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Cost-Benefit Analysis of Constructing and Operating a Streetcar System in Buffalo, NY

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Cost-Benefit Analysis of Constructing And Operating a Streetcar System in Buffalo, NY

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An Abstract of a Thesis in
Applied Economics

Submitted in Partial Fulfillment
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Buffalo State College
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Abstract

In about 30 of the largest 300 US metro areas, fixed-rail electric streetcars have been reintroduced or refurbished after 75 years of policy favoring petroleum-powered buses. Unlike buses, new streetcar systems are designed to enhance or regenerate economic activity along their routes in urban centers that lack the population density to support subway systems. This paper assesses the criteria utilized by the US Department of Transportation in its decision-making process for supporting streetcar projects. Using multi-factor cost-benefit analysis, a model of a potential streetcar reintroduction for Buffalo, New York is presented.

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Chapter 1: Introduction

Buffalo, NY was once home to one of the most extensive streetcar systems in the United States. Streetcar lines ran through busy commercial corridors and through dense urban neighborhoods. As private cars began to win favor with the American middle class, streetcar use declined. Eventually the streetcar lines in Buffalo, NY were totally removed in favor of paving streets for personal vehicles and buses.

This paper examines public transit in the United States and what it might take for Buffalo, NY to build a new streetcar line. Buffalo has a comparative advantage because of its geography and could completely alter its course if it chose to electrify its public transportation system and restore its historic streetcar grid.

In order to make this happen, Buffalo would need to grant money from the U.S. Department of Transportation. The U.S. DOT requires that projects requesting federal funds complete a benefit cost analysis to provide evidence that a particular project is worth investing in. As results show, Buffalo is an ideal candidate for recreating its former streetcar system. This study focuses on one branch of the historic line, Niagara Street. Niagara Street is a symbol of the rebirth of Buffalo where old factories have been renovated and a new wave of immigrants call it home. The street has also recently undergone a road diet. All of these factors make it a logical street to begin to study the rebirth of Buffalo's streetcar line.

Buffalo has a unique opportunity to build electric public transit because of its close proximity to the Niagara Power Project. The New York Power Authority runs the NPP and in 2015 created the Five Cities Smart Energy Plan. This plan included transportation specific recommendations to make Buffalo less reliant on cars and more reliant on walking, biking and electric public transportation.

Public transit by rail comes in different forms: streetcars, subways, light rail rapid transit, and commuter rail. Streetcars are defined as electrified rail cars that use rail lines integrated with city streets. A streetcar system often shares roads with personal vehicles, commercial vehicles and buses. Subways are a railroad system that is electrified and runs underground. Subway systems are most often found in the largest cities in the United States. New York, Chicago, and Boston are a few cities with vast subway systems. Light rail operates on city streets similar to the way streetcars do. The difference between the two is light rail often has its own right of way, larger passenger capacities, and moves faster. Commuter rail is not integrated with streets the way that a streetcar or light rail is. Commuter rail has its own dedicated lines and reaches from the core of cities to their suburbs.

Cities and regions use mass transit in order to efficiently move large groups of people to work, shop, public spaces, their homes, and more. The type of mass transit that you see within a city depends on certain characteristics of the city. While it makes sense to build a subway line in New York City, it would not make sense to build a subway line in Salt Lake City. New York is the largest city in the United States and is dense, 26,403 residents per square mile while Salt

Lake City has 1,919 residents per square mile. Travelling in New York by car is inefficient which makes investing in rail travel a good choice for the city. In Salt Lake City, travelling by car is a more efficient mode of transportation because of the lack of density and design layout that caters to cars.

Some cities that rely on heavy rail include New York, Boston, Chicago, Washington, and Philadelphia. In the book, *Trains, Buses, People,* Christof Spieler writes, “The New York subway carries a quarter of all transit trips in the United States. Seventy-five percent of the city’s residents are within walking distance of the subway. No other rail network is as comprehensive. Like the New York subway, Chicago’s ‘L’ runs into the heart of dozens of dense, walkable neighborhoods where transit has been the easiest way to get around for a century[1]”. Many cities across the United States are simply not large enough to justify having such expansive transit systems like New York and Chicago. This does not mean that smaller cities do not need transit, rather the type of transit they need does not need to be as intensive. For small to mid-sized cities like Portland, Cincinnati, and Milwaukee, the solution to their transit needs has been investing in streetcar systems within the city's urban core

1.1 Streetcars in the U.S.

Over the past few decades, the development of streetcars in American cities has become popular. The technology of the streetcar is over a century old, but they have become a tool used by cities for transit improvements and economic development.

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[1] Spieler, C. (2018). *Trains, Buses, People*. Island Press/Center for Resource Economics.

The streetcar was common to see in cities and even small towns across America in the early 20th century. Streetcars ran through busy downtowns, commercial districts, even in and out of urban neighborhoods. As the century moved along, the way that Americans moved from place to place changed. The innovations that created the assembly line allowed personal cars to be made affordable to middle-class Americans. In the 1920s, roughly a quarter of all Americans owned a car, while most were still relying on horse and buggy or walking everywhere they went[2]. At this time in cities, transit was a profit-making venture as the lines were privately owned and operated. Cities even relied on these transit companies for road maintenance and repairs, much different than the modern approach to roads.

Table 5 shows the 25 most populated cities in the U.S. in 1930 and whether they had an operating electric streetcar system. Only one of the top 25 populated cities, Jersey City, lacked a streetcar system. Of the cities with streetcar systems, 14 of them had a population density per square mile over 10,000. Buffalo, New York's population density in 1930 was 14,732, which was among the highest in the entire country. The city with the lowest population density that had a streetcar system in 1930 was New Orleans with 2,341 people per square mile.

Population density can be a misleading statistic because it does not account for where residential populations are located within a city. In 1930, Buffalo's population density was double that of Washington D.C., even though

[2] Spieler, C. (2018). *Trains, Buses, People*. Island Press/Center for Resource Economics.

Buffalo’s population was only larger by about 90,000. Washington's land area was 62 square miles, or about 59% larger than Buffalo.

By the start of the 1960’s, only 8 of the 24 cities had a functioning streetcar system. By the end of the decade, only 4 systems remained. Buffalo began to dismantle its streetcar network beginning in the 1930’s and ended operation for good in the summer of 1950. The only three cities to carry their streetcar service through the twentieth century and into the twenty first were New Orleans, San Francisco, and Philadelphia. Most cities thought the way of the future was to open up city streets to commuter traffic and bus systems. Many cities that got rid of their streetcar system have built new systems in the past 20 years or are currently trying to get federal funding to build a new system.

The decline in the use of transit can be linked to government policy decisions starting in the early 20th century. All levels of government began to take on responsibility for road maintenance, even in the most rural of areas. The federal government began to fund roads in 1916 and encouraged states to create their own highway departments[3]. As more people began to own and drive cars everywhere they went, cities began to invest in making their downtowns, commercial districts, and neighborhoods more car-friendly. Streetcar ridership began to fall sharply, and companies that owned streetcar lines could no longer turn a profit. As cars became more popular and government policies favored them, cities began to get rid of old streetcar lines in favor of roads meant for cars and buses.

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[3] Spieler, C. (2018). *Trains, Buses, People*. Island Press/Center for Resource Economics.

Automobile culture was cemented during the term of President Dwight Eisenhower when he signed the Federal Highway Act of 1956. The law created the interstate highway system, making it easier than ever before to commute by car in an efficient amount of time. Highways opened the floodgates for things like white flight[4] which became middle class flight, urban sprawl[5], and urban renewal[6], all contributed to the trend toward more concentrated poverty in urban centers and disinvestment in electrified public transit.

1.2 Streetcars Come Back in the U.S.

Even though the golden age of streetcars was from the 1890s to the 1910s, American cities in the 21st century are looking to streetcars as a way to give their cities and urban cores a boost. “As of September 2012, transit agencies in eight cities reported to the Federal Transit Administration (FTA) that they are operating streetcars in regular, year-round revenue service: Little Rock, Memphis, New Orleans, Philadelphia, Portland, Seattle, Tacoma, and Tampa[7].” There are several cities with streetcars that are labeled under construction or listed as a light rail line instead of a streetcar. At the start of 2020, there were 26 streetcar lines located in the U.S. that operate on a daily basis. The entire list of streetcar systems can be seen in Table 1. There are 4 different categories of streetcar systems in the U.S. today, prewar, 1980s-2000s "heritage" systems,

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[4] White Flight- A time during the 1950’s and 1960’s when large white populations left inner cities to move to inner ring suburbs.
[5] Urban Sprawl- Uncontrolled growth away from a city's urban core.
[6] Urban Renewal- The redevelopment of urban cores in the mid 20th century. Buildings were demolished in favor of parking for suburban workers and shoppers.Slums were also demolished.
[7] (Brown, Nixon, & Ramos, 2015)

2000s stand-alone "modern" systems, and 2000s "modern" systems connected to larger rail networks[8].

Public transit is not an easy public good for cities and regions to master. Every city is different and therefore their transportation needs will be different. Cities of the same population may not benefit from the same type of transit because of the way their population is dispersed. Some problems cities face when taking on transit projects include, lack of understanding of issues, resistance to innovation, and experts having their own agendas[9].

1.3 The Importance of Federal Funding

Streetcars are seen as a way for cities to spur economic development in commercial districts and neighborhoods. Milwaukee's Mayor said of their streetcar project in 2018, “Values within a quarter-mile of the 2.5-mile route increased 27.9% to $3.95 billion since the Common Council approved the project in 2015, and 13% across the rest of the city[10].” The federal government has programs through the U.S. Department of Transportation to help fund streetcar projects around the country. Cincinnati and Kansas City are viewed as success stories in investing in streetcars and seeing positive economic results.

New streetcar lines cannot be built without federal funding. Federal funding can sometimes account for 50% of a streetcar project's cost. Every major transit project in the United States is subject to review by the United States Department of Transportation (USDOT). The USDOT requires that all municipalities that are looking to be awarded federal grant money to submit a

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[8] See table 1 on page 7.
[9] (Schabas, Berridge, Burke Wood, & Fagan, 2019)
[10] (Nelson, 2018)

cost-benefit analysis of the proposed project with strict guidelines that need to be met for the project to be eligible for grant money.

The main form of funding from the federal government comes in the form of Transportation Investment Generating Economic Recovery (TIGER) grants. Between 2009 and 2014, TIGER grants awarded over $279 million to streetcar projects across the U.S.[11]

[11] (Mallett, 2014)

Chapter 2: Streetcar Projects in the U.S.

Across the United States, cities are turning to streetcar development as a way to promote density and spur economic development within their urban cores.

City	System Name	System Type
Philadelphia	15 Girard	Prewar
New Orleans	RTA Streetcars	Prewar
San Francisco	Cable Cars	Prewar
San Francisco	F Market	1980s-2000s "heritage" systems
Dallas	McKinney Avenue Trolley	1980s-2000s "heritage" systems
Houston	Galveston Trolley	1980s-2000s "heritage" systems
Tampa	TECO Line	1980s-2000s "heritage" systems
St. Louis	Delmar Loop	1980s-2000s "heritage" systems
Memphis	MATA Trolley	1980s-2000s "heritage" systems
El Paso	El Paso Streetcar	1980s-2000s "heritage" systems
Little Rock	METRO Streetcar	1980s-2000s "heritage" systems
Detroit	Q-Line	2000s stand-alone "modern" systems
Kansas City	KC Streetcar	2000s stand-alone "modern" systems
Cincinnati	Cincinnati Bell Connector	2000s stand-alone "modern" systems
Milwaukee	Milwaukee Streetcar	2000s stand-alone "modern" systems
Oaklahoma City	OKC Streetcar	2000s stand-alone "modern" systems
Tuscon	Sun Link	2000s stand-alone "modern" systems
Washington	DC Streetcar	2000s "modern" systems connected to larger rail networks
Dallas	Dallas Streetcar	2000s "modern" systems connected to larger rail networks
Atlanta	Atlanta Streetcar	2000s "modern" systems connected to larger rail networks
Seattle	Seattle Streetcar	2000s "modern" systems connected to larger rail networks
Seattle	Tacoma Link	2000s "modern" systems connected to larger rail networks
Phoenix	Tempe Streetcar	2000s "modern" systems connected to larger rail networks
Charlotte	CityLYNX	2000s "modern" systems connected to larger rail networks
Portland,OR	Portland Streetcar	2000s "modern" systems connected to larger rail networks
Salt Lake City	S-Line	2000s "modern" systems connected to larger rail networks
		Table 1

As seen in Table 1[12], there have been 15 new streetcar developments in the U.S. since the early 2000's, with more projects proposed.

2.1 Taking advantage of Density

Streetcar lines that are built-in high-density areas of a city are more likely to have high ridership compared to a line built in a car-oriented suburb. Many

[12] Spieler, C. (2018). *Trains, Buses, People*. Island Press/Center for Resource Economics.

studies have tried to determine the threshold for population density and public transit. At around 3,000 people per square mile, it makes sense for a city to have an infrequent bus service. Around 10,000 people per square mile are where a tipping point can be seen and a frequent service can be justified. Some cities that meet the 10,000 people per square mile threshold and have a light rail or bus rapid transit line include San Francisco, Boston, Philadelphia, Seattle, Newark, Jersey City, Buffalo, and Houston[13].

Looking at a city's population alone can be misleading when trying to determine how dense it is. While Dallas and Houston have metro areas over 6 and 7 million respectively, Buffalo’s metro population is just over 1 million people. Even though Buffalo is much smaller, it has the highest population density of the three cities at 6,172. This suggests that smaller cities like Buffalo could have transit systems that are able to serve the same amount or more people with greater efficiency than their larger counterparts. If transit networks are not placed in high-density areas, it is likely that it will be vastly underutilized. Cities will also not see the surrounding neighborhoods attract development with businesses and new residences like they may hope for. It can be hard for elected officials to convince already dense neighborhoods that fixed transit is a good idea, especially without policies in place to support these ideas. As a case in point, a modeling study of projected streetcar impacts in Cincinnati found that impacts were spatially limited without accompanying policies to support economic development[14].

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[13] Spieler, C. (2018). *Trains, Buses, People*. Island Press/Center for Resource Economics.
[14] (Hinners, Nelson, & Buchert, 2017)

2.2 Transit-Oriented Development

When streetcar lines are installed in cities, local representatives will often say that they have high hopes for transit-oriented development to occur around the new transit system. Transit-oriented development is simply new developments of residential, commercial, and office spaces built near a new or existing transit route. In the case of a streetcar, this development is generally measured in the quarter-mile radius surrounding a streetcar stop or station. It is proven more often than not that the addition of transit to a neighborhood will see surface parking lots and one-story residential or commercial buildings built into larger developments.

Developers and new residents see the development of a streetcar line as a commitment to their neighborhood. The cost of streetcar lines can be in the hundreds of millions of dollars. When a city decides to make an investment of that size, it sends a message to people and businesses that the neighborhood is going to be taken care of and seen as an essential corridor for the city's success.

2.3 Frequency and Reliability

Streetcar routes often face criticism by people who claim that the same form of transit can be achieved for much less by implementing something like Bus Rapid Transit to an area. While this may be true to an extent, Buses do not have the reliability or aesthetics of a streetcar line. Fixed transit such as a streetcar is seen as more reliable than a bus line because it does not have as many variables that can slow it down on the way to its next stop. Public transit is considered to be a frequent service for transit if a line is active at each station every 15 minutes. Transit planner Jarrett Walker says that when it comes to transit, frequency equals freedom[15]. High-frequency stops mean that a fixed transit system will be viewed as more reliable by those who consider to take it. The risk of being late to work, an appointment, sporting event, or show can be a turnoff to people, “A 2014 TransitCenter survey ranked it as the second most important factor in what mode people chose” (Spieler). Reliability is one factor as to why the U.S. sees such low numbers of public transit users. The least reliable form of public transit by far is bus networks, which see the reliability of around 60-70 percent (Spieller). Some of the better light rail and streetcar networks around the country see reliability upwards of 90 percent.

2.4 Kansas City Streetcar

The Kansas City streetcar project conducted a benefit cost analysis as is required by the U.S. Department of Transportation for their grant application for the TIGER 2017 program. The benefit cost analysis and the period of the analysis for the project correspond with guidelines set by the U.S. DOT.

The Kansas City streetcar application had plans for 2.2 miles of streetcar line extension and had three main partners, the Kansas City Streetcar Authority (KCSA), Kansas City Transportation Authority (KCATA), and the City of Kansas City, Missouri (KMCO). The goal of the project is as stated, “this extension is intended to provide connectivity between the Riverfront and the downtown, stimulate economic activity at the Riverfront, and provide a non-vehicle travel

[15] Spieler, C. (2018). *Trains, Buses, People*. Island Press/Center for Resource Economics

option to access the “string” of downtown districts, as well as address parking demand and growing congestion[16].”

The first phase of streetcar development in Kansas City was deemed to be extremely successful. The system had over 2 million riders before the end of its first full year in service, the estimated total first year ridership was initially projected to be around 1.15 million people. The original 2.2 mile streetcar line cost $102.5 million with $20 million in funding coming from a U.S. DOT TIGER 2013 grant.

According to the cost benefit study, the main benefits for the project were lowering vehicular travel and the emissions that it causes. “Eliminating up to 22,000 hours of travel per year will translate to substantial passenger time savings, which can be monetized. Additionally, the pedestrian and bicycle path allows for quantifiable sustainability-mobility as well as health benefits[17]”. The study also cites community development and safety improvements that the project would bring. Since it is hard to quantify community development and safety improvements within a benefit cost analysis, the study discussed their importance qualitatively.

In order to understand the results of the Kansas City study it is important to know the meaning of the terms used in the study. A benefit-cost ratio takes the benefits and costs of a project and divides the benefits by the costs. A number over 1.00 means that there are more benefits to a project than costs. Net Present Value takes the sum of the benefits and subtracts the sum of the costs. An NPV

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[16] ("KANSAS CITY: CONNECTING OUR RIVERFRONT FOR EVERYONE" 2017, 2)
[17] ("KANSAS CITY: CONNECTING OUR RIVERFRONT FOR EVERYONE" 2017, 9)

over $0 means the project yields a net gain in benefits. The benefits and costs of projects are discounted in order to make sure that benefits that are achieved over the course of many years are expressed in present terms. This is necessary to do because the time value of money says that money in the present is worth more than the same amount in the future. Discounting takes away this discrepancy.

Kansas City's study found that the undiscounted capital cost for their streetcar project would cost $32 million while the cost discounted at 7% was estimated to be $25.3 million. The operating and management cost undiscounted was estimated to be $20.7 million and $7.1 million when discounted at 7%. The project's benefits were estimated to amount to $50 million dollars when discounted at a 7% rate. The project has a Net Present Value of $17.6 million and a benefit cost ratio of 1.54. Both NPV and benefit cost ratio are discounted at a rate of 7%. The benefits for the Kansas City streetcar project are broken down into five categories, quality of life,

Long-Term Outcome	Benefit (Disbenefit) Category	Monetized @ 7% Discount Rate
Quality of Life / Livability	Health Benefits	$100,000
	Commuter Mobility Benefits	$400,000
	Recreational Benefits	$5,000
	Reduced Noise	$120,000
	Community Development	Qualitative
Economic Competitiveness	Travel Time Savings	$4,250,000
	Vehicle Operating Costs	$30,330,000
	Fuel Savings	$9,460,000
Safety	Reduced Incidents	Qualitative
State of Good Repair	Reduced Road Damage	$120,000
	Residual Value	$2,020,000
Environmental Sustainability	Reduced Emissions	$3,160,000

Table 2.[18]

[18] ("KANSAS CITY: CONNECTING OUR RIVERFRONT FOR EVERYONE" 2017, 4)

economic competitiveness, state-of-good repair, environmental sustainability, and community development and safety.

The environmental sustainability portion of the Kansas City streetcar project includes positive environmental impacts. Throughout the 30 year duration of the benefit cost analysis, the study expects to see vehicle-miles traveled decrease by 352,978,095.30 and amount of fuel consumed by 10,847,404.84 gallons.

Economic competitiveness is often a major reason cited as to why a city would benefit from the construction of a streetcar system. As seen in Table 2, the cost associated with travel time savings is $4,250,000, vehicle operating cost savings is $30,330,000, and fuel savings is $9,460,000.

Quality of life is given a quantitative measure by determining how the streetcar project will improve public health, mobility, increase recreation, and reduce noise levels. The first three elements rely on residents in Kansas City's downtown corridor to utilize cycling as one of their main modes of transportation. This project's health benefits are determined by assuming people will be more active and their healthcare costs will lower as a result. Noise reduction benefits are monetized based on the annual reduction in VMTs and noise monetization factors, estimated by the Federal Highway Administration[19]. Over the lifetime of the project discounted at 7%, health benefits were estimated at $103,000, community mobility benefits at $414,000, recreational benefits at $5,000, and reduced noise at $121,000.

[19] ("KANSAS CITY: CONNECTING OUR RIVERFRONT FOR EVERYONE" 2017, 20)

Over the 30 year study period the streetcar will create a time travel savings of $4.2 million when discounted at 7%. Vehicle operating costs are expected to provide over $30 million in benefits while fuel savings will provide just under $9.5 million. The streetcar will also contribute to reduced emissions in the Kansas City area because fewer cars will be on the road. Reduced emissions discounted at 7% is valued at $3,160,000 over the lifetime of the project.

	Undiscounted	Discounted 7%
Total Benefits	$184.2	$50.0
Total Costs	$52.7	$32.4
Net Present Value (NPV)	$131.4	$17.6
Benefit Cost Ratio (BCR)	3.49	1.54
Internal Rate of Return (IRR)	10.7%	10.7%
Payback Period (Years)	9.9	19
		Table 3[20]

Table 3 shows the final results for the benefit cost analysis for the Kansas City Streetcar. The positive benefit cost ratio of 1.54 means that benefits of the project outweigh the cost. This suggests that this project would have a positive impact on the Kansas City community and is a good candidate to receive federal grant money.

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[20] ("KANSAS CITY: CONNECTING OUR RIVERFRONT FOR EVERYONE" 2017, 25)

2.5 Cincinnati Streetcar

The Cincinnati streetcar project was introduced as an essential investment for the City of Cincinnati. The streetcar project application described the development as a way to invest in the downtown core, encourage private dollars to invest in downtown, and serve as an economic catalyst for the area. From a transit standpoint, the streetcar is meant to connect downtown with some of the surrounding residential areas.

In order to make the project a reality, federal funding was applied for by Cincinnati. In 2010, the project team applied for an Urban Circulator Grant from the Federal Transit Administration. The Urban Circular Grant awarded the project $24,990,000. The team also applied for a TIGER II grant at a total of $35 million[21]. The two federal grants combine to pay for almost $60 million of the entire project and account for 47% of the project's total funds. Without these federal grants, the streetcar project in Cincinnati could not have been built.

The project application cites out of pocket cost savings as being one of the major benefits of the project. Fuel savings to residents over the lifetime of the project was estimated to be $2.8 million after discounting. Depreciation savings on personally owned vehicles was estimated to be $2.5 million while maintenance was $1.28 million. Even after accounting for the cost of users to ride the streetcar, the estimated out of pocket savings was estimated to be $1.8 million.

The study showed five major long term benefits to constructing the streetcar, state of good repair, economic competitiveness, livability, sustainability,

[21] ("Cincinnati Streetcar Tiger II Application", 2010)

and safety. The state of good repair section states that the city will experience reductions in pavement maintenance costs because the way that roads are utilized will change with the streetcar. Less cars on the road will mean less accidents and less incidents where the road is damaged and needs to be repaired.

Economic competitiveness mentions improving the mobility of the people who live and work within access to the streetcar line. Travel savings costs are estimated to be roughly $2.3 million per year and $39 million over the life cycle of the project.

The application also cites improved use of land that will be immediately surrounding the streetcar line. The plan outlines a project benefit zone that estimates as many as 1,300 housing units could be created as a result of the streetcar line, an investment worth as much as an added value of $32 million a year. Streetcar lines can improve mobility and livability within neighborhoods, and the Cincinnati streetcar captures that idea within their application. Streetcars offer an amenity to a neighborhood that proves to be very desirable to live near. This will increase the property and home values of surrounding homes and businesses.

The streetcar should improve safety in the area simply because less cars will be on the roads. This means that there will be less accidents and less major injuries and deaths.

	7 percent discount	3 percent discount
Full alignment		
Total discounted benefits	$240.03	$414.64
Total discounted costs	$168.99	$198.89
Net present value	$71.05	$215.75
Benefit/Cost ratio	1.42	2.08
Internal Rate of Return (%)	10.8%	10.8%
Payback period (Yrs)	14 years	14 years
		Table 4[22]

The benefit cost analysis for the Cincinnati streetcar project was positive at both the 7 percent and the 3 percent discount rate. These rates along with positive net present values are reasons why the Cincinnati streetcar was approved for their federal grant and is considered to be a success in modern streetcar developments.

2.6 Streetcar Costs

When comparing streetcars on a per mile, capital cost basis, they are more expensive than buses but cheaper than light rail. Streetcars typically do not require municipalities to make many acquisitions because the lines are integrated with existing roadways. Streetcars can vary in price per mile, the S Line in Salt Lake City cost 27.8 million per mile in 2013 whereas the Q Line in Detroit cost 54.5 million per mile in 2017[23]. Bell also found that the operational cost for a

[22] ("Cincinnati Streetcar Tiger II Application", 2010)
[23] (Bell, 2017)

streetcar cost $1.41 per passenger compared to $1.09 for buses and $.75 for light rail. While streetcars may cost the most to operate these forms of transit, Bell found that they are the form that receives the most funding from passenger fares. Streetcars cover costs via passenger fares at a rate of 31.8% compared to 25.7% for buses and 27.9% for light rail transit.

Maintenance on streetcar lines can vary from city to city. Bell found that Detroit's 3.3-mile QLine estimates annual O&M costs approximately $6 million, Cincinnati 3.6-mile Bell Connector estimates O&M at $4.2 million, and Salt Lake City’s 2.0-mile S-Line estimates annual O&M at $1.5 million.

Chapter 3: Literature Review

3.1 Cost-Benefit Analysis and Relative Position

Over the past 50 years, cost-benefit analysis has found itself as a tool used by U.S. presidents on both sides of the aisle. The paper, *Cost-Benefit Analysis and Relative Position*, by Robert H. Frank and Cass R. Sunstein, dives into the ways that cost-benefit analysis has become a stable of all three branches of the federal government, how it can relate to our relative and actual positions in the economy, and more. Cost-Benefit has proven so popular that Presidents Regan, Bush, and Clinton have all called for a cost-benefit analysis to be done through executive orders. Congress has also shown considerable interest in cost-benefit analysis, requiring both the Office of Management and Budget ("OMB") and the Environmental Protection Agency ("EPA") to produce monetized accounts of consequences and regulation[24].

Both Frank and Sunstein believe that cost-benefit analysis is a beneficial practice for government agencies to get involved in. Issues begin to show themselves when trying to figure out problems such as how much a consumer is willing to pay for a particular good or service. When trying to determine a person's willingness to pay for something, analysts mainly rely on two methods. One of the methods is the *hedonic pricing* method. *Hedonic Pricing* attempts to infer valuations from observable market behavior[25]. The other is the *contingent valuation* approach. The *contingent valuation* approach is used when market

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[24] Sunstein, C. R., & Frank, R. H. (2001). Cost-Benefit Analysis And Relative Position. *SSRN Electronic Journal*, *68*, 323–324. doi: 10.2139/ssrn.237665

[25] See Robert W. Hahn and John A. Hird, *The Costs and Benefits of Regulation: Review and Synthesis*, 8 Yale J Reg 223, 241-43 (1991).

evidence is unavailable. Analysts will ask how much people would be willing to spend to avoid a widespread series of dangers[26]. The government has used cost-benefit to determine subjects from what is a life worth if lost on the job or basic illnesses and what people would be willing to pay to be cured of them. When this paper was published, the government had determined that the value of a human life was worth about $4 million dollars.

The authors believe that when people are looking at their financial and economic status, they care more about their relative position than they do about their actual position. This means that people care more about their status compared to their peers rather than their actual economic positions. Frank and Sunstein offer an example of an individual buying security for themselves and comparing it to a requirement among all people to purchase the same level of security. When an individual purchases security they experience both an absolute decline in goods and services they can buy and also a decline in relative living standards[27]. Since it seems that people care about their relative standing more than absolute, they will not feel the effects of this security purchase the same if all other people buy it at the same level.

When looking at the federal level, cost-benefit analysis has proven popular among presidents going all the way back to Nixon. One of the main problems with the government's use of cost-benefit is determining an agreed upon system for assessing relevant values. The authors point out that the Office of

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[26] See Paul R. Portney, *The Contingent Valuation Debate: Why Economists Should Care*, 8 J Econ Persp 3, 3-6 (Fall 1994).
[27] Sunstein, C. R., & Frank, R. H. (2001). Cost-Benefit Analysis And Relative Position. *SSRN Electronic Journal*, *68*, 326. doi: 10.2139/ssrn.237665

Management and Budget often gave out vague guidelines to agencies which made this determination difficult to make.

As previously stated, Frank and Sunstein stress the importance of relative position in the economy. In order to illustrate this importance, they give an example of two individuals with different individual income levels and different average income levels of all others. In World A, you earn $110,000 while other individuals earn $200,000. In World B, you earn $100,000 while others earn $85,000. Frank and Sunstein argue that World B is the ideal choice because even though you would make less money than in world A, your relative financial position and purchasing power is greater.

Another example used to explain the importance of relative position is salaries at a firm. If a new employee begins work and earns a higher salary than an employee who has been there many years, there is likely to be a problem. In order to combat this problem firms typically have very rigid scales that are used to give raises to employees. Company cultures also often discourage employees discussing salaries with one another. This strategy tries to avoid the relative position problem by killing the conversation before it can even begin.

The authors conclude by reinforcing the increasing use of cost-benefit analysis in all levels of government. The debate over cost-benefit analysis has shifted from whether people should be using it at all to what values should be used in order to get the most accurate results. One thing that the authors feel is not being done correctly is how large some regulatory benefits are. Frank and Sunstein write, “Our minimal submission here has been that the current numbers for regulatory benefits are too low, because they neglect the fact that people care about relative economic position, not only absolute economic position. In terms of the very framework to defend cost-benefit analysis, the current numbers should be increased[28]".

3.2 Exact Consumers Surplus and Deadweight Loss

Consumer surplus is one of the most controversial of widely used welfare economic concepts. Hausman writes, "The basic idea is to evaluate the value of a consumer or his "willingness to pay" for a change in price of a good from price^0 to price^1. Because price changes affect consumer welfare, an evaluation of this effect is often a key input to public to public policy decisions[29]". This type of calculation is often used in the study of welfare economics[30]. While welfare economists have differing opinions about welfare consumer surplus and the proper way to measure it, Hausman points to estimating a demand curve to show exact measure of utility change. It is important when looking at consumer surplus to ge rid of any variation in the numbers that are being used. If done properly, some of the calculations that are necessary could be done with a basic calculator.

Hausman sees problems with deadweight loss, specifically with the Marshallian measure. He writes, "Thus the Marshallian measure of deadweight loss is not accurate for the important measurements undertaken in applied

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[28] Sunstein, C. R., & Frank, R. H. (2001). Cost-Benefit Analysis And Relative Position. *SSRN Electronic Journal*, *68*, 374. doi: 10.2139/ssrn.237665
[29] Hausman, J. A. (1981). Nonparametric Estimation of Exact Consumers Surplus and Deadweight Loss. *American Economic Association* , *71*(4), 662. doi: 10.2307/2171777
[30] Welfare economics is the study of how to best allocate resources to increase the public good.

welfare economics and public finance studies"[31]. It is important to get these numbers right in order to have the most accurate analysis that is possible. In making his point about the shortcomings of the Marshallian model, Hausmann uses labor supply to prove his points. Hausman again rails against the Marshallian model for calculating deadweight loss, "Since finding the deadweight loss is often the goal in applied welfare economics, this finding strongly recommends use of the exact deadweight measure rather than the Marshallian approximation"[32].

Hausmanns paper shows that economists have different opinions of the best way to measure deadweight loss and consumer surplus. Using the market demand curve is deemed inappropriate by Hausmann, even though other economists would disagree with him.

3.3 Estimating the Social Benefit of Constructing an Underground Railway in London

C.D. Foster and M.E. Beasly's paper on the construction of the Victoria Line, an underground subways system in London, uses cost-benefit analysis to determine expected social gains and losses from building the line. The goal of the study was to determine that exact amount of social gain over social loss of the project. This can also be referred to as the consumer's surplus return on investment. A cost-benefit analysis is more than just a regular financial

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[31] Hausman, J. A. (1981). Nonparametric Estimation of Exact Consumers Surplus and Deadweight Loss. *American Economic Association* , *71*(4), 663. doi: 10.2307/2171777
[32] Hausman, J. A. (1981). Nonparametric Estimation of Exact Consumers Surplus and Deadweight Loss. *American Economic Association* , *71*(4), 672. doi: 10.2307/2171777

calculation. A regular financial calculation would only take into account the interests of private firms in the project and their fiscal outcomes.

Foster and Beasly give three main reasons why social cost-benefit analysis should be used instead of a basic financial analysis. The first reason is the investment being made is large and indivisible. They use constructing a dam as an example to explain what this means. While a dam may have low marginal value when it is built, and if it is made equal to the price would not yield enough revenue to cover the cost, but it has a high aggregate value and therefore should be built[33]. The aggregate value refers to all of the parts that go into building the dam and adding their values together into one sum. The second reason is that there are secondary costs which a private firm can avoid, or benefits which it is not paid because of imperfections of the market mechanism. When firms are involved in projects, they are often not responsible for any of the negative environmental or social costs that can be taken on by people who live near and around the project. Cost-benefit analysis takes into account all factors that a project will affect and even give a monetary value to things like social and environmental effects. The third reason is that there are specially desirable social consequences such as relief of unemployment.

When looking at a project like the construction of the Victoria Line it can be assumed that prices are going to be charged in order for the subway to cover its construction costs and to make a profit. Since the subway is going to be an asset of the UK government, the goal of the line is not to make a profit, instead

[33] Foster, C. D., & Beesley, M. E. (1963). Estimating the Social Benefit of Constructing an Underground Railway in London. *Journal of the Royal Statistical Society. Series A (General)*, *126*(1), 46. doi: 10.2307/2982446

they simply want to cover the costs of operating the line. This means that it will be much more affordable to use the subway and more of the population will have an opportunity to use it as a source of transportation.

It is important with any large infrastructure project to consider the life of the project and how long it will be in operation. In this paper, it is assumed to be 50 years' operation. The 50 year timeline does not mean that the entire line will be obsolete or need to be totally replaced within this time frame. This simply takes into account the possible need for changes or upgrades to the line, changes in the surrounding areas or neighborhoods, or even the possibility that the Victoria Line becomes obsolete by the time 50 years pass. The authors use a 6 percent discount rate on the project.

Some of the Benefits that the Victoria Line would provide include time savings, fare and cost savings, and comfort and convenience savings. Time is valuable to people and they will hopefully be able to save time in their daily commutes by using the Victoria Line. Cost-benefit analysis recognizes this time savings benefit and tries to put a monetary value on it so it can be compared with other benefits.

Chapter 4: Niagara Street Streetcar Line

4.1 Summary of Niagara Street Streetcar Line

Utilizing the benefit-cost guidelines from the U.S. Department of Transportation (see appendix), we test a hypothetical 3.10 mile single line streetcar line on Niagara Street in Buffalo, NY. The project is based off of the metrics employed in recent DOT-supported single-line projects like those in Kansas City, Milwaukee and Cincinnati.

The Niagara Street Streetcar line will connect the Black Rock and West Side neighborhoods to downtown Buffalo. The line would provide the only fixed transit connection from the northwest corner of Buffalo, home to SUNY Buffalo State, down to the central business district. Niagara Street has seen millions of dollars in investment in the past five years and the city is in the process of making it a complete street with protected bike lanes, improved sidewalks, new lighting and curb bump outs. The neighborhoods that the streetcar would pass through would provide fixed transit to a mix of income levels, major employers like Rich Products, and future developments planned. A streetcar line on Niagara Street would only strengthen the opportunity for future investment in residential and commercial development.

Buffalo, NY is a car dependent city. Investing in a streetcar line on Niagara Street improves mobility options for residents living in Downtown Buffalo, the West Side, and SUNY Buffalo State. The line would link directly to the Metro Rail that runs through downtown to the waterfront, Buffalo Niagara Medical Campus, and the University at Buffalo south campus. The project would improve mobility options for downtown and East Side residents as well as pedestrians, bicyclists, and other drivers.

Environmental benefits as well as travel cost savings are expected benefits of the system. Some residents who rely on personal transportation are also expected to use the streetcar instead of driving. Residents who cannot afford their own car will have a reliable mode of transportation in their neighborhood that can help them access new job opportunities and amenities in Buffalo.

The streetcar will improve the lives of those who are transit dependent. The line will also help to support the continued revitalization of a main arterial in the City of Buffalo, Niagara Street, including new investments in housing and commercial space. The line will be built in two phases. First a 3.10 mile phase creating a fixed transit line between downtown, the west side, and SUNY Buffalo State.

4.2 NY Power Authority Five Cities Energy Plan

Buffalo’s radial street design made the city one of the best planned in the entire country. Over time, investments in highways and urban renewal ruined the city's design, especially in the urban core. The New York Power Authority plan for transportation in Buffalo to embrace sustainable transit practices for smart growth and place based development. Buffalo is a car dependent city and transit plays a significant role in Buffalo’s energy consumption and greenhouse gas emissions.

State and federal regulations shape NYPA's diverse customer base, which includes large and small businesses, not-for-profit organizations, community-owned electric systems and rural electric cooperatives and government entities. NYPA provides the lowest-cost electricity in New York State and we're the only statewide electricity supplier. Economic development is a top priority for the New York Power Authority. NYPA works with state and local entities, including Governor Andrew M. Cuomo's 10 Regional Economic Development Councils, the Empire State Development Corporation, the New York State Economic Development Power Allocation Board and other local and regional economic development organizations to encourage businesses to locate and expand in the state and create and retain jobs. Power pricing information and comparisons are regulated by an entity called the NY Independent System Operator (NYISO). Electricity as a commodity is bought in regions with its own pricing and is sold in real time, hourly, day ahead and long-term contracts.[34]

A Niagara Street streetcar line in The City of Buffalo would reduce Vehicle Miles Traveled by over 35 million miles over the first 20 years of the project's life. This equates to a net discounted benefit of over $21 million. Reducing VMT’s is one of the power authority's main goals in The City of Buffalo, especially reducing trips that are made by automobile. 67 percent of Buffalo’s residents commute to work by single occupant vehicles. The NYPA suggests that by promoting an integrated, energy efficient transportation network, Buffalo will help lessen the challenges of increased traffic congestion in the urban core[35].

The third initiative of this section recommends that the NFTA promote transit use in the city. This initiative encourages residents and workers to use

[34] NYPA, 2015.
[35] NYPA, 2015.

transit as a means to reduce VMT's which will save travel time in congested traffic and fuel savings. A 1 percent reduction in VMT's in Buffalo coule equate to $2.7 million in annual energy costs.

The NYPA also encourages transit oriented development which a Niagara Street line would encourage. Niagara Street is currently seeing buildings being redeveloped adding value to the corridor and an increase in residential units. Investments have been made close to the downtown core at the Shoreline Apartments where a $4.5 million dollar investment will create 114 units of affordable housing. Farther north a $25 million investment two formerly abandoned buildings in the 1000 block have to created over 90 new apartment units. Rich products is also a major employer on Niagara Street with over 800 people working at its Buffalo headquarters. A streetcar line would encourage more development to go along with the Complete Streets initiative that Buffalo is currently investing in Niagara Street.

The streetcar line would encourage dense development in accordance with The City of Buffalo green code. The NYPA estimated that dense developments will help to save the city on energy costs, as much as $450,000 per year.

4.3 Pros to a Streetcar line

A summary of the changes proposed in the project and the associated benefits are provided in the section below.

Current Problems

- Lack of connectivity between neighborhoods and transportation options.

- Buffalo vehicle traffic decreases travel speed, increases travel time, and raises pollution levels.
- Limited transit options on the West Side of Buffalo leave residents without a reliable way to access job opportunities, essential businesses and services and amenities throughout the city.

Changes to the Current Situation

- Construction of the 3.10 Streetcar line from Niagara Street and Forest Avenue to Niagara Street and Elmwood Avenue.

Impacts if Project is Built

- Reduce number of automobile trips, vehicle miles traveled; increases speed of travel
- Reduce pollutant emissions
- Reduce number of injuries and fatalities
- Increase property values
- Create residual value of infrastructure after 20 years of operation

Population Affected by Impact

- Streetcar users, bus riders, automobile users, pedestrians and bicyclists
- Government
- Local, state, region, and national population
- Community in general and property owners

Economic Benefit

- Monetized value of reduced generalized travel cost for streetcar users and remaining automobile users
- Monetized value of pavement maintenance savings
- Monetized value of emission reductions
- Monetized value of accident costs
- Value of increase in property values (residential and commercial)
- Monetized residual value of Streetcar

4.4 Summary of Benefits

<u>Economic Competitiveness</u>

- Fixed transit line for the East Side of Buffalo.
- Opportunities to attract new housing and commercial investments in the West Side of Buffalo.

- The streetcar signals a commitment to investing in Downtown Buffalo, and the West Side of Buffalo.
- More job opportunities for low income families who cannot afford their own vehicles.

Livability

- Public Transit is enhanced from Downtown Buffalo through the West Side of Buffalo up to SUNY Buffalo State College.
- Mobility is increased for elderly residents and low income residents who cannot afford their own vehicle.
- Increased walkability and connectivity between Buffalo’s West Side and downtown.

Environmental Sustainability

- Car free travel is facilitated by the streetcar.
- Reduce emissions and the amount of space necessary to park and store personal vehicles.
- Supports the re-use of vacant and under-utilized buildings and promotes appropriately scaled infill development in agreement with the Buffalo Green Code.

Safety

- Station area improvements, such as lighting, improved sidewalks, and other pedestrian oriented investments, are likely to enhance the safety of these areas.
- Following the Buffalo Green Code and Buffalo Complete streets to create a safer commute for pedestrians, bicyclists, drivers, and public transit users.

4.5 Project Overview

The project proposes a 3.10 route streetcar line through the Niagara Street corridor to Downtown Buffalo. There will be 9 stations along the route.

Completion of this project will create a fixed transit line to serve residents of the West Side of Buffalo as well as commuters going to and from downtown and SUNY Buffalo State College. The project will support the growth and development of Buffalo's West Side by encouraging investment in housing and business along the streetcar line.

4.6 Base Cases and Alternatives

The base case, or no build alternative, assumes the continuation of the current public transit offered on this 3.10 mile portion of Niagara Street. Currently this section of the street is serviced by the number 6 NFTA bus line. In 2018 the Niagara bus line served roughly 1.65 million passengers and just over 1.6 million in 2019. Compared to light rail, buses in Buffalo served 2.6 passengers less per mile in 2019. This is evidence that streetcar development can move more people to use public transit than buses[36].

For the build alternative, it is assumed that the streetcar line will operate from 6am to 12am seven days a week. The streetcar will stop at each station between 10-20 from the previous train. Slower train times will be at less peak hours in the early morning and late at night.

[36] https://metro.nfta.com/media/xefnkvjb/2019-metro_annual_performance_report.pdf

4.7 Ridership Estimates

	Opening Year 2023	2028	2033	2038	2043
Total Daily Trips	2,323	2997	3626	4279	4450
Diverted from Auto	767	989	1197	1412	1468
Diverted from Bus	767	989	1197	1412	1468
Induced Demand	790	1019	1233	1455	1513

Year	Projected Ridership	Special Events	Total
2023	1,048,835	52,442	1,101,276
2024	1,098,130	54,906	1,153,036
2025	1,146,447	57,322	1,203,770
2026	1,194,598	59,730	1,254,328
2027	1,242,502	62,125	1,304,627
2028	1,289,717	64,486	1,354,203
2029	1,336,146	66,807	1,402,954
2030	1,382,912	69,146	1,452,057
2031	1,429,931	71,497	1,501,427
2032	1,477,118	73,856	1,550,974
2033	1,522,909	76,145	1,599,054
2034	1,570,119	78,506	1,648,625
2035	1,617,223	80,861	1,698,084
2036	1,664,122	83,206	1,747,328
2037	1,710,718	85,536	1,796,253
2038	1,756,907	87,845	1,844,752
2039	1,802,587	90,129	1,892,716
2040	1,849,454	92,473	1,941,926
2041	1,895,690	94,785	1,990,475
2042	1,943,082	97,154	2,040,237
2043	1,989,716	99,486	2,089,202

Ridership estimates for the Niagara Street line as based off of vehicle traffic and bus ridership on Niagara Street. Estimates are conservative and the rates by which they increase by year are based off of other streetcar studies. If the streetcar causes residential and commercial development to the Niagara Street corridor as it is estimated these numbers could end up being too low of an estimation. Niagara Street is already one of the most traveled streets by public transit in the entire City of Buffalo.

4.8 Project Cost and Schedule

Year	Construction	Operation & Maintenance	Total	Discounted 7%
2021	$43,713,287	0	$43,713,287	$40,853,539
2022	$81,598,135	0	$81,598,135	$71,270,972
2023	$20,399,534	$649,263	$20,399,534	$16,652,096
2024	0	$1,213,576	$1,213,576	$925,831
2025	0	$1,134,183	$1,134,183	$808,657
2026	0	$1,413,312	$1,413,312	$1,007,672
2027	0	$1,320,852	$1,320,852	$880,140
2028	0	$1,234,441	$1,234,441	$768,748
2029	0	$1,153,683	$1,153,683	$671,454
2030	0	$1,078,209	$1,078,209	$586,474
2031	0	$1,007,672	$1,007,672	$548,107
2032	0	$941,750	$941,750	$478,738
2033	0	$880,140	$880,140	$418,148
2034	0	$822,560	$822,560	$365,227
2035	0	$768,748	$768,748	$319,003
2036	0	$718,456	$718,456	$298,134
2037	0	$671,454	$671,454	$278,630
2038	0	$627,527	$627,527	$243,366
2039	0	$586,474	$586,474	$212,565
2040	0	$548,107	$548,107	$185,663
2041	0	$512,249	$512,249	$162,165
2042	0	$478,738	$478,738	$141,641
2043	0	$223,709	$223,709	$61,857
Total High Cost Estimate	**$145,710,956**	**$17,985,103**	**$163,046,796**	**$138,138,825**

Year	Construction	Operation & Maintenance	Total	Discounted 7%
2021	$39,341,958	0	$39,341,958	$36,768,185
2022	$70,815,525	0	$70,815,525	$61,853,022
2023	$18,359,581	$584,337	$18,943,917	$15,463,879
2024	0	$1,092,218	$1,092,218	$891,575
2025	0	$1,020,764	$1,020,764	$778,736
2026	0	$953,986	$953,986	$680,179
2027	0	$891,575	$891,575	$594,094
2028	0	$833,248	$833,248	$518,905
2029	0	$735,473	$735,473	$428,052
2030	0	$970,388	$970,388	$527,827
2031	0	$906,905	$906,905	$461,024
2032	0	$847,575	$847,575	$402,677
2033	0	$792,126	$792,126	$351,713
2034	0	$740,304	$740,304	$307,200
2035	0	$691,873	$691,873	$268,320
2036	0	$646,610	$646,610	$234,361
2037	0	$604,309	$604,309	$204,700
2038	0	$564,774	$564,774	$178,793
2039	0	$527,827	$527,827	$156,165
2040	0	$493,296	$493,296	$136,401
2041	0	$461,024	$461,024	$119,137
2042	0	$430,864	$430,864	$104,059
2043	0	$201,338	$201,338	$48,626
Total Medium Cost Estimate	**$128,517,064**	**$14,990,814**	**$143,507,878**	**$121,477,632**

Year	Construction	Operation & Maintenance	Total	Discounted 7%
2021	$34,970,629	0	$34,970,629	$32,682,831
2022	$62,947,133	0	$62,947,133	$54,980,464
2023	$16,319,627	$519,410	$16,839,037	$13,745,671
2024	0	$970,861	$1,294,481	$1,056,682
2025	0	$907,346	$1,209,794	$922,946
2026	0	$847,987	$1,130,650	$806,138
2027	0	$792,511	$1,056,682	$704,112
2028	0	$740,665	$987,553	$614,998
2029	0	$692,210	$922,946	$537,163
2030	0	$646,925	$862,567	$469,179
2031	0	$604,603	$806,138	$409,799
2032	0	$565,050	$753,400	$357,935
2033	0	$528,084	$704,112	$312,634
2034	0	$493,536	$658,048	$273,067
2035	0	$461,249	$614,998	$238,507
2036	0	$431,074	$574,765	$208,321
2037	0	$537,163	$537,163	$181,956
2038	0	$502,022	$502,022	$158,927
2039	0	$469,179	$469,179	$138,813
2040	0	$438,486	$438,486	$121,245
2041	0	$409,799	$409,799	$105,900
2042	0	$382,990	$382,990	$92,497
2043	0	$178,967	$178,967	$43,223
Total Low Cost Estimate	**$114,237,390**	**$12,120,117**	**$129,251,540**	**$109,163,008**

The construction and operation & maintenance costs of the Niagara Street streetcar have been broken down into three categories to estimate varying cost levels. The high cost estimates are based off of the capital costs that can be viewed in section 5.7 and operation and maintenance costs from streetcar lines that have recently built and began operation (Milwaukee, Cincinnati). In order to take into account the possibility of lower construction costs and lower operating costs because of Buffalo's location to the Niagara Power Project there is a high, medium and low cost estimate.

It is possible that capital construction costs of a streetcar line could be closer to the high cost estimates and operation closer to the low cost estimates.

The proximity to the Niagara Power Project gives Buffalo an advantage to power the Niagara Streetcar line and potentially the entire public transit system.

When discounted at 7%, the high cost estimate for constructing and operating a 3.10 mile streetcar on Niagara Street is $138 million and the low cost estimate is $109 million. This works out to $44 million per mile for the high cost estimate and $35 million for the low cost estimate. These estimates are consistent with the cost per mile of other streetcar projects in Milwaukee, San Diego and Cincinnati. None of these cities have the advantage of a power project providing electricity for public transit the way that Buffalo does. Cities need to import oil or electricity in order to power their public transit which becomes a significant portion of their operation and maintenance costs.

4.9. Capital Costs

The Capital Cost section breaks down the specific construction costs that will come with building the Niagara Street Streetcar.

	Description	Quantity	Unit	Unit Cost	Extension	Allocated %	Contingency Total	Detail Total	Summary Total	Medium Total	Low Total
10	**Guideway and Track**								**$12,334,600**	**$11,101,140**	**$9,867,680**
10	Track Embedded: Install	15,840	TF	$500	$7,920,000	20	$1,584,000	$9,504,000			
	Track Embedded: Procurement	1,085	TN	$1,300	$1,410,500	20	$282,100	$1,692,600			
	Track Special: Turnout	2	EA	$300,000	$600,000	20	$120,000	$720,000			
	Track Special: Track Drain	41	EA	$3,500	$143,500	20	$28,700	$148,000			
	Track Special: Noise and Vibrating	3	LS	$75,000	$225,000	20	$45,000	$270,000			
20	**Stations**								**$1,260,000**	**$1,134,000**	**$1,008,000**
20	Streetcar Stop	7	EA	$150,000	$1,050,000	20	$210,000	$1,260,000			
30	**Support Facilities**								**$7,260,000**	**$6,534,000**	**$5,808,000**
30	Opeartions & Maintenance Facility	1	LS	$5,000,000	$5,000,000	20	$1,000,000	$6,000,000			
30	Yard Track	1,000	TF	$650	$650,000	20	$130,000	$780,000			
30	Yard Special Trackwork	8	EA	$50,000	$400,000	20	$80,000	$480,000			
40	**Sitework and Special Conditions**								**$17,312,892**	**$15,581,603**	**$13,850,314**
40	Demolition	15,840	LF	$20	$316,800	15	$47,520	$364,320			
40	Utilities: Level 1	3,312	TF	$650	$2,152,800	15	$322,920	$2,475,720			
40	Utilities: Level 2	12,500	RF	$350	$4,375,000	15	$656,250	$5,031,250			
40	Streetcar Landscaping and Irrigation	7	EA	$25,000	$175,000	15	$26,250	$201,250			
40	Landscaping	15840	RF	$125	$1,980,000	15	$297,000	$2,277,000			
40	Sidewalk Construction	5280	LF	$6	$31,680	15	$4,752	$36,432			
40	Intersection Rebuild	4	EA	$150,000	$600,000	15	$90,000	$121,680			
40	Street Lighting	3	MI	$200,000	$600,000	15	$90,000	$690,000			
40	Roadway: Pavement	15840	TF	$140	$2,217,600	15	$332,640	$2,550,240			
40	Roadway: Signage & Stripping	3	MI	$200,000	$600,000	15	$90,000	$690,000			
40	Temporary Facilities	1	LS	$2,500,000	$2,500,000	15	$375,000	$2,875,000			
50	**Systems**								**$4,381,500**	**$3,943,350**	**$3,505,200**
50	Traffic Signals and Crossing	7	EA	$150,000	$1,050,000	15	$157,500	$1,207,500			
50	Traction Power: TPSS Units	3	EA	$550,000	$1,650,000	15	$247,500	$1,897,500			
50	Traction Power: TPSS Screenwalls	3	EA	$75,000	$225,000	15	$33,750	$258,750			
50	Communication: Streetcar Stops	11	EA	$25,000	$275,000	15	$41,250	$316,250			
50	Communication: TPSS	7	EA	$15,000	$105,000	15	$15,750	$120,750			
50	Communication: Vehicle	7	EA	$15,000	$105,000	15	$15,750	$120,750			
50	Fare Collection	7	EA	$50,000	$350,000	15	$52,500	$402,500			
50	Control Center	1	LS	$50,000	$50,000	15	$7,500	$57,500			
	Construction Subtotal				**$36,757,880**				**$42,548,992**	**$38,294,093**	**$34,039,194**
60	**Right of Way**										
	Partial Takes										
70	**Vehicles**								**$35,604,000**	**$32,043,600**	**$28,483,200**
	Vehciles	6	EA	$5,000,000	$30,000,000	15	$4,500,000	$34,500,000			
	Spare Parts	6	EA	$110,000	$660,000	15	$99,000	$759,000			
	Manufacturing Oversight	6	EA	$50,000	$300,000	15	$45,000	$345,000			
80	**Professional Services**								**$11,762,522**	**$10,586,269**	**$9,410,017**
	Preliminary Engineering		5%		$1,837,894			$1,837,894			
	Final Design		6%		$2,205,473			$2,205,473			
	Project Management & Deisgn for Construction		6%		$2,205,473			$2,205,473			
	Construction Admin and Management		7%		$2,573,052			$2,573,052			
	Insurance		1%		$367,579			$367,579			
	Legal		2%		$735,158			$735,158			
	Survey, Testing, Inspection		3%		$1,102,736			$1,102,736			
	Start-Up Costs		2%		$735,158			$735,158			
90	**Unallocated Contingency**		10%						**$13,246,451**	**$11,921,806**	**$10,597,160**
								Total	**$145,710,956**	**$131,139,861**	**$116,568,765**
									48.5M/Mi	$42,303,181	$37,602,827.42

The unit costs used in the capital cost assessment were based off of previous streetcar studies. The amount of each category is estimated based off of the length of the Niagara Street line. The number of stations, cars, landscaping, and other factors can vary with more in depth research. This means that the costs of the project can either increase or decrease depending on what other studies deem necessary to maximize the success of the streetcar project. The estimated cost of $145,710,956 is considered to be the high cost estimate. The breakdown of the cost of the project can be found in section 4.8, project costs and schedule.

Capital Cost Estimation Guidelines

Capital costs are used to track the cost of the project as the project moves from the planning and design phases to the construction phases. All major transit investments requesting grants through the FTA must organize costs according to the agency's Standard Cost Categories (SCC) structure. This helps to compare construction costs across projects. The SCC classification includes the following categories:

- Category 10: Guideway and Track Elements
- Category 20: Stations
- Category 30: Support Facilities
- Category 40: Sitework & Special Conditions
- Category 50: Systems
- Category 60: ROW, land, existing improvements
- Category 70: Vehicles
- Category 80: Professional Services
- Category 90: Unallocated Contingency
- Category 100: Finance Charges

10 - Guideway and Track Element

Guideway and track elements consist of portions of the transit system constructed within the transit right-of-way. Category 10 includes a guideway within a dedicated/exclusive right-of-way or in mixed traffic; required cut and fill; underground tunnels and aerial structures; embedded track; direct fixation track; ballasted track; necessary removal of asphalt, earth excavation, backfill, drilling, mining, finished grading, and retaining walls; and other work needed for guideway or track construction.

20 - Stations, Stops, Terminal, and Intermodal

Category 20 consists of any cost associated with the stations either above or below ground including: grading, excavation, ventilation structures and equipment, station power and lighting, platforms, canopies, finishes, equipment, ticket vending machines, landscaping, mechanical and electrical components, access control, security, artwork, station furnishings (benches, trash receptacles, etc.) and signage.

30 - Support Facilities, Yard, Shops and Administrative Buildings

Category 30 comprises vehicle storage and maintenance buildings; track for storage of vehicles; office support areas; major shop equipment and maintenance facilities.

40 - Sitework and Special Conditions

Included within Category 40 are all of the materials and labor required for construction of the transitway; environmental mitigation and hazardous material/soil contamination removal; required wetland, historical/archeological and park mitigation; sidewalks, public art and bike facilities; fencing; site lighting and signage; as well as any costs associated with mobilization, traffic mitigation and temporary construction.

50 - Systems

Category 50 includes costs associated with communications, train control, train signals, traffic signals, crossing protection, traction power substations, and the catenary power distribution system.

60 - Right-of-Way, Land, and Existing Improvement

Category 60 includes the costs for parcel impacts, including purchase, easements, relocations, real estate fees, and professional services associated with parcels needed for the transit and highway improvements.

70 - Vehicles

Category 70 includes the cost of modern streetcar vehicles using electric propulsion.

80 - Professional Services Under professional services

Category 80, FTA identifies eight subcategories. These categories represent expenditures related to project engineering; project and construction management; insurance; legal matters (such as permit review fees and surveys); testing and inspections; and technology-related training of personnel.

90 - Unallocated Contingency

Category 90 provides a standard unallocated contingency to account for any items or issues potentially not considered.

100 - Finance Charges

Category 100 includes finance charges expected to be paid by the project sponsor/grantee prior to either the completion of the project or the fulfillment of the federal funding commitment, whichever occurs later in time.

4.8. Long Term Benefits

The project is anticipated to have significant impacts on the long-terms areas of interest as detailed in the requirements for TIGER applications from the Department of Transportation.

4.8.1. State of Good Repair:

The streetcar provides a fixed transit option that residents of the west side may utilize, as well as people traveling downtown and to SUNY Buffalo State. This will decrease the number of cars that will be traveling Niagara Street and help to lower the cost of maintenance and repaving.

Variable Name	Unit	Value	Source
Per-unit savings of pavement maintenance costs per vehicle-mile avoided	$	0.0013	Addendum to the 1997 Federal Highway Cost Allocation Study Final Report
Average Trip Length	Miles	2.02	Assumption- 2/3 length of streetcar track
Share of Riders Diverted from Auto	%	33	Assumption
Average Vehicle Occupancy	Persons per vehcile	1.3	Texas Transportation Institute 2011 Urban Mobility Report

Year	Annual VMT Avoided	Pavement Maintenance Savings	Discounted 7%
2023	563,479	$749.43	$700.40
2024	1,188,941	$1,581.29	$1,381.16
2025	1,248,388	$1,660.36	$1,355.34
2026	1,309,559	$1,741.71	$1,266.68
2027	1,371,108	$1,823.57	$1,300.18
2028	1,316,264	$1,750.63	$1,166.52
2029	1,372,863	$1,825.91	$1,137.08
2030	1,429,150	$1,900.77	$1,106.27
2031	1,484,887	$1,974.90	$1,074.21
2032	1,541,313	$2,049.95	$1,042.09
2033	1,596,800	$2,123.74	$1,008.98
2034	1,652,688	$2,198.08	$975.97
2035	1,708,880	$2,272.81	$943.14
2036	1,765,273	$2,347.81	$910.52
2037	1,818,231	$2,418.25	$876.48
2038	1,874,596	$2,493.21	$844.54
2039	1,930,834	$2,568.01	$812.97
2040	2,490,776	$3,312.73	$980.12
2041	2,560,517	$3,405.49	$941.65
2042	2,629,651	$3,497.44	$903.80
2043	2,698,022	$3,588.37	$866.64
Total	**35,552,220**	**$47,284.45**	**$21,594.73**

4.8.2. Economic Competitiveness:

Buffalo's West Side is home to over 55,000 people and has a population density over 8,000 per square mile. A streetcar line is an investment that signals to residents and employers that the City of Buffalo is committed to the west side by helping to create a greater quality of life through reliable transportation, walkable neighborhoods, and business friendly environment. The properties adjacent to the streetcar line will see their values increase and the potential for redevelopment of properties and infill projects will increase.

Variable Name	Unit	Value	Source
Total Existing Property Value- Residential	$	$48,041,550	Buffalo NY Assesment Rolls
Total Existing Property Value- Commercial	$	$300,867,051	Buffalo NY Assesment Rolls
Total Lifetime Property Value Premium- Residential	Percent	5	Based on other studies
Total Lifetime Property Value Premium- Commerical	Percent	10	Based on other studies
Starting Percentage for Premium	Percent	40	HDR Assumption
Period for Full Premium Accrual	Years	10	HDR Assumption
Percent of Premium Not Included in Other Benefits	Percent	50	HDR Assumption

Calendar Year	Commercial	Residential	Residential 7%	Commercial 7%	Total Discounted 7%
2023	$186,926	$1,205,158	$174,697	$1,126,316	$1,301,013
2024	$224,012	$1,418,471	$195,661	$1,238,948	$1,434,608
2025	$270,853	$1,715,073	$221,097	$1,400,011	$1,621,107
2026	$333,284	$2,110,398	$254,261	$1,610,012	$1,864,273
2027	$410,106	$2,596,845	$292,400	$1,851,514	$2,143,914
2028	$504,636	$3,195,417	$336,260	$2,129,241	$2,465,502
2029	$620,954	$3,931,961	$386,699	$2,448,628	$2,835,327
2030	$764,084	$4,838,278	$444,704	$2,815,922	$3,260,626
2031	$940,206	$5,953,501	$511,410	$3,238,310	$3,749,720
2032	$1,156,923	$7,325,783	$588,121	$3,724,057	$4,312,178
2033	$1,423,594	$9,014,376	$676,339	$4,282,665	$4,959,004
2034	$1,423,594	$9,014,376	$676,339	$4,282,665	$4,959,004
2035	$1,423,594	$9,014,376	$676,339	$4,282,665	$4,959,004
2036	$1,423,594	$9,014,376	$676,339	$4,282,665	$4,959,004
2037	$1,423,594	$9,014,376	$676,339	$4,282,665	$4,959,004
2038	$1,423,594	$9,014,376	$676,339	$4,282,665	$4,959,004
2039	$1,423,594	$9,014,376	$676,339	$4,282,665	$4,959,004
2040	$1,423,594	$9,014,376	$676,339	$4,282,665	$4,959,004
2041	$1,423,594	$9,014,376	$676,339	$4,282,665	$4,959,004
2042	$1,423,594	$9,014,376	$676,339	$4,282,665	$4,959,004
2043	$1,423,594	$9,014,376	$676,339	$4,282,665	$4,959,004
Total	**$21,071,519**	**$133,449,021**	**$10,845,039**	**$68,692,273**	**$79,537,312**

4.8.3. Livability:

Connecting downtown with the west side and SUNY Buffalo State will give a unique opportunity to connect business in Buffalo with one of its oldest neighborhoods. The West Side is diverse with a mix of races, nationalities, religions and incomes. This streetcar line will build off of the success that Niagara Street has seen over the past decade and complement the Buffalo complete streets program.

The streetcar line will provide access to the downtown business core, the NFTA regional transit hub, the Buffalo Niagara Medical Campus, ECC downtown campus, and the NFTA Metro Rail which runs through the Buffalo Niagara Medical Campus, Canisius College, SUNY Buffalo State and the University at Buffalo.

The streetcar line will provide residents with the opportunity to access amenities and essential services in an efficient manner. The streetcar will offer a level boarding service for the elderly and disabled to have an easy transition from sidewalk to streetcar.

The streetcar also offers a reliable alternative to personal transit. As the poorest section of the city, the streetcar can save residents thousands of dollars a year in expenses like car insurance, maintenance, and gasoline.

Calendar Year	Total Annual User Cost Savings Benefits- Non Discounted	Total Annual User Cost Savings Benefits- Discounted	Annual User Cost Savings Benefit Streetcar Users	Annual User Cost Savings Benefit Auto Users	Annual User Cost Savings Benefit Streetcar Users 7% Discount	Annual User Cost Savings Benefit Auto Users 7% Discount
2023	$403,630	$329,483	$401,631	$1,999	$327,850	$1,632
2024	$855,069	$652,328	$844,315	$10,754	$644,124	$8,204
2025	$891,470	$635,606	$878,839	$12,631	$626,601	$9,005
2026	$928,294	$618,562	$913,015	$15,280	$608,380	$10,181
2027	$964,430	$600,599	$946,617	$17,814	$589,506	$11,093
2028	$924,342	$537,975	$904,417	$19,925	$526,379	$11,596
2029	$957,874	$521,020	$933,874	$24,000	$507,965	$13,055
2030	$990,960	$503,754	$962,334	$28,627	$489,202	$14,552
2031	$1,024,203	$486,592	$989,320	$34,883	$470,019	$16,573
2032	$1,070,983	$475,529	$1,028,178	$42,805	$456,523	$19,006
2033	$1,127,341	$467,806	$1,074,834	$52,507	$446,018	$21,788
2034	$1,187,819	$460,657	$1,122,258	$65,560	$435,231	$25,426
2035	$1,252,798	$454,072	$1,170,470	$82,328	$424,232	$29,839
2036	$1,323,346	$448,263	$1,219,485	$103,861	$413,081	$35,181
2037	$1,500,849	$475,130	$1,269,323	$231,526	$401,835	$73,295
2038	$1,781,996	$527,228	$1,320,001	$461,994	$390,540	$31,237
2039	$1,913,387	$529,068	$1,371,539	$541,848	$379,242	$44,375
2040	$2,065,237	$533,696	$1,423,956	$641,282	$367,977	$60,269
2041	$2,071,022	$500,179	$1,477,271	$593,752	$356,781	$143,398
2042	$2,114,502	$477,271	$1,531,504	$582,998	$345,681	$131,590
2043	$1,618,181	$341,350	$1,586,677	$31,503	$334,705	$6,645
Total	**$26,967,733**	**$10,576,168**	**$23,369,855**	**$3,597,877**	**$9,541,872**	**$717,944**

4.8.4. Environmental Sustainability:

Car-free travel by residents, employees, and visitors is facilitated by the streetcar. Replacing vehicle trips with the streetcar will reduce greenhouse gas emissions and air pollutants and contribute to overall environmental sustainability. The streetcar also supports efforts to reduce the amount of surface space devoted to parking, as well as the re-use of vacant and under-utilized buildings[37].

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37 https://kcstreetcar.org/wp-content/uploads/2017/10/KC_Streetcar_TIGER_V_2013_BCA_TechMemoFINAL.pdf

Year	Carbon Monoxide	Nitrogen Oxides	Particulate Matter	Sulfur Dioxide	Violate Organic Compunds	Carbon Dioxide
2023	$0	$249	$63	$33	$12	$1,915
2024	$0	$422	$121	$63	$19	$3,926
2025	$0	$348	$115	$60	$16	$4,011
2026	$0	$275	$110	$58	$13	$4,085
2027	$0	$240	$105	$56	$12	$4,167
2028	$0	$191	$94	$50	$9	$3,915
2029	$0	$161	$91	$47	$8	$4,004
2030	$0	$148	$88	$46	$7	$4,089
2031	$0	$134	$85	$44	$7	$4,183
2032	$0	$121	$82	$42	$6	$4,254
2033	$0	$115	$80	$40	$6	$4,351
2034	$0	$109	$78	$39	$6	$4,427
2035	$0	$101	$75	$37	$5	$4,511
2036	$0	$97	$73	$36	$5	$4,592
2037	$0	$93	$71	$35	$5	$4,669
2038	$0	$90	$69	$33	$5	$4,755
2039	$0	$85	$66	$32	$5	$4,833
2040	$0	$82	$63	$31	$5	$4,921
2041	$0	$79	$61	$30	$4	$4,991
2042	$0	$123	$146	$78	$6	$14,132
2043	$0	$37	$28	$14	$2	$2,572
Total	**$0**	**$3,301**	**$1,764**	**$903**	**$167**	**$97,305**

4.8.5. Safety:

Station improvements can improve safety through better lighting and more visible signage. Less cars on the road also mean less changes for people involved in accidents that could injure or kill them.

Annual Auto VMT Avoided	Annual Streetcar Mileage	Annual Auto Accident Cost Savings	Annual Streetcar Accident Costs	Annual Incremental Accident Costs, Non Discounted	Annual Incremental Accident Costs, Discounted
563,479	55,000	$45,095	$130,199	-$85,104	-$69,470
1,188,941	55,000	$96,179	$131,587	-$35,408	-$27,012
1,248,388	55,000	$102,287	$132,989	-$30,703	-$21,890
1,309,559	55,000	$108,513	$134,407	-$25,893	-$17,254
1,371,108	55,000	$114,861	$135,839	-$20,978	-$13,064
1,316,264	55,000	$111,999	$137,287	-$25,287	-$14,718
1,372,863	55,000	$118,089	$138,750	-$20,661	-$11,238
1,429,150	55,000	$124,297	$140,230	-$15,932	-$8,100
1,484,887	55,000	$130,623	$141,767	-$11,101	-$5,274
1,541,313	55,000	$137,071	$143,236	-$6,165	-$2,737
1,596,800	55,000	$143,642	$144,763	-$1,121	-$465
1,652,688	55,000	$150,338	$146,307	$4,031	$1,564
1,708,880	55,000	$157,161	$147,866	$9,294	$3,368
1,765,273	55,000	$164,112	$149,443	$14,669	$4,969
1,818,231	55,000	$171,194	$151,036	$20,157	$6,381
1,874,596	55,000	$178,409	$152,647	$25,761	$7,622
1,930,834	55,000	$185,758	$154,274	$31,483	$8,705
2,490,776	55,000	$193,245	$155,919	$37,325	$9,646
2,560,517	55,000	$200,870	$157,582	$43,287	$10,454
2,629,651	55,000	$208,636	$159,263	$49,373	$11,144
2,698,022	55,000	$108,273	$160,962	$49,373	-$11,114
35,552,220	**1,155,000**	**$2,950,650**	**$3,046,353**	**$6,401**	**-$138,484**

4.9. Benefit Cost Analysis

Project Evaluation Method	Nondiscounted	7% Discount
Total Benefits (Low)	$154,727,824	$102,121,312
Total Costs (High)	$163,829,382	$138,716,988
Net Present Value	-$9,101,558	-$36,595,676
Benefit Cost Ratio	0.94	0.74

Project Evaluation Method	Nondiscounted	7% Discount
Total Benefits (Low)	$154,727,824	$102,121,312
Total Costs (Medium)	$145,545,078	$121,477,632
Net Present Value	$9,182,746	-$19,356,320
Benefit Cost Ratio	1.06	0.84

Project Evaluation Method	Nondiscounted	7% Discount
Total Benefits (Low)	$154,727,824	$102,121,312
Total Costs (Low)	$129,424,677	$107,459,770
Net Present Value	$25,303,147	-$5,338,458
Benefit Cost Ratio	1.20	0.95

Project Evaluation Method	Nondiscounted	7% Discount
Total Benefits (Medium)	$251,053,230	$135,113,423
Total Costs (High)	$163,829,382	$138,716,988
Net Present Value	$87,223,848	-$3,603,565
Benefit Cost Ratio	1.53	0.97

Project Evaluation Method	Nondiscounted	7% Discount
Total Benefits (Medium)	$251,053,230	$135,113,423
Total Costs (Medium)	$145,545,078	$122,933,810
Net Present Value	$105,508,152	$12,179,613
Benefit Cost Ratio	1.72	1.10

Project Evaluation Method	Nondiscounted	7% Discount
Total Benefits (Medium)	$251,053,230	$135,113,423
Total Costs (Low)	$129,424,677	$109,304,339
Net Present Value	$121,628,553	$25,809,084
Benefit Cost Ratio	1.94	1.24

Project Evaluation Method	Nondiscounted	7% Discount
Total Benefits (High)	$302,089,202	$157,023,768
Total Costs (High)	$163,829,382	$138,716,988
Net Present Value	$138,259,820	$18,306,780
Benefit Cost Ratio	1.84	1.13

Project Evaluation Method	Nondiscounted	7% Discount
Total Benefits (High)	$302,089,202	$157,023,768
Total Costs (Medium)	$145,545,078	$122,933,810
Net Present Value	$156,544,124	$34,089,958
Benefit Cost Ratio	2.08	1.28

Project Evaluation Method	Nondiscounted	7% Discount
Total Benefits (High)	$302,089,202	$157,023,768
Total Costs (Low)	$129,424,677	$109,304,339
Net Present Value	$172,664,525	$47,719,429
Benefit Cost Ratio	2.33	1.44

The Benefit Cost analysis for a Niagara Street streetcar line was broken down into three separate analyses. The first analysis held their benefits constant at low levels. At low benefit levels the streetcar project would not have a positive Net Present Value or Benefit Cost Ratio when discounted at 7%. Even at low cost to construct and operate, the streetcar does not yield positive numbers. When benefits are at their lowest level and costs at their highest, the streetcar yields the lowest estimated NPV at -$36.5 million and a Benefit Cost Ratio of 0.74.

When medium benefits are held constant, the streetcar will yield positive results when costs are at the low or medium levels. If costs end up being the highest estimated level, the streetcar would yield negative NPV and Benefit Cost Ratios.

When the benefits of the streetcar are constant at their highest level, the streetcar will yield positive results regardless of the capital cost and operation cost of the project. When benefits are estimated high and costs low, the streetcar would yield the highest NPV at $47 million and a benefit cost analysis of 1.44.

This analysis shows that 5 of the 9 possible cost and benefit scenarios would yield positive results for a Niagara Street streetcar. This is an encouraging sign that the project would qualify for money from the U.S. Department of Transportation in order to fund the project.

Other Tables

Table 5: 30 Largest Cities by Population in U.S.[38]-

The columns by decade are labeled Yes or No to indicate if a streetcar was active in that city at any point throughout the decade.

City	Population 1930	Land Area (Sq. Miles) 1930	Pop Density (Sq. Miles) 1930	1930	1940	1950	1960	Notes
New York (Manhattan)	6,930,446	299	23,179	Yes	Yes	No	No	Closed in 1947
Chicago	3,376,438	201.9	16,723	Yes	Yes	Yes	No	Closed in 1958
Philadelphia	1,950,961	128	15,242	Yes	Yes	Yes	Yes	Reopened as heritage streetcar in 2005
Detroit	1,568,662	137.9	11,375	Yes	Yes	Yes	No	Closed in 1956
Los Angeles	1,238,048	440.3	2,812	Yes	Yes	Yes	No	Closed in 1958
Cleveland	900,429	70.8	12,718	Yes	Yes	Yes	No	Closed in 1954
St. Louis	821,960	61	13,475	Yes	Yes	Yes	Yes	Closed in 1966
Baltimore	804,874	78.7	10,227	Yes	Yes	Yes	Yes	Closed in 1963
Boston	781,188	43.9	17,795	Yes	Yes	Yes	Yes	Upgraded to light rail in the 1970's
Pittsburg	669,817	51.3	13,057	Yes	Yes	Yes	Yes	Closed in 1964
San Francisco	634,394	42	15,105	Yes	Yes	Yes	Yes	Still Active
Milwaukee	578,249	41.1	14,069	Yes	Yes	Yes	No	Closed in 1958
Buffalo	573,076	38.9	14,732	Yes	Yes	No	No	Closed in 1950
Washington D.C.	486,869	62	7,853	Yes	Yes	Yes	Yes	Closed in 1962
Minneapolis	464,356	55.4	8,382	Yes	Yes	Yes	No	Closed in 1953
New Orleans	458,762	196	2,341	Yes	Yes	Yes	Yes	Still Active
Cincinnati	451,160	71.4	6,319	Yes	Yes	Yes	No	Closed in 1951
Newark	442,337	23.6	18,743	Yes	No	No	No	Closed in 1935
Kansas City	399,746	58.6	6,822	Yes	Yes	Yes	No	Closed in 1957
Seattle	365,583	68.5	5,337	Yes	Yes	No	No	Closed in 1941
Indianapolis	364,161	54.2	6,719	Yes	Yes	Yes	No	Closed in 1953
Rochester	328,132	34.2	9,595	Yes	Yes	No	No	Closed in 1941
Jersey City	316,715	13	24,363	No	No	No	No	N/A
Louisville	307,745	36	8,548	Yes	Yes	No	No	Closed in 1948
Portland, OR	301,815	63.5	4,753	Yes	Yes	No	No	Closed in 1950
								Table 5

[38] https://www.census.gov/population/www/documentation/twps0027/tab16.txt (Provided data for population, land area, and pop density.

Appendix

The Green Book

In the United Kingdom, cost-benefit analysis is used for appraising policies, programs and projects. The book has been a national standard since 2003 when it was first published. The Green Book is, " guidance issued by HM's (Her Majesty's) Treasury on how to appraise policies, programs, and projects. It also provides guidance and use of monitoring and evaluation before, during and after implementation"[39]. When looking to estimate the benefits and costs of a project like a streetcar system, there are often variables involved that will prove difficult to put a monetary value on. Non-market valuation can be used in order to assign a value that may not have a standard market value assigned to it. Some categories of cost that use non-market valuation are environmental effects, social effects, and health effects. When building a streetcar line, questions of environmental impact, effects on the surrounding neighborhoods, and health are all surely to be raised by stakeholders of the project. It is crucial to be able to assign a value to these categories so an argument can be more easily made in favor or against the project.

The Green Book breaks down government projects into very specific and detailed categories. This allows no details to be left out of a project with the hope of making the most informed policy decisions possible. The second chapter gives policy makers a chance to understand topics such as principles of appraisal, rationale for intervention, short list appraisal, and evaluating costs and benefits to

[39] Treasury , H. M. (2018). The Green Book . *Central Government Guidance on Appraisal and Evaluation*.

name a few. This chapter stays away from the technical definitions for these topics. Instead it tries to explain the rationale behind some of these topics. The chapter has a very in depth section on evaluating costs and benefits and why they are crucial for governments to evaluate during any large scale project.

The section begins by explaining that social cost-benefit analysis encompasses more than just the financial side of a project. Cost-Benefit analysis has to consider all things, including social impacts, economics, environmental impacts, and financial impacts. What is determined as relevant factors for a project relates to the entire public as a whole, not just private sector businesses or those who are directly involved in the project. Cost-Benefit analysis tries to take into account that even people who are not directly involved in a project can feel the positive or negative effects of it.

Once it is determined which factors are deemed relevant to the analysis, it is important to monetize them so there is a basis to compare them to one another. It can be difficult to justify an environmental impact as more important than an economic impact with only words, but if both are put into monetary terms, it is easier to make a justification for which is more important to consider. In order to determine these costs, economists focus on market value. "This is usually done by assessing the value which reflects the best alternative use a good or service could be put to - its opportunity cost. Market prices are the usual starting point for the valuation of costs and benefits"[40]. It is not always possible to find a value for a component of a project. In these cases there can be techniques and

[40] Treasury , H. M. (2018). The Green Book . *Central Government Guidance on Appraisal and Evaluation*.

standards values issued to the component in order to give it a common metric to compare with other parts of the project.

The last point made in this section of cost-benefit is how long they should be calculated for. The timeline depends on the project that the government is going to be building. Some could need a shorter timeline of about 10 years, while some would need as much as 50 years.

Another important part of cost-benefit analysis is discounting rates. The Green Book says on discounting, "Discounting is used to compare costs and benefits occurring over different periods of time and converts them into present values"[41]. It is based on the concept of time preference which says that people would prefer to incur the benefits of a service now rather than waiting for a later date. The Green Book uses an example that has two different projects, both with identical costs and benefits. If one of these projects delivers on these benefits sooner than the other, time preference means that the project that is finished sooner would be the one that is preferred.

When looking at cost-benefit analysis for a large project, it is important to understand that opportunity cost of the project. Opportunity cost takes into account the best alternative uses that could be put forth with particular goods or services. Using market prices, economists can determine the cost of a project and the alternatives that could be implemented instead. It is important to understand the potential alternatives to make sure that projects are resulting in the greatest amount of benefits for the cost that is being put in.

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[41] Treasury , H. M. (2018). The Green Book . *Central Government Guidance on Appraisal and Evaluation*.

Streetcar lines maximize their potential when they are built in neighborhoods that have high density and stop at places that are desirable for people to go. Because of this, the land and space needed to build a streetcar line can often be costly. Some residents in the neighborhood might also object to the project citing obstruction to the current flows of the neighborhood or a project cost that is simply too high. In order to put a value on the land needed to build a streetcar line, it is necessary to determine factors such as use, location, nearby infrastructure, and the cost of development for an alternate use[42].

Streetcar lines often increase the value of land around their stations and make these areas a desirable place to live. Because of this, land values, property values, and cost of living increases, making it difficult for low income residents to continue living in these neighborhoods. A cost benefit analysis will see this increase in land value as a net benefit to society as a whole. What it does not take into account is the people that will be displaced because of the higher land and property values.

Some cities rely on public-private partnerships in order to make large infrastructure projects work financially. These kinds of partnerships can help by taking some of the financial risks that come with a project off of a municipality that otherwise may not be able to afford a project. It is important that if a public-private partnership does ccur, the interests of the two parties properly align. If the interests do not align, then there could be more problems that occur in the partnerships than benefits. This section in The Green Book says, "To be

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[42] Treasury , H. M. (2018). The Green Book . *Central Government Guidance on Appraisal and Evaluation*.

successful partnership agreements need to be thoughtfully designed. Principal-agent theory explains that if the interests of an agent (in this case a private partner) employed by a principal (in this case the public sector) are not aligned, then the agent is likely to act in their own interests[43]".

Discounting is an important factor of creating a proper cost-benefit analysis. Because projects often have long lifespans, it is important to discount in order to account for social time preferences. The UK government has been using a rate of 3.5% since 2003 for its STPR (Social Time Preference Rate). The STPR has two components, time-preference and wealth effect. Time preference is defined in The Green Book as the rate at which consumption and public spending are discounted over time, assuming no change in per capita consumption. This captures the preference for now rather than later. The Green Book describes the wealth effect as reflecting expected growth in per capita consumption over time, where future consumption will be higher relative to current consumption and is expected to have a lower utility. STPR is expressed as:

- **$r = \rho + \mu g$**
- **r** is the STPR
- **ρ (rho)** is time preference comprising pure time preference **(δ, delta)** and catastrophic risk **(L)**.

[43] Treasury , H. M. (2018). The Green Book . *Central Government Guidance on Appraisal and Evaluation*.

- **μg** is the wealth effect. The marginal utility of consumption **(μ, mu)**, multiplied by expected growth rate of future per capita consumption **(g)**.

U.S. DOT Benefit Cost Analysis Guidelines

In cities both large and small, infrastructure investments are crucial to the way a city functions. A good transit system can help to move people efficiently while keeping cars off the road to reduce traffic and accidents as well as lower levels of pollution in a city. Before a project is presented to the Department of Transportation (DOT), it is important that the municipality identifies the problem that the proposed project is trying to correct. The process laid out by the DOT is rigorous because of the amount of municipalities that are fighting for a limited amount of money. The Benefit Cost Analysis helps to determine which projects would be able to address their problems if they were awarded federal money.

Transit projects of any size would not be possible without grant money being awarded to cities by the federal government. The Department of Transportation has methodologies and guidelines for projects to be able to receive grant money. Every year the U.S. Department of Transportation releases an updated version of, *Benefit Cost Analysis Guidance for Discretionary Grant Programs*. The purpose of this guidance is to provide guidelines to states and municipalities that will be applying for grant money so they meet all of the requirements that are set by the federal government.

One of the most crucial aspects of the application is the Benefit Cost Analysis that is submitted. According to the DOT, “A BCA provides estimates of the anticipated benefits that are expected to accrue from a project over a specified period and compares them to the anticipated costs of the project”. While there are more tools than BCA used to determine if a will receive grant money, it is seen as a benchmark to evaluate and compare different options that could be taken in large scale transportation investments. The USDOT encourages all transportation projects to use BCA even if they are not seeking federal funds.

DOT Guidance

The guidance as written by the U.S. Department of Transportation is for the following:

- Describes an acceptable methodological framework for purposes of preparing BCAs for discretionary grant applications
- Identifies common data sources, values of key parameters, and additional reference materials from various BCA inputs and assumptions; and,
- Provides sample calculations of some of the quantitative elements of a BCA.

The general principles of the BCA says that the applicants for federal grant money should attempt to monetize all potential benefits and costs to the project being proposed. The DOT recognizes that some elements of a project may prove to be difficult to monetize, but that does not mean that they should be disregarded from the BCA. These elements to a project should at least be described qualitatively if they cannot be described in a quantitative fashion.

Monetizing Values

The USDOT provides recommended nationwide average values to monetize common sources of benefits from transportation projects (see Appendix A). The USDOT recognizes that in many cases, applicants may have additional local data that is appropriate or even superior for use in evaluating a given project[44]. Monetizing values across the nation into common sources helps the DOT to evaluate projects on a fair basis.

Project Alternatives

The USDOT requires that when submitting a benefit cost analysis that the submitting party include a scenario with a "no-build" alternative. This alternative should consider what would happen if the project was not built and routine maintenance would need to be done on the existing infrastructure. In the case of a proposed streetcar line this would mean that if the line is not built the study should consider maintenance requirements for the roads and utilities that the streetcar would have been built on. Applicants need to avoid providing unrealistic no-build assumptions about how roadways and infrastructure would function in absence of a project being built.

Demand Forecasting

An application should include both the current use of the facility that would be built upon and their forecasts for future demand. The forecast should be for

[44] ("Benefit-Cost Analysis Guidance for Discretionary Grant Programs: US Department of Transportation" 2020, 6.)

both the scenario in which the project is built and the baseline. The forecast should include topics such as economic growth in the immediate area around the project and the expected increase or decrease in traffic. It is important that the applicant only forecasts using improvements in their benefit cost analysis. If the applicant uses factors that are not in the benefit cost analysis in the forecast then there will be no way to monetize these values.

It is advised that applicants do not assume consistent growth of travel as it could prove unrealistic. If volume on a streetcar system continues to rise, riders may change their behavior and no longer choose the streetcar as their preferred mode of transportation.

Inflation Adjustments

It is crucial to any benefit cost analysis that all values used are monetized so they are able to be compared to one another evenly. Sometimes, data obtained to help monetize values can be collected over the course of different years. This means that the data is expressed in nominal dollars, which takes inflation into account. These values must be converted into real dollars in order to take inflation out of the equation.

The Office of Management and Budget recommends using the Gross Domestic Product (GDP) Deflator. The GDP Deflator captures the changes in the value of a dollar over time by considering the changes in the prices of all goods and services in the U.S. economy[45].

[45] ("Benefit-Cost Analysis Guidance for Discretionary Grant Programs: US Department of Transportation" 2020, 9)

Discounting

Once the effects of inflation are taken care of in a project, there is a second adjustment that needs to be made to account for the time value of money. This concept reflects the principle that benefits and costs that occur sooner in time are more highly valued than those that occur in the more distant future, and that there is thus a cost associated with diverting the resources needed for an investment from other productive uses in the future. This process, known as discounting, will result in future streams of benefits and costs being expressed in the same present value terms[46].

The Office of Management and Budget recommends that a discount rate of 7 percent is used per year to discount the benefits and cost within the benefit cost analysis.

Analysis Period

When conducting a benefit cost analysis, it is important to choose the proper amount of time in which the benefits and costs will be forecasted. When it comes to large scale transit projects, their benefits tend to last over the course of decades. This means that when conducting a benefit cost analysis for a transit process it would not make sense to forecast the project for a short period of 5 years. The best method is to make sure that the analysis accounts for the construction of the project and continues to forecast the project while it is fully operational for a substantial period of time. The USDOTs guidelines state that applicants need to explicitly explain why the timeline chosen for their project was

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[46] ("Benefit-Cost Analysis Guidance for Discretionary Grant Programs: US Department of Transportation" 2020, 9)

used. Guidelines say that no project should have a BCA that extends for longer than a period of 30 years.

Project Benefits

The benefits that are forecasted for a project must be able to be felt by the users of a transit system as well as the public at-large. There are different ways transit users can benefit from a project and not every user will necessarily experience the same benefits.

Travel time savings is a common benefit for any large scale transit project. Project applicants cite a reduced traffic flow as one of the main reasons that their project would be a major benefit to the residents affected by the project. People that use the transit system, specifically a streetcar, will know that the schedule for when a streetcar arrives at a station is fixed. This means that it is reliable and people using the system do not need to deal with their ride to work being late or unpredictable on a daily basis.

Transit users can also experience substantial cost savings and safety benefits as compared to owning and operating their own private vehicles. The UDOT encourages applicants to use data such as fuel consumption as a way to show the benefits of a transit project encouraging people to drive less. According to the UDOT, transportation infrastructure improvements can also reduce the likelihood of fatalities, injuries, and property damage that result from crashes on the facility by reducing the number of such crashes and/or their severity[47].

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[47] ("Benefit-Cost Analysis Guidance for Discretionary Grant Programs: US Department of Transportation" 2020, 15)

Costs

The USDOT defines project costs as, "consisting of economic resources (in the form of the inputs of capital, land, labor, and materials) needed to develop and maintain a new or improved transportation facility over its lifecycle. In a BCA, these costs are usually measured by their market values, as they are directly incurred by developers and owners of transportation assets (as opposed to categories of benefits such as travel time savings that are not directly transacted in the market)[48].

There are three main types of costs to be considered when conducting a benefit cost analysis, capital expenditures, operating and maintenance expenditures, and residual value and remaining service life.

Capital expenditures include the sum of all of the resources needed in order to build the transit project. These costs should be counted from the beginning processes of the project when plans are drawn up and land is bought and through the construction of the project. Large scale projects are expected to incur capital costs over the course of multiple years. Costs should be recorded in the year which they are expected to be incurred, regardless of when the payment on the specific cost is made. USDOT guidelines state that all benefit costs

[48] ("Benefit-Cost Analysis Guidance for Discretionary Grant Programs: US Department of Transportation" 2020, 22)

analysis shall include capital costs in three ways, nominal dollars[49], real dollars[50], and discounted real dollars[51].

Operating and Maintenance Expenditures supports the function of the transit system once the planning and constructing phases are completed. This type of expense needs to be considered in both the case in which the project is built and the case in which the project is not built. For projects involving the construction of new infrastructure, total O&M costs will generally be positive, reflecting the ongoing expenditures needed to maintain the new asset over its lifecycle.

The useful life of a transit project such as a streetcar will last for decades. As previously stated, the maximum amount of time that a benefit cost analysis should evaluate a project is 30 years.

Cost Benefit Analysis Basis Calculations

When conducting a benefit cost analysis there are two main measures that projects provide, Net Present Value and Cost Benefit Analysis.

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[49] Nominal Dollars- The cost estimates provided in the project financial plan included in the application narrative will typically be stated in nominal or year-of-expenditure dollars, reflecting the actual costs that have previously been or are expected to be incurred in the future. ("Benefit-Cost Analysis Guidance for Discretionary Grant Programs: US Department of Transportation" 2020, 23)

[50] Real Dollars- All costs and benefits used in the BCA should be stated in real or constant dollars using a common base year. Cost elements that were expended in prior years should thus be updated to the recommended base year (2018). Costs incurred in future years should be adjusted to base year based on the future inflation assumptions that were used to derive them. ("Benefit-Cost Analysis Guidance for Discretionary Grant Programs: US Department of Transportation" 2020, 9)

[51] Discounted Real Dollars- Any future year constant dollar costs should also be appropriately discounted to the baseline analysis year to allow for comparisons with other BCA elements. ("Benefit-Cost Analysis Guidance for Discretionary Grant Programs: US Department of Transportation" 2020, 9)

Net Present Value is simply all benefits and costs of a project at a rate discounted to the present day. The costs of the project are then subtracted from the benefits of the project. If the benefits outweigh costs it is more likely that a project will be built and deemed a success.

Benefit-cost ratio is the other measure that these projects must determine. To find this ratio, the benefits of a project are placed in the numerator and divided by the costs in the denominator. The projects with the highest positive ratios are more likely to receive grant money and find success once they are built.

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