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Toward a New Erie Boulevard East in Syracuse and Dewitt, New York: Bus Rapid Transit and Urban Forestry in a Time of Climate Challenge

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TOWARD A NEW ERIE BOULEVARD EAST IN SYRACUSE AND DEWITT, NEW YORK:
BUS RAPID TRANSIT AND URBAN FORESTRY
IN A TIME OF CLIMATE CHALLENGE

by

Yian-Kim Phan

A thesis
submitted in partial fulfillment
of the requirements for the
Masters of Science Degree
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College of Environmental Science and Forestry
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Disclaimer: The ideas and opinions expressed in this publication are those of the author and should not be interpreted as those of the State University of New York College of Environmental Science and Forestry.

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ABSTRACT

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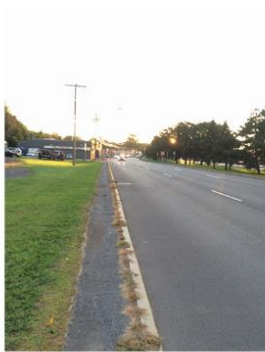
Erie Boulevard is a major corridor that runs east-west in the City of Syracuse and Onondaga County. It is a corridor that lacks sufficient multi-modal transportation options and pedestrian infrastructure. This study looked at design and design analysis to test the viability of: bus rapid transit and biophilic urbanism, to identify impacts on ecological systems, economy, and social well-being of communities and residents. The design was evaluated through i-Tree programs, Design, Canopy, and Hydro. The results revealed an increase in ecological and economic benefits. This project is important because it is relevant to many mid-size cities with major streets that are both urban and suburban in nature, have lost their design coherence, and need major revitalization that offers the opportunity for the application of new design concepts.

Key words: Biophilic urbanism, bus rapid transit, high-density development, mixed-use development, streetscape, resilience, transit oriented design, i-Tree, urban forestry

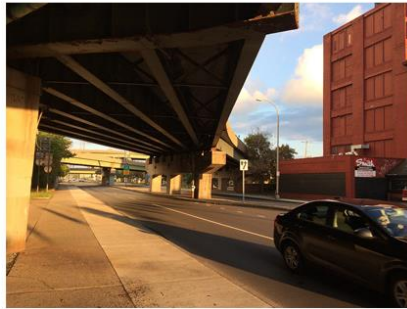
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INTRODUCTION

Erie Boulevard is the primary non-highway link between Syracuse's major eastern and western suburbs and between each of those suburbs and downtown Syracuse. In its current state Erie Boulevard reflects a struggling urban community. The boulevard is lined with many vacant lots and storefronts. The sidewalks are intermittent and pedestrian safety is compromised with the inconsistent availability of sidewalks. The sidewalks that do exist are rarely cleared in the winter. Erie Boulevard has become an increasingly chaotic road that serves businesses primarily arrived at by automobile, ignores pedestrian safety, and fails to accommodate an increasingly popular emphasis on pedestrian and bicycle circulation. In addition, Erie Boulevard offers no sense of attachment to adjacent neighborhoods and plays no strong role in articulating a coherent and desirable sense of place. Below are photos of existing conditions of Erie Boulevard and a map of the project site. Erie Boulevard is a corridor that needs to be reconsidered in terms of traffic, economic development, land use, environment, and identity.



2 foot wide asphalt snow strip.jpeg



690 highway overhead creates dark space underneath.jpeg



690 highway overhead in distance.jpeg



7-8 lane intersection at Bridge St..JPG



8 lane intersection at Thompson St..JPG



Asphalt snow strip serves as sidewalk.JPG



Crumbling sidewalk.jpeg



Lack of sidewalk.JPG



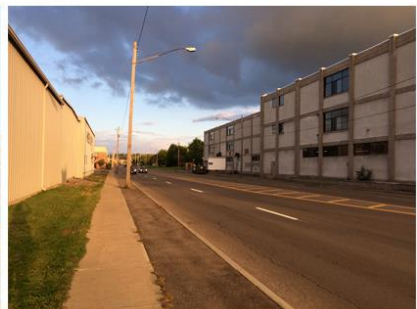
Pedestrian waits for bus on asphalt snow strip.JPG



Vacant parking lot under 690 highway adjacent to Erie Bou...



Vacant storefront.JPG



Windowless building facades.jpeg

Figure 1: Existing Conditions of Erie Boulevard East in Syracuse and Dewitt, New York

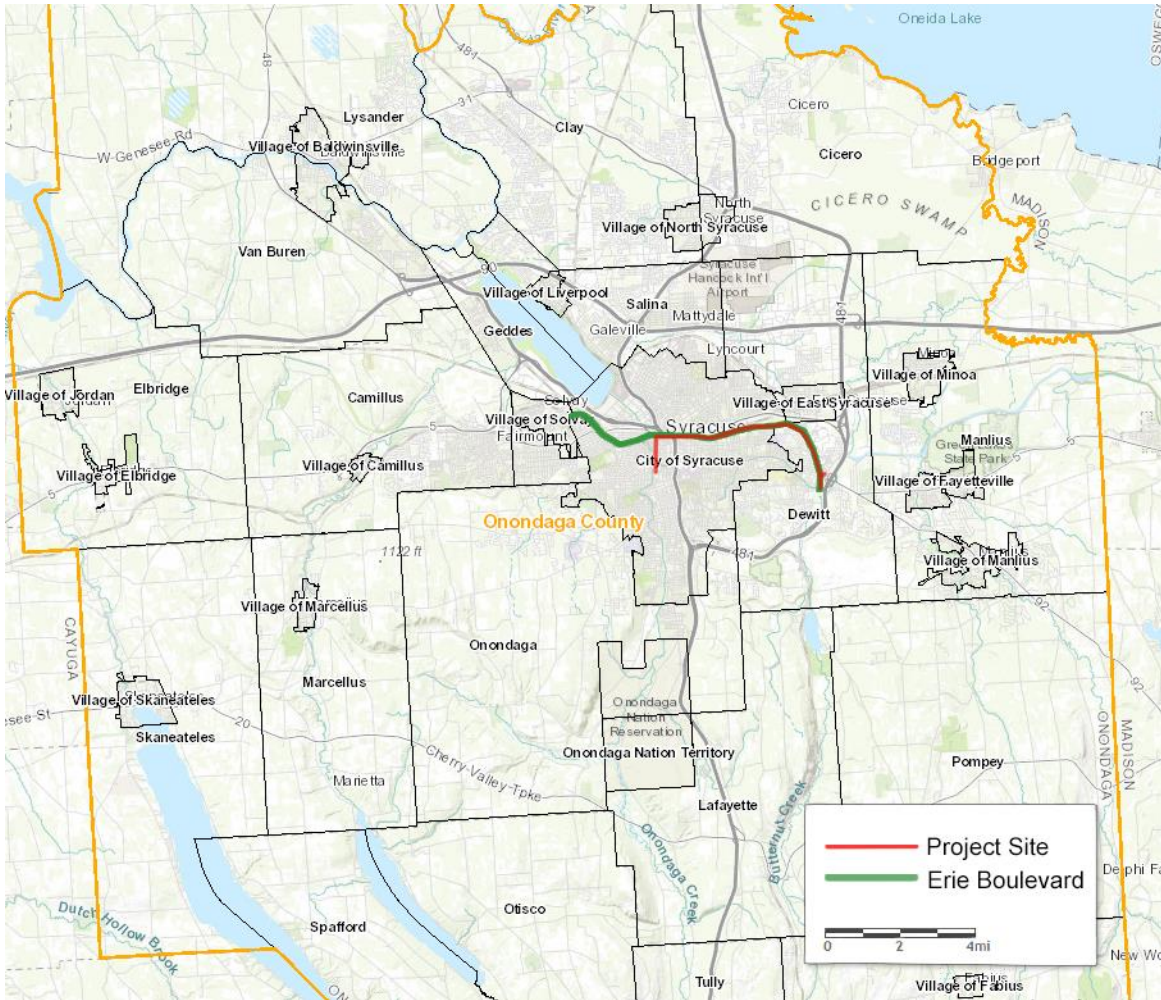


Figure 2: Map of Project Site, Onondaga County

As the major east-west corridor in the City of Syracuse and Central Onondaga County, Erie Boulevard has the potential to become a “great street” that not only serves suburban-style commercial businesses, but one that is beautiful, has desirable land uses, connects a matrix of desirable neighborhoods and districts, represents an evolving sense of economic, social, and civic identity in the greater community, and serves as a platform for better public transit and urban forestry. The reconsiderations of Erie Boulevard lend themselves to experimentation regarding two currently important planning concepts: (1) bus rapid transit (and by extension multi-modal design) and (2) biophilic urbanism.

According to Allan Jacobs, a “great street” should: “(1) facilitate people acting and interacting to achieve in concert what they might not achieve alone; (2) be physically comfortable and safe; (3) encourage participation [and engagement]; (4) can be remembered and leave strong, long-continuing positive impressions; and (5) is one that representative: it is the epitome of a type (Main Street, grand-boulevard, parkway, etc.)” Jacobs continues to mention that “As well as to see, the street is a place to be seen. Sociability is a large part of why cities exist, and streets are a major if not the only *public* place for that sociability to develop. At the same time, the street is a place to be alone, to be private, to wonder what it was once like, or what it could be like. It is a place for the mind to wander, triggered by something there on the street or by something internal, more personal, a place to walk while whatever is inside unfolds, yet again” (Project for Public Spaces).

It is through the implementation of bus rapid transit (BRT) and biophilic urbanism design principles that Erie Boulevard has the potential to be transformed. Currently, it is devoid of trees, ignores pedestrian safety, is dotted with vacant storefronts, and lacks design continuity. However, it has the potential to be remade into a corridor that is full of activity with pedestrians, bicyclists, buses, shops, parks, etc. It can become a revitalized streetscape full of life, with opportunities for social interaction along a safe and comfortable place.

The Town of Dewitt and the City of Syracuse recognized the potential for the Erie Boulevard corridor to close the gap in the Erie Canalway trail system, which runs from Albany, New York to Buffalo, New York. The 14-mile gap in the trail runs from the Town of Camillus to the Town of Dewitt. The Town of Dewitt recognized that in closing the gap, there could be the opportunity for redevelopment along the boulevard. In the fall of 2015, The Town of Dewitt and the City of Syracuse hosted an international design and idea competition to identify and guide

development along the Erie Canalway Trail corridor. A total of 64 proposals were received from 16 countries. The competition winners expressed ideas for reducing car dependence and transforming the corridor into one that is eco-friendly, pedestrian friendly, and accommodates multi-modal transportation options, and transforms the median into a community space. The big ideas from the design competition were incorporated into an online survey. The results of the survey revealed residents' and visitors' interest in eco-friendly and pedestrian friendly design and a desire to revamp the existing bus transit and bike transit options on Erie Boulevard (Town of Dewitt). Since then, the Governor of New York has announced plans to improve the Erie Canalway Trail throughout the State. Construction for the Central New York portion, the 14-mile gap between Camillus and Dewitt, will start in 2019. State officials will look to the Elevating Erie Design competition and the report developed by Syracuse Metropolitan Transportation Council for ideas on designing the Erie Canalway Trail route (newyorkupstate.com).

In addition, over the past year, the City of Syracuse has been working to develop a comprehensive plan to revise the City's current zoning ordinance and land use plan. In this process they have engaged the residents of the City of Syracuse through various community meetings for public input on proposed draft plans (syrgov.net).

Furthermore, the City of Syracuse Comprehensive Plan 2040 mentions transportation infrastructure should be built to support future population growth and in doing so "development within the City should be focused around Downtown and University Hill, neighborhood centers, and major transportation corridors" (15). Erie Boulevard is a major transportation corridor, receiving over 22,000 vehicles a day, on average (Qtd. in Erie Canalway Trail 53). There is potential to rezone and develop the boulevard to catalyze economic development and neighborhood growth. This is mentioned in the Syracuse Land Use Plan 2040 (a section of the

City of Syracuse Comprehensive Plan 2040) “Today this [Erie Boulevard] is one of the most pivotal areas of economic development opportunity for the City of Syracuse” (55). Furthermore, “Today they [West Fayette Street, West Genesee Street, Erie Boulevard, North State Street, Wolf Street, and Burnet Avenue] represent an opportunity for revitalization, as they’re close to Downtown and built in a pattern that can potentially support dense, mixed-use neighborhoods that are increasingly in demand among young professionals, baby boomers, and others searching out neighborhoods with more variety of activities occurring day-to-day” (79). The plan then mentions that these redevelopment projects have worked well in Armory Square and Franklin Square (80). However, the latest draft of the land use plan does not address the opportunity for mixed-use development along the prime Erie Boulevard corridor; instead the proposed Erie Boulevard East land uses remain the same, commercial and industrial, with parking zoned for the fronts of businesses. In a mixed-used scenario, parking would be zoned for the rears of businesses, creating greater opportunities for pedestrian friendly streets, which is mentioned in the land use plan, but not carried out in the latest land use map for Erie Boulevard East (ReZone Syracuse). The Comprehensive Plan, the Land Use Plan, The ReZone Syracuse and Elevating Erie all speak about the idea of transit oriented development, but none of these plans speak about how to implement transit oriented development.

This study addresses the redesign of the Erie Boulevard corridor in terms of multi-modal transportation systems, with an emphasis on bus rapid transit, and in terms of biophilic urbanism. The intention is to use these concepts to make Erie Boulevard a great street and improve the corridors’ ecological, economic, and social qualities. Another focus will be to test the viability of these concepts and identify best practices relevant to the redesign of major urban corridors across the United States.

LITERATURE REVIEW

Transit Oriented Design

Urban communities across the United States are turning to Transit Oriented Design (TOD) to address a range of problems. TOD is a widely used design concept that addresses regional planning, urban revitalization, suburban sprawl, and walkable communities. The Transit Oriented Development institute mentions states that TOD helps to build “vibrant, livable, sustainable communities” (tod.org) and has the potential to create desirable places for people to live, work, and play. TOD is defined as a “Compact, mixed-use development in a walkable environment near transit stations typically” (Vincent, W. and Jerram, C. L. 9). Creating such an environment alleviates the dependence on cars for “mobility and survival” (tod.org), especially for those with meager resources. In addition, TOD contributes to our social, economic and environmental health (Dittmar and Ohland 21.) Another reason why TOD is a highly utilized design concept is that it addresses issues such as reduced fossil fuel use, reduced carbon emissions associated with global climate change and energy consumption. TOD contributes to walkability, multimodal transit options, and denser neighborhoods. Building TOD communities and lifestyles “can reduce driving by up to 85%” (tod.org).

There are several problems that lead urban communities to turn toward TOD initiatives. These problems include: a growing interest in walkable communities, disinterest in suburban strip mall development, changes in family structure (growth in population of singles and empty-nesters), desire for better quality of life in urban communities, and support for smart growth concepts (tod.org.) These factors are echoed in the latest study conducted by the Onondaga Citizens League, How CNY Moves. The study indicates a “back-to-the city” movement and increasing aging population are creating more interest in walkable, bikeable, and transit-served

neighborhoods” (Onondaga Citizens League). Again, TOD is supported by survey respondents from the Elevating Erie survey results, see Appendix 1. The respondents ranked their top priorities for re-envisioning the Erie Boulevard corridor; they had the option to choose from eco-friendly design, economic development, pedestrian and bike transportation, connectivity and safety, community character, and transit alternatives. The top two highest ranked categories include pedestrian and bike transportation and connectivity and safety. (Town of Dewitt, et al. 6)

Some of the components of TOD include: walkable streets for pedestrians, highly visible transit stations, mixed land uses (retail, office, residential, etc.), high density walkable neighborhoods within close proximity to transit stations (10 minute walk or less), availability of connection to alternative transit options (buses, light rail, bicycle, etc.) at the station, bike share rental system, retail and services at stations (grocery stores, cafes, dry cleaners, etc.), and some parking available within a 10 minute walk from the station (tod.org). In summary, TOD “promote[s] inclusive development” (Suzuki, et al. 1) by creating mix-use land development that offers several amenities to the commuter and connects various modes of transit in one location, making it accessible to a wide variety of users. Dittmar and Ohland link the idea of livability to TOD. They define livability as having “access to services and recreation, mobility choice, environmental quality, commute times, and health and safety (e.g., fewer traffic accidents, less pollution)” (Dittmar and Ohland 22). TOD contributes to livability in urban communities by making multiple transit options available, making it easier for residents to reach goods, services, jobs, and offers improved air quality through reduced gas emissions. Utilizing TOD in cities

offers several benefits; these benefits are shown in the image below.

BENEFITS OF TRANSIT ORIENTED DEVELOPMENT

Americans believe transit oriented development provides an array of benefits ranging from lifestyle to environmental to economic.

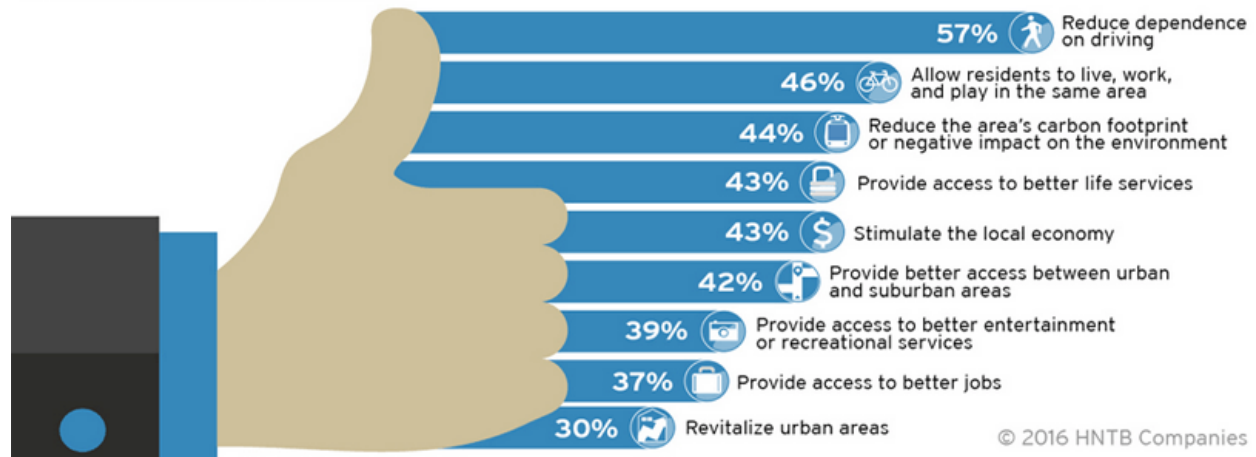


Figure 3: Benefits of Transit Oriented Design (tod.org)

The Urban Land Institute notes that transit systems are in and highways are out (tod.org.) Transit system investments provide twice the amount of economic revenue for the city than highway investment does (tod.org). TOD creates “Areas with good access to public transit and well-designed urban spaces that are walkable and bikeable become highly attractive places for people to live, work, learn, play, and interact. Such environments enhance a city’s economic competitiveness, reduce local pollution and global greenhouse gas emissions, and promote inclusive development.” (Suzuki, et al. 1).

The main component of TOD is a high-quality and reliable rail [and bus] system that fosters the development of dense, mixed-use, and walkable communities. “The rail [and bus] network becomes the organizing framework for a series of TOD developments into the creation of entire neighborhoods surrounding the rail [and bus] stations. A series of TOD neighborhoods emerge laid out like pearls along a string. These add up to entire networks of walkable communities creating a highly livable, 21st century lifestyle for all.” (tod.org). In addition, transit can be used

a tool to concentrate growth around stations, in efforts to encourage density; and thus, limiting suburban sprawl (tod.org). Dittmar and Ohland mention that “densities should be highest next to the station and scale down as you reach the quarter-and half-mile radius around the stop” (37).

Bus Rapid Transit

Transit is one of the two fundamental elements that drives TOD. The Bus Rapid Transit practitioner's' Guide references the Federal Transportation Administration and defines bus rapid transit (BRT) as “[a] rapid mode of transportation that can provide the quality of rail transit and the flexibility of buses” (Bus rapid transit Practitioner's Guide S-1). Again, this idea of BRT functioning like rail is referenced by Bus Rapid Transit Service Design Guidelines, written by the Santa Clara Valley Transportation Authority (VTA). They mention that bus rapid transit offers the same quality of services of rail; high quality, high frequency, high reliability, improved amenities, real-time service information, and a sense of permanence (1). In addition, when compared to rail, BRT has greater flexibility and is offered at a lower cost to cities. (nacto.org.) The Breakthrough Technologies Institute conducted interviews and distributed surveys to developers, public agencies, and government employees about their experiences with TOD in the York Region of Ontario and in El Monte, California. They mention that the respondents generally expressed a positive attitude toward BRT. The respondents did not see a difference between BRT and rail and its ability to attract TOD and government respondents “actively promoted TOD around BRT corridors and that the level of development activity appeared like what they would expect in a rail corridor” (Vincent, W. and Jerram, C. L. 27). In addition, “BRT, like rail, can increase density around transit nodes and serve both existing and future development markets” (Vincent, W. and Jerram, C. L. 11).

Transit stations serve as the link between the rail system and other transit options. Stations are where users “experience its image, service, and convenience” (tod.org). The design of stations and maintenance of the station represent the quality of transit a city has to offer, the value of the transit system to its customers, and the standards of customer service the transit authority provides (The Urban Design Center of Northeast Ohio and EcoCity Cleveland Forward). A station can serve to represent the city. “Proper location and design can elevate stations to become important civic icons of a city” (tod.org/stations/html). Stations can become part of neighborhood identity. “For many people, bus stops are neighborhood “gateways”, shaping first impressions of the area and quality of life it offers” (The Urban Design Center of Northeast Ohio and EcoCity Cleveland Forward).

An additional benefit that BRT can offer is a reduction in carbon dioxide emissions. A recent study looked at comparing carbon emissions by the personal vehicle, light rail, hybrid-diesel 40-foot BRT vehicles, hybrid-diesel 60-foot BRT vehicles, and natural gas 40-foot BRT vehicles in a “typical” medium-sized city in the United States (Vincent and Jerram 220). This study found that natural gas 40-foot BRT buses provide the greatest reduction in carbon dioxide emissions and provide nearly 300 times greater carbon dioxide reduction than that of light rail over a 20-year period. The drastic difference between BRT and light rail carbon dioxide production is because electricity is used to run light rail. Electricity produced from plants powered by fossil fuel produces large amounts of carbon dioxide. Additionally, BRT infrastructure costs less to implement, so additional buses can be installed per dollar. However, even without the additional buses, the amount of carbon dioxide generated per mile per passenger is lower than that of a light rail passenger. Vincent and Jerram then mention that if 20 cities install BRT and can achieve results of carbon dioxide reductions like this study, then these cities can collectively reduce carbon

dioxide emissions by 13 million metric tons over the next 20 years (Vincent and Jerram 232-233). Below is an image comparing the amount of street and road space utilized by cars, buses, light rail, and bicycles to transport two hundred people. Cars occupy the most amount of street and road space, whereas, the other alternative modes of transit occupy much less road space (Public Square) and natural gas buses would provide the greatest amount of carbon dioxide reduction, alternative to bicycling.

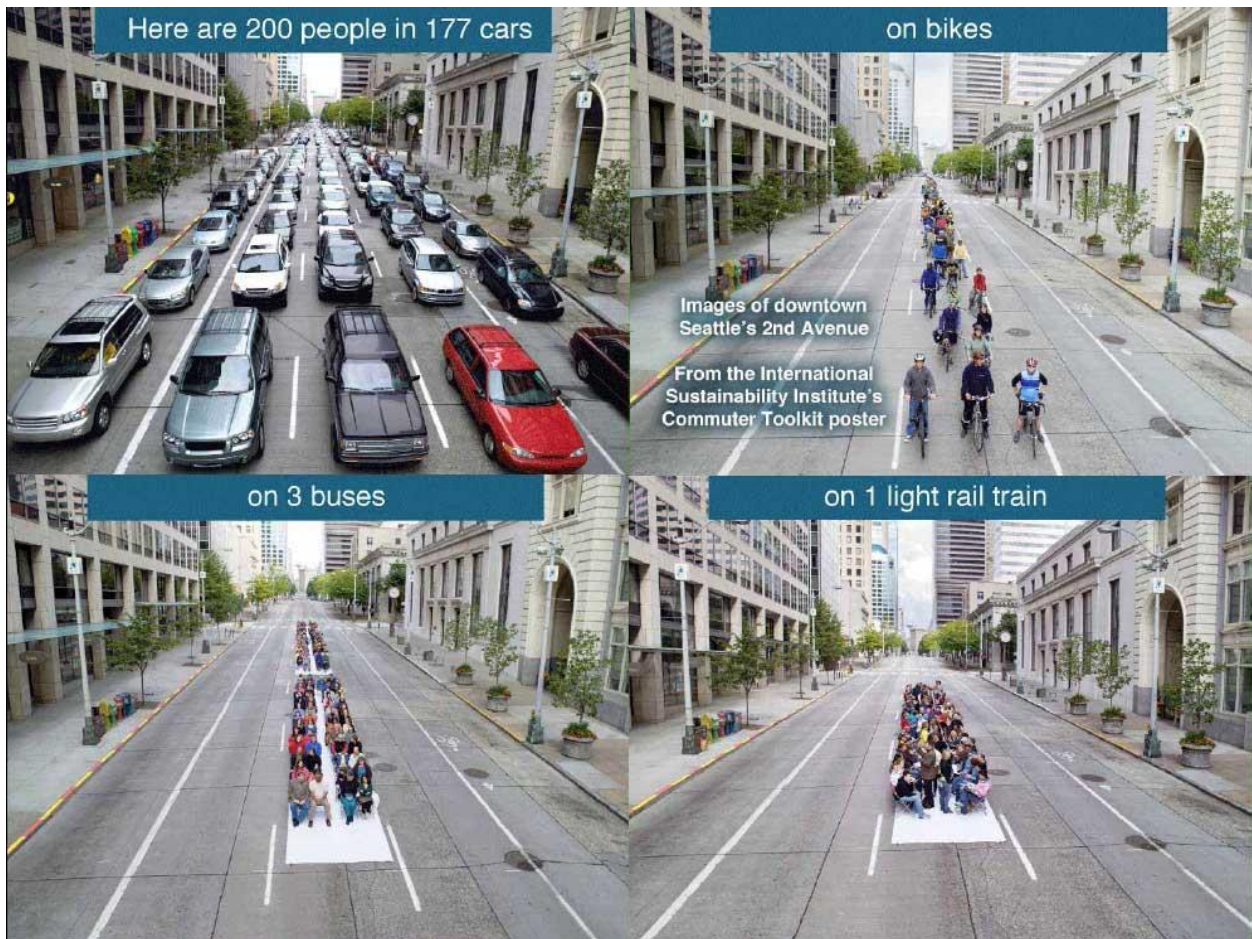


Figure 4: Comparison of Transit Modes Carrying Two Hundred Passengers (International Sustainability Institution)

Some BRT systems provide park-and-ride systems (American Public Transportation Association (APTA) “Bus Rapid Transit Stations and Stops” 26). APTA notes that some of the advantages of off-street station locations include the following: “it eliminates potential conflicts between motor

vehicles and transit riders; may lend a feeling of permanence; and may provide opportunities for additional amenities, such as park-and-ride. Overall, it may enhance the system brand. In addition, it can become a new amenity for the surrounding community and enhance TOD potential” (6). However, the off-street location should not be located too far back from the right-of-way, as it may not be as visible and thus lead to a reduced sense of permanence and brand (12).

Benefits of Implementing BRT

1. BRT is flexible. It can function in various environments, urban and suburban and it can operate on a range of roads, (arterials, freeways, separated rights-of-way, tunnels, etc.)
2. BRT stations have the potential to accommodate rapid and local bus routes.
3. BRT is less costly to implement, and it provides similar benefits and services to that of rail.
4. BRT does not cost much more than local bus routes when implemented on arterial streets and highways.
5. BRT has the potential to create infill and high-density development. (Bus rapid transit Practitioner's Guide S-1)
6. BRT has the potential to reduce carbon emissions. (Vincent, et. al. 233)

Principles of BRT

1. BRT should be seen and developed as a long-lasting system of facilities, services, and amenities.
2. BRT works in conjunction with “transit first policies” that promote TOD, reduced parking opportunities, and park-and-ride systems.
3. BRT should be fast transit that operates in separate rights-of-way and benefits from transit signal priority.
4. BRT should fast on time, easy to use, and cost effective

5. BRT should have a consistent appealing image that contributes to urban design quality
(Bus rapid transit Practitioner's Guide S-3)

Metrics of BRT

The Santa Clara Valley Transportation Authority (VTA) Transit Sustainability Policy notes that there are two types of BRT systems that can be implemented based on capital investment required and available infrastructure. BRT 1 functions in a mixed-traffic lane and BRT 2 functions in a bus-only lane; BRT 1 has a longer headway, frequency of bus arrival, whereas BRT 2 has a shorter headway; BRT 1 has basic amenities at stations and BRT 2 has greater amenities at stations, the right-of-way already exists to accommodate the bus lane traffic for BRT 1, whereas in the BRT 2 scenario, the right-of-way may need to be purchased to accommodate the additional space needed for bus-only lanes (1-3). Additional characteristics of each type of BRT are shown in the chart below.

Table 1 Characteristics of BRT 1 and BRT 2		
Characteristics	BRT 1	BRT 2
Service	Long corridors serving major destinations	
Running Way	Mixed traffic lane, bus-only lane created out of an existing mixed-flow or parking lane, or HOV lane converted out of existing highway/expressway lane.	Bus-only lane — physically separated and created in a new ROW, HOV lane — created in a street median or shoulder of a highway or expressway, at-grade, or grade-separated transitway
Transit Priority	Bus Signal Priority (BSP) and/or queue jump lanes	Bus Signal Priority (BSP) and/or queue jump lanes
Capacity	Medium	Medium to High
Vehicle Type	Standard 40 Foot	Standard 40-foot to Articulated 60-foot (with double-triple articulated vehicles if demand warrants, as in Curitiba)
Operating Characteristics	Limited Stop Service	Limited/Express Stop Service
Headway	10–15 minutes	5–15 minutes
Station Spacing	0.75 miles on average (may be shorter to serve key activity nodes)	
Station Amenities	Basic amenities including unique signage and real-time passenger information.	Enhanced and more robust amenities similar to rail stations, including real-time passenger information, fare ticket machines, enhanced lighting, larger distinctively designed shelters, and higher-capacity boarding areas, such as curb bulbout stops.
Vehicle Branding	Special branding, unique to BRT services	
Cost	Low to Medium	Medium to High
Construction Requirements	Limited, often involving striping and landscaping	May require major construction
ROW Requirements	ROW already exists and does not need to be purchased/converted.	May require ROW purchase/conversion
Examples	VTA's Rapid 522 Los Angeles Metro Rapid Vancouver B-Line AC Transit San Pablo Rapid	Pittsburgh's Busways Miami-Dade Busway Ottawa Transitways Las Vegas MAX Los Angeles Orange Line Lane Transit (Eugene, OR) Houston Metro HOV System

Figure 5: Comparison of BRT 1 and BRT 2 Characteristics (VTA Transit Sustainability Policy 3)

Overall, BRT provides a premium level of service, with fewer stops, faster service, enhanced reliability, higher quality amenities, and specially branded buses and stations when

compared to traditional local bus service. Spacing of BRT stations can vary depending on desirable walking distance to the station, adjacent bus routes, and speed and service of the BRT route. BRT station spacing varies from city to city, ranging anywhere from .20 miles in the Cleveland Health Line to 1.10 in Los Angeles on the Orange Line (American Public Transportation Association 12). BRT systems can combine Intelligent Transportation System (ITS) technology, as well as signal and roadway design priority treatments for transit, with clean and quiet vehicles, rapid and convenient fare collection, and enhanced integration between stations and adjacent land uses (VTA Transit Sustainability Policy 1).

Bus Station Amenities

Several sources, such as Side Street Factors, Delaware County Regional PC, Transit Waiting Environments, Centro, a traffic engineer from the City of Philadelphia, and Pedestrian and Transit-oriented Design agree on common features for bus station design and surrounding streetscapes. Below is a chart compiled from the various sources reflecting minimum design guidelines.

Item	Dimensions	Reference Source
bus length	40'	Side Street Factor, Transit Waiting Environment
	41.5'	DCRPC
bus length with bike rack	6'	DCRPC
bus width	8.5'	Side Street Factor
	9'	Transit Waiting Environment
bus width with mirrors	10.5'	Side Street Factor
bus height	10.75'	Side Street Factor
	11.1'	DCRPC
	11.5"	Transit Waiting Envt
loading pad from face of bus	8'	Side Street Factor, DCRPC
	6'	Philadelphia Traffic Engineer
	9'	Centro
loading pad width	5'	Side Street Factor, DCRPC, Transit Waiting Environment
bus lane width	12'	Side Street Factor
	11'	DCRPC, Philadelphia Traffic Engineer
overhead obstruction min clearance above street surface	12'	Side Street Factor, DCRPC, Transit Waiting Environment
obstructions min clearance from edge of street	2'	Side Street Factor, DCRPC, Transit Waiting Environment
bus station req zone		
nearside	100'	Side Street Factor, DCRPC, Transit Waiting Environment
farside	90'	Side Street Factor, DCRPC, Transit Waiting Environment
mid-block	150'	Side Street Factor, DCRPC, Transit Waiting Environment

Figure 6: Bus Rapid Transit Standard Design Guidelines

*Nearside (bus stops just before the intersection)

*Farside (bus stops after the intersection)

*Midblock (bus stops mid-block to avoid intersection stop) (Transit Waiting Environment 8)

In addition to these guidelines, these sources agreed on the addition of traffic signals for pedestrians and buses, in the form of a WALK or DON'T WALK signal, pedestrian push button, or longer green lights for buses. Furthermore, all sources agreed on having some form of pavement marking near intersections allowing for greater awareness for buses, bike lanes, and pedestrian crossings. Moreover, the three BRT sources agreed on the essential amenities needed at bus stations, which include shelter, benches, signage, information systems, trash receptacles, bike racks, publication racks, and lighting. In addition, these stations should feel comfortable and safe, with ample lighting, protection from the vehicular traffic, a clear view of oncoming traffic, protection from the weather, and accommodations for ADA accessibility. Some secondary

amenities include heating in the station, landscaping, and public art. A chart of amenities and sources of references is shown below.

Amenities	Reference Source
Shelter	DCRPC, Transit Waiting Environment, Pedestrian and Transit Oriented Development
Benches	DCRPC, Transit Waiting Environment, Pedestrian and Transit Oriented Development
Signage	DCRPC, Transit Waiting Environment
Information Systems	DCRPC, Transit Waiting Environment
Trash Receptacles	DCRPC, Transit Waiting Environment
Bike Racks	DCRPC, Transit Waiting Environment
Publication racks/info kiosks	DCRPC, Transit Waiting Environment
Lighting	Sidestreet Factor, DCRPC, Transit Waiting Environment
Heating in bus shelter	Transit Waiting Environment
Landscaping	Transit Waiting Environment, Pedestrian and Transit Oriented Development
Public art	Transit Waiting Environment
Connection to historical & cultural information	Transit Waiting Environment
Protection/buffer from passing traffic	Sidestreet Factor, DCRPC, Transit Waiting Environment, Pedestrian and Transit Oriented Development
Clear view of approaching traffic	DCRPC, Transit Waiting Environment
Highly visible pavement marking	Transit Waiting Environment, Pedestrian and Transit Oriented Development

Figure 7: Bus Station Amenities

Designing for Walkable Communities and “Great Streets”

“It’s no big mystery. The best streets are comfortable to walk along with leisure and safety. They are streets for both pedestrians and drivers. They have definition, a sense of enclosure with their buildings; distinct ends and beginnings, usually with trees. Trees, while not required, can do more than anything else and provide the biggest bang for the buck if you do them right. The key point again, is great streets are where pedestrians and drivers get along together” (Project for Public Spaces).

The other essential feature of TOD is to design for walkable communities. Ewing and Barthelme, co-authors of the book Pedestrian and Transit-Oriented Design, write about the essential features for “creating healthier, stronger communities that will thrive in the 21st century.” The essential features are items that are needed to develop a walkable and healthy urban environment. Their list includes the following:

1. Medium-high-densities – density is the key to developing walkable communities and transit use. Higher density means that more people are within proximity to stations, more people on the street, a sense of security, more traffic and higher parking fees, thus, leading to drivers more inclined to walk and/or use transit. Density is highest near stations, within the first quarter-mile, and subsides away from the station (21.)
2. Fine-grained mix of land uses – a mix of land uses has a greater effect on transit use and walking than does density. A quarter mile is the radius at which people are willing to walk within to get to goods and services (25-26.)
3. Short to medium-length blocks – smaller blocks increase walkability. It gives the pedestrian a greater sense of control, giving them more options for crossing. “The increased walkability that smaller blocks provide also appears to be valued in real estate markets” (28).
4. Transit routes every half mile or closer – TOD manuals indicate that people are willing to walk one-eighth to one-half mile to transit stations and up to one-half mile to bus stations, any further beyond that, ridership numbers will drastically drop off. (32)
5. Two-to-four lane streets – studies show that reducing multi-lane roadways into two lanes result in slower and safer roadways. Narrower roadways make it more comfortable for pedestrians and increased social interactions. (34-35)
6. Continuous sidewalks appropriately scaled – sidewalks should be adding value to the community in three ways “(1) as transportation infrastructure [safely providing pedestrians the space for travel from one place to the next], (2) as spaces for everyday life, and (3) leisure destination” (Qtd. in Ewing and Barthelme 41). The addition of streetscape amenities, such as places to sit, and trees, etc. can facilitate a desire for a

walking trip, a longer walking trip, or none. Sidewalks should be scaled to pedestrian traffic. (41)

7. Safe crossings – creating safe crossing makes it safe for pedestrians and can lead to more activity for businesses. Some items that can improve safe crossings include highly visible pavement markings, such as stop bars in front of intersections, creating advance stop lines for vehicles. Raised intersections create a place of refuge for pedestrians crossing a multi-lane road. In addition, shortening the corner radii, adding pedestrian activated signals and raised crosswalks are other techniques that contribute to a safe crossing. (41-44)
8. Appropriate buffering from traffic – techniques can include a parking lane, street trees, and street furniture. Vehicular crash rates are lower on streets where these streetscape amenities are present. (46-48)
9. Street-oriented buildings – street oriented buildings help to create a sense of enclosure and definition along the streetscape. (51)
10. Comfortable and safe places to wait – provide for seating and protection from the elements at transit stations and bus stops. Provide lighting and setback/protection from vehicular traffic. (52-53)

Additionally, items on the highly desirable features list include traffic calming, closely spaced shade trees, nearby parks and other public spaces, few dead spaces, pedestrian-scale lighting, and attractive transit facilities. These highly desirable features follow the essential features in terms of priorities.

These fundamental items listed are reiterated by Allan Jacobs, in *Great Streets*. Jacobs mentions that the requirements for great streets need to include the following attributes: places

for people to leisurely walk, physical comfort, definition, qualities that engage the eye, transparency, complementarity, maintenance, and quality of design construction. Below is a checklist for designing great streets, along with examples and techniques to achieving the features.

	Places for people to walk for leisure	Physical comfort	Definition	Qualities that engage the eyes	Transparency	Complementarity	Maintenance	Quality of design construction
Technique	"walkways that permit people to walk at varying paces...that are safe, primarily from vehicles."	"best streets are comfortable... they offer warmth or sunlight when it is cool and shade and coolness when it is hot."	they have boundaries, usually walls of some sort or another, that communicate clearly where the edges of the street are, that set the street apart..."	"many different surfaces over which light constantly moves that keeps the eyes engaged; separate buildings, many separate windows or doors, or surface changes."	"One can see or have a sense of what is behind what it is that defines the street; one senses an invitation to view or know, if only in the mind, what is behind the street wall"	"except for buildings along the grand canal, those along the best streets are generally of similar height."	"cleanliness, smooth, no potholes."	"quality' of construction and design"
Technique	"curbs and sidewalks are the most common ways of separating and thereby protecting pedestrians from vehicles."	"they offer reasonable protection from the elements without trying to avoid or negate the natural environment."	streets are defined in two ways: vertically, which has to do with height of buildings or walls or <i>trees</i> along a street; and horizontally, which has most to do with length of and spacing between whatever is doing the defining.	"visual complexity is what is required, but it must not be so complex as to become chaotic or disorienting."	"Usually it is windows and doors that give transparency."	"a common architectural style"	"care of trees, materials, buildings, and all the parts that make up a street is essential. Given a choice, and there usually are choices, people would prefer to be on well-maintained rather than poorly maintained streets."	appropriate materials and care.
Technique	" <i>trees</i> added at the curb line, if close enough to each other, create a pedestrian zone that feels safe."	" <i>The trees on the Boulevard Saint-Michel bring shady relief on hot sunny days, making it a delightful place to be, and they provide some protection from the rain, as do the shop awnings.</i> "		"what makes <i>trees</i> so special is their movement, the constant movement of their branches and leaves, and the ever-changing light that plays on, through, and around them."				
				<i>the special character of so many great streets-roslyn place, the ramblas, the mills college entry street, and perhaps most dramatically Boulevard Saint-Michel--has to do with the constant challenge to the eyes of light and leaves.</i>				

Figure 8: Great Streets Design Guidelines

The chart above shows that of the nine criteria listed, five of these can be fulfilled through the planting of street trees. Transparency refers to the degree to which one can see beyond the wall or street edge (Ewing and Bartholomew 15 and Jacobs 285.) Ewing and Bartholomew note that "transparency is a material condition that is pervious to light or air" (13). This would include built structures, such as glass walls or windows and trees. They continue to note that trees add a sense of transparency if placed in front of blank walls. This is accomplished through their irregular structure texture and permeability. In addition, Jacobs mentions that several entryways contribute

to a sense of activity nearby, however, blank walls detract from the sense of activity; blank walls create a sense of vastness and lack of activity. This idea, is again, echoed by Jacobs, he notes “with the branches and leaves of a tree overhanging the wall, that offer a kind of transparency. The branches, the leaves, the vine take you over the wall, into the garden [and spaces] beyond” (Jacobs 287). Thus, trees planted along a streetscape would be able to fulfill the transparency item on Jacobs’s great street guidelines. Planting trees along a streetscape will fulfill five of the nine items on Jacobs’s great street guidelines. Additionally, the use of trees is mentioned in BRT design standards. Providing shade trees helps to vertically define a space and add protection from the elements and provide shade near the transit station.

Case Study 1 - Arlington, Virginia

TOD is implemented for several reasons, one of those being to combat urban-suburban sprawl. Many American cities are familiar with and tend to have some experience with urban-suburban sprawl; residents move out of the city for better homes, more land, etc., thus leaving the downtown core empty and dwindling in population and activity. In the 1960s and 1970s the Rosslyn-Ballston Corridor in Arlington, Virginia saw a decline in retail sales, population decline with families fleeing to the suburbs, and lack of investment in residential areas surrounding the corridor. Arlington government officials and planners turned to transit in efforts to lay the infrastructure for revitalization of a blighted corridor and a depressed economy. In the early 1970s, these officials hoped to spur growth in the area and developed the “Bull’s Eye” concept, a redevelopment initiative that planned for high density development immediately surrounding the transit station with a transition to lower density development as distance increased away from the station. This plan aimed to revamp the existing transit system by encouraging high-density development in and immediately surrounding the transit stations, and by reinvesting in the

residential neighborhoods surrounding the corridor. During the planning process, city officials and planners met with each community to determine the identity of each station.

The vital role that transit played in Arlington, Virginia turned a blighted neighborhood into a renewed economic development opportunity. In the aftermath, development around the station increased, employment and population increased, and ridership of the transit system increased. In addition, residents began to walk and cycle more. The results include a population growth of “nearly 107 percent within the quarter-mile radius of the Rosslyn-Ballston metro stations, accounting for 28 percent of the County’s overall growth. Today, the results shine in seven mixed-use, walkable and bicycle-friendly Metro transit villages” (Arlington County Government).

Case Study 2 - Cleveland, Ohio

One of the ways in which the local government can conduct community outreach is by educating residents on the benefits of transit and by encouraging transit ridership. In addition, the local government can implement policies that encourage higher-density development. A prime example of a city that has experience with both scenarios is Cleveland, Ohio. In the 1950s Cleveland’s population began to slowly decline due to loss of more than half its manufacturing jobs. Additionally, the real estate market was in a decline, creating less of an incentive for any new residents to move to the area. In the mid-1990s the Greater Cleveland Regional Transit Authority began to plan for a makeover of the Euclid Avenue corridor that ran through downtown. This corridor connected two major employment areas, the central business district and the university area. One of the big ideas behind this revitalization project was to utilize BRT to provide fast transit that linked these two major employment areas. In addition, this project included a complete streetscape renovation that included sidewalks, lighting, and street

furniture. The use of BRT and a new streetscape helped to give the corridor the facelift it needed, linking the corridor visually and physically.

Due to Cleveland's depressed real estate market, the city offered various financial incentive programs to attract investors to the area. Financial incentives programs included property tax abatement, loan programs, and historic preservation tax credits, etc. In addition, transit oriented zoning policies were implemented to encourage the use of BRT. Under the new zoning regulations, 60% of the ground level floor must have commercial or retail frontage and parking behind the building.

Over time relationships became reciprocal; the existing and new employers, particularly the large employers in the area, began to provide financial support by funding projects to make "the area more pedestrian and transit friendly" (Vincent, W. and Jerram, C. L. 41). Planning, visioning, and collaboration played a large role in the remaking of the Euclid Avenue corridor. There were many players that included city officials, non-profit agencies, developers, employers, etc. that made the renovation of the corridor possible, turning it from one that was an eyesore to one that is now safe, attractive, and vibrant (Vincent, W. and Jerram, C. L. 30-31).

Case Study 3- Ottawa, Ontario

Ottawa, Ontario is another example of a city that experienced urban-suburban sprawl. Ottawa creatively utilized the transit system as a solution to the sprawl problem. The government utilized bus transit routes in efforts to concentrate growth around transit corridors. "Ottawa implemented land use policies that led to several major retail centers being integrated with the Transitway." These mixed-use areas attracted a fair amount of TOD and are within proximity to transit systems, such that it was advertised to potential tenants and homebuyers (Vincent, W. and Jerram, C. L. 6).

Relevance to Erie Boulevard, Syracuse, New York

Several other cities, such as Boston, Toronto, and San Francisco have used the model of concentrating growth near transit stations. For those cities, transit is used as a redevelopment initiative to boost the economy and to promote multi-modal transportation such as walking, biking, rail, bus, etc. The Urban Design Center notes that “the principles of development that support transit use include building at higher densities, mixing land uses, and creating pedestrian-friendly streetscapes. The areas within walking distance of bus stops should be developed in these patterns to maximize the advantage of proximity to transit and to allow more citizens to access transit as a convenient transportation choice.” (Urban Design Center & EcoCity Cleveland 6.) If several cities are turning toward transit and TOD in efforts to revitalize and catalyze economic development, and have been successful in doing so, then the concentrated growth or bull’s eye concept is worth exploring for Erie Boulevard. The success of Arlington, Cleveland, and Ottawa planning efforts is a noteworthy feat that could potentially be replicated elsewhere.

If TOD, BRT, and safe pedestrian design guidelines are applied to Erie Boulevard, then the results can be transformative; bringing Erie Boulevard East into the 21st century means transforming it into a street that offers multi-modal transit options, green, and safe for pedestrians. The first step needed to allow spaces for TOD, BRT, and pedestrian-friendly environments would be changes to land use and zoning codes. If these design concepts are implemented correctly, then Erie Boulevard can see benefits in the economy, ecology, and social well-being of neighborhoods and individuals in the City of Syracuse and Onondaga County.

Biophilic Urbanism

Edward O. Wilson, a Harvard myrmecologist and conservationist first coined the term biophilia in the 1980s. Wilson believed that humans and nature have been evolving together for a long time. He suggested that a strong human relationship to nature is necessary for our mental health and survival. Timothy Beatley drew his ideas from Wilson and developed the theory of biophilic urbanism. Biophilic urbanism is an urban design theory that aims to reform the innate connection between nature and humans through design and policies. (“Biophilic Cities” 16.) A “biophilic city is at once concerned about the ecological integrity of its network of nature and its accessibility and the ability of a resident to move from a neighborhood to larger green realms” (“Biophilic Cities” 50). There are biophilic design elements that can be applied in cities to make nature accessible to residents. These elements can occur at various scales; the building, block, street, neighborhood, community, or regional level. The design elements can occur in various forms such as green walls, green roofs, street trees, neighborhood parks, community gardens, green schools, greening of major transportation corridors, etc. (“Biophilic Cities” 83-84.) Beatley mentions that the extent of biophilic urbanism in cities can be measured in various ways; though the percentage of biophilic elements, residents’ attitude and knowledge of nature, residents’ activities, and institutions and governance. (“Biophilic Cities” 47-49.) In summary, biophilic urbanism is a design theory that aims to develop a holistic approach to creating ecological systems and human connections to those ecological systems in cities.

Scales of Biophilic Urbanism

A city does not become a biophilic city by implementing one or two of the design elements, but rather by implementing interventions at multiple scales. Biophilic urbanism is about building an ecological system that creates connections from one green realm to another. “Biophilic

urbanism requires action on multiple geographic scales in a "rooftop to region" or "room to region" approach" ("Biophilic Urbanism" 210). Beatley mentions that the degree of biophilic urbanism in a city can be measured in the percentage of parks and accessibility to its residents, biophilic activities of the residents, attitudes and knowledge of its residents, and government's budget allocated to institutions that foster connections to nature and the natural sciences (Arizona State University). Beatley then mentions that biophilic urbanism is about the physical installation of green structures and its availability to residents and the government efforts on implementing programs and policies that encourage and foster connection with nature.

A chart displaying the various opportunities for installing biophilic urbanism elements in the urban landscape is shown in Figure 6. This chart is shown in all readings, minus the two case studies. However, these case studies speak to the idea of inserting biophilic urbanism elements at multiple scales.

Biophilic Urban Design Elements across Scales

<i>Scale</i>	<i>Biophilic Design Elements</i>
Building	Green rooftops Sky gardens and green atria Rooftop garden Green walls Daylit interior spaces
Block	Green courtyards Clustered housing around green areas Native species yards and spaces
Street	Green streets Sidewalk gardens Urban trees Low-impact development Vegetated swales and skinny streets Edible landscaping High degree of permeability
Neighborhood	Stream daylighting, stream restoration Urban forests Ecology parks Community gardens Neighborhood parks and pocket parks Greening grayfields and brownfields
Community	Urban creeks and riparian areas Urban ecological networks Green schools City tree canopy Community forest and community orchards Greening utility corridors
Region	River systems and floodplains Riparian systems Regional greenspace systems Greening major transport corridors

Source: Modified from Girling and Kellett, first appeared in Beatley, 2008.

Figure 9: Scales of Biophilic Urbanism (“Biophilic Cities” 84.)

Benefits of Biophilic Urbanism

Beatley, Newman, Coates, and Reeve et al. highlight that biophilic urbanism offers several benefits for human beings. The top noted benefit is that nature has healing properties--it can reduce stress and improve mood. When working in a setting of one or more plants people have experienced 30%-56% less anxiety, anger, depression, fatigue, and confusion (Qtd. in Reeve, et al. 8). Atchley, et al. stated that “The presence of nature, moreover, is associated with improvements in positive mood, cognitive performance and even creativity” (Qtd. in Beatley and

Newman 3329). Communities within proximity to nature have less crime, lower stress, and a higher percentage of healthy related activities, such as walking. “Access and proximity to parks and nearby green spaces... were found to be associated with lower stress levels and lower likelihood of obesity” (“Biophilic Cities” 6.) In addition, Freiburg, Germany, one of the most well-known European cities for environmentalism and sustainable architectural and urban design, conducted a survey in the district of Vauban that revealed “38% of respondents reported that they use a bicycle more than they did before moving to Vauban and more than 27% walk more often than they did when they lived elsewhere” (Qtd. in Coates 11). Furthermore, Beatley, Kuo et. al., and Wolf suggest that nature has a magical effect on humans and that the benefits that biophilic urbanism offers can lead humans to live longer and healthier lives, mentally and physically. Furthermore, Beatley reveals that the “presence of nature may actually help us to be better human beings.” People are more likely to be generous when surrounded by nature (Arizona State University).

Nature, urban forests for example, can provide social benefits for communities and individuals. Social benefits of urban forests include better physical and mental health and improved academic performance when individuals are exposed to nature or have views of nature (Dovetails Partners Inc. 3). Matsuoka conducted a study on students from 101 schools in Michigan to test the correlation between nature and academic performance. He found a positive relationship between views and exposure to trees and shrubs and the academic performance of students. Students’ performance improved on standardized tests, graduation rates, and the number of students planning to attend colleges increased. In addition, schools lacking in trees and shrubs and prevalent in lawn and parking lots showed a decrease in test scores, decrease in plans for college,

and increased crime rates (Matsuoka 280). This shows the important role urban forests can play in everyday life and benefits offered for overall human well-being.

Not only does nature have restorative properties that can reduce stress, heal humans from illness, and enable humans to lead healthier lives, and become creative and more productive beings; it can also serve to “heal broken human landscapes and humanize and reinvigorate distressed cities and built environments” (“Biophilic Cities” 9). Beatley mentions that “There are great inequalities in the distribution of nature and green features in cities today, which we must be cognizant of and seek to overcome in the design of biophilic cities” (“Biophilic Cities” 9). Nature and its ability to aid broken neighborhoods and make nature accessible to all economic and social classes is a goal of biophilic design. The inequalities that Beatley refers to is the parkland per capita in African and Latino communities compared to that of Caucasian communities in Los Angeles. Beatley notes that nature has potential to restore community hope and to repair ecological systems in struggling neighborhoods. Cities like Detroit, Philadelphia, Los Angeles, and New York have been working to improve the urban ecological system by greening vacant lots and planting trees (“Biophilic Cities” 9). “Neighborhood tree plantings and stewardship projects stimulate investment by local citizens, businesses, and governments for the betterment of their communities. Community forests bring opportunity for economic renewal, combating development woes, improving human health, and increasing quality of life for community residents” (Northeast Community Tree Guide 2).

The idea of accessibility to green space for all residents is carried out in Copenhagen, Denmark. Copenhagen is a dense city of 600,000 (World Population Review). The Copenhagen government acknowledges that residents living in less well-off neighborhoods have less green space available to them because of higher density in those neighborhoods. Beatley states that

“the greatest challenge is to find spaces for greening of the underprivileged districts of Copenhagen” (“Green Cities of Europe” 98.)

Copenhagen does not stop at a challenge, but instead seeks creative opportunities to make green space available using abandoned railways and neglected industrial spaces. (“Biophilic Cities” 98.) New York Restoration Project, NYRP, an environmental nonprofit organization in New York City is another of example of an organization that works toward making a biophilic city. NYRP aims to improve the quality of life for New York City, with special focus on communities of need (New York Restoration Project). In the 1990s community gardens and vacant lots were about to be sold for development and NYRP helped to protect these green spaces by purchasing 50 parcels from the City of New York. Since then, NYRP has worked to renovate these gardens and vacant lots, making more green space available to New York City residents (New York Restoration Project). NYRP works in community garden, parks, schools, vacant lots, and housing projects, green one block at a time. Furthermore, NYRP engages the community by providing a green-jobs workforce, training of volunteers, and educating community members and school groups interested in the maintenance of urban nature (New York Restoration Project).

Another characteristic of biophilic cities is to make its residents a priority. The district of Vauban is an example of how residents were made a priority in the decision-making process of a biophilic planning project. The goal for Vauban was to “facilitate expanded citizen participation in both the planning and development of the district” (Coates 3). In addition, Reeves et al. points to a community planning project that included the participation of thousands of residents in Seoul, Korea. A highway that ran through the city was dismantled and the corridor was transformed into a park. The planning process included a total of 4,000 meetings and participation from 20,000

residents (Reeves, et al. 12). Furthermore, Reeve et al., notes that the inclusion of residents in the planning process helps to decrease resistance to biophilic design, programs, and policies (Reeves, et al. 9).

By making community participation a priority in biophilic city planning, these cities help strengthen community, as Beatley, Newman, and Coates indicate. Residents living in biophilic cities are actively immersed in nature; they tend to socialize and build stronger bonds with other individuals and with nature, and thus build social capital. (“Biophilic Urbanism” 213). An Australian community organization called Community Care Groups mentions that their Bushcare program creates opportunities for members to socialize and build friendships and forge connections to nature and the community. (Qtd. in “Biophilic Urbanism” 216). Beatley mentions that nature can build social capital and nature can bring people together who would otherwise not normally come together on their own (Arizona State University). This was demonstrated in a Chicago case study. The study revealed that individuals living adjacent to a common green space tend to have stronger social ties. Individuals tend to know their neighbors, gather together more often, and support one another, and have a stronger sense of community belonging (Kuo 842-843). With a strengthened relationship to community and place, this can lead to urban resilience.

Beatley and Newman mention that residents who are invested in a community develop a stronger desire to stay in their community to revitalize it when faced with a disaster (Beatley and Newman 3336). Beatley and Newman argue that resilient cities respond to shock and adapt to “dynamic social and ecological conditions in ways that protect and enhance quality of life, long term ecological productivity and public and personal health” (Beatley and Newman 3332). The shocks refer to “...climate change, natural disasters and economic uncertainty and various other shocks that cities will face in the future” (Beatley and Newman 3328). Resilience does not only

have to apply to cities, but can apply to individuals, as well. Beatley and Newman state that resilience is the ability for families [and communities] to be able to cope with these stresses and rebound back to a stable state. The diagram below highlights the steps that contribute to becoming a resilient community. This diagram shows that by implementing physical green infrastructure for biophilic elements, incorporating community participation in planning, encouraging participation in nature activities and natural science institutions leads to biophilic knowledge, healthier behaviors, dedication to place, a stronger community, and ultimately a resilient community.

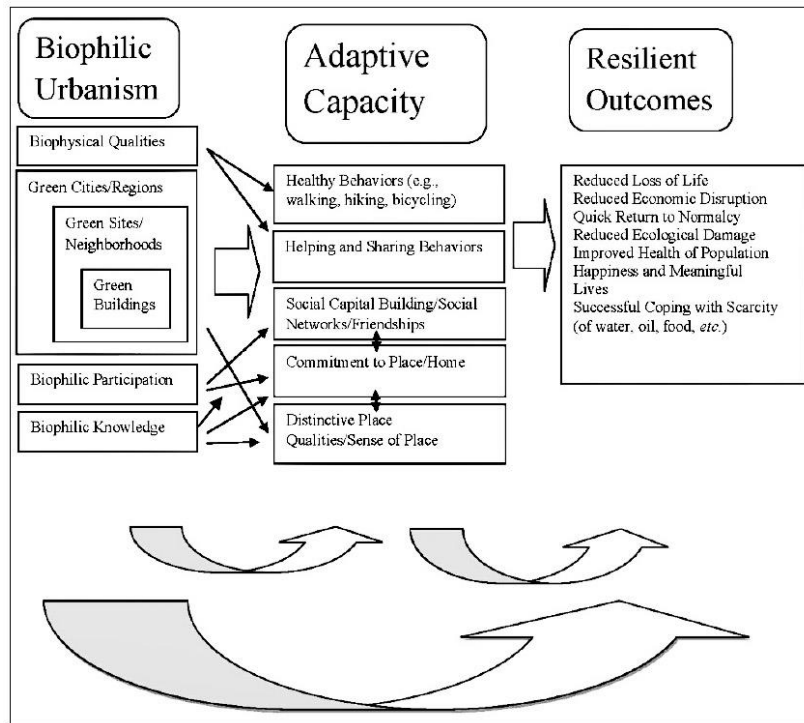


Figure 10: Pathways to Resilience (Beatley and Newman 3333)

Another quality of biophilic cities is that they strive to mimic nature. McDonough believes in designing cities where “buildings [are designed] like trees, [and] cities like forests” (Qtd. In “Biophilic Cities” 53). Trees and forests generally do not emit carbon emissions and do not add waste to the environment. In this sense trees and forests do not negatively impact the environment. Beatley notes that an ideal biophilic city can be described as carbon neutral,

biodiverse, waste-neutral, and energy balanced. "...urban environments might be reshaped in ways that are informed and inspired by nature" ("Biophilic Cities" 53). Beatley gives an example of where one of the buildings on the Oberlin College campus produces more energy than it needs, and collects and treats the stormwater and waste water on site. ("Biophilic Cities" 53.) We can understand that biophilic cities strive to not negatively impact the environment, and this can be done through policies, education, and green design. In addition, biophilic cities in mimic design forms and patterns found in nature. Examples are shown below in the figures below.



Figure 11: Biophilic Design Example (Newman 55)

Singapore, Garden by the Bay's 'super trees' are educational structures demonstrate the process of ecological systems.



Figure 12: Biophilic Design Example (bbc.com)

London's the Gherkin building is designed with an air ventilation system that is like that of sea sponges and anemones.

Case Study 1 – Singapore, Malaysia

Singapore is an example of good biophilic design. Newman notes that Singapore was known as the 'garden city', but took the next step to become a 'city in a garden.' Government officials planned to bring nature and biodiversity to the front doorsteps of its residents (Newman 48). Everything in between buildings and existing green spaces became an opportunity for implementing biophilic urbanism design elements. This included the facades of buildings, rooftops, linking existing green spaces, and greening of roadway corridors. The Singapore government made it a requirement for developers to implement green elements in or on the building in the form of green roofs or green walls, equivalent to the footprint of the building.

Furthermore, over the course of 21 years, 1986 to 2007, the canopy cover in Singapore increased by 20%, even though there was a 70% population increase (Newman 54). Newman mentions that “Singapore is a good example of biophilic urbanism, where the development of green areas and green buildings are being shown as regenerating the natural systems in the city and creating an urban ecosystem like the original structure, but with better biodiversity outcomes” (Newman 64). Newman shares an example of how a teacher taught himself and his students how to build and install a green roof, and they implemented one on their school. Newman concludes by stating that anyone can take initiative to implement elements of biophilic urbanism, if determined enough.

Urban Forest Benefits

The various elements of biophilic urbanism can be applied to cities to maximize environmental benefits, (i.e.: reduced carbon footprint, reduced stormwater runoff, and better air quality). The greening of cities can be implemented through urban trees and urban forests. They provide several economic, social, environmental, and health benefits. Some of these benefits include the following:

1. Trees provide shade by reducing the amount of heat absorbed in hard surfaces, such as buildings and asphalt pavement. The shade provided by trees protects asphalt from heat and prevent them from breaking down sooner. As a result, trees reduce cost of asphalt pavement maintenance (McPherson and Muchnick, 308.)
2. Trees help to cool the air.
3. Trees reduce wind speed onto buildings and as a result reduce building heat loss.
4. Trees reduce carbon dioxide emissions and other air pollutants.
5. Trees improve water quality by detaining particulate matter that would otherwise end up in the stormwater system.

6. Trees increase biodiversity and wildlife habitat.
7. Trees add interest and beauty to the streetscape by adding texture, color, line, and form.
8. Trees and nature can improve mood, reduce stress, and improve psychological and social well-being that in turn can help to reduce crime in neighborhoods.
9. Trees add property value to the neighborhoods “people are willing to pay 3 to 7 percent more for properties with ample trees versus few or no trees.” In addition, depending on the sale price of the house, trees can add revenue to the city’s property taxes (Northeast Community Tree Guide 16).

Furthermore, i-tree.org notes that “the more impervious the surface, (e.g., concrete, asphalt, rooftops), the more quickly pollutants are washed into our community waterways. Drinking water, aquatic life, and the health of our entire ecosystem can be adversely affected by this process. Trees act as mini-reservoirs, controlling runoff at the source. Trees reduce runoff by:

- “Intercepting and holding rain on leaves, branches, and bark
- Increasing infiltration and storage of rainwater through the tree’s root system
- Reducing soil erosion by slowing rainfall before it strikes the soil” (i-tree.org)

Even though trees provide several benefits, there are several disadvantages to planting a lot of trees urban areas. During large storm events, trees can come down and cause damage to houses and utility lines, which are costly for homeowners and municipalities to repair. Additionally, trees can suffer damage from pests and diseases. Currently, cities are facing the struggles of managing ash trees. Cities need to develop management plans to cope with the inevitable emerald ash borer arriving in their community and killing ash trees. This can cause a financial burden on cities and homeowners to manage these trees. In addition, trees produce leaf litter that adds maintenance for homeowners and municipalities, requiring time and budget. If leaf

litter is not maintained, then leaf litter and fruit can end up in storm sewer systems and clog storm structures. Furthermore, trees species release pollen and contribute to allergies and can contribute to allergy induced asthma; in up to 30 percent of adults and 40 percent of children. Certain species of trees produce less pollen than others; specifically, female species produce less pollen than male species of trees (Ogren). Furthermore, trees also produce carbon dioxide during tree planting, pruning, and decomposition of dead wood (Northeast Community Tree Guide 10). In addition, trees can trap pollutants that can contribute to asthma, if there is a lack of wind movement or closed canopy effect, if trees are not properly planted in the right place (Qtd. in Rodriguez). Furthermore, certain tree species will release biogenic volatile organic compounds (VOCs) that add to ozone formation. Nowak mentions that low emitting tree species can be used to minimize ozone formation. (Qtd. in Nowak, et. al. 119.) For these reasons, it is important to select the proper tree species to minimize the amount of pollen produced and to minimize VOCs production, that would contribute to human health issues. In addition, the placement of trees is important, to avoid a closed canopy effect that would trap pollutants under tree canopy. Trees species and placement should be properly selected and planted in the right location to enhance human health benefits, not detract from it.

The overall benefits that trees provide and the large quantities of trees that contribute good VOCs outweigh the negative VOCs and carbon dioxide released. (Northeast Community Tree Guide 9-11). In addition, Rodriguez mentions that a study in Baltimore, Maryland revealed that 25 urban forests and parks help to reduce “ground-level ozone by about 9% compared with adjacent open spaces” (Qtd in Rodriguez). According to the 2010 U.S. Census, 80% of Americans live in urbanized areas. Nowak, et. al. mention that because human populations are concentrated in cities, the health effects and quantity of pollution removal are greatest in cities, thus trees in cities have a greater impact on human health than in rural areas due to the proximity of trees to people (Qtd. in Nowak, et. al. 124.)

METHODS

The author desired to test spatial feasibility of BRT and biophilic urbanism on Erie Boulevard East. To understand the ecosystem and economic benefits of biophilic urbanism, the author utilized i-Tree Suite and Photoshop to quantify impacts on carbon dioxide emissions, air quality, and stormwater runoff and reductions in impervious surfaces and increases in green permeable surfaces. In addition, archival research, site analysis, and the Online Survey helped the author better understand the historical importance of the Erie Canal, the current conditions of Erie Boulevard East, and the desires and needs of the residents and visitors to the Erie Canalway Trail.

Archival Research – This project began as an attempt to better understand the history of Erie Boulevard, how it came to be, and what values were placed on Erie Boulevard. How did people perceive the Erie Canal, what was the atmosphere like, and why was it important to them? These questions were answered in part by archival research at the Onondaga Historical Association (OHA) and the Erie Canal Museum. “For the researcher exploring history the archive is a place where they look for documents that will tell them about the past” (Cresswell 166). Additionally, the archives are “collections already created, as resources to be tapped or even exploited” (DeLyser 209). The Onondaga Historical Association and the Erie Canal Museum provided information on the past and a better understanding of the atmosphere and perspectives that surrounded the Erie Canal in its booming days. Nathaniel Hawthorne mentions that there must be something in the water, as the Canal caused towns to spring up overnight. He mentions, that towns spring up with businesses with “luxury and refinement” and “gay dames and polished citizens” (Erie Canal Museum). These words were recorded in history, but they were articles that were selected by readers or archivists, given value, and made worthy for the archives, and ultimately becoming part

of recorded history. The archives serve as a starting point for gathering information on the past, but it can be distorted or partial information. Cresswell mentions that the archive is a place where objects are valued, but these values are not clear. He continues by referring to Cook and mentions that “Cook reminds us, archivists are valuing things in a way that not only constructs the past but preserves the future” (Cresswell 168). As the archive is used, researchers need to keep in mind that history is created by archivists who place values on the items in the archives and that certain stories may remain untold. Some untold stories include those who worked to build the canal; for them life was not the glamorous thing that Hawthorne mentions, but rather a life of low pay and poor living conditions.

Site Analysis - Site analysis gathers data on the history, existing conditions (infrastructure, topography, hydrology, and climate, etc.) of a specific site. To better understand the existing conditions of the site, the author traveled the site on foot from Clinton Square to Kinne Street, a total of approximately four miles. The research included four visits, at one-hour increments each; two stretches in the evening hours in early October and two stretches during the weekend mornings in late October of 2016. During the walks the author took photographs of site conditions and following the walks, the author recorded thoughts and feelings in a journal, see Appendix 11 for journal notes. In addition to the site visit, parcel maps were gathered from onondagagis.gov that shows the right-of-way boundary and topography for the site. The right of way boundary became the limits of design for this project.

I-Tree Suite - i-Tree suite is a computer program that is used analyze “the local, tangible ecosystem services that trees provide, i-Tree users can link forest management activities with environmental quality and community livability” (i-tree.org.) i-Tree Design is one of the programs in the i-tree suite package. i-Tree Design was utilized to estimate tree benefits for the Erie Boulevard

alternative case (proposed design). The tree species, quantities, and locations, for the alternative case were entered into i-tree Design. The results showed quantitative information on stormwater capture, energy saved, air quality improvement, and carbon dioxide sequestration. I-Tree Design provided a report that showed the benefits for the current year, over a specific time span, in years, and total benefits for a selected future year.

i-Tree Hydro measures land cover scenarios, change in pervious and impervious surfaces in a pre-and post-conditions, and the measured changes and effects on the hydrological system (i-tree.org). For the program to provide results comparing the pre-and post-scenarios, the user must select a year from which to draw the annual precipitation data from. In addition, the user must enter the land cover information; this includes canopy above pervious surfaces, tree canopy above impervious surface, herbaceous cover percentage, conifer percentage, and impervious surface percentage. This information is entered for both the base case (existing condition) and alternative case. The results compared the two cases, and provided data on stormwater runoff capture and reduction in pollutants.

Photoshop - Photoshop was utilized to calculate the amount of square feet of pervious land cover, impervious land cover, and canopy for the existing condition and alternative condition scenarios. The alternative condition was calculated with a 30' width tree canopy. This site boundary for the calculations included Bridge Street to Salina Street to the right of way on Erie Boulevard East. The Salina Street corridor from Erie Boulevard to Adams Street section of the project site was not included in the calculations because the conditions for pre- and post are the same, except for one tree median that is five feet wide by 100 long. This stretch of added green would not have been significant enough to affect the overall pervious and impervious calculations, and thus, was not included in the calculations for pre-and post stormwater runoff calculations.

Iterative Design - These are graphic generations of spatial relationships that allow the designer to explore potential compositions. This process is about testing, analyzing, and refining a range of design compositions, eventually leading to a final design.

Online Survey Results - The Town of Dewitt planner shared the results of the Elevating Erie online survey with me. The results of the survey are shown in Appendix 1. This survey was utilized to understand the desire and need of the community for BRT, biophilic urbanism, and improved streetscapes. In addition, the survey results were used to determine if the design goals aligned with the community's desires and needs. The survey results showed a high percentage of residents that desired pedestrian friendly areas and protected bike lanes in the connectivity and safety section of the survey. In addition, the highest scoring amenity in the eco-friendly design section was a desire for increased tree canopy and green infrastructure. Furthermore, for the transit section, several community residents felt that more frequent bus service, improved shelters, and real-time bus information would help improve transit options on Erie Boulevard East. The results are indicative of a need and importance for designing a BRT, biophilic urbanism, and pedestrian oriented landscape.

DESIGN

Through the archival research, the author learned that the Erie Canal was of historic importance. The Erie Canal served as an instrument of progress for New York State and for the country. It was a defining corridor that represented movement, growth, and progress through transportation and provided goods and services nationwide. It was catalytic for its time and it was through the construction of the Erie Canal that New York State prospered. The re-design of Erie Boulevard can be another opportunity to make the Erie Canal corridor (Erie Boulevard) of at least local historic importance once again. Erie Boulevard can become a symbol of progress once again, progress that is about making urbanism in harmony with ecological systems and to enhance individual and public welfare.

The site inventory and analysis, see Figure 13 on page 43, indicated that Erie Boulevard East is far from becoming a Great Street. Currently, Erie Boulevard East has intermittent sidewalks, and those that exist are mostly in poor condition, blocks are long in length, there is few, if any, buffers from traffic, major intersections are 5-8 lanes, there are no pedestrian crossing signals, there is full exposure to sun, few street trees exist, most buildings are set far back from the sidewalk, and bus stops do not have a bus shelter or seating. These qualities create unsafe environments for the pedestrian and for drivers of vehicles. The author walked the site and felt fear, exposed to the elements, and isolated. The site was dominated by cars. The author felt confused and unsure of when to cross at major intersections due to lack of pedestrian crosswalk signals, and the signal system addresses cars and not pedestrians. Walking the blocks felt long and was uninteresting. The site inventory and analysis indicate that Erie Boulevard is not a great street, but it has the potential to become one, and can benefit from a design that utilizes the Great Street, BRT, TOD, and biophilic urbanism design guidelines.

Inventory

A large percentage of the site does not have sidewalks.
 Intermittent sidewalks, some in poor condition.
 Asphalt snow shelf exists in place of sidewalk in some areas.
 Whatever walking path exists vary in grades.

Blocks are long in length.

No buffer from cars traveling 40+ mph.
 Not all intersections have stripped crosswalks.
 5-8 lane intersections.
 No pedestrian crosswalk signals.

Exposure to full sun.
 No street trees exist.

Bus stops do not have a bus shelter

Buildings are set far back from the sidewalk.
 Vacant storefronts.



8 lane intersection on Thompson Ave.



No sidewalk



Poor condition sidewalk, no street trees, exposure to sun



Vacant storefront

Site Analysis

- Felt unsafe, afraid to get too close to curb edge
- Absence of interesting site details made long blocks seem longer
- Eight directions of lights for vehicular traffic, no lights for pedestrian made it confusing on when to cross, cautious when crossing, can not make it across entire crosswalk
- Hot and uncomfortable in the summer, no overhead structures to seek shelter under during inclement weather
- Bus stops signs are small and not visible, no place to sit and wait for bus
- Creates a sense of isolation and discomfort

Erie Blvd. E. fails as a Great Street because it does not meet the criteria for a Great Street

Allen Jacobs' Great Streets formula includes creating:

- Places for people to walk for leisure,
- Physical comfort,
- Definition,
- Qualities that engage the eyes,
- Transparency
- Complementarity
- Maintenance
- Quality of design construction

Reid and Bartholomew recommend the following:

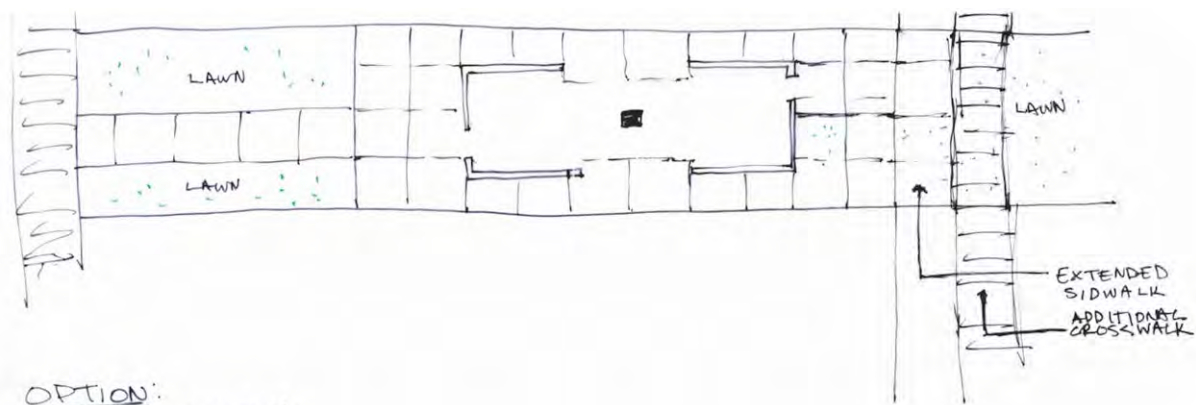
- Medium-high densities,
- Fine-grained mix of land uses,
- Short to medium-length blocks
- Transit routes every half mile or closer
- Two-to-four lane streets
- Continuous sidewalks appropriately scaled
- Safe crossings
- Appropriate buffering from traffic
- Street-oriented buildings
- Comfortable and safe places to wait



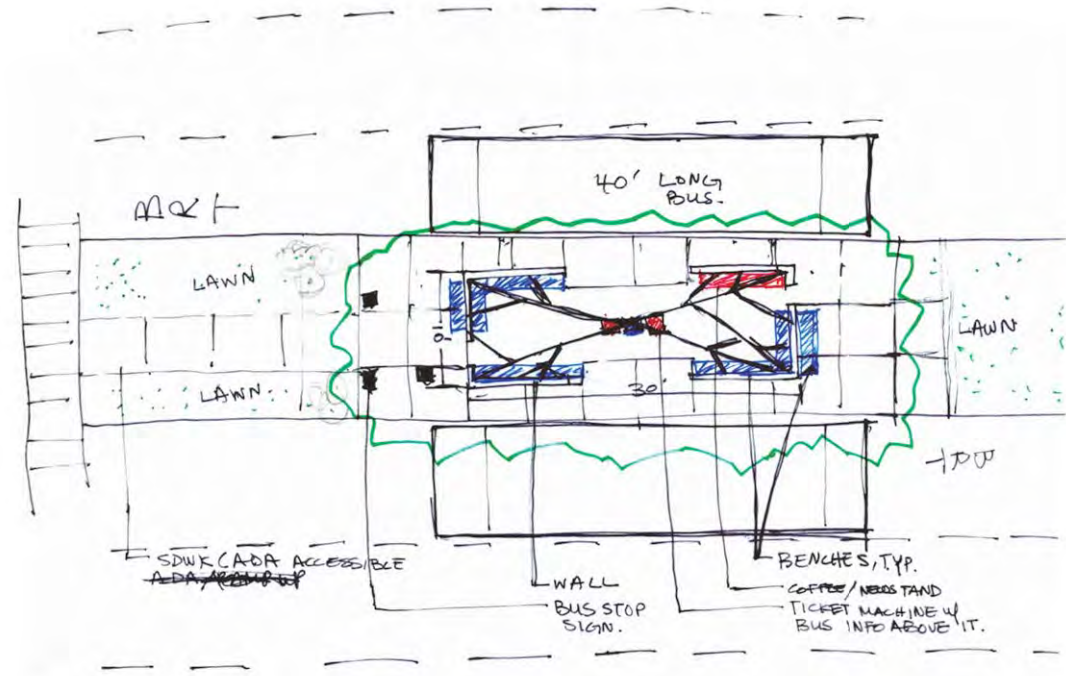
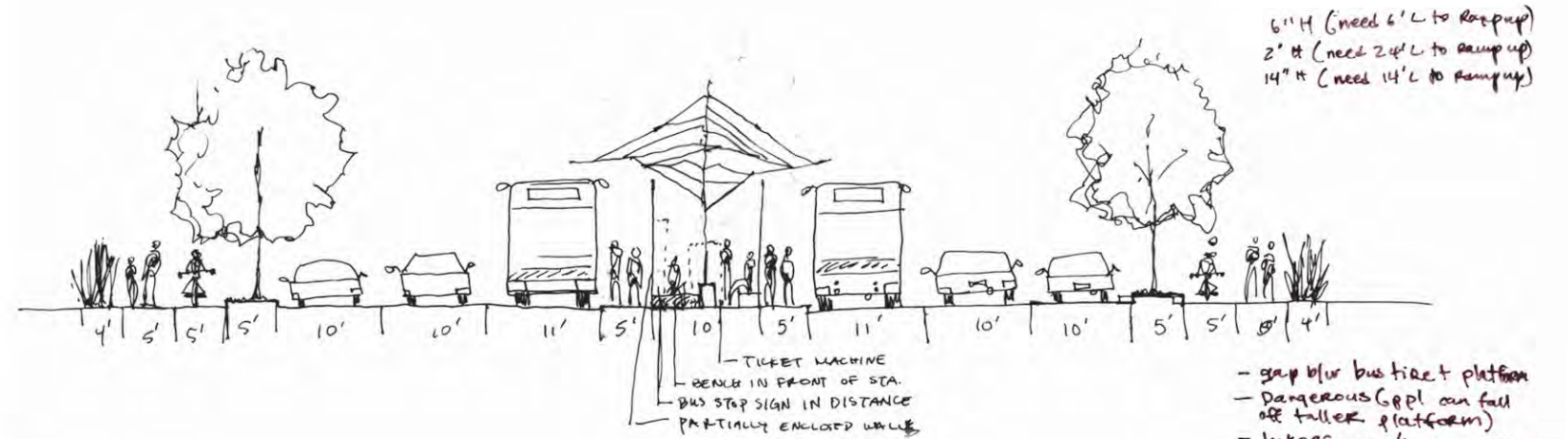
Creating a design that utilizes Great Streets, biophilic urbanism, and bus rapid transit guidelines and recommendations

Figure 13: Inventory and Analysis of Erie Boulevard East

BRT can serve to increase density around transit nodes for current and future development. The design program includes a nodal TOD approach that incorporates BRT, urban forestry, and great streets. The major intersections along Erie Boulevard East were selected for node locations due to higher traffic counts and pedestrian counts than other intersections. BRT was of highest priority in this design project, therefore the author located the BRT stations first. The author studied BRT station typologies, reviewing the location of the station, scale, and amenities. Each typology is pictured in Appendix B; each typology offered pros and cons in its application on Erie Boulevard. The author then sketched section elevations of each possible typology; see figures 14A-C on pages 45-47 below. The author then selected the central platform typology based on project goals and the spatial opportunities available. This typology allowed for the maximum shelter size, accommodates the greatest number of amenities, allows for maximum green space capacity, and is highly visible. Next, was exploring the proper shelter size, identifying the width, height, and location at the intersection, and what amenities the shelter would accommodate. The final design of the BRT station is shown below, Figure 15A-B, pages 48-49. With the station design complete, the remainder of the boulevard was designed utilizing biophilic urbanism and streetscape design guidelines. The author designed outward from the station to determine the location of vehicular travel lanes, the number of lanes, and the width of lanes for bus and cars. In addition, bicycle and sidewalk locations and widths were explored. Bicycle lanes would be a conventional bike lane, five feet wide from the curb to lane strip, and with bicycle boxes at signalized intersections (FHWA Lesson 19 19-2 and Nacto Conventional Bike Lanes and Bike Boxes), see appendix 7 for graphic presentation. In addition, the sidewalks are five feet wide, the minimum recommended sidewalk width (FHWA Lesson 13 13-1). The iterative design of section



OPTION:
CENTRAL STATION



- WIDEN OUTFORM PLATFORM AREA.
3' → 5 or 6'
- REF. DIMENSION/ DESIGN GUIDELINE FOR BRT/MEDIAN STA.

OPTION 1
CENTRAL STA.

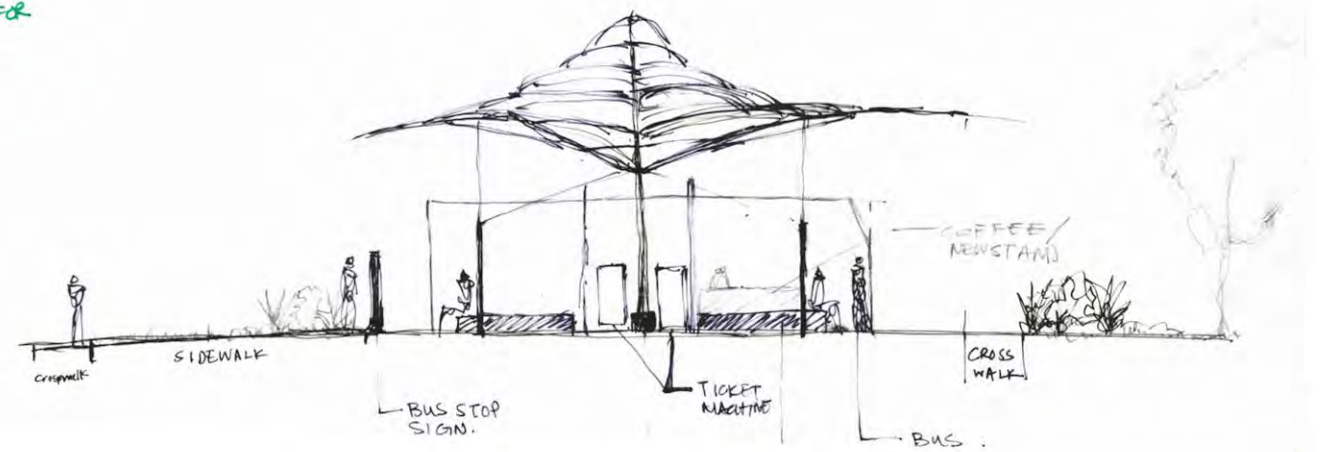


Figure 14A : Typologies of bus station locations (Central Bus Station)

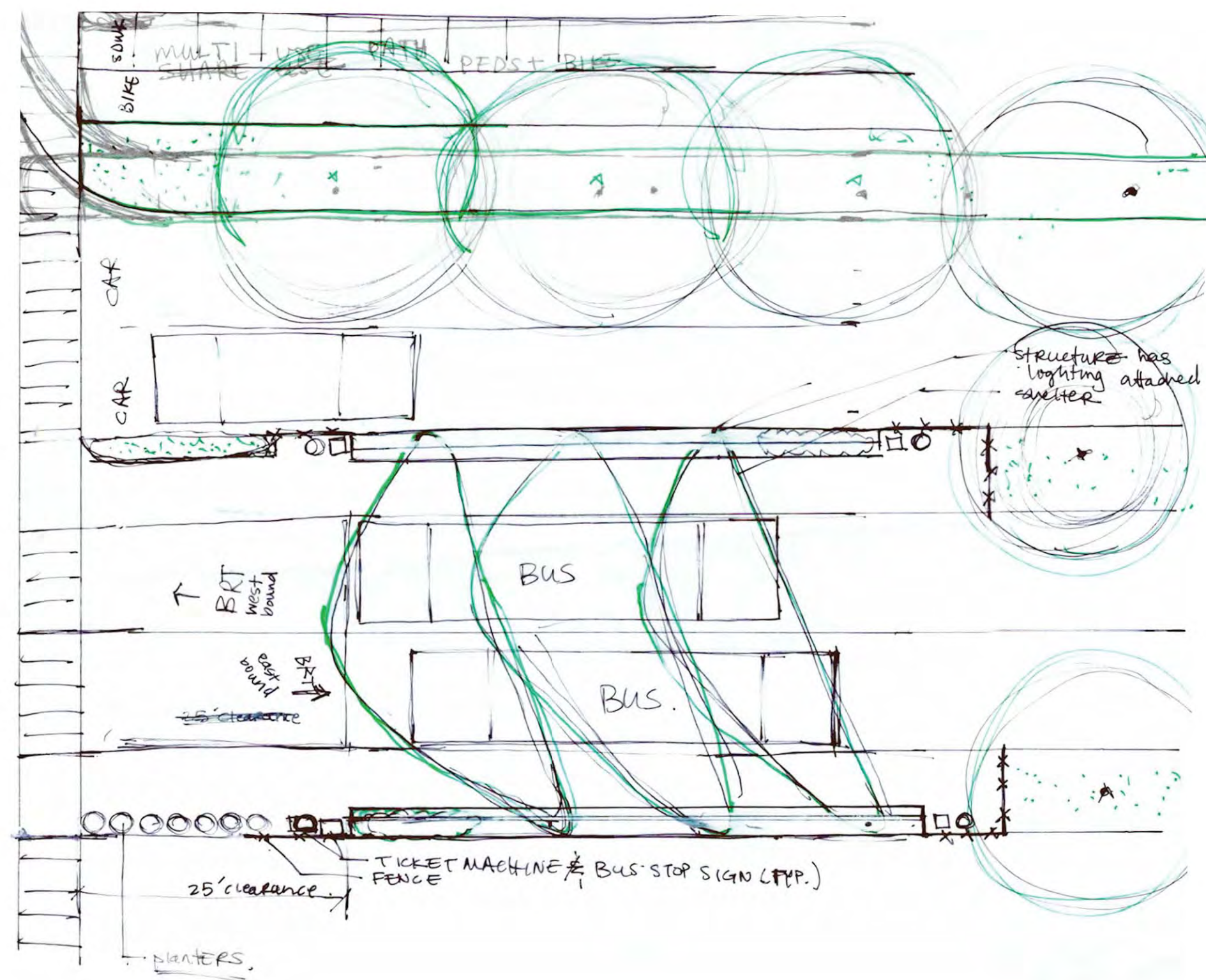
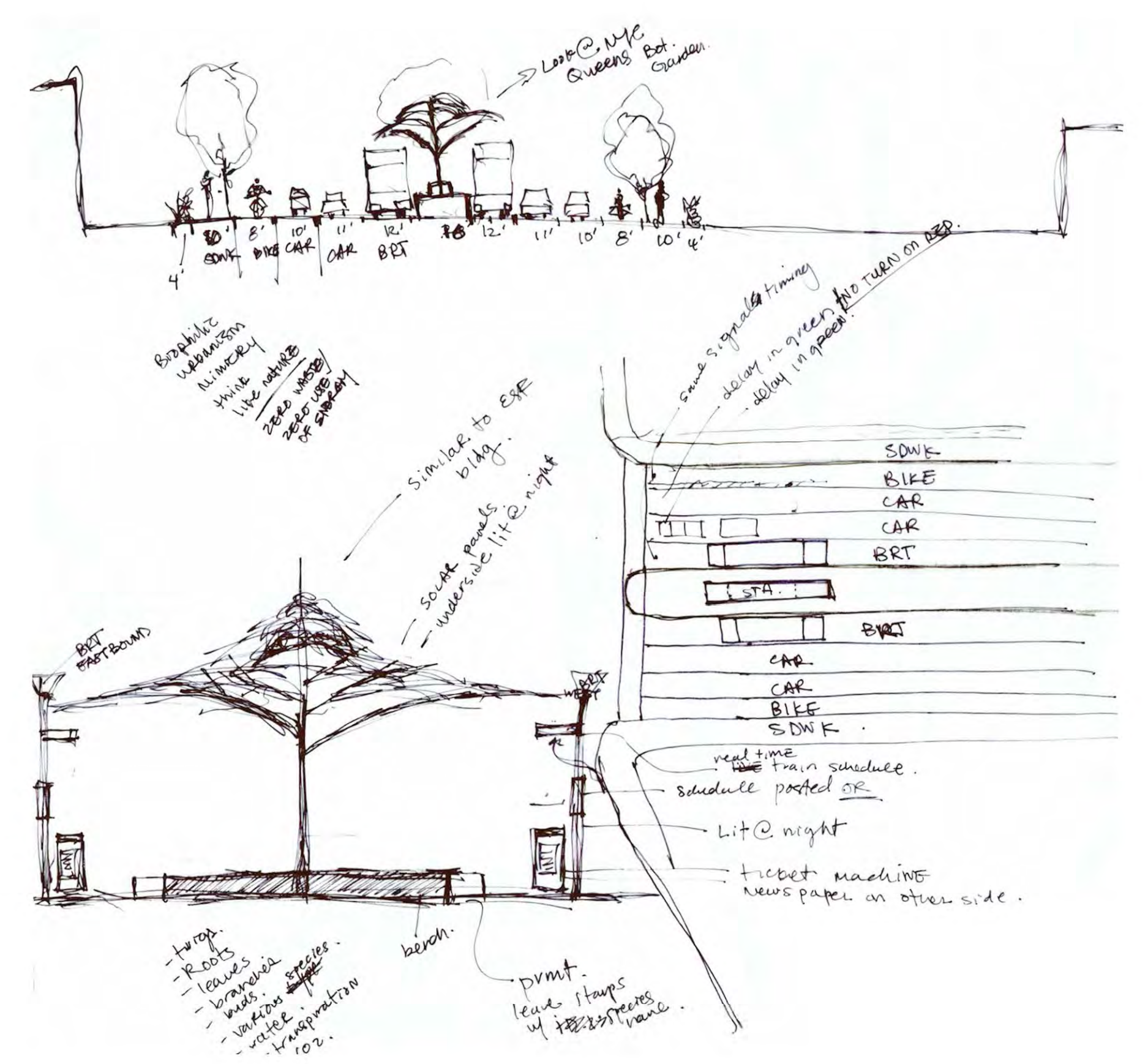
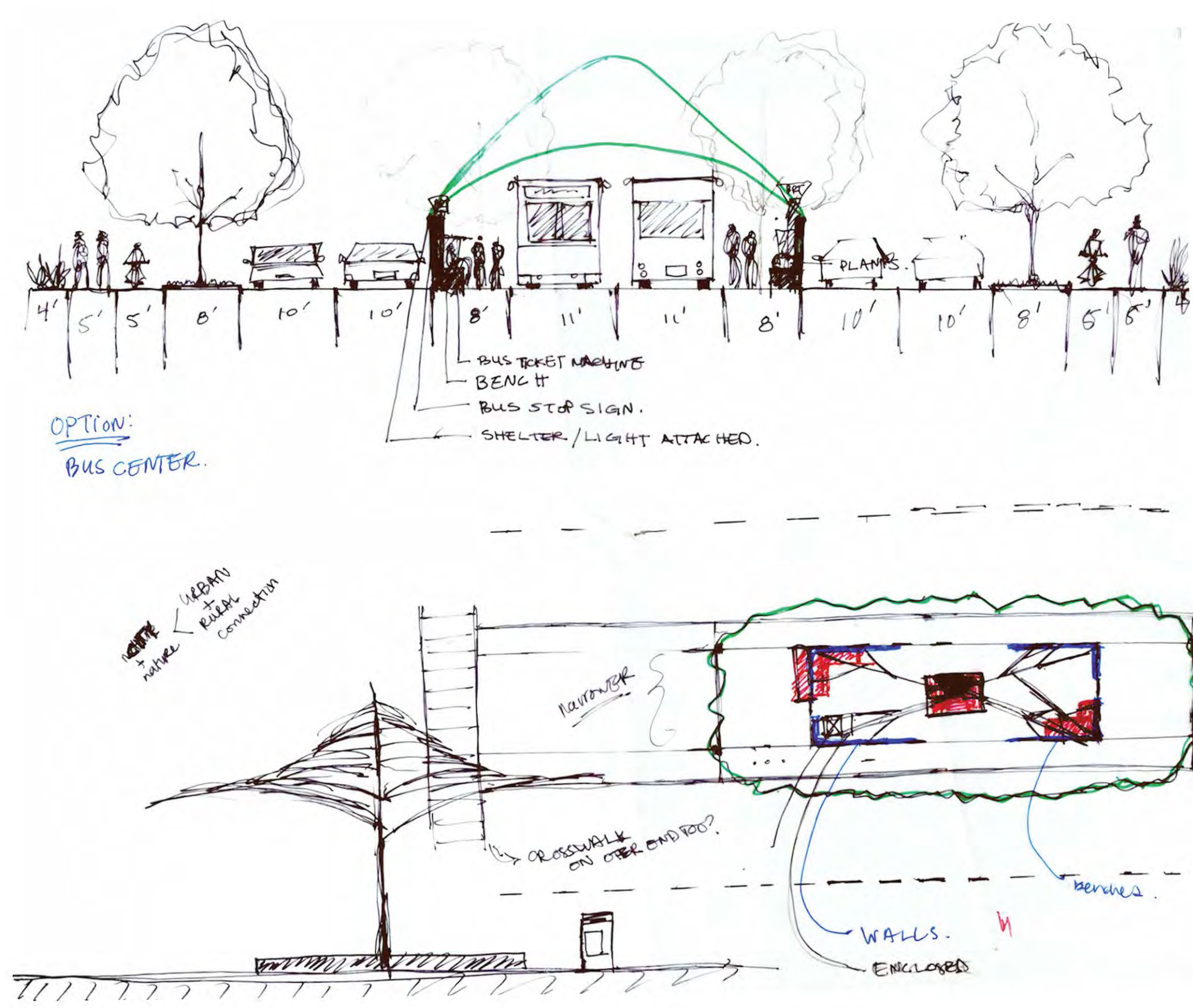


Figure 14B: Typologies of bus station locations (Central Bus Lanes)



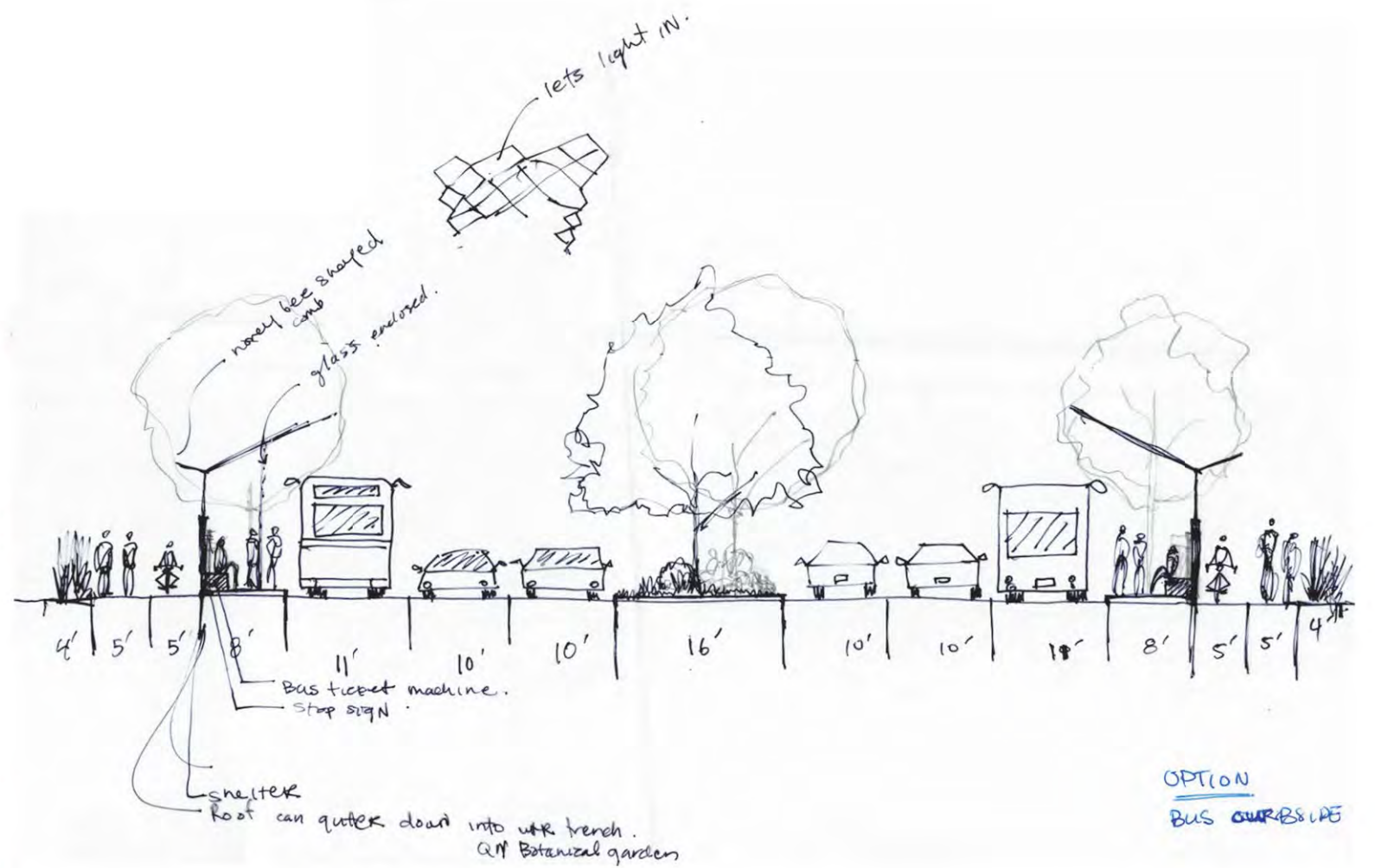
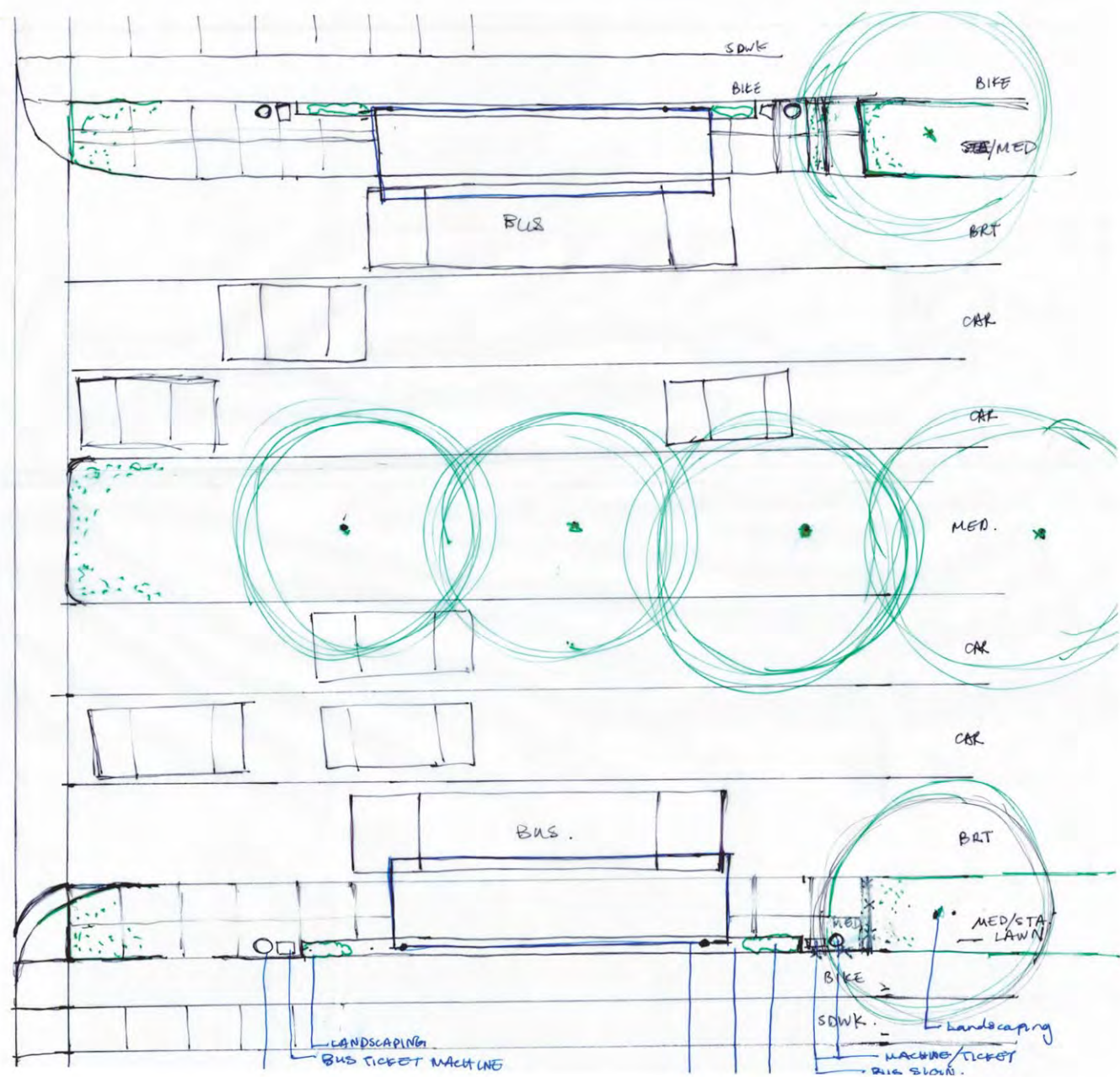


Figure 14C: Typologies of bus station locations (Bus Stations at Curbside)

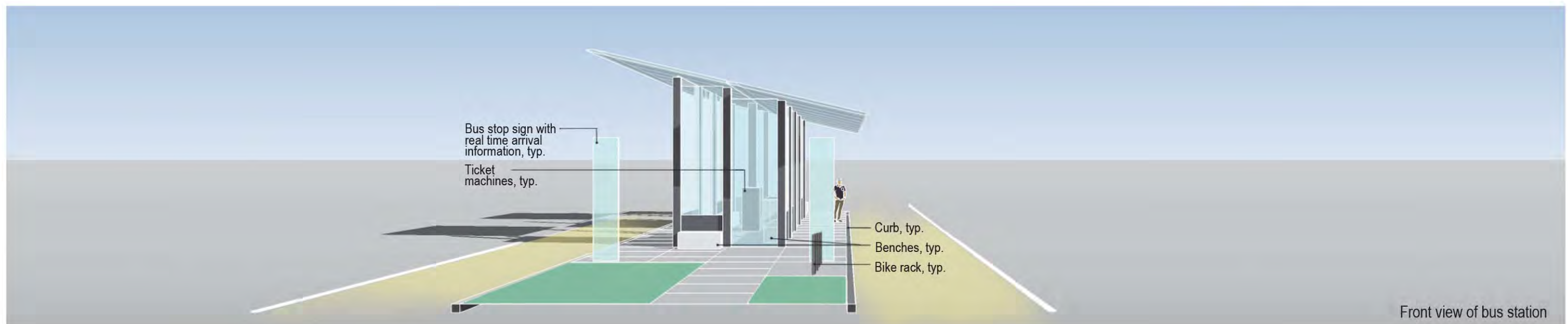
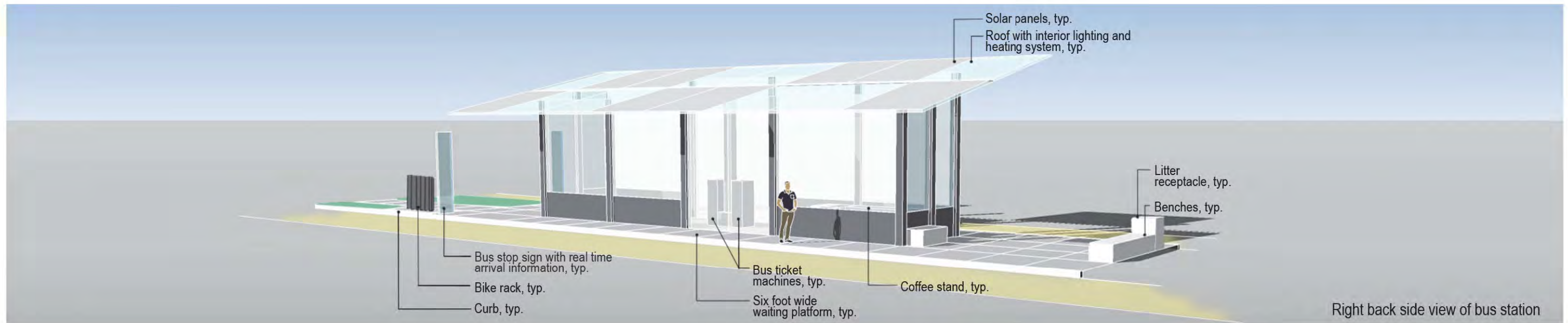


Figure 15B: View of prototypical bus shelter with amenities identified and labeled.

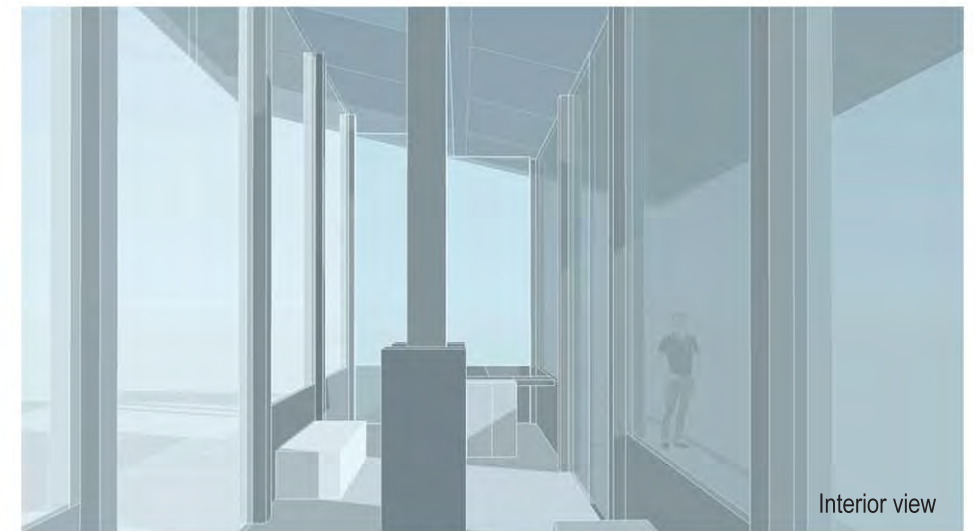
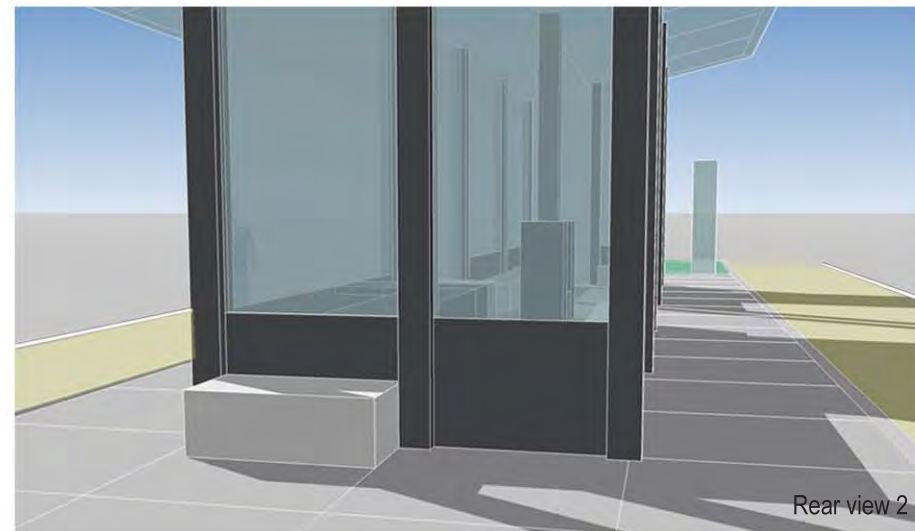
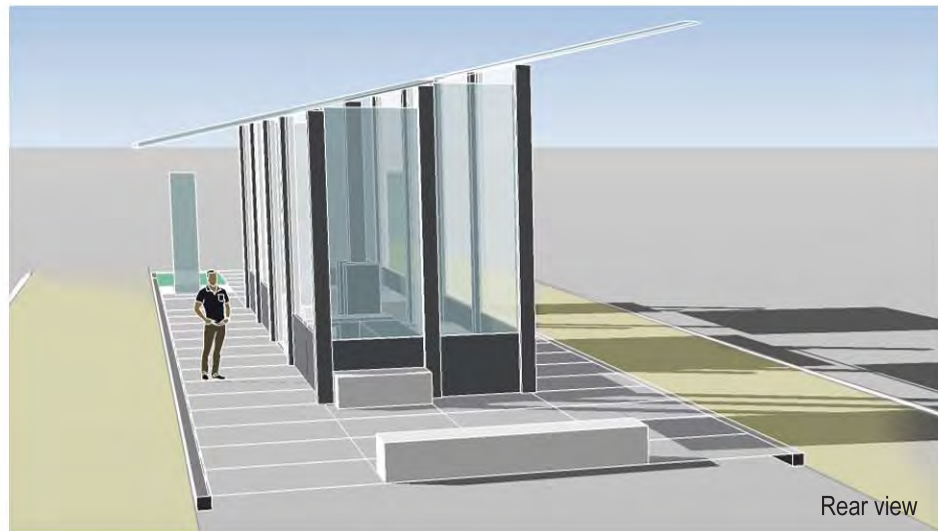
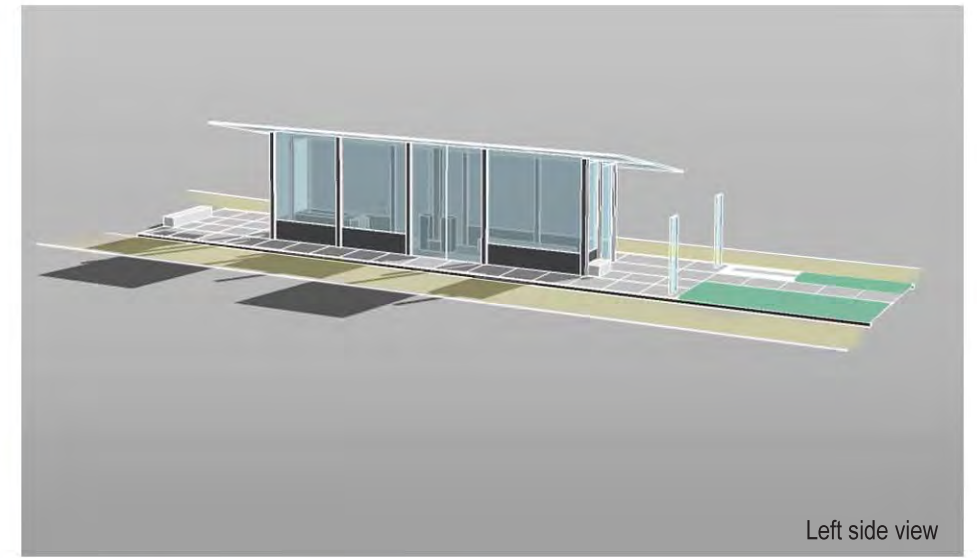
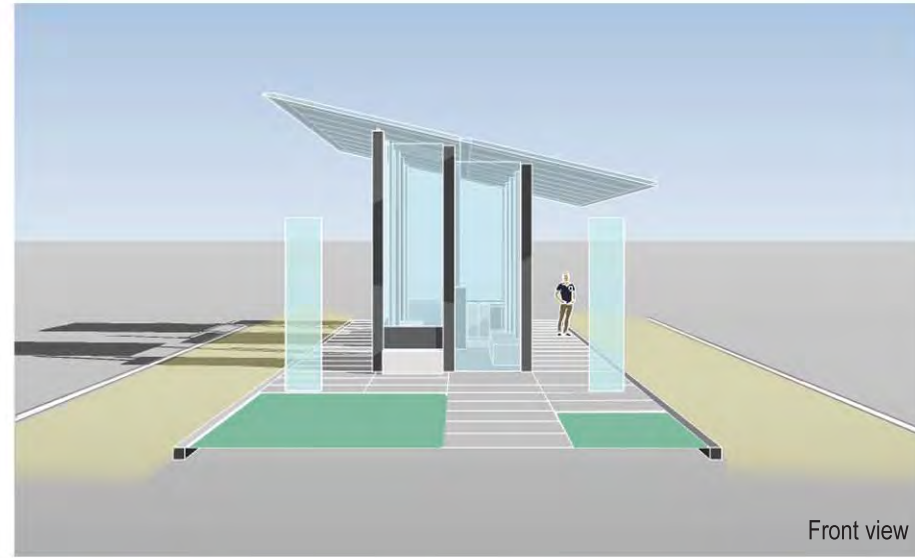
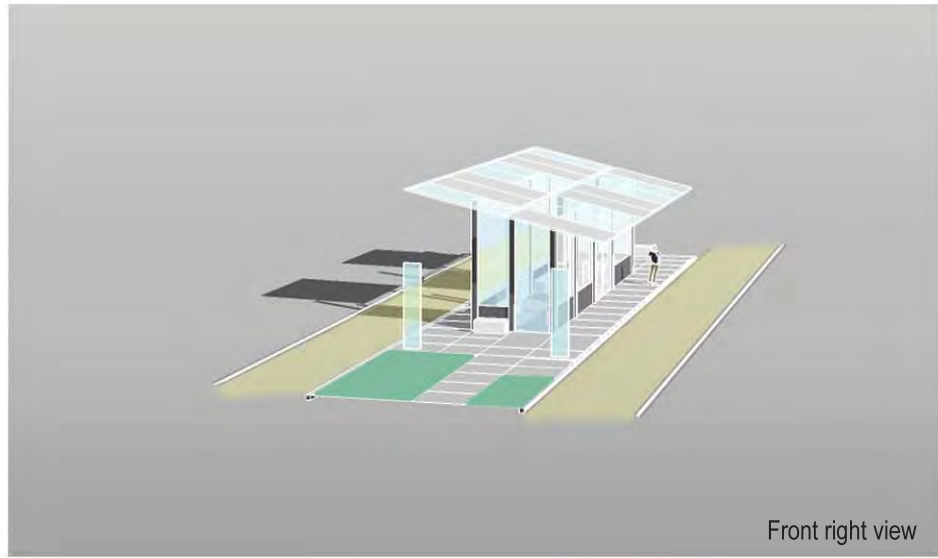


Figure 15A: View of prototypical bus shelter. Amenities at bus stations will be identical at each station. Artwork and landscaping may vary at individual stations to address neighborhood character.

renderings through Erie Boulevard can be seen below in Figures 16A-G on pages 51-57.

The final node design and design of Erie Boulevard includes the following elements:

- Bus station in the center median (central platform)
- Traffic signal priority for buses
- Bus lane on either side, accommodating eastbound and westbound traffic
- Two Vehicular travel lanes and a turn left lane at Bridge Street, Thompson Avenue, Midler Avenue, and Teall Avenue
- One vehicular travel lane at Almond Street and Fayette Street
- Stripped crosswalks
- Crosswalk signals
- Bike lanes, eastbound and westbound
- Sidewalks
- Street trees
- Trees, shrubs, and herbaceous plants in the center medians
- Pedestrian oriented street lights

See Figure 17 on page 58, below for a labeled plan of the nodal design at Bridge Street, this nodal design is typical of major intersections, except for where the right-of-way was constrained. A fully rendered plan is shown below, Figure 18 on page 59 and final section elevations can be seen below, Figures 19A-C on pages 60-62. Perspective renderings of the Bridge Street intersection can be seen below, Figure 20A-B on pages 63-64.

Selecting the Right Plants

Beatley mentions that nature is mysterious, that being immersed in nature creates a sense of wonder and discovery. Creating such opportunities for people to immerse themselves in urban nature is one of the big ideas of biophilic cities, and this is what Piet Oudolf and Ohme van Sweden accomplish through their planting designs. These two design firms create alluring and colorful landscapes, playing with dimensionality and textures. One of Ohme van Sweden's designs is the



Figure 18A: Iterative Designs - Location options for BRT lanes, bike lanes, vehicles lanes, sidewalks, medians and shared and non-shared lanes



Figure 16B: Iterative Designs - Location options for BRT lanes, bike lanes, vehicles lanes, sidewalks, medians and shared and non-shared lanes

West of Teall Ave



Figure 16C: Iterative Designs - Location options for BRT lanes, bike lanes, vehicles lanes, sidewalks, medians and shared and non-shared lanes

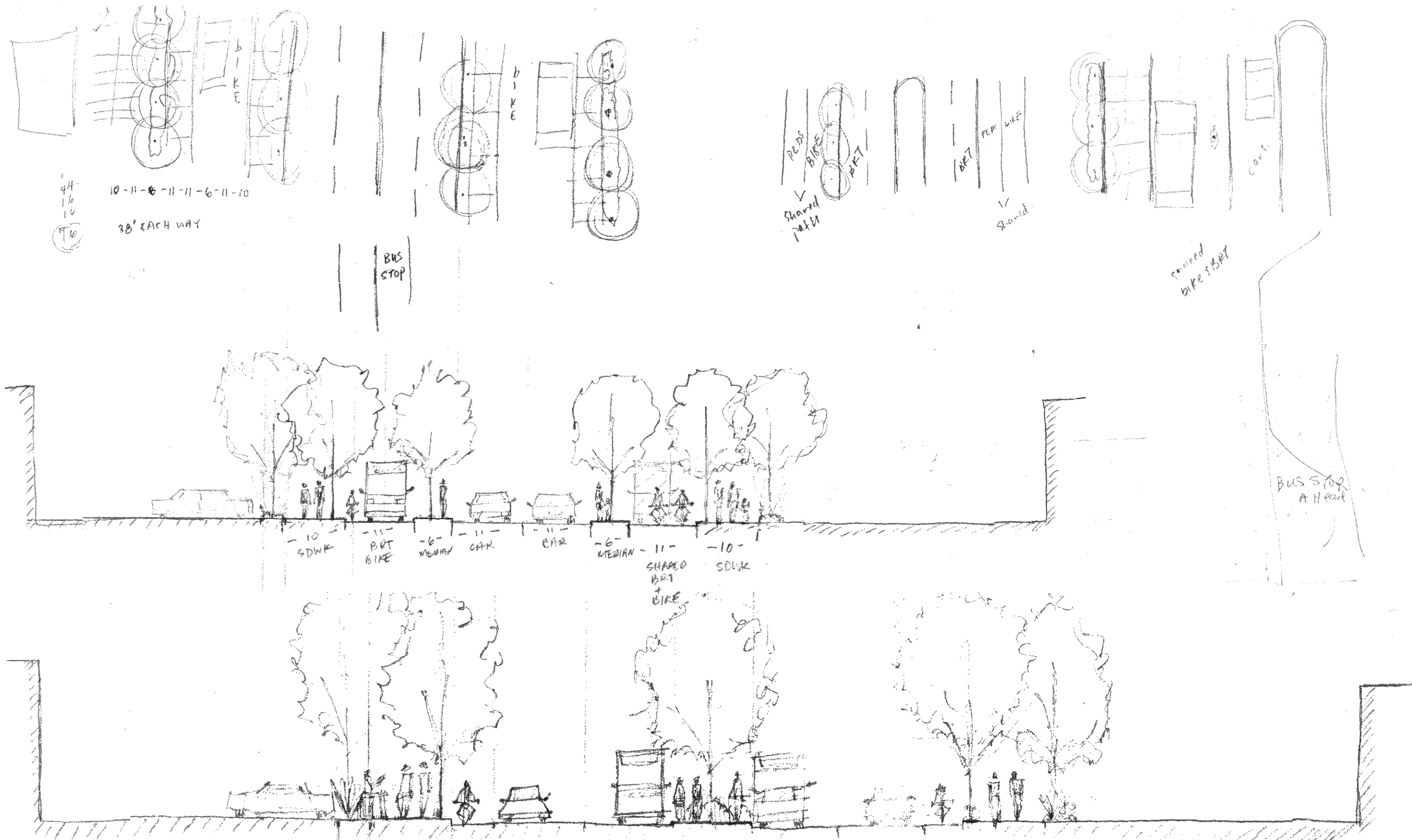


Figure 16D: Iterative Designs - Location options for BRT lanes, bike lanes, vehicles lanes, sidewalks, medians and shared and non-shared lanes

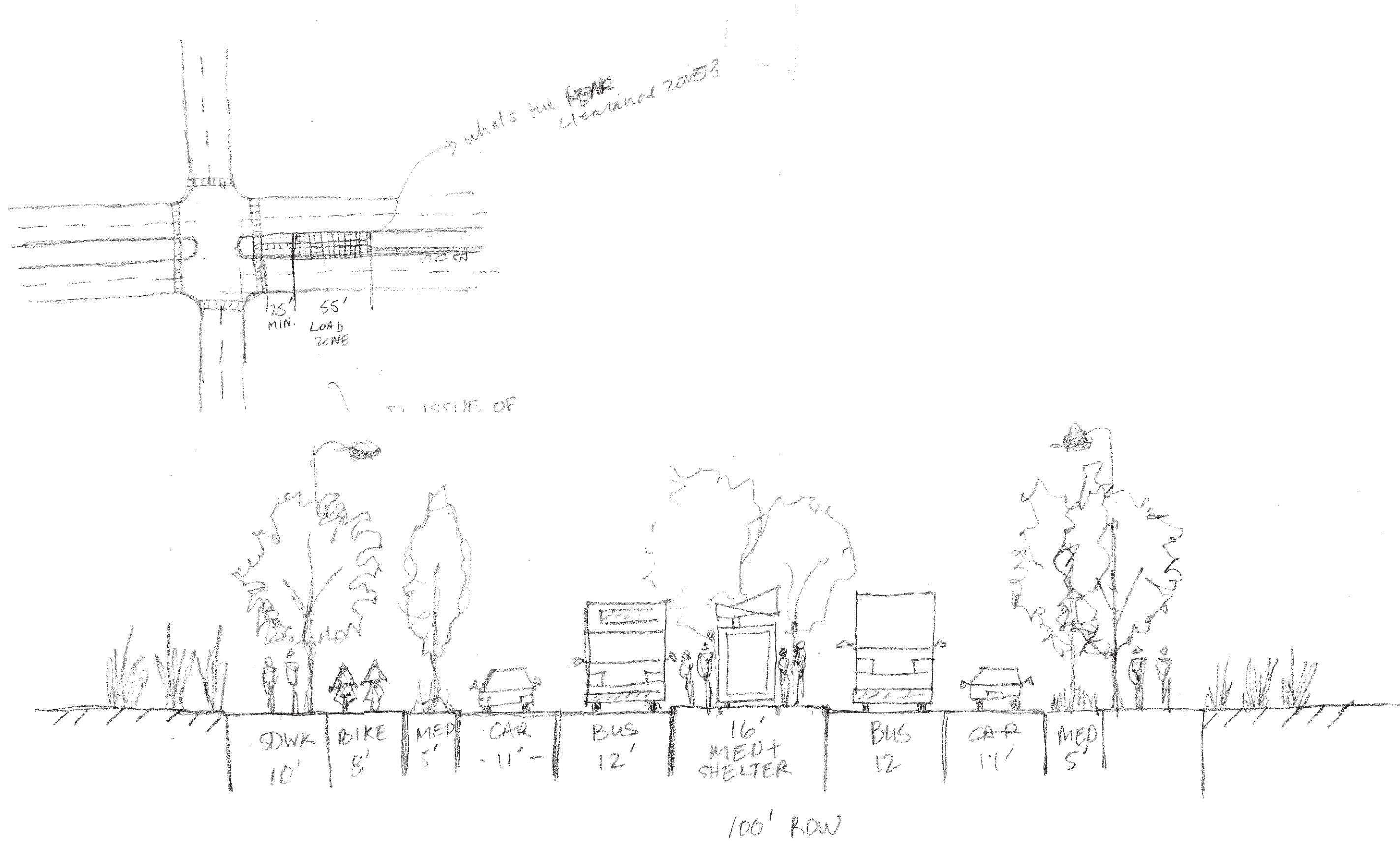


Figure 16E: Iterative Designs - Location options for BRT lanes, bike lanes, vehicles lanes, sidewalks, and medians that moved into conceptual design

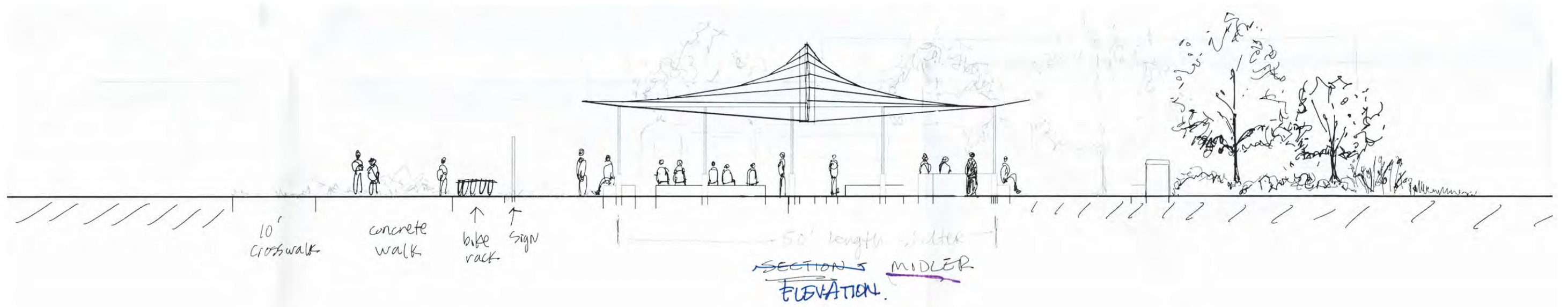


Figure 16F: Iterative Designs - Location options for BRT lanes, bike lanes, vehicles lanes, sidewalks, medians that moved into conceptual design

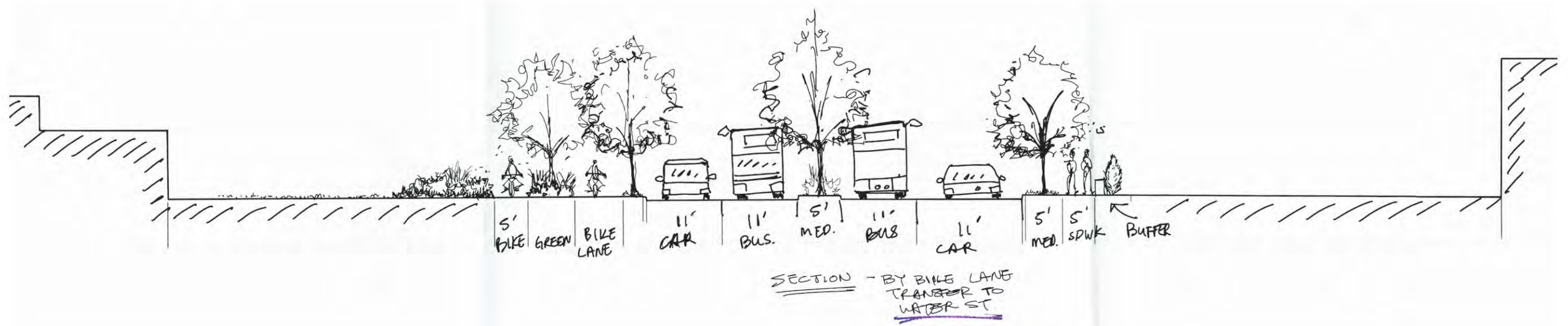
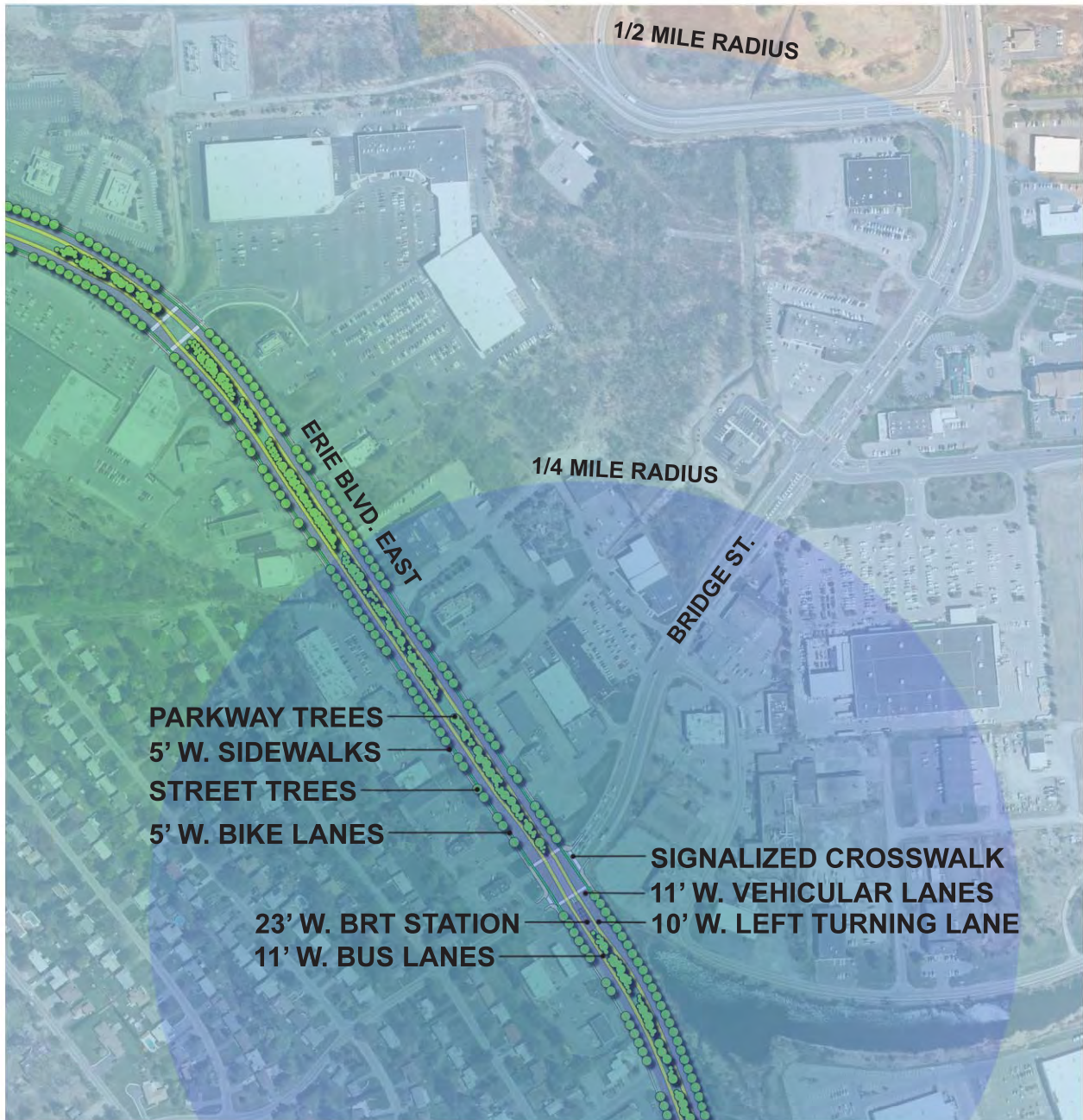


Figure 16G: Iterative Designs - Location options for BRT lanes, bike lanes, vehicles lanes, sidewalks, medians that moved into conceptual design



Each BRT node accommodates the elements shown above. The widths of the elements were dictated by dimensions of the existing right-of-way. Elements such as sidewalks, bike lanes, bus stations, bus lanes, and vehicular lanes were consistent in their dimension throughout the design. In areas where the right-of-way was smaller or larger, the width of the landscape in the parkway medians varied. Where the right-of-way width allowed, bus stations were designed at 23 feet wide. Where the right-of-way was narrower, such as at the intersections of Almond and Fayette Streets, the bus stations were designed at a narrower dimension, due to site constraints. In addition, due to site constraints, the Almond and Fayette intersections accommodated only one 11 foot wide vehicular lane, whereas other intersections accommodate two 11 foot wide vehicular travel lanes and a turn-left turn lane.

Figure 17: Prototypical Node Design

The New Erie Boulevard

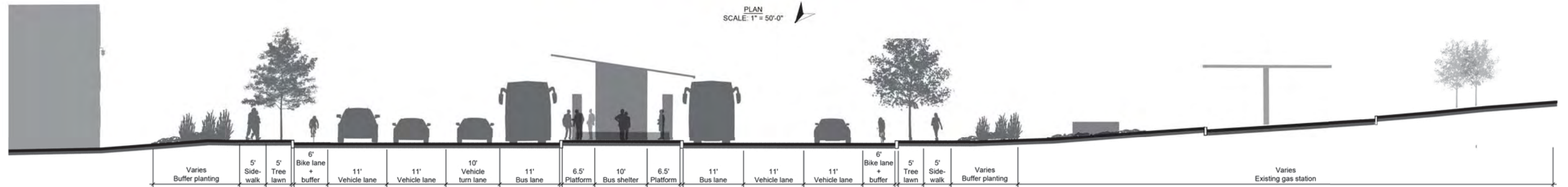
The new Erie Boulevard design re-envisioned Erie Boulevard East and South Salina Streets into a corridor that is walkable, offers multi-modal transportation options, is green and beautiful. The new design accommodates bus rapid transit, bike lanes, sidewalks, street trees, pedestrian crosswalks, and reduced number of vehicular travel lanes from Shoppingtown Mall in Downtown, New York to South Salina Street, in Syracuse, New York. The new Erie Boulevard provides a reduction in impervious surfaces from 74.4% to 50%, a 33% reduction in asphalt. The amount of vegetation, trees, shrubs, and lawn increases from 23.1% to 50%, more than doubling in size. In addition, one of the benefits bus rapid transit provides is the ability to decrease carbon emissions, with increased ridership and reduced single passenger vehicles. Bus transit offers an alternative to the single passenger vehicles. Shoppingtown Mall will offer a park-and-ride lot for commuters, and serve as location for transfer onto the bus rapid transit.



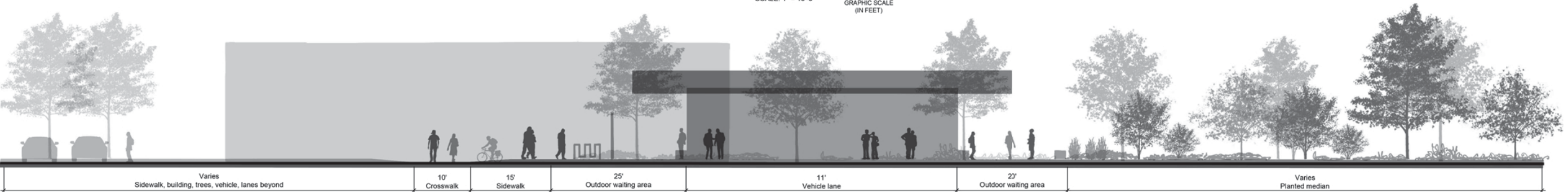
Figure 18: Erie Boulevard Proposed Plan



PLAN
SCALE: 1" = 50'-0"



0 5 10
GRAPHIC SCALE
(IN FEET)



0 5 10
GRAPHIC SCALE
(IN FEET)

Figure 19A: Section-Elevations at Bridge Street Intersection



PLAN
SCALE: 1" = 50'-0"

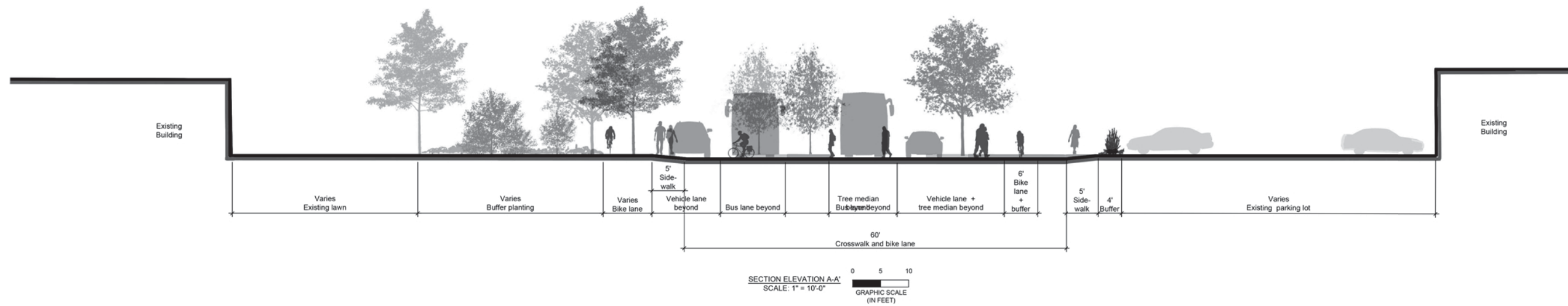
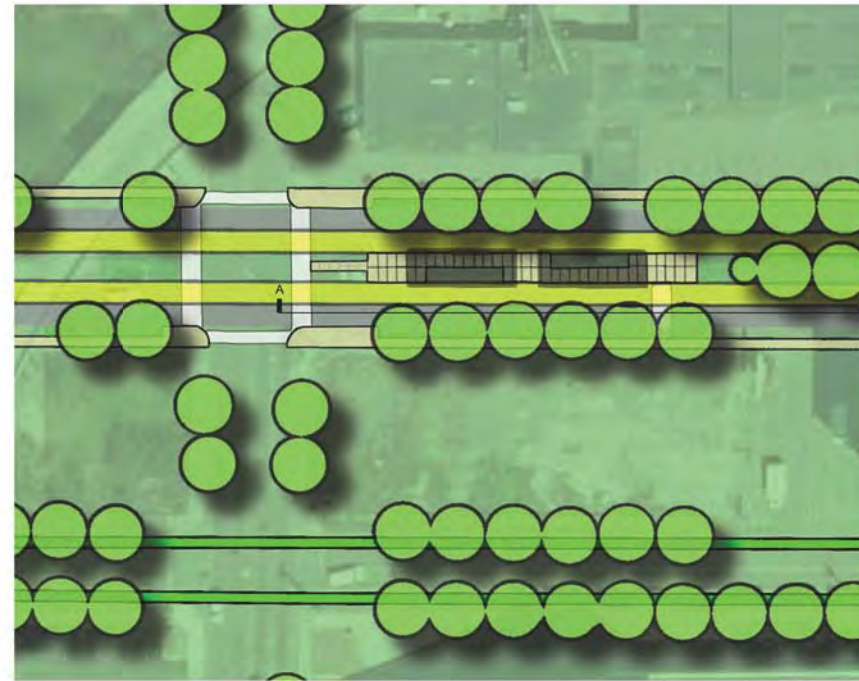


Figure 19B Section-Elevation at Water Street Intersection



PLAN
SCALE: 1" = 50'-0"

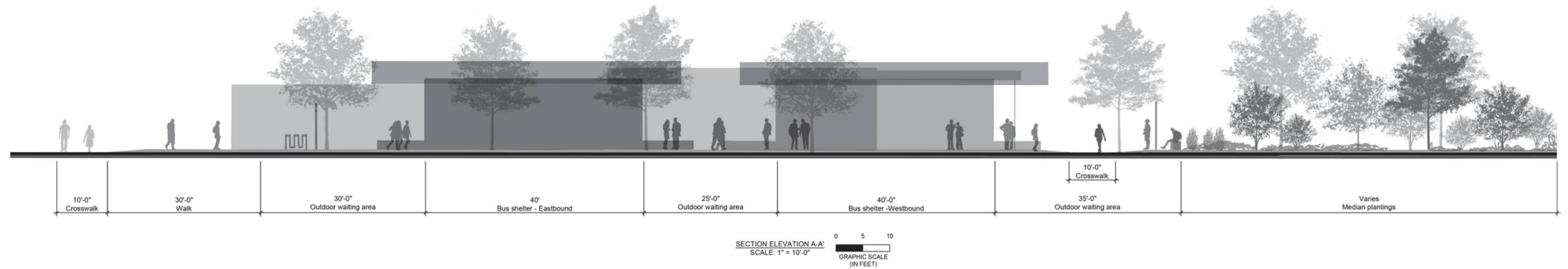


Figure 19C: Section-Elevation at Almond Street Intersection



BEFORE

The current conditions of the Bridge Street intersection include:

- No sidewalks for the pedestrian
- No pedestrian crosswalk available
- No bus shelter for buses
- 8 lanes of vehicular traffic, each 13 foot wide
- Asphalt median
- No street trees

Crossing at the intersection is dangerous as there are eight directions of lights for cars, but none exist for the pedestrians.



AFTER

The addition of a bus station, streetscape amenities, and landscaping transforms the Bridge Street intersection into a street that is beautiful and safe. What was once automobile oriented is now a street that offers multi-modal transportation options. The BRT lane will receive traffic signal priority, allowing buses to move out of the intersection first, prior to other vehicles. In addition, residents have the opportunity to experience:

- Continuous 5' wide sidewalks
- Pedestrian signalized crosswalks
- 5' wide bike lane
- A bus station
- Reduced number of lanes for vehicular traffic, from 8 lanes to 5 lanes, 1 of which is a turn left only lane
- Reduced lane width from ~13' to 11'
- A vibrant and lush green median
- Street trees with a 5 foot wide lawn strip serving as a buffer from traffic

Figure 20A: Perspective renderings - view to the southeast



Current conditions

BEFORE

The current conditions of the Bridge Street include a dangerous crossing intersection, with eight directions of lights for cars and none for pedestrians.



Proposed conditions

AFTER

The addition of a bus station, landscaping, and an improved streetscape transforms the Bridge Street intersection into a street that is beautiful and safe. What was once the asphalt median becomes an ecological corridor that offers environmental, social, and economic benefits to Onondaga county and its residents.

Figure 20B: Perspective renderings - view to the northeast

azaleas garden, which is located at the New York Botanical Garden. This garden is said to be “Layered masses of foliage that boldly celebrate the ephemeral through mystery, intrigue and discovery” (Rothstein). In addition, Ohme van Sweden himself has said “I want to put the mystery back into the heart of garden design, where it needs to be. It’s what lures you in through the gate, keeps you moving through the landscape, and fills you with excitement along the way. The sense of mystery is what turns a mere display of plants, paths, and ornaments into an adventure” (The Cultural Landscape Foundation). Furthermore, Oudolf’s landscapes, such as the Highland, are said to “create an air of mystery that blocks out the outside world and entices the viewer to come inside and explore” (Spencer). In addition, not only does Oudolf create an air of mystery in his planting designs, but he purposely selects plants that display year-round interest, creating a greater potential for people to notice, be attracted to, and become immersed in these naturalistic landscapes. “While trees and shrubs provide seasonal changes, perennials can look dramatically different from week to week. Oudolf’s work takes advantage of these metamorphoses, enabling visitors to experience the transformative power of time and to connect with natural processes that are not as visible over longer durations. Rather than erasing the signs of seasonal decline, Oudolf encourages us to enjoy the inherent beauty of the browning of flowers and foliage, seed-heads persisting into winter, and the graceful lean of one plant on another. In showcasing nature’s changes, we feel the cyclical pull of the seasons, and ultimately, we can make connections about our own place in time” (Wade). Terry Guan of Terry Guan Design associates mentions that “Piet’s work enables us to experience beauty, access to nature, and ecological performance intertwined” (Wade).

Due to snow in Central New York, salt is used in roadways to clear snow and ice. Therefore, new plants along Erie Boulevard should be salt tolerant. In addition, Erie Boulevard

does not receive much shade; therefore, plants should be drought tolerant as well. Since the trees in the medians and tree pits will receive salt spray in the winter months, salt and drought tolerant trees species were selected from the list made by the City of Syracuse Arborist. See list in Appendix 10. This is supported by the Penn State Extension, Master Gardener Program, University of Minnesota Master Gardener Program and the Center for Coastal Management; they recommend salt tolerant species for planting in tree medians. Oudolf and Ohme van Sweden's planting designs served as an inspiration for creating similar landscapes along the Erie Boulevard corridor. The plants they used in their landscapes were cross referenced by the author with salt tolerant species. A compiled list of selected salt and drought tolerant plants is shown in Appendix 12.

RESULTS

There are many ways to evaluate the design; one of the ways is through i-Tree Hydro. Using the i-Tree Hydro method, described above in the methods section, the year 2005 was selected to run the i-tree Hydro model. In the year 2005, Syracuse received 40.15 inches of precipitation. The 2005 precipitation data was chosen and utilized for i-tree Hydro inputs because it is the closest to the annual precipitation rate for Syracuse, New York, which is 38 inches.

The quantified results from i-tree Hydro, comparing the base case and alternative case is provided in the table below, i-Tree Hydro Executive Summary. The results show a reduction of 115,140.50 cubic meters in stormwater runoff, which is equivalent to 4,066,148.38 cubic feet, or nearly 30.5 million gallons of stormwater runoff captured when comparing the base and alternative cases, in the year 2005. The 2005 weather data from the National Weather Service was utilized for i-tree Hydro data entry. The alternative case includes a reduction in impermeable surface by reducing vehicular travel lanes and widths, and through the addition of permeable surfaces at bus stations. In addition, alternative conditions include turning the tree medians between Thompson and Genesee Streets into permeable surfaces by adding lawn, herbaceous cover, shrubs, and trees, and widened tree medians. Urban street trees face several challenges, soil compaction, soil and air pollution, salt during winter months, conflicts with utilities, vehicles, and buildings, and lack of soil volume for root growth. Trees need soil volume for roots to grow. Where soil volume is limited, tree growth and health are compromised (Urban Horticulture Institute 1-2). For these reasons, the street trees along Erie Boulevard will receive CU structural soils. “CU-Structural Soil™ (U.S. Patent # 5,849,069) is a two-part system comprised of a rigid stone “lattice” to meet engineering requirements for a load-bearing soil, and a quantity of soil, to meet tree requirements for root growth. The lattice of load-bearing stones provides stability as well as interconnected

voids for root penetration, air and water movement” (Urban Horticulture Institute 3). In addition, a minimum of 20% heavy clay loam or loam soil is required for CU-Structural Soil. Clay soil can hold the most water and nutrients compared to other soil types. Furthermore, 2% - 5% of organic material is required for CU-structural soil to help aid in microbial activity and water and nutrient storage (Urban Horticulture Institute 3).

i-Tree Hydro Executive Summary

Project Location: Syracuse, New York
 Project Time Span: 01/01/2005 - 12/30/2005



Model Parameters

Watershed Area <i>square kilometers</i>	Rainfall <i>millimeters</i>		Total Runoff <i>cubic meters</i>		Stream Gage	Weather Station			
0.86	925.58		435,588.45		0	725190-14771			
Land Cover	<i>Base</i>	<i>Alternative</i>			<i>Base</i>	<i>Alternative</i>	LC beneath Tree Cover	<i>Base</i>	<i>Alternative</i>
Tree Cover %	5.0	23.0	Tree LAI	4.7	4.7		Soil Cover %	100.0	48.0
Shrub Cover %	0.0	5.0	Shrub LAI	2.2	2.2		Impervious Cover %	0.0	52.0
Herbaceous Cover %	18.1	22.0	Herbaceous LAI	1.6	1.6				
Water Cover %	0.0	0.0							
Impervious Cover %	74.4	50.0	Directly Connected Impervious Cover (%)	74.4	50.0				
Soil Cover %	2.5	0.0							

Streamflow Predictions

	Total Runoff		Baseflow		Pervious Flow		Impervious Flow	
	<i>Base</i>	<i>Alternative</i>	<i>Base</i>	<i>Alternative</i>	<i>Base</i>	<i>Alternative</i>	<i>Base</i>	<i>Alternative</i>
Total Flow (cubic meters)	435,588.5	320,448.0	10,182.2	15,069.8	72,639.0	112,208.7	352,767.3	193,169.5
Highest Flow (cubic meters / hour)	38,534.1	36,148.4	1.4	2.0	14,686.5	22,868.6	23,847.0	13,278.9
Lowest Flow (cubic meters / hour)	0.5	0.8	0.5	0.8	0.0	0.0	0.0	0.0
Highest Flow Date	07/14/05	07/14/05	12/29/05	12/29/05	07/14/05	07/14/05	07/14/05	07/14/05
Lowest Flow Date	01/01/05	01/01/05	01/01/05	01/01/05	01/01/05	01/01/05	01/01/05	01/01/05
Median Flow (cubic meters / hour)	1.3	1.9	1.2	1.8	0.0	0.0	0.0	0.0
Number of flow events ABOVE median flow	74.0	75.0	11.0	11.0	51.0	51.0	46.0	45.0
Average length of flow events with flow ABOVE median (hours)	57.2	56.4	419.0	418.6	82.6	82.6	91.8	93.8
High Flow: Number of flow events ABOVE 1 standard deviation	31.0	23.0	0.0	0.0	17.0	18.0	29.0	30.0
Average length of flow events ABOVE 1 standard deviation (hours)	127.8	162.8	0.0	0.0	102.5	100.1	100.6	96.3
Number of flow events BELOW median flow	74.0	75.0	11.0	11.0	51.0	51.0	46.0	45.0
Average length of events BELOW median (hours)	59.0	58.2	396.5	396.8	85.6	85.6	95.0	97.1

The tree species, tree placement, and number of trees for the Bridge Street intersection was entered into i-Tree Design, and the results indicated a removal of 187,454 pounds of carbon dioxide reduced, over the next thirty years. The amount of carbon dioxide removal was measured by i-tree design based on tree species and tree canopy growth. i-tree design assumes that 11,000 pounds of carbon dioxide is generated by the average car each year. The amount of carbon dioxide reduced is representative of the Bridge Street intersection alone. To figure out the amount of carbon dioxide removed throughout the five-mile corridor, from Salina Street to Bridge Street, a simple math cross multiplication can be applied; therefore, over the next thirty years there will be 7,949,329 pounds, or the equivalent of 722.67 cars removed off the road in addition to the benefits that current trees provide. Current trees provide a benefit of 1,882,688 pounds of carbon dioxide removal over the next thirty years. With the current trees and new trees, the net carbon dioxide removed over the next thirty years will total 9,832,017 pounds, or the equivalent of 893.8 cars removed off the road.

The results of the carbon dioxide reduction along the new Boulevard does not account for shrubs and herbaceous material that will be implemented. This was not quantified because i-Design does not have the capability for quantifying shrub or herbaceous material. Since shrub and herbaceous material is lacking in the carbon dioxide reduction results, then it is safe to assume that a more representative number will be greater than what is shown above.

The Northeast Community Tree Guide notes that over a period of 40 years, the net benefits of a tree are significant, such that small deciduous trees are valued at \$364, medium deciduous trees valued at \$2,066, large deciduous trees valued at \$4,531 and conifers at \$1,322 (28). When these numbers are applied to the tree planting design along the Bridge street intersection, over the next 40 years, the trees will have a net benefit of \$193,937. The four-mile corridor will have a net

benefit valued at \$8,222,929 over the next 40 years. Additional environmental benefits include improved air quality through the absorption and filtration of gaseous pollutants through leaf surfaces, such as ozone, nitrogen dioxide, and sulfur dioxide, removal of particulate matter, lowered air temperatures through shading and water perspiration and thus reducing ozone formation and levels, production of oxygen through photosynthesis, and improved water quality (Northeast Community Tree Guide 10). The net worth of benefits does not include the benefits offered to residents, such as mental and physical well-being, which are not captured in these monetary net benefits values.

3260 Erie Blvd E, Syracuse, NY 13214, USA

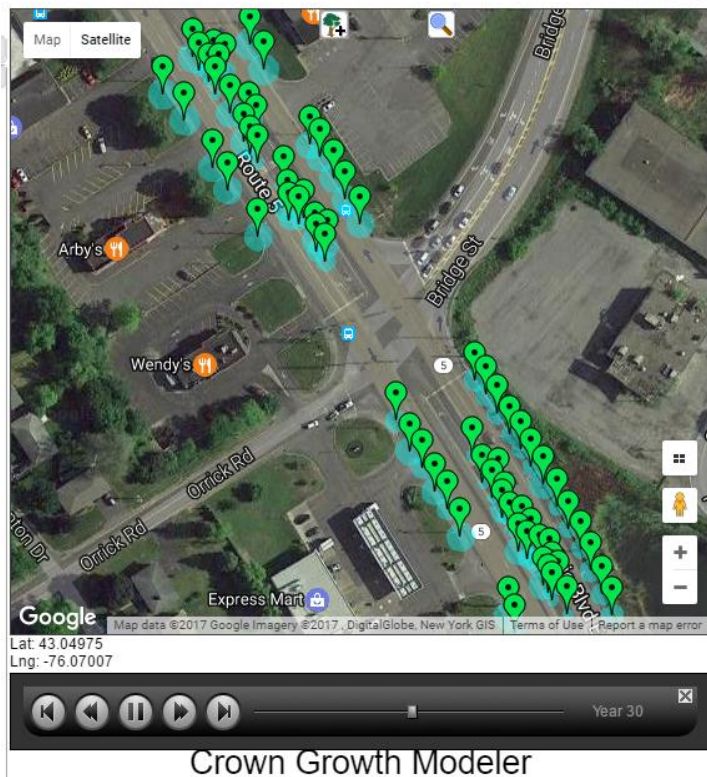


Figure 21: i-Tree Design and Modeled Canopy Growth at 30 Years

DISCUSSION

This design study examined Erie Boulevard East to test the viability of bus rapid transit and biophilic urbanism in terms of carbon sequestration, stormwater capture, and reduction of air pollutants, and in terms of economic impacts such as reduced heat-island effect, the monetary value of trees; and the potential impacts on the social well-being of communities and residents.

Design Review

The implementation of BRT and biophilic urbanism design elements along Erie Boulevard is feasible. The new design is an improvement from existing conditions in that there are significant environmental and economic benefits and potential social benefits. The new design is one that is walkable, accommodates multi-modal transit options, and is green. The new design provides a reduction in impervious surface from 74.4% to 50%, about 33% less asphalt. In addition, the amount of permeable surface, vegetation, trees, shrubs, herbaceous material, and lawn increases from 23.1% to 50%, more than doubling in size. The number of crosswalks increased from 45 to 128, nearly tripling in number (marking defined crosswalks in each direction at all existing intersections). The addition of crosswalks will make the corridor safer for cars and pedestrians.

The assessment of the new Erie Boulevard design includes comparing the design to the recommended guidelines for BRT, biophilic urbanism, and pedestrian streetscape improvements and identifying the number of features fulfilled. The design of the BRT lanes meets all the recommended minimum dimensions, shown in the chart below, Figure 20. In addition, when identifying the number of amenities fulfilled, the bus stations meet fourteen of the fifteen recommended amenities. The items fulfilled are highlighted and shown in the chart below.

Bus Station Recommended Guidelines		
Item	Minimum Dimension	Item fulfilled?
Loading pad from face of bus	6'	Yes
Loading pad width	5'	Yes?
Loading zone distance from intersection	5' from edge of crosswalk or end of radius (whichever is farther)	Yes
Bus lane width	11'	Yes
Overhead obstruction minimum clearance above street surface	12'	Yes
Obstructions minimum clearance from edge of street	2'	Yes
Nearside station	100'	Yes
Farside station	90'	Yes
Station sizing	7-10 s.f. per person	Yes - station accommodates 38-54 persons
Traffic signals		Yes
Pavement markings	yellow or red painted curb	Yes

Figure 22: Bus Station Recommended Guidelines

Amenities	Reference Source
Shelter	DCRPC, Transit Waiting Environment, Pedestrian and Transit Oriented Development
Benches	DCRPC, Transit Waiting Environment, Pedestrian and Transit Oriented Development
Signage	DCRPC, Transit Waiting Environment
Information Systems	DCRPC, Transit Waiting Environment
Trash Receptacles	DCRPC, Transit Waiting Environment
Bike Racks	DCRPC, Transit Waiting Environment
Publication racks/info kiosks	DCRPC, Transit Waiting Environment
Lighting	Sidestreet Factor, DCRPC, Transit Waiting Environment
Heating in bus shelter	Transit Waiting Environment
Landscaping	Transit Waiting Environment, Pedestrian and Transit Oriented Development
Public art	Transit Waiting Environment
Connection to historical & cultural information	Transit Waiting Environment
Protection/buffer from passing traffic	Sidestreet Factor, DCRPC, Transit Waiting Environment, Pedestrian and Transit Oriented Development
Clear view of approaching traffic	DCRPC, Transit Waiting Environment
Highly visible pavement marking	Transit Waiting Environment, Pedestrian and Transit Oriented Development

Figure 23: Bus Station Recommended Amenities

When reviewing the design against Beatley’s biophilic urbanism guidelines, the design fulfills Beatley’s design elements across all the various scales, shown in the chart below by the highlighted elements. A column was added by the author, which indicates where the element is applied along the new Erie Boulevard corridor.

Biophilic Urban Design Elements across Scales		
Scale	Biophilic Design Elements	Application
Building	Green rooftops	
	Sky gardens and green atria	
	Rooftop garden	
	Green walls	
	Daylit interior spaces	Bus station roof
Block	Green courtyards	
	Clustered housing around green areas	
	Native species yards and spaces	Trees and shrubs planted in the median and street trees
Street	Green streets	Street trees
	Sidewalk gardens	
	Urban trees	Street trees
	Low-impact development	
	Vegetated swales and skinny streets	
	Edible landscaping	
	High-degree of permeability	Street trees
Neighborhood	Stream daylighting, stream restoration	
	Urban forests	Street trees
	Ecology parks	Trees and shrubs planted in the median
	Community gardens	
	Neighborhood parks and pocket parks	Pocket parks throughout the parkway
	Greening grayfields and brownfields	
Community	Urban creeks and riparian areas	
	Urban ecological networks	Trees and shrubs in the median
	Green schools	
	City tree canopy	
	Community forest and community orchards	Trees and shrubs in the median and street trees
	Greening utility corridors	Trees and shrubs in the median and street trees
Region	River systems and floodplains	
	Riparian systems	
	Regional greenspace systems	
	Greening major transport corridors	Trees and shrubs in the median and street trees

Source: Modified from Girling and Kellert, first appeared in Beatley, 2008.

Figure 24: Biophilic Urban Design Elements across Scales

There are various design elements that were not applied to the design, but have opportunity to be applied on adjacent streets or properties. Following, the design was analyzed against Jacob's Guidelines for Great Street, the chart is shown below.

Allan Jacobs's Great Streets		
Features	Technique	Features fulfilled?
Places for people to walk	Sidewalks	Yes
Physical comfort	Trees - provide shade on hot summer day	Yes
Definition	Trees - define spaces vertically	Yes
Qualities that engage the eyes	Trees - everchanging movement, shapes, and color create interest along the streetscape	Yes
Transparency	Trees - leaves create sense of transparency	Yes
Complementarity		No
Maintenance	Yes	Yes
Quality of design	Yes	Yes

Figure 25: Allan Jacobs's Great Street Guidelines

The new design fulfills all the recommended guidelines, except for complementarity. The addition of sidewalks is the first step to creating a comfortable environment for people to walk. Following, trees help to define great streets, in more than one way. Trees help to create definition along the streetscape, in addition to the continuous and consistently defined lane widths, curbs, and sidewalks. Furthermore, trees provide physical comfort by creating shade on hot summer days and engage the eyes with their ever-changing movements, colors, and varying shapes, species to species. The use of glass at the bus station allows for transparency into and out of the station. Trees also provide a sense of transparency along the streetscape. One of the features on the checklist, complementarity of building design and building height, falls outside the design limits, the right-of-way, but this criterion should be considered in future design studies of the corridor. This Erie Boulevard design has met a high quality of design with innovative solutions for BRT, biophilic urbanism and streetscape improvement elements. However, it is impossible to address maintenance without getting into construction detailing.

In addition to Jacobs's Great Street design guidelines, Ewing and Bartholomew, urban planners, recommended the following as fundamental features for creating urban streetscapes: medium to high density development, a mix of land uses, short to medium length blocks, transit

stops every half-mile or less, two to four lane streets, consistent and intact sidewalks, secure pedestrian crossings, buffer from traffic, street oriented buildings, and safe places to wait. Most of the features were met in the Erie Boulevard design except for those features that fell outside the bounds of the project limits. Below is a chart depicting the features that were fulfilled in the Erie boulevard design. The features that were not fulfilled in the design should be considered and implemented through zoning, improved land use guidelines, and improved urban design guidelines.

Pedestrian and Transit Oriented Design	
Feature	Fulfilled
Medium to high densities	No - Opportunities fell outside of project limits
Fine-grained mix of land uses	No - Opportunities fell outside of project limits
Short to medium-length blocks	No
Transit routes every half mile or closer	Yes
Two-to-four lane streets	Yes
Continuous sidewalks appropriately scaled	Yes
Safe crossings	Yes
Appropriate buffering from traffic	Yes
Street-oriented buildings	No - Opportunities fell outside of project limits
Comfortable places to wait	Yes

Figure 26: Pedestrian and Transit Oriented Design Guidelines

Guidelines for creating pedestrian and TOD will help to create a safe, walkable, and healthy environment. A narrower roadway will make it more comfortable for pedestrians, leading to increased social interactions (Ewing and Bartholomew 34-35). Trees and other biophilic elements will add to creating physical comfort, visual interest, defining the edges of sidewalks, all helping to create a safer and leisurely pedestrian streetscape. These are all items that residents and visitors to Onondaga County expressed interest in through the Elevating Erie Survey, along with sidewalks, trees, bike lanes, and improved bus transit.

Trees and other biophilic elements can improve mood, reduce stress, and improve psychological and social-wellbeing, that in turn help to reduce crime in neighborhoods. In addition, Beatley notes that there is a higher percentage of healthy related activities, such as walking, when within proximity to nature. Furthermore, exposure to nature can lead humans to live longer and healthier lives, mentally and physically, as noted by Beatley, Wolf, and Kuo et. al. In addition, neighborhood greening efforts can help to encourage involvement from residents, businesses, and governments, for a common goal, the improvement of their community. Community forests can help to improve human health and social well-being for residents (Northeast Community Tree Guide 2). A study performed by Kuo revealed that people who live in proximity to a common green space tend to gather more often, know their neighbors, have stronger social ties, and a stronger sense of community (842-843). All these items are benefits to that can be experienced through the new design of the Erie Boulevard.

Results Review

The results from i-Tree Hydro and i-Tree Design show an improvement from existing conditions to alternative conditions in terms of carbon dioxide sequestered, stormwater runoff captured, and reduction in air pollutants. In addition, trees will add economic value to the community, increase property values, improve social well-being by reducing stress and improving mood, add beauty and visual interest to the streetscape, and improve ecosystem performance.

One result that disappointed the author is the amount of carbon dioxide sequestered. Even through canopy coverage increased from five to twenty-eight percent, it became clear that trees can only do so much to remove carbon dioxide from the air. Therefore, other means need to be considered to achieve a reduction in the quantity of carbon dioxide. These means include designing for BRT, bicycle lanes, and places for people to walk (in short, reducing automobile

use) which is accounted for in the Erie Boulevard design. The planning literature indicates that BRT has the potential to increase ridership and remove cars from the road, if implemented properly. Cities of similar size and conditions, such as Cleveland, have implemented BRT along major corridors and have seen an increase in ridership numbers. The desire for BRT is echoed by the residents of Onondaga County, as noted in the Elevating Erie survey results. When responding to transportation concerns, 73% of respondents indicated they desired real time arrival information, modernized bus shelters, increased bus headway, and Wi-Fi on buses (Town of Dewitt, et al). As the planning literature indicates, BRT has the following benefits:

- Is flexibility and adaptability for various environments, such as urban or suburban conditions, and the ability to be implemented on various roads, arterials, freeways, etc.
- Less costly to implement than other modes of transit, such as rail.
- Can stimulate high-density mixed-use development. (Bus rapid Transit Practitioner's Guide, S-1)

BRT should be implemented with the following features:

- Permanent long-lasting facilities, services, and amenities
- Compatibility with “transit-first policies” that promote TOD, and reduced parking opportunities and park-and-ride systems.
- Designated lanes with transit signal priority.
- Speed, reliability, ease of use, and cost effectiveness.
- Attractive branding that enhances the streetscape image (Bus rapid transit Practitioner's Guide, S-3)

Disadvantages of implementing BRT include:

- Expensive designated lanes
- Potentially slow increase in ridership (relative to elevated costs for implementation)
- Reduction of road space for other vehicles
- Potential for other vehicles to drive in designated BRT lanes

BRT has the potential to be an effective approach to reducing carbon dioxide emissions when implemented correctly and if following the guidelines above. In addition, it is reasonable to believe that adding BRT on the Erie Boulevard will be an effective alternative transportation option for existing and future bus riders. Cities such as Arlington, Virginia, Cleveland, Ohio and Ottawa, Ontario have turned around their once crumbling downtown cores and major corridors. Even though there are potential disadvantages to implementing BRT, the benefits outweigh the disadvantages. A designated BRT lane is one of the least costly to transportation assets to implement. Studies have shown that when properly designed, multiple transit options can reduce traffic delays (Jaffe 2014). If several cities are turning toward transit and TOD, in efforts to revitalize and catalyze economic development, and have been successful in doing so, then this concept is worth exploring along the Erie Boulevard East corridor.

In addition, there is potential for increased use of bicycle lanes. The Elevating Erie survey shows that 40% of respondents feel that adding protected bicycle lanes would improve connectivity and safety (Town of Dewitt, et al). Similarly, to BRT, the use of bicycle lanes, if protected, has the potential to attract significant ridership. The planning literature indicates that cities across the United States have seen increases anywhere from twenty-one percent to one-hundred and seventy-one percent.

Another layer in the re-design of the corridor that can be added to reduce carbon dioxide numbers is the implementation of new policies. Several cities have implemented policies that restrict the use of use of cars in downtown centers or create incentives that attract residents to utilize alternate transportation options. Policies that make car usage less attractive and alternative transportation more attractive can include higher parking fees in downtown cores, less costly bus ticket fees, or a BRT system with all its conveniences and comforts.

Project Limitations

One of the limitations in the design process was the limits of the design boundary, the right-of-way. The right-of-way prohibited the design from addressing certain existing issues along Erie Boulevard, such as incongruent land use and lack of building design continuity. These two issues are items that are recommended to be addressed in the guidelines by Beatley, Jacobs, and Bartholomew and Ewing when considering a corridor redesign. However, the right-of-way served to limit the spatial boundaries of the project. If the project boundary was greater than the right-of-way then it would have created an increase in scope and scale making the project not feasible.

Further Research

This project looked at design and design analysis to test the feasibility of BRT and biophilic urbanism on Erie Boulevard and its impacts on ecological systems, economic impacts on the community, and influences on social well-being. Following the results, BRT and biophilic urbanism design elements are feasible on Erie Boulevard. This project did not attempt to address the fine-grain land use nor green infrastructure design. There are several features and additional problems along Erie Boulevard in which further research can investigate. One area that a subsequent researcher can study is the broader urban design issues along the Erie Boulevard corridor, addressing land use and zoning as they relate to buildings and street connections to

neighborhoods and the potential to collaborate with the current Rezone efforts in the City of Syracuse. Alternatively, one can explore the fine-grain green infrastructure that would complement built structures and forms. Another area in which a subsequent researcher can investigate is how Erie Boulevard can connect to the University area. The University area is one of the largest employers in the City of Syracuse and this would seem like a natural extension of the Erie Boulevard BRT route. In addition, this subsequent researcher can explore design options for continuing the Erie Boulevard East route to Erie Boulevard West to Camillus or Fairmount. Finally, one can take the freedom to adjust the right-of-way boundaries and consider adjacent properties that could accommodate additional biophilic urbanism elements; again, this offers the opportunity to augment current planning efforts in Syracuse. These are some of the design problems that can be, and should be, studied in further depth prior to any design implementation that would accommodate the Erie Canalway Trail, bus rapid transit, bike lanes, streetscape improvement, or development opportunities. This boulevard has the potential to become a great street and should be studied carefully and in depth, as it has the opportunity to catalyze economic development, improve social well-being and provide environmental benefits.

CONCLUSION

Results indicate that BRT and biophilic urbanism design elements are feasible on Erie Boulevard. Currently, Erie Boulevard East is a major corridor that lacks safe pedestrian infrastructure with inconsistent availability of sidewalks. It is a corridor that serves automobiles, fails to accommodate pedestrians and alternative transportation options. With the implementation of BRT and biophilic urbanism design elements, the Erie Boulevard design is transformed into a street that is walkable, accommodates multi-modal transit options, is green and creates opportunity for high-density mixed-use development in the future. The Erie Boulevard design can improve the current conditions of Erie Boulevard in terms ecosystem improvements by sequestering carbon dioxide, capturing stormwater, and improving air quality. In addition, the design has the potential to offer economic benefits and social well-being improvements.

The Town of Dewitt and the City of Syracuse have acknowledged the potential for Erie Boulevard East to serve as a platform for better transit (particularly BRT), urban forestry and redevelopment. These ideas were expressed by the winners of the fall 2015 Elevation Erie design competition. These ideas were reiterated by the larger community, the survey respondents, residents and visitors (Town of Dewitt). In addition, the City of Syracuse has been working to revise the City's current zoning ordinance and land use plan (syrgov.net). The current City of Syracuse Comprehensive Plan 2040 mentions that transportation infrastructure should be built to support future population growth and focus on Downtown, University area, and major transportation routes (15). Erie Boulevard is one of the major transportation corridors, receiving over 22,000 vehicles a day, on average (Qtd. in Erie Canalway Trail 53). Given that, there is potential to redevelop the boulevard in a way that will stimulate economic development and neighborhood growth. Cities like Arlington, Virginia, Cleveland, Ohio, and Ottawa, Ontario have

turned their once depressed streetscapes into vibrant corridors through the use of BRT, TOD, and biophilic urbanism design guidelines. It is not unreasonable to think that this design will work in the City of Syracuse and Onondaga County.

The initial vision for the Erie Canal in the early 1800s eventually led to exponential growth and economic prosperity for several towns and cities along the canal route. The Erie Canal was progressive for its time; it changed the urban landscape and created economic stability for communities and families. The City of Syracuse and Onondaga County have the opportunity, now, to showcase progress once again. The Erie Boulevard design offers opportunities for a major rethinking of streetscape design for the City of Syracuse and Onondaga County, on a level that has not occurred since the Erie Canal came through. A redesign of Erie Boulevard creates the chance for a new cityscape that is pursuant on new economic opportunities; opportunities that pave the way for large scale economic revitalization, social, and environmental change that will impact the future of the City of Syracuse, Onondaga County and the lives of residents'. The proposed design changes, to Erie Boulevard, to the streetscape, and other streets can be catalytic in revitalizing this community.

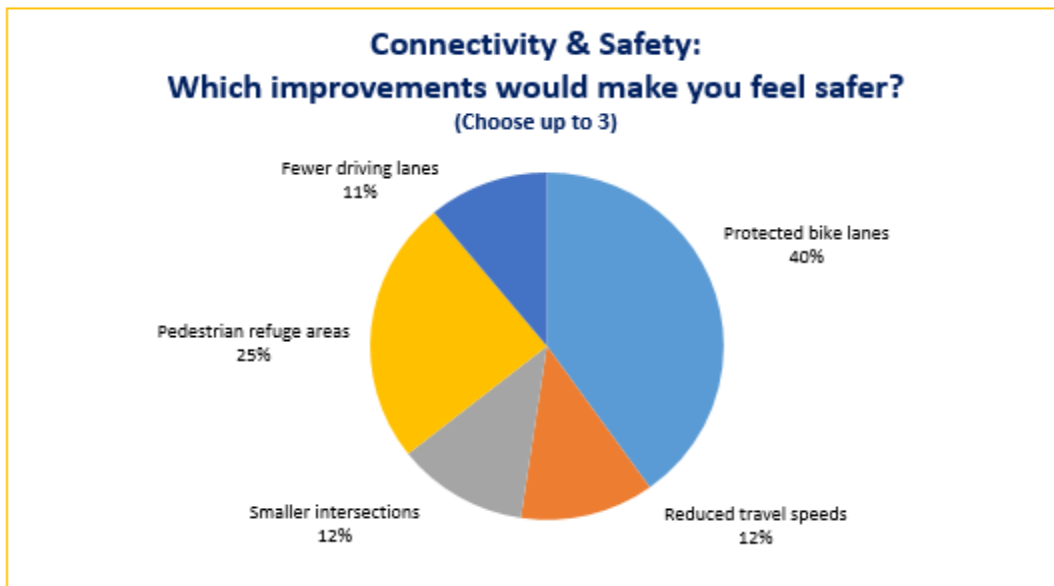
Appendix 1: Elevating Erie Survey Results



Connectivity & Safety: Which improvements would make you feel safer?

40% of respondents chose protected bike lanes as a priority safety and connectivity improvement for the Erie Boulevard corridor, despite the likely limited number of cyclists in the community. Pedestrian refuge areas also scored well, with 25% of respondents choosing it as a priority. Solutions that lessened infrastructure and slowed traffic fared equally, averaging 11-12%.

Other common suggestions included burying utility lines, pedestrian centered improvements, and elimination of undesired land uses and big box building types.



What other safety improvements would you support?

- Better lighting
- Snow removal / year round access
- Continuous sidewalks
- Pedestrian bridges
- Safety from criminal activity
- Synchronized traffic signals
- Sidewalks buffered from traffic

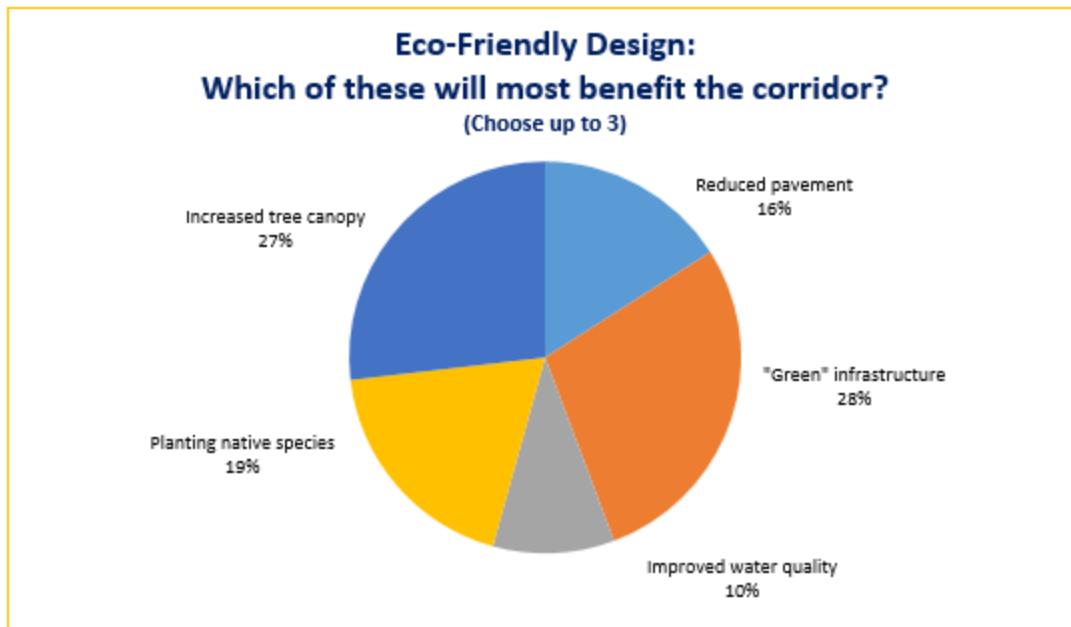




Eco-Friendly Design: Which of these will most benefit the corridor?

The design solution deemed to have the greatest benefit for the environment within the Erie Boulevard corridor was the incorporation of “green infrastructure”, with 28% of responses, followed closely by increased tree canopy at 27% of respondents.

Other solutions suggested for consideration included planting grass or other vegetation within the median (with proper maintenance), use of native species plantings, incorporating wildlife habitat areas, and use of solar energy on the corridor.



How else could we improve the Environment here?

- Plantings within the median
- Incorporate wildlife habitats
- Slow down / reduce traffic
- Use native species
- Address vacant buildings and lots
- Add trees / Add solar panels
- Maintain plantings /grounds

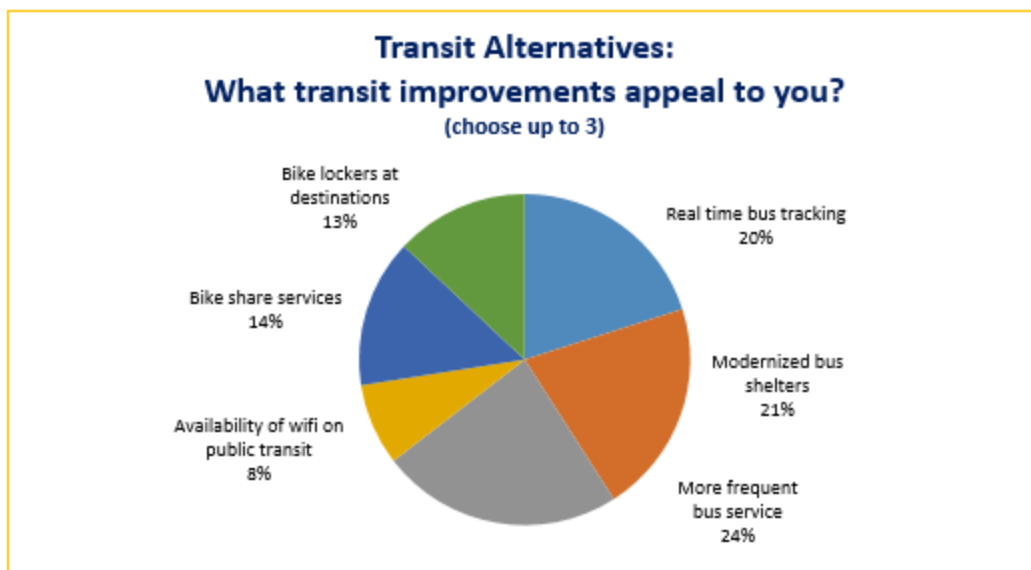




Transit Alternatives : What transit improvements appeal to you?

When given a choice of four bus transit service improvements and two bicycling based improvements, respondents opted most for more frequent bus service, modernized bus shelters and real time bus tracking. Bike lockers and bike sharing were chosen less, but bicycle needs featured heavily in the subsequent open ended question.

Respondents provided several suggestions to improve existing bus service, including improved signage, shelters, hours and reliability. Many pointed out the need for support infrastructure for bicycling, such as bike racks at shops and destinations. Write-in support for trolleys and light rail, and bus rapid transit was also reflected in the answers.



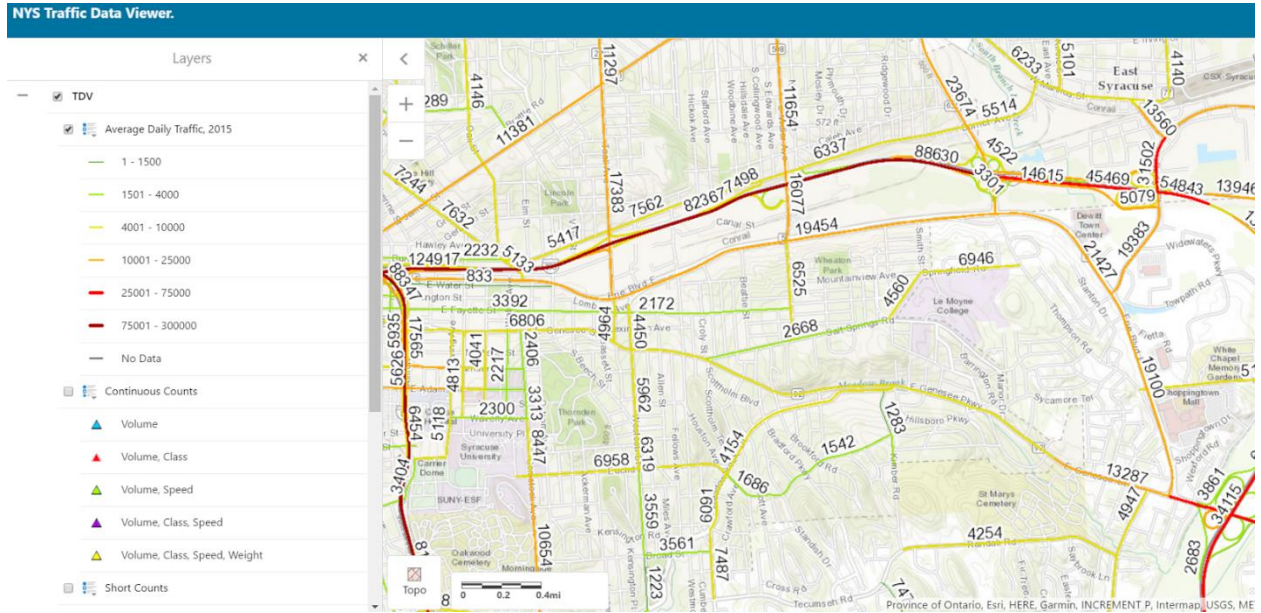
Did we forget anything?

- Electric trolley
- Light rail
- Better bus timing /signage / shelters
- Affordable transit
- Bicycle infrastructure (bike racks, lockers, etc)
- Park n ride
- Safer bus stops
- Electric bike chargers



(Town of Dewitt, et al.)

Appendix 2: Erie Boulevard East - Traffic Count at Major Intersections



(NYS Traffic Data Viewer)

Erie Boulevard East PEDESTRIAN STUDY

Vehicle Traffic Counts

- 17,000-22,000 vehicles per day on Erie Blvd
- Roughly 14,000 on East Genesee Street



Erie Boulevard East PEDESTRIAN STUDY

Pedestrian/Bicycle Counts

- 18 hour counts (5 AM – 11 PM)
- 10 signalized intersections

Intersection with Erie Boulevard East	Number of Movements over 18 Hours (5:00 a.m. – 11:00 p.m.)	
	Pedestrian	Bicyclist
Beech Street	217	42
Teall Avenue/Columbus Avenue	287	32
Peat Street/Westmoreland Avenue	203	43
Midler Avenue/Seeley Road	246	18
Thompson Road	69	8
DeWitt Town Center/Empire Plaza	76	9
Bridge Street/Orrick Road	42	8
Fietta Road	63	6
Kinne Road	76	11
East Genesee Street	76	8

(Syracuse Metropolitan Transportation Center)

Appendix 4: i-Tree Design Bridge Street Results

Overall Benefits Stormwater Energy Air Quality Carbon Dioxide

Current Year (2017) Future Year (2032) Total (2017-2032) Total to Date

Over the next 15 years, these trees will conserve a total of 154.4 Kilowatt-hours of electricity and reduce consumption of heating fuel by 32.1 therms.

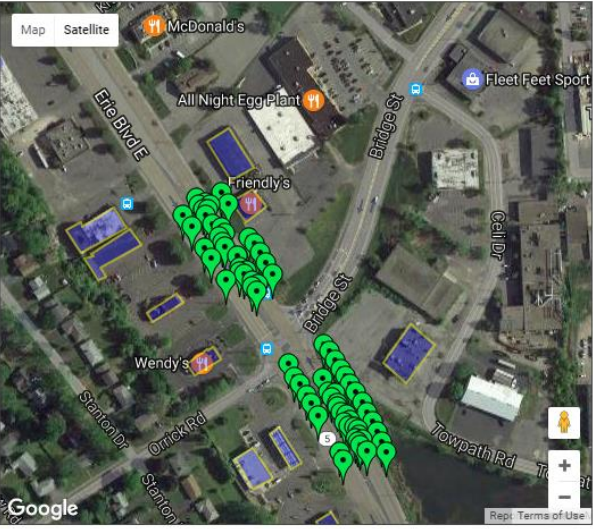
Trees modify climate and conserve building energy use in three principal ways:

- Shading reduces the amount of heat absorbed and stored by buildings.
- Evapotranspiration of moisture by foliage reduces air temperatures.
- Trees slow down winds thereby reducing the amount of heat lost from a home.

Strategically placed trees can increase home energy efficiency. In summer, trees shading east and west walls generally keep buildings cooler. In winter, allowing the sun to strike the southern side of a building can warm interior spaces.

Unexpected results may include the following:

- A tree may produce negative energy savings due to an increase in winter heating costs. For example, if southern walls are shaded by dense evergreen trees there may be a resultant increase in winter heating costs.
- A building that is neither heated nor air conditioned will have no associated energy benefits.
- A tree that is too small or located too far from a structure may have no energy benefits.
- A tree may have an energy effect even if it is located outside of the illustrated colored benefit zones, as wind break effects can occur at significant distances from a structure.
- When two or more tree crowns overlap the total energy savings are adjusted so that benefits are not double-counted in the overlap area.



Overall Benefits Stormwater Energy Air Quality Carbon Dioxide

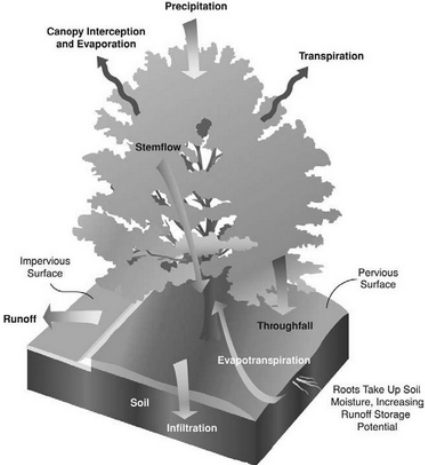
Current Year (2017) Future Year (2032) Total (2017-2032) Total to Date

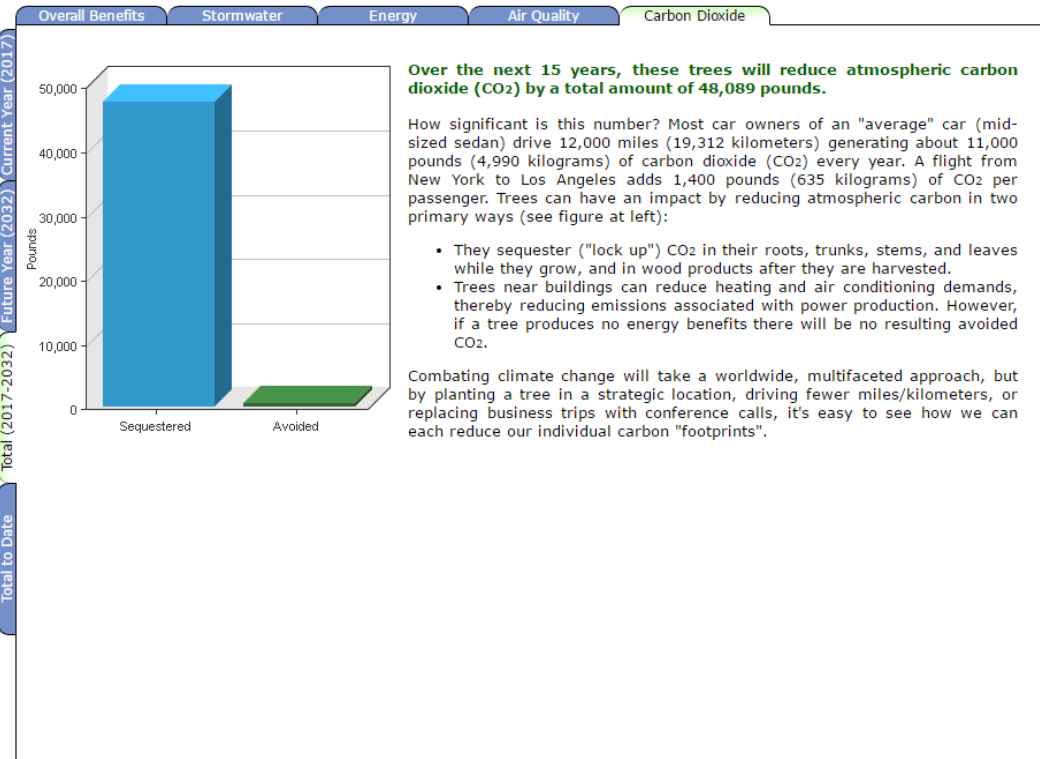
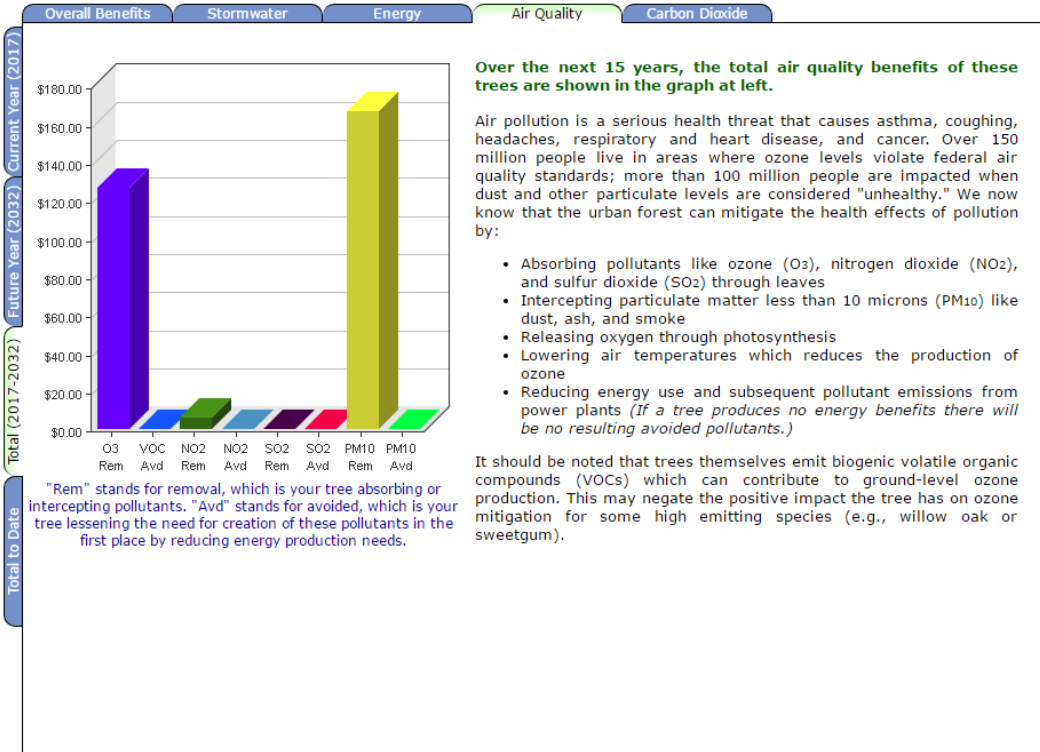
Over the next 15 years, these trees will intercept a total of 339,976 gallons of stormwater.

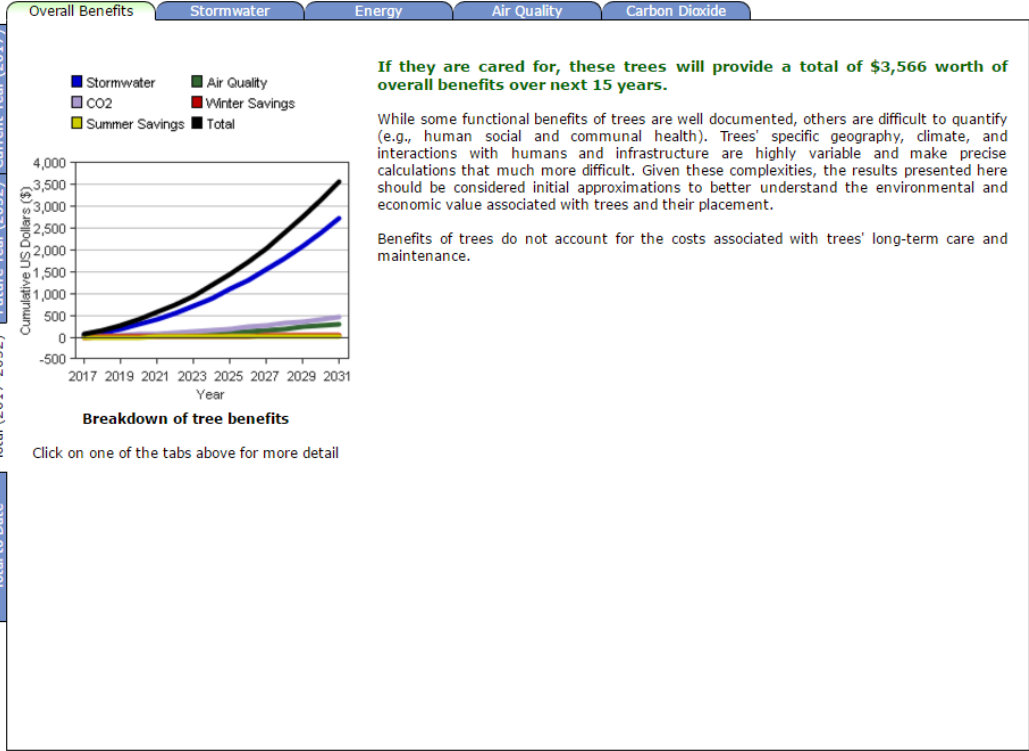
Urban stormwater runoff (or "non-point source pollution") washes chemicals (oil, gasoline, salts, etc.) and litter from surfaces such as roadways and parking lots into streams, wetlands, rivers, and oceans. The more impervious the surface (e.g., concrete, asphalt, rooftops), the more quickly pollutants are washed into our community waterways. Drinking water, aquatic life, and the health of our entire ecosystem can be adversely affected by this process.

Trees act as mini-reservoirs, controlling runoff at the source. Trees reduce runoff by:

- Intercepting and holding rain on leaves, branches, and bark
- Increasing infiltration and storage of rainwater through the tree's root system
- Reducing soil erosion by slowing rainfall before it strikes the soil










(i-tree.org)

Appendix 5: Pros and Cons of Bus Stop Location

Table 1: Advantages and disadvantages for typical stop location types

		
Far-side stop	Near-side stop	Midblock stop
Advantages	Advantages	Advantages
<ul style="list-style-type: none"> ▶ Minimizes conflicts with right-turning vehicles. ▶ Minimizes sight line conflicts for drivers and pedestrians. ▶ Encourages pedestrians to cross more safely behind the bus. ▶ Stopping at the far-side of the intersection creates a shorter deceleration zone for the stop area because the intersection absorbs some of the space requirement. ▶ The gap in traffic flow created by the signal allows the driver room to pull back into the travel lane. ▶ Most effective stop location for Transit Signal Priority (TSP): preferential treatment for transit vehicles at traffic signals (typically extended green or shortened red phases). ▶ If the bus is unable to fully pull through the intersection during peak hours, traffic conflicts may occur ("blocking the box"). ▶ A bus stopped near the intersection may block sight lines for pedestrians and vehicles crossing the intersection. ▶ Can cause the bus to double stop (once for the light and once for passenger activity). ▶ Rear-end incidents may be more frequent if distracted drivers do not realize the bus is stopping beyond the intersection. 	<ul style="list-style-type: none"> ▶ Minimizes traffic interference during peak traffic flow hours. ▶ Passengers are able to board the bus closer to the crosswalk. ▶ Bus can use the intersection for acceleration space. ▶ Avoids double stopping for both signal and passenger movements. ▶ The driver has the advantage of full view of intersection activity. ▶ Can be coordinated with a far-side stop for a crossing route to allow passengers to transfer without crossing the street. ▶ Conflicts between the bus and right-turning vehicles may arise. ▶ The bus can physically obscure general traffic sight lines for both intersection movements and signals. ▶ Multiple buses queuing during peak hours may obstruct traffic. ▶ Crossing pedestrian sight lines are obstructed. ▶ May present a conflict between pedestrians crossing the intersection and passengers waiting to board the bus. 	<ul style="list-style-type: none"> ▶ Minimizes sight line obstructions for both driver and passengers. ▶ Because the stop is located away from intersection activity, conflicts with intersection traffic are minimized. ▶ A more spacious waiting area may be provided because the stop is located outside intersection sidewalk congestion. ▶ Works well when a high volume of passengers board and alight, or the bus has an extended dwell time. ▶ Greater passenger convenience at key midblock trip generators. ▶ Can present safety concerns if a midblock crosswalk is not provided. ▶ Requires more physical space for the bus to accelerate and decelerate. ▶ Reduces space available for on-street parking because this stop type requires a longer bus zone.

(Delaware Valley Regional Planning Commission)

Appendix 6: Bus Station Typologies



central_lane.png



central_lane_albany.jpg



central_lane_dc.png



central_platform.jpg



central_platform_chicago.jpg



central_platform_Nantes.jpg



curbside.jpg



curbside_chicago.jpg



curbside_nyc.jpg



flanking_station1.jpg



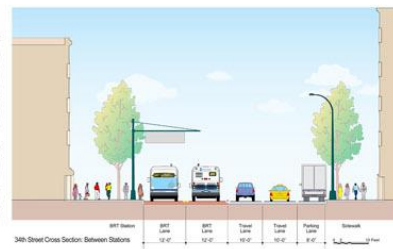
flanking_station2.jpg



flanking_station3.jpg



separated_transitway.jpg

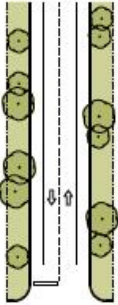


separated_transitway_NYC.jpg

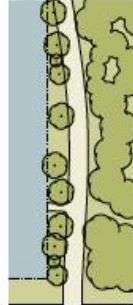


separated_transitway_nyc2.jpg

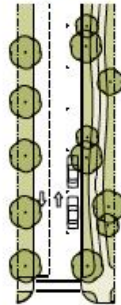
A COLLECTION OF BIKEWAY TYPES



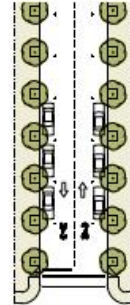
Shoulder



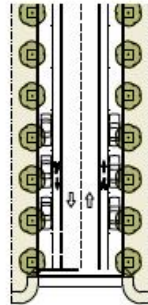
Shared Use Path - Rural



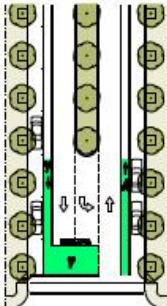
Shared Use Path - Urban



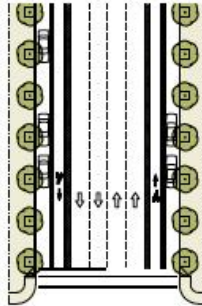
Shared Use Lane Marking



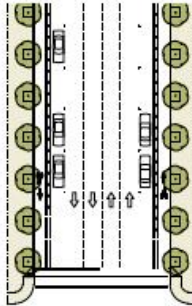
Bicycle Lane



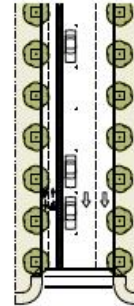
Bicycle Box



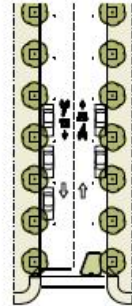
Buffered Bicycle Lane



Physically-Separated Bicycle Lane



Two-Way, Physically-Separated Bicycle Lane



Bicycle Boulevard

(Reconnecting America)

Reconnecting America. The Bikeway Network. 2010. Accessed October 3, 2017.

<http://reconnectingamerica.org/news-center/half-mile-circles/2010/the-bikeway-network/>

Parked Cars with Striped Buffer

Cost: <\$15K Bang for Buck: 10



Photo by Eric Fischer



Linear Barriers - Short

Cost: \$10-75K Bang for Buck: 8



Linear Barriers - Tall

Cost: \$80-400K Bang for Buck: 8



Curbing

Cost: \$25-600K Bang for Buck: 6.5



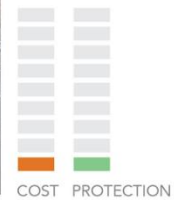
Raised Bikeway

Cost: \$8-26M Bang for Buck: 6

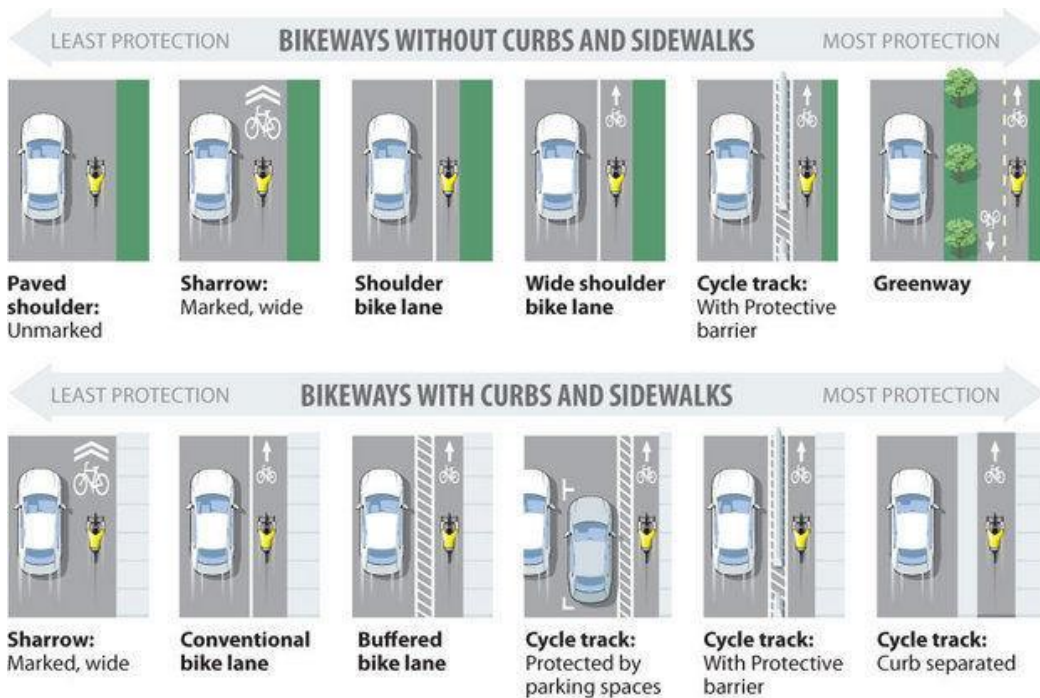


Striped Buffer

Cost: <\$15K Bang for Buck: 6



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Source: Jefferson Parish Bicycle Master Plan

Dan Swenson, NOLA.com | The Times-Picayune

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Appendix 8: Bicycle Intersection Crossings - Pavement Options



bike-box-lloyd-blvd-portland_or.jpg



vancouver-bc.JPG



Washington-zebra stripping.jpg



Dutch-junction.jpg

Appendix 10: Plant Matrix and Images

TREES	HEIGHT X WIDTH	FLOWER COLOR	FLOWER MONTH							FRAGRANT	FALL INTEREST	WINTER INTEREST	WILDLIFE	EVERGREEN
			APR	MAY	JUN	JUL	AUG	SEP	OCT					
Service berry	25X15	white			X						X		X	
Redbud	20X25	pink	X	X							X		X	
Sargentii Crabapple	8X12	white			X						X		X	
Ironwood	25X30										X			
River Birch	40X40													
Honey locust	40X30										X			
Little leaf Linden	50x35	yellow			X					X	X		X	
Freeman Maple	50X35										X			
Ginkgo biloba	60X45										X		X	
Kentucky Coffeetree	70X50										X		X	
Red Oak	80X70										X			
Zelkova serrata	50x50										X	X		
Eastern red cedar	40x10											X		X
Pitch pine	50x40											X		X
SHRUBS	HEIGHT X WIDTH	FLOWER COLOR	FLOWER MONTH							FRAGRANT	FALL INTEREST	WINTER INTEREST	WILDLIFE	EVERGREEN
APR	MAY	JUN	JUL	AUG	SEP	OCT								
Artic Fire Dogwood	4x4	white		X	X						X	X		
Gro Low Sumac	2x6	yellow	X								X		X	
Grey Owl Juniper	2X4												X	X
Winterberry	6X6												X	
Black Chokeberry	4X4	white			X						X		X	
Bayberry	6X6										X	X	X	
PERENNIALS	HEIGHT X WIDTH	FLOWER COLOR	FLOWER MONTH							FRAGRANT	FALL INTEREST	WINTER INTEREST	WILDLIFE	EVERGREEN
APR	MAY	JUN	JUL	AUG	SEP	OCT								
New England Aster	3x2	pink-purple					X	X					X	
Big Leaf Aster	3x2	white-blue					X	X					X	
Dianthus	1X1	pink		X	X						X			
Coreopsis	2x2	yellow			X	X	X						X	
Geranium sp.	1X1	pale pink	X	X										
Iris Germanica	2x1	purple		X							X			
Lupine sp.	3X1	purple-pink		X	X	X							X	
Persicaria	3X3	red			X	X	X	X	X				X	
GRASSES	HEIGHT X WIDTH	COLOR	FLOWER MONTH							FRAGRANT	FALL INTEREST	WINTER INTEREST	WILDLIFE	EVERGREEN
APR	MAY	JUN	JUL	AUG	SEP	OCT								
Little Bluestem	2x2	blue-green									X	X	X	
Karl Foerster Reed Grass	3X2	brown-green									X	X	X	
Elijah Blue Fescue	1x.5	blue-green									X			
Shenandoah Switchgrass	3x3	red-green									X	X		



eastern red cedar.jpg



Freeman maple.jpg



ginkgo biloba.jpg



Honeylocust.jpg



ironwood.jpg



Japanese zelkova.jpg



kentucky coffee tree.jpg



Little leaf linden.jpg



pitch pine.png



Red Oak.PNG



Redbud.jpg



River birch.JPG



sargentii crabapple.jpg



Serviceberry.jpg

Tree Images



Dianthus.jpg



Karl foerester.jpg



little bluestem.jpg



new england aster.jpg



Persicaria.jpg



shenendoah red switchgrass.jpg



aster-macrophyllus-twilight.jpg



Coreopsis_pale.JPG



festuca glauca elijah blue.jpg



iris-germanica.jpg



Karl foerester.jpg



lupinus perennis.jpg



bayberry.jpg



black chokeberry.jpg



cornus arctic fire.jpg



grey owl juniper.jpg



gro low sumac.jpg



winterberry.jpg

Shrub and Perennial Images

APPENDIX 11: Author's Journal Notes Following Site Visits

10/6/16
mid-o. early Oct - after work - 5:30 pm.
walk Erie Blvd from Water st to 1000 block
of Erie Blvd East.
→ walking underneath 690 - felt very
uncomfortable / scared. there were two
homeless men near the bridge.
I walked very fast. past this section,
looking back every minute or
so - checking that ~~no one was~~ ^{no one was} following me.
I was alone walking and the sun was
starting to set.

11/5/16
it was warm in the early afternoon sun - no
protection from the heat - no shade provided.
Thompson area - so much traffic
feel out of place - like I stuck
out like a sore thumb. I pedestrian
among several dozens of cars. crossing
~~from~~ westbound from Thompson - there
was no light for me. I made sure
that there were no cars - double -
triple checking that cars in all directions
were not headed towards my direction
of crossing. ^{I ran for it.} made it to the center
median + waited. until it was clear
again + crossed. felt like I was
being watched by all the drivers, why
is this woman walking across here? felt isolated
→ I began to realize that the pedestrian
realm does not exist on Erie Blvd.
A couple wks later I was driving
from University area to home, must have
been near pine street + water - I
stopped @ a stop sign - there was a
woman @ crosswalk on slwt. I waved her
here to go. She, the pedestrian, waved +
thank me. for letting her cross. The
pedestrian realm does exist when the
pedestrians think cars have right of way,
when its actually them that do.

10/11/16
~~10/11/16~~ I was walking 1100 block of Erie
+ ~~1100~~ and I noticed a woman who
was talking to herself - she made me a
bit nervous b/c there was no one else on the
street besides me and her, ^{she was talking} I walked
quickly past her and looked back every
so often - she ended up crossing over to
the median to wait - maybe b/c ~~there~~
was some respite from the sun. near
the trees in the median.

upon my return walk in the westbound lane
and return to my car, (I parked near the
park) I noticed the cops were investigating
a man who was outside of his car (made
me nervous b/c I felt like I was doing
something wrong just by walking along the
belt + out of place.)

concluding thoughts

I was surprised to see other pedestrians
in my 4 mile (4 times) walk/exploration
of the site. Each time I saw about 8-10
pedestrians or bicyclists. with an hour span.
I was surprised to see this amount of ppl -
even though actually so few I suppose -
my being surprised is indicative of how
the pedestrian realm doesn't exist.

what did I notice:

- intermittent sidewalks
- asphalt for slwt
- cracked concrete / gravel present
- sloped asphalt to gutter system
- felt unsafe by passing vehicular traffic -
cars fast + some narrow spots - bldg
close to whatever walk fence was.
- there was construction @ one spot - so no
walk @ all available - construction fence
went into vehicular lane - making pedestrian
cross into vehicular travel lane to get
past onto walk beyond
- crossing across core is an safe -
have to ~~stop~~ ^{stop} in median b/c not
enough time to cross the whole way
- ~~uncomfortable~~ underneath. 690 on Erie,
elements
- no protection from ~~sun~~ - no trees -
no places to rest - sit

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RESUME

KIM ZHANG

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OBJECTIVE

To obtain a position where I can revitalize and strengthen communities through collaborative planning, design, and management.

SKILLS

- Landscape architecture design
- Community planning and design
- Urban forestry
- Facilitating meetings
- Community outreach
- Permitting and zoning knowledge
- Research and data assessment
- Proficient in AutoCAD
- Adobe Creative Suite
- GIS, beginner
- Microsoft Office expert
- Strong verbal and written communicator
- Solid public speaker
- Spanish-speaker , intermediate
- Project management
- Organized, motivated self -starter

EXPERIENCE

ENVIRONMENTAL DESIGN & RESEARCH

Landscape Designer

Syracuse, NY
06/2016 – Present

- Prepare and edit construction plans and details.
- Research local ordinance requirements for design projects.
- Perform SWPPP (stormwater pollution prevention plan) site inspections.
- Provide graphic support (illustrations, presentation materials, and report figures.)

CORNELL COOPERATIVE EXTENSION ONONDAGA COUNTY

Urban Forestry Program Coordinator

Syracuse, NY
07/2013 – 06/2016

- Led and reviewed project goals and tasks with Save the Rain tree team.
- Collaborated with city and state agency officials to coordinate site approvals.
- Conducted site inventory, developed planting plans, and managed the planting of over 1,500 trees.
- Wrote reports updating project sponsors on program development and progress.
- Developed and facilitated public forums, educating residents on invasive species.

NEW YORK RESTORATION PROJECT

Project Coordinator /Landscape Designer

New York, NY
09/2010 – 07/2013

- Designed and facilitated community design meetings with residents in preparation of land renovations.
- Analyzed results from meetings and generated design alternatives.
- Researched products and communicated with vendors on product specifications.
- Managed project schedules, budgets, material selection, and project implementation for MillionTreesNYC.
- Supervised and assessed contractors' work; verifying that the work met code and specification standards.
- Served as a liaison between contractors and the Director of Design.

CENTER FOR COMMUNITY DESIGN AND RESEARCH

Design Research Assistant

Syracuse, NY
08/2008 – 05/2010

- Developed presentation material and worksheets for community design workshops.
- Guided small groups of neighborhood stakeholders through community design process and activities.
- Researched design products and design options appropriate for community.
- Analyzed findings and produced comprehensive community influenced design alternatives.

OFFICE OF ECONOMIC AND COMMUNITY DEVELOPMENT

Community Design Intern

Bradford, PA
05/2007 – 08/2007

- Worked with an Economic and Community Development team to rehabilitate use of vacant lots.
- Collaborated with town agencies and partners to coordinate blight removal and streetscape improvements.
- Analyzed project cost feasibility; updated project costs and wrote project summary report.

EDUCATION

SUNY – COLLEGE OF ENVIRONMENTAL SCIENCE & FORESTRY

Bachelor of Landscape Architecture

Candidate for Master of Science in Landscape Architecture

Syracuse, NY
08/2005 – 05/2010
Expected Spring 2017

AFFILIATIONS

TOASTMASTERS INTERNATIONAL

Vice-President of Public Relations and Vice-President of Membership, Syracuse VA Voices Club

Syracuse, NY
06/2015 – Present

CITIZEN'S ACADEMY OF SYRACUSE

Member, Class of 2015

Syracuse, NY
09/2015 – 11/2015