Thesis Project Portfolio

North Grounds Stream Restoration Design

(Technical Report)

The Role of Urban Greenways in Creating an Equitably Resilient City Through An Examination of the Rivanna Trail Network in Charlottesville, Virginia

(STS Research Paper)

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Executive Summary

In the city of Charlottesville, a tributary of Meadow Creek has experienced significant degradation due to development in the surrounding watershed. The goal of this technical research is to conduct an assessment of the current state of the stream and create a stream restoration design aimed at restoring the natural stream ecosystem. The tributary of focus runs alongside the Rivanna Trail, an urban greenway network encircling the city. Forms of green infrastructure, like greenways, have emerged as a powerful tool to enhance the resilience of urban spaces and protect cities against the threats of climate change. While urban greenways are an important form of green infrastructure, disparities in use and accessibility persist across socioeconomic strata and racial demographics. Strategies to equitably implement greenways to ensure that their resilience benefits are distributed must be investigated. By acknowledging both the social and technical dimensions of green infrastructure, urban greenways and the streams that run through them have the potential to work towards creating resilient and equitable urban landscapes.

This capstone project was centered on analyzing two unnamed tributaries of a stream within Charlottesville's Meadow Creek Watershed. Increased urbanization in the area surrounding the site has altered the hydrology, resulting in increased runoff. Within the reaches of the stream, this has manifested in bank destabilization, stream channelization, and increased erosion. This affects not only the health of the tributary itself, but the overall health of the greater watershed. This project began with a comprehensive analysis of the existing stream conditions, which involved water quality monitoring, surveying of reaches and existing hydraulic conditions modeling in HEC-RAS and HEC-HMS, Results from testing and modeling went on to inform an AutoCAD design for restoration as well as post-restoration modeling to measure design success.

The resulting restoration design emerged in the form of a regenerative step pool conveyance system featuring energy dissipating pools and riffles. Design specifications, including riffle sizing, were informed by the standards of the Anne Arundel County Bureau of Watershed Protection & Restoration guidelines. Additional plunge pool and rock size specifications were determined using DEQ standards. Limitations to this process include human and tool error during surveying, as well as sample size and detection ranges in water quality sampling. Through the implementation of a Bank Erosion Hazard Index and hydrologic modeling of post-restoration conditions, our assessment reveals promising outcomes of significant reductions in sediment loading and shear stresses along both reaches. Our design aims to restore balance to the natural stream ecosystem, preventing further erosion and safeguarding the integrity of the stream for years into the future.

This thesis seeks to address the need for resilient urban green infrastructure in the face of the challenge of urbanization and a changing climate. Urban populations are expected to continue to grow rapidly, with the threats of climate change expected to further exacerbate inequalities in urban spaces. The use of green infrastructure to combat these effects is essential, however ways to implement them equitably is not fully understood. Urban greenways specifically have been a popular form of green infrastructure due to the number of both social and ecological benefits they provide. Through the investigation into literature as well as a case study of the Rivanna Trail network in Charlottesville, this thesis seeks to understand the strategies that can be employed to use urban greenways to create an equitably resilient urban landscape. Spatial analysis in GIS is employed to examine existing physical accessibility to the greenway.

The evidence from the literature review and spatial analysis reveals several key insights into equity and resiliency in the urban greenway planning and implementation process. The literature review emphasizes the existing patterns of disparities in green space access across socioeconomically and racially diverse communities, further revealing the need for an equity and environmental justice lens in greenway planning. Community engagement in the planning process emerges as a crucial aspect for promoting inclusivity and cultural representation in green spaces. The needs for funding distribution and equitable spatial planning to prioritize underserved populations is highlighted. Additional challenges of green gentrification are explored, as well as strategies to mitigate these effects. Overall, this thesis underscores the possibility that urban greenways planned with an environmental justice mindset could play in creating an equitable and resilient urban landscape.

The intersection of technical research in stream restoration design and the exploration of social equity aspects of green infrastructure highlight the need for a holistic approach to the design of urban green spaces. The perspectives offered from this research emphasize the potential of well planned and designed urban green spaces and waters to serve as a vital strategy in providing both social and ecological resilience benefits to urban spaces.