

Meadow Creek Stormwater Management Plan

Analysis of the Sociotechnical Effects of Urban Greening in Washington, D.C.

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On my honor as a University student, I have neither given nor received unauthorized aid on this assignment as defined by the Honor Guidelines for Thesis-Related Assignments.

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Introduction

A Green City and Social Injustice, a book that discusses urban greening and social injustice in Washington, D.C., states the following startling quote, “Washington, DC is one of the most intensively gentrifying cities in the United States, but gentrification and displacement are not homogenous across its landscape” (Anguelovski et al., 2021). As global climate change continues to worsen, urban areas are working toward greening cities in hopes of a better environment, but are running into unintended consequences. In her presentation of Sustainable D.C., a sustainability plan for the Nation’s Capital, D.C. Mayor Muriel Bowser stated, “My vision is to make the District of Columbia the healthiest, greenest, most livable city for all District residents” (Benjamin, H. 2021). Urban greening involves introducing green technology, such as green infrastructure (GI), sustainable transportation and energy, and permeable areas. These green initiatives lead to positive outcomes in terms of climate change, but they lead to negative social impacts in the community. As the popularity of green initiatives increases, they become more desirable in communities. Greening combats climate change, but also creates disparity in the society. Areas become greener, but the greening results in the marginalization of certain groups. This idea is known as green gentrification, for the implementation of green technology leads to specific people groups being displaced or marginalized. The sociotechnical portion of this paper will explore how green technology affects Washington, D.C.

Past mistakes, regarding green gentrification, are learning opportunities for future design, for all areas that undergo greening risk creating division in the society. In Charlottesville, VA, Meadow Creek Watershed is currently in despair. Specific areas are in need of stormwater GI to collect pollutants, handle greater water loads, and remain resilient against climate change. The technical deliverable includes analyses of the current conditions, a redesign of a Charlottesville

parcel affecting the creek, and the impact that climate change will potentially have on the redesign. Technical and societal components must be addressed together to avoid further negative effects of green technology.

Meadow Creek Watershed Stormwater Management Plan

Meadow Creek, a waterway in Charlottesville, VA, is ecologically impaired due to an excess of nitrogen, phosphate and sediment entering the stream from surface runoff. The impairment requires total maximum daily load management (Virginia Department of Environmental Quality, 2020). Large amounts of impervious surfaces within the watershed create conditions optimal for fast moving runoff that carries pollutants and deteriorates downstream stream banks. According to Müller (2020), pollutants enter the watershed through a combination of atmospheric deposition and anthropogenic practices that introduce sediment, nitrogen, phosphorus, and a host of other substances onto the land surface. As the Charlottesville community continues to develop, the increase in impervious surfaces and decrease in vegetation creates more strain on Meadow Creek to filter and manage stormwater runoff. Climate change will also affect stormwater runoff because as temperatures change and storms become more frequent and intense, the amount of water flowing will increase, therefore increasing pollutant loads.

The health of the Meadow Creek is vital because it eventually flows into the Chesapeake Bay. The Chesapeake Bay is the largest estuary in the United States and is between the Mid-Atlantic region and Delmarva Peninsula, eventually opening into the Atlantic Ocean. The Chesapeake Bay is home to a plethora of unique animal and plant species. Additionally, the Bay serves as the primary source of income for many people, through fishing, boating and the presence of seaports. The Chesapeake Bay is in ecological despair due to impairments further

upstream. The impairments put the lives of many plants, animals, and humans at risk and could lead to the collapse of an entire watershed and associated ecosystems. The project team plans to address these upstream issues in the senior design capstone project.

Taking several factors into consideration, the Fashion Square Mall was chosen for a redeveloped stormwater management design.

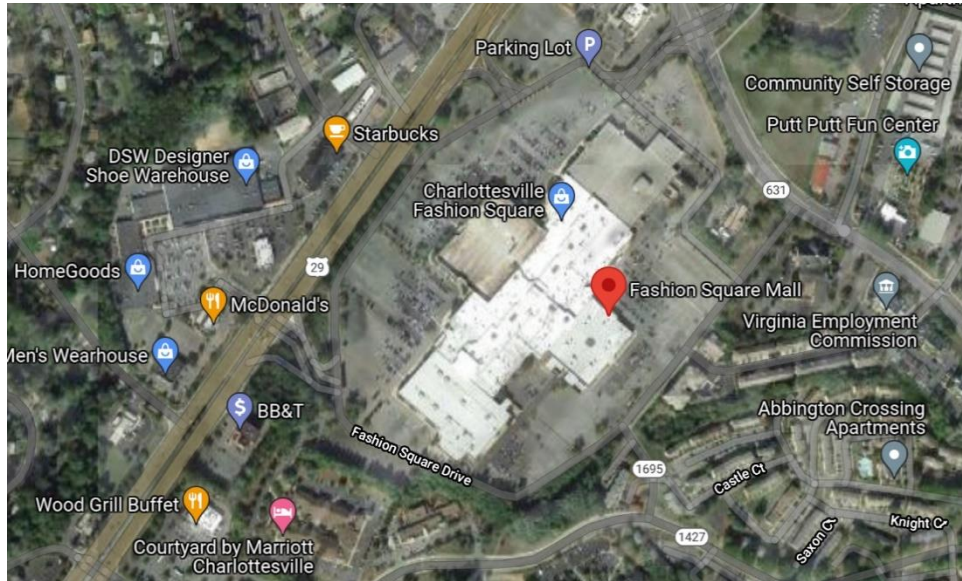


Figure 1. Google Maps Aerial Photo of Fashion Square Mall in Charlottesville, VA (Google, n.d.)

The Fashion Square Mall is located within the Meadow Creek watershed, directly off of Route 29 and approximately 5 miles from the University of Virginia, as seen in Figure 1. In June 2021, the mall owner filed for bankruptcy, and it was auctioned off to Charlottesville JP a month later (Hirschheimer, 2021; Hammel, 2021). With the new ownership, the mall is expected to be redeveloped, so the team took this opportunity to create a redesign that met the stormwater management needs of Meadow Creek.

A key component of the team's stormwater management design at Meadow Creek is the inclusion of green infrastructure (GI), a method of integrating nature into the built environment through the placement of vegetated land and structures such as rain gardens, bioretention ponds, and green streets. GI is recognized for its ability to conserve natural environmental systems and

provide a variety of ecological benefits including water quality improvement, air temperature reduction, and habitat provisioning (Gagne & Tayouga, 2016, p. 1). GI is particularly beneficial for stormwater management since it provides a method of naturally percolating and irrigating stormwater runoff before it is discharged into downstream water bodies. Additionally, green stormwater infrastructure controls excessive outflow by using precipitation to hydrate vegetation. For instance, green roofs can retain between 5 and 100 percent of rainfall (Gagne & Tayouga, 2016, p. 2). The goal of integrating GI into the stormwater management design of Meadow Creek is to reduce the impervious surface on which runoff travels, therefore reducing pollutant pickup and improving the water quality in the watershed. The team will decide what GI to add to the design with the help of stormwater management modelling.

The second key component in the team's design is a climate change analysis. As climate change worsens, storms grow in intensity and frequency. Over the past few decades, the Chesapeake Bay Watershed has faced an abundance of extreme weather events. In 2019, the watershed experienced a historic amount of rainfall and flash floods. The watershed is projected to have an eight to twenty percent increase in events that produce extreme precipitation by 2099 (DeGaetano et al., 2021). The team plans on evaluating how the GI design will be affected by potential extreme weather events in the future. Additionally, they plan to evaluate how the GI will potentially alleviate other side effects of climate change, for example, the urban heat island effect, which refers to the "phenomenon where temperature in urban areas is higher than that in rural areas" (Balany et al., 2020, p. 1). As climate change brings longer and stronger heat waves, urban areas grow warmer leading to health issues among the residents (US EPA, 2014). The GI design will incorporate design aspects that will lessen the heat island effect. The final deliverable

will be a proposal for the county with the redesign of the Fashion Square Mall parcel and the research and models that the team develops.

Analysis of the Sociotechnical Effects of Urban Greening in Washington, D.C.

The idea of environmental gentrification was introduced in the early 2000's in an economic review by Holger Sieg, V. Kerry Smith, H. Spencer Banzhaf, and Randy Walsh. Gentrification refers to the act of converting an area from lower to higher value while unintentionally pushing out lower socioeconomic class residents as a result (Malsin, n.d.). Green gentrification refers to the act of gentrification through green technology. The topic relevancy has grown in importance in recent years as Climate Change continues to worsen. Two effects that climate change has on urban areas are increased stormwater and the heat island effect. As climate change worsens, the intensity and likelihood of precipitation events increases leading to an abundance of rain runoff. Cities are full of impervious areas, such as concrete and asphalt, and the runoff cannot soak into these areas. The storm sewers collect water, but with precipitation amounts increasing, the sewers cannot always handle the amount of runoff leading to flooding and increased pollution in waterways. Green Infrastructure (GI) is a common solution for urban areas to alleviate climate change stresses on runoff. Similar to stormwater issues, the urban heat island effect is also affected by impervious areas. As climate change worsens, heat waves also grow in intensity and likelihood. A lack of green areas in a city leads to less shade, less moisture in the air, and more stress on buildings to cool their interiors (US EPA, 2014). Adding more green areas to a city provides climate change benefits as well as stormwater benefits. Though these strategies have their benefits, they also have their downfalls. In 2004, a study on air quality changes in communities coined the term "environmental gentrification". The study shows that as air quality was improved in an area, the cost of living significantly increased (Sieg et al., 2004).

The general trend seen with greening a city or area is that as green elements are added, the price of the area increases. This trend tends to marginalize certain people groups leading to wealthier populations moving in and less wealthy people groups being pushed out. This phenomenon is present in Washington, D.C.

The presence and effects of green gentrification in Washington, D.C. presents itself as a wicked problem. Wicked problems are problems that do not have an obvious problem definition or an easily implemented solution (Roberts, 2001). Green gentrification is a wicked problem as there is no apparent solution. It seems that the nature of the world will inevitably lead to gentrification when new technology is added to an area. Facing the problem as a wicked problem will help to form coping strategies. When looking at a city like Washington, D.C., there may not be an apparent solution, but there may be strategies that could help lessen the problem. Though the problem of green gentrification presents itself as a wicked problem, critics may argue that the wicked problem framework only paralyzes a problem making it harder to work toward solutions (Termeer et al., 2019). While examining the wicked problem and coping strategies, the green technology will be treated as a technological fix. According to Alvin Weinberg, an American Nuclear Physicist, “A technological fix is a means for resolving a societal problem by adroit use of technology and with little or no alteration of social behavior” (Weinberg, 1978). The green technology is a technological fix as it is made to solve a problem affecting the society, the effects of climate change, but the society does not have to change the way they are going about their lives as a result. Critics may say that urban greening is not a technological fix as it is successfully warding off climate change effects, but due to the nature of these technologies and the force of climate change, these technological fixes are simply bandaging up a problem until the next one appears.

Research Methodologies

Research Question: How does the presence of green technology affect the society of Washington, D.C.?

This research question will be analyzed using three methodologies: documentary resource method, discourse analysis, and historical case studies. The sources for the study will be gathered using document resource method. This will help to organize the sources into different uses such as background, evidence, arguments, and methods. Discourse analysis will help to show how people feel about the problem and will provide a variety of source options as the sources are not all academic papers, for example, a tweet about green gentrification could be used. This method brings the societal side of the problem into the paper as it is not all academic. The third research method is historical case studies. This method will help to provide a historical context for Washington, D.C. and the topic of gentrification. This historical context will highlight the importance of the problem as the city is rapidly changing. Some key words in research include: gentrification, green gentrification, Washington, D.C., environment, and green infrastructure. The words highlight themes in the research question and result in a variety of related sources.

Conclusion

This paper discusses the stormwater management redesign and climate change analysis of Fashion Square Mall in Charlottesville, VA as well as the sociotechnical analysis of green technology in Washington, D.C. The team will use different modeling tools to analyze the stormwater management practices at the site and create a redesign using GI. They also plan to analyze the effects of climate change on the redesign as well as how the redesign alleviates climate change effects. The team expects that the stormwater redesign will lessen pollutants and volumes of water entering the stream, adapt to future climate change predictions, and positively

affect the community. Additionally, this paper discusses the sociotechnical effects of green technology on Washington, D.C. Green technology positively affects the society by lessening the effects of climate change in urban areas, but it also negatively affects the society by aiding in gentrification. The negative effects tend to marginalize specific people groups in the city. The analysis will discuss the wicked problem nature of urban greening, how the technology acts as a technological fix, and coping strategies that deal with green gentrification in Washington, D.C.

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