CEE 5061 - Transportation Engineering Team M. Eng Project

Renewal of Interstate 81 in City of Syracuse

Final Report

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2.0 Executive Summary

The I-81 Viaduct Replacement Project aims to address the structural, social, and environmental challenges posed by the aging highway in Syracuse, New York. Originally built to improve mobility, the viaduct has reached the end of its useful lifespan, with outdated design features leading to high accident rates and safety concerns. The elevated highway also caused significant social harm, particularly in the historically Black 15th Ward, dividing communities and limiting economic opportunities. To resolve these issues, a Community Grid will replace the viaduct with a surface-level network of streets designed to reconnect neighborhoods, improve urban accessibility, and foster economic growth.

The Community Grid will prioritize multimodal transportation, incorporating pedestrian pathways, bicycle lanes, and enhanced public transit options, particularly along Almond Street and Erie Boulevard. New York State Route 481 will be permanently re-designated as the new I-81 to accommodate regional through-traffic, reducing congestion downtown. The project also includes significant modifications to I-690 to streamline traffic flow and improve local access, as well as innovative roundabout designs to enhance safety and reduce conflict points at key intersections.

The report outlines the anticipated benefits of the Community Grid, including improved safety through modernized infrastructure, environmental sustainability through reduced vehicle emissions, and social equity by addressing historical injustices. Comparisons are drawn with similar cases, such as the Alaskan Way Viaduct in Seattle, the Boston Big Dig Project and the Akron, Ohio Freeway Innerbelt, to demonstrate the potential for urban freeway removal to transform cities. While the project poses challenges, such as gentrification risks and construction disruptions, careful planning, community engagement, and equitable redevelopment strategies can ensure the grid meets its goals.

Overall, the I-81 Renewal Project offers Syracuse an opportunity to create a safer, more sustainable, and connected urban environment. By balancing transportation needs with social and environmental priorities, the project will foster economic revitalization and enhance the quality of life for residents. Future research and ongoing community input will be critical in addressing remaining concerns and maximizing the project's long-term success.

3.0 Team Members

3.1 Background Information

Zihao Cai is originally from Fuzhou, Fujian, China. He pursued undergraduate studies in Civil Engineering at Cornell University and is currently working toward a Master of Engineering degree in Transportation Systems Engineering.

Vincent Eynon is from Springfield, New Jersey. He received his undergraduate degree in Civil Engineering from Cornell University in 2024 and is continuing his studies at Cornell through the Transportation Systems Engineering M.Eng. program. Vincent is projected to graduate in May 2025; he hopes to pursue a career in railway engineering.

Chenkai Wang is from Shanghai, China. He is a M.Eng student in the CEE department with a focus on Transportation System Engineering at Cornell University. He received his undergraduate degree (BS) majoring in Construction Engineering and Management at Virginia Tech in 2023. Chenkai is expected to graduate in May 2025, and pursue a career in the construction engineering industry.

3.2 Research Goals

While studying this project, our team set out to:

1. Evaluate the historical impacts of freeways to understand the motivation behind urban freeway decommissioning, including the Interstate 81 Renewal Project.
2. Analyze project alternatives to assess potential outcomes and the decision-making process behind selecting the Community Grid.
3. Examine environmental impacts to evaluate changes in emissions and sustainability before and after construction.
4. Assess social impacts to determine how the project benefits local communities, particularly those historically affected by the viaduct.
5. Study traffic impacts to understand improvements in mobility, safety, and overall connectivity along Interstate 81.
6. Investigate the Community Grid and other alternatives to determine their feasibility and effectiveness.
7. Analyze the benefits and limitations of roundabouts as a key design feature within the new transportation network.

4.0 Project Motivation

Interstate 81 is an integral component of the Syracuse metropolitan area. The infrastructure serves as a major commuter route which provides access to jobs, businesses, and services in downtown Syracuse, as well as the hospitals and institutions on University Hill. This connectivity is essential since it influences the livability, economic vitality, and sustainability of Syracuse. There are approximately 100,000 vehicles that use the infrastructure every day. However, the freeway has reached the end of its useful lifespan, and several concerns surrounding its current configuration have created a demand for alternative infrastructure solutions. This report will compare the historical impacts of freeways on multiple urban centers, underlining the social, environmental, and traffic-related benefits of modifying I-81. In addition, the report will evaluate alternative solutions to the problems posed by I-81, including the construction of the Community Grid and the first-ever roundabout in Syracuse.

5.0 Introduction

The replacement of I-81 is critical due to both historical and current concerns. Years of heavy traffic have severely deteriorated the highway, which no longer meets modern engineering standards. Many sections of the road, including the viaduct, are accident-prone, with an accident rate three times the state average. This trend stems from outdated design features, such as narrow lanes, the absence of shoulders, and tight curves, which no longer conform to today's safety regulations. In addition, the aging concrete and steel components on I-81 have deteriorated well beyond their intended lifespan, and the structure no longer meets modern seismic and load-bearing codes. Widening the highway to meet modern standards would require annexing surrounding buildings, an approach that would be both disruptive and costly. A primary goal of the renewal project is to create a safer, more pedestrian-friendly thoroughfare by replacing the dangerous sections of the viaduct [1]. The new design will prioritize safety for all road users, including vehicles, pedestrians, and cyclists. Examples from successful urban infrastructure renovations will be applied to reduce accident rates and improve traffic safety. Enhancing the urban environment with wider lanes, improved traffic management, and modern safety features will help to decrease the risk of accidents and create a more secure transportation network.

In addition to its flaws as a roadway, I-81 has had a profound negative social impact on downtown Syracuse. The historically Black 15th Ward was split by the I-81 viaduct. Its construction divided the community, destroyed local businesses, and forced residents to relocate. The underpasses of the viaduct have become an infamous scar on the neighborhood, lowering property value and stifling opportunities for residents to have a sense of community. The I-81 Renewal Project aims to address these structural deficiencies while also considering the broader social, environmental, and economic challenges. By replacing the viaduct, the renewal project aims to reconnect the communities that were divided by the highway, particularly in the 15th Ward. The Community Grid Project is a key aspect of this effort, focusing on creating safer streets, improving access to local services, and fostering social equity [3]. In doing so, the renewal will help repair the historical injustices that have long plagued the area, allowing for the revitalization of neighborhoods and the restoration of local businesses.

Environmental sustainability is another critical consideration in the I-81 Renewal Project. The current viaduct has contributed to both air and noise pollution, negatively affecting the health and well-being of nearby residents. The new design will prioritize reducing pollution through the incorporation of green spaces, bike lanes, and public transportation options. These elements will help to improve the city's environmental footprint, creating a cleaner, more sustainable urban environment. In addition, modern technologies, such as smart traffic management systems, will be explored to further enhance sustainability and efficiency.

In the long term, the I-81 Renewal Project aims to transform Syracuse's transportation infrastructure into a safer, more equitable, and more sustainable system. By addressing the structural deficiencies of the aging highway while also tackling broader social and environmental issues, this project will set a new standard for urban infrastructure renewal, balancing safety, justice, and sustainability to create a better future for the city.

6.0 Scoping Statement

Project Title: Renewal of Interstate 81 in City of Syracuse

Project Stakeholders:

- **Primary:** New York State Department of Transportation (NYSDOT), City of Syracuse, local residents, and business owners.
- **Secondary:** Regional economic councils, environmental groups, and advocacy groups for sustainable urban design.

Project Objective: The project aims to replace the aging I-81 viaduct through the City of Syracuse with an improved and sustainable infrastructure solution. The primary objective is to enhance urban connectivity, improve safety, reduce congestion, and support regional economic development by reconnecting divided neighborhoods with a Community Grid.

Project Deliverables:

- Complete demolition of the current viaduct.
- Construction of the Community Grid with enhanced urban streets and pedestrian pathways.
- Comprehensive report documenting environmental and social impacts.

Topics Included:

- Demolition of the existing I-81 viaduct and construction of the new Community Grid.
- Redesign of Almond Street to include pedestrian, bicycle, and transit-friendly features.
- Reconstruction of intersections, streetscapes, and green spaces to improve accessibility.
- Installation of environmental impact mitigations, such as noise barriers and stormwater management systems.
- Public engagement to ensure community needs and concerns are integrated into the project.

Topics Excluded:

- Testing and utilization of novel construction methods.
- Life Cycle Analysis such as embodied energy in construction and waste from demolition and construction material.
- Carbon emissions measuring and evaluation.

Assumptions and Caveats:

- The project will be completed over five years, with funding support from state and federal agencies.
- Weather conditions and seasonal changes may impact construction timelines.
- Environmental regulations and community feedback may affect design and construction phases.

7.0 Expression of Contracts

The I-81 Renewal Project is divided into eight contracts, each focusing on specific construction phases to improve traffic flow, safety, and connectivity [2]. Contract 1 will reconstruct the section of I-81 at the interchange of I-481 to Business Loop 81 (BL 81) and convert I-481 to the new I-81 between Kirkville Road and the northern I-81/I-481 Interchange. Contract 2 focuses on constructing the southern interchange of BL 81 and I-81, modifying the new I-81 (former I-481) interchange with State Routes 5 and 92 in DeWitt (Exit 3), and expanding the corridor between I-690 and Kirkville Road (Exit 5). Contract 3 will create new on and off-ramps to North Clinton Street from the future BL 81 (existing I-81) and build a new bridge connecting Bear Street to future Business Loop 81 northbound. Contract 4 aims to create a new gateway to University Hill, along with the reconstruction of I-690. Contract 5 will involve the construction of BL 81, a new Northbound Exit to Colvin Street, and the replacement of the Rail Bridge over Renwick Avenue, as well as the creation of a roundabout at Van Buren Street. Contract 6 includes the reconstruction of I-690 and the West Street Interchange, enhancing access to important parts of the city. Contract 7 focuses on constructing BL 81 from I-690 to Hiawatha Boulevard, along with a new interchange at New Bear Street. Lastly, Contract 8 focuses on the construction and improvement of Almond Street, Burt Street, and Burnet Avenue, creating better urban connectivity. *Figure 1* below shows the location and schedule of each contract for the I-81 Viaduct Project.

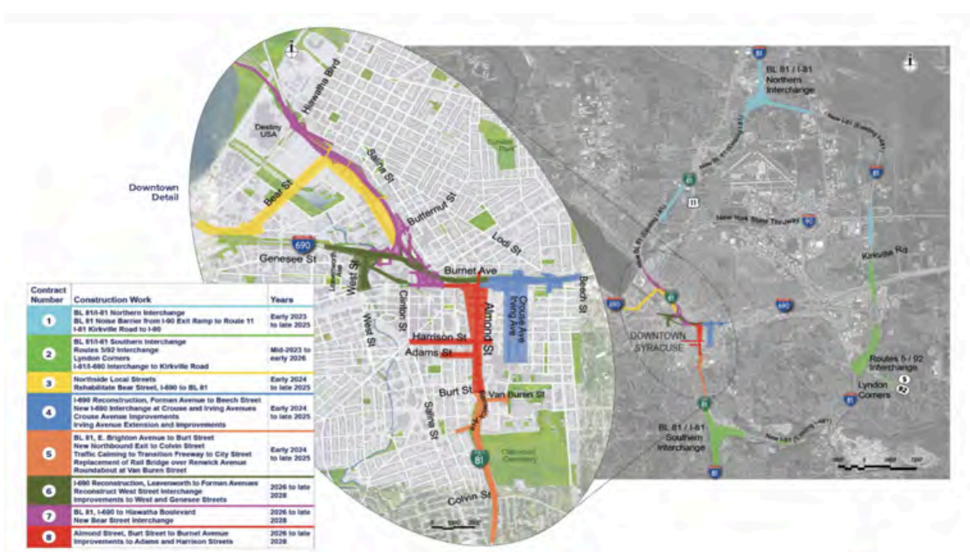

Figure 1. Illustration of The Project Site With Each Contract

8.0 The Community Grid

8.1 Overview

The Community Grid plan for the renewal of Interstate 81 (I-81) in Syracuse, New York, is a transformative approach designed to address the city's urban and infrastructural needs. It will replace the 1.4-mile stretch of highway with walkable streets. The grid will be a designated "business loop," connecting commuters from the interstate to downtown business districts. It will reclaim 25 acres of land in Syracuse, turning what is now mostly parking lots into a walkable urban space [4].

Figure 2. Render of the Proposed Community Grid

The Community Grid Alternative involves demolition of the existing viaduct between the New York, Susquehanna and Western Railway (NYS&W) bridge near Renwick Avenue and the I-81/I-690 interchange. The section of I-81 between the southern I-81/I-481 interchange (Interchange 16A) and the I-81/I-481 northern interchange (Interchange 29) would be re-designated as an interstate, and existing I-481 would be re-designated as the new I-81 and would carry a minimum of four travel lanes (two in each direction) of through traffic. The portion of existing I-81 between its northern and southern intersections with I-481 would be re-designated as a business loop of I-81 (BL 81). The character of BL 81 would vary from a high-speed facility to a signalized city street [1].

The Community Grid will also include reconstruction of I-690 between Leavenworth Avenue and Beech Street, with a partial I-81/I-690 interchange, as well as interchange modifications, bridge replacements and other features[5]. Almond Street would be reconstructed and include new pedestrian and bicycle amenities.

The renewal of Interstate 81 in Syracuse, New York, involved careful consideration of several alternatives for replacing the aging elevated highway structure. The primary options were the Community Grid, rebuilding the viaduct, or constructing a tunnel or depressed highway [1].

Rebuilding the viaduct would involve reconstructing the elevated highway so that it would meet modern standards. This would maintain a high-speed route through Syracuse but at the cost of continuing the physical division of the city created by the viaduct [6]. Additionally, rebuilding the viaduct was seen as a short-term solution, as it would likely require extensive maintenance in the future due to exposure and aging.

The tunnel or depressed highway alternative proposed a below-ground route for I-81, either through a tunnel or as a depressed roadway. This option would allow I-81 to bypass the city at the same location while eliminating the visual and physical obstruction of an elevated highway. However, constructing a tunnel or depressed highway presented major financial and engineering challenges. The project cost would be significantly higher than other options due to the complex construction requirements, high water table in the area, and potential environmental impact.

Ultimately, the Community Grid was selected for its ability to reconnect neighborhoods, promote local economic growth, and create a safer, more accessible urban environment. This option removes the viaduct entirely, replacing it with a network of city streets at ground level, and reroutes regional traffic to I-48. This approach aims to improve urban cohesion by allowing pedestrians, cyclists, and local traffic to move freely between neighborhoods that used to be separated. The community grid option is also more cost-effective than the tunnel or viaduct rebuild options, reducing future maintenance demands and minimizing environmental disruption. By choosing the Community Grid, the project team embraced a vision for downtown Syracuse that prioritizes urban livability, connectivity, and sustainable growth.

The final maintenance plan for the community grid will be a cooperative effort between state and local agencies, with the New York State Department of Transportation (NYSDOT) and the City of Syracuse playing central roles. Generally, NYSDOT will remain responsible for any roadways designated as state routes, while the city will maintain local streets and infrastructure enhancements integrated into the new grid.

Maintenance will likely include routine roadway resurfacing, winter snow removal, upkeep of bike/pedestrian facilities, street lighting, and landscaping. In the years following construction, NYSDOT and city engineers would also conduct periodic inspections of any new bridges or overpasses to ensure they continue to meet safety standards. The goal is to maintain smooth traffic flow, multimodal connectivity, and long-term infrastructure health for the newly reconnected neighborhoods.

8.2 Benefits

The Community Grid Plan for the I-81 Viaduct Renewal Project in Syracuse aims at creating a safer, more sustainable, and equitable city. By replacing the elevated viaduct with an at-grade boulevard, the Community Grid addresses key transportation challenges, enhances environmental sustainability, and fosters social cohesion.

The Community Grid fundamentally reimagines transportation in Syracuse. It prioritizes accessibility and safety for all users. The grid disperses vehicular traffic across the city rather than concentrating it on a single elevated highway. This reduces congestion at major bottlenecks and promotes smoother traffic flow through multiple routes. The project supports diverse transportation modes including walking, biking, and public transit. The newly constructed or reconstructed sidewalks, shared-use paths, and bike lanes encourage active transportation. These options reduce dependency on cars, making the city more accessible to non-drivers. Pedestrian-friendly features, including raised crosswalks and median islands, further improve safety for all road users.

Figure 3 . A More Pedestrian Friendly West Street at The Intersection of West and Genesee Streets

The Community Grid also integrates sustainable practices that mitigate the environmental impact of urban transportation infrastructure. By lowering traffic volumes on elevated highways and promoting sustainable transportation modes, the grid reduces greenhouse gas emissions and noise pollution, particularly in residential areas [7]. This improves overall public health and urban livability. The project incorporates features such as permeable pavements, rain gardens, and green spaces that enhance stormwater management. These measures reduce urban flooding risks and support local ecosystems. By creating safe and accessible pathways for pedestrians and cyclists, the grid reduces reliance on fossil-fuel-powered vehicles. Enhanced public transit options further contribute to reducing the city's carbon footprint.

Figure 4 . Birds Eye View Render of Dr. King School and Business Loop 81

Last but not least, the Community Grid addresses long standing social challenges, particularly those caused by the original construction of the viaduct. I-81 historically divided neighborhoods, particularly the 15th Ward, which was predominantly a Black community. The Community Grid removes this barrier, fostering unity and accessibility across the city. The project prioritizes the needs of marginalized communities by improving accessibility and creating opportunities for economic and social revitalization. The upgraded infrastructure supports mobility for individuals who do not have private vehicles. With the combination of reconnected neighborhoods and modern infrastructure, the project will support local businesses and attract investments, leading to job creation and economic activity.

8.3 Traffic Analysis

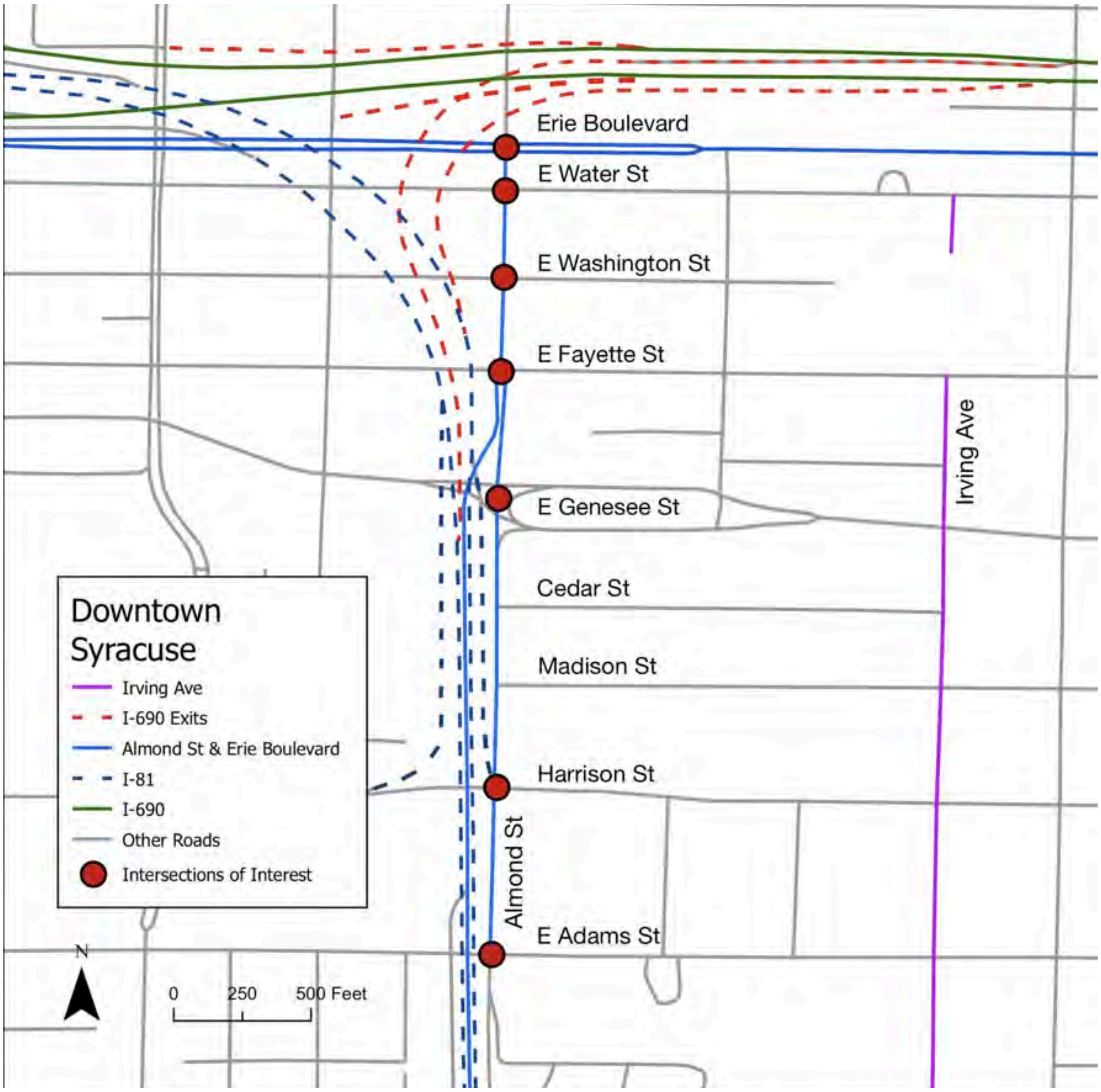

Figure 5. A Map of Downtown Syracuse, Denoting Select Streets in the Community Grid

Interstate 690

I-690 serves as a critical east-west transportation corridor through central New York, connecting major regional destinations such as Rochester and Albany. It is another viaduct that passes directly through Syracuse, experiencing average daily traffic flows of about 70,000 eastbound and 53,000 westbound vehicles when it passes through the city. I-690 is closely intertwined with I-81, the two highways intersect near the city's downtown core, creating a complex network of interchanges. The I-81 viaduct provides direct connections to I-690, however, the aging infrastructure and congestion at these interchange points have become sources of operational inefficiencies. The planned removal of the I-81 viaduct and its replacement with the Community Grid will redefine the relationship between I-690 and downtown Syracuse. The project will include the removal of partial interchanges at Townsend Street and McBride Street, which are denoted in red in *Figure 5*. This will be supplemented by the creation of a full connection at Irving Avenue, which is denoted in purple in *Figure 5*. The will be extended to intersect with Erie Boulevard where traditional on and off ramps will be implemented. Another additional connection to I-690 will occur at West Genesee Street further uptown. These changes aim to streamline traffic flow, reduce congestion, and enhance connectivity between I-690 and the restructured city grid. This component of the project will correct the current limitations of I-690's connectivity with downtown, and seeks to improve the safety, accessibility, and efficiency of Syracuse's transportation network.

Arterial Streets

Almond Street will serve as the central arterial route of the Community Grid. Currently running parallel and underneath parts of I-81, the road will undergo a significant transformation as part of the renewal project. Almond Street currently has two to four lanes, but will be widened into a four lane boulevard, with two lanes in each direction with an occasional third lane to accommodate turns at certain intersections. In the project's environmental impact statement, it is anticipated that Almond Street will absorb approximately 20% of the traffic previously carried by I-81. Improvements to Almond Street will create a safer, more multimodal corridor that reconnects neighborhoods and fosters urban accessibility.

Erie Boulevard runs parallel to I-690 and will form a key east-west link within the Community Grid, extending business loop 81 beyond Almond Street into uptown. Erie Boulevard is expected to experience a moderate increase in traffic volumes, as it already serves as an arterial route located next to I-690.

Key Intersections

Several major roads intersect with Almond Street, and their roles will evolve within the new Community Grid. East Genesee Street, Harrison Street, and East Adams Street currently provide connections to I-81 and are projected to experience significant decreases in traffic volumes since there will be more access points for traffic throughout the grid. This reduction offers an opportunity to repurpose these streets for enhanced pedestrian and local vehicular access. Single lane roads such as East Water Street, East Washington Street, and East Fayette Street have surplus capacity and are expected to see an increase in traffic as part of the grid's redistribution of vehicle flow. Partial connections at Cedar Street and Madison Street will support localized movement and improve access to residential and commercial areas.

New York State Route 481

Route 481 will be permanently redesignated as the new I-81 as part of the renewal project, serving as the primary north-south corridor for regional traffic. This shift is a cornerstone of the I-81 Viaduct Replacement Plan, as it enables the decommissioning of the existing elevated highway while maintaining regional mobility. To prepare for this role, Route 481 will undergo significant upgrades, including lane expansions, interchange improvements, and enhanced signage, ensuring it can accommodate the increased traffic volumes that previously relied on the viaduct.

The permanent re-routing of I-81 to Route 481 will significantly reduce traffic that goes directly through Syracuse. Interchanges along Route 481, such as those at Kirkville Road and Routes 5 and 92, will be modified to handle increased capacity, ensuring smooth traffic flow and reliable access for regional travelers. By diverting traffic away from the city center, Route 481 will alleviate congestion on local roads, allowing these roads to prioritize local traffic, civilian leisure, and multimodal transportation.

8.4 Other Concerns

Public Transportation

Centro, the primary public transportation provider for the Syracuse metropolitan area, does not anticipate the project will cause significant alterations to existing bus routes. Current bus routes already use many of the streets that will compose the Community Grid. Key routes that serve University Hill, Downtown Syracuse, and surrounding neighborhoods will remain operational, with minor adjustments being phased in to accommodate the changing geometries of intersections and street alignments. Centro is considering increasing service along Almond Street once it is upgraded, but this has yet to be determined. Additionally, Centro will collaborate with the New York State Department of Transportation and local stakeholders to evaluate any necessary service adjustments during construction, ensuring reliable access to jobs, education, and services across the city.

Safety

The Community Grid is designed to create a safer transportation environment by addressing the fundamental issues that made the I-81 viaduct so accident-prone. Much of the elevated highway’s safety challenges stemmed from outdated geometry that did not align with modern engineering standards, such as narrow lanes, tight curves, and the lack of adequate shoulders. In contrast, the Community Grid incorporates modern design principles that prioritize safety for all road users, including pedestrians, cyclists, and vehicles. Features like wider lanes, improved sightlines, and designated turning lanes at intersections will reduce the likelihood of collisions caused by sudden lane changes or poor visibility. The roundabouts at the north and south entrances of the business loop are specifically designed to mitigate accidents by lowering vehicle speeds and reducing conflict points. The design elements of the Community Grid implement traffic calming measures, more pedestrian-friendly infrastructure, and clear signage, which will promote safer behavior over time.

Interim Traffic Conditions

During the transition period while the I-81 viaduct is being demolished but the Community Grid has yet to be fully implemented, Syracuse will rely on a combination of traffic management strategies and temporary infrastructure to minimize disruptions and maintain mobility throughout the network. Route 481 will already have upgraded capacity and rerouted interchanges before the demolition of the viaduct begins, ensuring a reliable north south bypass for regional traffic. This expanded route will divert traffic away from downtown Syracuse, reducing congestion on local streets. For local traffic, certain portions of the Community Grid will have already been implemented, such as the connection between Irvington Avenue and I-690, and others will be phased into operation as they are completed. Temporary surface streets and detour routes will maintain local access to key areas such as University Hill and downtown businesses. Adaptive traffic signal systems along major routes can also be used to optimize traffic flow through construction areas. Lastly, enhanced public communication measures, including digital updates and signage, will keep residents informed of closures and detours.

9.0 Roundabouts

9.1 Introduction

Roundabouts are gaining popularity as a sustainable and efficient intersection design that enhances traffic flow, reduces congestion, and improves road safety. Unlike traditional intersections, roundabouts use a circular layout where vehicles navigate in one direction, yielding to circulating traffic. This eliminates the need for traffic signals and minimizes conflict points, making roundabouts an attractive option for cities like Syracuse undergoing infrastructure renewal [17].

In Syracuse, the inclusion of roundabouts as part of the I-81 Viaduct Project signifies a critical step toward modernizing urban infrastructure. Syracuse's first non-residential roundabout, located at East Brighton Avenue and the I-481 off-ramp, serves as a pilot project to demonstrate the benefits and feasibility of roundabouts in urban settings [17]. Additional roundabouts are planned at key intersections such as Van Buren Street and Colvin Street as part of the community grid realignment, aimed at improving connectivity, enhancing pedestrian safety, and reducing traffic bottlenecks [18][19].

9.2 Benefits

Roundabouts provide significant advantages over traditional intersections in terms of safety, efficiency, and environmental impact.

Roundabouts significantly reduce the frequency and severity of accidents. By design, vehicles approach at lower speeds and move in a single direction, which eliminates head-on and T-bone collisions. According to the Federal Highway Administration (FHWA), roundabouts reduce total collisions by 37%, injury-related collisions by 75%, and fatal collisions by up to 90% [17].

The city of Carmel, Indiana, which has implemented over 140 roundabouts, reported an 80% drop in injury-related accidents after converting signalized intersections to roundabouts [19]. These results demonstrate the potential for Syracuse to enhance road safety, particularly in areas with heavy pedestrian and cyclist activity.

Roundabouts also promote continuous traffic flow by eliminating the stop-and-go patterns associated with traffic signals. Vehicles yield upon entry but do not need to stop if gaps are available, reducing delays. This is particularly beneficial during off-peak hours when traffic signals can create unnecessary stoppages [18]. Studies highlight the efficiency of multi-lane roundabouts and advanced designs like turbo roundabouts, which guide traffic into specific lanes to minimize weaving conflicts. For Syracuse, incorporating bypass lanes and compact designs in high-traffic areas can further enhance traffic capacity and reduce congestion [20].

From an environmental perspective, roundabouts contribute to sustainability by reducing vehicle emissions and fuel consumption. The absence of idling at traffic lights lowers greenhouse gas emissions and improves air quality. Additionally, roundabouts require a smaller footprint compared to signalized intersections, preserving urban green spaces [20].

9.3 Challenges of Roundabouts

While roundabouts offer numerous benefits, they are not without challenges, particularly in high-traffic and urban settings.

During peak traffic hours, roundabouts can experience delays when entry volumes exceed their capacity. This issue is exacerbated by unbalanced traffic flows, where one entry point dominates circulating traffic, limiting opportunities for other vehicles to merge. To address this, engineers recommend adaptive strategies such as signalized roundabouts, where entry points are controlled by traffic lights during peak times to manage flow [20].

Another challenge is driver adaptation and education. For cities like Syracuse, where roundabouts are relatively new, driver education and clear signage are critical to ensuring smooth adoption. Initial confusion can lead to inefficiencies, especially in multi-lane roundabouts where lane navigation is more complex. Public outreach programs and temporary designs can help drivers adapt before permanent layouts are implemented [21].

9.4 Innovative Roundabout Designs

Modern roundabout designs address many of the challenges associated with traditional layouts, improving both capacity and safety. Below are four of the most practical and widely implemented roundabout designs that offer significant benefits:

Turbo roundabouts feature spiral lane markings that guide vehicles toward their exits, reducing lane-change conflicts and improving traffic flow. These are particularly effective in high-capacity intersections where weaving movements can cause congestion [20].

Bypass lanes allow right-turning vehicles to skip the roundabout entirely, minimizing delays and reducing conflict points. This design is ideal for intersections with significant right-turn volumes, ensuring smoother traffic movement while enhancing safety [18].

Compact island roundabouts are designed for urban areas with limited space. Smaller central islands encourage lower speeds, enhancing safety for pedestrians and cyclists while maintaining the benefits of traditional roundabouts [21].

Multi-lane roundabouts accommodate higher traffic volumes by providing two or more circulating lanes. Proper signage and lane markings help drivers navigate these intersections safely and efficiently, making them suitable for busy urban and suburban areas [19].

By integrating these innovative roundabout designs into urban infrastructure, engineers can address varying traffic demands and spatial constraints. These solutions ensure intersections remain safe, efficient, and adaptable to community needs.

9.5 Roundabouts in Syracuse

The East Brighton Avenue roundabout marks Syracuse's initial step toward integrating roundabouts into its traffic management system. Serving as a key connection between the new I-81 and Business Loop 81, this roundabout improves traffic flow and safety while gathering valuable data on local traffic patterns [17].

The Van Buren Street roundabout was originally planned near Dr. Martin Luther King Jr. Elementary School but was relocated following community concerns about its proximity to the school. The new site at Van Buren Street enhances pedestrian safety, reconnects the neighborhood, and supports smoother local connectivity [18]. Similarly, the Colvin Street roundabout, part of the broader I-81 Viaduct Project, addresses existing traffic bottlenecks and facilitates improved access to surrounding neighborhoods [19]. Together, these roundabouts play a crucial role in modernizing Syracuse's infrastructure.

Community engagement has been central to these projects, ensuring local voices guide the planning and design processes. Concerns related to pedestrian crossings, driver behavior, and traffic signage have been addressed through outreach and iterative improvements. The lessons learned from these roundabouts, particularly the East Brighton Avenue project, will inform future designs, ensuring that Syracuse's roundabouts effectively balance safety, efficiency, and community needs [20].Conclusion

Roundabouts represent a forward-thinking approach to traffic management, offering significant safety, efficiency, and environmental benefits. While challenges such as peak-hour congestion and driver adaptation must be addressed, innovative designs like turbo roundabouts and bypass lanes provide effective solutions [20].

For Syracuse, the East Brighton Avenue roundabout and planned roundabouts at Van Buren and Colvin Streets demonstrate the feasibility and advantages of this intersection type. By incorporating community feedback and modern design strategies, Syracuse can position itself at the forefront of sustainable urban infrastructure development [19].

10.0 Background From Similar Decommissioning Projects

10.1 The Alaskan Way Viaduct

Introduction

The Alaskan Way Viaduct, built in the early 1950s, was a double-decked elevated highway that formed part of State Route 99 (SR 99) in Seattle, Washington. Stretching along the city's waterfront, the viaduct was a critical north-south arterial route, offering an alternative to Interstate - 5 and providing a connection between downtown Seattle and industrial areas to the south [8]. However, the viaduct was a controversial structure. Although it alleviated traffic concerns in Seattle, it also created a physical and visual barrier between the city's downtown core and its iconic waterfront. The structure was weakened in the 2001 Nisqually earthquake, raising urgent safety concerns. Engineers discovered that the structure had weakened considerably and was at high risk of collapse in the event of another major earthquake. Because of the viaduct's age and vulnerability to earthquakes, replacing it was critical to public safety.

Figure 6. View from Above of Alaskan Way Viaduct

After years of deliberation, the state decided to replace the viaduct with a tunnel and demolish the elevated highway. A new SR 99 Tunnel, a deep-bore tunnel running beneath downtown Seattle, was constructed. The Alaskan Way Viaduct Replacement Program, with an estimated cost of $3.35 billion, started in 2007 and was completed in 2023. The program consists of 30 projects led by the Washington State Department of Transportation, King County, the City of Seattle and the Port of Seattle. The Federal Highway Administration is a partner in this effort. Funding comes from state, federal and local sources, as well as the Port of Seattle and tolls.

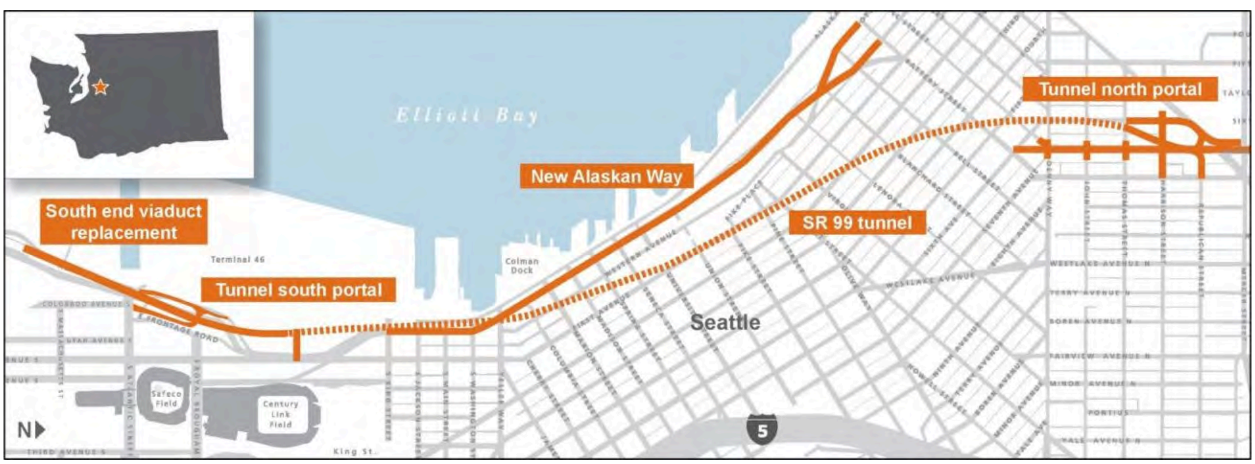

Figure 7. Proposed Plan of Alaskan Way Viaduct Replacement Program

The completion of the Alaskan Way Viaduct Replacement Project has had a profound and transformative impact on Seattle, particularly in terms of transportation, urban development, and environmental considerations. The SR 99 tunnel has successfully diverted significant traffic away from surface streets, reducing congestion in downtown Seattle. The improvements to bicycle lanes and pedestrian paths also contributed to a more multimodal transportation network, encouraging alternative means of commuting. The removal of the viaduct created new opportunities for real estate development and increased property values in the surrounding areas. The revitalization of the waterfront has spurred commercial investment, from restaurants and shops to office spaces, all benefiting from improved access and more attractive surroundings. The Alaskan Way Viaduct Replacement Project serves as a significant example of modern infrastructure planning. It highlights the role of innovative engineering, community input, and sustainable urban design in addressing complex challenges faced by growing cities.

Cost & Funding

The total cost of the project is $3.35 billion. The majority of the cost was spent on the central waterfront viaduct replacement (bored tunnel) including north and south access and new north surface street connections, which is $2.04 billion. The south end viaduct replacement costs $351 million. The central waterfront viaduct removal, new Alaskan Way surface street, and decommissioning of the Battery Street Tunnel cost $291.7 million. The environmental review and design, program management, and other projects and construction mitigation cost $441.6 million. The final cost of this project is $200 million more than the original budget, caused by the breakdown of Bertha, a massive tunnel boring machine that was among the largest of its kind at the time.

In terms of funding, a large amount of money came from the State ($2.05 billion), composed of Seattle gas taxes, state gas taxes, and tolls. The federal government provides $787.2 million, along with the $267.7 million supported by the port of Seattle.

Transportation Improvements

The Alaskan Way Viaduct Replacement Project significantly impacted transportation in Seattle, both during and after its construction. The new tunnel, which is built to modern seismic standards, enhances safety for drivers by reducing the risk of collapse in the event of an earthquake [8]. The old viaduct was highly vulnerable to seismic activity, making the upgrade urgent for safe transportation in the area. With the viaduct's removal and the introduction of the SR 99 tunnel, traffic flow through downtown Seattle becomes smoother. The tunnel's design accommodates faster-moving traffic with fewer entry and exit points than the previous viaduct, which helps reduce congestion for vehicles passing through the city. The project also restructures access points to downtown Seattle, making direct access to some areas more limited. This change necessitates route adjustments for commuters and required additional planning for drivers accustomed to the old system.

The project facilitates better integration with Seattle's public transit systems, as the SR 99 tunnel reduces surface-level traffic, making bus routes and other transit services more efficient. With less congestion on surface streets, buses can now move more freely. This improves transit reliability and encourages public transit use. The viaduct's removal also allows for a rethinking of bus routes and other transit services in the waterfront area. The new transit design helps Seattle achieve a more connected and comprehensive transit network.

Environmental Improvements

The Alaskan Way Viaduct Replacement Project brings several environmental improvements to Seattle's waterfront and the surrounding area. The removal of the viaduct and the construction of the SR 99 tunnel contributes to a reduction in vehicle emissions in the waterfront area [9]. By allowing for smoother traffic flow and reducing congestion on surface streets, the tunnel helps to minimize the amount of idling vehicles, which in turn lowers carbon emissions and air pollutants.

With the removal of the viaduct, Seattle's waterfront is revitalized, allowing for more green spaces and natural habitats. This includes the addition of native plants and trees, which help improve air quality and contribute to a healthier urban ecosystem. The demolition of the viaduct opens up valuable land along Seattle's waterfront, which is used to create new parks, trails, and recreational areas. These green spaces not only provide ecological benefits but also contribute to the mental and physical well-being of Seattle's residents by offering outdoor spaces for relaxation and exercise.

Figure 8. Seattle New Waterfront with Walkways and Park

The tunnel reduces traffic noise at street level, creating a quieter environment on the waterfront and in surrounding neighborhoods. The previous viaduct amplified traffic noise due to its elevated structure, which impacted businesses and residents in the area. With the tunnel, noise levels have dropped, improving the overall quality of life and creating a more enjoyable space for visitors and wildlife.

During the construction of the SR 99 tunnel and the new waterfront design, modern stormwater management systems were installed to prevent polluted runoff from reaching Puget Sound. This is essential for protecting the local marine ecosystem, as runoff from roads and highways often contains oil, heavy metals, and other pollutants that harm aquatic life. The updated infrastructure includes bioswales and other green stormwater infrastructure that help filter and treat rainwater before it reaches natural waterways.

Social Improvements

The Alaskan Way Viaduct Replacement Project significantly improves the city's urban landscape and social fabric. By replacing the aging viaduct with the SR 99 Tunnel and revitalizing the waterfront, the project addresses safety concerns while fostering community connectivity, economic growth, and environmental enhancements.

One of the most notable social benefits of the project is the creation of accessible public spaces along the waterfront. The removal of the elevated viaduct reconnects downtown Seattles to its waterfront, enabling residents and visitors to experience the area more freely. This transformation allows the development of pedestrian-friendly pathways, parks, and plazas that encourage outdoor activities, relaxation, and community gatherings. These public spaces enhance the quality of urban life by providing recreational opportunities and fostering a sense of community pride.

The removal of the viaduct and the enhancement of the waterfront also brings economic revitalization in the area. Local businesses, particularly those near the waterfront, have experienced increased foot traffic and customer engagement. The project’s construction phase also created thousands of jobs, boosting the local economy and supporting families in the community. In the long term, the enhanced waterfront and improved urban connectivity attract tourists and investment, reinforcing Seattle’s position as a vibrant economic and cultural hub. The waterfront’s transformation also fosters a sense of civic pride and community identity, as it redefines the city’s relationship with its iconic Puget Sound location.

Figure 9. Puget Sound, WA

Throughout the project, extensive community involvement ensured that the final design reflected the needs and aspirations of Seattle's residents. Public input played a critical role in shaping plans for public spaces, transportation improvements, and waterfront redevelopment. This inclusive approach fostered a sense of ownership and collaboration, strengthening the community's connection to the city's evolving infrastructure.

10.2 The Boston Big Dig

Introduction

The Boston Big Dig, formally known as the Central Artery/Tunnel Project (CA/T), represents one of the most ambitious and transformative infrastructure projects in U.S. history. The project aimed to solve Boston's chronic traffic congestion caused by the elevated Central Artery (I-93), a six-lane highway that cut through the city center. Initially constructed in the 1950s, the Central Artery became infamous for severe congestion, environmental degradation, and its role as a physical barrier dividing neighborhoods. Before the Big Dig, the Central Artery carried over 200,000 vehicles daily, yet rush-hour traffic speeds averaged just 10 miles per hour. These conditions led to widespread delays, noise pollution, and diminished urban livability [10], [11]. The Big Dig sought to replace this aging infrastructure with modern, sustainable solutions, reconnecting the urban landscape and addressing the city's long-standing transportation needs [12].

Project Scope and Engineering Innovations

The Big Dig's scope included a massive overhaul of Boston's transportation network, marked by groundbreaking engineering achievements. A 3.5-mile underground tunnel replaced the elevated I-93 highway, creating a more streamlined route for vehicular traffic. This tunnel not only improved mobility but also reclaimed valuable urban land previously occupied by the elevated structure. Simultaneously, the construction of the 1.6-mile Ted Williams Tunnel under Boston Harbor provided a direct connection between the city center and Logan International Airport, further alleviating congestion on surface streets and improving regional access [11], [13].

One of the most iconic components of the Big Dig was the Zakim Bunker Hill Memorial Bridge, a cable-stayed bridge that combined architectural beauty with innovative engineering. The bridge's design symbolized Boston's urban renewal, offering an efficient crossing over the Charles River while serving as a landmark structure [12], [13]. Equally transformative was the creation of the Rose Fitzgerald Kennedy Greenway, a 27-acre linear park that replaced the footprint of the elevated highway. This greenway integrated pedestrian pathways, public spaces, and recreational areas, fostering a renewed sense of community and urban engagement [13].

The project's engineering innovations were groundbreaking. Tunneling through unstable soil and maintaining groundwater levels required advanced construction techniques, such as slurry walls and tunnel jacking. The challenge of navigating beneath active roadways, rail lines, and utilities demanded precision and careful planning to minimize disruptions in a densely populated urban environment [13], [14]. Despite these innovations, the project was not without its controversies and setbacks.

Challenges and Controversies

The Big Dig encountered significant challenges that tested its engineering, financial management, and public support. One of the most notable issues was the extraordinary cost escalation. Originally estimated at $2.6 billion in 1985, the final cost exceeded $14.6 billion, making the project one of the most expensive infrastructure undertakings in history. Unforeseen engineering complexities, evolving safety standards, and scope changes contributed to the cost overruns. Poor initial risk assessments and mismanagement further exacerbated the financial challenges, drawing criticism from taxpayers and public officials [12], [13].

The timeline for completion also far exceeded initial projections. The project took over 15 years to complete, with delays stemming from the intricate underground construction processes and the need to maintain traffic flow during the work. Frequent design modifications, political pressures, and environmental compliance requirements added to the prolonged schedule [14], [15].

In addition to financial and scheduling issues, the Big Dig faced safety concerns. The most tragic incident occurred in 2006 when a tunnel ceiling panel collapsed, resulting in a fatality. This event highlighted deficiencies in construction oversight and material quality, prompting extensive safety reviews and additional repairs. Despite this setback, the project ultimately delivered a safer and more modern transportation network [15].

Transformative Outcomes

The Big Dig profoundly transformed Boston's transportation infrastructure, urban environment, and economic landscape. The Central Artery Tunnel significantly improved traffic flow through the city, increasing average peak-hour speeds from 10 miles per hour to over 45 miles per hour. By redirecting traffic underground, the tunnel eliminated numerous bottlenecks and provided a more reliable transportation route for commuters and travelers. The Ted Williams Tunnel further alleviated congestion by creating a direct, high-capacity connection to Logan International Airport [10], [13].

The project's impact extended beyond traffic improvements. The removal of the elevated highway reconnected neighborhoods that had been physically and socially divided for decades. The Rose Fitzgerald Kennedy Greenway replaced the highway's footprint with green spaces, walking paths, and public plazas, enhancing urban livability and fostering community engagement. This transformation revitalized Boston's downtown core, attracting businesses, tourism, and residential development while creating opportunities for cultural and recreational activities [12].

Environmental benefits were another significant outcome of the Big Dig. By reducing traffic congestion and vehicle idling, the project lowered greenhouse gas emissions and improved air quality in the city center. The introduction of green spaces further contributed to environmental sustainability, creating urban ecosystems that promoted biodiversity and public health. Noise pollution also decreased substantially, improving the quality of life for residents and businesses along the former highway corridor [11].

Economically, the Big Dig spurred growth in Boston's commercial and real estate sectors. Improved transportation access boosted property values and encouraged investment in previously underutilized areas. Businesses benefited from enhanced regional connectivity, while the revitalized urban spaces attracted tourists and new residents. The project strengthened Boston's position as an economic hub, reinforcing its competitiveness in a globalized economy [12], [16].

Lessons Learned for Future Projects

The Boston Big Dig offers valuable lessons for future infrastructure projects, particularly those of similar scale and complexity. A key takeaway is the importance of comprehensive planning and risk management. Thorough feasibility studies, realistic cost estimates, and robust contingency plans are essential to mitigating cost overruns and schedule delays. Project managers must anticipate engineering challenges and develop proactive solutions to address unforeseen issues [13], [16].

Effective communication with stakeholders is equally critical. Public engagement and transparency help build trust and ensure that infrastructure projects align with community needs and priorities. The Big Dig demonstrated that large-scale projects must balance technical requirements with social and environmental considerations to achieve sustainable outcomes [14], [15].

Sustainability should remain a central focus in modern infrastructure projects. Integrating green spaces, reducing emissions, and prioritizing pedestrian-friendly designs deliver long-term benefits for cities and their residents. The Big Dig's success in transforming urban spaces highlights the potential for infrastructure projects to enhance environmental quality and promote inclusive growth [12].

Conclusion

The Boston Big Dig stands as a landmark achievement in urban infrastructure, showcasing both the challenges and opportunities of large-scale projects. While the project's financial and logistical struggles underscore the importance of careful planning and execution, its successes in reducing congestion, revitalizing neighborhoods, and fostering environmental sustainability serve as a model for future efforts. For Syracuse's I-81 Viaduct Replacement Project, the lessons learned from the Big Dig can help ensure a more efficient, inclusive, and sustainable outcome, paving the way for transformative urban renewal.

10.3 The Akron Freeway Innerbelt

Introduction

The Akron Innerbelt, a six-lane freeway through downtown Akron, Ohio, is a case study of freeway decommissioning aimed at reclaiming urban space and addressing historical injustices. Built in the 1970s as part of federal efforts to enhance urban mobility, the highway spanned 2.24 miles as part of State Route 59. Originally envisioned to connect State Route 8 to US Route 224, the project was left incomplete due to construction delays, cost overruns, and shifting regional priorities. Over time, the underutilized highway failed to meet its intended purpose, serving as a physical and social barrier rather than a transportation solution.

The freeway's construction displaced over 700 predominantly Black households and more than 100 businesses, severing key cultural and communal connections. Many displaced residents, who were first-time landowners, struggled to rebuild generational wealth, amplifying long term social and economic disparities. As the population declined, the Innerbelt became an underused corridor, contributing to urban decay and community fragmentation.

Decommissioning & Community Engagement

Recognizing the opportunity to reclaim valuable land and repair historical damage, Akron initiated the decommissioning of the Innerbelt in the 2010s. The city began land acquisition and partial highway removal in 2016, repurposing sections as surface streets. A notable challenge was rebuilding trust with affected communities, as many residents remained skeptical of the city's intentions. In 2020, Akron hired a spatial justice specialist to engage the community and ensure that residents' needs shaped the project's direction.

This two-year engagement process culminated in the selection of *Sasaki* as the lead design firm, chosen by Akron's residents through a series of town halls. In 2023, the city received $960,000 from the federal "Reconnecting Communities" program to advance the project. Further funding applications, including a request for $10 million, reflect Akron's long term commitment to transforming the Innerbelt into a resource that benefits the entire community.

Social & Urban Impact

The decommissioning of the Innerbelt represents a significant shift in urban infrastructure priorities. Unlike traditional highway removal projects, Akron faced little pressure to replace the freeway's traffic capacity, allowing a more focused effort on community redevelopment. Plans for the reclaimed land include mixed-use development, green spaces, and opportunities to reconnect neighborhoods previously divided by the freeway.

By prioritizing extensive community engagement and equitable redevelopment, Akron aims to rectify the historical harms caused by the Innerbelt's construction. The project sets a compelling precedent for smaller cities facing similar challenges, highlighting the importance of resident input, social justice, and sustainable urban design.

Shared Concerns with Syracuse

Both cities share common challenges rooted in the legacy of urban freeway construction, particularly the displacement and disenfranchisement of historically marginalized communities. Each of these freeways disrupted predominantly Black neighborhoods, severing social and economic connections that continue to affect residents today. The amount of care and consideration that Akron’s elected officials have put into revamping the Innerbelt demonstrates the critical importance of extensive community engagement in addressing these historical harms.

This case serves as a valuable example for Syracuse as it undertakes the I-81 Community Grid project. By hiring a spatial justice specialist and actively incorporating resident input into redevelopment plans, Akron prioritized the needs of those most impacted, ensuring that the project benefits long term residents rather than displacing them once again. A similar emphasis on equitable redevelopment would be pivotal in Syracuse, where the renewal of I-81 has the potential to reconnect neighborhoods but must be guided by sustained, transparent collaboration with the community.

Both projects also face the looming risk of gentrification, where revitalized neighborhoods may attract investment and development that inadvertently pushes out existing residents due to rising property values and living costs. To avoid this, both cities should implement proactive policies to ensure that redevelopment fosters inclusive growth.

Akron’s focus on local engagement and trust building provides a strong foundation for equitable outcomes, a lesson Syracuse can apply to ensure that their Community Grid creates opportunities for its current residents rather than further disenfranchising local communities. By prioritizing social justice and anti-displacement measures, both cities have the opportunity to transform their urban landscapes for the better while respecting the cultural and economic integrity of the communities they aim to reconnect.

11.0 Recommendations for Future Research

We have done concrete research and study on the components written in this report. However, there were some subjects we were interested in but we did not have time to address during the project. Our recommendations for future research are listed below:

1. If the Community Grid does not provide sufficient capacity to accommodate future traffic demands, how feasible is it for the city of Syracuse to review and implement capacity enhancements? How could additional capacity be integrated into the existing grid without compromising urban livability or pedestrian safety?
2. What are the most significant risks associated with the project, including accident rates, capacity shortfalls, cost overruns, and construction delays? How can these risks be effectively monitored and mitigated throughout the project timeline and after implementation?
3. A detailed analysis of the project's carbon emissions and environmental impact, both during construction and post implementation. What are the net effects on emissions after transitioning from the elevated viaduct to the Community Grid? How does the project align with regional and state sustainability goals?
4. While some community feedback has been documented, particularly regarding concerns about the introduction of roundabouts, a more extensive investigation into local perceptions of the project would be informative. How do residents, business owners, and commuters view the changes? What measures can be taken to improve public satisfaction and address ongoing concerns, particularly about traffic flow and safety?
5. After the Community Grid has been implemented, how will the municipality of Syracuse relegate and regulate downtown land use? What specific plans exist to ensure equitable redevelopment, prevent gentrification, and prioritize spaces for housing, local businesses, and public amenities?
6. An expanded traffic analysis is required for the sections of Business Loop 81 that extend into uptown Syracuse. How will increased traffic volumes along this corridor impact local neighborhoods and businesses?
7. Interactions between the Community Grid and local railroad infrastructure were mentioned as a significant obstacle during our site visit. How has the project planned to accommodate rail crossings, and what strategies can be implemented to enhance safety and ensure smooth traffic operations in areas where roads intersect with active rail lines?

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