Analyzing the Effectiveness of Dubuque's Green Alley Reconstruction

School of Planning and Public Affairs
University of Iowa
MPA Capstone Project

Stephanie Gutierrez, Zachary Slocum, and Clara Tang

In partnership with

IOWA Initiative for Sustainable Communities

THE CITY OF DUBUQUE
Masterpiece on the Mississippi

IOWA School of Planning and Public Affairs

TABLE OF CONTENTS

LIST OF FIGURES

ACKNOWLEDGEMENTS

In collaboration between the School of Planning and Public Affairs and the city of Dubuque, a dedicated team of Master of Public Affairs students: Stephanie Gutierrez, Zachary Slocum, and Clara Tang conducted a policy analysis on the city of Dubuque's Green Alley Reconstruction Project. This project received guidance from Professor Haifeng Qian and Travis Kraus from the School of Planning and Public Affairs, as well as Jon Dienst, representing the City of Dubuque as our project partner. Special thanks to Professor Ja Young Kim, Professor Phuong Nguyen, and Professor Scott Spak, whose expertise played a pivotal role in conducting our comprehensive analysis.

EXECUTIVE SUMMARY

Every time it rains, millions of gallons of water that pour onto the ground must find a pathway, and not all of it can be absorbed by the soil beneath us. This runoff, which includes the water flowing off roofs, through yards, and along streets, is commonly known as stormwater runoff[1]. If there is no pathway for stormwater to flow, it can pose significant dangers to both urban infrastructure and natural ecosystems, leading to erosion, flooding, water pollution, and habitat degradation. Decisions-makers are tasked with determining effective strategies such as green infrastructure development to manage stormwater runoff within their communities. Some municipalities such as the City of Dubuque have adopted permeable paver practices.

Residential and commercial infrastructure within the Bee Brach Watershed has a vulnerability to repeated flash flooding from stormwater runoff during heavy rain events. With an area that has experienced six presidential disaster declarations with a total damage estimate of almost $70 million[2], the City of Dubuque responded with a Bee Branch Watershed Flood Mitigation Project. This plan is a multi-phased investment to mitigate flash flooding, improve water quality, stimulate investment, and enhance the quality of life within the Bee Branch Watershed.[3] The Green Alley Reconstruction Project is a facet of the Bee Branch Flood Mitigation Project and set out to convert impervious grey alleys into pervious green alleys. This transformation would reduce the volume of stormwater as pervious surfaces allow for water to permeate through the surface and seep into the soil below. Beyond mitigating flooding, these green alleys also capture pollutants from running to the storm sewer system and the Mississippi river. Construction of the alleys began in 2009 and to date 80 of the planned 240 green alleys have been completed, with the remainder scheduled for reconstruction between 2029 and 2040, their specific construction years yet to be determined.[4]

Our team was tasked with evaluating the effectiveness of the Green Alley Reconstruction Project thus far in its progress. Based on literature review and the purpose of the Green Alley Reconstruction Project, we choose four evaluation metrics. Our evaluation metrics include environmental sustainability, fiscal responsibility, economy, and equity. Within the evaluation metrics, a set of impact categories was utilized to assess the Green Alley Reconstruction Project. Based off our analysis, the Green Alley Reconstruction Project offers significant potential benefits for the community. However, to fully capitalize on these benefits and ensure long-term success we recommend:

- Following a comprehensive maintenance plan for the green alleys
- Incorporating a watershed management authority (WMA) into the Bee Branch Watershed
- Establishing a monitoring and evaluation framework

INTRODUCTION

Project Background

In spring 2024, a three-member team of Master of Public Affairs students from the School of Planning and Public Affairs at the University of Iowa is conducting a policy analysis of the City of Dubuque's Green Alley Reconstruction Project. This project is undertaken in collaboration with the City of Dubuque government, with Jon Dienst, Civil Engineer II, serving as the city representative. The project is overseen by two faculty members from the School of Planning and Public Affairs, Professor Haifeng Qian and Professor Travis Kraus. This initiative represents a partnership between the City of Dubuque government and the School of Planning and Public Affairs, facilitated through its Iowa Initiative for Sustainable Communities (IISC).

Policy Analysis

Policy analysis involves examining and evaluating potential courses of action or policies to address specific problems or issues within a given context. It typically involves gathering relevant data, assessing various policy options, predicting their potential impacts, and making recommendations based on analysis and evidence.

In the context of the Green Alleyway Reconstruction Project, we focused on flood mitigation, water quality, economic, and equity aspects. Our policy analysis entails several key steps:

- **Identifying the Problem**: The analysis begins by identifying key issues within the alleyway project, including concerns about water quality, flood risks, economic stagnation, and ethical considerations related to funding access and community participation.
- **Research and Data Collection:** Extensive research was conducted to gather data on the current state of the alleyway and its surroundings. This includes assessing water quality levels, flood vulnerability, economic indicators such as job availability and property values, and understanding the demographics of the community, particularly those with access to funding.
- **Policy Options:** Various policy options are explored to address the identified issues. These may include implementing green infrastructure to improve water quality, enhancing flood mitigation measures, fostering job growth through green business initiatives, and ensuring equitable access to funding opportunities for all community members.
- **Impact Assessment**: Each policy option is carefully evaluated for its potential impacts. This assessment considers factors such as the effectiveness of water quality improvements, the resilience of flood mitigation strategies, the potential for job creation, and the impact on property values. Additionally, ethical considerations are paramount, including ensuring fair access to funding opportunities and promoting community engagement in decision-making processes.
- **Recommendations:** Based on the analysis, recommendations are formulated to address the identified challenges while maximizing benefits for the community. This may involve prioritizing policies that not only improve water quality and mitigate flood risks but also stimulate job growth and enhance property values in an equitable manner. Recommendations also include strategies for ensuring fair access to funding and fostering community participation throughout the project lifecycle.

By integrating economic, environmental, and ethical considerations into the policy analysis process, the Green Alleyway Reconstruction Project can achieve its goals of improving environmental sustainability, fostering economic growth, and promoting social equity within the community.

Overall, our policy analysis of Dubuque's Green Alleyway Reconstruction Project integrates environmental, economic, and ethical considerations to develop holistic recommendations that will enhance the alleyway's sustainability and benefit the community as a whole.

Brief History of Alleys and Green Alleys

Alleys were not popular and disappeared from American residential planning in the 1930s and earlier, alongside the emergence of the New Deal's Federal Housing Administration (FHA), due to the notion that they were indecent, described as a 'nuisance landscape of wasting and dereliction.'[5] This decline was also attributed to the additional costs related to improvements and maintenance, aesthetics, function, health, and safety.[6] During this time, the attention was given to the 'front roads.'

However, alleys have returned to the discourse of city planners and policymakers, ironically, due to the very same considerations that led to their rejection before.[7] The revived back-alley is incorporated into a plan with the goal of enhancing the attractiveness of streets and restoring them for pedestrian and social purposes.[8] New urbanists argue that suburban streets are overloaded and are in need of relief from the ubiquitous presence of cars and garages.[9] As a result, by the end of the 1990s, many alleys in the US underwent significant transformations into green alleys that are often linked with urban revitalization and social innovation initiatives.[10] Organized alley greening efforts in the United States date back to 2006, with the establishment of Chicago's pioneering Green Alley Program.[11]

Green alleys are a part of broader 'green infrastructure' concepts. The term 'green infrastructure' may be relatively recent, but its underlying concept has historical roots dating back 150 years to early planning and conservation initiatives.[12] This idea emerged from two key predecessors: first, the integration of parks and green spaces for human well-being, and second, the connection of natural areas to promote biodiversity and mitigate habitat fragmentation.[13] However, today, the meaning of the term 'green infrastructure' has expanded and could mean different things to different people depending on the context in which it is used.[14] Therefore, conceptualizing alleys as green infrastructure represents a new vision for an old design feature.[15]

Background on the Green Alley Reconstruction Project in Dubuque

The history of green alley projects in Dubuque is relatively recent. As in many cities in the US, Dubuque's green alley goal is to address flooding and water quality control,[16] aligning with the objectives of many green alley projects in the US.

Dubuque's history is marked by a vulnerability to storms and flooding, with significant events in 1999, 2002, 2004, 2008, 2010, and most recently in July 2011, resulting in substantial loss and hardship.[17] In response to the 1999 storm, the city commissioned the Drainage Basin Master Plan (DBMP) in 2001, a $275,000 study that identified around 1,150 homes and businesses at risk during heavy rainfall.[18]

In August 2003, the Dubuque City Council initiated the Bee Branch Citizen Advisory Committee, partnering with engineering firms Camp Dresser & McKee, Inc. and WHKS & Co., to devise a solution for redirecting water in the North End and Washington Street neighborhoods. The committee concluded its alignment study in November 2004, with the City Council adopting the recommended plan to "day-light" the Bee Branch Creek, creating an open channel.

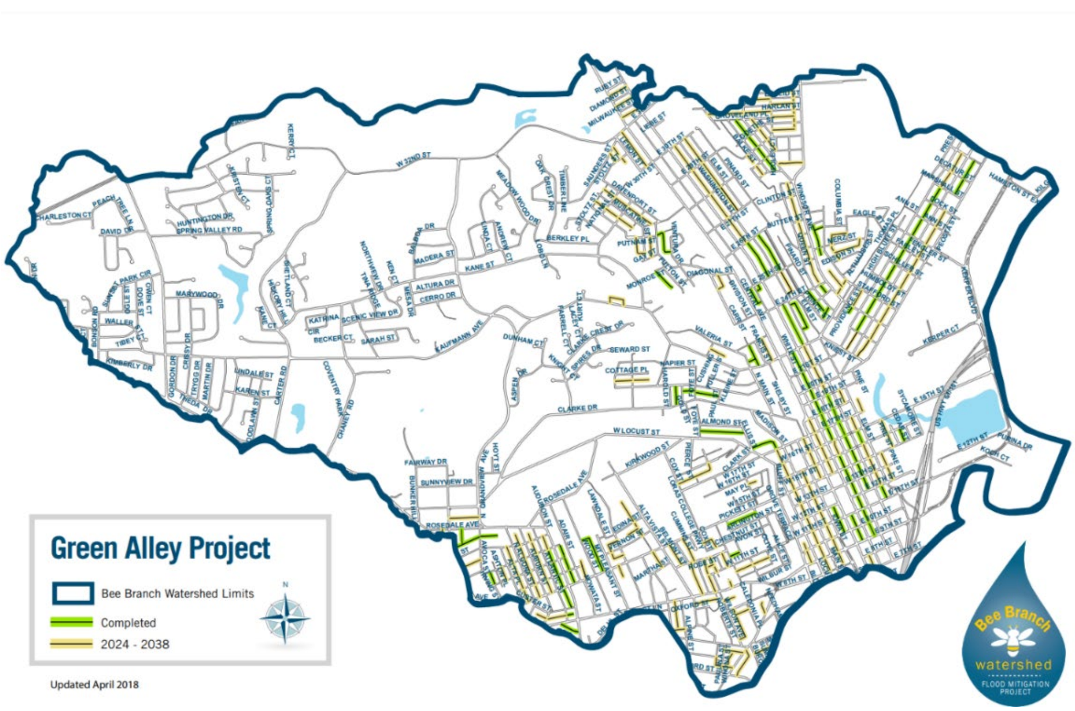
The Green Alley Reconstruction Project, a facet of the broader Bee Branch Watershed Project, was initially piloted and expanded based on its success in flood mitigation and neighborhood revitalization. To date, 80 of the planned 240 green alleys have been completed, with the remainder scheduled for reconstruction between 2029 and 2040, their specific construction years yet to be determined.[19] This conversion is expected to reduce stormwater runoff in the Bee Branch Watershed by up to 80 percent.[20]

Although today, a total of over 80 green alleys are constructed, to show a timeline of when the green alleys are constructed, the 2017 data[21] is used. A majority of green alleys are concentrated in the downtown area of the city.

Figure 1: Number of Green Alleys Constructed Per Year

Year	**Number of Green Alleys Constructed**
2009	2
2010	1
2011	1
2012	1
2013	3
2014	1
2015	18
2016	28
2017	25
Total	**80**

Figure 2: Green Alleys Map



The estimated cost of converting approximately 240 green alleys is $57.4 million, with Dubuque's commitment encompassing a "local match," which includes stormwater utility funds and special assessments to property owners.[22] Moreover, when the City embarks on the reconstruction of a street or alley, property owners adjoining the project area typically shoulder approximately 15% of the total expenses, while the remaining 85% is funded through city resources or grants.[23]

To determine the expenses associated with constructing green alleys, an evaluation is conducted on individual properties, with the assessment being proportionate to the size of the lot or property.[24] The assessment amounts are determined based on the lot's frontage (width) and depth.[25] Typically, for most alleys within the Bee Branch Watershed, a rough estimate places the cost to property owners for paving at approximately $25 per foot of frontage.[26] For instance, if the lot is 50 feet wide, the estimated cost can be calculated by multiplying $25 by 50, resulting in a net paving cost of $1,250.[27] However, these figures can be influenced by contractor bids and potential cost overruns during construction.[28] Additionally, assessments might encompass extra utility expenses if there's a need to replace private water or sewer service lines.[29] Generally, final assessments for average-sized lots, excluding utility costs, are anticipated to fall within the range of $1,000 to $1,500.[30]

Payment for green alley assessments can be made in full or in part, without interest, at the City Treasurer's Office located at City Hall within 30 days of receiving the final assessment notice.[31] Residents with a balance exceeding $500 also have the option to spread the assessment over 15 years at a 3% interest rate.[32] Financial aid is accessible for owner-occupied properties, with eligibility based on family size and gross household income.[33] The level of assistance provided varies from 20% to 100%.[34]

Before the inception of the first green alleys in 2009, the City of Dubuque initiated two pilot projects for green alleys. The success of these pilot projects led to the construction of over 80 green alleys. As a responsible governing body, the City of Dubuque is now poised to reevaluate its evaluation methods through a comprehensive policy analysis. This marks a pivotal moment as the City of Dubuque undertakes its first comprehensive reassessment of the Green Alley Reconstruction Project. This reevaluation signifies the city's commitment to staying responsive to evolving challenges and ensuring that its infrastructure projects remain aligned with contemporary environmental and community needs.

This undertaking reflects the city's proactive stance toward embracing innovation and best practices. As the city of Dubuque strives for an improved evaluation framework, it signals a commitment to sustainable urban development, resilience against environmental challenges, and a dedication to providing equitable and enhanced services to its vibrant community. This policy analysis will not only assist in holistically evaluating existing green alleys but also provide essential information to project partners regarding the expansion of the project.

POLICY ANALYSIS FRAMEWORK

Research Questions

In undertaking this policy analysis, the central focus will be on addressing the overarching question- **how can the City of Dubuque best evaluate the Green Alley Reconstruction Project to promote equitable and sustainable development?**

To delve into this primary question, the research will seek answers to the following sub-questions:

a) How does the implementation of green alleys influence the economy, particularly property value and job creation?

b) How do streamlined processes, prioritizing the fiscal responsibility, contribute to enhancing overall efficiency?

c) How has the implementation of green alleys contributed to the pursuit of equity in the City of Dubuque and preventing disparities among residents?

d) How can the City of Dubuque assess the sustainability goals of green alleys in flood mitigation and water quality?

Literature Review

While alleys in general, and green alleys in particular, received minimal attention in the 1930s, modern urban planners and policy analysts have shown an increased interest in them. Consequently, there has been a surge in studies focusing on green alleys, particularly those aimed at their evaluation. This section aims to identify how green alleys are studied in other locations.

Figure 3: Evaluation Metrics Used by Other Studies

Newell et. al (2013)[35]	Stormwater management	Harvest rainwater	Urban heat island mitigation
	Light pollution mitigation	Energy conservation	Beautification
	Facilitate active recreation/physical activity	Encourage or facilitate non-motorized transportation	Empower community members to change their neighborhoods
	Enhance safety	Expand greenspace	Build community
	Increase connectivity between local destinations	Environmental education	
Pham et. al (2022)[36]	Promoting socialization and inclusion	Fostering mutual exchange of services and knowledge	Facilitating more sustainable mobility
	Greening	Reducing water runoff	
Wolch et. al (2010)[37]	Access to parks and play spaces	Physical activity and health	Urban walkability and mobility
	Environmental benefits		
Im (2019)[38]	Stormwater management	Environmental preservation & improvement	Social improvement
	Transportation enhancement	Economic efficiency	

Four academic studies are examined for their approaches to green alleys. Green alleys, closely intertwined with green infrastructure, reflect the concept of sustainability, which is evident in the focus of these studies. Depending on their respective scopes and interests, the studies embody various aspects such as transportation, social benefits, and more.

While these studies represent academic research constructed based on theories and conceptual frameworks, and therefore may not be directly comparable to a policy analysis like the one conducted in this study, their evaluation metrics significantly influence the foundation of this policy analysis. However, these four studies do not directly address the topics of economy, equity, and beyond.

Despite this, the metrics of environmental sustainability, fiscal responsibility, economy, and equity are employed in this policy analysis draw inspiration from these academic studies. Adjustments, however, have been made to align with the nature of policy analysis and the specific needs of the study area. For example, while Im (2019) approaches economic efficiency as a cost-effective solution for stormwater management and economic development enhancement, this policy analysis adapts it to property value and job creation through green alley construction. Moreover, fiscal responsibility has been added to better reflect the needs of the city of Dubuque. Equity is not directly addressed by the four studies. However, since financial assistance is provided to residents in Dubuque, this policy analysis adds equity as a key consideration. Additionally, stormwater management and reducing water runoff from the studies are adopted under the environmental sustainability study of this policy analysis.

Methods for Impact Categories

Environmental Sustainability

Environmental Sustainability is fundamental for ensuring that projects meet the needs of the present without compromising the ability of future generations to meet their own needs. In the context of green alley projects, sustainability involves mitigating environmental impacts, such as flooding and water pollution, while promoting long-term resilience and resource conservation. By prioritizing sustainability, cities can address pressing environmental challenges, enhance quality of life, and create healthier, more resilient communities for current and future generations. We gave particular attention will be given to the study of stormwater runoff and capture and water quality.

Fiscal Responsibility

By streamlining processes and implementing intuitive systems, cities can optimize resource allocation, reduce operational bottlenecks, and enhance overall efficiency. Moreover, incorporating a robust maintenance plan into the framework is essential for ensuring the longevity and functionality of projects like green alleys. An effective maintenance plan not only preserves their intended benefits but also fosters public trust by demonstrating a commitment to sustained upkeep. This commitment translates into cost savings over time, as proactive maintenance prevents larger issues from arising and ensures timely project completion. Alongside the maintenance plan, a reliable funding mechanism is paramount for the long-term sustainability of Green Alley projects. Adequate funding ensures ongoing maintenance efforts and facilitates future expansion, safeguarding the investments made in these environmentally friendly initiatives. Together, a comprehensive maintenance plan and a sustainable funding mechanism contribute to the successful management and longevity of green alley infrastructure, ultimately enhancing urban resilience and community well-being.

Economy

The economic aspect is paramount as it directly impacts financial resources. Understanding the economic implications of green alley projects, including their influence on property value and job creation, is essential for informed decision-making and resource allocation. By assessing how green alleys affect property values and job creation through construction, cities like Dubuque can ensure that investments yield favorable returns and contribute to long-term financial stability.

Equity

Equity is essential for promoting fairness and inclusivity in project outcomes. By considering the distribution of project benefits among different socio-economic groups, policymakers can address disparities and ensure that marginalized communities have equitable access to positive outcomes. Within this framework, three crucial impact categories play a pivotal role. First, assessing equitable distribution of cost and benefits provides us insights of how the benefits of a green alley go beyond the environmental purposes they serve. Second, evaluating the fairness of special assessments ensures that the financial burden is equitably distributed among stakeholders, preventing disproportionate impacts on vulnerable populations. Lastly, analyzing the impact on rental housing costs for neighborhoods with green alleys helps identify any disparities or gentrification pressures, enabling policymakers to implement strategies to promote equitable outcomes for all residents.

Final Policy Analysis Framework

The objective of this research project is to conduct a policy analysis by formulating guiding values and principles that underpin the evaluation metrics, with a focus on their relevance to the specific location and socio-economic contexts. When choosing evaluation metrics, emphasis is placed on aligning with the primary objective and the nature of the project as well as concepts and approaches largely shaped by contemporary literature related to green alleys.

This research adopts the following values as foundational pillars for the evaluation metrics and their impact categories:

Figure 4: Evaluation Metrics

Evaluation Metric	Impact Categories
Sustainability	Water quality
	Stormwater capture
Fiscal Responsibility	Maintenance costs
	Construction Cost
Economy	Property values increase
	Total wages created through construction
Equity	Equitable distribution of costs and benefits
	Utilization of financial assistance among vulnerable households
	Impact on rental housing costs

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ENVIRONMENTAL SUSTAINABILITY

Stormwater runoff, with implications for both water quality and flooding, underscores the need for strategies like Green Alleys in the Bee Branch Watershed to mitigate these challenges. At the core of such initiatives lies environmental sustainability, ensuring that present needs are met without compromising the ability of future generations to meet their own. Green alley projects exemplify this commitment by tackling environmental threats such as flooding and water pollution, while promoting resilience and resource preservation. By prioritizing sustainability, cities can address pressing environmental issues, enhance living standards, and foster healthier, more resilient communities. Our specific focus will be on studying stormwater runoff and capture, alongside enhancing water quality.

Currently, the City of Dubuque lacks a structured system to assess water quality and flood mitigation, particularly concerning the green alleys within its jurisdiction. To bridge this gap, our team employed alternative methodologies to gauge performance, such as analyzing specifications of pervious paver products, consulting external research, utilizing the Green Values Calculator, and seeking insights from industry experts. Moreover, Dubuque lacks a formal maintenance plan for its permeable paver system, relying heavily on citizen reports and visual assessments to identify maintenance needs.

Literature Review Findings

Implementing green infrastructure practices offers significant opportunities for communities to reduce both municipal and domestic energy consumption.[39] By decreasing rainwater flows into sewer systems, recharging aquifers, and conserving water, these practices contribute to energy efficiency and sustainability efforts. Cities, states, or regional entities can enhance these benefits by linking the energy savings resulting from green infrastructure implementation to reduced demand at power plants.

Permeable pavement can reduce the concentration of some pollutants either physically (by trapping it in the pavement or soil), chemically (bacteria and other microbes can break down and utilize some pollutants), or biologically (plants that grow in-between some types of pavers can trap and store pollutants). By slowing down the process, permeable pavements can cool down the temperature of urban runoff, reducing the stress and impact on the stream or lake environment.[40] Compared to asphalt runoff, permeable pavement drainage has been shown to have decreased concentrations of several stormwater pollutants, including heavy metals, motor oil, sediment, and some nutrients.[41] Permeable pavements can buffer acidic rainfall pH likely due to the presence of calcium carbonate and magnesium carbonate in the pavement and aggregate materials.

The Green Values Strategy Guide developed by the Center for Neighborhood Technology indicates that the utilization of permeable pavers has a high benefit of reducing flooding and protecting water quality by reducing stormwater runoff and combined sewer overflows.[42]

Another benefit of permeable pavement is the reduced need to apply road salt for deicing in the wintertime. Researchers at the University of New Hampshire have observed that permeable asphalt only needs 0 to 25% of the salt routinely applied to normal asphalt. Other researchers have found that the air trapped in the pavement can store heat and release it to the surface, promoting the melting and thawing of snow and ice.[43]

Schueler (1994) was among the first to identify imperviousness as a simple, easily measured quantity to be used as an index of environmental disturbance. His paper identifies threshold ranges of total imperviousness within a watershed associated with different degrees of stream quality: sensitive (1–10% impervious cover), impacted (11–25% impervious cover), and non-supporting (26% and greater impervious cover). Increasing urbanization has resulted in increased amounts of impervious surfaces—roads, parking lots, rooftops, and so on— and a decrease in the amount of forested lands, wetlands, and other forms of open space that absorb and clean stormwater in the natural system. This change in the impervious-pervious surface balance has caused significant changes to both the quality and quantity of the stormwater runoff, leading to degraded stream and watershed systems: an increased quantity of stormwater for stream systems to absorb, sedimentation, and an increased pollutant load carried by the stormwater. An impervious surface prevents natural pollutant processing in the soil by preventing percolation; and impervious surfaces convey pollutants into the waterways, typically through the direct piping of stormwater.[44] Widely accepted research indicates that stream channels begin to erode when effective impervious cover approaches 10 percent of a watershed. When effective imperviousness exceeds 25 percent, channel erosion and habitat degradation become significant, as well as the potential for contamination of drinking water sources. A large volume of scientific and technical research literature has established the association between impervious surfaces and negative impacts on waterways. In fact, effective impervious surfaces can be used as an indicator of aquatic health and biodiversity.[45]

A key indicator of urbanization within a watershed is the extent of impervious surfaces. As these surfaces increase, more rainfall is unable to infiltrate the ground and instead becomes runoff. To mitigate the adverse effects of high stormwater flow rates and pollutants in runoff, it's common to employ best management practices (BMPs) that slow down the flow of water. In regions experiencing new development or redevelopment, the most efficient approach to managing stormwater discharge impacts is by minimizing the amount of rainfall that turns into runoff.

Imperviousness has become an accurate predictor of urbanization and urban impacts on streams and many thresholds of degradation in streams are associated with an impervious surface coefficient (ISC) of 10–20%. Impervious surfaces can alter the natural hydrological condition by increasing the volume and rate of surface runoff and decreasing groundwater recharge and base flow, leading to larger and more frequent local flooding. Other direct environmental impacts of increasing impervious surface area (ISA) in watersheds include the degradation of water resources and water quality when surface runoff transports non-point source pollutants from their source areas to receiving lakes and streams.[46]

The Iowa Stormwater Management Manual (ISWMM), developed by the Iowa Department of Natural Resources (IDNR) provides stormwater management strategies that complement the storm drain network and flood control efforts of the past. A primary focus of the manual is to provide design guidelines for practices that infiltrate small runoff events to protect water quality. The manual also provides design guidelines for stream corridor protection, which is important because stream corridor erosion causes up to 70 percent of sediment loading in urban areas. These practices provide significant water quality benefits and protect pipelines, sanitary sewers, and other infrastructure from the challenges of flooding caused by excessive stormwater runoff.

Adding water quality and channel protection practices to traditional storm drain networks and flood control practices make stormwater management strategies more holistic and effective.[47]

A variety of inorganic, organic, and bacteriological pollutants are added to the surface runoff as it moves across the urban landscape. The greater portion of the annual pollutant loading is added to local streams from the smaller, high-frequency storms. With the implementation of the Iowa DNR's Stormwater NPDES (National Pollutant Discharge Elimination System) Phase I and Phase II regulations, stormwater runoff quality is now an additional management goal for some communities. Stormwater management traditionally was, and still is in many cases, a flood control, rather than a water quality control, program. Local governments intending to improve the quality of their runoff-impacted streams are incorporating (BMPs) into their stormwater programs. The implementation of the stormwater NPDES Phase I and Phase II regulations require regulated jurisdictions with Municipal Separate Stormwater Systems (MS4s) to manage water quality for construction activities and post-construction conditions.

One of the 11 Sustainability Principles identified by Dubuque citizens is Clean Water. According to Sustainable Dubuque, the Green Alleys offer a significant and measurable improvement in water quality in the Bee Branch Creek and Mississippi River. [48] Our studies have shown that to date there have not been substantial efforts to measure the water quality of the Bee Branch Watershed. One of the main reasons for this because the watershed management plan pertaining to the Bee Branch does not mandate or necessitate this sort of testing. This means that there has been no actual testing in the Bee Branch Watershed that would reflect improvements or degradation of the water quality as a result of the Green Alleys.

The Bee Branch Watershed Flood Mitigation Project Plan

According to the City of Dubuque's website, The Bee Branch Watershed Flood Mitigation Project (BBWFMP) is a multi-phased, fiscally responsible investment to mitigate flash flooding, improve water quality, stimulate investment, and enhance the quality of life within the Bee Branch Watershed. Throughout the BBWFMP water quality is mentioned only six times, primarily in that the management plan protects water quality by reducing sediment and nutrient loads. The watershed management plan identifies a Steering Committee of the America's Watershed Initiative that has a seat for the City of Dubuque. This collaborative effort is among those states also involved in the Mississippi watershed system. Through collaboration with these other organizations, the City of Dubuque hopes to address issues in the watershed that could impact those who are downstream, this would include water quality. The Land Use and Water Quality Workshop has many applications but an important aspect we saw was that it helped to clarify planning and water resources issues faced by the City of Dubuque throughout the city, with specific focus on Bee Branch Creek Watershed, and helped raise awareness of those issues. It also identified needs and potential strategies for addressing those needs going forward. Additionally, through this workshop the Environmental Protection Agency (EPA) provided the City of Dubuque with technical assistance to examine existing codes, ordinances, and other policies that may hinder additional water quality protection.

Catfish Creek Watershed Management Plan (CCWMP)

A key component to consider from the CCWMP is the United States Environmental Protection Agency (USEPA) Watershed Management Plan Requirements. This document helps ensure that Watershed Management Plans and projects make progress toward restoring waters impaired by non-point source pollution. By following the elements identified in this document, the City was able to access 319 Grant funding for watershed improvement projects. The elements mentioned effectively address water quality concerns and mandate that watershed management plans incorporate a multi-faceted approach. These plans typically include identifying pollution sources (Element A), estimating pollution reduction potential (Element B), and outlining Best Management Practices (BMPs) for implementation (Element C). Securing resources (Element D) and fostering public engagement (Element E) are also crucial aspects. The plan establishes a timeline (Element F) with measurable milestones (Element G) to track progress. Finally, water quality monitoring (Elements H & I) ensures the implemented solutions are making a positive impact.

Section 2.0 of the CCWMP deals with the missions, goals, and objectives of the plan. All of which were developed by the Catfish Creek Watershed Management Authority which is comprised of political stakeholders from around the area. To facilitate future measurement of progress toward achieving goals, the plan established detailed and quantifiable objectives for each one. The report prioritizes achieving watershed goals through the Management Measures Action Plan. This section outlines programmatic and site-specific actions for each goal. Section 9 then dives deeper into the goals and objectives, establishing milestones and "Report Cards" to measure progress and gauge the plan's success. These goals and objectives are what the entire plan strives to achieve. These goals represent the collective interests of the community regarding the watershed.

A Watershed Vulnerability analysis was conducted, splitting the Catfish Creek Watershed into 34 Subwatershed Management Units. Each of these units was analyzed according to predicted future land use and graded according to the United States Department of Agriculture’s Technical Release 55. Here they were able to compare the current status/level of impermeability within the watershed to the future level of impermeability predicted for the future. This part of the report is an important aspect that will help planners as they plan for low-impact development and decreasing impermeable surface area.

Section 4.0, Assessment and Pollutant Loading Analysis identifies point source and nonpoint source pollutants. Acknowledgment and utilization of the National Pollutant Discharge Elimination System (NPDES) mandates regulation of point source discharges of pollutants into U.S. waters. This permitting program establishes monitoring and reporting requirements and is designed to prevent stormwater runoff from washing harmful pollutants into local surface waters such as streams, rivers, lakes, or coastal waters. The Iowa Department of Natural Resources (IDNR) has overseen the NPDES permitting program since 1978. A water quality report is generated and submitted to the U.S. Environmental Protection Agency twice a year. This section is important for protecting water quality because it identifies the sources of pollution that will be targeted by the watershed management plan. By identifying these sources of pollution, the plan can then recommend strategies to reduce them. These strategies, outlined in a later section of the plan, are critical for improving water quality. This is a vital first step in developing a plan to protect water quality. By identifying the sources of pollution, the plan can then outline strategies to address them.

Section 5.0, Causes/Sources of Impairment and Reduction Targets, goes beyond the identification of polluters in the area and identifies key areas where Best Management Practices (BMPs) should be installed. From this assessment, they were able to determine based on the recommended BMP the level of nutrient and sediment load reduction. Also in this section, they identify watershed impairment reduction targets which is important because these targets provide a means to measure how the implementation of management measures at critical areas is expected to reduce watershed impairments over time.

Section 6.0, Management Measures Action Plan, encompasses an "Action Plan" crafted to offer stakeholders tailored "Management Measures" aimed at achieving plan objectives both broadly and at individual site levels. These suggested measures, spanning programmatic and site-specific domains, form a robust framework for safeguarding and enhancing watershed conditions. However, it is imperative to review and refine these measures periodically, aligning them with completed projects or emerging opportunities. Principal implementers are urged to foster partnerships with key stakeholders and devise diverse funding mechanisms to facilitate the delegation and execution of these recommended actions. Regularly reviewing and updating the Management Measures Action Plan is vital to keep it aligned with evolving environmental conditions, stakeholder needs, and available resources. This ensures that the plan remains effective, accountable, and responsive to changing circumstances. Engaging stakeholders in the process, fosters ownership, enhances stakeholder engagement, and optimizes funding strategies to support implementation efforts.

Summary of Environmental Sustainability Findings

Flood Mitigation

Utilizing the Center for Neighborhood Technology's Green Values Stormwater Management Calculator, various parameters related to the Green Alley Reconstruction Project were computed, including the amount of stormwater captured and allowable runoff by the permeable pavers.

To date Dubuque has installed roughly 372,000 sq ft of pavers, allows for the capture of about 580,000 gallons or 77,500 cubic feet of stormwater annually (based on average annual rainfall for the area of 36 inches) that would have otherwise been runoff and threatened to flood the Bee Branch Watershed area. With the current level of permeable pavers within the Bee Branch Watershed, the Dubuque will experience roughly 54.8 million cubic feet (about 409.5 million gallons) of runoff. Without this existing permeable paver system, that runoff would be roughly 1% higher, about 55.1 million cubic feet (412.4 million gallons). As part of a much larger watershed, the green alleys have a relatively minimal effect on mitigating major flood events.

Figure 5: Green Values Stormwater Management Calculator at current implementation.

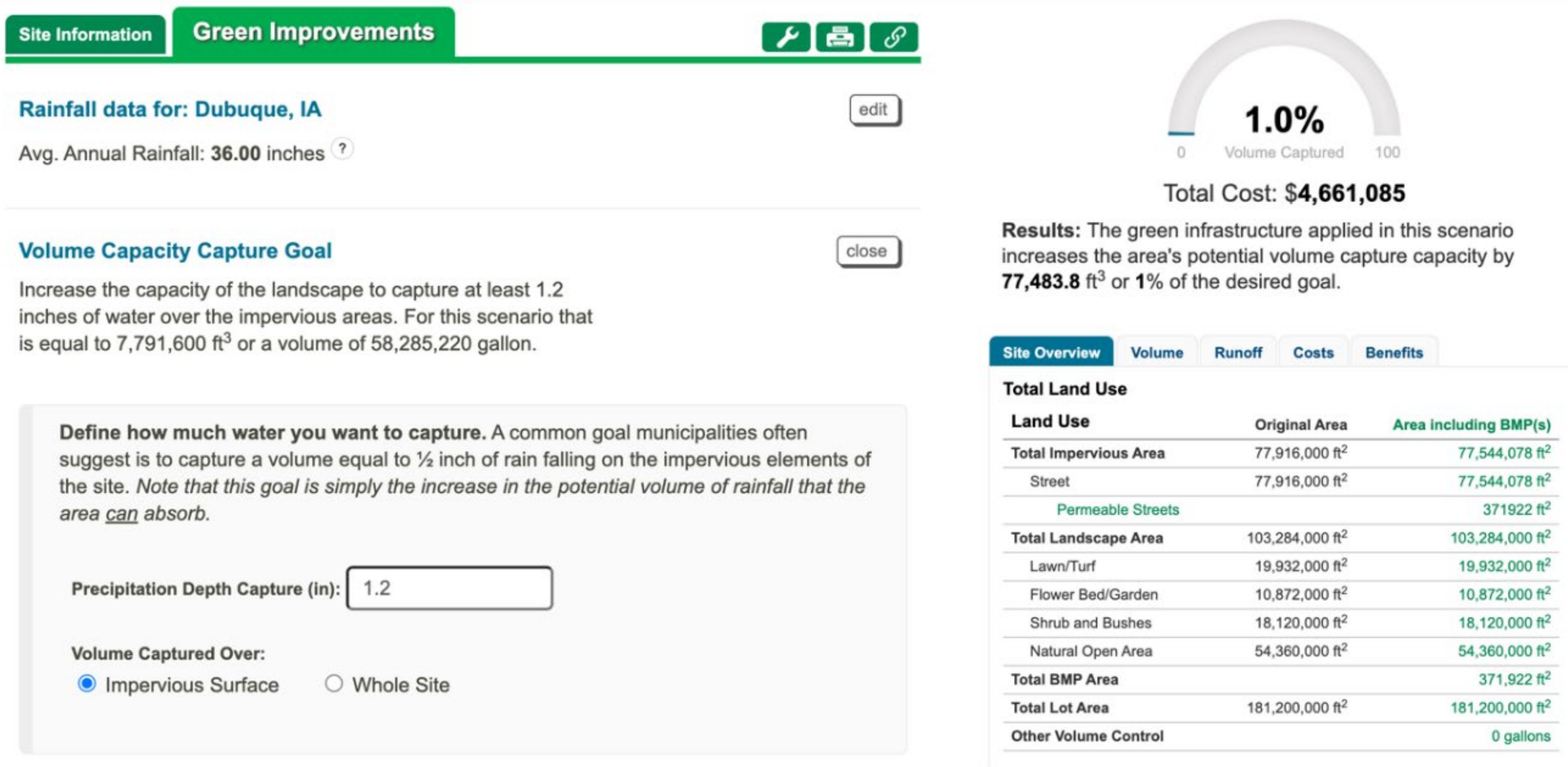


Figure 6: Green Values Stormwater Management Calculator, Runoff and Hydrology at current implementation.

Results: The green infrastructure applied in this scenario increases the area's potential volume capture capacity by **77,483.8** ft^3 or **1**% of the desired goal.

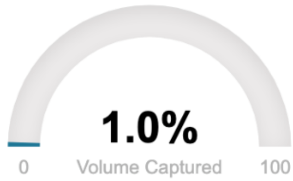
Site Overview | Volume | **Runoff** | Costs | Benefits

Runoff and Hydrology

Runoff	Without BMPs	With BMPs	Difference
Average Annual Rainfall: 36" Rain			
Runoff	3.651"	3.626"	1%
Runoff Volume	55124127.7 ft^3 412357139.4 gal.	54746736.7 ft^3 409534058.6 gal.	377391 ft^3 2823080.8 gal.
Average Storm Rainfall: 2.30" Rain			
Runoff	0.958"	0.954"	0%
Runoff Volume	14465615.7 ft^3 108210327.6 gal.	14409897 ft^3 107793522.5 gal.	55718.7 ft^3 416805.1 gal.

Hydrology	Without BMPs	With BMPs	Difference
Average Initial Abstractions Rainfall: " Rain			
Initial Abstractions	0.38"	0.39"	0%
Initial Abstractions Volume	5790942.68 ft^3 43319262.51 gal.	5818873.87 ft^3 43528202.4 gal.	27931.2 ft^3 208939.89 gal.
Average Cumulative Abstractions			
Cumulative Abstractions	1.92"	1.93"	0.01%
Cumulative Abstractions Volume	28954713.38 ft^3 216596312.56 gal.	29094369.37 ft^3 217641011.99 gal.	139655.99 ft^3 1044699.43 gal.
Curve Number	83.9	83.8	

Figure 7: Green Values Stormwater Management Calculator, Volume capture at current implementation.



Total Cost: $**4,661,085**

Results: The green infrastructure applied in this scenario increases the area's potential volume capture capacity by **77,483.8** ft^3 or **1**% of the desired goal.

Site Overview | **Volume** | Runoff | Costs | Benefits

Volume Control

Required Volume Capture Potential from 1.2" over 77916000 ft^2 of impervious area is: 7,791,600 ft^3 or 58,285,220 Gallons.

BMP	ft^3	Gallons
Permeable Streets	77483.8	579618.7
Total of all BMPs	77,483.8	579,618.7
Percentage of Volume Capacity Capture Goal	1	%

Once the City of Dubuque fully completes its Green Alley Reconstruction Project it will have added in total of 1.33 million square feet of permeable pavers, further minimizing the total area of imperviousness from 77.9 million square feet to 76.6 million square feet. This represents a total change of 2% given the large area of the watershed. At this level, the City of Dubuque is able to capture about 277,000 cubic feet (2.1 million gallons) of stormwater with its permeable paver system.

Figure 8: Green Values Stormwater Management Calculator at full implementation.

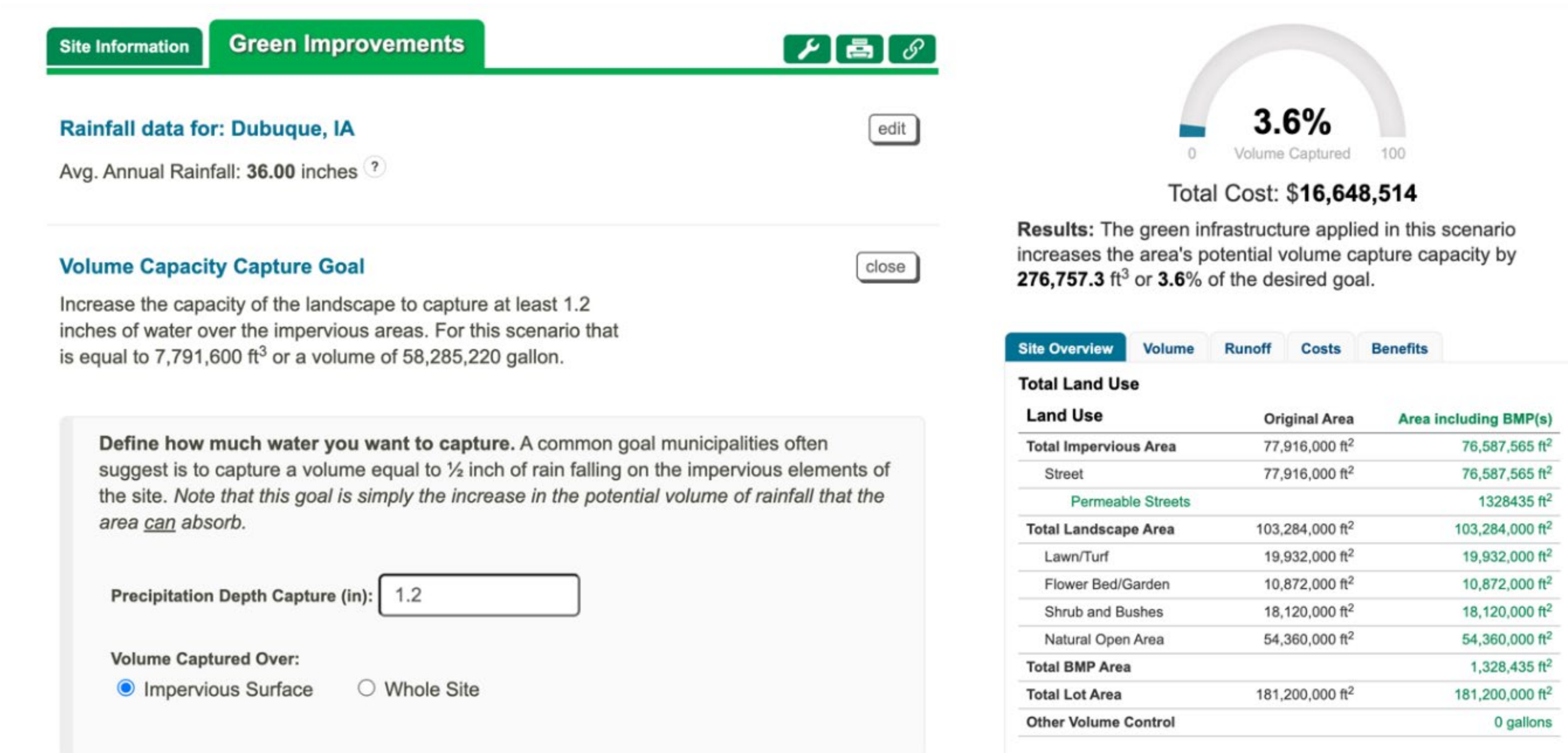


Figure 9: Green Values Stormwater Management Calculator, Runoff and Hydrology at full implementation.

Results: The green infrastructure applied in this scenario increases the area's potential volume capture capacity by **276,757.3** ft^3 or **3.6**% of the desired goal.

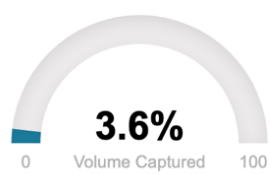
Site Overview | Volume | **Runoff** | Costs | Benefits

Runoff and Hydrology

Runoff	Without BMPs	With BMPs	Difference
Average Annual Rainfall: 36" Rain			
Runoff	3.651"	3.562"	2%
Runoff Volume	55124127.7 ft^3 412357139.4 gal.	53787996.3 ft^3 402362182.2 gal.	1336131.3 ft^3 9994957.2 gal.
Average Storm Rainfall: 2.30" Rain			
Runoff	0.958"	0.945"	1%
Runoff Volume	14465615.7 ft^3 108210327.6 gal.	14267159.2 ft^3 106725769.8 gal.	198456.5 ft^3 1484557.8 gal.

Hydrology	Without BMPs	With BMPs	Difference
Average Initial Abstractions Rainfall: " Rain			
Initial Abstractions	0.38"	0.39"	0.01%
Initial Abstractions Volume	5790942.68 ft^3 43319262.51 gal.	5890983.81 ft^3 44067622.23 gal.	100041.14 ft^3 748359.71 gal.
Average Cumulative Abstractions			
Cumulative Abstractions	1.92"	1.95"	0.03%
Cumulative Abstractions Volume	28954713.38 ft^3 216596312.56 gal.	29454919.06 ft^3 220338111.13 gal.	500205.68 ft^3 3741798.57 gal.
Curve Number	83.9	83.7	

Figure 10: Green Values Stormwater Management Calculator, Volume capture at full implementation.



Total Cost: $**16,648,514**

Results: The green infrastructure applied in this scenario increases the area's potential volume capture capacity by **276,757.3** ft^3 or **3.6**% of the desired goal.

Site Overview | **Volume** | Runoff | Costs | Benefits

Volume Control

Required Volume Capture Potential from 1.2" over 77916000 ft^2 of impervious area is: 7,791,600 ft^3 or 58,285,220 Gallons.

BMP	ft^3	Gallons
Permeable Streets	276757.3	2070288.5
Total of all BMPs	276,757.3	2,070,288.5
Percentage of Volume Capacity Capture Goal	3.6	%

All of these are rough estimates as regular maintenance is necessary to ensure the permeable paver system continues to work effectively. Utilizing data from the National Oceanic and Atmospheric Association (NOAA), this study can determine that during a 10-year storm event and over a 24-hour period, the City of Dubuque will be able to effectively capture roughly 11% that stormwater across the entire Bee Branch Watershed. According to professionals at the Iowa Flood Center, they consider the volume of stormwater capture as a negligible effect. Our analysis shows the infiltration rate of the permeable pavement system could potentially retain a large portion of the smaller events (1- through 10-year), and still a large reduction of the larger events (25-year and greater). You can expect this effect specifically and only at the locations where Green Alleyways are located.

Additional comments from Dan Gilles, PE, Water Resources Engineer for the Iowa Flood Center regarding the effectiveness of the permeable paver system in the Bee Branch Watershed.

- Runoff reductions provided by the permeable alleyways are influenced by the intensity and total depth of rainfall. They are most effective at reducing runoff occurring from more frequent rainfall events and less effective at reducing runoff from less frequent precipitation events.
- Typical infiltration rates of 0.5-2 inches per hour are common, which can greatly reduce local runoff. However, since the permeable pavement area is small relative to the whole Bee Branch watershed area, they likely have minimal (or negligible) effect along the main stem of Bee Branch to reduce flood flows. As you get further away from the alleys and/or further downstream, the benefit they provide becomes less and less.

Water Quality

Research Hydrologists for the USGS stated that permeable pavers have a high ability to reduce the concentration of solid sediments, a medium ability to reduce total phosphorus and particulates, and a low ability to filter dissolved fractions. One expert in the field that we contacted was Professor Adam Hoffman, a Professor of Environmental Chemistry at the University of Dubuque. He and his students have conducted water quality tests throughout Dubuque County since 2017. Their mission is to help the county to meet its water quality improvement goals. From this conversation, we learned that when testing water quality in a watershed, scientists and environmental professionals are looking for a variety of factors to assess the overall health of the water body and the ecosystem it supports. This includes factors like water temperature, clarity (turbidity), color, and odor. These can indicate potential problems like pollution, algae blooms, or excessive sediment. Assessing the chemical characteristics involves measuring the levels of various chemicals dissolved in the water, such as nutrients (nitrogen, phosphorus), dissolved oxygen, heavy metals, and pollutants. We spoke about the biological characteristics of the Bee Branch Watershed and its current capacity to maintain muscles.

Our conversation with Professor Hoffman led me to Erik Schmekel from the Dubuque County Watershed Organization, a governing body in the area for watershed management. He in his role for the organization has helped shape watershed management plans for Dubuque County. Through our conversations with him and members of his team, our understanding is that there is not much being done with water quality monitoring specifically within the Bee Branch

Watershed. It was mentioned that it is cumbersome in both time and money to monitor water quality. The lack of monitoring and regular water quality testing is primarily to do with the lack of incentives and mandates from the Bee Branch Watershed Flood Mitigation Project Plan (BBWFMP). The current plan primarily emphasizes flood mitigation and not water quality. Throughout these conversations, another watershed management plan from an adjacent watershed, the Catfish Creek Watershed, was brought up numerous times. The Catfish Creek Watershed Management Plan (CCWMP) utilizes multiple 28E agreements to ensure holistic monitoring and improvements over the watershed. These agreements are a joint powers agreement (between the City of Dubuque, Duque County Watersheds, and others) that allows for collaboration, funding and to work toward achieving a common goal. A later section of this report discusses the key aspects of the CCWMP that should be adopted into the BBWFMP to begin making significant water quality improvements within the Bee Branch Watershed.

Through various meetings we have had with representatives from The City of Dubuque's Engineering Department, Dubuque County Watersheds, and a Professor of Environmental Chemistry from Dubuque University we understand that there are simply no mandates that necessitate that water quality be monitored, tested, recorded, or maintained in the Bee Branch Watershed given the current edition of the BBWFMP. We discussed the critical components of the CCWMP that ensure water quality and compared those components to those, or lack thereof within the BBWFMP. The BBWFMP emphasizes the work that will be done to address the flooding issues and does not have much detail about what will be done to improve water quality within the Bee Branch Watershed. Because there is no regulatory need to meet water quality goals there has not been any significant data gathered to definitely determine the impact of the Green Alleyways on water quality.

It is understood that permeable pavers can have a positive effect on improving water quality, but that can be hard to prove or determine when there is no regular water quality testing being done. The CCWMP can achieve results and gather water quality data because of the intricacies written into that watershed management plan. The Watershed Management Authority created out of this plan is the driving force behind all the necessary permitting with local environmental authorities such as the Environmental Protection Agency, the Iowa Department of Natural Resources, and the Dubuque County Watershed Organization. The City of Dubuque could consider merging their two independent efforts between the CCWMP and the BBCWMP into one cohesive watershed management strategy. This would effectively incorporate the preexisting Watershed Management Authority for the CCWMP into the BBCWMP and therefore directly implement the water quality control attributes. A great example of this is the Mud, Camp, and Spring Creek Watershed Management Authority[49]

Both the WQI (Water Quality Initiative) and the 319 program are specific funding sources related to water quality improvement efforts in the United States.

Water Quality Initiative (WQI) The WQI is a program initiated by various government agencies at the federal, state, and local levels aimed at addressing water quality challenges, particularly in areas affected by agricultural runoff and other nonpoint source pollution. These initiatives typically involve funding for projects such as implementing best management practices (BMPs) on farms, restoring riparian buffers, promoting soil conservation practices, and improving watershed management. The specific details of WQI programs may vary by state or region, but they generally focus on collaborative efforts between government agencies, agricultural stakeholders, environmental organizations, and local communities to enhance water quality.

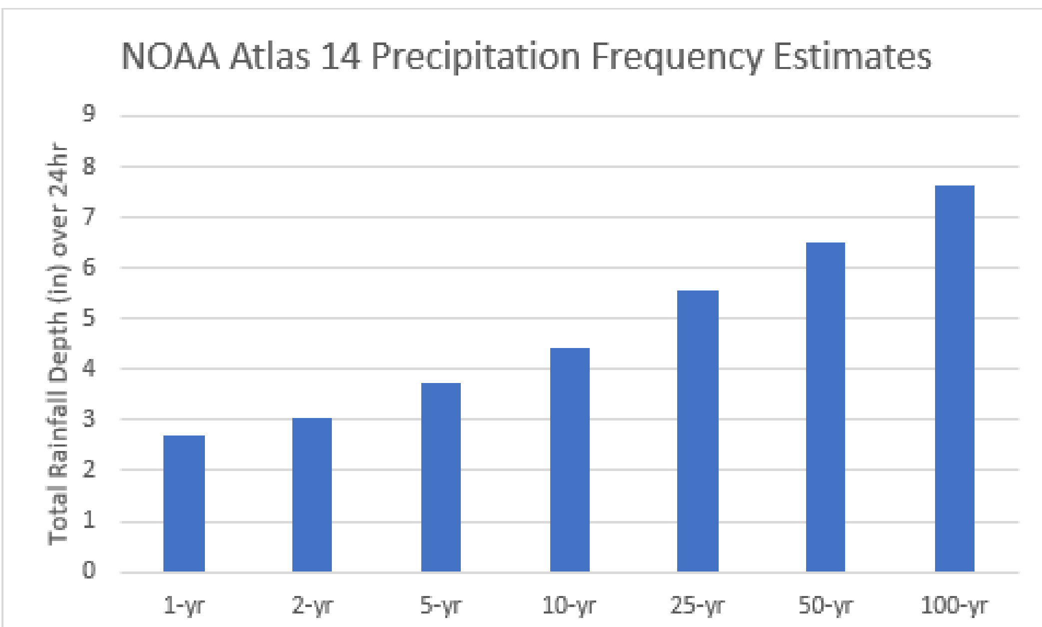
Section 319 Nonpoint Source Pollution Control Program: Section 319 of the Clean Water Act is a federal grant program administered by the U.S. Environmental Protection Agency (EPA) that provides funding to states, territories, and tribal governments to implement projects and programs aimed at controlling nonpoint source pollution. Nonpoint source pollution refers to pollution that comes from diffuse sources such as agricultural runoff, urban stormwater runoff, and atmospheric deposition, rather than from discrete point sources like industrial facilities or sewage treatment plants. The 319 program supports a wide range of activities, including watershed planning, implementation of best management practices, public education and outreach, monitoring and assessment, and technical assistance to address nonpoint source pollution and improve water quality in impaired watersheds.

These funding sources play crucial roles in supporting local and regional efforts to address water quality challenges and promote sustainable water management practices. Those two funding sources, WQI and 319, are the start, there would be even bigger opportunities to go after something like USDA-NRCS funding in the RCP Regional Conservation Partnership Program) which has MUCH higher funding than 319 and probably more available than WQI as well. The only holdup with RCPP is the level of partnership needed, including funding as a match, which the IDNR can help provide but takes a high level of organization. That said, "USDA is trying to push a lot of money Iowa's way through this framework so there's a lot of partners willing to help get you there if it's Dubuque's goal." -Steve Konrady, IDNR. All of these different funds benefit greatly from having a watershed management plan (which includes a "research plan" or more specifically a water quality sampling plan).

Conclusion

Permeable pavers have been proven to be able to capture stormwater runoff and improve water quality. It is important to note that these pavers are most effective when they undergo proper routine maintenance. As stated earlier, our findings show that permeable pavers have a high ability to reduce the concentration of solid sediments, a medium ability to reduce total phosphorus and particulates, and a low ability to filter dissolved fractions. The permeable paver systems of Dubuque's Green Alley Reconstruction project have a medium ability to capture stormwater runoff. To elaborate we mean that permeable pavers are mainly effective during high frequency 0-5 year storm events. For more severe, low-frequency 5+ year storm events, permeable pavers are not as effective in capturing stormwater runoff. Figure 8 below details different levels of storm events based on total rainfall over a 24-hour period. Given the sheer size of the Bee Branch Watershed compared to the relatively small size of the permeable paver system within the Bee Branch, they likely have minimal (or negligible) effect along the main stem of Bee Branch to reduce flood flows. As you get further away from the alleys and/or further downstream, the benefit they provide becomes less and less. In other words, the runoff from the drainage areas not captured by permeable pavers becomes larger and larger as you go downstream or away from Green Alleyways, diluting benefits they are providing. At the outlet of Bee Branch, the 32 acres of permeable pavers are being overwhelmed by the other 4,200 acres of watershed that haven't changed. The permeable pavers have the greatest impact at areas within or immediately near the permeable alleyways. The performance of permeable pavement depends greatly on the design of the system, underlying soil properties, or performance of the in-situ drainage system.

Figure 11: National Oceanic and Atmospheric Administration Precipitation Frequency Estimates



FISCAL RESPONSIBILITY

The primary maintenance concern associated with permeable pavements is clogging, an occurrence that can impede infiltration rates. Fine particles, originating from various sources such as vehicular traffic, atmospheric deposition, and stormwater runoff from adjacent surfaces, contribute to this issue. The frequency of these sources, such as vehicular use, and the size of the drainage area play significant roles in the rate of clogging. While clogging tends to escalate over time and with increased usage, it typically does not result in complete impermeability. Extensive studies have shown that permeable pavements exhibit initially high infiltration rates which gradually diminish over time, eventually stabilizing. Although these long-term infiltration rates decrease from their initial values, they generally remain well above 1 inch per hour, which is often adequate for managing stormwater from intense precipitation events in most scenarios.[50]

By streamlining processes and implementing intuitive systems, cities can optimize resource allocation, reduce operational bottlenecks, and enhance overall efficiency. Moreover, incorporating a robust maintenance plan into the framework is essential for ensuring the longevity and functionality of projects like green alleys. An effective maintenance plan not only preserves their intended benefits but also fosters public trust by demonstrating a commitment to sustained upkeep. This commitment translates into cost savings over time, as proactive maintenance prevents larger issues from arising and ensures timely project completion. Alongside the maintenance plan, a reliable funding mechanism is paramount for the long-term sustainability of Green Alley projects. Adequate funding ensures ongoing maintenance efforts and facilitates future expansion, safeguarding the investments made in these environmentally friendly initiatives. Together, a comprehensive maintenance plan and a sustainable funding mechanism contribute to the successful management and longevity of green alley infrastructure, ultimately enhancing urban resilience and community well-being.

Literature Review Findings

The term "Best Management Practices" or BMP was introduced and defined by the U.S. Environmental Protection Agency as "a practice or combination of practices that is an effective, practicable means of preventing or reducing the amount of pollution generated by nonpoint sources."[51] In this case, Dubuque's nonpoint source of pollution is the stormwater runoff that is capturing and carrying polluting substances into the local streams and waterways. Maintaining a regular maintenance schedule for a permeable paver program is crucial for ensuring permeable pavers' long-term effectiveness and efficiency. Utilizing stormwater control BMP for routine inspections is an integral part of regularly performed maintenance activities.[52] These inspections are described in three categories; one of them is routine inspections. This includes cleaning, repair, and replacement necessary to ensure the integrity and effectiveness of the permeable paver system. The other two categories include inspections both before and after a rain event.

To ensure the efficiency and longevity of a permeable paving system, proper maintenance is essential. Routine maintenance involves regular sweeping and vacuuming to clean the voids and prevent clogs, along with landscape upkeep to control grass, leaves, moss, and algae growth. Additionally, cleaning as needed is crucial for addressing specific issues and should be done semi-annually or quarterly to keep various substances from getting stuck inside the void and creating a clog up or other complications. [53] Protective measures should also be taken during construction to prevent damage to the paving system. By following these maintenance guidelines, you can ensure your permeable paver system remains effective for years to come, maintaining its functionality and appearance. Appropriate operation and maintenance activities ensure that green infrastructure will continue to function properly, yield expected water quality and environmental benefits, protect public safety, meet legal standards, and protect communities' financial investments.[54]

Just like traditional pavement surfaces, maintenance is essential for permeable pavements. Rainscaping Iowa, a statewide initiative championing infiltration-based stormwater management practices, underscores the necessity of crafting a comprehensive maintenance strategy and conducting regular inspections for these pavements. Following storm events, visually assessing the pavers for any signs of ponding is recommended. Scheduled cleaning with a vacuum truck is essential to prevent plugging, as sand can obstruct porous spaces and should be avoided. Additionally, organic materials such as dirt or leaves must be promptly removed. Surrounding soils should be stabilized with permanent vegetation or relevant cover to prevent sediment from clogging the pavement surface. Immediate stabilization of surrounding soil is crucial to prevent sediment from encroaching onto the pavers. Lastly, it's important to refrain from staging landscape materials such as mulch or soil directly on the pavers.[55]

Section 8.3 of the Iowa Department of Natural Resources' Iowa Storm Water Management Manual details the need for maintaining permeable pavers through regularly scheduled maintenance and provides further details on the recommended maintenance activities. This section of the manual offers "do" and "don't" activities on or around permeable paver systems and provides cautionary tips that should be considered during the maintenance process. Details the two service types for maintaining the integrity of a permeable paver system. The Manual discusses specific types of maintenance according to the type of project for the permeable paver system, including a seasonal maintenance schedule.

In 2016, experts from the Kansas Water Organization and EPA recommended that permeable pavers receive maintenance worth approximately $1.50 per square foot. Adjusting for inflation, this rate was increased to $2, resulting in a calculated annual maintenance cost of roughly $743,844 based on the current level of implementation of the Green Alley Reconstruction Project. With an estimated total of 1,328,435 square feet of pavers upon project completion, the City of Dubuque would need to allocate approximately $2,656,870 annually for proper routine maintenance.

Incorporating advice from State Department experts in Iowa and aligning with the guidelines established by the Iowa Department of Natural Resources, including their Iowa Storm Water Management Manual and the Permeable Pavers Maintenance Requirements from Clean Water Iowa Org, is essential for communities seeking to maintain their permeable paver systems effectively. Following these recommendations ensures the proper upkeep of the system, enhancing its capacity to retain stormwater and mitigate flooding while also improving water quality in the area. Localities such as Clinton in Iowa rely on these resources to uphold the integrity of their permeable paver systems, thereby guaranteeing their long-term functionality.

Water Resources Engineer for the Iowa Flood Center, Dan Gilles, PE, also mentions how as parts of the permeable pavement system get saturated, clogged, or overwhelmed, performance will decrease. This further solidifies the notion that an important part of keeping a permeable paver system functioning properly is by performing regular maintenance. The Clean Water Iowa Organization has a helpful document that outlines the maintenance requirements for a permeable paver system. It is significant because it provides a clear set of guidelines for ensuring the effective operation and longevity of the system. By following these maintenance tasks, the City of Dubuque can uphold the functionality of the permeable paver system. Regular maintenance is essential to keep the pavers free of debris, ensure proper drainage, address any damage or deterioration, and maintain the integrity of the system over time. Compliance with these maintenance requirements can help maximize the environmental benefits and cost-effectiveness of the permeable paver system in managing stormwater runoff and maintaining the urban environment.

Case Studies

In **Charles City, Iowa**, the assessment of stormwater infiltration through pavers is conducted via visual inspections to verify the absence of water pooling on the surface. Additionally, the city ensures the upkeep of all permeable paver surfaces by vacuuming and re-chipping them twice annually. These maintenance practices aim to uphold the effectiveness of the pavers in managing stormwater runoff and promoting infiltration.

In **West Union, Iowa**, the City maintains its permeable paver systems by conducting sweeping and re-chipping activities approximately three to four times per year. Alongside these routine maintenance efforts, visual assessments are carried out on the permeable pavers to ensure their optimal functionality. Additionally, plans are underway to implement a "constant head permeability test" as part of the assessment process, demonstrating the city's commitment to enhancing the effectiveness and longevity of its permeable paver infrastructure.

In **Clinton, Iowa**, the City conducts regular visual inspections of its permeable paver system to verify its functionality and prevent any pooling of stormwater. Furthermore, the city adheres to the maintenance management recommendations provided by the Iowa Storm Water Education Partnership. These practices reflect the city's proactive approach to managing stormwater and maintaining the effectiveness of its permeable paver infrastructure in promoting infiltration and minimizing runoff.

In **Madison, Wisconsin**, the City implements a comprehensive approach to managing stormwater and maintaining its permeable pavement infrastructure. This includes monthly street sweeping to remove debris and prevent clogging of drainage systems. Specifically, the permeable pavement undergoes vacuum assist sweeping twice annually, in spring and fall, with the aim of ensuring optimal performance. However, the effectiveness of regenerative (Crosswind) Air sweepers fell short of expectations, prompting the city to experiment with whirlwind vacuum technology. Moreover, the city actively monitors the total flow of stormwater out of watersheds following storm events and utilizes USGS protocol to track the current infiltration rate, striving to achieve a constant head/pressure. These measures underscore Madison's commitment to improving stormwater management and enhancing the functionality of its permeable pavement systems.

In **Chattanooga, Tennessee**, the city employs innovative methods to assess the effectiveness of its paver system in managing stormwater. One such approach involves the use of a ring infiltration system to test the permeability and water absorption capabilities of the pavers, ensuring they meet performance standards. Additionally, Chattanooga gathers valuable data on nutrient and pollution levels through monitoring wells, providing insights into the environmental impact of stormwater runoff. These initiatives reflect the city's commitment to sustainable stormwater management and environmental stewardship in Hamilton County.

In the **State of Minnesota**, as outlined in the Minnesota Stormwater Manual, the operation and maintenance of permeable pavement are crucial for effective stormwater management. The manual recommends monitoring the rate of sediment deposition and conducting vacuuming at least twice annually. Owners are advised to maintain detailed maintenance records to track the condition of the pavement over time. The frequency of vacuuming should be adjusted based on the intensity of use and the rate of sediment deposition on the pavement surface. A typical vacuum cleaning schedule may involve sessions at the end of winter (April) and after autumn leaf-fall (November), with at least one pass recommended at the end of winter to prepare the pavement for the upcoming season. These maintenance practices are essential for preserving the functionality and longevity of permeable pavement systems in Minnesota's stormwater management efforts[56]

The **Kansas City Missouri Water Department** underscores the importance of meticulous maintenance for permeable paver systems. Recognizing that smaller areas often incur higher mobilization costs, the department emphasizes the need for careful consideration of factors such as installation location. While exact costs can vary depending on various factors, a rough estimate provided in 2016 suggests a ballpark figure of $1.50 per square foot for maintenance. These considerations highlight the department's commitment to ensuring the longevity and effectiveness of permeable paver installations throughout Kansas City.

The **Iowa Department of Agriculture and Land Stewardship** advocates for the use of the Maintenance Guide offered by the Clean Water Iowa Organization. This template offers a comprehensive list of essential maintenance tasks for permeable pavers, along with recommended frequencies for executing these activities. By utilizing this resource, stakeholders can ensure effective maintenance practices for permeable paver installations, aligning with the department's commitment to water quality and environmental stewardship efforts in Iowa.

The **Iowa Department of Natural Resources** emphasizes the importance of proper inspection and maintenance for stormwater management, as outlined in Chapter 8 of the Iowa Stormwater Management Manual. Section 8.3, which is detailed in Chapter 2 of the report, comes highly recommended by experts from both the IDNR and the Iowa Department of Agriculture and Land Stewardship. This section serves as a valuable template for maintaining permeable paver systems effectively, providing stakeholders with guidance on ensuring the functionality and longevity of these sustainable stormwater management solutions. Interested parties can access the manual via the provided link to gain insights into best practices for permeable paver maintenance in Iowa.

Unilock, Optilock Manufacturer[57], stresses the importance of regular cleaning as part of a comprehensive maintenance plan. This routine ranges from simple sweeping or blowing to remove loose debris to occasional deep cleaning with cleaning products and water. High-pressure spray methods, sometimes incorporating water and cleaner, are effective for overall cleaning. Recommended steps include inspecting the surface for damaged units, protecting adjacent vegetation during cleaning, wearing protective clothing, and rinsing cleaning solutions thoroughly. To prevent material from becoming trapped in joints, common tools for cleaning include handheld brittle brooms, leaf blowers, rotary brush machines, broom sweepers, and regenerative air sweepers. Additionally, during winter maintenance, it is advised to equip plow scrapers with shoes or high-density plastic blades to avoid damaging paver joints and surfaces. Furthermore, only minimal amounts of de-icing salts should be applied, with excess salt removed after ice melts to preserve the integrity of the pavement.

Calculations

The City of Dubuque utilizes Cartegraph software to report the maintenance/management of their permeable paver systems. From this we were able to determine approximately how many square feet of pavers have been installed to date and how many should be installed upon project completion. Additionally, from the Cartegraph data, we gathered data pertaining to maintenance costs provided for the newly constructed Green Alleyways, once again we were able to calculate what these costs are at the current level of project completion and that once the project has been completed. In order to compare these costs with the best practices of other organizations we sought the opinion from the EPA and Lisa Treese, RLA, LEED AP, Senior Landscape Architect, Engineering Division for the Kansas City Water Organization.

To determine an effective management and maintenance schedule for permeable paver systems, we conducted research in local communities with similar projects. We engaged with representatives from organizations such as the Iowa Department of Agriculture and Land Stewardship and Unilock, the manufacturer of the Optilock paver used in the Bee Branch Watershed. Our inquiries focused on the frequency and effectiveness of maintenance practices for permeable pavers. Jon Dienst from the City of Dubuque highlighted the challenges of inadequate maintenance in their system, emphasizing the importance of regular upkeep for optimal efficiency. Without proper maintenance, permeable pavers can clog, lose efficiency, and become sources of pollution. To develop a comprehensive maintenance plan, we consulted experts such as the Iowa Department of Natural Resources (IDNR) and gathered maintenance recommendations from successful communities with permeable pavement systems.

Summary of Fiscal Responsibility Findings

The City of Dubuque utilizes Cartegraph software to report the maintenance/management of their permeable paver systems. Our calculations show that the total costs per year to maintain the Green Alleyways averages $21,222. Our estimates show that once the Green Alley Reconstruction Project has been finished and all of the traditional alleyways have been reconstructed into Green Alleyways, the total costs to maintain those alleyways following the same maintenance patterns that the City has been will be roughly $61,363.86 per year.

There are currently about 371,922 sq ft of permeable pavers installed. The City of Dubuque provides roughly $21,221.67 worth of maintenance per year. Recommendations of approximately $2 per square foot is recommended for maintaining permeable pavers. At this level, the City of Dubuque should be spending approximately $743,844 per year. When the Green Alley Reconstruction Project is finished the City of Dubuque will have approximately 956,513 sq ft of pavers and if they continue providing maintenance at the same degree as they are currently, they will spend roughly $61,363.86 per year on maintenance. Using the inflation-adjusted cost for permeable paver maintenance of $2 per sq ft, the projected annual cost for the permeable paver system when following a proper routine maintenance plan will be $1,913,026 annually.

Conclusion

Incorporating advice from State Department experts in Iowa and aligning with the guidelines established by the Iowa Department of Natural Resources, including their Iowa Storm Water Management Manual and the Permeable Pavers Maintenance Requirements from Clean Water Iowa Org, is essential for communities seeking to maintain their permeable paver systems effectively. Following these recommendations ensures the proper upkeep of the system, enhancing its capacity to retain stormwater and mitigate flooding while also improving water quality in the area. Localities such as Clinton in Iowa rely on these resources to uphold the integrity of their permeable paver systems, thereby guaranteeing their long-term functionality.

Water Resources Engineer for the Iowa Flood Center, Dan Gilles, PE, also mentions how as parts of the permeable pavement system get saturated, clogged, or overwhelmed, performance will decrease. This further solidifies the notion that an important part of keeping a permeable paver system functioning properly is by performing regular maintenance. The Clean Water Iowa Organization has a helpful document that outlines the maintenance requirements for a permeable paver system. It is significant because it provides a clear set of guidelines for ensuring the effective operation and longevity of the system. By following these maintenance tasks, the City of Dubuque can uphold the functionality of the permeable paver system. Regular maintenance is essential to keep the pavers free of debris, ensure proper drainage, address any damage or deterioration, and maintain the integrity of the system over time. Compliance with these maintenance requirements can help maximize the environmental benefits and cost-effectiveness of the permeable paver system in managing stormwater runoff and maintaining the urban environment.

ECONOMY

In the realm of urban development and policy implementation, assessing the effectiveness of interventions is crucial for making well-informed decisions. Within this context, understanding the impact of initiatives such as green alley policies is paramount. The benefits of the green alley project extend far beyond flood mitigation and stormwater management, encompassing a diverse range of advantages that surpass mere infrastructure development. Its impact and benefits are multifaceted, significantly influencing socio-economic growth and community empowerment. Therefore, analyzing the dynamics of property values adjacent to green alleyways, as well as the creation of wages through the construction of such projects, emerges as a focal point for comprehensive assessment.

Literature Review Findings

In the City of Dubuque, six Presidential Disaster Declarations were issued, with total damage estimates reaching nearly $70 million before the implementation of green alleys.[58] This underscores the significant negative impact of floods and natural disasters on the economy. Introducing green alleys becomes imperative as they offer a solution to mitigate such losses and damages, thereby lowering the risk of future economic downturns by preventing the floods and subsequent damages.

Furthermore, green alleys have the capacity to stimulate economic growth. Among their manifold benefits, one significant advantage lies in their ability to foster neighborhood revitalization, consequently elevating property values in the surrounding area. Viewed through the lens of urban economy, green infrastructure initiatives like green alleys can enhance property values by enhancing the appeal and livability of neighborhoods. As positive attributes are added to the neighborhood, property values tend to increase. This upsurge in property values can result in increased tax revenues for local governments, heightened economic activity within the area, and potentially augmented property tax revenues.

While there is no study on the impact of job creation by green alleys, a study approaches the impact of green infrastructure on jobs. Green infrastructure projects can generate job opportunities across various sectors such as landscaping, construction, and maintenance, thereby contributing to local economic expansion. Moreover, they can attract investment and spur business development, as companies may be attracted to areas boasting high-quality green spaces. This has been proven by the work of Shakya and Ahiablame (2021). They emphasize that infrastructure development and maintenance require a labor force, and green infrastructure is no different.[59] It depends on skilled and unskilled workers for construction and upkeep tasks.[60] Consequently, the demand for a consistent workforce in green infrastructure initiatives leads to the creation of green jobs, which can bolster household incomes.[61] For example, in Philadelphia, Shakya and Ahiablame (2021) project that approximately 250 individuals could find employment in green jobs annually.[62] This forecast equates to an estimated present value of $125 million in savings on social assistance costs (including expenses for food stamps and homelessness support) over a 40-year span.[63] Similarly, in Milwaukee, the introduction of green jobs is expected to yield an annual reduction of $5.5 million in social assistance expenses, amounting to a present value of $68 million over a 20-year period.[64]

Approaching the subject from an environmental economics standpoint, green infrastructure offers cost-effective solutions to environmental challenges such as stormwater management, air and quality enhancement. Air quality enhancement refers to the economic benefits derived from improving the quality of air in urban areas. Poor air quality can lead to health problems, reduced productivity, and increased healthcare costs, all of which have economic implications. By investing in green infrastructure projects that enhance air quality, such as planting trees and creating green spaces, governments can mitigate these negative economic impacts. By integrating natural elements into urban landscapes, green infrastructure endeavors can diminish costs, thereby saving funds for governments and taxpayers in the long term.

Moreover, green infrastructure projects, including green alleys, often receive funding from the federal and state governments. The ongoing green alley initiative of the city of Dubuque, for example, is financed through the State Revolving Fund (SRF), allocated by Congress and administered by the Environmental Protection Agency (EPA).[65]

Khoshnava and colleagues' research (2020) underscores the role of green infrastructure in fostering economic growth.[66] Their findings suggest that integrating green infrastructure with principles of the green economy can yield significant benefits across various dimensions of sustainable development, notably contributing to economic prosperity. The study emphasizes the importance of prioritizing specific criteria within green infrastructure projects, including affordability, resource efficiency, energy efficiency, and air quality, all of which collectively enhance economic growth. Furthermore, the research identifies effective combinations of these criteria that can optimize positive impacts on the economy, particularly in implementing green economy initiatives. Hence, while the study acknowledges the broader benefits of green infrastructure beyond economic aspects, it underscores its crucial role in promoting economic prosperity within the framework of sustainable development.

Mell and colleagues (2016) conducted a study in the UK on residents' willingness to pay for living near green infrastructure, which indirectly impacts the economy.[67] As more individuals express a willingness to pay for proximity to green infrastructure, it positively influences economic conditions.[68] The findings from The Wicker investigation support this notion, indicating that people are willing to pay higher rents or mortgages to reside in urban areas perceived as greener and more functional.[69] Their willingness to pay extra is based on their valuation of the physical, social, and economic benefits associated with urban green spaces. Preferences are stronger for areas with more greenery, but the quality of physical infrastructure is also significant.[70] Various types of green investments should be assessed to ensure they offer optimal economic value.[71] Favorable perceptions of green investments are also tied to location management, with well-maintained areas being more highly regarded.[72] Locations with appealing visuals, good accessibility, and abundant greenery are particularly valued by residents.[73] Consequently, when a location is seen as visually appealing, easily accessible, and rich in greenery, residents are more inclined to pay a premium for green infrastructure.[74] Investing in green infrastructure can enhance the economic viability of urban development projects, particularly when addressing local demands for green and open spaces.[75]

Calculations

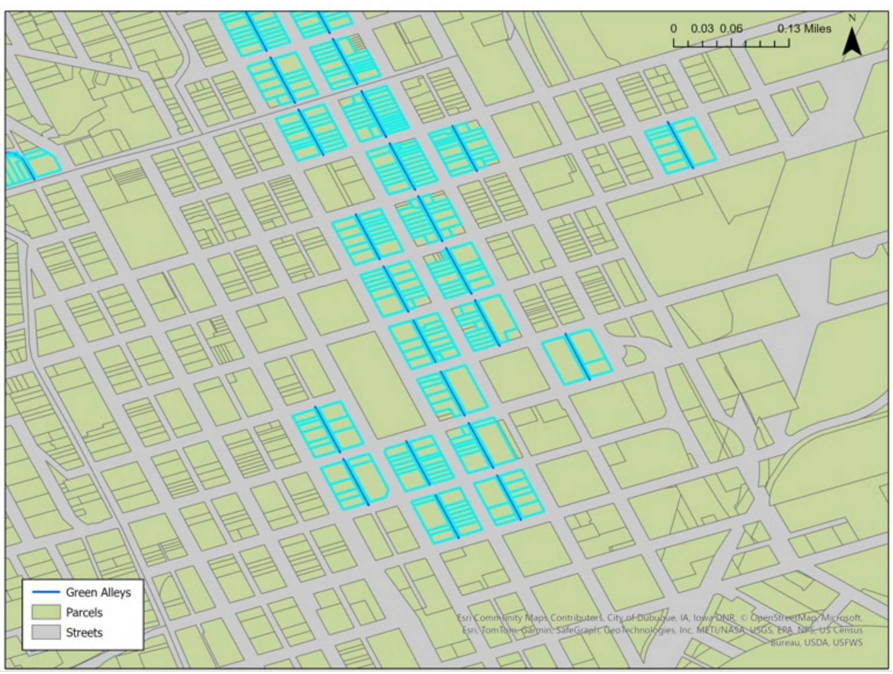
Project Impact on Adjacent Property Values

Simply analyzing properties adjacent to green alleys is insufficient to determine whether the project has affected property values. To accurately assess this impact, a comparative approach known as the difference-in-differences method is employed. This method involves establishing a comparison group, parcels within a census track within downtown, to measure changes in property values relative to those adjacent to green alleys. To calculate the total wages generated through the construction of green alleys, this study employs a straightforward estimation method based on wages defined by the U.S. Department of Labor under the Davis-Bacon and Related Acts.

The difference-in-differences (DID) method is a statistical technique used to estimate the causal effect of a treatment or policy intervention. It compares changes in outcomes over time between a group that receives the treatment (the treatment group) and a group that does not (the comparison group). The key idea behind DID is to control for time-invariant differences between the treatment and comparison groups by differencing the changes in outcomes over time for both groups. By doing this, the method aims to isolate the effect of the treatment from other factors that may be influencing the outcome.

Property parcels adjacent to green alleys in the city of Dubuque, IA, are identified using ArcGIS Pro and designated as the treatment group. A comparison group is formed using parcels from a selected census track within downtown of the city, chosen for its relative similarity to the treatment group in terms of relevant characteristics.

Figure 12: Selection of Parcels Adjacent to Green Alleys



Comparative interrupted time series analysis is employed, utilizing two time series data points: 2012 (pre-treatment) and 2023 (post-treatment). Despite variations in alley construction timing, only these two years are analyzed due to data constraints. Property value data is sourced from Beacon Dubuque County, IA, a publicly available database providing comprehensive property information.

The total assessed value of the property is utilized, encompassing both the assessed land value and assessed building value for commercial properties, as well as the assessed dwelling value for residential properties. However, parcels without buildings or dwellings are excluded from this analysis.

Inflation is not adjusted for in the two years of the study, as both the treatment and comparison groups experience the same inflation rate. This is not a concern, as the difference-in-differences regression effectively establishes a causal relationship even in the presence of inflation. This study does not aim to calculate the actual value of property increase or decline due to green alleys, considering the inflation rate. Instead, its purpose is to determine whether the properties adjacent to green alleys experience decreases or increases compared to the comparison group after the implementation of the project.

Scope & Limitations

The scope of this study is centered on the Green Alley Reconstruction project in Dubuque, with a focus on evaluating its impact on adjacent property values and wage creation through construction.

Limited Property Data Time Series: The study faces a constraint due to the availability of property data limited to a specific time series. While the project spans from 2009 to around 2019, only data from 2012 and 2023 are accessible. This restricted time frame may not capture the full extent of long-term changes in property values resulting from the green alley project.

Comparison Group: Another limitation stems from the comparison approach employed in the analysis. The study compares property data from the treatment group (parcels adjacent to green alleys) with a single census track designated as the comparison group. Although the census track with the most green alleys is selected, this approach overlooks other census tracks that also feature green alleys. A more comprehensive approach would involve including parcels from all ten census tracks in the comparison group.

Estimation of Wage Creation During Construction

Using an average estimation that one green alley is constructed by 1 operator, 2 finishers, and 3 laborers (totaling 6 personnel) for a period of three months, working 40 hours a week, wages are calculated for both the currently completed green alleys and the projected full completion. The wages specified by the U.S. Department of Labor under the Davis-Bacon and Related Acts[76] for the city of Dubuque in 2012 are utilized for this calculation.

Limitation: Exclusion of Indirect Job Creation

The study does not address indirection job creation. This includes employment opportunities stemming from businesses benefiting from the presence of green alleys, which are not accounted for in the analysis. For example, the opening of a coffee shop due to the presence of the green alley, resulting in the employment of several local workers, is not considered.

Summary of Economy Findings

Project Impact on Adjacent Property Values

Assessing the impact of the green alley project on adjacent property values is crucial as it provides valuable insights into the broader effects of urban interventions. Changes in property values serve as indicators of economic health, community desirability, and policy effectiveness. Higher property values signify prosperity, reflecting positively on the quality of life for residents.

Before running the regression analysis, it is beneficial to examine the mean values of each treatment and comparison group, as presented in the table below. The table presents the mean property values for both the treatment (properties adjacent to green alleys) and comparison (properties not adjacent to green alleys) groups in 2012 and 2023. In 2012, the mean property value for the control group is $102,420, while for the treatment group, it is slightly lower at $102,084. However, by 2023, both groups show an increase in mean property values, with the comparison group rising to $115,496 and the treatment group significantly higher at $124,541. The difference in mean values between 2012 and 2023 indicates the change in property values over time. For the comparison group, the mean difference is $13,076, while for the treatment group, it is substantially higher at $22,457. This suggests a larger increase in property values within the treatment group compared to the comparison group over the specified time period.

However, it's important to note that while these mean differences provide insights into potential trends, they do not alone establish statistical significance or the internal validity of the study. Therefore, a more robust analysis, the difference-in-differences regression, is conducted to further examine the relationship between the green alley policy and property values, while accounting for other potential confounding factors. This regression analysis helps determine whether the observed differences are statistically significant and can be attributed to the implementation of the green alley policy, thus providing more robust evidence for the impact of the intervention.

Figure 13: Comparison of Means: Treatment and Comparison Groups

	2012	2023	Difference
Comparison	$102,420	$115,496	$13,076
Treatment	$102,084	$124,541	$22,457

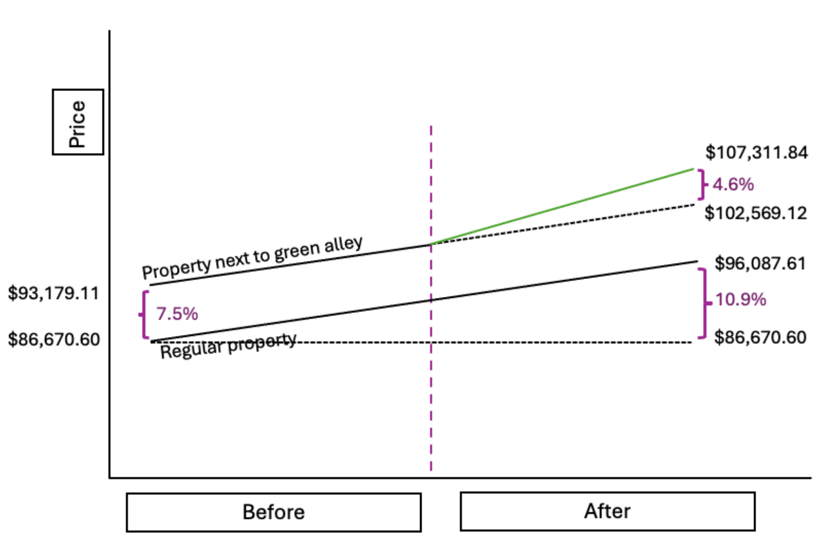
Figure 14: Difference in Differences Result

	Property Value Without Fixed Effects	Property Value With Fixed Effects
DID indicator	0.0459639	0.0459639***
	(0.0327)	(0.0148)
Green alley indicator	0.0750948***	-
	(0.0231)	
2023 indicator	0.1086529***	0.1086529***
	(0.0230)	(0.0105)
N	1,918	1,918

Standard errors are reported in parentheses.
** indicates significance at the 90% level.*
*** indicates significance at the 95% level.*
**** indicates significance at the 99% level.*
Fixed effects are used to control for all factors that remain constant within observations for instance property characteristics, location, etc.

The analysis reveals that properties adjacent to green alleys experience an increase of 4.6% compared to non-green alley properties. However, it's important to note that this does not necessarily mean that the properties next to green alleys increase by 4.6% over the observed period (between 2012 and 2023). Rather, it indicates that if the value of non-green alley properties increases by 10% over the observed period, the value of properties next to green alleys will rise to 14.6%, representing an additional 4.6% growth above the market average. This finding is statistically significant at the 99% confidence level.

Figure 15: Differences in Property Values Between Properties Adjacent to Green Alleys and a Comparison Group



Before the implementation of the green alley policy intervention, the average value of properties adjacent to green alleys is 7.5% higher compared to those in the comparison group. The average value of a regular property is $86,670, while properties adjacent to green alleys average $93,179. The properties in the comparison group are expected to increase, on average, by 10.9%, representing the natural market growth, resulting in a value of $96,087. Similarly, properties adjacent to green alleys would experience the same rate of increase without the policy intervention, reaching a value of $102,569.

Following the policy intervention, the properties next to green alleys experience an average increase of 4.6%, resulting in a value of $107,311. This 4.6% increase surpasses the market growth rate, signifying growth initiated by the green alley policy. All calculations are based on averages, meaning that individual properties may experience a higher or lower growth rate.

To put this increase into context, the total additional value of properties adjacent to green alleys in 2023 was approximately $3.7 million. For example, assuming the total property values adjacent to green alleys before the construction of green alleys were $2 million, after one-third of the project implementation (current implementation) in 2023, they increased to $5.7 million ($2 million + $3.7 million). Assuming everything else remains constant and the property values continue to grow at the same rate, the total additional increase in property values after full implementation of the project would be approximately $11.5 million. Although these are rough estimates, they provide a general sense of the project's impact on property values.

Creation of Wages Through Construction

Wages emerge as a central element in the project's success, acting as a catalyst for fostering local prosperity and social cohesion. With a substantial workforce engaged in the construction of green alleys, the wages earned not only sustain individual livelihoods but also stimulate broader economic dynamics. These earnings circulate within local economies, stimulating increased consumer spending, generating employment opportunities in related sectors, and ultimately elevating the overall quality of life for residents. Thus, recognizing the significance of wages within the green alley project is indispensable for a comprehensive understanding of its impact on both the local economy and societal well-being.

Based on an average estimation that one green alley is constructed by 6 personnel: 1 operator, 2 finishers, and 3 laborers, for a period of three months, working 40 hours a week, this study assesses the wages generated during both the current stage of completion and the projected full implementation of the project. The wages used in this assessment are determined by the U.S. Department of Labor under the Davis-Bacon and Related Acts[77] for the year 2012.

Figure 16: Total Wages Estimation for Construction Personnel for the Project

Personnel	Hourly Wage 2012	Per day (40hrs)	Per week	Per year (52 weeks)	1/3 Project Implementation	Full Implementation
2 Finishers	21.77	348	1,741.60	90,563	1,811,264	5,433,792
3 Laborers	17.38	417	2,085.60	108,451	2,169,024	6,507,072
1 Operator	23.95	192	958	49,816	996,320	2,988,960
Total		**$ 957**	**$ 4,785**	**$ 248,830**	**$ 4,976,608**	**$ 14,929,824**

With the assumption outlined above, the total collective earnings for the six personnel amount to approximately $248,830 per year. At the current implementation stage (one-third of the project completed), their total wages accumulate to around $5 million. Upon the full implementation of the project, this cumulative figure is expected to rise to approximately $15 million.

Conclusion

The analysis of the Green Alley Reconstruction Project's economic impact underscores its significance in urban development and policy implementation. Understanding how initiatives like green alley policies affect property values and job creation is essential for informed decision-making and resource allocation.

The assessment reveals a notable increase in property values adjacent to green alleys, surpassing the market growth rate. Properties near green alleys experienced a 4.6% increase, indicating positive growth attributed to the project. Additionally, the construction of green alleys has generated substantial wages, approximately $5 million in the current stage and expected to increase to approximately $15 million upon full implementation, benefiting local economies and fostering social cohesion.

These findings underscore the project's potential to contribute to long-term economic prosperity. By continuing the project and monitoring its economic impact, policymakers can ensure that investments in green alley projects yield favorable returns and promote sustainable urban development.

In conclusion, the Green Alley Reconstruction Project demonstrates the importance of considering economic factors in urban policy initiatives. By leveraging the insights gained from this analysis, stakeholders can make informed decisions to maximize the project's benefits and enhance the overall quality of life for residents in Dubuque.

EQUITY

The impact of green alleys extends beyond their environmental benefits, potentially influencing rental housing costs and equity within communities. By analyzing median gross rent and contract rent, this study aims to uncover whether the introduction of green alleys affects rental prices, potentially exacerbating disparities in affordability. Additionally, the utilization of financial assistance programs in special assessments can demonstrate the City of Dubuque's commitment to equity in green infrastructure development. Moreover, understanding the equitable distribution of cost and benefits of the Green Alley Reconstruction Project sheds light on how such initiatives can positively impact underserved communities prone to environmental hazards.

Literature Review Findings

Green Alleys are one of many forms of green infrastructure used to manage runoff from stormwater.[78] Systems like green alleys are used to mitigate the impacts of flooding caused by heavy rainfall, safeguarding properties, and infrastructure from significant damage. These environmental challenges can exacerbate existing community issues such as economic development and poor health-outcomes.[79]Areas prone to flooding are shown to disproportionality affect historically underserved and socially vulnerable communities.[80] Therefore, green infrastructure offers communities an opportunity to enhance their resilience and achieve environmental, social, and economic benefits.[81] Green alleys have the capacity to go beyond their environmental function and act an investment for underprivileged communities. While green alleys can serve as equitable development, it can also cause a disproportionate burden for some. Communities with a motive to include green infrastructure can experience new developments like green alleys/roofs, rain gardens, and planter boxes. These are environmental investments which can increase an area’s property values, rent burden, and perceived desirability of a neighborhood.[82] The CREATE initiative labels this phenomenon as green gentrification, stemming from efforts to foster environmental sustainability within an area. When incorporating equity, it is imperative to examine the positive or negative effects green alleys can have on a community like the City of Dubuque. While equity is also understudied in green alleys, this section will incorporate studies about green infrastructure.

Wolch and colleagues examine the distribution of alleys in Los Angeles. Green alleys involve repurposing existing alleys, making their locations significant. Alleys are widely but unevenly distributed throughout the city, with a concentration in low-income Latino and, to a lesser extent, African American communities. In subregions with high alley densities (South, South Bay, and Metro), Latinos constitute more than half of the total population. Notably, the South subregion has a 2% white population, with the majority being Latino (56%) and African American (38%). Over one-third of the population in this subregion lives below the federal poverty line, including 11% of children (17 years and under). Furthermore, more than half of all households in this subregion had an annual income in 1999 of less than US $25,000. The inference drawn from the study's findings suggests that if the existing alleys in low-income Latino and African American communities were to be converted into green alleys, these particular neighborhoods would likely have a higher density of green infrastructure compared to wealthier or predominantly white neighborhoods in the city. This means that residents in these marginalized communities would potentially have greater access to green spaces and environmental amenities provided by the green alleys. Traditionally, these communities experienced dirty and unsafe alleys, so this investment in green infrastructure such as green alleys has enhanced an underserved neighborhood.

The Natural Resources Defense Council (NRDC), an international nonprofit environmental organization, found that green infrastructure improvements can add tremendous value to a property and increase rental rates. Landscaping such as trees can add seven percent to the average rental rate for an office building. Specifically for Philadelphia this can be an additional $72,150 in rental income for a medium-sized office rental property.[83] As a result, property owners benefit from green improvement that also reduces costs associated with flooding. While the impact of rent prices is unexplored in the context of green alleys, Ichihara and Cohen have found that green roofs can increase rent prices in New York. Green roofs, which are planted on rooftops, use vegetation that enables rainfall infiltration and evapotranspiration of stored water.[84] Using hedonic regression techniques, they found that apartment rent in buildings with green roofs in the Battery Park city area of New York was about 16% higher on average than apartments in budlings without green roofs in the Battery Park city area.[85] Green infrastructure can have a financial benefit for commercial property owners but may disproportionately impact low-income renters.

Green infrastructure primarily serves an environmentally purpose, so it is crucial to acknowledge that equity may not be prioritized in these projects. Capturing all potential benefits and drawbacks of a green improvement like a green alley is something cities may overlook in their planning process. A study done by the Cary Institute of Ecosystem assessed the overall equity in 122 city plans using the term green infrastructure for 20 different-sized US cities.[86] Their findings suggest that city plans fail to achieve equity by not specifying methods, processes, implementation, and evaluation. Also, very few city plans acknowledge potential negative impacts or uneven investment that may occur in green infrastructure. This study evaluated Chicago's green infrastructure strategy, which incorporated green alleys, and found no mention or definition of equity impacts.[87] The four plans reviewed have no discussion of possible disparities created in their improvements and the uneven distribution of present hazards. Cary Institute of Ecosystem also evaluated whether city plans incorporate input from communities, and the Chicago green infrastructure plans do not appear to include stakeholders or a process for this. Lack of equity is prevalent in environment-focused planning such as green alley, but it is imperative to include equity consideration to ensuring residents benefits equitably from such initiatives.

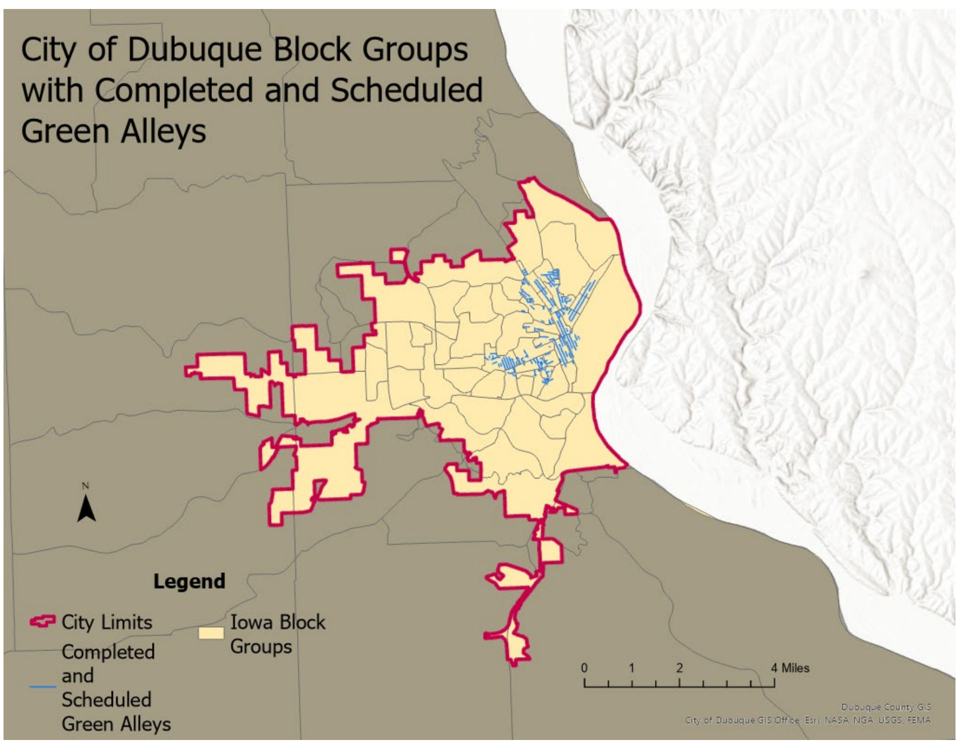
In the context of the green alley projects in Dubuque, Iowa, the primary goal is to address flooding, aligning with the objectives of many green alley projects in the US. The selection of project locations is informed by flood-prone areas, as identified in the Drainage Basin Master Plan (DBMP), a comprehensive $275,000 study commissioned by the city in 2001. The DBMP identified approximately 1,150 homes and businesses at risk during heavy rainfall. The City of Dubuque strives to be a viable, livable and equitable community.[88] In order to achieve this goal, it is crucial to address the impact green alleys have had on the equitable distribution of benefits and unintended consequences among different racial and socio-economic groups. While the equity perspective may not clearly be defined for the green alley reconstruction project, it is vital in order to foster accountability for the City of Dubuque and ensure the success of the remainder of this project.

Calculations

This study relies on publicly available data sources, primarily utilizing the American Community Survey. Block group data is utilized for the impact categories analyses.

Our assessment of impact categories uses block group data. Using an ArcGIS file of the green alleys completed and scheduled, our team was able to collect the respected block groups, figure 23 demonstrates this. Our evaluation will focus solely on block groups with completed green alleys, block groups with scheduled green alleys, combination of both block groups with completed and scheduled green alleys, and block groups without completed or scheduled green alleys. Based off figure 23, there are seventeen block groups with completed green alleys. In comparisons there are eight block groups with scheduled green alleys. Our evaluation chose ten block groups without green alleys based on their proximity to downtown and their connection to or adjacency with block groups featuring green alleys. The impact categories discussed in this section will utilize data for some or all block groups with completed, scheduled green alleys, and without green alleys.

Figure 17: City of Dubuque Block Groups with Completed and Scheduled Green Alleys

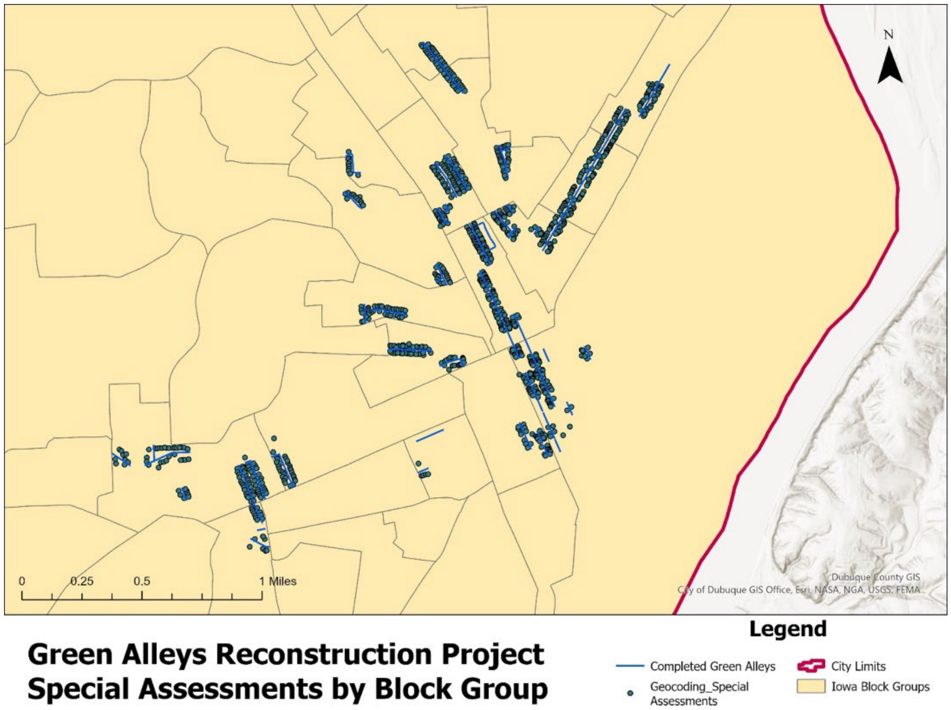


Impact on rental housing costs

Using a difference-in-difference method and capturing percentage change on rental housing costs before and current implementation of the Green Alley Reconstruction Project, this study is able to assess median gross and lower contract rent. This study employs a difference-in-differences approach to analyze whether the median gross rent in block groups with green alleys changes before and after the implementation of the project compared to block groups that do not have green alleys. This study uses eight block groups with green alleys and ten block groups without green alleys included in the analysis. Eight block groups with green alleys were used because they were the only block groups out of seventeen with values for median gross rent for the years analyzed. Two time series datasets, covering the periods 2005-2009 and 2018-2022 from ACS data is utilized. The 2005-2009 data serves as the "before project implementation" period, while the 2018-2022 data is designated as the "after project implementation" period. The same analysis was done for lower contract rent, using seven block groups with scheduled green alleys and seven block groups without green alleys. Seven block groups with scheduled green alleys were used because they were the only block groups out of eight with values for the years analyzed. Similarly, seven block groups without green alleys were used because they were the only block groups out of ten with values for the years analyzed.

When capturing the percentage change on rental housing costs, this study uses ACS data from 2005-2009 as "before implementation" of the Green Alley Reconstruction Project and ACS data from 2018-2022 as the "after implementation" of the project period thus far. Using block group data, this study evaluates median gross rent for eight block groups with completed green alleys, eight block groups with scheduled green alleys, and eight block groups without green alleys. These block groups were chosen based on availability of data for median gross rent for the year analyzed. To calculate percentage change, we used the formula of (new value-old value)/old value * 100%, where the old value is 2005-2009 rental cost and the new value is 2018-2022 rental cost. The same analysis was done for lower contract rent for seven block groups with completed green alleys, seven block groups with scheduled green alleys, and seven block groups without green alleys. These block groups were chosen based on the availability of data for lower contract rent between the years analyzed. This section also included the City of Dubuque's percentage change of median gross rent and lower contract rent between 2005-2009 and 2018-2022 to compare.

Figure 18: Geocode of special assessments of Green Alley Reconstruction Project



Utilization of financial assistance among vulnerable households

Since this study did not have access to individual socioeconomic data for property owners that received special assessments, this study relied on block group ACS data. Of the special assessments received from our project partner, ArcGIS pro was used to geocode all the addresses that received special assessments and financial assistance. This was overlayed with an ArcGIS pro layer of the green alleys completed. Both of these layers were overlayed with the block groups within the City of Dubuque. After this was complete, we were able to find which block groups these addresses belong to in order to find socioeconomic data on them. Of the 1,059 special assessments, we found eight census track and seventeen block groups. We then created a table to assess each block group based on number of special assessments, number of people that received financial assistance, percentage of renters, percentage of homeowners, percentage non-white, household income in the past 12 months below $50,000, percentage below the poverty line, and percentage above the poverty line. Using the 2023 financial application for special assessment and including these topics will give us somewhat of an analysis on how equitable this policy has been.

Equitable distributions of costs and benefits

Since we did not have access to individual socioeconomic data of residents with green alleys, this study relied on block group ACS data. Our team used an ArcGIS pro file of the completed and scheduled green alleys. We then layered this file with a file of block groups within the City of Dubuque. Given the study's focus on the impact of green alleys, we choose to assess the green alleys that have been completed for current implementation and completed and scheduled green alleys for full implementation. Of the 80 alleys completed, we found seventeen block groups. To assesses the impact of green alleys at full implementation we include eight block groups of scheduled green alleys. Using ACS data, we choose to focus on percentage of renter occupied, percentage of owner occupied, percentage of those employed, percentage of those unemployed, percentage of household income in the past 12 months below the poverty line, percentage of income in the past 12 months at or above the poverty line for the block groups with green alleys, percentage of those with cash public assistance or food stamps/SNAP, percentage without cash public assistance or food stamps/SNAP. Alongside these ACS topics, we included the racial and ethnicity breakdown for block groups with completed green alleys and block groups with completed and scheduled green alleys. Assessing these topics for block groups with completed green alleys and block groups with completed and scheduled green alleys will give us a sense of the community receiving green alleys.

Summary of Equity Findings

Impact on rental housing costs

When conducting a difference-in-difference test for lower contract rent and median gross rent, table 37 and table 38 in the appendix indicate that both the difference-in-differences indicator and the green alley indicator are not statistically significant. Consequently, this study cannot establish any conclusive argument regarding whether the Green Alley Reconstruction Project has any impact on the median gross rent and lower contract rent.

Utilizing ACS data from NHGIS, median gross rent was found for the block groups in figure 25[89]. For block groups with green alley, one block experienced a 2% decrease in their median gross rent, five block groups experienced an increase of median gross rent ranging from 47% to 93%, and two block groups experienced an increase of median gross rent over 100%. For block groups with scheduled green alleys, three block groups experienced an increase in median gross rent ranging from 27% to 78% and one block group experienced an increase of median gross rent over 100%. Four block groups had inconclusive percentage change because values for median gross rent were missing for before or after implementation. One block group experienced an increase of median gross rent over 100%. For block groups without scheduled or completed green alleys, one block group experienced a 13% decrease in median gross rent, six block groups experienced an increase of rent ranging from 29% to 43%, and one block group experienced an increase of median gross rent over 100%. When compared to the City of Dubuque, there was 62% percentage change of median gross rent before and after implementation of the Green Alley Reconstruction Project.

While the percentage change of median gross rent for block groups with completed green alleys has a larger range than the percentage change for the City of Dubuque or block groups without scheduled or completed green alleys, it can be assumed that green alleys impact median gross rent. However, including information about block groups with scheduled green alleys, we can observe a similar trend where the median gross rent is a slightly larger range than the percentage change for the City of Dubuque or block groups without scheduled or completed green alleys. As a result, we cannot credit the discrepancy of percentage change to green alleys between block groups with completed green alleys, City of Dubuque, and block groups without completed or scheduled green alleys. A reason for this larger range in percentage change can be the concentration of the block groups closer to downtown but we cannot confidently make this statement.

Figure 19: Percentage Change of Median Gross Rent for 2005-2009 and 2018-2022

	2005-2009 (Before Implementation)	2018-2022 (After Implementation)	Percentage Change
City of Dubuque	$565	$915	62%
Block Groups with Completed Green Alleys			
	2005-2009 (Before Implementation)	2018-2022 (After Implementation)	Percentage Change
Block Group 1, CT 1	$515	$902	75%
Block Group 1, CT 3	$697	$684	-2%
Block Group 2, CT 4	$701	$1590	127%
Block Group 2, CT 5	$520	$738	42%
Block Group 1, CT 6,	$519	$1000	93%
Block Group 2, CT 6	$494	$724	47%
Block Group 1, CT 7.01	$674	$1244	85%
Block Group 2, CT 7.01	$378	$995	163%
Block Groups with Scheduled Green Alleys			
	2005-2009 (Before Implementation)	2018-2022 (After Implementation)	Percentage Change
Block Group 2, CT 1	N/A	$811	N/A
Block Group 1, CT 5	$461	$972	111%
Block Group 3, CT 7.01	$766	N/A	N/A
Block Group 1, CT 7.02	$588	$745	27%
Block Group 2, CT 7.02	$642	$966	50%
Block Group 4, CT 7.02	$543	$967	78%
Block Group 3, CT 11.04	N/A	$856	N/A
Block Group 4, CT 11.04	N/A	N/A	N/A
Block Groups without Scheduled or Completed Green Alleys			
	2005-2009 (Before Implementation)	2018-2022 (After Implementation)	Percentage Change
Block Group 3, CT 6	$573	$1651	188%
Block Group 2, CT 8.01	$625	$817	31%
Block Group 3, CT 8.01	$663	$855	29%
Block Group 3, CT 9	$1031	$895	-13%
Block Group 2, CT 11.01	$532	$721	36%
Block Group 1, CT 12.01	$508	$728	43%
Block Group 2, CT 12.01	$710	$961	35%
Block Group 2, CT 101.03	$957	$1334	39%

Utilizing ACS data from NHGIS, lower contract rent was found for the block groups in figure 26[90]. For block groups with green alleys, three block groups experienced an increase of lower contract rent ranging 6% to 57% and four block groups experienced an increase of lower contract rent over 100%. For block groups with scheduled green alleys, four block groups experienced an increase of lower contract rent ranging from 25% to 66% and one block groups experienced an increase of lower contract rent over 100%. In this analysis, three block groups were inconclusive because values for lower contract rent were missing values for before or after implementation. For block groups without completed or schedule green alleys, six block groups experienced an increase of lower contract rent ranging from 7% to 58% and once block group experiences an increase of lower contract rent over 100%. When compared to the City of Dubuque, there was 36% percentage change of lower contract rent before and after implementation of the Green Alley Reconstruction Project.

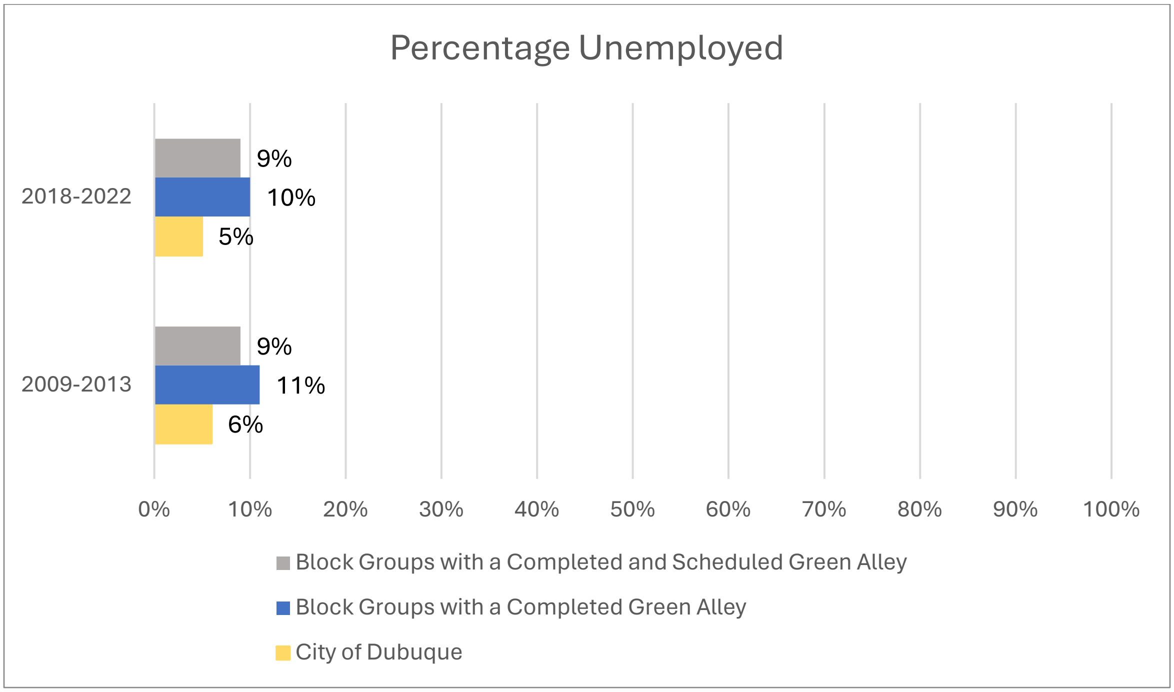
Similar to median gross rent, the lower contract percentage change analysis shows that we cannot exactly pinpoint if greens alleys are the reason for an increase lower contract rental cost. While block groups with green alleys have a higher percentage change range in lower contract rent compared to the City of Dubuque or block groups without completed and scheduled green alleys, a similar trend is observed for block groups with scheduled green alleys. Green alleys may not be sole reason for a larger percentage change range in lower contract rent, it may be the location of these block groups concentrated near downtown Dubuque, once again we cannot confidently make this statement.

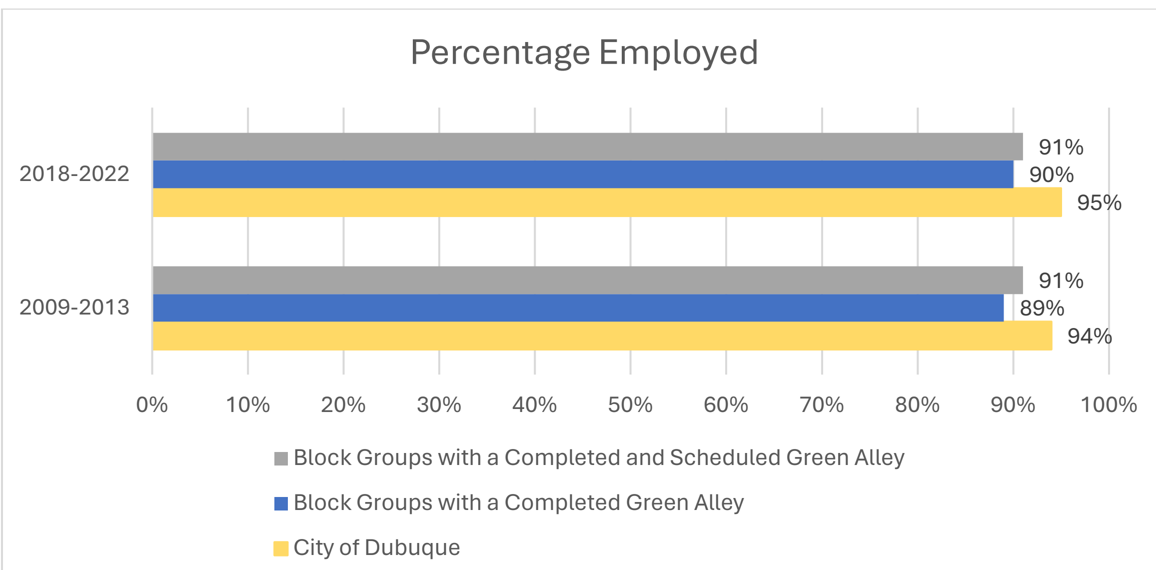
Figure 20: Percentage Change of Lower Contract Rent for 2005-2009 and 2018-2022

	2005-2009 (Before Implementation)	2018-2022 (After Implementation)	Percentage Change
City of Dubuque	428	582	36%
Block groups with Completed Green Alleys			
	2005-2009 (Before Implementation)	2018-2022 (After Implementation)	Percentage Change
Block Group 1, CT 1	244	567	132%
Block Group 1, CT 3	389	413	6%
Block Group 2, CT 4	376	906	141%
Block Group 1, CT 6,	382	413	8%
Block Group 2, CT 6	318	498	57%
Block Group 1, CT 7.01	373	891	139%
Block Group 2, CT 7.01	255	771	202%
Block Groups with Scheduled Green Alleys			
	2005-2009 (Before Implementation)	2018-2022 (After Implementation)	Percentage Change
Block Group 2, CT 1	N/A	556	#VALUE!
Block Group 1, CT 5	249	544	118%
Block Group 3, CT 7.01	390	487	25%
Block Group 1, CT 7.02	464	660	42%
Block Group 2, CT 7.02	419	629	50%
Block Group 4, CT 7.02	390	648	66%
Block Group 3, CT 11.04	N/A	680	#VALUE!
Block Groups without completed or scheduled Green Alleys			
	2005-2009 (Before Implementation)	2018-2022 (After Implementation)	Percentage Change
Block Group 2, CT 8.01	308	656	113%
Block Group 3, CT 8.01	378	592	57%
Block Group 3, CT 9	561	608	8%
Block Group 1, CT 11.01	575	618	7%
Block Group 1, CT 12.01	347	461	33%
Block Group 2, CT 12.01	604	817	35%
Block Group 1, CT 12.02	411	640	56%

Equitable distribution of costs and benefits

Figure 21: Employment statistics for block groups with Green Alleys

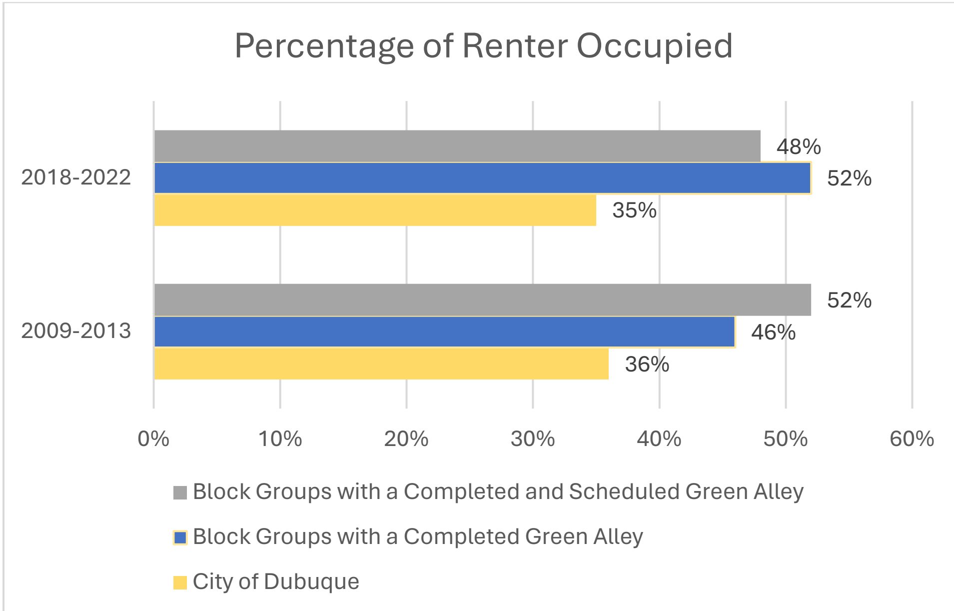


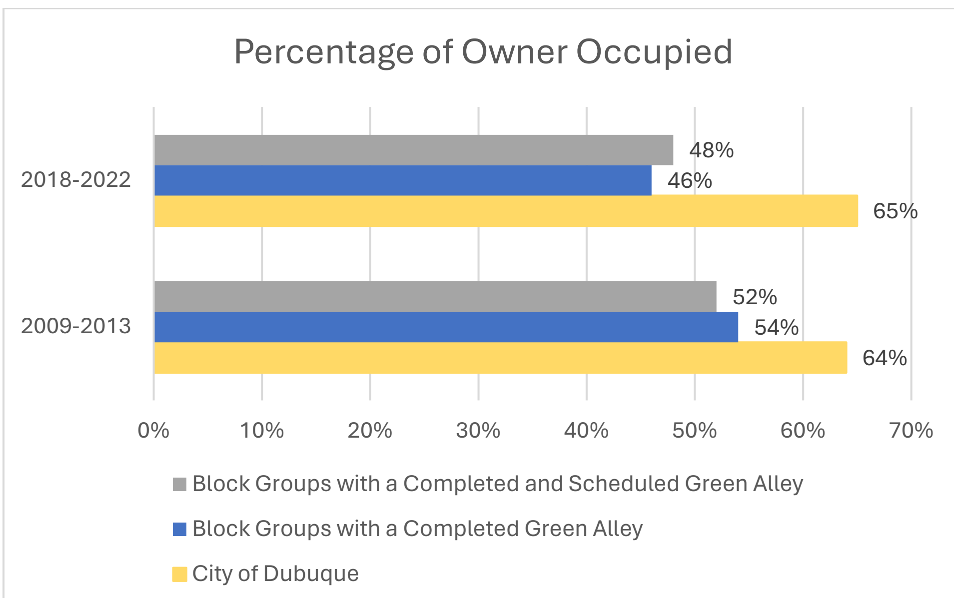


Source: 2009-2013 & 2018-2022 ACS 5-year estimate detailed tables for employment status for the population 16 years and over

Block groups with a completed green alley and block groups with completed and scheduled green alleys have had a little to no increase in employment or unemployment from 2009-2013 and 2018-2022. When compared to the City of Dubuque, block groups with a completed green alley and block groups with completed or scheduled green alleys are 4% to 5% behind in percentages of employment and unemployment.

Figure 22: Tenure statistics for block groups with Green Alleys

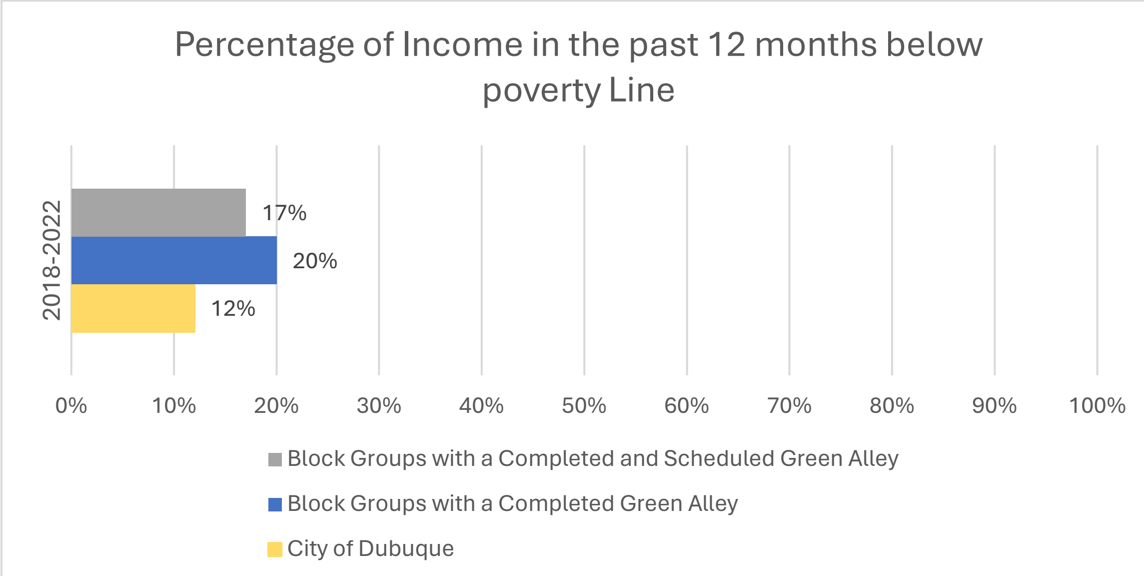


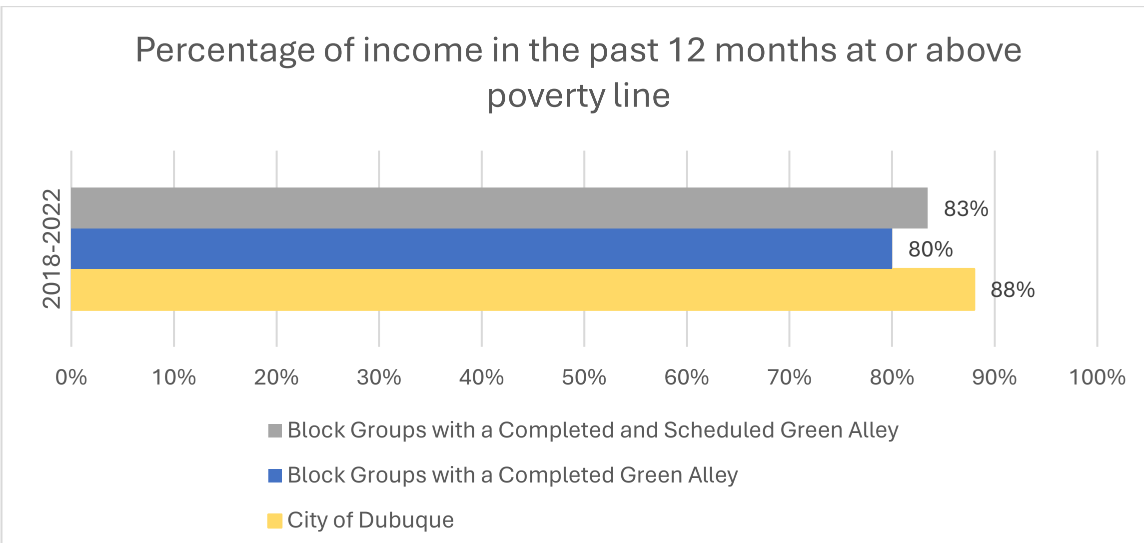


Source: 2009-2013 & 2018-2022 ACS 5-year estimate detailed tables for tenure

Block groups with a completed green alley and block groups with completed and scheduled green alleys are prominently more renter-occupied than the City of Dubuque as a whole. For current implementation to full implementation, the percentage of renters decreases by 4% and increase 4% for the percentage of owner occupied.

Figure 23: Percentage of income below, at, or above the poverty line for block groups with Green Alleys

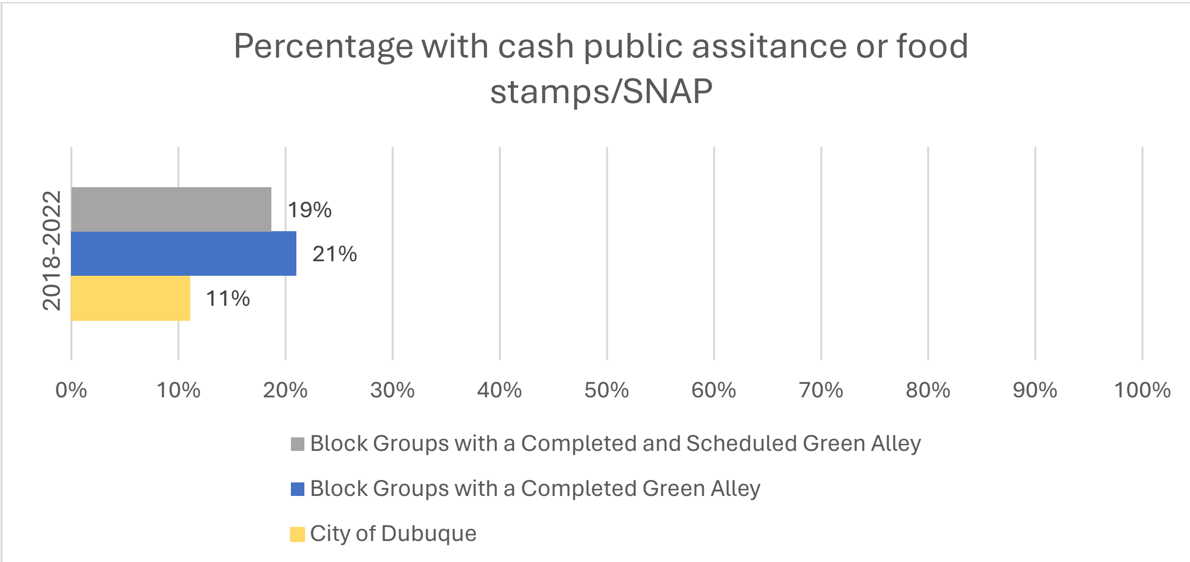


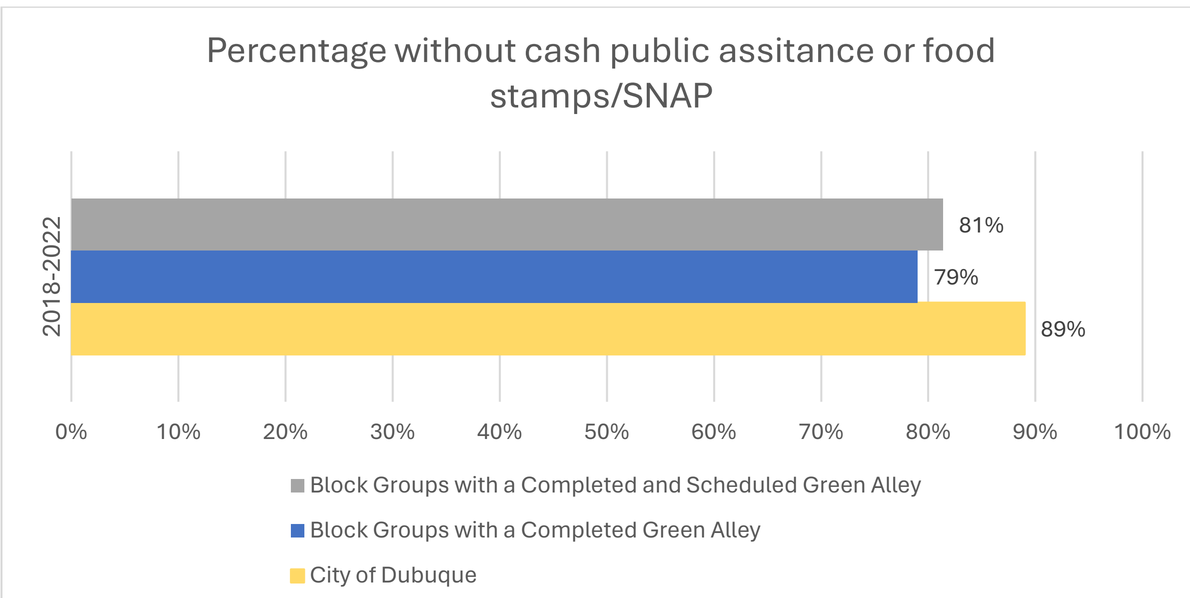


Source: 2018-2022 ACS 5-year estimate detailed tables for poverty status in the past 12 months

At current implementation, 20% of residents having an income in the past 12 months below the poverty level. At full implementation, this decreases to 17%. When compared to the City of Dubuque which is at 12% below the poverty line, block groups with a completed green alley and block groups with completed and scheduled green alleys are slightly higher.

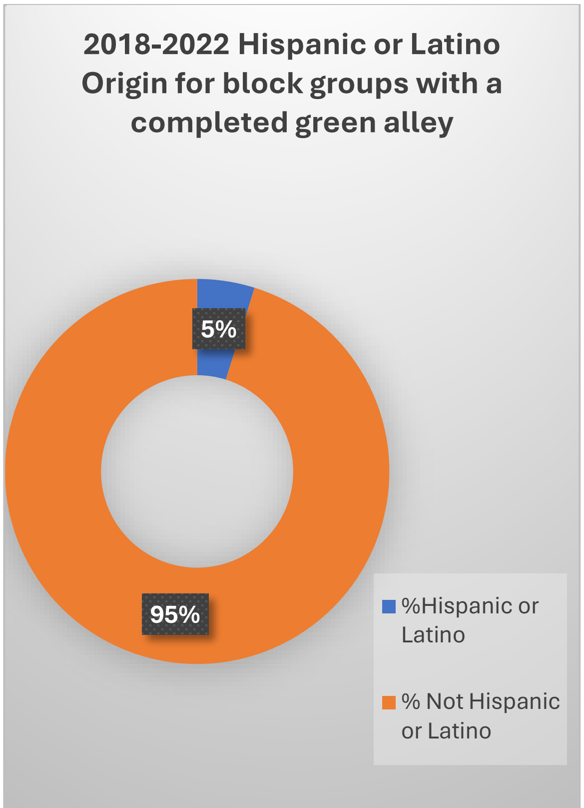
Figure 24: Percentage with and without cash public assistance or food stamps/SNAP for block groups with Green Alleys

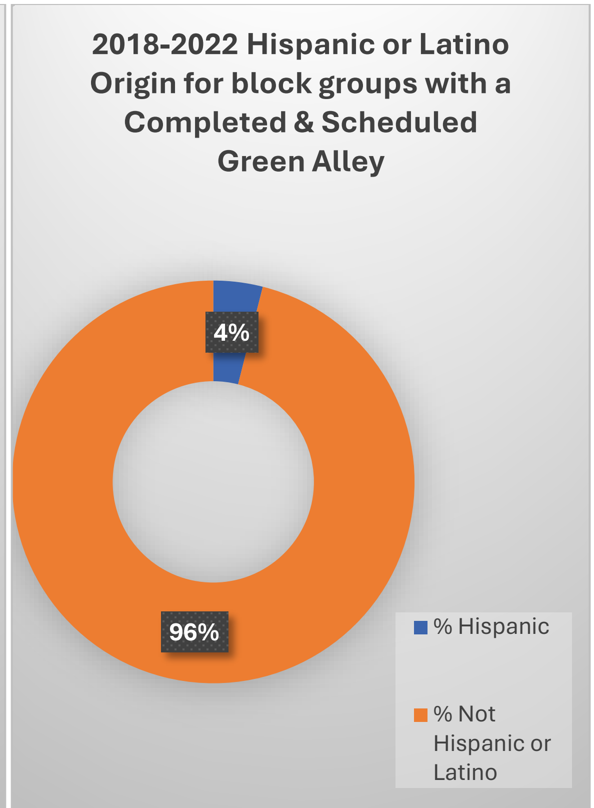


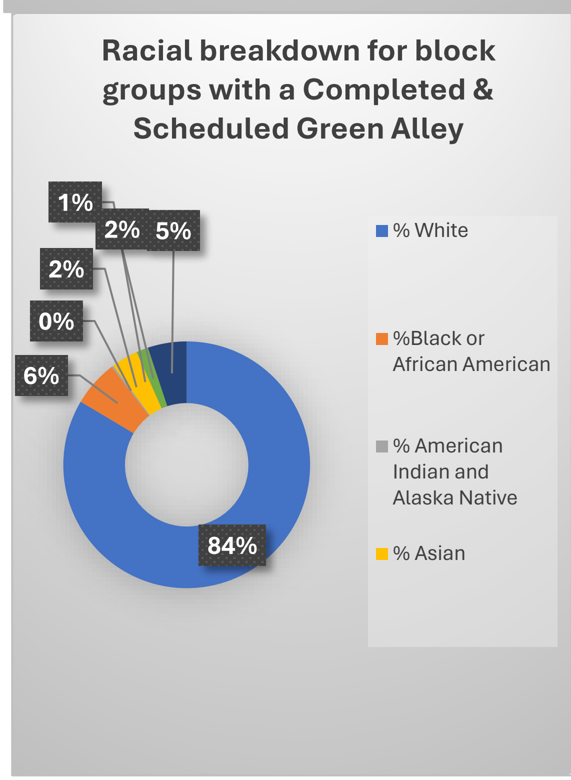


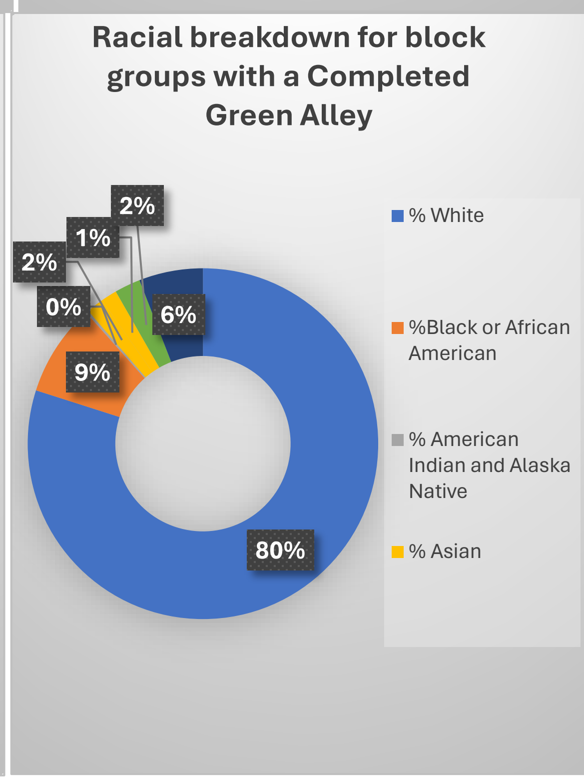
Source: 2018-2022 ACS 5-year estimate detailed tables for public assistance income or food stamps/SNAP in the past 12 months for households

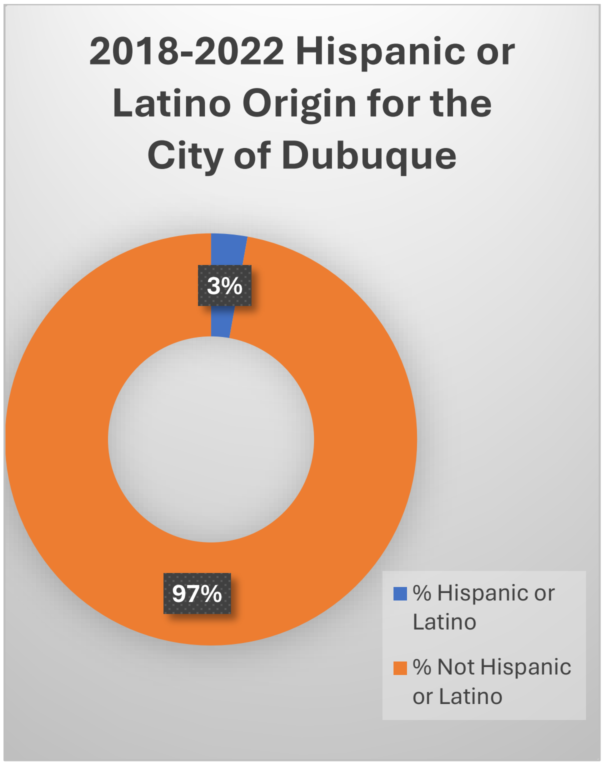
At current implementation, 21% of household use cash public assistance or food stamps/SNAP. At full implementation, this decreases to 19% but when compared to the City of Dubuque, at 11%, block groups with completed green alleys and block groups with completed and scheduled green alleys are serving a population with a slightly higher dependence on cash public assistance or food stamps/SNAP.

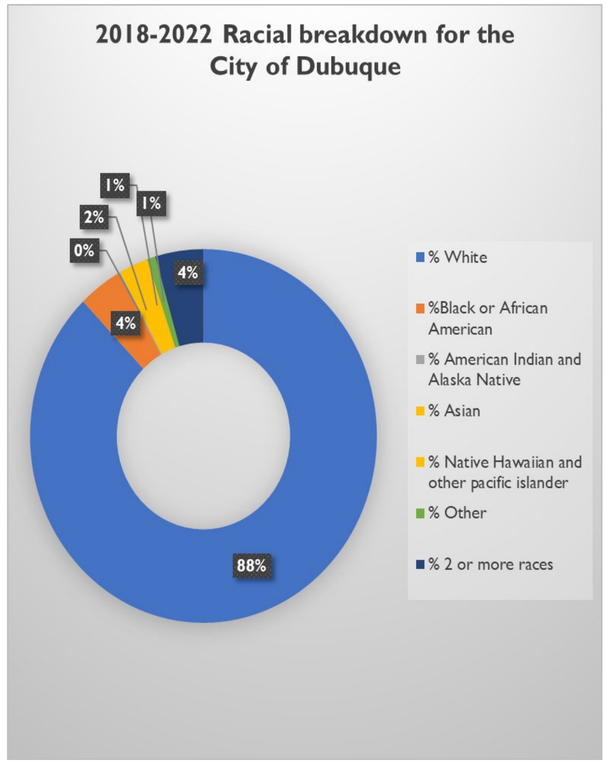

2018-2022 Hispanic or Latino Origin for block groups with a completed green alley
5%
95%
%Hispanic or Latino
% Not Hispanic or Latino


2018-2022 Hispanic or Latino Origin for block groups with a Completed & Scheduled Green Alley
4%
96%
% Hispanic
% Not Hispanic or Latino


Racial breakdown for block groups with a Completed & Scheduled Green Alley
1%
2%
5%
2%
0%
6%
84%
% White
%Black or African American
% American Indian and Alaska Native
% Asian


Racial breakdown for block groups with a Completed Green Alley
2%
1%
2%
0%
6%
9%
80%
% White
%Black or African American
% American Indian and Alaska Native
% Asian





At current implementation, green alleys are in communities with a 20% non-white population. At full implementation, this drops down to 16% non-white population. These statistics are slightly higher than the City of Dubuque's 12% non-white population.

At full and current implementation, there is no significant difference of Hispanic or Latino origin. Similarly, there is no difference when compared to the City of Dubuque.

In this analysis of ACS data, we find a neutral impact of green alleys at current and full implementation. The topics analyzed do not experience a major difference between block groups with completed green alleys and block groups with completed and scheduled green alleys. As a result, there is no group greatly benefiting or being disadvantaged by the Green Alley Reconstruction Project. When including the City of Dubuque statistics, it can be observed that areas with either completed or scheduled green alleys are serving a slightly higher number of non-white residents, unemployed residents, households with cash public assistance and food stamps/SNAP, and residents below the poverty line. This analysis also demonstrates that green alleys are developed in higher renter-occupied areas. When comparing to the City of Dubuque, the topics statistics differ by 4% to 5% for block groups with completed and scheduled green alleys, therefore this is labeled as a neutral impact. Although there is not a largely positive or negative impact of the topics, we can assume that green alleys have been a neutral investment for communities.

Utilization of financial assistance among vulnerable households

Figure 25: Special Assessment Breakdown

Total number of special assessments	1059
Total special assessments with financial assistance	68
Median special assessment with financial assistance	71%
Median special assessment	$867
Range of special assessment	$195-$20,344

Since this study is using ACS data with a large margin of error, we cannot make any conclusive statements on the special assessment program. However, using ACS data we are able to understand what percentage of residents may be eligible for financial assistance and compare that with the number of residents who received financial assistance. This section focuses on ACS topics such as household income in the past 12 months, percentage non-white, percentage below the poverty line, and percentage above the poverty line. Using the most recent income guidelines from the 2023 financial assistance application for special assessment will be used to analyze the eligibility.

Figure 26: 2023 Eligibility for financial assistance for special assessments

Family Size	Income Maximum Allowable
1	$51,900
2	$59,300
3	$66,700
4	$74,100
5	$80,050
6	$86,000
7	$91,900
8	$97,850

Figure 27: Special Assessment Evaluation

	Total housing units	Total Special Assessments	# of HH that received financial assistance	% Assessments w/ assistance	% HH Income < $50,000	% Renters (B25003)	% Non-White	Median HH Income
Census Tract 1, Block Group 1	826	126	7	6%	55%	0.86	0.18	46050
Census Tract 1, Block Group 3	521	40	0	0%	35%	0.79	0.5	60938
Census Tract 3, Block Group1	826	71	0	0%	54%	0.22	0.08	47386
Census Tract 3, Block Group 2	411	81	0	0%	47%	0.42	0.28	52431
Census Tract 4, Block Group 1	474	30	5	17%	28%	0.15	0.07	71250
Census Tract 4, Block Group 2	558	55	11	20%	50%	0.38	0.25	50865
Census Tract 5, Block Group 2	345	107	12	11%	81%	0.41	0.09	30104
Census Tract 5, Block Group 3	529	80	0	0%	92%	0.83	0.42	34688
Census Tract 5, Block Group 4	615	140	7	5%	61%	0.66	0.16	36250
Census Tract 6, Block Group 1	341	39	0	0%	27%	0.23	0.28	63750
Census Tract 6, Block Group 2	554	64	1	2%	72%	0.85	0.22	N/A
Census Tract 7.01, Block group 1	545	29	0	0%	55%	0.75	0.23	44342
Census Tract 7.01, Block Group 2	391	5	0	0%	48%	0.72	0.18	N/A
Census Tract 9, Block Group 1	763	113	14	12%	32%	0.25	0.07	58789
Census Tract 9, Block Group 2	272	23	1	4%	39%	0.17	0.16	68209
Census Tract 11.04, Block Group 1	322	12	2	17%	51%	0.43	0	N/A
Census Tract 11.04, Block Group 2	443	40	8	20%	36%	0.32	0.09	73365

For census track 1 block group 1, 6% of residents received financial assistance in their special assessment. Using ACS data on household income in the past 12 months, 55% of residents have a household income below $50,000. Based on the eligibility standards, there is an expectation for there to be more residents financial assisted.

For census tract 1, block group 2, 0% of residents received financial assistance in their special assessment. 35% of residents in this block group have a household income below $50,000. With this background on the block group income levels, there is an expectation for there to be least some financial assistance within this block group.

For census tract 3, block 1, 0% of residents received financial assistance in their special assessment. This block group has 54% of residents with a household income below $50,000. With over 50% of residents eligible for financial assistance, none is given

For census tract 3, block group 2, 0% of residents received financial assistance in their special assessment. 47% of residents in this area have a household home income below $50,000. Yet again, no financial assistance is given.

For census tract 4, block group1, 17% of residents received financial assistance in their special assessment. The number of financial assistances given matches with 28% of residents with a household income below $50,000.

For census tract 4, block group 2, 20% of residents received financial assistance in their special assessment. This financial assistance is expected based on 50% of residents with a household income below $50,000 in this block group.

For census tract 5, block group 2, 11% of residents received financial assistance in their special assessment. This percentage can be somewhat higher based on the 81% of residents in this block group with a household income below $50,000.

For census tract 5, block group 3, 0% of residents received financial assistance in their special assessment. While 92% of residents have a household income below $50,000, Therefore, there is an expectation for there to be some financial assistance because majority of this block group are within the eligibility standard.

For census tract 5, block group 4, 5% of residents received financial assistance in their special assessment. While 61% of residents in this block group have a household income below $50,000. Once again this is an expectation for there to be more financial assistance.

For census tract 6, block group 1, 0% of residents received financial assistance in their special assessment. 27% of residents in this block group have a household income below $50,000, therefore at least 1-2% of financial assistance is expected.

For census tract 6, block group 2, 2% of residents received financial assistance in their special assessment. Within this block group, 72% of residents have a household income below $50,000. There is an expectation for more than 2% financial assistance given based on the over 50% of residents with eligible income brackets.

For census tract 7.01, block group 1, 0% of residents received financial assistance in their special assessment. While 55% of residents in this block group have a household income below $50,000. As a result, there is an expectation for there to be at least 1-2% financial assistance given.

For census tract 7.01, block group 2, 0% of residents received financial assistance in their special assessment. 48% of residents within this block group have a household income below $50,000. Once again, at least one financial assistance application is expected based on the large percentage of eligible residents.

For census tract 9, block group 1, 12% of residents received financial assistance in their special assessment. The number of financial assistances given matches with 32% of residents with a household income below $50,000.

For census tract 9, block group 2, 4% of residents received financial assistance in their special assessment. While 39% of residents have a household income below $50,000. There is some financial assistance, but there is an expectation for there to be slightly more.

For census tract 11.04, block group 1, 17% of residents received financial assistance in their special assessment. Within this block group, 51% of residents have a household income below $50,000. While there is some financial assistance given, it should be slightly higher.

For census track 11.04, block group 2, 20% of residents received financial assistance in their special assessment. The number of financial assistances given matches with 36% of residents with a household income below $50,000

Based off the eligibility standards, we can observe that more households are eligible for assistance than actually receive it, however we cannot say anything definitely since we do not know the income for each special assessment. However, these numbers can be complicated by a higher percentage of renter in some block groups, which makes them ineligible for financial assistance.

Conclusion

Our analysis proves that green alleys have little to no observable impact on equity distributions within the City of Dubuque. This can be viewed positively, as green alleys have had no influence on rental costs, which is usually expected when developing green infrastructure, based on literature review. Also, green alleys have a neutral impact on communities, so this development is not negatively or positively impacting residents. Our analysis also demonstrates that green alleys are constructed in areas with a slightly higher number of non-white residents, unemployed residents, households with cash public assistance and food stamps/SNAP, and residents below the poverty line when compared to the City of Dubuque. While these are not dramatically high statistics, we can observe a neutral impact on the residents in block groups with completed or scheduled green alleys. When evaluating the utilization of financial assistance among vulnerable household, our analysis shows this is very low. While this topic is not a direct impact of green alleys, we encourage the city of Dubuque to raise awareness of this assistance. Since these analyses are nonexistent or constant among current and full implementation, equity was not considered in this policy analysis.

SUMMARY AND CONCLUSION

Improving a policy initiative is a continuous endeavor. The Green Alley Reconstruction project in the city of Dubuque was initiated in 2009 primarily to mitigate flood and stormwater issues. Today, as one-third of the project concludes, it is imperative to revisit and reassess both its successes and areas for improvement. This is crucial because public policies often have broader impacts beyond their intended goals, necessitating vigilant observation of these spillover effects by society. Therefore, the objectives of this policy analysis are to develop a set of evaluation metrics and conduct an assessment based on these metrics, utilizing publicly available data and resources.

Policy Analysis Table

The evaluation metrics encompass sustainability, economy, equity, and fiscal responsibility. For each evaluation metric, a set of impact categories has been developed. Under sustainability, the project's significant impact on environmental sustainability is assessed through four unique approaches: water quality, stormwater capture (low frequency +5-year storm events), stormwater capture (high frequency 0-5-year events), and flood mitigation. Stormwater capture (low frequency +5-year storm events) assesses how well a system manages heavy rainfall that occurs infrequently, like once every five years or more. Conversely, stormwater capture (high frequency 0-5-year events) evaluates a system's ability to handle more common rainfall events, occurring about once every 0 to 5 years. Regarding the economy, the impact of the Green Alley project on adjacent property values and wages created through construction is examined. In terms of equity, the equitable distribution of costs and benefits among different socio-economic groups is analyzed. Lastly, under fiscal responsibility, the project’s maintenance plan and construction costs are evaluated.

Based on these impact categories, the policy analysis assesses the outcomes of the existing implementation (one-third of the project) and projects the estimated outcomes of the full project implementation. This comprehensive evaluation provides stakeholders with insights into the effectiveness of the Green Alley Reconstruction project and its broader implications for Dubuque's community and environment. Such a holistic evaluation enables informed decision-making, facilitates iterative improvements, and fosters continued progress towards sustainable urban development.

Figure 28: Impact Assessment and Performance Metrics Impact Assessment and Performance Metrics

Goals/Metrics	Impact Categories	Before implementation	Current Implementation	With Recommended Maintenance	Full implementation	With Recommended Maintenance
Sustainability	Water Quality	Low, there is no permeable paver best management practice in place to improve water quality.	Low considering current degree of maintenance management	High ability to reduce the concentration of solid sediments. Medium ability to reduce total phosphorus and particulates Low ability to filter dissolved fractions	Low considering current degree of maintenance management	High ability to reduce the concentration of solid sediments. Medium ability to reduce total phosphorus and particulates Low ability to filter dissolved fractions
	Stormwater Capture (low frequency +5-year storm events)	Low (barring other Best Management Practices)	Low	Low	Low	Medium
	Stormwater Capture (high frequency 0-5-year events)	Low (barring other Best Management Practices)	Medium	Medium	Medium	Medium
	Flood Mitigation	0% additional stormwater capture	Low	1% total stormwater capture	Low	3.6% total stormwater capture
Economy	Property Value Increase	$0	$ 3.7 million		$11.5 million	
	Total Wages Created Through Construction	$0	$ 5 million		$ 15 million	
Fiscal Responsibility	Maintenance Plan	$0	$21,221.67	$743,844	$61,363.86	$2,656,870
	Construction Costs	$0	$10 million	$10 million	$57 million	$57 million

While four evaluation metrics were developed, this table only presents three, with equity excluded due to its relatively consistent impact across both current and full implementation stages.

Sustainability

The project's impact on improving water quality is rated as low in both the current implementation and full implementation stages. This evaluation suggests that the project's current maintenance management practices are insufficient to significantly improve water quality, and the impact heavily relies on the project's capacity, which can be enhanced through proper maintenance.

The project's effectiveness in capturing stormwater during low-frequency +5-year storm events is rated as low for both current and full implementation stages. This suggests that the project may not adequately handle heavy rainfall events that occur infrequently, such as those occurring once every five years or more. While green alleys in general are not designed for such heavy rainfall events, their ability to manage stormwater during less frequent, high-intensity storms remains a crucial aspect to consider for overall project effectiveness and resilience.

The project's ability to capture stormwater during high-frequency storm events, occurring approximately every 0 to 5 years, is rated as moderate for both current and full implementation stages. This indicates that while the project demonstrates some effectiveness in managing more common storm events, there is still room for improvement to enhance its resilience against such occurrences through an improved maintenance plan.

The project's performance in flood mitigation, specifically in terms of total stormwater capture, is low. However, generally speaking, with the current implementation covering one third of the project's intended scope, it should achieve only 1% total stormwater capture. In the envisioned full implementation, it has the capacity to achieve 3.6% total stormwater capture.

Economy

The marginal property value increase shows significant growth, rising from $3.7 million in current implementation to $11.5 million in full implementation. This suggests that the project has had a substantial positive effect on property values in the area. Such an increase can have wide-ranging benefits, including increased tax revenues for the local government and improved wealth for property owners.

Similarly, the total wages created through construction have tripled, increasing from $5 million in current implementation to $15 million in full impleme`ntation. This indicates a significant boost to employment and income generation within the community. The increase in wages reflects the scale and scope of the construction activities associated with the project, which involves hiring local labor and contractors, thus contributing to the economic vitality of the region.

Fiscal Responsibility

The current maintenance plan incurs an annual cost of $21,221. However, recommendations propose a higher standard of maintenance, estimating an annual cost of $743,844, based on a rate of $2 per square foot. This means that only about 2.8% of the recommended maintenance costs have been utilized in the current implementation. The cost of full implementation under the current maintenance plan stands at $61,363 annually, whereas the recommended maintenance cost for full implementation reaches $2,656,870 annually. Without increasing the maintenance plan and costs, when the project is fully implemented, only 2.3% of the recommended maintenance costs would be allocated.

The current implementation phase involves construction costs amounting to $10 million. However, for full implementation, the expenditure escalates significantly to $57 million. Although these construction costs represent direct expenditures in hiring construction companies and do not account for local government employees' compensations, it is evident that full implementation comes at a substantial cost.

POLICY RECOMMENDATION

Effective public policies require a careful balance between benefits and costs. Upon analyzing the aggregated benefits and costs of the Green Alley Reconstruction Project, it is concluded that the project offers significant potential benefits for the community, provided sufficient maintenance plans are provided. Despite some impact categories remaining constant between the current and full implementation stages, the project has the potential to generate substantial benefits for the community.

Maintenance Plan

To maximize these benefits and ensure the project's long-term success, it is crucial to incorporate a comprehensive maintenance plan. This plan serves as the core foundation of the project's effectiveness in capturing stormwater and mitigating floods. Addressing the current shortcomings in water quality management and stormwater capture, as identified in the analysis, is essential. By implementing regular maintenance practices and investing in the recommended maintenance costs, the project can enhance its effectiveness in improving water quality, managing stormwater runoff, and mitigating floods. The maintenance plan is not only important for the success of today's green alley project but also the long-term effectiveness and sustainability of the project. By doing so, stakeholders can ensure the long-term success and sustainability of the Green Alley Reconstruction project, ultimately maximizing its benefits for the community and the environment.

We have developed a comprehensive outline, the Best Maintenance Practices For Permeable Pavers, where we compiled the best practices and recommendations from leading experts in the field. Most of the communities we spoke with stated that they follow the recommendations from the Iowa Stormwater Education Partnership which is directly from the IDNR's Stormwater Management Manual (SWMM). This manual combines the SWMM with the Iowa Department of Agriculture and the Iowa Stormwater Education Partnership's Permeable Pavement Maintenance Document.

Incorporating a WMA into the Bee Branch Watershed

The City of Dubuque would benefit from a thoughtful reevaluation of its Bee Branch Watershed Flood Mitigation Project (BBWFMP) by integrating the water quality improvement aspects mentioned in the case study earlier from the Catfish Creek Watershed Management Plan (CCWMP). This integration could take two potential paths: firstly, a consolidation of efforts into a unified watershed management plan, blending the strengths of both initiatives for a more robust strategy; or secondly, a targeted enhancement of the BBWFMP by incorporating key water quality improvement elements from the CCWMP.

Should the City of Dubuque opt for consolidation, merging the environmental sustainability endeavors of the adjacent Bee Branch and Catfish Creek watersheds into a singular, coherent blueprint would be advantageous. Such a move would entail the Bee Branch Watershed adopting the watershed management authority overseeing the Catfish Creek Watershed. Conversely, should the decision be to refine the BBWFMP while incorporating pivotal water quality enhancements from the CCWMP, the City would necessitate establishing its own independent watershed management authority.

Independent watershed management plans are typically good down a HUC 12 scale, which after some research I have confirmed the Bee Branch Watershed is in fact a HUC 12. There are enough differences between Bee Branch, which is more urbanized, and Catfish Creek, which has more stretches of spring-fed cold-water than Bee Branch to justify different approaches to management, as well, regardless of watershed size[91]

WMAs have been formed across Iowa for a variety of reasons. While the driving motivation for WMA formation may be water quality improvement and/or flood risk reduction, there are multiple benefits to cooperating with other jurisdictions within a watershed:

- Conduct planning on a watershed scale, which has greater benefits for water quality improvement and flood risk reduction.
- Foster multi-jurisdictional partnership and cooperation
- Leveraging resources such as funding, technical expertise
- Facilitate stakeholder involvement in watershed management.

The actual steps to forming a WMA in your watershed will vary based on local needs and available resources. That would lend itself to the "watershed management authority" type organization and would then enable access to the $125K watershed planning grant that the IDNR offers yearly. Additional funding to help the City of Dubuque

The Bee Branch Watershed is classified as a HUC 12 scale, indicating its suitability for an independent watershed management plan. Moreover, the differences between the Bee Branch and Catfish Creek, such as urbanization levels and water characteristics, justify tailored approaches to management despite their comparable size.

Forming a WMA offers several benefits, including conducting planning on a watershed scale, fostering multi-jurisdictional partnerships, leveraging resources like funding and technical expertise, and facilitating stakeholder involvement. This approach would also enable access to the $125,000 watershed planning grant offered by the Iowa Department of Natural Resources (IDNR) annually, providing additional funding support for the City of Dubuque.

Furthermore, funding sources like the Water Quality Initiative (WQI) and the Section 319 Nonpoint Source Pollution Control Program can significantly aid water quality improvement efforts. Pursuing additional funding opportunities, such as the USDA-NRCS funding in the Regional Conservation Partnership Program (RCPP), could further enhance resources for watershed management. However, accessing these funds often requires a high level of organization and partnership, which can be facilitated through a comprehensive watershed management plan.

In conclusion, developing a watershed management plan, either independently or through a WMA, presents an opportunity for the City of Dubuque to enhance its water quality improvement efforts in the Bee Branch Watershed. By leveraging available funding sources and fostering collaboration with stakeholders, the city can effectively address water quality challenges and promote sustainable water management practices in the region.

Other Recommendations

Establishing a robust monitoring and evaluation framework is crucial for tracking the project's progress and assessing its impact over time. This involves regular data collection, analysis, and reporting to stakeholders, allowing for timely adjustments and interventions as needed. By continuously monitoring the project's performance, policymakers can identify areas for improvement and make informed decisions to optimize outcomes.

Figure 29: Median Gross Rent Difference in Difference Result

	Median Gross Rent Without Fixed Effects	Median Gross Rent With Fixed Effects
DID indicator	0.2213233	0.2213233
	(0.1723814)	(0.1456542)
Green alley indicator	-0.2020458	
	(0.1218921)	
2023 indicator	0.3198679***	0.3198679***
	(0.1149209)	(0.0987559)
N	18	18

Standard errors are reported in parentheses.

** indicates significance at the 95% level. *** indicates significance at the 99% level.

Fixed effects are used to control for all factors that remain constant within observations.

Figure 30: Lower Contract Rent Difference in Differences Result

	Lower Contract Rent Without Fixed Effects	Lower Contract Rent With Fixed Effects
DID indicator	0.2714309	0.2714309
	(0.1925758)	(0.1817885)
Green alley indicator	-0.2942751***	-
	(0.1361717)	
2023 indicator	0.3408942***	0.3408942***
	(0.1361717)	(0.0897257)
N	14	14

Standard errors are reported in parentheses.

** indicates significance at the 95% level. *** indicates significance at the 99% level.

Fixed effects are used to control for all factors that remain constant within observations.

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