part of the city's goal to become "the Greenest City in America."[11] Likewise, In New York, green infrastructure development falls to the New York Department of Environmental Protection.[12]

Other cities have incorporated green infrastructure into general infrastructure or sewerage planning, which may include expanding gray infrastructure as well. In Pennsylvania, the City of Lancaster and Philadelphia are both incorporating green infrastructure in city planning as key strategies to reduce stormwater runoff and associated water pollution.[13,14] Other major cities such as Seattle and Milwaukee have emphasized green infrastructure as a key means to meet growing sewerage demands during heavy rain events.[15,16] Given the similarity in challenges for stormwater management across the Midwest and mid-Atlantic, it is no surprise that Detroit-based organizations frequently cite Philadelphia, Cleveland, and New York as cities that influence their approaches to green infrastructure implementation.[17]

Policies
Cities have employed a number of policies to encourage or mandate adoption of green infrastructure. The City of Lancaster requires that property owners building new impervious surfaces on site manage the first inch of rainfall, called the "first flush," that falls on their property to prevent it from entering city sewerage systems.[18] Green infrastructure is one mechanism for meeting this ordinance.

Milwaukee, Philadelphia, and Lancaster have also adopted another incentive mechanism to encourage investment in green infrastructure. Stormwater management fees, sometimes implemented by newly created stormwater utilities, are assessed based on the percentage of impervious surface on a given property.[19] More impervious surfaces result in higher fees. This policy provides a financial incentive to increase green infrastructure on site (or decrease impervious surfaces) and provides transparency into the true costs of managing stormwater. In addition to a prescriptive measure, a stormwater management fee can

be performance-based, using volume of water diverted from sewerage as the metric for success.[20]

In Detroit, DWSD is conducting a rate reduction pilot program in collaboration with Detroit Future City, but at present residents and businesses have no financial incentive to manage stormwater.[21,22] By introducing such an incentive, city planning could shift toward prioritizing implementation of trees along highways, retention ponds, and more pervious surface in project design. Many of these actions would serve a dual purpose of reducing sewer overflow and improving city aesthetics.

In lieu of a stormwater fee, the city could develop a public-private partnership wherein private property owners develop green infrastructure systems to divert stormwater from sewers in exchange for a fee paid by DWSD.[23] Such a system shifts project transaction costs to the participating private entity and helps to ensure that green infrastructure projects meet the aesthetic and structural interests of residents.

To develop a process to support the advancement of green infrastructure in Southeast Michigan, SEMCOG recently conducted broad stakeholder outreach in the region, including developing a Green Infrastructure Task Force comprised of over 60 representatives from local governments, state and federal agencies, environmental groups, the transportation sector, the education community, and economic development groups. Over two years, this task force developed the following ten regional policies to increase development of green infrastructure.[24]

SEMCOG Regional Policies for Green Infrastructure [26]
1. While there are many different types of green infrastructure and many owners of it, Southeast Michigan's green infrastructure is a network that needs to be managed as a system.
2. Additional public green infrastructure should focus on connecting the public network together, focusing on riparian corridors and trails as well as meeting unmet recreation needs.
3. Southeast Michigan has high quality, unique natural areas that need to be managed, preserved and, in some cases, restored.
4. Public accessibility to the green infrastructure network is paramount, including access to parks, trails, water and ensuring public spaces are designed for all residents.
5. Increasing tree canopy is a priority because of the numerous benefits, including water quality, property value enhancement, aesthetics, and connecting the green infrastructure network in urban areas.
6. In urban areas, constructed green infrastructure should be focused on publicly-owned land such as roads and government property, as well as areas with large impervious surfaces, such as private parking lots, to improve the quality of local and regional water resources.
7. The transportation network is a key component of the regional green infrastructure network, through development of green streets and complete streets in addition to connecting the green infrastructure network.
8. Vacant property provides a unique opportunity to increase connectivity, buffer high-quality areas, improve public access to waterways, and provide long-term solutions in high-vacancy areas including providing a local food source.
9. Education of and promotion to elected officials and the public about the environmental, economic, and social benefits of the green infrastructure network is needed.
10. Sustainability of the green infrastructure is essential, including maintenance, fiscal sustainability, and innovative partnerships.

figure 2

To support these high-level policies, there are a number of existing and planned development activities to increase green infrastructure in Southeast Michigan, including regional, county, and local parks and recreation plans, state grant priority setting (e.g., Michigan Natural Resources Trust Fund), stormwater management activities, watershed management plans, non-motorized (biking and walking) planning and projects, capital improvement programs, the state Pure Michigan campaign, and regional water quality/air quality campaigns.[27] These activities will help Michigan work toward the vision for green infrastructure outlined in Figure 3.

Incentives
In addition to stormwater management fee, many cities offer direct financial incentives to property owners that install green infrastructure on-site. Lancaster helps to fund the marginal cost of retrofitting green infrastructure on properties that are otherwise not planning to redevelop through a Green Infrastructure Grant Fund.[29] Likewise, Seattle offers a rebate to building owners who construct rain gardens and stormwater cisterns on-site, which covers about 88% of the costs.[30]

The challenge with such incentive programs is the administrative burden that accompanies microgrants. City agencies like DWSD may not have the administrative capacity to manage a program that allocates a large pool of funding across thousands of program participants. Moreover, city agencies may find that these financial resources are more effective at meeting environmental and water management goals when concentrated

on fewer, larger projects.[31] Despite the inherent administrative challenges, incentive programs are viewed as an important tool for both increasing implementation of green infrastructure and raising public awareness in Detroit.[32]

Green Infrastructure Vision
for Southeast Michigan[28]

Legend:
- Increase Tree Canopy
- Potential Green Streets
- Conservation & Recreation Lands
- Potential Conservation & Recreation Lands
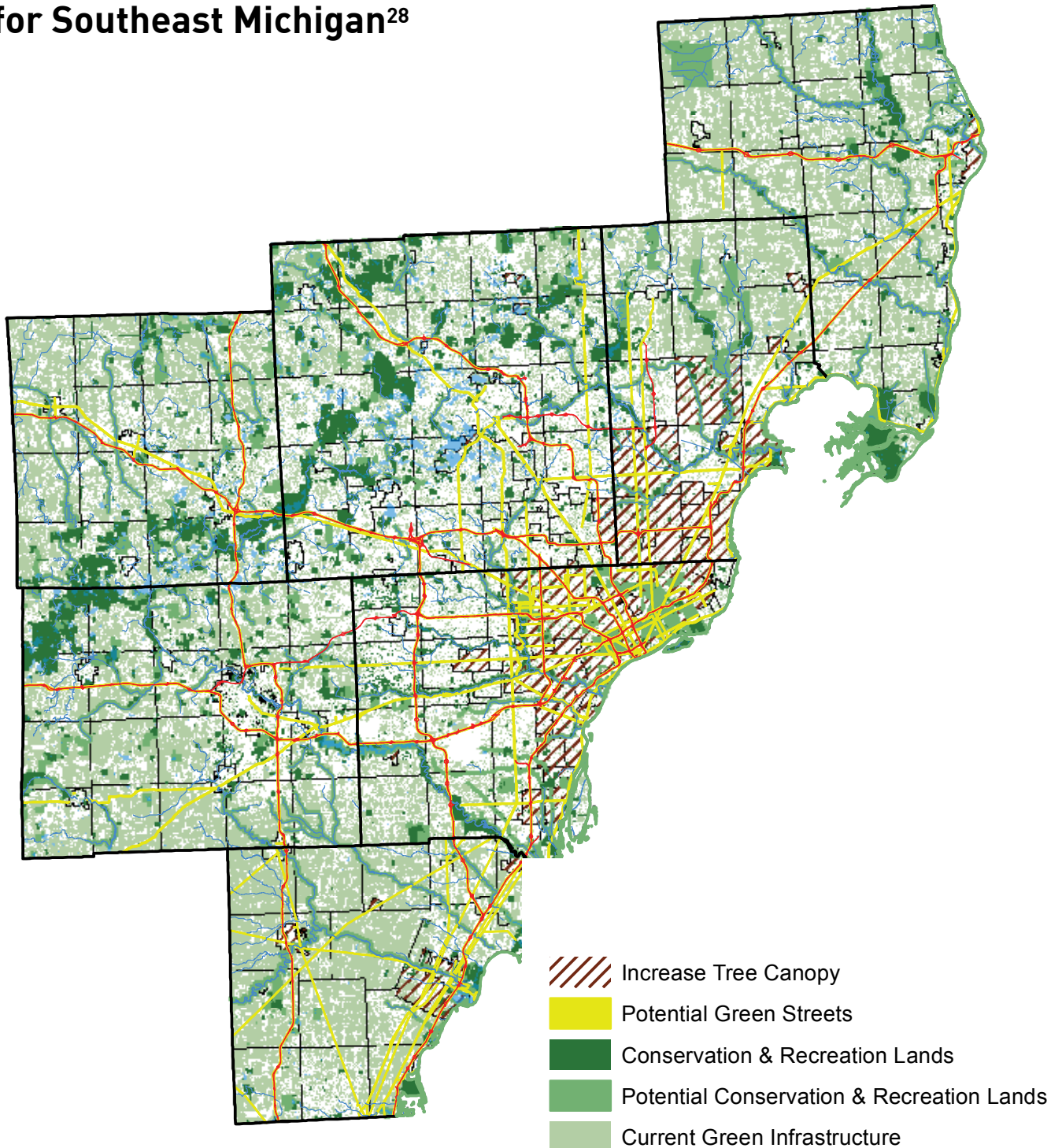- Current Green Infrastructure

figure 3   Map courtesy of SEMCOG

Organizations

The majority of the following organizations were selected during our secondary research phase. Initially we searched online for organizations involved in green infrastructure. Once we had several good leads, we conducted phone interviews with each using a standard set of interview questions intended to help us understand the work that they had already done or are interested in doing. During these interviews many organizations suggested others for us to contact.

The following is a brief description of each organization interviewed.

Center for Neighborhood Technology

Headquartered in Chicago, Illinois, The center for Neighborhood Technology is concerned with researching, inventing, and testing sustainable urban strategies.
Their interests span from transportation to climate to water. Notably they have helped members of the Lower Eastside Action Plan (LEAP) and the Toledo-Lucas County Sustainability Commission use tools to quantify the benefits of green infrastructure and incorporate green infrastructure practices into their plans to mitigate flooding.[33]

Data Driven Detroit (D3)

Data Driven Detroit (D3) is a statewide organization with a focus on the city of Detroit. D3 houses a comprehensive data system that includes current and historic demographic, socioeconomic, educational, environmental, and other indicators to drive informed decision-making. This system allows analysts to illustrate complex relationships by combining different datasets to reveal the true stories of our regions, cities and blocks.[34]

Detroit Department of Recreation - Planning, Design, and Construction Management Division - Landscape Architecture (City of Detroit Landscape Architecture)

The City of Detroit Landscape Architecture provides professional planning, design and construction management services that act as a catalyst for Detroit neighborhood revitalization. The primary focus of the Division's Capital Improvement efforts is directed towards parks and center which service Detroit neighborhoods.[35]

Detroit Future City (DFC)

The organization that oversees the implementation of the Detroit Future City Strategic Framework Plan by working closely with local stakeholders. The priorities of the city's long term Framework Plan include increasing employment of local Detroiters, regulatory reform, neighborhood stabilization, innovative and strategic renewal of city systems, and transforming vacant land into an innovative open space network.[36]

Detroit Land Bank Authority (DLBA)

The Detroit Land Bank Authority (DLBA) stimulates neighborhood stabilization and economic growth through the acquisition, management, and disposition of tax reverted and acquired properties. Currently, some techniques used by DLBA is their side-lot program, community partnerships, and demolition.[37]

Detroit Water and Sewer Department (DWSD)

As a branch of the City of Detroit government, DWSD provides water service to almost one million people in Detroit and three million people in 127 neighboring Southeastern Michigan communities throughout Wayne, Oakland, Macomb St. Clair, Lapeer, Genesee, Washtenaw and Monroe counties. The Department is organized into five operating groups: Financial Services, Information Technology, Public Affairs, Wastewater Operations and Water Supply Operations.[38]

Erb Family Foundation (EFF)

The Foundation's mission is to nurture environmentally healthy and culturally vibrant communities in metro Detroit, and support initiatives to restore the Great Lakes basin. The Foundation is focused on improving water quality, especially in the watersheds impacting metro Detroit and Bayfield, Ontario; promoting environmental health and justice; and supporting the arts as a means to strengthen the metropolitan Detroit region.[39]

Greening of Detroit (Greening)

Greening of Detroit is a resource agency that partners with government, private commercial, and foundations to assist neighborhood groups, churches and schools in their efforts to improve the ecosystem in Detroit. Some of the organization's activities include tree planting projects, environmental education, urban agriculture, open space reclamation, vacant land management, and workforce development programs.[40]

Lawrence Technological University (LTU)

Located in Southfield, Michigan, Lawrence Tech is a private university specializing in engineering, science, mathematics, architecture, graphic design, and business. Lawrence Tech is home to the Great Lakes Stormwater Management Institute which serves as a regional resource for innovative stormwater management techniques and low impact design strategies. Similarly, the University has been implementing examples of stormwater management on campus to serve as both functional and educational resources.[41]

Lower Eastside Action Plan (LEAP/Land, Inc.)

LEAP is a project that seeks to transform and improve vacant land in Detroit by encouraging and facilitating community participation. LEAP is operated by Eastside Community Network, a non-profit organization which facilitates positive change in the Eastside of Detroit. In 2014, LEAP established the Blight Elimination Standards. Part of these standards is to promote innovative stormwater management practices.[42]

Michigan Department of Environmental Quality (MDEQ)

Department of Environmental Quality Water Programs establish water quality standards, assess water quality, provide regulatory oversight for all public water supplies, issue permits to regulate the discharge of industrial and municipal wastewaters, monitor State Water resources for water quality, the quantity and quality of aquatic habitat, the health of aquatic communities, and compliance with state laws.

The Department of Environmental Quality was created by Executive Order No. 1995-18, which transferred environmental regulatory programs from the Department of Natural Resources to the newly created Department.[43]

Michigan State Housing Development Authority (MSHDA)

The Michigan State Housing Development Authority provides financial and technical assistance through public and private partnerships to create and preserve safe and decent affordable housing.[44]

The Michigan Chapter of the Sierra Club Great Lakes Program (Sierra Club)

The nation's largest grassroots environmental organization with ten different regional volunteer groups in Michigan. Among the group's many concerns are clean water and

air, wild biodiversity, and a safe energy future. Under the umbrella of the larger organization, the Great Lakes Program created the Great Lakes Regional Collaboration Strategy in order to protect and restore the Lakes. The Strategy, which includes a comprehensive plan for the region, is intended for implementation by federal and state governments.[45,46]

Southeast Michigan Council of Governments (SEMCOG)

SEMCOG was established as a regional planning partnership in Southeast Michigan. We are accountable to local governments who join as members. Membership is open to all counties, cities, villages, townships, intermediate school districts, community colleges, and public universities in Livingston, Macomb, Monroe, Oakland, St. Clair, Washtenaw, and Wayne Counties.
As the designated water quality management agency for Southeast Michigan, SEMCOG's water quality program works to implement the policies and recommendations in the "Water Quality Management Plan for Southeast Michigan."[47]

Sustainable Water Works (SWW)

Sustainable Water Works is a nonprofit organization building a network of collaborative partners committed to sustainable water, public policy, innovative products and new businesses in Michigan.
Sustainable Water Works is dedicated to ensuring there is clean, abundant and affordable water for communities and businesses in Michigan and the Great Lakes region. They are also active in Great Lakes restoration, Detroit urban farming and green infrastructure projects.[48]

Tetra Tech

Tetra Tech is a provider of consulting, engineering, construction and technical services which includes resource management and infrastructure, based oPadena, California. Tetra Tech works with commercial and government agencies providing project support for issues concerning water, environment, energy, infrastructure, and natural resources. The company has 330 offices worldwide with one in Detroit.[49]

UM Water Institute (UMWI)

The U-M Water Center was established in October 2012 to bolster freshwater ecosystem restoration and protection efforts. By engaging researchers, practitioners, policymakers, and nonprofit groups, they support, integrate, and improve current and future freshwater restoration and protection efforts. Initial efforts are focused in the Great Lakes, working closely with academic colleagues and practitioners in the region to improve restoration outcomes.[50]

Wayne State University (WSU)

Public research institution located in Midtown Detroit. As such, Wayne State believes in taking advantage of the unique urban laboratory provided by the city of Detroit.[51]
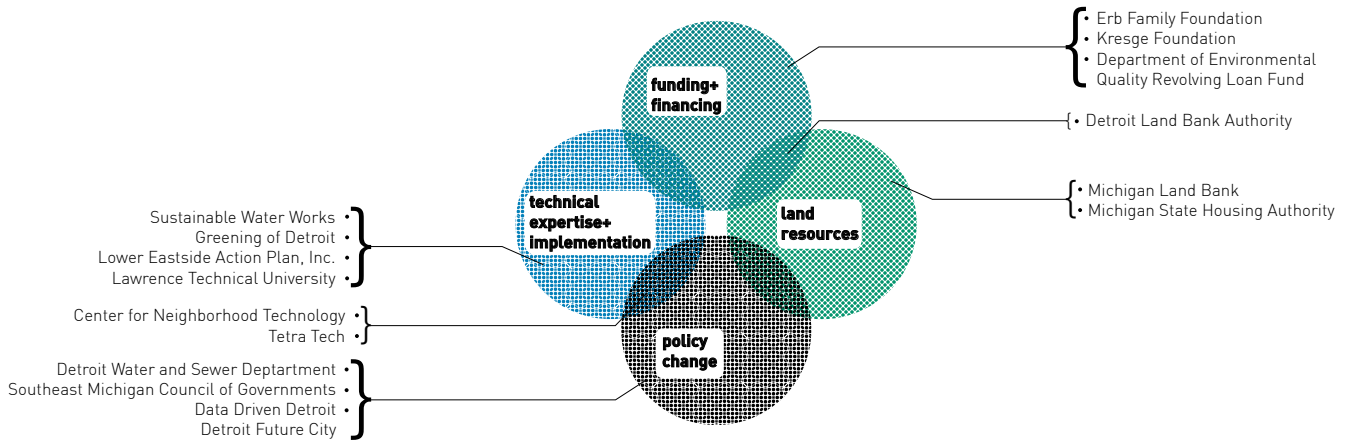
Erb Family Foundation
Kresge Foundation
Department of Environmental
Quality Revolving Loan Fund

Detroit Land Bank Authority

Michigan Land Bank
Michigan State Housing Authority

Sustainable Water Works
Greening of Detroit
Lower Eastside Action Plan, Inc.
Lawrence Technical University

Center for Neighborhood Technology
Tetra Tech

Detroit Water and Sewer Deptartment
Southeast Michigan Council of Governments
Data Driven Detroit
Detroit Future City

funding+
financing

technical
expertise+
implementation

land
resources

policy
change

figure 4

After speaking with each organization we began synthesizing our findings. One way in which we did this was to create a graphic laying out each group's role relative to green infrastructure. We deduced that organizations generally fell into one or more of the following categories: policy change, technical expertise and implementation, land resources, and/or funding and financing as can be seen in Figure 4.

Opportunities

"We're on the edge of a lot of good things happening," explains Donald Carpenter of LTU.[52] Despite Detroit's political and socioeconomic challenges, actors name a number of promising factors facilitating green infrastructure in Detroit.

figure 5
Word cloud created using top 75 words used by respondents to describe opportunities in Detroit with regard to GI.

Increased Awareness
Actors cite an attitude shift toward acceptance of green infrastructure as a solution for storm water management in the city, even if a great deal of work remains. Greening, SEMCOG, Sierra Club and EFF credit both on-the-ground educational efforts and higher level collaboration for this increased awareness, and several actors cite active community involvement.[53] Sierra Club initiated a "Great Lakes Pledge," for which participating community members promise to take one action to protect the Great Lakes, and the EFF mentioned that this self-identification as "being the Great Lakes" reinforces the importance of the work underway.[54,55]

"We're on the edge of a lot of GOOD things happening"

National Pollutant Discharge Elimination System (NPDES) Permit
In light of limited financial resources and the high cost of violating Environmental Protection Agency standards, DWSD has been motivated to consider green infrastructure as a mechanism to decrease combined sewer overflow.[56,57] While some institutions feel that DWSD could have gone further in this effort, all agree that the simple inclusion of green infrastructure in the permit is an important and necessary first step.[58]

Partnerships
Tetra Tech describes current efforts as "pulling the rope the same way," in that actors at many levels, from grassroots community groups to donors such as Kresge Foundation and EFF, are supportive of green infrastructure.[59] The NPDES permit is reinforced by the inclusion of green infrastructure in DFC's strategic framework, which is considered a common vision for the city's future.[60] LTU also cites plans for an annual summit of watershed planners to further emphasize collaborative action.[61]

Drainage Charge
Detroit is in the process of implementing a drainage charge for residents and businesses, which is viewed by many actors as necessary to incite behavior change.[62] Both Tetra Tech and DFC highlight the importance of this ultimately serving as an incentive for residents to reduce stormwater runoff, citing work in cities such as Chicago, Milwaukee and Philadelphia.[63,64]

Challenges

For a "rust belt city" emerging from bankruptcy and preoccupied by issues of safety, education and employment, there are also numerous challenges associated with introducing and implementing green infrastructure in Detroit. DFC frames the central challenge as: "How can we flip the whole equation from being an industrial leader to a sustainability leader?"[65]

RISK SEMCOG SITES DETROIT REPLACE NEW PLAN PERCEIVED HELP START SCALE WASTE PROBLEMS STORMWATER COST DEPARTMENTS BANKRUPTCY FLOODING TRIBUTARIES FUNDING STRESSED PROPERTY GROUPS OUTSIDE SURFACE INSTALL LARGER SHORT-TERM CITY DIFFICULT BEAUTIFICATION NEEDS CREDIT COMMUNITY PERMIT SUSTAINABILITY RELATIONSHIP OPERATING DWSD PERCEPTION SYSTEM CONSIDERED LAND TRANSIT PLACE WATER RIVER

figure 6
Word cloud created using top 75 words used by respondents to describe challenges in Detroit with regard to GI.

Additional Coordination
Many actors cite Detroit's large geographic territory and the plethora of institutions involved within as posing a challenge for coordination.[66] EFF signals a need for greater coordination across organizations and departments; as LEAP/Land, Inc. explains, "It would be nice if we had a master plan on this," pointing to bankruptcy organizational changes as a challenge.[67] SEMCOG echoes this sentiment, remarking on the importance of having all actors together in the same room to flesh out priorities together.[68] Several partners mention city government inefficiency, bureaucracy and mismanagement as challenges, including a lack of leadership advocating for green infrastructure.[69] Finally, D3 mentions a need for additional data to assess green infrastructure actors' collective work.[70]

"How can we flip the whole equation from being an industrial leader to a sustainability leader?"

Need for Increased Awareness
Despite the efforts of several institutions, there remains a need for increased awareness about green infrastructure as a stormwater management tool in Detroit. Although most

actors interviewed held a strong understanding of green infrastructure approaches, a handful referenced general sustainability or energy efficiency efforts (such as switching to LED light bulbs) rather than storm water management in describing their green infrastructure efforts.[71] EFF signals a lack of "green ethic" in the city, given its industrial roots , and Greening mentions that the idea of green infrastructure is met with a mixture of community acceptance, indicating a need for ongoing education.[72,73] Sierra Club reinforces this, adding that education in schools about storm water management, similar to other successful programs about recycling, is essential.[74] The City of Detroit Landscape Architecture furthermore raises the issue of vandalism of public structures as a barrier for implementing green infrastructure.[75]

Antiquated Infrastructure and Approaches
Sierra Club, SEMCOG and Tetra Tech each point to a lack of policy (codes and ordinances) to support green infrastructure as a central challenge.[76] Tetra Tech describes Detroit's current stormwater management policy as being traditional, or in the "get it away" stage.[77] While the potential of "leap frogging" approaches is therefore possible, this will require a great deal of effort and education to accomplish. The City of Detroit Landscape Architecture remarks that the infrastructure itself is housed within a very aged system , while EFF cites the need for better understanding of how the various components of the system function.[78,79] (see Figure 7)

Financing and Maintenance

Many partners signal financing as a major challenge. DWSD explains that developers often come with "big ideas" but without funding , and the City of Detroit Landscape Architecture echoes this concern in inquiring, "A lot of people have great ideas, but want the city to fund them."[80,81] Interestingly, the City of Detroit Landscape Architecture cites the cost of green infrastructure as a barrier, while MSHDA cites the perception that green infrastructure is more costly as a barrier.[82,83] A consistent concern among actors is the question of green infrastructure maintenance and even liability once in place. UMWI, for example, mentions that storing water in neighborhood sites is perceived as risky due to potential flooding.[84] DFC insists that an effective incentive structure must be in place if change is to be expected, asking "What if DWSD reduced the storm water drainage charge for people who planted trees or created retention ponds?"[85] Greening mentions that actors are in the process of identifying a financial model that makes sense for this very question.[86]

Evaluating Impact

Nearly all actors interviewed cited difficulty in evaluating the effectiveness and/or impact of green infrastructure, while many describe this as a work in progress.[87] Sierra Club highlights the challenge of long term project evaluation due to limited resources.[88] Some actors identify frustration with the fact that DWSD's work is evaluated less on outcomes achieved and more on money spent, leading to larger scale, "one shot" projects managed by engineering firms.[89,90] DWSD confirms that a key method of evaluating impact is, in fact, dollars spent.[91] Some actors point to reduced

Detroit's current combined sewers
sanitary sewage   stormwater runoff

Detroit has 3,500 miles of sewer pipes

As of 2/24/14 there were 90 water main breaks running in the city
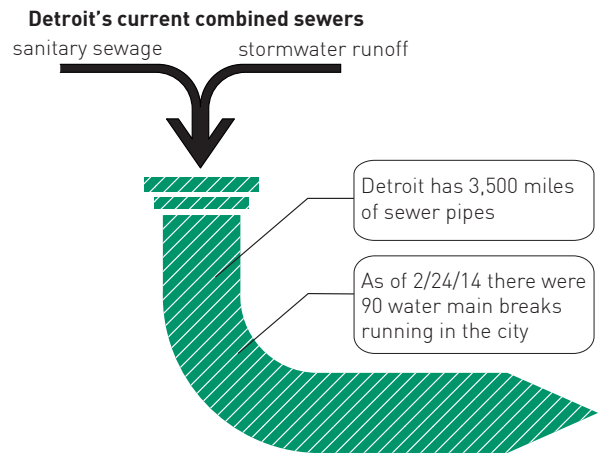
figure 7

stormwater going to the sewer system, as well as associated costs, as a key measure of impact, while others signal the challenge in capturing other green infrastructure benefits, such as community engagement, quality of life and safety.[92,93]

The Vacant Land Question

In considering green infrastructure
opportunities in Detroit, one must include
a discussion on vacant land. This topic was
nearly universally cited as a challenge and/
or an opportunity for the city by all actors
interviewed.

Opportunities

MSHDA describes Detroit's landscape as a wide canvas.[94] Vacant land in Detroit, accounting for over 105,000 land parcels and 20 square miles, presents a unique opportunity to expand urban green infrastructure (see Figure 9).[95] These commercial, industrial, and residential plots can support both short-term developments, such as tree nurseries, and long-term solutions, like forests and woodlots.[96] Greening cites the fact that many neighborhoods are in decline, but that green infrastructure can be part of the solution by increasing property value.[97] Furthermore, green infrastructure offers a stabilizing effect, combating vacancy rates with maintained properties.[98]

SWW mentions that vacant land is currently only available in small pockets, therefore inhibiting large scale efforts.[99] However, the UMWI contends that this is actually ideal to maximize the impact of green infrastructure.[100] Furthermore, this lack of "development pressure" represents a unique opportunity for the City of Detroit to weave green infrastructure into its landscape now such that future development will be built around it.[101] DWSD also cites the unique possibility for the city to conduct side-by-side impact studies related to green infrastructure; an opportunity most cities do not have due to the high cost or unavailability of land.[102]

vacant occupiable land in Detroit {20 square miles}

total land area of Detroit {143 square miles}

14%
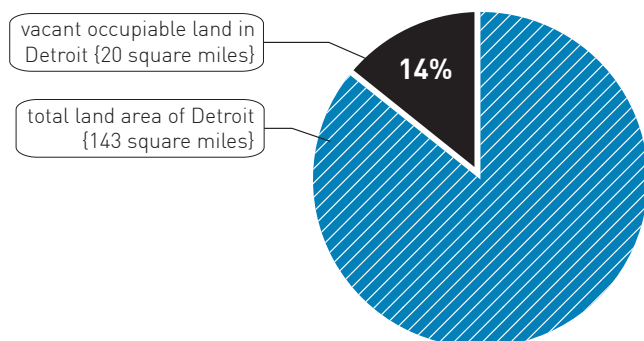
figure 8

Challenges

While LTU identifies the vacant land as usable, it highlights the fact that it is underutilized.[103] DWSD signals the low cost of land as an advantage, but EFF cites the process of actually acquiring the land as a challenge due to ambiguity concerning who owns the land as well as the purchasing process.[104] Areas with high degrees of vacancy can even present the challenge of multiple landowners in a given space, requiring greater organization and stakeholder engagement than would a single owner plot.[105] At present, the principle strategy for addressing the issue of multiple landowners is using a land bank to act as land assembly for projects that designed as long-term infrastructure.[106]

Sierra Club remarks that many groups are working on the vacant land issue already, emphasizing that several toolkits and guides already exist while on-the-ground resources are limited.[107] Greening agrees, identifying financing as the largest barrier to addressing the vacant land question.[108] Interestingly, Tetra Tech cites the unique opportunity for blight and green infrastructure to work together in updating the city's infrastructure, as either is more costly when considered alone.[109]

Additional Considerations

Tetra Tech acknowledges the sensitivity of this topic, given the desire for residential development despite a shrinking population in the city.[110] EFF agrees, citing the tension of green infrastructure development somehow representing the city's leadership "giving up" on growth.[111] In the meantime, however, the city's infrastructure remains too large for the current population and distressed properties contribute to additional run off due to a lack of maintenance.[112]

block groups excluded (fewer than 100 parcels surveyed

0%-12.5%

12.6%-25%

25.1%-50%

50.1%-100%
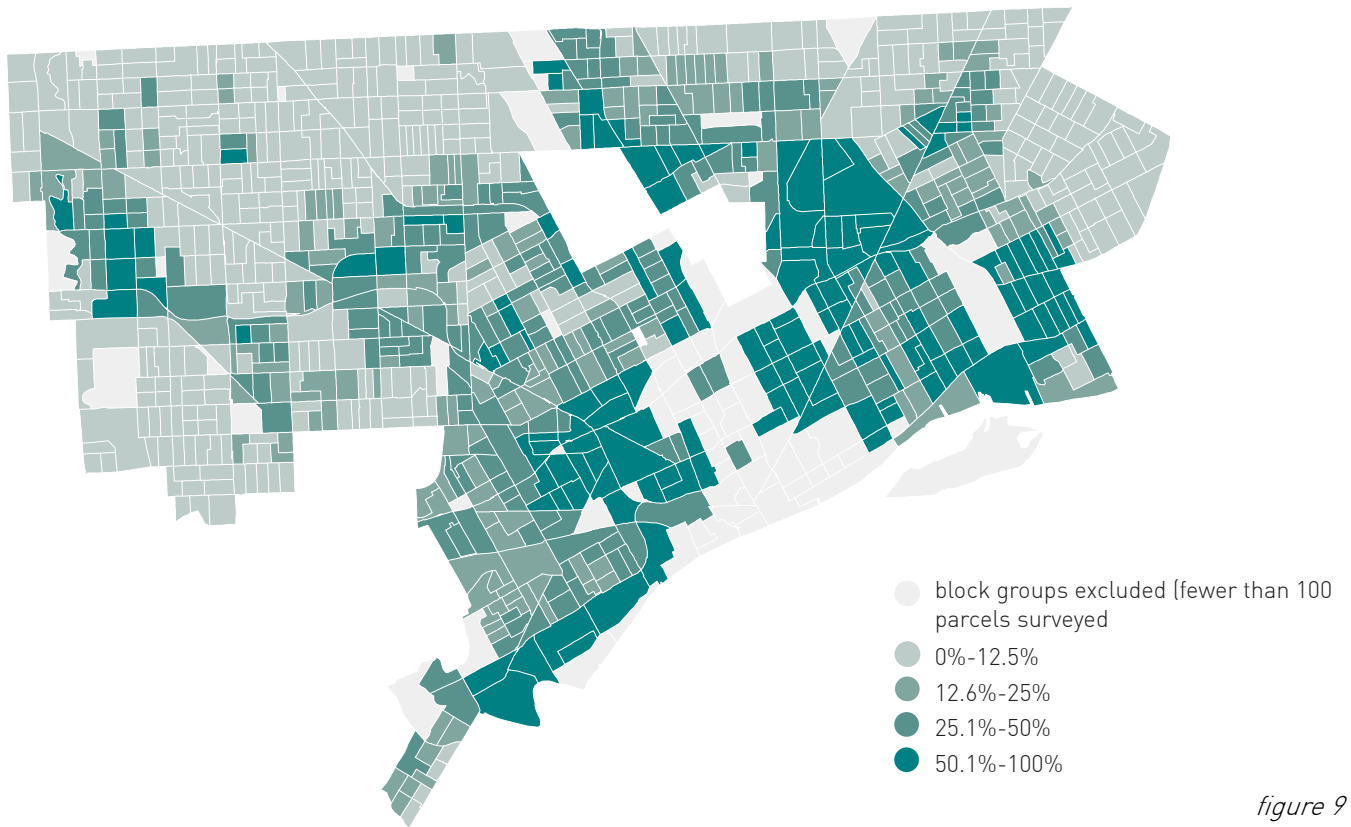
figure 9

Map above predominantly portrays residential parcels by census block group, but also includes vacant lots in neighborhood commercial areas adjacent to residential areas. The map does not include vacant lots in other commercial or industrial areas. Map data courtesy of Data Driven Detroit.

Successes + Next Steps

Detroit's green infrastructure actors have seen many successes in recent years. Each organization will define success differently depending on its focus. However, as a result of our discussions four themes emerged as particularly successful aspects of green infrastructure: public engagement, policy and planning, capacity building, and small to medium scale implementation.

Community Engagement
Much has been done to inform and engage Detroit's citizens on green infrastructure benefits and design. Organizations such as Detroit Future City, Sierra Club, SEMCOG, Greening of Detroit, and Lawrence Technological University, and the UM Water Center are actively working towards community engagement and education through a variety of activities. Engagement ranged from active volunteers to plant trees One activity that is critical to green infrastructure success is to engage and educate neighborhoods where green infrastructure is to be installed (DWSD, Greening of Detroit, UM Water Center). Engagement on design and implementation helps assuage resident concerns, increase understanding of green infrastructure, and gain community support.

Another success in community engagement is finding the right message. The Center for Neighborhood Technology identified that speaking to citizens about flooding rather than combined sewer overflows or water pollution was more likely to engage citizens due to the direct consequences. This messaging has helped CNT engage citizens who will in turn engage policy makers to act. The Sierra Club has similarly found that focusing on residents' water bills helps make the case for rain barrels usage as it can cut down on outdoor water usage (car washing, gardening, etc.).

Lastly, green infrastructure is expected to create a sense of place and city investment in neighborhoods. Current research at the UM Water Center is evaluating residents' "perception of attractiveness and desirability in their neighborhood" alongside other qualitative metrics in order to evaluate how GI can impact a community's sense of place and value of that place.[113]

Policy and Planning
SEMCOG, DEQ, and DWSD are the primary policy groups working towards green infrastructure in the Detroit area. Recently DEQ has improved its stormwater permitting process to simplify installation of green infrastructure, (SEMCOG, DEQ). Also, because water is managed at the county level in Michigan, there is a need for cross-county collaboration on water management. Recently, relevant organizational bodies in Southeast Michigan have begun to collaborate across counties to discuss policy issues at biannual roundtables and have also developed a regional water quality plan (Lawrence Technological University, SEMCOG).

Capacity Building
Due to the cross-cutting nature of green infrastructure, many of the policy-oriented organizations (such as the DEQ and DWSD) lack the organizational processes and structures that green infrastructure requires. However, this has recently begun to change in both the DEQ and within DWSD. The DEQ has organized internal teams to support green infrastructure from the top down and is using its overarching role as a statewide organization to provide forums for other organizations to collaborate and build relationships, (DEQ). The DWSD has recently added a technical consultant for green infrastructure to help facilitate and coordinate implementation, (DWSD). In the short term such organizations will be working on building the institutional framework for green infrastructure to succeed by updating of city and state codes and

internal policies to aid in cross-departmental coordination, (DEQ).

Implementation
In addition to the above themes, Detroit is proud of the physical green infrastructure projects that have already been launched. These organizations and their projects are listed below and can be referenced for additional information.
- DWSD/LEAP, GLRI Shoreline[114]
- LEAP/Land, Inc., Green T Project[115]
- Sustainable Water Works, Ford River Rouge Redevelopment
- Greening of Detroit, Dendroremediation Research & Tree Plantings[116]
- Greening of Detroit/SEMCOG/DFC, Vacant Land Treatment Program[117]

Next Steps: Ideas to Move GI Forward in Detroit
When asked what the biggest needs are to achieve green infrastructure goals in Detroit respondents' answers fell in these general categories:
- Culture shift to incorporate green infrastructure – 4 responses
- Funding for implementation – 2 responses
- Updating City/State Code – 2 responses
- Financial incentive structures – 2 responses
- Coordination – 2 responses
- Equipment
- Manpower
- Education on technical implementation
- More human resources
- Support of city leadership
- City-wide strategic planning

Out of these needs, respondents provided several suggestions for programs, projects, and tools to advance GI in Detroit:
- Conduct studies on a coordinated large-scale green infrastructure to create the scientific basis that would reduce perceived risk and allow municipalities to invest large amounts in such projects.[118]
- Create a financial system similar to a social bond that is connected to the long-term performance of the green infrastructure, this will help with financial viability.[119]
- Create model legislation from around the state or country to show how financing and taxes can help keep green infrastructure funded.[120]

More ideas for green infrastructure financing are included on

Stakeholder Map

An important part of this project for us was to understand how each organization related to one another. We wanted to know which groups have worked together to understand the level of coordination and cooperation in the city.

The following is a map of the organizations we spoke with and how they are connected to one another. The connections were largely determined during the interview process as we asked which organizations each interviewee had worked with. Some of these partnerships were also found through an organization's website.

The lines on the map represent a connection, which was usually the result of working together on a project. The size of each circle is determined by the number of connections leading to it.

Legend:
- non-profit
- private foundation
- state university
- private university
- publicly held company
- governmental/public authority

Michigan State Housing Development Authority +Lansing, MI

Detroit Future City

The Sierra Club of Michigan Great Lakes Program

Sustainable Water Works

Data Driven Detroit

Wayne State University

LEAP (Conner Street)

Lawrence Technological University Southfield, MI

Erb Family Foundation Bloomfield Hills, MI

UM Water Institute Ann Arbor, MI

Michigan DEQ Lansing, MI

Center for Neighborhood Technology Chicago, IL

DWSD

Detroit Land Bank Authority

TetraTech

City of Detroit Planning, Design, + Construction Division Landscape Architecture Design Unit

Greening of Detroit

SEMCOG

figure 10

Financing Green Infrastructure

Financing
There are a number of financing mechanisms available to fund green infrastructure projects. One of the most popular is applying for the EPA's Clean Water State Revolving Fund, which offers low and no-interest loans to cities for clean water projects, which can include green infrastructure.[121] The EPA also administers a website that collects national experience with implementing green infrastructure, including case studies, regulatory information, and funding opportunities.[122] Other mechanisms include allocating funding directly, as Mayor Rahm Emanuel did in Chicago,[123] and assessing new taxes to cover green infrastructure construction and maintenance costs. Chicago's strategy clearly requires significant capital outlay at the city level, which may prove politically challenging in some locations. Lenexa, Kansas has successfully employed a tax strategy, assessing a 1/8th cent voter-approved sales tax to increase green infrastructure funding.[124]

Yet in Detroit, vacant lots present a unique challenge to project financing, one that DWSD is seeking to address through public-private partnerships. In collaboration with Detroit Land Bank, DWSD is exploring the potential for combining demolitions with green infrastructure development. For example, after Detroit Land Bank acquires a property and takes down the house, DWSD could pay the incremental cost of installing green infrastructure features.[125] Of course, demolition is often neither the feasible nor desirable. For current residents in Detroit, Quicken Loans provides landscape grants to conduct stabilization in neighborhoods.[126]

Finance Opportunities
There are a number of opportunities for structuring financing for green infrastructure projects to maximize impact and increase project adoption. In Figure 10 below we categorize finance mechanisms into: best practice project structures, local funding, external funding, revenue generators, and local sustainable financing.

Best Practice Project Structure[127]	• Incorporate green infrastructure projects into broader sewerage infrastructure development. Projects should build ongoing O&M into capital financing plans or make other arrangements for project upkeep.
Local Funding[128]	• Strategic Water Quality Initiatives Fund (SWQIF) Loans through the Department of Environmental Quality ($10-20 million available annually)
	• Stormwater, Asset Management, and Wastewater (SAW) Grants and Loans through the Department of Environmental Quality ($97 million available, started 2013).
	• Michigan Community Development Block Grant Program from the MEDC on behalf of MSF ($4 million available).
	• Michigan Transportation Alternatives Program through the Michigan Department for Transportation ($16.5 million available annually with a 20% match requirement).
External Funding[129]	• Water Pollution Revolving Fund (Clean Water State Revolving Fund) Loans from the U.S. EPA with the Michigan Department of Environmental Quality ($280 million available annually).
Revenue Generation	• Stormwater Utility to generate revenue and create incentive to implement green infrastructure on-site.
	• Tax increase through sales tax or other mechanism
Local Sustainable Financing Mechanisms[130]	• In conjunction with a stormwater utility to generate revenue, develop an on-bill financing program to fund green infrastructure projects that would be repaid through monthly stormwater charges. Addition of green infrastructure would decrease stormwater charges simultaneously, resulting in a net zero change in bill or a reduction
	• Local revolving loan fund developed with seed funding from stormwater utility, tax, NGO, private party, city bond, or other means. Low interest loans would be offered to parties interested in developing green infrastructure, Participating projects could include urban agricultural development with a stable revenue stream, resulting in a net zero cost or positive net income.

figure 11

Conclusion

Green infrastructure offers a multitude of benefits for cities like Detroit. While barriers persist, there are ample opportunities for both near term project development and long term restructuring to prioritize green infrastructure as a primary means of stormwater management. Organizations in Detroit have made substantial progress in overcoming many of these barriers and we hope that the findings in this report aid future efforts to bring green infrastructure into the mainstream.

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