# BARRIERS TO USING URBAN GREEN INFRASTRUCTURE

Ву

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#### ABSTRACT

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By

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Landscape architects, urban designers, planners, and others in the design profession are attempting to identify challenges, increase the importance of seeking sources of inspiration, and learn from previous projects involving urban green infrastructure. This thesis identifies key barriers to using urban green infrastructure and defines urban green infrastructure from government officials who have experienced its functionality. Its implementation in urban areas can be misunderstood if there is little involvement and communication amongst both government officials and communities. For instance, provision of valuable information can guide communities and their officials to recognize the various benefits that urban green infrastructure has to offer, no matter how it is defined. Innovative urban green infrastructure designs would not only enhance stormwater management but most importantly improve public green space for social and recreational activities in urban settings while already providing reasonable environmental benefits. Ultimately, urban green infrastructure is a fascinating design approach that improves livability and connections between green spaces that can commit to being functional with social interactions within environments.

This thesis is dedicated to: My late grandfather, who is always watching over me with his spirit.

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#### CHAPTER 1: INTRODUCTION

#### **Revealing Green Infrastructure**

Greenways are similar to green infrastructure for the simple fact they both implement open spaces consisting of natural vegetation and provide community benefits. However, green infrastructure has a lot of different meanings. This thesis will focus on urban green infrastructure defined, as both a cost-effective and multipurpose strategy that mimics the natural land managing rainwater impacts with social and environmental benefits in relation to people and the planet. Moreover, green infrastructure is an alternative to single-purpose gray infrastructure and a reason to call for a long-term investment in developing urban green infrastructure systems. Green infrastructure is commonly known as practices we use in our environments such as rain gardens, green roofs, constructed wetlands or permeable pavements. These design efforts manage wet weather impacts but do not link a net of open green spaces for public use. "It is also generally understood and scientifically proven that green infrastructure in cities offers health benefits such as alleviating mental, physical and social pressure" (Guerrero, P., et al. 2016, p. 2). Urban green infrastructure actually has the potential to impact how we live; targeting the social aspects and benefits within a green infrastructure.

In fact, the world is changing as know it and we stick to our old ways of doing things such as repairing single-purpose gray infrastructure. Many surfaces in cities

struggle with managing heavy rainfalls and snowmelt runoff. Current infrastructure systems are designed to hide drains and remove water as quickly as possible but cause a major source of water pollution. Led by water not being soaked into the ground as it should. It carries trash, bacteria, heavy metals, and other pollutants from the urban landscapes and discharging these containments into nearby water bodies.

Our "ecosystem supports human survival and maintains an atmosphere that allows for the existence of life on the planet" (Rottle and Yocom, 2010, p. 55). For this reason, biodiversity and its resilience "to respond and adapt to change while maintaining its core function and character" (Rottle and Yocom, 2010, p. 56) show a balance between people and the environment. The natural elements of land, water, air, and vegetation are the greatest assets that have been allowing us to live on this earth, which we take for granted. These natural elements are worth fighting for because it is the only thing that lasts and has a present purpose. Over time, natural disasters such as flooding have become overwhelming events. In response to natural disasters and everyday living, there is an urgent need to examine urban areas. Successful green infrastructure implementation would help maintain our land use by human activity which influences how rainwater makes its way back to our nation's rivers, lakes, and estuaries.

#### Adapting Green Infrastructure in Urban Areas

Urban areas are dense with impermeable structures and surfaces. They take up space where current gray infrastructure fail. At a city or urban scale, green infrastructure, and its importance of green spaces in urban areas should seek a place to connect, be active, take notice, gain knowledge, and embrace natural elements. For instance, urban green infrastructure can solve social and environmental issues such as improving human interactions within environments. The use of green infrastructure in urban areas can both create, and reinforce a sense of open green space, and be accessible to everyone, which allows people to feel good. Green infrastructure has the opportunity to make cities functional in every aspect possible. Communities in urban areas can gain benefits from green infrastructure implementation that focus on heath and engagement within natural environments.

Implementing urban green infrastructure as a multipurpose strategy can have many benefits, lasting for years to come. These benefits relate to sustainable elements, green infrastructure public-use, and community givebacks. The design efforts of urban green infrastructure help manage rain-related impacts and create open green spaces with programs for public use. For example, designing landscapes that integrate both recreational space(s) and water basins that temporarily manage or store stormwater have a greater outcome of successful implementation. Green infrastructure designs in urban settings have to commit to the values of the natural elements and people. All

urban areas should have plenty of fresh water, clean and fresh air; including native plant and animal species. Strategic planning emphasizes on values that improve the physical and social environment. So, exploring ideas through designs beyond just solving stored rain-related impacts created by gray infrastructure is necessary.

# Missing Aspects of Urban Green Infrastructure

The amount of research and growth across the country allows us to experience the benefits of green infrastructure. However, pieces of the puzzle are missing; ones that show the big picture as it relates to social aspects in designing or implementing for both people and nature. For example, incorporating cultural characteristics helps amplify recreational and educational opportunities for urban green infrastructure. At this moment, communities in urban areas do not contribute to the advancement of green infrastructure sustainability nor ecosystem services. It is necessary to design a magnitude of multipurpose programs that fit the needs of the environment; revealing various opportunities of green infrastructure design. There is a curiosity of identifying barriers to using urban green infrastructure and how it adapts to social aspects. First, educate people about green infrastructure and how it can correlate with urban areas because the common use of green infrastructure can be misleading. Besides the norm of committing to stormwater management; integrated recreational opportunities can exploit community givebacks. Secondly, solidifying long-term goals with support from

both design or planning professions and communities can make the best out of urban green infrastructure implementation.

Green infrastructure contributes to human well-being where public spaces enhance "ecosystem services", in which urban areas focus on a linkage between people and the planet that result in benefits. The effect of adding ecosystem services to urban green infrastructure is that people will "become aware of the benefits of ecosystem services as well, their behavior with respect to nature may change" (Opdam, P., et al. 2015, p. 223) because "everyone in the world depends completely on Earth's ecosystems and the services they provide, such as food, water, disease management, climate regulation, spiritual fulfillment, aesthetic enjoyment" (Millennium Ecosystem Assessment. 2015, p. 1). In other words, urban green infrastructure as a multipurpose design action, contributes to at least one or more subcategories in each of the ecosystem services. Those essential ecosystem subcategories are: 1) fresh water, 2) regulating of water timing and flows, 3) education and values, 4) water cycling, 5) recreation and ecotourism are goals within urban green infrastructure.

#### CHAPTER 2: LITERATURE REVIEW

#### Historical Landmarks

"The first truly publicly funded new urban park in Britain can be found across the River Mersey from Liverpool in the town of Birkenhead, designed by Sir Joseph Paxton (1803-1865) in 1843. The Park features building structures surrounding a common and carriageways around and through the park. The park design features eclectic design of styles to educate children about places around the world. In 1850, Fedrick Law Olmsted, an American, visited the park and was inspired for Central Park in New York City" (Burley, J. and Machemer, P. 2016, p. 270). This man is famous for creating historical landmarks through landscape design. "Federick Law Olmsted, Sr. (1822-1903) is recognized as the formative leader in the development of the planning and design of exterior spaces and is considered the Father of Landscape Architecture. Although scholars also considered Andrew Jackson Downing as a major figure in the formation of this profession, too" (Burley, J. and Machemer, P. 2016, p. 330). "Olmsted stated that Central Park needed to carry a "pastoral" concept as a refuge from the city but still be an integral part of the city" (Burley, J. and Machemer, P. 2016, p. 331). Calvert Vaux, an English born architect partnered with Olmsted in designing Central Park after A. J. Downing introduced them both and died in 1852. Olmsted and Vaux had features in the park that produced a broader landscape experiential plan, leading to implementing viewpoints from the geological high point of the park. The advantage led to

incorporating the design with the existing land. In Olmsted's projects, he created a connective greenway environment with a modern American architect, Henry Hobson Richardson (1838-1886). This design was known as the Emerald Necklace in Boston, Massachusetts. The Emerald Necklace plan created a greenway with ecological functions, natural preservation, water management, wildlife habitat, and an arboretum (Burley, J. and Machemer, P. 2016).

Furthermore, in regards to additional historical landmarks there is an H. W. S. Cleveland (1814-1900). "He is considered a naturalist designer, and he promoted sustainability. H. W. S. Cleveland is known as the designer for Sleepy Hollow Cemetery, Concord, Massachusetts. He designed Minnehaha Park in Minneapolis, Minnesota and developed the Minneapolis Park System, which included The Chain of Lakes, a circular route that is now a scenic byway" (Burley, J. and Machemer, P. 2016, p. 341). Sustainability is no new term and Dr. Burley (Burley, J. and Machemer, P. 2016) states, "Olmsted and Cleveland have been practicing sustainability for over 100 years." Charles Eliot (1859-1897) another innovator of its time designed the Boston Metropolitan Park System. "He promoted the reservation protection system, leading to the scenic beauty conference (Massachusetts Institute of Technology, 1890), and the Massachusetts Trustees of Reservations (1891)" (Burley, J. and Machemer, P. 2016, p. 341).

#### **Historical Connections**

Green connections historically in cities have enhanced communities through greenways. "Greenways are generally referred to as linear open spaces consisting of natural vegetation. Greenways are recognized as playing an important role in bringing nature and personal well-being back to cities, thereby increasing the quality of life for communities across the nation" (Balmes, R. 1997, p. 1). In regards to greenways integrated in urban settings it enhances the quality of life in various ways. These aspects are recreational, cultural & education, transportation, environmental and economic benefits. The implementation of greenways creates recreational aspects, increasing the opportunities for walking, biking, jogging, and hiking. Cultural education helps develop a sense of place for communities by preserving historic districts and parks. These places provide a wonderful environment for learning about the earth's ecological processes. Transportation can be improved through connections for mobility and environmental aspects that support natural systems and help people engage with nature. Lastly, economic benefits impact property values, tourism, as well as assisting communities in attracting businesses and cooperate relocation (Balmes, R. 1997). Historical research and demonstrations have been an advantage in addressing issues in using structural elements for maximizing greenway operational features with formalized plans (Burley, J. 1995). These features can be added by "humans to the landscape to improve wildlife

habitat. One can design spaces for a variety of wildlife types" especially when the connectivity of structural features form corridors (Burley, J. 1995, p. 200).

# Understanding Urban Settings

"Rapid development has exacerbated land cover conversion of much of the existing green space, resulting in a decrease in bio-diversity. It is important to preserve green space not only for people to access nature, but also provide habitats" (Kim, J., et al. 2015, p. 91). Green infrastructure is present in many cities with various uses and many practices. However, continuing this trend without the thought of public use would diminish human activity. "All forms of open space have a role in shaping its environment and must be seen to provide multiple values and benefits. Opportunities are made available for richer, more diverse and more useful urban places. They assume multifunctional roles, embodying the principle of a working landscape that encompasses conservation and protection and enhancement, economic benefits from resource productivity, recreation and a new aesthetic perspective. It gives new dimensions to the form, purpose and design of open space. The inter-connections between land, energy and biology within an integrated resource management framework provide the essential strategy for the design of the urban landscape and give it renewed relevance and purpose" (Hough, M. 1989, p. 243). Therefore, if green infrastructure commits to urban areas, cities would manage rain-related occurrences, as well as social and environmental characteristics through innovative designs. Urban green infrastructure would then

advance values and functions of its implementation. Human health and well-being would also be a link to the functionality of our environments.

On the other hand, Low Impact Development (LID), an innovative approach in minimizing the influence of adverse stormwater, "has been more widely adopted and incorporated into the planning and design of environments as a planning and design philosophy" (Wang, M., et al. 2015, p. 2). In contrast, the green infrastructure – "LID controls employ green infrastructure that mimic natural systems of water movements; hence, they purify water and reduce the burden of storm drains" (Burley, J., et al. 2016, p. 67). One of the challenges is how different organizations confront stormwater regulations because these regulations may contradict with LID techniques. Other challenges relate to the lack of knowledge, awareness, and support of LID. Despite challenges, the progress of LID development is improving; sharing the same benefits as urban green infrastructure. These benefits create social aesthetics and help stormwater management by reducing maintenance and irrigation cost. "Providing diverse commuting solutions and reducing of ecological footprints enhance the value of natural environments" (Kim, J., et al. 2015, p. 90) helps understand green infrastructure in urban settings. The significance of land-use is associated with its uniqueness to create multiple benefits within urban green infrastructure implementation. Not to mention, the public green spaces that provide ecosystem services within urban green can be a contributing factor to human well-being. For example, cultural linkage in regards to aesthetics,

spiritual, educational, and recreational services promote a favorable place for good social relations and health.

## Green Infrastructure Revealing Social Aspects

The term green infrastructure has been described as "a cost-effective, resilient approach to manage wet weather impacts that provide many community benefits" ("What is Green Infrastructure?" EPA). In response to an increasing population, there is also a growing understanding of green infrastructure benefits. Historically, natural systems have become a great achievement as an example of human engineering's potential to control nature. However, systems such as gray infrastructure which is considered the norm have limitations such as flooding, which becomes worse as population rises. In today's society, there are frequent changes that are caused by industrialization and urbanization which affect a decline in "human community and cultural well-being" (Maller, C. 2005, p. 46). Therefore, implementing unique designs incorporated with green infrastructure would provide a holistic approach to combat environmental, physical, and social challenges.

The idea is to strategically guide multipurpose green infrastructure in order to improve urban microclimate and the built environment. This strategy would also promote mental health, build social capital, and community cohesion. However, there are very few demonstrations in urban areas that embody such idea. Some examples of which are visible in Figure 1 and 2.

# FIGURE 1: Brooklyn Bridge Park in Brooklyn, NYC



FIGURE 2: William G. Milliken State Park, Lowland Park in Detroit, MI



Figure 1, has several existing piers that each serve as public green spaces and ecological features. The park design alternatives are active and passive from end to end ("Brooklyn Bridge Park: A Twenty-Year Transformation." ALSA Professional Awards, 2018.). This site also presents a multipurpose strategy that generates opportunities for environmental quality and public spaces (environmental and social outcomes) within existing industrial piers. These spaces can be used for recreation and to socialize. The design engages urban nodes with connection points to adjacent neighborhoods. From the ecological standpoint, Brooklyn Bridge Park includes gardens and salt marsh grasses with riprap control to provide natural transitions from land to water as well as remnant piles that protect the marsh from excessive waves ("Brooklyn Bridge Park: A Twenty-Year Transformation." ALSA Professional Awards, 2018). Figure 2, has various landscape performance benefits, which relate to environmental, social, economic outcomes ("William G. Milliken State Park, Phase 2 Lowland Park." Landscape Performance Series, 2018). This site is an environmental example of reducing runoff into nearby water bodies and removing contaminated materials. Milliken State Park identifies native habitats with wetlands that present educational opportunities about wetlands and how they function. Milliken State Park also provides outdoor recreation such as exercise and relaxation ("William G. Milliken State Park, Phase 2 Lowland Park." Landscape Performance Series, 2018). These two projects both express a unique way of using multipurpose programming for urban green infrastructure implementation.

Green infrastructure "elevates the significance of natural resources to be on par with conventional infrastructure" (Kohut, 2013, p. 34). It will be a shift in the "way communities think about and prioritize green space and environmental services; it is an effort to plan for both conservation and development simultaneously" (Kohut, H. 2013, p. 34). Although most communities are different from one another; they are more likely to use green infrastructure in a unique way to address its specific social and environmental challenges, but there is no single best way for a green infrastructure approach to be applied. Incorporating strategies that encourage habitat interactions into larger municipal projects and plans have a high probability of health and community well-being benefits. However, high adaptability means cities could use green infrastructure, not just in areas with large open spaces; but in neighborhoods of low socioeconomic status that have high levels of industrial pollutants and least likely "contain adequate, safe, usable parks and green spaces" (Kohut, H. 2013, p. 43). So, the planning approaches to green infrastructure strategically need to "focus on creating a comprehensive and interrelated system of parks, recreation areas, open spaces, and greenways" that protect our environment, provide community needs and conditions, and become both visually pleasing and very active (Bowler, D. 2010, p. 456). Urban green infrastructure, "like other forms of the built infrastructure, planning and management of green infrastructure are often seen as a rationalist exercise. However,

the scope and scale of the practical issues to address, such as recreational needs and conservation requirement arise some certainty" (Matthews, T. 2015, p. 157).

## Effective Participation and Perceptions

With technology becoming a major influence on our future, social media seems to do the same. Keeping up with generations and using technology to make a difference in how public officials and communities engage. This approach during the design process could be impactful in determining sustainable solutions. The benefits of using technology helps understand everyone's (public officials, stake holders, and communities) perceptions of social and environmental goals without misinterpreting core duties. For example, Brown and Kytta; Linders (gtd. in Guerrero et al., p. 2) stated: "the use of technologies such as social media and smartphones may represent a way around challenges as they create interactive channels for broad civic participation and new ways to deliver valuable public and scientific information". Social media application programs such as Instagram and Twitter are prime examples of "engaging citizens in governance set-ups using modern technology" (Guerrero, P., et al., p. 2). These platforms are a form of networking online applications that focus on sharing images and comments. The purpose in doing so is to "explore the way in which participants of a neighborhood online forum examine the authenticity and validity of comments made by the others in the forum" (Afzalan, N., & Moller, B., p. 70). However, the comments that become a form of networking should not "focus on single comments but on the way

comments interrelate in the context of the whole discussion. To explore the meaning behind the participants' comments, by reviewing the entire discussion, read each comment, and interpret the relationships among arguments" (Afzalan, N., & Moller, B., p. 70).

Participation from communities means a lot and public officials should be able to make collaborating worthwhile with their knowledge which could change people's perspective. As a result, could lead to a new way of understanding the relations between communities and urban green infrastructure advantages. Given that, "an important step in the collaborative planning process is to decide how and where adaptations in landscapes would meet with demands for benefits" (Opdam, P, et al. 2015, p. 224) in relations to implementing green infrastructure in urban settings. Some community groups, such as deprived urban areas, do not have the opportunity to participate; which means, public officials should be obligated to figure out solutions in involving community groups as such. "This shift is adding new ways and perspectives to knowledge sharing and knowledge gathering that can support the development of ideas and practices regarding urban planning and governance. Online and smartphone applications have the potential to act as media for transparent, democratic, inclusive and situation-based participatory processes of interest to planners, citizens/users, politicians and scientists" (Guerrero, P., et al., p. 3). Furthermore, public engagement needs primary goals that follow embodying innovative approaches to community meetings and

developing relationships with residents and community leaders to ensure community input are taken into account through the design process. Overall, the main goal in incorporating technology to implement urban green infrastructure is "to obtain an understanding of people's perceptions of parks and natural environments by interpreting their images" and feedback stated by Mackay & Couldwell (qtd. In Guerrero, P., et al., p. 11).

Urban Green Infrastructure Planning and Its Landscape Context

Green infrastructure's multifunctionality is unique because of its relations of landscape urban context. Multifunctional meaning "multiple ecological, economic, and also social functions to be explicitly considered" (Hansen, R. and Pauleit, S. 2014. p. 518). Firstly, understanding the physical scale of a site and its ecological footprint as well as its historical land patterns is an advantage towards urban green infrastructure planning. Analyzing inventory and analytics at local scales could resolve environmental issues. Secondly, to understand the duties of landscapes, landscape architects must strategically provide a framework that allows everyone to grasp a site's function through a series of overlapping and integrated systems. Recognizing existing features such as natural areas (habitats), existing trails, topography and other land use opportunities can lead to specific site identification.

Specific site identification is to increase potential site selections based on the public use to demonstrate design proposals to change the way a landscape is perceived.

Implementing green infrastructure practices and programming become more successful with ecosystem services playing an integral part. Overlapping layers to demonstrate urban green infrastructure can help discover site identification. These overlapping layers include nearby water bodies, open space, bare land, roads, parks, and beyond. Overlapping layers allows us to see connections and features, in which can be implemented in urban green infrastructure designs. This approach on a computerized geographic information system (GIS) program is called ArcGIS. Geographic information systems is a tool that deepens the understanding of critical issues and impactful opportunities. This program is known to create maps that compile geographic data; which could be "a call to incorporate GIS methods into urban planning as this provides a more tangible way of representing issues regarding human environment interactions" stated by Kabisch, Qureshi, & Haase (gtd. In Guerrero, P., et al., p. 11) as well as "to analyze these interactions and green space social values" (Guerrero, P., et al., p. 11). This "aims to improve our understanding of the mapping of ecosystem services so that ecosystem services become more highly valued and to support green decision-making in urban settings" (Guerrero, P., et al., p. 12). This long-term investment provides various benefits including social and environmental aspects that emphasize the values related to people, the planet, and most importantly the quality of life.

On the subject of the quality of life, "examining the transformation of urban areas environmental quality, comparing pre-settlement environments from the 1800s to

current conditions" (Jin, Y., et al. 2018) can change the narrative of values of such areas. The key is to look at areas of "urban savanna" (residential environments) and "cliff detritus" (downtown-like environments) (Jin, Y., et al. 2018). In general, most of the transformations in urban areas go from woodland to urban savanna or cliff detritus. Using this information of landscape context, planners and designers must determine how "to contribute to greenways and other efforts to preserve natural areas in urban fabrics" (Jin, Y., et al. 2018., p. 223). Redefining the landscape context with the knowledge of pre-settlement environments to current conditions in which understanding settings contributes to strategic planning. This type of critical thinking in regards to urban green infrastructure can have many perceptions of environmental quality and long-term sustainability.

Not to mention, this could potentially show the value of green infrastructure and how it facilitates working on numerous schemes at various scales that reinforce spatial and functional attributes in a variety of ways. The purpose of strategic urban green infrastructure planning is to use development "to reflect the existing use of the surroundings of the district and to maximize the regional and environmental context, resulting in long-term sustainable development" (Kim, J., et al. 2015, p. 93). For example, "today, urban parks are not seen as the total solution to social problems" (Transforming the Discussion, Breaking Our Landscape Architecture Chrysalis. 2018. p. 514) so sustainability would be an interesting concept to emphasize on existing functional

attributes in urban parks. However, "nothing is truly sustainable. What is known is that life evolves and environmental conditions may change" (Burley, J. 2018. p. 514) so, having different approaches to plan sustainability as it relates to urban green infrastructure implementation is effective. Secondly, planning should focus on identifying areas or zones. Those zones are recreation, development, zones, and urban green infrastructure demonstration zones. This ultimate goal in that is strategizing longterm goals of urban green infrastructure implementation in communities at various scales. Then there are numerous opportunities for specific projects touching on education, multipurpose programming, safety, tourism, water and human activity expanding the idea of landscape context.

# Capturing, Cleaning, and Conveying Stormwater

Combined sewer systems are a poor technique in urban cities where capturing, cleaning, conveying stormwater is not adequate. For example, in areas where water infiltrates into wetlands or cisterns creates a connectivity for the rest of the city. Capturing stormwater through a process of cleaning and conveying it helps communities water reuse. Therefore, urban green infrastructure in urban areas has a means of addressing hydrology and water quality. The approaches in managing existing wetland environments and land-uses would be most effect with the collaborative design effort from landscape architects, engineers, and planners in "predicting estimated water flow for various types of storm events" (Wu, Z., et al. In publication. p. 3) using data

referring to yearly rainfall. In today's era the process is more convenient with a GIS program illustrating overlays of land covers (bare space & open green space), soil types, hydrology, and most importantly topography to pursue capturing, cleaning, and conveying stormwater as well as improving water quality (Wu, Z., et al. In publication).

Some of the most well-known urban green infrastructure practices to support stormwater management are green roofs, bioretention systems, constructed wetlands, porous pavements, and rain barrels or cisterns. For example, constructed wetlands can demonstrate multiple uses in an urban setting through designs that implement trails and bridges through wetlands which enhances the interaction with the people. This helps "people learn about the value of wetlands, exercise spaces, and socialize" (Wu, Z., et al. In publication. p. 18). The core duty of urban green infrastructure practices is to manage stormwater and maintain efficiency in maintenance. Kang (gtd. In Liu, Y. et al., 2017, p. 586) stated: performances while minimizing maintenance costs, optimal maintenance interval is necessary, and maintenance needs to be conducted before efficiencies degrade unacceptable levels. Performances must obtain "top priorities for urban water sustainability include the provision of safe drinking water, wastewater handling for public health, and protection against flooding" (Larsen, T., et al. 2016, p. 928).

"However, rapidly aging infrastructure, population growth, and increasing urbanization call into question current urban water management strategies" (Larsen, T.,

et al. 2016, p. 928) such as urban green infrastructure programming or practices. As a concept, one of the primary goals "is to maintain or reintroduce a more natural state of the urban hydrological catchment, to reduce the impact of stormwater drainage on the aquatic environment, and to reduce flood risk" (Larsen, T., et al. 2016, p. 931). This concept "introduces a strong element of decentralized measures and emphasize the importance of long-term planning" (Larsen, T., et al. 2016, p. 931). "Without adequate drainage infrastructure, unwanted urban flooding events will occur" (Larsen, T., et al. 2016, p. 938). At a local scale, there are a number of opportunities related to urban green infrastructure and greenways. In particular, greenways adjacent to roads have a huge benefit in capturing stormwater from streets and other hard surfaces (roofs, large areas of pavement, and asphalt parking lots). Ideally, the implementation of urban green infrastructure has opportunities where education and human interactions within the environment become apparent while accomplishing its main duty of stormwater management.

Furthermore, with the implementation of green infrastructure and the outcome of its benefits guides "future development, while providing the means for balancing economic growth and sustainability of human and nature" (Kim, J., et al. 2015, p. 90). Using urban green infrastructure is important because "with the increased development, impervious surfaces will occupy a larger portion of land, causing a lower infiltration rate and resulting in greater stormwater runoff volumes and increased flood risk. The low

infiltration rate can also result in a deficiency of groundwater supply in the long-term, causing land subsidence associated with infrastructure damage" (Kim, J., et al. 2015, p. 91) such as gray infrastructure.

## Identifying Barriers to Urban Using Green Infrastructure

Green infrastructure can be described "as a multifunctional, interconnected network of waterways, wetlands, woodlands, wildlife habitats, and other natural areas; greenways, parks, and other conservation lands; and open spaces that support native species, maintain natural ecological processes, sustain air, and water resources" (Youngquist, 2009, p. 21). Identifying barriers to urban green infrastructure would change its definition and its implementation. It can strategically place a definite amount of green infrastructure in urban settings and motivate how its implementation could improve all functions within an urban area. Like, the means of achieving several environmental, social, cultural and economic urban policy aims (Madureira and Andersen, 2014, p. 38). The services of green infrastructure are essential in urban areas because of increased population. Therefore, green infrastructure is a key component in striving to incorporate interested citizens into environmental decisions. The benefits of such services include reducing floods and creating green spaces for the public. Green infrastructure is believed to be valuable for landscape enhancement and multifunctional aims: "for increasing the adaptive capacity of the environment for climate change and long-term sustainability whilst protecting its ecological and social values" (Roe and Mell,

2013, p. 650). Despite such potential benefits, identifying barriers to green infrastructure may include: 1) lack of knowledge, 2) lack of community cooperation, 3) services of maintenance and monitoring, 4) support for long-term visions, and 5) lack of design optimization in regards to performance objectives.

1) One of the major barriers to using urban green infrastructure is that "there is often a misinterpretation of green infrastructure as a straightforward way to promote multifunctionality without the need to make choices among functions" (Madureira and Andersen, 2014, p. 38). One of the goals is to show how green infrastructure facilitates working on numerous schemes at various scales that reinforce each other's spatial and functional attributes in a variety of ways. People need to be aware of the benefits of green infrastructure and its constituents of well-being such as security, the basic material for good health, good social relations and freedom of choice and actions. It is essential for people to know that urban green infrastructure serves as the basis of sustainability between social, economic, environmental qualities and has to be sensitive to people, planet, and profit.

2) There is a lack of community cooperation where there is little involvement in the processes of guiding the development of urban green infrastructure designs. The lack of involvement from the public in incorporating safe access, viewsheds, lighting, and other safety features into designs is critical. There is also quite a challenge from the role of public officials engaging in community involvement in which public officials need

to be informative of all the multifunctional and benefits that urban green infrastructure has to offer to communities besides the environment. Bendict and MchMahon (2006) argued: "communities that want more housing, more jobs, and more open space can use green infrastructure to achieve all of these goals" (qtd. Matthews, T. 2015, p. 157). With a dense place such as cities, communities should be involved in the entire process of urban green infrastructure planning. Design and planning professions must also take into account social media platforms during the design process in order create impactful urban green infrastructure landscapes.

3) Another barrier to using urban green infrastructure would be maintenance and limited monitoring. In general, green infrastructure maintenance requires more labor and regular inspections than that of gray infrastructure to assure proper performance. The upside is that urban green infrastructure has the potential to conduct maintenance activities within communities to enhance community engagement. It is crucial to grasp the economic, social, and political forces active within communities to see progress. This progress could manifest in collaborative opportunities. On the other hand, there could also be another approach of green infrastructure practices by exploring other design efforts that will optimize performance and decrease maintenance.

Urban green infrastructure designs have the potential to enhance our lives through social and environmental aspects that will continue to be a stepping-stone towards learning life here on earth but also "becoming familiar with and accepting

green infrastructure within the community" (Keeley et al., 2013, p. 11). Putting knowledge out there for communities is important because communities are the ones who are giving adequate feedback. However, sometimes these communities might misunderstand social and environmental values. In this case, professionals such as landscape architects and urban planners must conduct effective activities that are informative about urban green infrastructure. For example, creating public engagement activities that include writing that expresses the feelings from respondents when shown a precedent image. The outcome of community cooperation would be an idea for specific activities and can provide alternative recreational activities. Particularly, lowincome communities are less likely informed about solutions and are more likely to feel as though they do not have a voice to address problems. Proper input and education about green infrastructure in low income areas can result in a widespread acceptance in implementing urban green infrastructure. Therefore, community involvement can be one of the many solutions in implementing urban green infrastructure and can become a solid foundation for growing and solidifying partnerships.

4) Green infrastructure implementation has not reached its peak in terms of supporting long-term goals that have become stagnant. This barrier takes us back to public involvement; having community backing can lead to accountability of long-term goals that landscape architects, urban designer, and planners, etc. put into place. Knowing a community's perspective can lead to mutual agreements in implementing

green infrastructure in urban areas and establish adaptability. Stakeholders uphold this responsibility to invest in these efforts. From this point forward, Stakeholders do not take into consideration the education, preparation, and collaboration that it takes to go from grey to green in the most efficient way possible. In the near future, green infrastructure will be the first steps in promoting greater health, while achieving several environmental, social, cultural and economic urban policy aims. In addition, the adapting atmosphere will set high expectations to live better and become better servants to the environment. Without stakeholders' interest in green infrastructure, it'll be difficult to work closely "together to align public and private knowledge and resources to promote green infrastructure. They will highlight the broad community benefits of green infrastructure including improving air quality, reducing energy use, mitigating climate change, and increasing resilience to climate change impacts" (Green Infrastructure Operations and Maintenance). In response, a commitment to the local changes in stormwater regulations and regional perspectives with the Environmental Protection Agency (EPA) approval comes into play as well as in seeking long-term goals.

5) Lastly, in regards to performance objectives the lack of design optimization hinders establishing a holistic green infrastructure framework. Connecting initiatives provides the means through which such endeavors generate long-term cumulative impacts that are mutually beneficial to both society and the environment (Lennon and Scott, 2014, p. 581). On the other hand, collaboration from professionals could ease

things when there is clear knowledge of green infrastructure implementation. Madureira et. al. (2014, p. 48) stressed: "the importance of locally-defined visions of green infrastructure that are both 'strategic-based' and 'place-based' is essential. Strategicbased meaning that the pursuit of multifunctionality, which is not a straightforward and simplistic result of green infrastructure promotion, depends on an aprioristic vision of the functions of green infrastructure more suitable to the local context. Place-based meaning that the success of a multifunctional green infrastructure depends on its adaptation to the environmental, social, cultural, economic and institutional context that calls for a proper assessment". Ji (2010, p. 2) expressed: "in urban areas, trails, greenways, and other infrastructures can link communities into a regional landscape matrix, making connectivity a key concept in landscape ecology thinking and planning for green infrastructure networks".

In conclusion, overcoming barriers to using urban green infrastructure not only provide services for communities that relate to stormwater management, air, and water quality but the environmental, social, and economic benefits it represents. Technical and physical barriers include maintenance services as well as a lack of knowledge and understanding of what green infrastructure is. Like a domino effect of its comprehension, communities lack cooperation and institutional values that underappreciate green infrastructure aesthetics, and characteristics. In respect to implementing green infrastructure, community cooperation has to be in full effect.

Community involvement in urban green infrastructure designs would not only satisfy the thought of investing in long-term aspirations but would also break down some of the communities' misconceptions. The more the community is informed and involved, the more cooperation there will be. An action like this would take a huge direction in advancing urban green infrastructure.

Eliminating Barriers to Using Urban Green Infrastructure

With everything improving by the minute these days, green infrastructure is at a standstill. Barriers to using urban green infrastructure seem to be a prominent issue preventing us from advancing even further. To respond to these issues some of the main goals of urban green infrastructure implementation are by 1) providing and promoting multi-programming activities 2) designing healthy communities 3) enhancing environmental quality 4) strengthen economic growth. The first priority in using urban green infrastructure is to create a community-based design process. This process would include an in-depth understanding of context, awareness, knowledge, opportunities, goals, and priorities through focus groups. Public meetings involving social media engagement and design focus activities are most effective in seeking input and feedback for future development. Communities will then understand how green infrastructure integrated into urban areas will display a way of living a positive life through impacts that result in longevity. Urban green infrastructure will allow landscapes to serve its purpose of all environmental and social characteristics once there is a formal
understanding of a process. Managing rainwater impacts the social and environmental benefits in relations to people and the planet, which helps enhance a healthy and well active community. An advantage would be for urban green infrastructure to mimic the biomimetics of natural land. Therefore, urban green infrastructure projects would include "a wider spectrum of natural and built environmental factors, more systematical design processes that should be considered to successfully develop planning and design solutions" (Kim, J., et al. 2015, p. 95).

1) In order to enhance urban green infrastructure for both the people and the planet; there must first be an action in providing and promoting multi-programming activities. Multiprogramming is similar to multifunctionality and services. The concept of multiprogramming is taking innovation detention ponds, rain gardens, and sports fields, etc. that serve a purpose to be grouped as social and ecological because this creates cultural functions of green spaces (Hansen, R. and Pauleit, S. 2014). This action responds to limited human activity within urban green spaces by incorporating innovative programs or elements that also corresponds to the objective of reducing stormwater. For example, creating a designated area(s) made for handling rainwater related challenges temporarily, with the intentions of the landscape to serve as a playground, sports or skate-basin (a sports field or structure acting as a detention pond that holds water temporarily and infiltrates it at a predetermined rate), and/or gathering spaces

where surface water drains to. This example describes a multi-purpose opportunity in regards to using green infrastructure in urban settings.

2) Designing healthy communities' correlates to the multiple functions of infrastructure by encouraging outdoor physical activities as well as addressing health problems such as obesity through innovative recreational space(s). Also, in improving healthier communities, wildlife interactions are major because the number of educational opportunities would enhance wildlife movement and influence vegetation in urban environments that provide habitats. In addition, urban green infrastructure implementation improves recreation opportunities and air purification. This ecosystem service has a more direct effect on people (Derken, M. et al., 2017) and valuing the environment often correlates to a healthier life with urban green infrastructure being the way to do so.

3) The planet we live on has negative effects of natural disasters that is why enhancing environmental quality is so crucial. With that being said, urban green infrastructure can help communities become more resilient to the impact of natural disasters or climate change. Landscapes would then become a continuous flow of functions that "represent the process and relate to the impacts associated with the movement of water, wind, plants, wildlife, and people" (Rottle and Yocom, 2010, p. 64).

4) Because many cities have pilot programs to enhance funding for green

infrastructure implementation such as cost reduction on drainage fees this would be tremendous for economic growth. Cost reduction fees relates to the actual based number of hard surfaces that sends rain and snow into sewer systems. Increased green infrastructure can create construction and maintenance jobs which would demand green infrastructure skills, new training, and certification programs ("What is Green Infrastructure?" EPA). Not to mention, property values would increase when beautification is improved.

## Conclusion

In all, based on the material gathered from literature reviews, the implementation of urban green infrastructure performs effectively as we know through its common practices: rain gardens, green roofs, constructed wetlands, and permeable pavements. Thus, to achieve urban green infrastructure's full potential in regards to design optimization (the best design objectives); it is necessary to further explore any barriers that prevent its multi-purpose. There should be an improvement in engaging with both public officials and communities where activities or discussions fit the modern time. Ideally, this would produce innovative ideas and designs to reach design optimization. Designs should then focus on social aspects in regards to opportunities for recreational activities in green infrastructure spaces that temporarily store rainwater, serving two functions. Equally important, green infrastructure would still serve its core duty of stormwater management and be both a cost-effective and multipurpose strategy that

mimics the natural land managing rainwater impacts with social and environmental benefits. The functions between storing rainwater and recreational activities also provide an improvement in educating the public about environmental quality and urban spaces with long-term planning. This research conducts a methodology that involves experience from those who encountered the process of urban green infrastructure planning.

### CHAPTER 3: RESEARCH METHODOLOGY

### Phenomenological Principles

This research report "is more of an approach, an attitude, an investigative posture with a certain set of goals" (Hycner, R, 1985, p. 279). "It is presented more as an attempt to sensitize the researcher to a number of issues that need to be addressed in analyzing interview data rather than as a "cookbook" procedure" (Hycner, R, 1985, p. 280). The phenomenological method was chosen as an investigative posture in identifying barriers to using urban green infrastructure. In addition, to reveal approaches to incorporate multipurpose programming in designs that fit the needs of the environment and the people, emphasizing on ecological and social aspects. Contrary to the many methods that exist. This method describes live experiences such as interviews, rather than explaining it. Phenomenology focuses on the experiences from the perspective of participants whereas the methodology does not speak about a hypothesis or preconceived ideas about the data results. In general, this methodology creates less structured and more open-ended questions to promote the respondents to share value information regarding their experience with urban green infrastructure.

Preceding this method, literature reviews related to stormwater and green infrastructure implementation were thoroughly analyzed. Selective readings were valuable information towards defining urban green infrastructure and its barriers, revealing the opportunities of social aspects. In addition, the survey interviews in this

research had specific questions related to urban green infrastructure and its implementation process. Also, the results from respondents remained a phenomenon of perspectives and perceptions from those who actually experienced the situation of interest. This approach sets aside biases and preconceived assumptions about urban green infrastructure; with the data collected there is an attempt to identity a generalization among all respondents of the phenomenon and how it is perceived.

### Research Questionnaire

The intent of this research was to recruit and conduct a 30-minute interview style survey with at least 5-10 mid-level experienced public officials in urban planning and designing within municipality areas. The interview questions are an effort to provide insight for citizens and government officials concerning urban green infrastructure. The intent of the set of open-ended questions determined valuable feedback regarding public officials defining urban green infrastructure and how it is used. In addition, to find out how public officials engage with communities, and what actions are being done to improve its implementation, etc. These questions set a focus of perceptions related to urban green infrastructure through high appointee public officials who plan its implementation. Furthermore, the results collected in the phenomenological method allows for identifying preconceived beliefs, keeping an open-mind of the phenomenon and immerse in the study. This method also helps analyze the data and develop common themes amongst all respondents and understanding the data results to define

the phenomenon in order to communicate it to others (Grand Canyon University. Web).

More importantly, the feedback from respondents is considered the general meaning

and then analyzed into units of relevant meaning - themes amongst all respondents.

## Questionnaire

## Public Officials In-person Survey Interview

- 1. Who are the key decision makers?
- 2. What are the techniques and methods used to engage with communities?
- 3. In what manner do local officials emphasize social and environmental values?
- 4. How would you define urban green infrastructure?
- 5. Do you think urban green infrastructure is suitable in the Metro Detroit Area? Explain
- 6. Do you think urban green infrastructure is compatible with social activities? Explain
- 7. Which community groups would be more comfortable with urban green infrastructure? What community groups would be less comfortable with urban green infrastructure? Explain
- 8. Are there any actions being proposed to enhance maintenance and monitoring of urban green infrastructure?
- 9. How would you define successful urban green infrastructure implementation?

## CHAPTER 4: DATA RESULTS

## Units of General Meaning

### Who are the key decision makers?

### Respondent #1

Stated the key decision maker(s) are municipal departments such as water and sewer department(s) to meet with group/agencies and private property owners/businesses/universities to discuss green infrastructure implementation.

# Respondent #2

Detroit Water and Sewer Department, Building, Safety Engineering, and Environmental Department, the Mayor's Office are responsible for the implementation of green infrastructure with efforts of creating policies and regulations. In addition, people who hold investments are involved in key decision making.

### Respondent #3

The general public's (participants) knowledge of green infrastructure before implementation is essential in guiding decision making, but also the decision makers must search for funding.

### Respondent #4

Stated the mayor is usually hands-on in implementing green infrastructure as well as approval for funding to support implementation. On the other hand, city councils play a part in making key decision making.

<sup>1</sup>The key decision makers are high position appointees within Detroit Water & Sewer Department (DWSD).

### Respondent #6

Key decision makers in implementing green infrastructure are government officials in departments responsible for design aspects such as the General Services Department (GSD) – Landscape Design Unit (LDU) with the support from capital funding.

## What are the techniques and methods used to engage with communities?

## Respondent #1

<sup>2</sup>Stated the educational aspect within partnerships and communities do a great job emphasizing community values. <sup>3</sup>This technique persuades activities for programs that have an everyday use; bridging the gap of opinions between public officials and communities.

## Respondent #2

<sup>4</sup>Workshops implemented within City of Detroit departments are great ways of engaging with communities where justifying details for community needs and adapting to the environment is valuable. Other techniques/methods are to provide resources (financial and technical) to communities explaining expectations.

Meetings involving focus groups that result in forums. <sup>5</sup>A technique/method is to host public events that are informative, and influential by making sure information and visual preferences are a high priority.

### Respondent #4

<sup>6</sup>Stated that public officials engage in multiple community meetings where communication is valuable to reveal problems and improvements that need to be approached.

## Respondent #5

<sup>7</sup>Techniques and/or methods are related to community meetings evolved around planning for future development where live poll readings (votes) are created. <sup>8</sup>This technique/method helps to understand how to connect and persuade green infrastructure at various scales.

#### Respondent #6

Techniques and/or methods can be considered as making sure future plans are secured before meeting communities; meeting focus groups and <sup>9</sup>providing valuable information such as a fact sheet. Furthermore, providing activities that include photos and precedent images to engage with communities have an outstanding outcome. <sup>10</sup>Building relationships and having frequent visits to communities make a difference.

# In what manner do local officials emphasize social and environmental values? <u>Respondent #1</u>

Stated tackling neighborhood benefits and green infrastructure techniques related to sustainability is a must. <sup>11</sup>Community feedback is vital for potential programs that have everyday use and investing in partnerships helps encourage community givebacks.

### Respondent #2

Local officials point out values that are high priority such as long-term investments, reducing cost (drainage charge to a property), saving homes and providing safety. <sup>12</sup>In addition, being aware that committing to other needs besides immediate needs is important.

### Respondent #3

<sup>13</sup>Stated ordinances that follow regular outcomes such as cost are favorable in communities through residential and water programming interactions.

### Respondent #4

<sup>14</sup>Local officials have been trying to distinguish social and environmental values, but values depend on the type of project and/or objective.

### Respondent #5

Local officials' emphasis on social and environmental values by <sup>15</sup>supportive funding for green infrastructure projects that relate to solving environmental and social issues such as blight and stormwater.

<sup>16</sup>In the manner of local officials emphasizing on social and environmental values, they first must follow policies to provide social and environmental benefits that fit specific projects.

## How would you define urban green infrastructure?

## Respondent #1

Stated urban green infrastructure is natural systems that relate to environmental issues

and social aspects (public space) that eliminate single use such as gray infrastructure.

## Respondent #2

Urban green infrastructure is basically defined as green stormwater infrastructure.

## Respondent #3

<sup>17</sup>Urban green infrastructure can be defined as appropriate stormwater tools in connections to the environment having strategic goals that focus on contrast areas and programming.

## Respondent #4

Stated urban green infrastructure mostly consists of bioswales and temporary places or areas for storing stormwater.

## Respondent #5

<sup>18</sup>Urban green infrastructure is defined by infrastructure systems that handle stormwater and solve environmental aspects.

Green infrastructure can be described as simply a stormwater feature improving drainage or stormwater management.

# Do you think urban green infrastructure is suitable in the Metro Detroit Area?

## Explain

### Respondent #1

Yes, because the Metro Detroit Area in relations to climate and how the urban area is adaptable to changes shows how suitable Detroit if for implementing urban green infrastructure. Overlaying Detroit's existing systems (natural and built) provides an option to be suitable for long-term investment opportunities.

### Respondent #2

Yes, in the Metro Detroit area existing spaces have flat surfaces so green infrastructure is suitable in Detroit which is key in using systems to control stormwater and the Great Lakes that rising; <sup>19</sup>demonstrating the importance of keeping systems clean.

## Respondent #3

Yes, a team effort focusing on residential benefits and cost-effective (investments). <sup>20</sup>Suggesting social impacts, connectivity, and long-term planning emphasis on social and economic development. Approaching from Olmstead's perspective at large scales greatly supports its function.

Yes, urban green infrastructure is suitable in the Metro Detroit Area especially with Detroit having combined sewer systems. The purpose of urban green infrastructure in this particular situation is to keep polluted wastewater out of rivers and Lake Erie.

## Respondent #5

Yes, urban green infrastructure is suitable in the Metro Detroit Area because of the various land mostly vacant to transform /adapt to green infrastructure and/or manage stormwater. Now there are more opportunities for development.

## Respondent #6

Yes, urban green infrastructure is suitable in the Metro Detroit Area because of its permit mandate. Detroit has a lot of opportunities with the access land available for future planning of green stormwater infrastructure.

## Do you think urban green infrastructure is compatible with social activities?

## Explain

## Respondent #1

Yes, because the urban green infrastructure is also a response to enhance a place/space wherein dense urban areas green infrastructure can be looked as an opportunity to access social settings.

Yes, the act of creating and maintaining green infrastructure is possible with green spaces. <sup>21</sup>Implementing spaces embedded within the natural land that share shows that urban green infrastructure is compatible with social activities.

### Respondent #3

Yes, urban green infrastructure is compatible with social activities which emphasis on the context of the landscape. Concerns are engineers and groups with very little knowledge of green infrastructure.

## Respondent #4

<sup>22</sup>Yes, urban green infrastructure is compatible with social activities; with the use of multi-purpose tools/programs to assist with social activities is a major component in implementing urban green infrastructure.

## Respondent #5

Yes, urban green infrastructure is compatible with social activities because there are various opportunities for green spaces to be incorporated with green infrastructure especially in communities that are unaware of the opportunities presented to them.

### Respondent #6

Yes, urban green infrastructure is compatible with social activities, but it has to be <sup>23</sup>project specific and fit the needs of what the project objective is; keeping in mind of passive programming and planning green infrastructure around those programs for safety purposes.

Which community groups would be more comfortable with urban green infrastructure? What community groups would be less comfortable with urban green infrastructure? Explain

### Respondent #1

There are not necessarily groups who feel more/less comfortable, but age groups both youth and seniors that are. <sup>24</sup>Youth involvement is heavily considered in being more comfortable. The youth are the future in which they are the ones who become beneficial towards green infrastructure implementation.

### Respondent #2

Seems as though a majority of people are comfortable with the implementation of green infrastructure besides the people in poverty areas who focus on immediate needs rather than other important needs such as programs serving multiple benefits.

### Respondent #3

A challenge for groups that do not have a major drive to make a difference. <sup>25</sup>Groups having a misinterpretation of what's going on at a large scale. People with the most experience usually are the most comfortable and do the most planning and implementing.

Community groups that are familiar with natural features in neighborhoods are more comfortable with the implementation of urban green infrastructure. People of less comfortability tend to not know of understanding green infrastructure or its benefits, or do not care.

### Respondent #5

Local focus groups who are concerned about issues are more comfortable with urban green infrastructure such as developers that have an expertise. <sup>26</sup>The youth is a strong focus group who are willing to make or adapt to green infrastructure. Elderly people are more concerned about kids/youth safety than anything else in which they less comfortable with green infrastructure.

### Respondent #6

There are a lot of community groups that are comfortable with green infrastructure, but some groups (focus groups) need a history of building trust with public/local officials that are responsible for implementing green infrastructure.

Are there any actions being proposed to enhance maintenance and monitoring of urban green infrastructure?

<u>Respondent #1</u> Yes, there has been funding that supports monitoring of green infrastructure. Monitoring matters to a certain extent and becomes more in-depth in relations to the context of drainage.

<sup>27</sup>Yes, there are stages of planning, implementing, and finding/exploring solutions to maintain and monitor urban green infrastructure.

## Respondent #3

Yes, pilot programming is in effect for credit billing, DWSD – churches. There are actions in committing to Geographic Informational System (GIS) features truly focusing on maintenance and monitoring strategies.

## Respondent #4

Yes, DWSD emphasis on the importance of maintenance and monitoring of urban green infrastructure. As far as proposed actions, contractors are responsible for maintaining and monitoring green infrastructure systems.

### Respondent #5

Yes, actions are being proposed to enhance maintenance and monitoring. For example, commercial corridors are becoming a constant deal of taking on that task as well as the General Services Department (GSD) and Landscape Design Unit (LDU) following plans of enhancing green infrastructure.

## Respondent #6

<sup>28</sup>Yes, providing a contract portion requiring maintenance and monitoring for a certain duration is highly suggested as well as a long-term plan for vegetation restoration.

# How would you define successful urban green infrastructure implementation?

### Respondent #1

Successful urban green infrastructure implementation involves community embracing designs, beautification, and ability to communicate multiple needs as well as having the community figuring it out if this system matters.

### Respondent #2

Successful urban green infrastructure implementation can be defined as implementation in being well maintained and provides a long-term success. Also, explaining demonstrations of green infrastructure should be easy to comprehend.

### Respondent #3

Stated green infrastructure performing its water duties and following appropriate landscape forms as well as respecting implementations is defined as successful urban green infrastructure. <sup>29</sup>Culture aspects/characteristics related to stewardship, social interactions, safety habits fall under the branch of successful green infrastructure implementation.

### Respondent #4

Successful urban green infrastructure implementation means a project is designed well enough <sup>30</sup>to do what its designed to do; storing stormwater in functional spaces, but also being aesthetically pleasing.

Green infrastructure is successful when used as a tool and/or used for programming that has a functional purpose. <sup>31</sup>In addition, creating amenities in communities that support the public realm as well as green infrastructure being cost-effective.

### Respondent #6

<sup>32</sup>Urban green infrastructure implementation is successful once met permit obligations and providing community benefits as a whole; providing a cleaner & alethically pleasing environment.

## Conclusion

From the respondents' feedback follows the analyzed portion into units of relevant meaning - themes amongst all respondents. These themes include effective community communication (how people send and receive information), prioritizing community needs, and effective community communication (expressing one's feelings about things), which then ties into the discussion topics identified through the entire research.

### **CHAPTER 5: DISCUSSION**

#### Overall

A survey interview style approach was conducted and analyzed to understand the characteristics of green infrastructure in an urban setting. The results present valuable data that reveals and illuminates the research statement, identify barriers to using urban green infrastructure. In fact, the knowledge of urban green infrastructure implementation is a broad beneficial method. This method expresses the various benefits it offers to both the people and planet where environmental and social aspects have different meanings amongst public officials and its communities. However, this is a discovery of the shared benefits amongst public officials, and the communities despite their different meanings of urban green infrastructure implementation. A collaborative effort between public officials and communities can led to common goals and multiple benefits of urban green infrastructure implementation. When in fact urban green infrastructure in "frames" (Opdam, P, et al. 2015, p. 227) defined as a multipurpose strategy can be identified by the multiple benefits. Those frames are: "1) a recreation frame (a specification of the social-cultural frame), where green infrastructure contributes to the attractiveness of the landscape and its species representing socialcultural services; 2) a water-regulation frame (a specification of a sustainability frame), where green infrastructure contributes to the management of water, representing regulation services and 3) biomass-production frame (a specification of the economic

frame), where green infrastructure contributes to the production of biomass, representing the production services" (Opdam, P, et al. 2015, p. 227). These frames set objectives for projects for their particular purpose once determined.

Public officials within the government departments are usually responsible for being key decision makers in implementing urban green infrastructure as well as stakeholders. For example, during a timeline of a project, communication is expressed between communities, stakeholders, or other focus groups in regards to urban green infrastructure planning. With the continuous growth of green infrastructure, specific actions are being proposed based on trial and error demonstrations. Green infrastructure demonstrations such as the commonly used green infrastructure practices, implement with the intentions of building knowledge and new potential approaches as well as programming for future designs. An advantage could be designed optimization where landscape architects, urban designers, and planners avoid doing the bare minimum in designing urban green infrastructure including the efforts of improving the engagement with communities. It is best to design multipurpose green spaces of urban green infrastructure because its implementation would result in enhancing long-term goals such as reduced flooding for sustainability and improved cultural characteristics (social givebacks).

This research reveals that effective and affective communication are major keys during the design process of implementing urban green infrastructure because of its

various meanings. Communication is essential for having a mutual understanding of urban green infrastructure implementation in a way where all suggestions are incorporated somehow through its specific objective(s). Whereas building the knowledge of urban green infrastructure is not only for those making the decisions but for the public officials' knowledge as well. Green infrastructure is often misinterpreted so engaging with communities is guite a challenge. In order to decrease community pushback, techniques and methods that are used to receive valuable feedback have to be effective. Focus groups vary depending on the type of subjects you are dealing with in public meetings. In determining how to effectively receive valuable information, it is necessary to conduct activities that relate to a particular focus group and using the potential concepts of a specific project to engage. Also, it would allow communities to see examples of urban green infrastructure and present any questions unanswered. There should be opportunities for the communities to get involved in the planning process of urban green infrastructure so that they can feel as though they have had an equal contribution to their neighborhood. Knowingly, there will be perceptions from public officials and communities where urban green infrastructure has a variety of benefits. "This means that the planning and design of the environment must be multifunctional to benefit and respect economic, ecological, aesthetic, and cultural considerations" (Burley, J., et al. 2011, p. 46). On the hand, analyzing the feedback from public officials through the survey interviews showed distinguishing themes amongst all

respondents. From the interviews, there are determining themes extracted from the data: 1) Effective Community Communication, 2) Prioritizing Community Needs, 3) Affective Community Communication.

## Units of Relevant Meaning

## Effective Community Communication

<sup>19</sup>The importance of green infrastructure is to manage stormwater and keep systems clean <sup>21</sup> with the intentions of creating and maintaining green infrastructure when planned to embed natural land with shared activity spaces. <sup>1</sup>Initiating this urban green infrastructure process starts from the approval and supportive funding from public officials within departments such as the Detroit Water and Sewerage Department (DWSD), General Services Department (GSD) – Parks and Recreation, Planning and Development Department (PDD) and the Mayor's office. <sup>11</sup>Urban green infrastructure implementation involves intense communication between public officials and communities where community feedback is vital <sup>3</sup>to persuade activities for programs that have an everyday use which can result in bridging the gap of the misunderstandings between both groups. <sup>4</sup>In doing so workshops to engage with communities are necessary to justify specifics or details, resources (funding), and expectations of urban green infrastructure implementation. This technique serves as an investment <sup>2</sup>by creating partnerships that emphasize community values and realizing that the <sup>24</sup>youth are the ones most comfortable for future planning in urban green

infrastructure implementation as they are the future. Effective community communication in this instance is the ability to help people understand what green infrastructure is and how it works in urban settings.

## Prioritizing Community Needs

<sup>12</sup>On the other hand, urban green infrastructure should commit to important needs and not immediate needs with <sup>27</sup>planning actions of maintaining, finding and exploring solutions for successful green infrastructure implementation. <sup>26</sup>Communtiies willing to adapt to appropriate green infrastructure tools only if they <sup>17</sup>commit to strategic goals that focus on contrast areas and programming. <sup>25</sup>Those goals have to be constructed by engaging with communities through activities that eliminate the misinterpretation of what urban green infrastructure does and <sup>13</sup>its outcomes through residential and water programming interactions. <sup>5</sup>Whereas proposed activities should keep informative and visual preferences together; <sup>29</sup>responding to cultural characteristics related to social aspects and stewardship while making sure urban green infrastructure does its core duties. Green infrastructure <sup>20</sup>core duties which are not limited to social impacts, connectivity, and long-term investments such as cost. The various opportunities of urban green infrastructure can lead to <sup>18</sup>solving social, economic, and environmental aspects, but the first step is for public officials to discuss <sup>8</sup>the importance of how to connect and persuade green infrastructure at various scales within communities <sup>31</sup>by creating new amenities in neighborhoods that support the

public realm. <sup>23</sup>Projects implementing urban infrastructure must keep in mind funding criteria, permit obligations, project specifics, and fit the needs of what the project objective is as well as considering passive programming. <sup>16</sup>This action would provide social and environmental benefits for every project emphasizing on social and environmental benefits for every project emphasizing on social and

### Affective Community Communication

Furthermore, <sup>32</sup>in order for urban green infrastructure to be successful future planning led by government officials have to meet permit obligations. <sup>10</sup>Following that priority is engaging with communities through activities and building relationships which helps generate valuable information that can be put forth in implementing urban green infrastructure. <sup>9</sup>For example, providing a fact sheet from previous projects as a stepping stone <sup>28</sup>in enhancing environments not limited to maintenance and monitoring or <sup>7</sup>providing live poll readings related to urban green infrastructure implementation and how to use the <sup>15</sup>supportive funding to solve environmental issues such as blight and stormwater. <sup>6</sup>The constant community engagement from city councils before implementing urban green infrastructure is essential in addressing problems. The idea is to make improvements <sup>30</sup>to do what it is designed to do, store stormwater in functional spaces as well as create <sup>22</sup>multipurpose programming to assist with social activities. Not to mention, sometimes <sup>14</sup>social aspects are a higher priority than environmental values upon project types and objectives. Affective community communication in this instance would express methods that lead to the planning of urban green infrastructure.

### Urban Green Infrastructure System

Urban areas have a very complex structure made up of mobility, water, habitats, and communities called compound parts which are sensitive to design because they change over time. However, these compounds are a part of life with various benefits and negative impacts. To understand the duties of urban green infrastructure, designers must allow everyone in a community to grasp the concept of green infrastructure implementation, where both the natural land and built systems promote social and environmental benefits. Meaning to create a vision for future urban green infrastructure as a route to sustainability and a vision for the world. Furthermore, natural and built systems are another form of classified systems. Natural systems can be referred to as a system that operates independently of human encountering and conserves its ecosystems values and provided associated benefits to human populations such as water quality. On the other hand, built systems are human engineered and are commonly constructed to move supplies of water into the city and out for water resources. Integrating these two systems would create something called, green infrastructure. Green infrastructure is responsible for social and environmental benefits through design efforts that link networks of open space and natural areas. The components of green infrastructure can refer to 1) community open space system, 2)

habitat system, 3) the hydrological system, 4) active transport system, and 5) the metabolic system (Rottle and Yocom, 2010).

1) "The community system is comprised of the diverse public open spaces that improve livability and connect people to one another and the places where they live. Included in this system are parks, plazas, markets, recreational spaces, civic art and the public of the street. Such spaces can contribute to physical, mental and community health, and make residing in dense urban contexts attractive. 2) The habitat system addresses the ecological preservation and restoration of functioning habitat to support urban wildlife and provide human contact with nature. Elements include urban forests, wetlands, streams, restored shorelines and even backyard wildlife gardens. Cities are often located in critical habitat areas, such as river estuaries, and are part of larger environmental systems, such as riparian corridors, and the flyways of migratory birds" (Rottle and Yocom, 2010, p. 49). 3) Water plays a major role on this planet we call, "earth" these components create a solid foundation in urban environments to use natural processes that provide ecological services while promoting the health of humans in their related environments. 4) Current road systems "impact waterbodies, wildlife & the public realm but active transport systems provide opportunities for alternative modes of transportation such as biking and walking. These active modes tend to have fewer associated environmental consequences while enhancing the physical and mental health of users and often promoting strong social connections. Not to mention, the

connectivity that supports the active transport is considered a system of green infrastructure in regards to street design that provide facilities for bikers and pedestrians" (Rottle and Yocom, 2010, p. 52). 5) A platform for integrating systems must promote a metabolic system in regards to sustainability. "The metabolic system encompasses the processes and elements that provide energy, nourish populations, neutralize toxins and transform waste into turbines, micro-hydro, biogas digesters, and local solar production" (Rottle and Yocom, 2010, p. 53). This system could possibly change the way land-uses were once used by remediating urban brownfields. On the other hand, it is mindful to analyze previous projects to determine future urban green infrastructure implementation that seeks longevity. Green infrastructure has a stigma of only managing stormwater but exploring designs beyond just solving the main problem would be most effective. In addition, metropolitan areas should consider committing to new codes and regulations since the use of urban green infrastructure has continued to rise in development.

## Urban Green Infrastructure Multipurpose Design

This study focused on urban areas and its relations to implementing green infrastructure. Ideally, this research discovers the approaches of green infrastructure in urban areas by incorporating multipurpose programs designed to fit the needs of the environment, as well as the people. Let's not forget, urban green infrastructure is both a cost-effective and multipurpose strategy that mimics the natural land managing

rainwater impacts with social and environmental benefits in relations to people and the planet.

It is important to learn from existing projects demonstrating green infrastructure. Past projects have given us the knowledge to enhance and incorporate innovative ideas in urban settings. One of the main core duties of green infrastructure is stormwater management. Other benefits such as hands-on educational opportunities, reducing maintenance costs (roads and other infrastructure systems), community givebacks (recreational opportunities and social interactions), and a clean environment help show that urban areas have an opportunity to flourish. These opportunities and benefits are a majority of the time left out of urban green infrastructure implementation, especially social aspects. Urban green infrastructure serves its core duty of stormwater management but also has an opportunity to integrate human activities as well.

Long-term planning, aims for initial projects to show short-term wins to change public opinions. A question may occur as to, why now? Urban areas cannot afford to wait to act on long-term planning with rainwater impacts changing our landscapes. For instance, short-term visions can have immediate success such as building support from communities and investors. In doing so, pilot programs are a starting point in creating innovative ideas that focus on urban green infrastructure multipurpose programming. The most effective way to take on a project of urban green infrastructure implementation is by identifying the project type and objective then determining what

design(s), needs, and ecosystem services to address. Barriers to using urban green infrastructure can be reduced by altering people's perspectives through sensitive designs, emphasizing values in communities that have multiple benefits. This process is important because this builds a foundation towards successful urban green infrastructure and "inform practitioners on crucial aspects in the design of planning process from a social-ecological perspective" (Hansen, R. and Pauleit, S. 2014, p. 517).

### Conclusion

The overall process to design for environmental justice correlates with the implementation of urban green infrastructure. It is necessary for urban green infrastructure implementation to provide public education and participation for people to embrace the opportunities that come with it, supported by public officials and environmental groups. Urban green infrastructure is a fascinating approach that has numerous benefits, but one of the most important aspects missing from its implementation is social givebacks (recreational opportunities and social interactions). Green infrastructure has to commit to urban settings, where cities would manage rain-related occurrences, as well as social and environmental characteristics through innovative designs. This response would then advance the values and functions of its implementation. However, urban green infrastructure faces many barriers. These barriers include: misinterpreting the term, support, policies, maintenance, and performance objectives. In response to these barriers, public officials should use affective and

effective communication (the ability to express and transfer understanding) among communities to prioritize needs. A mutual understanding of what green infrastructure has to offer in an urban setting is beyond just solving one problem like stormwater management. Social and environmental aspects intertwine here on earth and are a part of our system. To enhance these aspects equally, integrating green infrastructure in urban settings must plan on preserving cultural characteristics which may potentially create a culture shift in the way we live. This strategy would amplify design optimization to maximize multipurpose programming in serving both the people and the planet.

According to the literature reviews and the interview style surveys conducted, most studies on green infrastructure mainly focused on stormwater management and its connections with ecosystem services. Additionally, there is a curiosity of investing in urban green infrastructure where "recreational environments that enrich the social and aesthetic nature of a city" (Hough, M. 1989, p. 240) presents a principle of diversity. "Urban environments then become apparent when it is seen as an ecological context, which involves connections with other resources. This implies a management strategy that will integrate and link the various resources of a city, and exploit their environmental social benefits" (Hough, M. 1989, p. 242). In this study, urban green infrastructure is not only analyzed for its influence of stormwater management but other beneficial aspects as well such as social givebacks of recreational opportunities and social interactions. These beneficial aspects are related to social and cultural patterns in urban areas. Social and cultural patterns define the urban green infrastructure for what it serves. For example, the creation of rain-basins (a function of temporarily storing rainwater) collecting rainwater then during dry weather open spaces or sports programming are in use along with other functions. This example describes integrating innovative programming that designers use to improve the knowledge of how and why spaces operate. There are various opportunities for green infrastructure projects to be implemented in urban areas because of the advantage of evolving landscape forms in cities. Green infrastructure being such a diverse function, it has become adaptable towards many aspects of delivering environmental and economic benefits but most importantly social benefits with cultural characteristics. Urban green infrastructure is believed to play a key role in sustainability and revitalization in urban areas. As a result, all interpretations of what urban green infrastructure is; can manifest into all that it can be because all interpretations are true. In this research, urban green infrastructure is expressed for its importance of managing stormwater but also identifying and eliminating barriers with a more a comprehensive approach. Although there are limitations, my thesis can generally provide useful information and potential steps in enhancing green infrastructure in urban areas as well for future research.

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