WATERFRONT SEATTLE

LOCAL WATERFRONT TRANSIT

JUNE 2013

DRAFT

Intentionally left blank

WATERFRONT SEATTLE

LOCAL WATERFRONT TRANSIT

JUNE 2013

DRAFT

Prepared for:
Central Waterfront Committee,
The Seattle Department of Transportation,
Department of Planning and Development,
and Department of Parks and Recreation

Prepared by:
Parametrix

ACKNOWLEDGMENTS

Parametrix acknowledges and thanks the following individuals for providing information and data used in the report.

King County Metro
Doug Hodson
Rand Juliano
Don Okazaki

Seattle Department of Transportation
Bill Bryant
Ethan Melone
Steve Pearce

Link Transit
Todd Daniel

James Corner Field Operations
Tatiana Choulika
Andrew Ten Brink

CH2M Hill
Andrew Barash

LTK Engineering Services
Chris Glasen
Michael Hall
John Schumann

waterfront Seattle

CONTENTS

1.0 EXECUTIVE SUMMARY

A key part of the Waterfront Seattle project access and mobility objective is the addition of a waterfront transit service. The purpose of this service is to connect a variety of community destinations along the nearly 2-mile long waterfront that could not be reached on foot alone. Riders of this service would be primarily recreational visitors and local waterfront employees and residents. The transit service would be frequent, easy to use and would extend from the Olympic Sculpture Park to Pioneer Square to allow for efficient movement along the waterfront.

The waterfront transit service would interact with improved east-west pedestrian connections to the waterfront. Other transit improvements serving the waterfront include the Madison Street rapid trolley bus route connecting Colman Dock to First Hill and beyond, the new First Hill streetcar line which will terminate near 1st Avenue and Jackson Street, and a possible City Center Streetcar line on 1st Avenue.

Colman Dock is also an important connection along the waterfront. Washington State Ferries plans to replace much of the dock structure and the passenger terminal building between 2015 and 2020. Both the larger vehicle ferries and passenger-only ferries will continue to arrive and depart from Colman Dock. Safe, pleasant and convenient pedestrian access from Colman Dock to nearby transit service on Alaskan Way, 1st Avenue and Madison, Marion and Columbia Streets will be provided through new sidewalks, crosswalks and a wider Marion Street pedestrian bridge.

This study evaluates and compares historic streetcars, modern streetcars, and rubber tire transit for operating characteristics, effects on the environment, and cost. These transit options will focus on moving people along the waterfront; characteristics include high frequency operations, ease of passenger boarding, and connections to other major transit modes.

HISTORIC STREETCAR

The historic streetcar alternative would reinstate the George Benson trolleys, which previously operated along the Seattle waterfront. There are two options being considered for this alternative:

- Option A is a lower level of investment including minor modifications such as doors on both sides of the vehicle and a modern PA system. There would be no change to the high-floor stations and passenger loading. The waterfront streetcar would not be integrated with the rest of the streetcar system. A streetcar maintenance facility would be located on the waterfront in this option
- Option B includes the elements in option A and adds elective upgrades such as automated door operation, conversion to operate on similar power service as the modern streetcar, and wheelchair lifts so station platforms can be at street level (instead of the high platforms with option A). The step up entry would be reinstated for this option. The streetcar maintenance facility could be located on the waterfront or in other locations where access is provided by the streetcar system.

Historic Seattle 'George Benson' Streetcar

1.0 EXECUTIVE SUMMARY

HISTORIC STREETCAR OPTION COMPARISON

	Historic Streetcar Option A	Historic Streetcar Option B
Operates in the inside lane in both directions on new Alaskan Way (two lanes in either direction north of Columbia Street)	X	X
Operates independently from modern streetcar system	X	
Can be integrated with modern streetcar system (except portions of First Hill route that are not electrified)		X
Retrofitted to operate on the same 750 volt power supply as modern streetcars		X
Doors added to both sides of streetcars	X	X
Automatic doors/one operator per vehicle		X
Manual doors/two operators on each vehicle	X	
Low floor loading from sidewalk grade		X
High floor loading from high platforms with ADA ramp access	X	
Wheelchair lifts and restored steps on vehicles		X
Loading from center median platforms	X	X
Maintenance facility on waterfront on private property or under Elliott Way	X	
Maintenance facility may either be on the waterfront or elsewhere adjacent to modern streetcar tracks		X

MODERN STREETCAR

The modern streetcar alternative examines constructing a streetcar alignment along the waterfront that is similar to the existing South Lake Union Streetcar and proposed First Hill Streetcar services. Only one option was considered for this alternative.

Modern South Lake Union Streetcar in Seattle

RUBBER TIRE TRANSIT

The rubber tire transit alternative evaluates implementing a mini-bus style service (option A) similar to Quebec City's Ecolobus service and a larger bus coach similar to King County Metro's 40-foot buses (option B). The rubber tire vehicles analyzed in this report serve as examples of possible vehicle types and would potentially not be the exact vehicles selected for rubber tire transit.

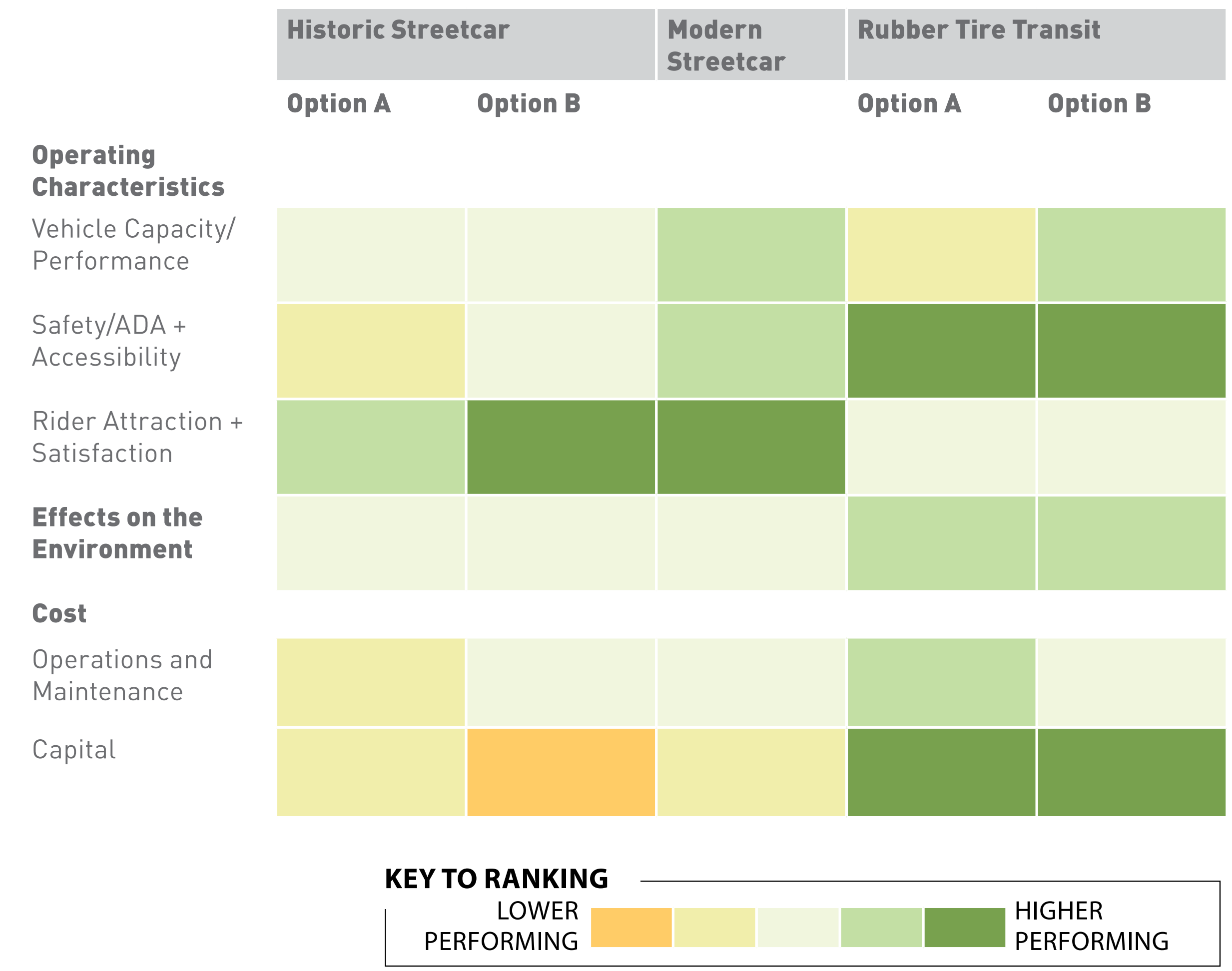
- The option A vehicle would be a smaller mini-bus style vehicle with large side windows and exterior row seating. It would provide low floor boarding similar to the Tecnobus Gulliver bus operating in Quebec City. This vehicle would be powered by a battery electric system with zero emissions.
- Option B would be a coach style bus with front and back door loading and unloading, similar to coaches operated by King County Metro. This vehicle could use diesel-hybrid or electric propulsion. The Proterra bus assumed for the evaluation is a battery-powered electric bus with a rapid charge system at a terminus station.

Tecnobus Gulliver mini-bus

Proterra Electric Bus

SUMMARY RESULTS

The following table summarizes the results of a waterfront transit's operating characteristics, environmental impacts, and costs.



Intentionally left blank

SUMMARY RESULTS

OPERATING CHARACTERISTICS (4.1)

Measures	Historic Streetcar Option A: Lower Investment	Historic Streetcar Option B: Higher Investment	Modern Streetcar	Rubber Tire Transit Option A: Mini-bus	Rubber Tire Transit Option B: Coach
1. Vehicle/System Capacity	• 15 minute headways; approximately 290 passengers per hour per direction • Headways limited by single track with a passing track between Lenora and Broad • Vehicles would serve 2004 ridership and be slightly over capacity for potential future peak summer ridership		• 15 minute headways; approximately 450 passengers per hour per direction • Easy to purchase additional vehicles • Headways limited by single track with a passing track between Lenora and Broad • Largest passenger capacity • Vehicles would serve 2004 ridership and potential future peak summer ridership	• 10 minute headways • Approximately 150 - 200 passengers per hour per direction • Easy to purchase additional vehicles • Vehicles would serve 2004 ridership, but not potential future peak summer ridership.	• 10 minute headways • Approximately 250-350 passengers per hour per direction • Easy to purchase additional vehicles • Vehicles would serve 2004 ridership and potential future peak summer ridership
2. Vehicle Operations (flexibility, grade)	• Cannot alter route during construction or a track obstruction • Can operate on maximum grade reached on route • Can only operate on waterfront line	• Cannot alter route during construction or a track obstruction • Can operate on maximum grade reached on route • Can be interlined with other all-electrified streetcar alignments (except First Hill)	• Cannot alter route during construction or a track obstruction • Can operate on maximum grade reached on route • Can be interlined with other streetcar services	• Can easily reroute during construction or avoid lane blockages if needed • Can operate on maximum grade reached on route	
3. Connectivity	• Operates within close proximity to other transit service • Difficult to extend route to the north because of grades, BNSF crossing and Myrtle-Edwards Park		• Operates within close proximity to other transit service • Difficult to extend route to the north because of grades, BNSF crossing and Myrtle-Edwards Park	• Operates within close proximity to other transit services • Easy to extend route	
4. Travel time	• Round trip run time is approximately 32 minutes; 17 minutes for northbound trip and 15 minutes for southbound trip. • Passenger load time would be approximately 30-40 seconds. • Faster ADA load time with level boarding	• Round trip run time is approximately 32 minutes; 17 minutes for northbound trip and 15 minutes for southbound trip. • Passenger load time would be approximately 20-30 seconds. • Slower ADA load time with wheelchair ramp deployment	• Round trip run time is approximately 30 minutes; 16 minutes for northbound trip and 14 minutes for southbound trip. • Passenger load time would be approximately 10-15 seconds • Faster ADA load time with level boarding	• Round trip run time would be approximately 37 minutes; 20 minutes for northbound trip and 17 minutes for southbound trip • Passenger load time would be approximately 30-40 seconds • Slower ADA load time with wheelchair ramp deployment	• Round trip run time would be approximately 37 minutes; 20 minutes for northbound trip and 17 minutes for southbound trip • Passenger load time would be approximately 15-20 seconds • Faster ADA load time with level boarding
5. Safety	• Needs federal safety certification		• Vehicles would meet federal safety requirements	• Vehicles would meet transit bus safety regulations	
6. Rider Attraction	• Legible and predictable service with trackage and overhead wires • Historic quality of this service could encourage people to travel to waterfront to ride this service		• Legible and predictable service with trackage and overhead wires	• Less predictable and legible transit service compared to rail vehicles	• Less predictable and legible transit service compared to rail vehicles
7. Rider Comfort/ Satisfaction	• Nostalgic appeal of riding historic streetcar • Operation not as smooth as modern • No A/C • Passengers load from median	• Nostalgic appeal of riding historic streetcar • Operation not as smooth as modern • No A/C, but automated doors • Passengers load from median island	• Smooth operations • Two double-doors and a single door for fast loading and unloading • Climate control on streetcars • Passengers load from median island • Attractive and comfortable form of commuting	• New environmentally friendly vehicle, quiet and no fumes • Ride not as smooth as streetcar • Passengers load from curb side stop, which is more protected and pleasant. • Climate control on vehicles	• New environmentally friendly vehicle, quiet and no fumes • Ride not as smooth as streetcar • Passengers load from curb side stop, which is more protected and pleasant. • Climate control on vehicles
8. ADA / Accessibility	• Difficult for ADA passengers to access high platform stations in median	• Low level platforms more comfortable to access for ADA passengers • Median stations can be challenging to access for some ADA passengers	• Level, low-floor boarding • Median platform loading (less comfortable than curb side waiting)	• Vehicle would allow low floor boarding • Curb side loading	• Vehicle would allow low floor boarding • Curb side loading

KEY TO RANKING

LOWER PERFORMING — HIGHER PERFORMING

EFFECTS ON THE ENVIRONMENT AND OTHER WATERFRONT USERS (4.2)

Measures	Historic Streetcar: Option A: Lower Investment	Historic Streetcar: Option B: Higher Investment	Modern Streetcar	Rubber Tire Transit: Option A: Mini-bus	Rubber Tire Transit: Option B: Coach
1. Noise	• Operating noise similar to a passenger car • Tight turns could generate noisy wheel squeal		• Operating noise similar to a passenger car • Tight turns could cause noisy wheel squeal	• Operating noise similar to a passenger car or electric trolley	
2. Air Quality	• Electric powered; Seattle's electric power is 98% non-GHG generating		• Electric powered; Seattle's electric power is 98% non-GHG generating	• Electric powered; Seattle's electric power is 98% non-GHG generating	• Electric powered; Seattle's electric power is 98% non-GHG generating
3. Visual Quality	• High platform stations along waterfront may obstruct views • Visual clutter with catenary system (span wires and poles) • Historic streetcars are visually appealing	• Low platforms would preserve waterfront views • Visual clutter with catenary system (span wires and poles) • Historic streetcars are visually appealing	• Sleek and modern looking vehicles • Visual clutter with catenary system (span wires and poles) • Battery operation in some portions of the alignment would eliminate visual impact • Low platforms would preserve waterfront views	• Could use sleek and modern looking vehicle • Curb side bus stops could blend in with surroundings	• Could use sleek and modern looking coaches • Curb side bus stops could blend in with surroundings
4. Traffic Impact	• Operate in the inside lane • In-lane stops have intermittent but not significant effects on traffic • Passenger load time would be approximately 30-40 seconds.	• Operate in the inside lane • In-lane stops have intermittent but not significant effects on traffic • Passenger load time would be approximately 20-30 seconds.	• Operate in the inside lane • In-lane stops have intermittent but not significant effects on traffic • Passenger load time would be approximately 10-15 seconds	• Vehicles will operate primarily in outside lane • In-lane stops have intermittent but not significant effects on traffic • Passenger load time would be approximately 30-40 seconds	• Vehicles will operate primarily in outside lane • In-lane stops have intermittent but not significant effects on traffic • Passenger load time would be approximately 15-20 seconds
5. Utility Conflicts	• Major utility corridor under tracks • Possible transit service disruption for utility repairs		• Major utility corridor under tracks • Possible transit service disruption for utility repairs	• Minimal conflicts with utilities	

COST (4.3)

Measures	Historic Streetcar: Option A: Lower Investment	Historic Streetcar: Option B: Higher Investment	Modern Streetcar	Rubber Tire Transit: Option A: Mini-bus	Rubber Tire Transit: Option B: Coach
1. Operations and Maintenance Costs	• Two operators required per vehicle, additional $250,000/year in labor costs compared to option B • Total: $3.5 million/year	• One operator required • Total: $3.3 million/year	• Annual operations and maintenance costs approximately $3.3 million	• Mini-bus could be operated by non-profit • Total: $1.5 - 3.1 million/year depending on operator	• Larger coach likely operated by transit agency • Total: $3.1 million/year
2. Capital Costs (vehicles, power supply, stations)	• 5 streetcars at approximately $1.4 million total • High capital investment for power supply, stations, and new trackage (approximately $16.7 million) • New maintenance facility required, approximately $17 million to $23 million • Total: $35 - 41 million	• 5 streetcars at approximately $14.8 million total • High capital investment for power supply, stations, and new trackage (approximately $16.7 million) • New maintenance facility required, approximately $17 million to $23 million • Total: $49 - $55 million	• 3 streetcars at approximately $11.3 million total • High capital investment for power supply, stations, and new trackage (approximately $17.5 million) • Need additional storage at or near Charles Street Base, approximately $3 to $10 million • Total: $32 - $39 million	• 6 vehicles at approximately $4.2 million total • 2 charging stations at approximately $100,000 • Bus stops at approximately $1.7 million • Total: $6 million	• 6 vehicles at approximately $5.4 million total • 2 charging stations at approximately $100,000 • Bus stops at approximately $1.7 million • Total: $7 million

KEY TO RANKING

LOWER PERFORMING → HIGHER PERFORMING

2.0 INTRODUCTION

The central waterfront extends nearly 2 miles along the shore of Elliott Bay, from Pioneer Square and the Stadium District to the south to the Olympic Sculpture Park and Myrtle-Edwards Park to the north. This stretch of urban public waterfront is a unique and significant part of Seattle and is home to a combination of urban development, industry and spectacular views of big nature (see illustration on following page).

The removal of the Alaskan Way Viaduct and replacement of the Elliott Bay Seawall present an opportunity to re-imagine Seattle's central waterfront and reconnect it to the rest of the city, while respecting its local icons and history as a working waterfront. A set of principles guide the Waterfront Seattle project. These guiding principles have been developed by the community and adopted by the City Council:

- Create a waterfront for all.
- Put the shoreline and innovative, sustainable design at the forefront.
- Reconnect the city to its waterfront.
- Embrace and celebrate Seattle's past, present and future.
- Improve access and mobility.
- Create a bold vision that is adaptable over time.
- Develop consistent leadership - from concept to construction to operations.

A key proposal of the access and mobility guiding principle is the addition of a waterfront transit service, with frequent service and accessibility. The purpose of waterfront transit service is to provide local access to the multitude of waterfront destinations, which are not all easily reached on foot. Users of this service would primarily be recreational visitors and waterfront employees and residents. The service would interact with improved east-west pedestrian connections to the waterfront and downtown area. Other transit improvements serving the waterfront include the Madison Street rapid trolley bus route connecting Colman Dock to First Hill and beyond, and the new First Hill streetcar line which will terminate near 1st and Jackson.

A series of goals that waterfront transit should achieve have been developed through collaboration with the Design Oversight Subcommittee (DOS) and the public. Waterfront transit should:

- Serve the local waterfront market
- Operate in the street in a shared lane to keep the transportation footprint compact and allow for new public spaces next to the water
- Be frequent
- Be user friendly
- Be legible
- Be iconic
- Fit the waterfront character and demand
- Be a compelling alternative to driving
- Be complimentary to other downtown transit

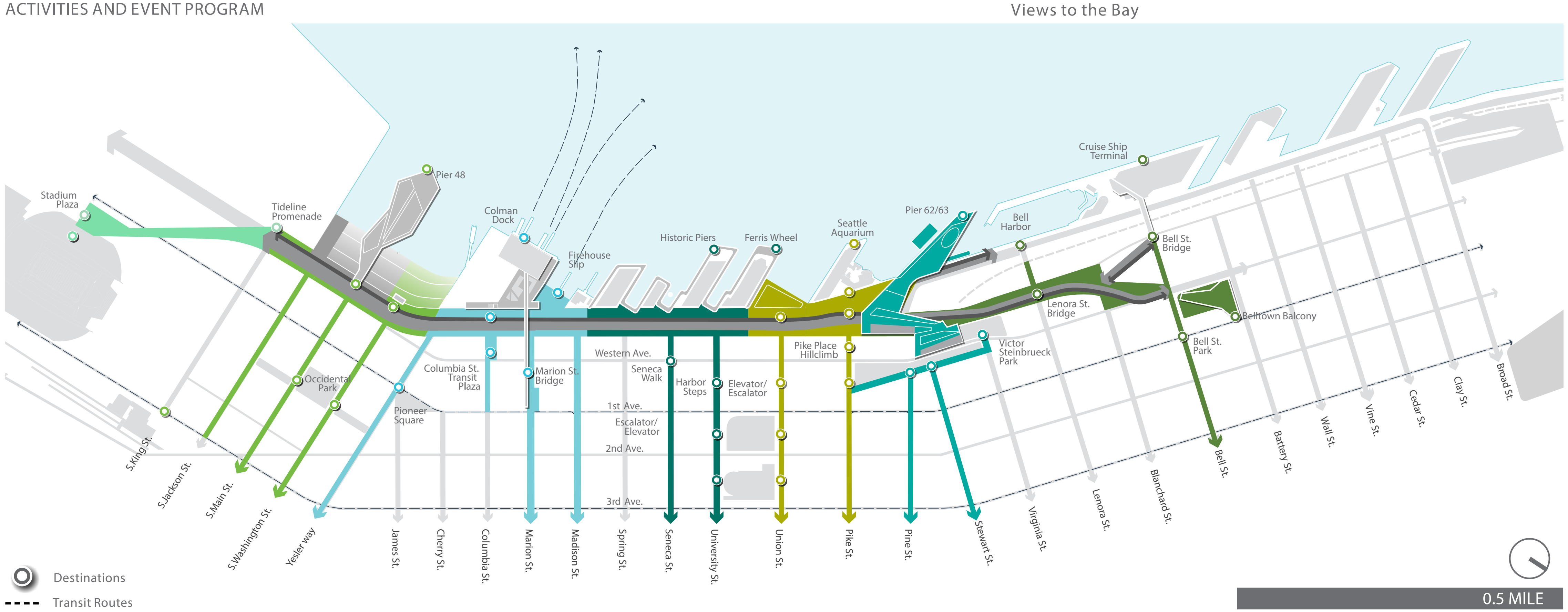
This study evaluates and compares historic streetcars, modern streetcars, and rubber tire transit for their relative performance on operating characteristics, effects on the environment, and cost. These transit options will focus on moving people along the waterfront; characteristics include high frequency operations, ease of passenger boarding, and connections to other major transit modes.

JULY 2012 FRAMEWORK PLAN WATERFRONT ACTIVITIES + DESTINATIONS

The following illustrates the multitude of activities and destinations a waterfront transit system would improve access to.

RAILROAD WAY + STADIUM PLAZA	PIONEER SQUARE	COLMAN DOCK TRANSIT	HISTORIC PIER WALK	UNION ST. PIER + AQUARIUM PLAZA	PIER 62/63	OVERLOOK WALK	BELLTOWN BLUFF
Eating Street Festival Game Day	Sitting Jogging Fishing Boating Sunning Touch the Water	Ferrying Commuting Touring Shopping Viewing Exhibiting	Eating Dining Shopping Strolling Boating Touring	Festival Concert Eating Event Water Fountain Display	Rollerskating Sunning Concerts Ice Skating Swimming Events Market Views to the Bay	Views to the Bay Children's Play Climbing Sliding Events Shopping Market	Views to the Bay Community Events Urban Agriculture

ACTIVITIES AND EVENT PROGRAM



James Corner Field Operations

Intentionally left blank

3.0 TRANSIT ALIGNMENT + ANALYSIS ASSUMPTIONS

GENERAL OVERVIEW

Historic Streetcar

The historic streetcar alternative examines reinstating the Melbourne Model W-2 'George Benson' trolleys, which previously operated along the Seattle waterfront. A recent evaluation of the historic streetcars found that 5 trolleys could be refurbished and used for serving the waterfront (see Seattle Local Waterfront Historic Streetcar Technical Evaluation prepared by LTK Engineering Services). There are two options being considered for this alternative:

Option A

Option A is a lower level of investment and leaves the streetcars unchanged except for minor modifications that include manual doors on both sides of the vehicle that are controlled by an additional operator and a modern PA system. This option maintains high floor loading and platforms. Streetcars operate on a different power system than the existing Seattle modern streetcar.

Option B

This includes option A modifications and adds elective upgrades such as automated door operation that reduces the number of required operators to one, improved lighting, conversion to operate on similar power service as modern streetcar, and wheelchair lifts so station platforms can be at street level.

Modern Streetcar

The modern streetcar alternative examines constructing a streetcar alignment along the waterfront that is similar to the existing South Lake Union Streetcar and proposed First Hill Streetcar services. The Inekon 12-Trio's, operating on the South Lake Union Streetcar line, are manufactured by Skoda. These vehicles could operate on battery power for a portion of the alignment, which could reduce the need for overhead wire. Only one option was considered for this alternative.

Rubber Tire Transit

This alternative evaluates implementing a rubber tire transit service. The vehicles evaluated for rubber tire transit serve as examples of possible vehicles and would potentially not be the exact vehicle selected for operation along the waterfront.

Option A

The option A vehicle would be a mini-bus style vehicle with large side windows and low floor boarding similar to the Tecnobus Gulliver bus operating in Quebec City. This vehicle could use diesel-hybrid or electric propulsion. The option A vehicle was assumed to be an all-electric vehicle.

Option B

This would be a coach style bus with front and back door loading and unloading, similar to coaches operated by King County Metro. This vehicle could use diesel-hybrid or electric propulsion, including all-electric trolley buses or battery operated buses. An all-electric trolley bus would perform similarly to a battery operated bus but would have visual impacts similar to the streetcar options. For this evaluation, the Option B vehicle was assumed to be an all-electric battery operated vehicle.

3.0 TRANSIT ALIGNMENT + ANALYSIS ASSUMPTIONS

HISTORIC STREETCAR

commons.wikimedia.org

MODERN STREETCAR

commons.wikimedia.org

RUBBER TIRE TRANSIT: MINI-BUS

www.athaitraveller.com

RUBBER TIRE TRANSIT: COACH

Proterra.com

3.0 TRANSIT ALIGNMENT + ANALYSIS ASSUMPTIONS

ALIGNMENT + STATION LOCATIONS

Historic Streetcar

ALIGNMENT

This alignment would provide transit service between Main Street and Occidental Street in Pioneer Square, and Alaskan Way and Broad Street, near the Olympic Sculpture Park and Pier 70.

STATION LOCATIONS

The following stations would be located in the median and serve both directions of historic streetcar service:

- Main Street west of Occidental Avenue
- Yesler Way south of 1st Avenue
- Alaskan Way south of Marion Street
- Alaskan Way south of Spring Street
- Alaskan Way south of Pike Street
- Alaskan Way at Bell Street
- Alaskan Way at Vine Street
- Alaskan Way at Broad Street

Modern Streetcar

ALIGNMENT

This alignment would provide transit service between Jackson Street and Occidental Street in Pioneer Square, and Alaskan Way and Broad Street, near the Olympic Sculpture Park and Pier 70.

STATION LOCATIONS

The following stations would be located in the median and serve both directions of modern streetcar service:

- Jackson Street west of Occidental Avenue
- Yesler Way south of 1st Avenue
- Alaskan Way south of Marion Street
- Alaskan Way south of Spring Street
- Alaskan Way south of Pike Street
- Alaskan Way at Bell Street
- Alaskan Way at Vine Street
- Alaskan Way at Broad Street

Rubber Tire Transit

ALIGNMENT

This alignment would provide transit service between 3rd Avenue and Jackson Street, near King Street Station, and Broad Street, near the Olympic Sculpture Park and Pier 70.

STATION LOCATIONS

The following bus stops would be served by one-way only transit service:

- Jackson Street west of 3rd Avenue
- Jackson Street west of Occidental Avenue

The following bus stops would be served by two-way transit service with bus stops located on the far-side of signalized intersections for the direction of travel:

- Yesler Way at 1st Avenue
- Alaskan Way at Marion Street
- Alaskan Way at University Street
- Alaskan Way at Pike Street
- Alaskan Way at Bell Street
- Alaskan Way at Vine Street
- Alaskan Way at Broad Street

3.0 TRANSIT ALIGNMENT + ANALYSIS ASSUMPTIONS

ALIGNMENT + STATION LOCATIONS
HISTORIC STREETCAR

3.0 TRANSIT ALIGNMENT + ANALYSIS ASSUMPTIONS

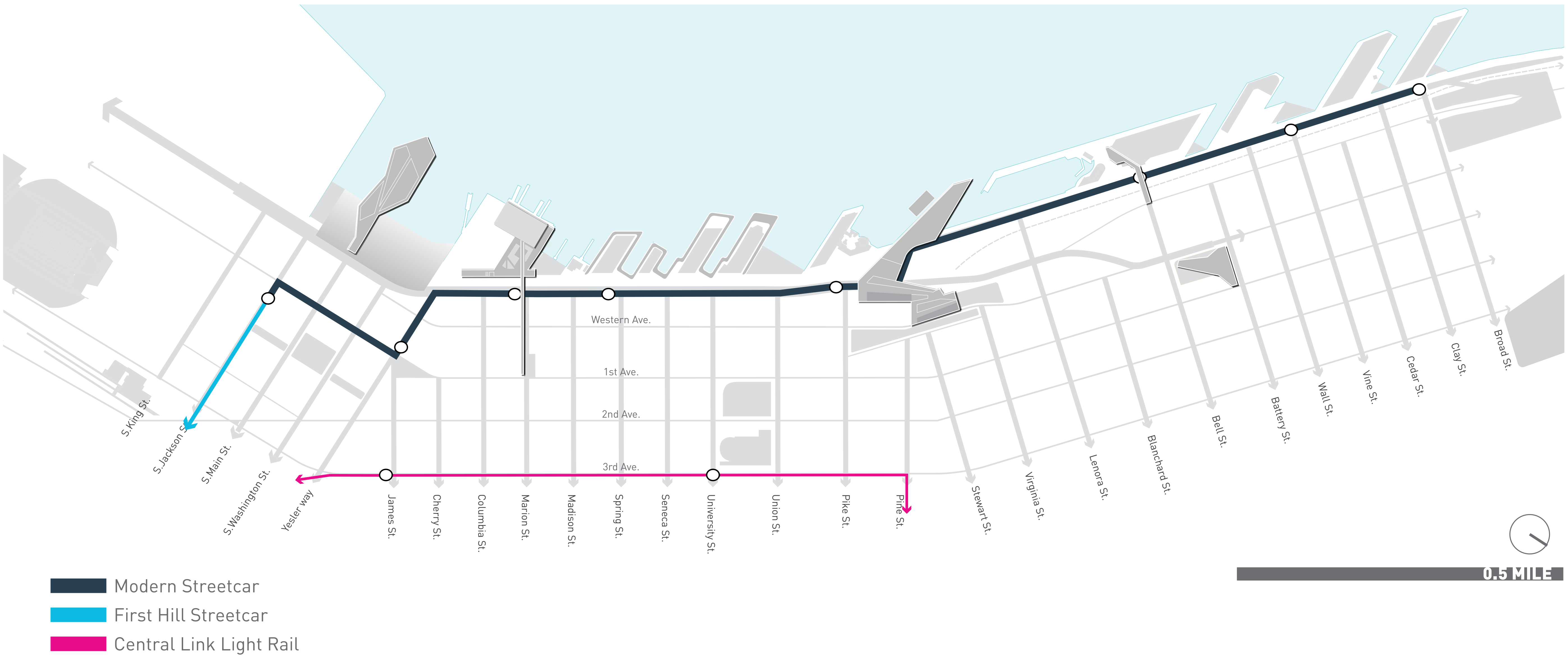
ALIGNMENT + STATION LOCATIONS
HISTORIC STREETCAR

STREET DESIGN
STREET CAR STOP BETWEEN MADISON AND SPRING

3.0 TRANSIT ALIGNMENT + ANALYSIS ASSUMPTIONS

ALIGNMENT + STATION LOCATIONS

MODERN STREETCAR



3.0 TRANSIT ALIGNMENT + ANALYSIS ASSUMPTIONS

ALIGNMENT + STATION LOCATIONS
MODERN STREETCAR

STREET DESIGN
STREET CAR STOP BETWEEN MADISON AND SPRING

3.0 TRANSIT ALIGNMENT + ANALYSIS ASSUMPTIONS

ALIGNMENT + STATION LOCATIONS
RUBBER TIRE TRANSIT

3.0 TRANSIT ALIGNMENT + ANALYSIS ASSUMPTIONS

ALIGNMENT + STATION LOCATIONS
RUBBER TIRE TRANSIT

STREET DESIGN
RUBBER TIRE TRANSIT STOP BETWEEN SENECA AND UNIVERSITY

3.0 TRANSIT ALIGNMENT + ANALYSIS ASSUMPTIONS

STREETCAR OPERATING LANE ASSIGNMENT

A streetcar, whether historic or modern, would share a travel lane with vehicles along 1st Avenue, Yesler Way, and Alaskan Way south of Lenora Street. This means that cars and trucks would drive in the lane the streetcar operates in. The choice of operating lane for streetcars on multi-lane roadways has different benefits and impacts to both streetcar operations, general purpose traffic, and utilities. Operating lane configurations considered for the waterfront transit alternatives included inside/inside, outside/outside and inside/outside alignments. For the purposes of this analysis, an inside/inside operating lane assignment was assumed.

- **Inside/Inside:** both northbound and southbound tracks would use the inside lane (closest to the median). This operating lane assignment was assumed for this study.
- **Outside/Outside:** both northbound and southbound tracks would use the outside lane (closest to the curb). This operating lane assignment was not assumed for this study.
- **Inside/Outside:** the streetcar would operate in either the inside or outside lane depending upon the direction of travel. For waterfront transit, the northbound track would use the outside lane, and the southbound track would use the inside lane. This operating lane assignment was not assumed for this study.

STREETCAR TURNS + SIGNAL MODIFICATIONS

Streetcar left turns from multi-lane roadways are less disruptive to traffic with streetcars operating along the inside lane compared to the outside lane. This is because left-turns from the outside lane (curb lane) by a streetcar would require a special signal phase to facilitate a safe lane change, which would stop all other movements. This typically increases the delay experienced at an intersection by motorists and nonmotorized users. Similarly, right turns by vehicles from multi-lane roadways are less disruptive to streetcars operating in the inside lane compared to the outside lane.

Conflicts with bicyclists are also reduced with streetcars operating along the inside lane compared to the outside lane. This is because bicyclists typically ride on the curb side of the street in either dedicated lanes or with mixed traffic. With the streetcar operating in the outside lane, bicyclists could collide with passing streetcars or bike tires could get caught in the tracks.

With an outside operating lane assignment, the southbound right-turn at Pine Street may not provide enough space for streetcars to turn directly into the outside lane. Streetcars would likely turn into the inside lane south of Pine Street and would either merge directly or require a special signal phase at Pike Street to assist with the merge.

Streetcars would turn left off of Alaskan Way in both the northbound and southbound directions, which would require special signal phases for both directions. No special signal phase is required for the northbound right turn from Yesler Way to Alaskan Way because there is only one westbound lane and the streetcar would not need to merge right. A special signal to transition the streetcar from the dedicated right of way north of Lenora Street would be needed. This would allow the streetcar to navigate to the southbound right turn at Pine Street so a special signal would not be required for this turn.

STATION LOCATIONS

With an inside alignment, stations would be located on the median, but they could not be located on blocks with left turn pockets. This is because the left turn pockets would not leave enough space on the median for a station. With an outside alignment, stations would be located on the curb. This would reduce the number of parking spaces available on blocks with stations.

3.0 TRANSIT ALIGNMENT + ANALYSIS ASSUMPTIONS

ON-STREET PARKING IMPACTS

Parking and loading will be cut into the sidewalk in the proposed roadway design for the new Alaskan Way surface street. Impacts to parking on this portion of the alignment would be minimal with an inside/inside operating lane assignment. Platforms that extend from the curb would be provided with an outside/outside alignment to allow vehicles to stop at stations. Parking on one side of Yesler Way between 1st Avenue and Alaskan Way would likely be removed to provide dedicated bike facilities.

UTILITIES

Alaskan Way is a primary utility corridor. Although there would be utility conflicts with providing streetcar along the waterfront, none of the utility conflicts are seen as a fatal flaw. Construction of a streetcar system would likely require design approaches to limit heat impacts to underground power lines. Additional technical assessment and interagency coordination to address any utility conflicts would be required. If needed, streetcar service would be temporarily shut down to allow for work on utilities that conflict with streetcar infrastructure. During these times a temporary bus service would operate.

TRACK GAUGE

The track gauge for historic and modern streetcar measures 4 feet 8 1/2 inches (1,435 mm). New track would likely be needed for the length of the alignment between the south terminus and Lenora street. The single track between Lenora and Broad Streets would not be replaced. A passing track would be provided near Bell Street to allow streetcars to pass each other on the single tracked segment.

PROPOSED ROADWAY CONFIGURATIONS

The current street design generally accommodates all the transit options studied, though there are some differences such as platform locations and median design.

HISTORIC STREETCAR + MODERN STREETCAR

Streetcars would travel along the inside lane or a dedicated right of way.

Main Street: 1st Avenue to Occidental Avenue

Main Street is a two-lane roadway with on-street parking; the historic streetcar would likely operate along a dedicated lane at the stations because of the need for a crossover rail switch. The configuration would be similar to the First Hill Streetcar station on Jackson Street.

1st Avenue: Main Street to Yesler Way

1st Avenue is a two-lane road with on-street parking on both sides and a planted median; the streetcar would operate along the travel lane. There are no stops along this segment.

Yesler Way: 1st Avenue to Alaskan Way

Yesler Way is a two-lane roadway with sharrows, painted symbols on the street indicating where bicyclists should ride, and on-street parking. The historic streetcar would operate along the travel lane and serve a median station. Parking on one side of the street would likely be removed to provide dedicated bike facilities. This would reduce the potential for bicycle and streetcar conflicts.

Alaskan Way: Yesler Way to Columbia Street

Alaskan Way provides three lanes in each direction and a southbound left turn lane separated by a median. The streetcar would operate along the inside lane in both directions.

Alaskan Way: Columbia Street to Seneca Street

Alaskan Way provides two lanes in each direction separated by a median with southbound

PROPOSED ROADWAY CONFIGURATIONS

turn pockets where needed. The streetcar would operate along the inside lanes in both directions with stations located in the median south of Marion Street and south of Spring Street.

Alaskan Way: Seneca Street to Pine Street

Alaskan Way provides two lanes in each direction and the streetcar would travel along the inside lane with a station south of Pine Street in the median.

Alaskan Way: Pine Street to Broad Street

The streetcar would leave Alaskan Way just north of Pine Street and operate along a dedicated right of way. This segment would be a single-track with a passing track configuration with stations located west of the tracks. Stations would be located at Bell Street, Vine Street, and near Broad Street.

RUBBER TIRE

Rubber tire transit would travel along the outside lane, which is commonly known as the curb lane.

Main Street: 1st Avenue to 3rd Avenue/3rd Avenue: 2nd Avenue Extension to Jackson Street (south terminus turnaround)

Vehicles would operate in the travel lane of South Main Street, which is a two-lane roadway with on-street parking. The coach would make a slight right onto Second Avenue Extension, which is a one-way four-lane road with on-street parking and a bike on the left side; the coach would travel in the west curb lane and make a slight right onto Third Avenue. Third Avenue is a one-way one-lane road with on-street parking and a bike lane; the coach would operate in the lane of travel.

Jackson Street: 3rd Avenue to 1st Avenue

Jackson Street is a two lane roadway with sharrows, painted symbols on the street indicating where bicyclists should ride, and on-street parking on both sides of the street. Rubber tire vehicles would operate in the travel lane with bus stops located in extended curb areas.

1st Avenue: Main Street to Yesler Way

Similar to streetcar.

Yesler Way: 1st Avenue to Alaskan Way

Similar to streetcar, except bus stops would be located curb side.

Alaskan Way: Yesler Way to Columbia Street

Alaskan Way provides three lanes in each direction and a southbound left turn lane separated by a median. After serving the southbound stop, vehicles would merge to the inside lane for the left-turn onto Yesler Way. Northbound buses turning from Yesler Way would use the middle lane on Alaskan Way to avoid the right-turn only to Columbia Street.

Alaskan Way: Columbia Street to Seneca Street

Similar to streetcar, except buses would travel in the curb lane and bus stops would be located curb side. Bus stops would be located on the far side of Marion Street for the direction of travel.

Alaskan Way: Seneca Street to Pine Street

Similar to streetcar, except buses would travel in the curb lane and bus stops would be located curb side. Bus stops would be located on the far side of University Street and Pike Street for the direction of travel. After serving the Pike Street bus stop, vehicles would merge to the inside lane for the left-turn at Pine Street.

Alaskan Way: Pine Street to Broad Street

Alaskan Way is a two-lane roadway with on-street parking on both sides of the street. Vehicles would travel and stop in the curb lane. Stations would be located at Bell, Vine and Broad Streets. A new roadway would be constructed south of Broad Street for a vehicle turnaround (see figure on page 42).

Right turns from multi-lane roadways are less disruptive with vehicles movements. The turnaround at the south terminus reduces traffic disruption, since the coach can travel in the outside lane and reduce conflicts with motorists and nonmotorized users.

3.0 TRANSIT ALIGNMENT + ANALYSIS ASSUMPTIONS

DOUBLE + PASSING TRACKS

Between Lenora Street and Broad Street, there is currently a single track for streetcars to operate along. It is estimated to take streetcars approximately 12 to 15 minutes to travel from Lenora Street to Broad Street and return if a passing track is provided along this section of the alignment. With only a single track, other streetcars would have to wait on the passing track until the single track was clear. This segment would limit how frequently streetcars could operate, which is known as the headway. To alleviate this system limitation, the segment could provide a separate northbound and southbound track.

Streetcar Passing Track between Union and Pike Streets

SERVICE PLAN

Waterfront transit service was assumed to operate from 6 AM to 9 PM during weekdays with extended hours to 11 PM on Friday and Saturday. Sunday service operates from 10 AM to 7 PM.

During seasons of higher waterfront use, such as May through September, service hours could be extended to midnight.

3.0 TRANSIT ALIGNMENT + ANALYSIS ASSUMPTIONS

ALTERNATIVES CHARACTERISTICS

	Historic Streetcar	Modern Streetcar	Rubber Tire Transit
VEHICLE DIMENSIONS	The historic streetcar measures 8 feet wide by 48 feet in length.	The modern streetcar measures 8 feet wide by 66 feet in length.	The length of a rubber tire vehicle would be approximately 7 to 8 feet wide by 17 to 40 feet in length .
PROPULSION	Both options rely on electricity to power the vehicles; but vary in how compatible they are with operating on Seattle's modern streetcar power system. The historic streetcars would be connected to overhead wires, similar to the existing Seattle modern streetcar lines. **Option A** This would retain the GE K35JJ controllers with two 40 horsepower motors per truck. Motor types include Westinghouse MV101AH and MV101AR, and British Thompson-Houston BTH265p. This propulsion system is configured to operate on a 600 volt DC system. This option is not compatible with Seattle's modern streetcar network. **Option B** This would convert trolleys to a 750 volt DC power system similar to Seattle's modern streetcar system. These historic streetcars would need to convert to 1,000 volt rated components and traction motors to be compatible with existing systems. Also, the vehicle compressors would require re-winding and possible increased insulation.	The modern streetcar alternative would use electricity to power the streetcars via overhead wires similar to the South Lake Union and First Hill streetcar systems. The existing Inekon-12 vehicles are equipped with Elin EBG propulsion and operate on a 750 volt DC power system.	**Option A** Mini-bus-style vehicles could be equipped with diesel, diesel-hybrid or all-electric motors. The option A vehicle was assumed to be an all-electric battery-powered vehicle with no overhead wires. **Option B** Larger coaches would be equipped with diesel, diesel-hybrid, electric, or other types of motors. For this evaluation, the Option B vehicle was assumed to be an all-electric battery-powered vehicle with no overhead wires.

3.0 TRANSIT ALIGNMENT + ANALYSIS ASSUMPTIONS

ANALYSIS ASSUMPTIONS

The following analysis assumptions were used for evaluating the system performance, environmental effects, and cost for the selected transit alternatives.

	Historic Streetcar	Modern Streetcar	Rubber Tire Transit
NUMBER OF VEHICLES	3 vehicles in service, 2 in reserve	3 vehicles in service, share reserve vehicle with First Hill streetcar system.	Option A: 5 vehicles, 1 in reserve Option B: 5 vehicles. 1 in reserve
PASSENGER CAPACITY	43 seated and 53 standing for a total of 96 passengers per vehicle.	27 seated and 80 standing for a total of 107 passengers per vehicle.	Option A: 30 to 40 passengers. Option B: 50 to 70 passengers.
HEADWAYS	15 minute headways	15 minute headways	Option A: 10 minute headways Option B: 10 minute headways
STATION DWELL TIMES	Option A: 30-40 seconds Option B: 20-30 seconds	10-15 seconds	Option A: 30-40 seconds Option B: 15-20 seconds
STATION DESIGN	Option A: high platform, center median stations Option B: low platform, center median stations	Low platform, center median stations	Low platform, curbside stations

4.0 TRANSIT ALTERNATIVES EVALUATION

This chapter summarizes the evaluation of waterfront transit operating characteristics, environmental impacts, and cost.

4.1 OPERATING CHARACTERISTICS

1. VEHICLE/SYSTEM CAPACITY

There are many different options that could be chosen for vehicle system capacity depending on the vehicle size, vehicle frequency, route length and route conditions. The options analyzed in this report were selected to be roughly similar in passenger capacity. Although the mini-bus option has lower capacity than the others, it serves as an example of a smaller vehicle type within a range of many different rubber tire options.

	Historic Streetcar	Modern Streetcar	Rubber Tire Transit
A. VEHICLE PASSENGER CAPACITY	The historic streetcar could accommodate approximately 43 seated and 53 standing passengers with level boarding (96 total passengers).	Modern streetcars are capable of accommodating approximately 27 seated and 80 standing passengers; the maximum passenger load is approximately 140 to 150 passengers, which is considered the crush load of the vehicle.	Rubber tire vehicles accommodate a wide range of seated and standing passengers depending on the selected vehicle. **Option A** Mini-bus vehicles could generally accommodate a total of 30 to 40 seated and standing passengers. **Option B** Transit coach vehicles could accommodate approximately 50 to 70 total seated and standing passengers. Proterra's 35-foot all-electric coach accommodates 38 seated and 34 standing passengers, for a total of 72 passengers.

4.1 OPERATING CHARACTERISTICS

On Board a Historic 'George Benson' Streetcar

On Board the South Lake Union Streetcar

Interior of a Tecnobus Gulliver

On Board a Modern Transit Bus

4.1 OPERATING CHARACTERISTICS

1. VEHICLE/SYSTEM CAPACITY

	Historic Streetcar	Modern Streetcar	Rubber Tire Transit
B. HEADWAYS	The historic streetcar was assumed to operate on 15 minute headways.	The modern streetcar was assumed to operate on 15 minute headways. Because the modern streetcar can accommodate more passengers in a single trip than the other alternatives, it is anticipated that it would operate on 15 minute headways.	**Option A** The mini-bus vehicle was assumed to operate on 10 minute headways and would accommodate the least amount of passengers. **Option B** Larger coach vehicles were assumed to operate on 10 minute headways and could accommodate similar amounts of passengers as the historic streetcar.
C. ASSUMED PASSENGER CARRYING CAPACITY	The assumed peak hour capacity is the maximum number of passengers vehicles can accommodate (seated and standing) multiplied by the number of vehicles serving the route in an hour.		
	The historic streetcar could accommodate approximately 290 passengers an hour operating on 15 minute headways (3 streetcars an hour).	The modern streetcar could accommodate approximately 450 passengers an hour operating on 15 minute headways (3 streetcars an hour).	**Option A** Mini-bus style vehicles could accommodate approximately 150 to 200 passengers an hour operating on 10-minute headways (5 mini-buses an hour). **Option B** Larger coaches could accommodate approximately 250 to 350 passengers an hour operating on 10-minute headways (5 coaches an hour).

4.1 OPERATING CHARACTERISTICS

1. VEHICLE/SYSTEM CAPACITY

	Historic Streetcar	Modern Streetcar	Rubber Tire Transit
D. MAXIMUM PASSENGER CAPACITY	With 15 minute headways, the maximum passenger carrying capacity would be approximately 380 passengers per hour in each direction.	With 15 minute headways, the maximum passenger carrying capacity would be approximately 600 passengers per hour in each direction.	**Option A** With 10 minute headways, the maximum passenger carrying capacity would be approximately 180 to 240 passengers per hour in each direction. **Option B** With 10 minute headways, the maximum passenger carrying capacity would be approximately 300 to 420 passengers per hour in each direction.

E. ABILITY TO MEET PAST + FUTURE RIDERSHIP DEMAND

King County provided 2004 ridership data for waterfront streetcar service, which had an annual ridership of approximately 400,000 passengers. Ridership was highest on the weekends and during the summer months (June through September). All waterfront transit alternatives are anticipated to meet 2004 ridership demand. If ridership demand doubles because of waterfront revitalization, all alternatives would need to increase the assumed base service levels to meet demand, except modern streetcar and rubber tire transit option B.

4.1 OPERATING CHARACTERISTICS

1. VEHICLE/SYSTEM CAPACITY

	Historic Streetcar	Modern Streetcar	Rubber Tire Transit
F. ABILITY TO INCREASE FREQUENCY OF SERVICE	With only four vehicles available at a time, historic streetcar service could achieve headways, the time between streetcars, of 10 minutes.	The modern streetcar was assumed to operate on 15-minute headways; headways of 10 minutes could be achieved by placing an additional streetcar in service.	Rubber tire transit was assumed to operate on 10-minute headways; the number of buses serving the waterfront alignment could be increased to reduce the time between buses. Decreasing headways would require additional layover space to maintain schedule reliability and allow time for operators to have breaks.

Historic Streetcar and Modern Streetcar: To achieve headways of less than 10 minutes, the section between Lenora Street and Broad Street would need to be a double-track configuration instead of a single- and passing track configuration.

All options: The span of service, or the hours of operations, could be extended with additional operation and maintenance costs for all options.

4.1 OPERATING CHARACTERISTICS

2. VEHICLE OPERATIONS

	Historic Streetcar	Modern Streetcar	Rubber Tire Transit
A. ABILITY TO REROUTE DURING CONSTRUCTION OR TRACK OBSTRUCTION	The historic streetcar would not be able to reroute during construction that disrupts rail connectivity, such as utility work under the track bed or to overhead wires. Construction impacting historic streetcar operations could require supplemental rubber tire service until construction is complete. Historic streetcar would also not be able to move around any obstruction of the track, such as stopped or turning vehicles.	The modern streetcar would not be able to reroute during construction that disrupts rail connectivity, such as utility work under the track bed. The modern streetcar could be equipped with an auxiliary power unit (battery pack), which would allow the vehicle to travel short distances without overhead power. Construction impacting modern streetcar operations could require supplemental rubber tire service until construction is complete. Modern streetcar would also not be able to move around any obstruction of the track, such as stopped or turning vehicles.	Rubber tire transit can be rerouted to parallel roadways if construction activities cause significant delays or street closures. With electric coaches, construction activity blocking access to the charging station location would require vehicles to return to base for charging (impacting frequency of service) or be supplemented with a non-electric vehicle.
B. INTERLINING WITH OTHER TRANSIT SYSTEMS	**Option A** This option could not be interlined with other streetcar alignments because it operates on a different power system than the current Seattle streetcar system. **Option B** Historic streetcar could be operated on other streetcar alignments provided they don't have non-electrified sections, such as the First Hill streetcar. Historic streetcars would not be equipped with auxiliary power units (battery backup system).	Modern streetcar could be interlined with other streetcar alignments, including the First Hill streetcar and 1st Avenue streetcar, provided the streetcars were equipped with auxiliary battery systems.	Electric buses would potentially be able to operate anywhere regular bus service operates but would require charging stations and scheduling considerations.

4.1 OPERATING CHARACTERISTICS

2. VEHICLE OPERATIONS

C. OPERATIONS IN ADVERSE WEATHER

Historic Streetcar / **Modern Streetcar**

Streetcars could operate during snow events unless the tracks, switches, or overhead wires have snow or ice build-up . During extreme winter weather events, relief operators could operate out of service streetcars to keep the track and overhead wires clear of snow and ice. Heavy rain could prevent operations if the tracks or support infrastructure were flooded. Streetcars could sustain operations in the event of high winds with some degradation in overall performance, such as acceleration, deceleration and travel speed.

Rubber Tire Transit

Rubber tire mini-bus and coaches would operate similar to a heavy truck in adverse weather conditions. The roadway grade between Pike and Lenora Streets (grade between 2.0% and 6.75%) would be a challenge to travel during icy conditions. Because most of these vehicles are two-wheel rear-wheel drive, they would be equipped with snow chains in wintry conditions. This requires vehicles to operate at slower speeds. High winds and heavy rain events would likely slow operations.

Historic streetcar in snow

Modern streetcar in snow

Rubber tire transit in snow

4.1 OPERATING CHARACTERISTICS

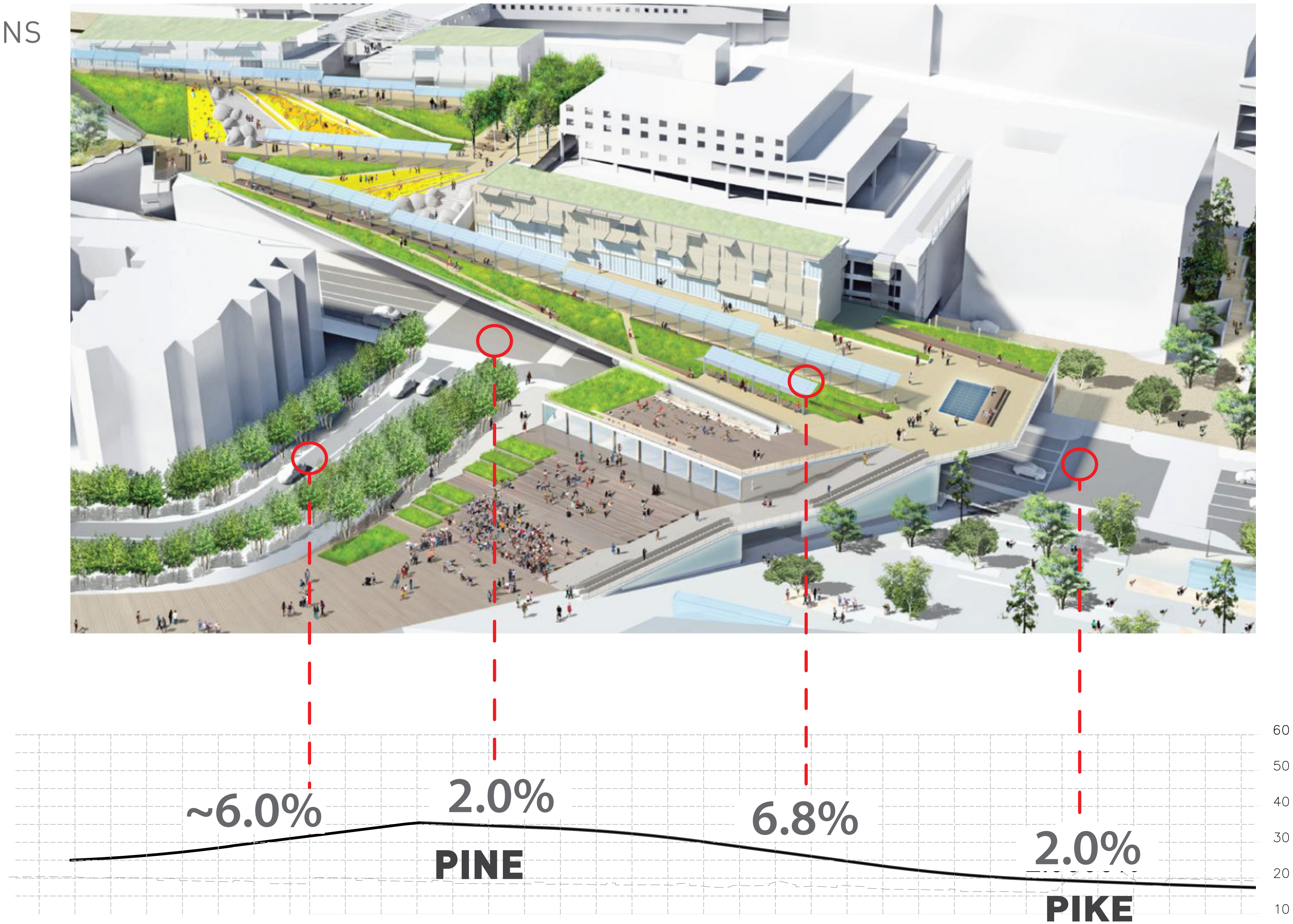
2. VEHICLE OPERATIONS

	Historic Streetcar	Modern Streetcar	Rubber Tire Transit
D. ABILITY TO OPERATE ON HILLS	The proposed transit alternatives could operate on grades greater than 7%, which is the maximum grade for the waterfront alignment.		
	It is recommended grades on alignments be limited to 7% to 7.5% except for very short distances. The historic streetcars have simple air operated brakes, which are effective and reliable but have neither the response speed when applied nor the degree of redundancy that a modern streetcar is equipped with. The historic streetcars would not likely receive an upgrade of their braking system. The expectation is that the existing air brake system is acceptable for normal service reactivation, and the cars should be able to meet braking requirements. Historic streetcars have electric speed regulation to control speeds while going uphill, level, or downhill.	The maximum operating grade for a modern streetcar is approximately 9%. Modern Streetcars generally have three forms of braking: dynamic braking, applied through the propulsion system; a modern hydraulically, air or spring operated friction brake; and, an electrically actuated track brake to be used in emergencies. This braking system provides a degree of redundancy and increased safety. Seattle's modern streetcars are also equipped with a traction motor to reduce the wear and tear on the braking system.	The maximum operating grade for rubber tire transit varies by vehicle; the Gulliver electric coach claims a maximum operating grade of 16%. Fully loaded mini-buses and larger coaches would have slower acceleration and travel speeds on uphill grades.

4.1 OPERATING CHARACTERISTICS

2. VEHICLE OPERATIONS

D. ABILITY TO OPERATE ON HILLS



Grade of Alaskan Way Roadway

4.1 OPERATING CHARACTERISTICS

3. CONNECTIVITY

Historic Streetcar	Modern Streetcar	Rubber Tire Transit

A. CONNECTIONS WITH OTHER TRANSIT SYSTEMS

All proposed transit alignments provide passenger connections to other bus transit, light rail, and commuter rail transit, as well as the Washington State Ferry system. Access to Link Light Rail would be located at the Pioneer Square Station, which is approximately 2 blocks from the proposed Yesler Street station. 3rd Avenue is the primary transit spine and is located 2-4 blocks from most proposed waterfront transit stops (pedestrians could use the proposed escalators at Seneca and Union Streets to access 3rd Avenue).

Historic Streetcar

The southernmost station for the historic streetcar is approximately 1 block north of the First Hill streetcar station on Jackson Street and approximately 4 blocks from King Street Station.

Alternatively, the historic streetcar alignment could be extended along Yesler Street and terminate at 2nd Avenue; this would improve the connection to Link light rail and other transit services operating along 3rd Avenue and in the Seattle Transit Tunnel.

Modern Streetcar

The modern streetcar alternative proposes sharing the 2nd Avenue/Jackson Street station with the First Hill streetcar. It would also connect the two service lines and could eliminate the need to transfer if each streetcar serves both the waterfront and First Hill routes. King Street station is approximately 3 blocks to the east of the proposed waterfront south station. However, if interlined with the First Hill streetcar, this alternative would connect directly to the King Street Station transit hub.

Rubber Tire Transit

The rubber tire transit alignment was assumed to provide a bus stop within 1 block of the First Hill Streetcar 2nd Avenue/Jackson Street station. It would also provide a bus stop near 3rd Avenue/King Street, which is approximately 1 block from King Street Station and 2 blocks from the International District transit tunnel station.

4.1 OPERATING CHARACTERISTICS

3. CONNECTIVITY

JULY 2012 FRAMEWORK PLAN DOWNTOWN SEATTLE TRANSIT CONNECTIONS

The adjacent map illustrates the multitude of existing and proposed transit connections serving downtown Seattle, including bus rapid transit, Link light rail, ferry service, bus route, and streetcar.

Light Rail
Transit Tunnel Stations
Bus Transit Spine + Pathways
Madison Street BRT Corridor
Existing + Planned Streetcar
Alternative Center City Connector Corridors
SW Transit Pathway Options
Frequent Trolley Bus Routes
Waterfront Connector

0' 750' 1500' 3000'

4.1 OPERATING CHARACTERISTICS

3. CONNECTIVITY

B. ABILITY TO EXPAND ROUTE

Historic Streetcar

Expanding service to the north along Broad Street would be challenging due to the BNSF heavy rail line crossing at Broad Street to the east of the streetcar route. The historic streetcars would not be able to climb the steep grades on Broad Street.

Modern Streetcar

Expanding service to the north along Broad Street would be challenging due to the BNSF heavy rail crossing and steep roadway grades. Modern streetcar service could be interlined with the First Hill streetcar line and any future streetcar alignments.

Historic Streetcar and Modern Streetcar

Expansion of the route north through Myrtle Edwards Park and the Olympic Sculpture Park to Terminal 91 would have significant impacts to the existing bicycle facilities and park. Also, transportation uses are not permitted in parks, and Referendum 42 requires the replacement of park land taken with similar quality parkland in the near vicinity.

Rubber Tire Transit

The route could be expanded to the north or south easily due to the flexibility of rubber tire vehicles and the existing road infrastructure. However, expansion to the north would require rubber tire transit to cross the BNSF track at Broad Street. Crossing the heavy rail tracks could create schedule reliability issues when buses need to wait for passing trains.

4. TRAVEL TIME

A. VEHICLE PERFORMANCE

Historic Streetcar

Prior to starting operation, the historic streetcar would require deceleration speed testing to establish operating speeds along the waterfront alignment; the historic streetcar has a slower acceleration rate and reduced components for emergency braking compared to the modern streetcar. This results in a slower operating speed and increased following distance, the distance between the historic streetcar and the vehicle in front of it, which was accounted for in the travel time analysis.

Modern Streetcar

The modern streetcar has an acceleration rate of 3.0 mph per second and a deceleration rate of 3.0 to 2.5 mph per second from 35 mph. The modern streetcar would accelerate to 28 mph in 9.3 seconds at a distance of 192 feet.

Rubber Tire Transit

The acceleration and deceleration rates are vehicle dependent. Limits on the top speed of vehicles, such as with some electric vehicles (of approximately 20 mph), were not considered in the evaluation of route travel time. Vehicles with lower top speeds could take slightly longer to travel the route depending on traffic conditions.

4. TRAVEL TIME

A. VEHICLE PERFORMANCE CONTINUED

Historic Streetcar

The historic streetcar has an acceleration rate of 2.5 miles per hour per second and an estimated deceleration rate of 3.0 to 2.5 miles per hour per second from a speed of 35 mph. The historic streetcar would be able to accelerate to 28 mph in 11 seconds in a distance of approximately 230 feet.

Modern Streetcar

Intentionally left blank

Rubber Tire Transit

Intentionally left blank

B. STATION DWELL TIME

The time vehicles are stopped to load and unload passengers at a station or bus stop.

Historic Streetcar

Option A

The low level investment alternative requires an operator for fare collection, which increases the time to load passengers. This option was assumed to have streetcars stop at stations (dwell time) for approximately 30 to 40 seconds with 10 passengers loading and unloading.

Option B

With the high level investment, some passengers would pay for their fare at kiosks located near the station. This would reduce the time it takes for passengers to load. Also, the high level of investment provides two doors; one to unload and another to load. By providing an at-grade station, passengers would take slightly longer because they would use steps to load and unload the streetcar. Streetcars were assumed to stop at stations (dwell times) for

Modern Streetcar

Modern streetcars are equipped with three doors, one single-wide door and two double-wide doors, to allow efficient passenger loading and unloading. The double-wide doors are used by disabled passengers to access the car. Some wheelchair users deploy a bridgeplate to eliminate the small gap between the curb and car; others choose not to use the bridgeplate. Fare payment would be collected off-board at station kiosks. These factors would result in modern streetcars stopping at stations (dwell time) for approximately 10-15 seconds with 10 passengers loading and unloading.

As ridership increases, the amount of time modern streetcars would remain at stations increases slightly because of the multiple doors and off-board fare payment: dwell time increases at a lower rate compared to the other alternatives with increased ridership.

Rubber Tire Transit

Vehicles would be equipped with an onboard fare payment box, similar to public transit in Seattle. Low floor boarding would allow passengers to easily step from the bus stop area onto waiting buses. Many of these vehicles are also equipped with a kneeling function, which allows the operator to lower the front door of the bus to near level with the adjacent bus stop.

Option A

Vehicles are typically equipped with one door that also serves as the wheelchair ramp access point. Mini-buses would stop at bus stops for approximately 30 to 40 seconds with 10 passengers loading and unloading.

Option B

Coaches would be equipped with two doors and would stop at bus stops for approximately 15 to 20 seconds with 10 passengers loading and unloading.

4.1 OPERATING CHARACTERISTICS

4. TRAVEL TIME

B. STATION DWELL TIME
CONTINUED

The time vehicles are stopped to load and unload passengers at a station or bus stop.

Historic Streetcar

approximately 20 to 30 seconds with 10 passengers loading and unloading.

For both historic streetcar options, wheelchair ramp deployments would increase the time a streetcar is stopped by approximately 60 seconds. The frequency of ramp deployments would be higher with at-grade stations (option B) because some riders would find the stairs difficult to navigate. However, in the event streetcars are unable to achieve a difference +/- 2 inches of the platform height, the time at stations could increase by approximately 60 seconds for wheelchair lift operations.

An increase in ridership would increase the dwell time at a greater rate for the low level investment (option A) with only one door compared to the high level investment (option B) with two doors.

Modern Streetcar

Intentionally left blank

Rubber Tire Transit

For both rubber tire transit options, wheelchair ramp deployments would increase the time vehicles are stopped by approximately 60 seconds. Also, an increase in ridership would increase the dwell time at a greater rate for the mini-bus vehicles (option A) with only one door compared to the larger coaches (option B) with two doors.

4.1 OPERATING CHARACTERISTICS

Historic 'George Benson' Streetcar Fare Collection

Seattle Streetcar Offboard Fare Kiosk

King County Metro Onboard ORca Card Readers

4.1 OPERATING CHARACTERISTICS

4. TRAVEL TIME

C. FARE COLLECTION

Off board fare payment reduces total passenger load time (part of station dwell time) by approximately 1 to 1.5 seconds per passenger. Passengers take an extra 1 to 2 seconds when using stairs to enter a transit vehicle compared to low-floor boarding.

Historic Streetcar

Option A

Option A would require onboard fare payment. This could include both a cash collection box and a card reader, which could be similar to King County Metro's ORCA card readers. An operator would monitor payments.

Option B

This would allow for off board fare payment, which uses ticket vending machines or card readers located at the station. Off board fare collection allows for faster passenger boarding since the driver does not have to monitor passenger payment or give change for cash fare payments and passengers load and unload through all vehicle doors.

Modern Streetcar

Modern streetcars are equipped with three doors, one single-wide door and two double-wide doors, to allow efficient passenger loading and unloading. The double-wide doors can be used by disabled passengers to load and unload the car without requiring the deployment of a ramp or lift because station design permits wheelchairs to roll onto the vehicle. Fare payment would be collected off-board at station kiosks. These factors would result in modern streetcars stopping at stations (dwell time) for approximately 15 seconds with 10 passengers loading and unloading.

As ridership increases, the amount of time modern streetcars would remain at stations increases slightly because of the multiple doors and off-board fare payment: dwell time increases at a lower rate compared to the other alternatives with increased ridership.

Rubber Tire Transit

Option A and B would likely use onboard fare payment, which would use a fare box at the front of each vehicle. On board fare payment increases the time vehicles stop at bus stops because the driver will have to monitor payments and passengers must load through the front door.

4.1 OPERATING CHARACTERISTICS

4. TRAVEL TIME

D. TRAVEL TIME

Travel times were estimated using traffic modeling software and represent 2030 traffic conditions during the busiest hour of the evening commute period.

Northbound travel times are slightly longer than southbound because there is a higher volume of opposite direction traffic, such as the southbound left turns.

Historic Streetcar

The historic streetcar options A and B would take approximately 32 minutes to complete a round trip. The northbound trip would take approximately 17 minutes and the southbound trip 15 minutes.

The average speed on the 3.2-mile roundtrip route, including intersection delay and dwell time at stops is approximately 6.0 miles per hour.

The travel time difference between the historic and modern streetcars is because of the longer assumed dwell time for historic streetcars and greater vehicle following distance requirement.

Option B could experience greater increases in travel time compared to option A during high ridership conditions. This is because option B requires passengers to navigate steps. Also, ADA passenger would have to use wheelchair lifts that could increase dwell time.

Modern Streetcar

The modern streetcar would take approximately 30 minutes to complete a round trip. The northbound trip would take approximately 16 minutes and the southbound trip 14 minutes.

The average speed on the 3.3-mile roundtrip route, including intersection delay and dwell time at stops is approximately 6.5 miles per hour.

The modern streetcar would complete the trip slightly faster than the other transit alternatives considered.

Rubber Tire Transit

Rubber tire transit options A and B would take approximately 37 minutes to complete a round trip. The northbound trip would take approximately 20 minutes and the southbound trip 17 minutes.

The average speed on the 3.5-mile roundtrip route, including intersection delay and dwell time at stops is approximately 5.7 miles per hour

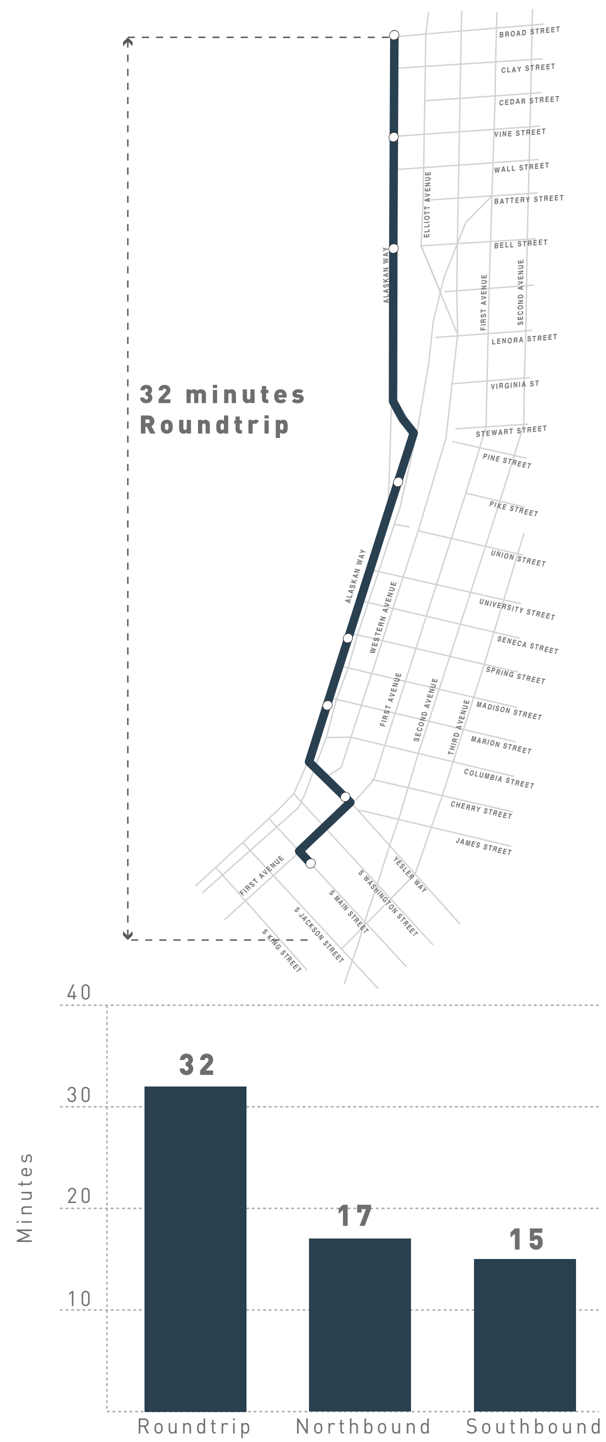
Rubber tire transit is estimated to have longer travel times compared to streetcars because of longer dwell times at bus stop and a slightly longer route.

Option A could experience greater increases in travel time compared to option B during high ridership conditions. This is because the option B vehicle accommodates approximately 2 times the passengers as option A.

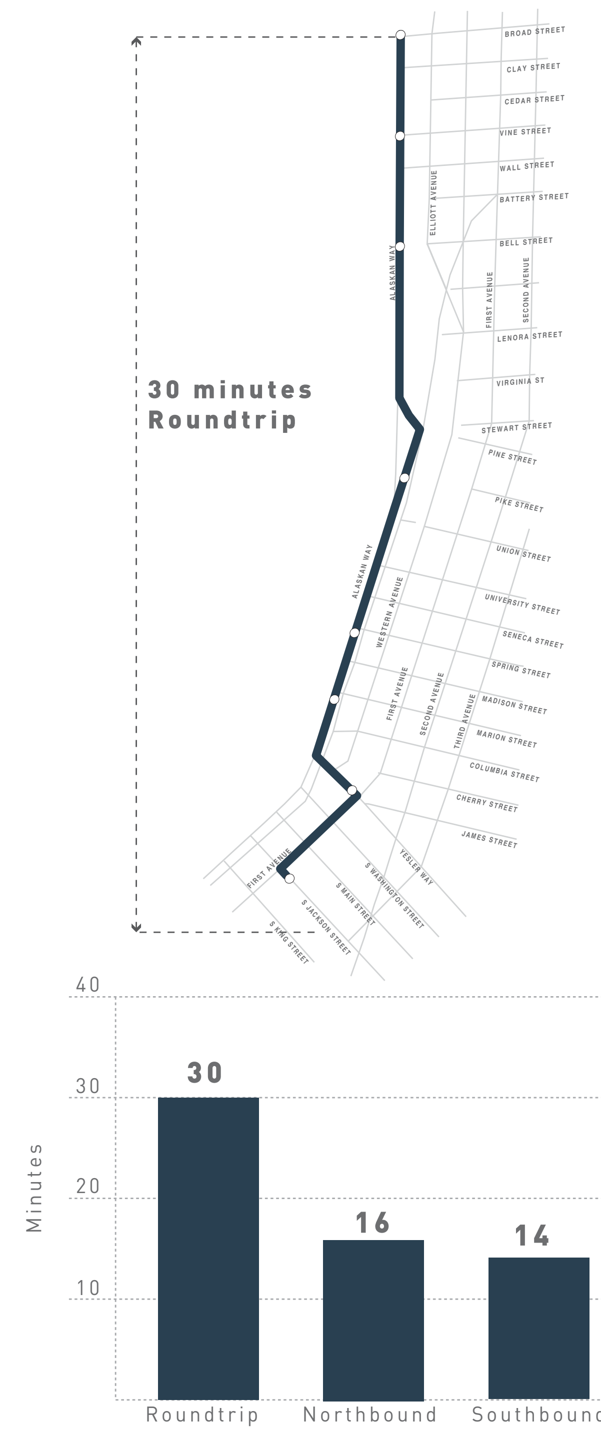
4.1 OPERATING CHARACTERISTICS

4. TRAVEL TIME

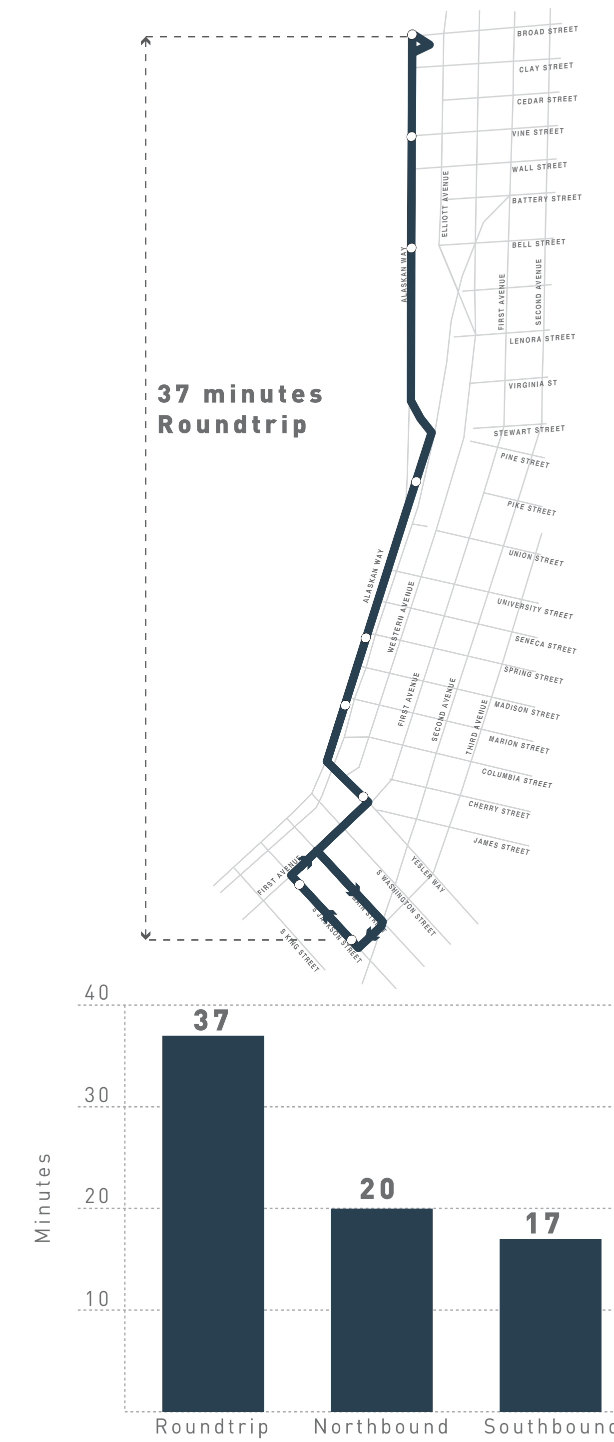
Historic Streetcar



Modern Streetcar



Rubber Tire Transit



4.1 OPERATING CHARACTERISTICS

4. TRAVEL TIME

E. TURNAROUND + LAYOVER

Historic Streetcar

For both investment levels, it was assumed that streetcars would have doors on both sides of the cars. This improvement eliminates the need for a turnaround track at either end of the alignment.

Historic streetcars would most likely layover at the end of the line stations; operators would switch to operate the streetcars from the other end, and likely use a switch track after leaving the station on the return trip. Operators would use the station platform to change ends of the streetcar for return trips.

Modern Streetcar

A crossover track, which would be used by streetcars to change from one direction of rail to the other (turnaround), at the southern terminus would be designed to minimize impact to First Hill streetcar operations. Design for layover space would need to be coordinated with First Hill streetcar operations. It is likely that a separate area for layover would be needed at this station, which could extend the First Hill Streetcar station between Occidental and 1st Avenue along Jackson Street.

The northern terminus (Alaskan Way and Broad Street) would have a single track at the station for streetcars to load, unload, and layover.

Rubber Tire Transit

The proposed rubber tire transit alignment does a loop, connecting along Main Street, 3rd Avenue, and Jackson Street. This eliminates the need for layover along this segment provided vehicles can layover along Main Street.

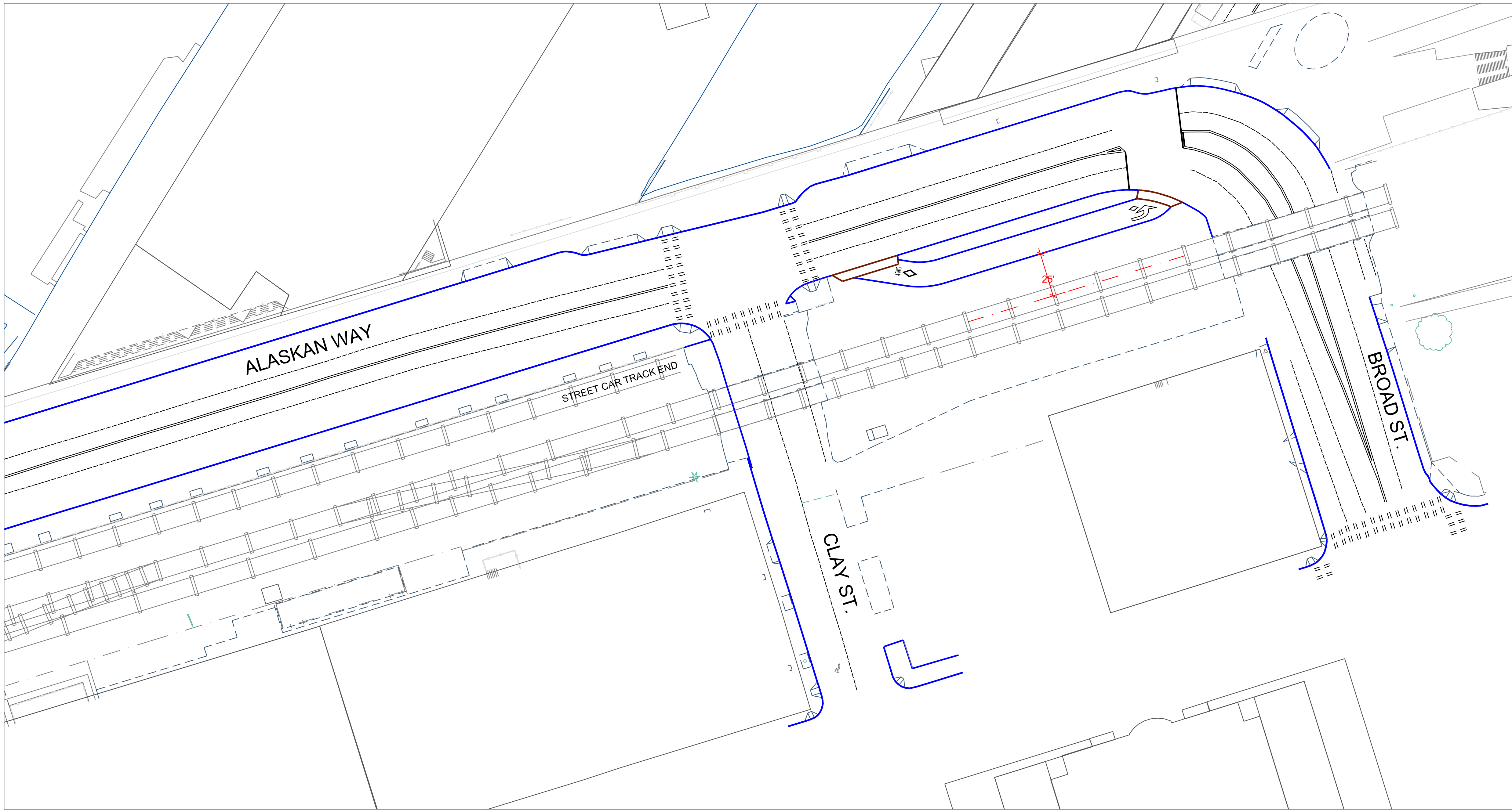
At the northern end of the alignment (Alaskan Way and Broad Street), a new transit-only roadway would be constructed to the east of Alaskan Way between the existing sidewalk and the BNSF rail line. A signal would be provided to permit vehicles to turn from the new road to return along Alaskan Way. Alternatively, vehicles could turnaround by continuing on Broad Street, and turning at Western Avenue, Clay Street and Elliott Avenue to return to Broad Street and then Alaskan Way. However, this routing would require buses to cross an active railroad and could increase the time to turnaround or negatively impact the reliability of mini-buss beginning service on-time.

Layover space for approximately 1 vehicle is needed; this would require approximately 30 to 80 feet of single lane road space. The transit-only roadway could provide space for layover.

4.1 OPERATING CHARACTERISTICS

4. TRAVEL TIME

E. TURNAROUND + LAYOVER, CONTINUED



North Terminus Turnaround for Rubber Tire Transit

4.1 OPERATING CHARACTERISTICS

5. SAFETY

	Historic Streetcar	Modern Streetcar	Rubber Tire Transit
A. CRASH-WORTHINESS + VEHICLE SAFETY	The historic streetcars do not meet modern strength and crash standards. While operating on city streets, in mixed traffic lanes, they can be exposed to Class 4 (450 and 4500 series trucks) and heavier vehicles (such as buses, dump trucks, and transport trucks) at speeds up to 35 mph. The braking system on historic streetcars is not as robust as a modern streetcar. These vehicles would undertake a certification process with the Federal Transit Administration. Necessary recommendations would be implemented to ensure compliance with FTA. This could include operating characteristics such as safe braking distances and following distances as well as operator training. However, historic streetcars operate in mixed traffic on San Francisco's Market Street with relative success. The historic streetcar is partially constructed of wood and does not comply with the modern National Fire Protection Association (NFPA) 130 Standard for Fixed Guideway Transit and Passenger Rail Systems. A complete rebuild with a steel superstructure and other modern fire-resistant materials would remedy NFPA compliance issues. However, Melbourne W-2	Modern streetcars meet standard strength and crash standards. Streetcars are tested to ensure safety and reliable operation upon delivery.	Rubber tire transit vehicles would meet modern strength and crash standards per the Federal Transit Administration's requirements.

4.1 OPERATING CHARACTERISTICS

5. SAFETY

	Historic Streetcar	Modern Streetcar	Rubber Tire Transit
A. CRASH-WORTHINESS + VEHICLE SAFETY CONTINUED	cars operate on a number of Heritage Lines despite these issues. Further risk analysis should be conducted if historic streetcars are chosen as the preferred alternative. The vehicle age, overall condition, and overall operating characteristics would likely result in more accidents per vehicle miles traveled compared to modern streetcars or rubber tire transit.	Intentionally left blank	Intentionally left blank
B. IMPACTS OF GRADE TO THE SYSTEM	The historic streetcar braking system would need to be able to respond quickly to traffic conditions, such as vehicles slowing down while in operation. Depending on the vehicle test findings, streetcars may need to travel at slower speeds and provide a greater separation distance between the streetcar and the vehicle it is following.	Intentionally left blank	Mini-buses and coaches may operate slower on uphill sections with a higher number of passengers.

4.1 OPERATING CHARACTERISTICS

6. RIDER ATTRACTION

	Historic Streetcar	Modern Streetcar	Rubber Tire Transit
A. SYSTEM VISIBILITY	Streetcars have a permanent quality because of their fixed track and overhead wires. It has a predictable destination because riders can see where the route goes along the waterfront. Also, some people will find it appealing to ride streetcar, whether historic or modern. This draws ridership to the system that rubber tire transit could not attract. These factors could increase ridership and reduce the demand for parking on the waterfront.		Rubber tire transit service is not as legible and predictable as streetcar service because there is no permanent infrastructure except for bus stops.

4.1 OPERATING CHARACTERISTICS

7. RIDER COMFORT + SATISFACTION

A. RIDER SATISFACTION

Historic Streetcar

Modern Streetcar

Streetcars provide a unique form of transit commuting for local residents and visitors to the waterfront. Streetcars can be quieter than other forms of transit with proper design and retrofitting. The relatively low environmental impact of the streetcar power system (electricity) and absence of exhaust fumes from the streetcar could be considered a positive aspect to riders.

Stations are located in the median of Alaskan Way, which is a busy 4-lane street. This could be uncomfortable and noisy for some riders. There could be limited weather protection at these stations because a shelter would be the only structure providing protection from wind and rain.

Historic streetcars provide a level of historical importance, nostalgia, and can be tourist attractors. They do not operate as smoothly as modern streetcars and air conditioning is not currently installed, which would reduce passenger comfort during warm weather. Space heaters are provided for warmth during cooler weather. Also, some of the streetcar seats are wooden and small compared to the other transit alternatives, which some passengers may find uncomfortable.

Modern streetcars are climate controlled and maintain quiet operations compared to other forms of transit. The controlled acceleration and deceleration of streetcar systems provides a smooth ride for passengers. These vehicles can accommodate between 140 to 150 passengers per streetcar, which could reduce the likelihood of full loads. Three sets of doors and retractable bridge-plates for access challenged passenger on each side of the streetcar allow passengers to load and unload quickly. Bikes and strollers can also be easily loaded and unloaded from the streetcar with its wide doors and open floor plan.

Rubber Tire Transit

Rubber tire transit vehicles are available that are modern and sleek, which riders may find appealing. All rubber tire vehicles would be climate controlled and may not operate as smoothly as modern streetcars. Curb side stops would allow passengers to look in store fronts while waiting, which provides a more pleasant experience. Passengers waiting at curb side stops would likely have greater protection from inclement and wet weather.

The relatively low environmental impact and absence of exhaust fumes from an all-electric bus (battery operated) could be make these buses more attractive to riders than the typical type of buses operated in Seattle.

Option A

Smaller mini-bus style vehicles would accommodate fewer passengers per trip than other alternatives, which may require passengers to wait for the next vehicle. If buses are nearly full, it can be difficult to unload people located near the rear of the vehicle.

Option B

Larger coaches would accommodate a similar number of passengers as the historic streetcar.

4.1 OPERATING CHARACTERISTICS

8. ADA + ACCESSIBILITY

A. STATION DESIGN

Historic Streetcar

Option A

The low level investment alternative (option A) would have high platforms similar to the existing stations. The historic streetcars were previously modified to provide level boarding for wheelchairs. This eliminated the original running boards and two-step entries on the streetcars, but required raising the station platforms to reach the floor height of the historic streetcar. Passenger shelters were provided on top of the elevated platforms.

These high platforms require ADA access ramps, which have requirements for how steep (expressed as a percent slope) and how long they can be. The existing streetcar platforms on Alaskan Way and Main Street had slopes measuring between approximately 3.8% and 5.3% and were approximately 16 feet to 27 feet in length. These ramp measurements meet current ADA accessible route standards, which have slopes between 8.3% and 6.25% for 30 feet in length. To improve access to these stations, ADA elevators could be installed at an additional cost. The existing historical streetcar platforms vary in width between

Modern Streetcar

Modern streetcar stations would be constructed similar to the South Lake Union and First Hill streetcar stations. Modern streetcars are constructed so that passengers can enter at near sidewalk level. Stations may require a slight elevation from the typical 6 inch curb, but modern streetcar floor heights are designed to be within +/- 0.5 inches of the platform height. These stations would be ADA compliant and equipped with passenger shelters. Arrival information signs could also be provided to increase passenger comfort and ease of use of the streetcar system.

Rubber Tire Transit

Bus stops would be located curb side and provide near level boarding from the sidewalk. Stops could feature a unique shelter design and signage to identify and brand the waterfront transit alignment.

All bus stops would allow buses to stop in the travel lane to avoid bus travel time delays associated with merging back into the vehicle traffic lane. The sidewalk area would extend through the parking lane to meet the bus and would provide additional area for passengers and bus stop amenities. This design would reduce the impact on sidewalk space from rubber tire transit activities.

4.1 OPERATING CHARACTERISTICS

8. ADA + ACCESSIBILITY

Historic Streetcar

A. STATION DESIGN
CONTINUED

approximately 6.9 feet and 8.0 feet. With the current configuration, it can be difficult for two wheelchairs to pass each other along the ramps and platforms.

Option B

The higher level investment would have at-grade platforms. This would require wheelchair lifts on vehicle or at stations; platform lifts similar to those used in Memphis and in Portland (such as Spectralift) could be installed. This would require removal of the existing stations.

Modern Streetcar

Intentionally left blank

Rubber Tire Transit

Intentionally left blank

Historic streetcar station

Modern streetcar station

Rubber tire transit station

4.1 OPERATING CHARACTERISTICS

8. ADA + ACCESSIBILITY

	Historic Streetcar	Modern Streetcar	Rubber Tire Transit
B. COMFORT ACCESSING STATIONS	With the selected alignment of streetcars operating in the inside lanes along Alaskan Way, stations would be located in the median. This would require passengers to access stations via signalized crosswalks whether arriving at or leaving the streetcar. Some patrons may find waiting at a median station uncomfortable because of the number of vehicles traveling on Alaskan Way during the peak commuter periods. All station areas would be well lit to improve visibility for users and people traveling near station areas.		Passengers would be relatively comfortable accessing stops compared to high-platform median streetcar stations because the rubber tire transit service is accessed via low platform curb side stops.

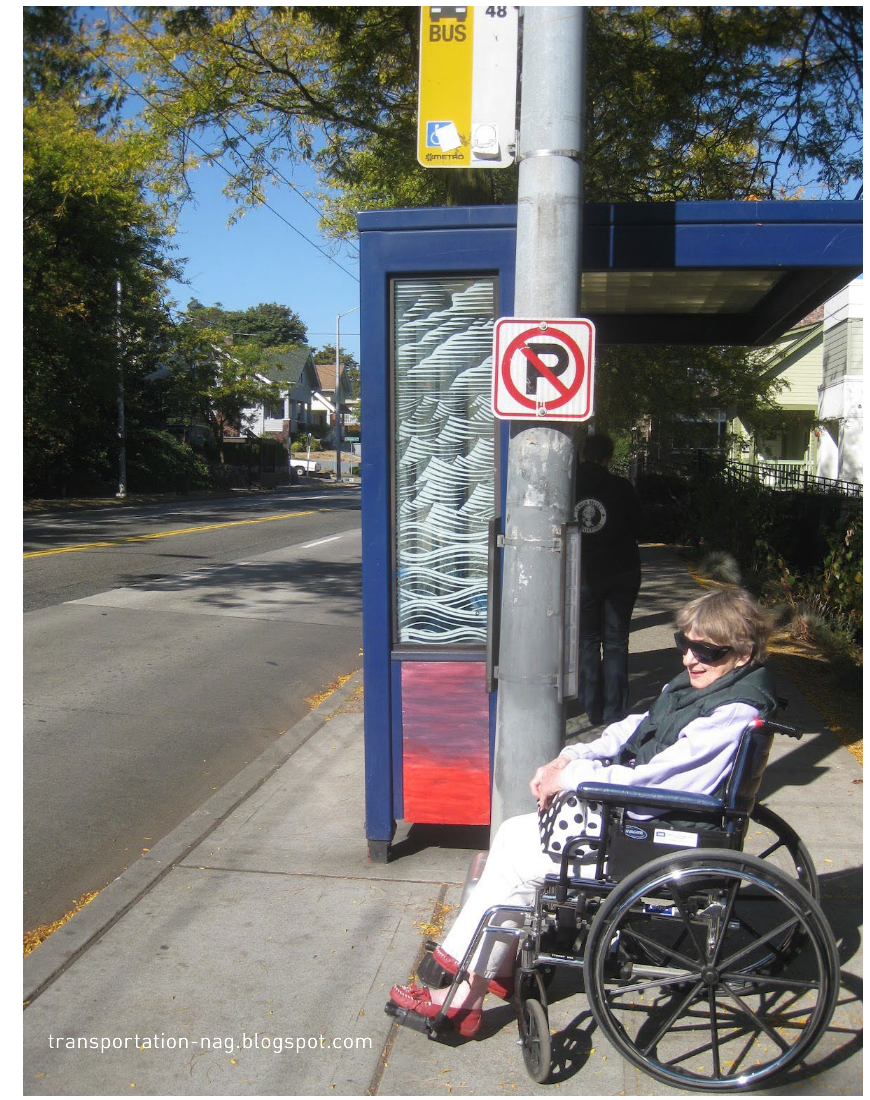
Option A

Median stations for the low level investment would be elevated more than 2 feet above the roadway. This requires ramps leading up to the station platform for ADA accessibility. This design could create discomfort for some passengers.

4.1 OPERATING CHARACTERISTICS

Historic streetcar station ADA ramp

ADA passenger accessing modern streetcar station



ADA passenger accessing bus stop

4.2 EFFECTS ON THE ENVIRONMENT AND OTHER WATERFRONT USERS

1. NOISE

Historic Streetcar / Modern Streetcar

Electric motors operate at lower decibel levels than diesel engines. Streetcars would produce similar amounts of noise as a passenger vehicle.

Turning on tracks can create noise issues if the turn radii are less than 1,000 feet. Mitigation measures to reduce sound from wheel squeal could be considered in locations where the turn radius is expected to be at or below 1,000 feet. These include the use of resilient, damped, or profiled wheels; alternative rail materials and rail lubrication.

While streetcars are generally less susceptible to wheel squeal than long-wheelbase subway cars, wheel squeal can occur where turn radii are less than 1,000 feet. Squeal is irritating to people nearby because it includes high-frequency noise and can generate an Lmax noise level around 100 dBA at 50 feet from the tracks. It can be eliminated by increasing curve radius or reduced with several measures discussed under mitigation. With incorporation of appropriate mitigation measures, substantial squeal is not anticipated from the streetcar.

Rubber Tire Transit

All-electric vehicles would have similar operating noise levels as passenger vehicles.

2. AIR QUALITY

Historic Streetcar / Modern Streetcar

Electricity that would be used to power the streetcar system has been and will continue to be obtained from Seattle City Light, which uses coal and natural gas to generate only 2 percent of its electricity and the remaining 98 percent is generated from non-GHG emitting sources (hydroelectric, wind, nuclear, etc.).

Rubber Tire Transit

An electric bus would have similar air quality impacts as the streetcars.

4.2 EFFECTS ON THE ENVIRONMENT AND OTHER WATERFRONT USERS

3. VISUAL QUALITY

Historic Streetcar

Historic streetcars are visually interesting and bring a historic character to the waterfront. Trolley wires and poles are required to operate the streetcar and contribute to visual clutter and view obstruction. Also, high platform stations with shelters assumed in option B could block sight lines and are visually intrusive in discrete areas along the waterfront.

Modern Streetcar

Modern streetcars have a sleek and modern appearance that could contribute to the overall visual quality of the waterfront. Also, modern streetcars could incorporate colorful and contemporary design elements into the streetscape. Trolley wires and poles are required to operate the streetcar for at least a portion of the alignment, which contributes to visual clutter and view obstruction. However, some sections of the alignment could be operated on battery power to reduce the presence of trolley wires.

Rubber Tire Transit

Rubber tire transit vehicles would be the least aesthetically pleasing vehicle option for waterfront transit. However, they could have a unique waterfront branding scheme. Buses would have the least negative visual impacts because vehicles are smaller and would not require overhead wires.

The mini-bus (option A) could develop an iconic element similar to the iconic character of the streetcar because of its unique appearance.

Historic Streetcar with station and overhead wires

South Lake Union Streetcar Catenary (overhead wire) System

Seattle bus stop with minimal view obstruction

4.2 EFFECTS ON THE ENVIRONMENT AND OTHER WATERFRONT USERS

4. TRAFFIC IMPACTS

	Historic Streetcar	Modern Streetcar	Rubber Tire Transit
A. TRAFFIC SIGNAL MODIFICATIONS	A new signal would be needed to provide a protected movement for southbound streetcars to transition from the dedicated right of way at Lenora Street to the travel lane along Alaskan Way. Also, transit signal priority, which provides a green light to streetcars at a signalized intersection sooner than general purpose traffic, is not anticipated to be provided along the waterfront. If alternative lane running options are considered, such as the streetcar operating along the outside (curb) lane, different traffic signal modification would be required. These are described in chapter 3.		Transit signal priority, which provides an advance green light to buses stopped at a signalized intersection sooner than general purpose traffic, is not anticipated to be provided along the waterfront. A transit queue jump, which allows buses to move through an intersection ahead of other vehicles, could be provided northbound at Pike Street. This would allow rubber tire vehicles to efficiently merge from the bus stop south of Pike Street to the left turn lane at Pine Street. This may also reduce any impact associated with a proposed Pike Street Market bus stop on the east side of Alaskan Way between Pine and Pike Streets.
	Signal modifications along Alaskan Way for pedestrians are required as part of the street redesign. Signal modifications for vehicle movement at the Waterfront Landings driveway, located near Virginia Street, will also be required. All signal modification elements could be incorporated and designed as part of the Alaskan Way surface street redesign.		
B. IMPACTS TO OTHER TRANSIT SERVICE	King County Metro is anticipated to operate bus service along Alaskan Way that connects to Columbia Street, which replaces the Alaskan Way Viaduct service entering from Columbia Street and exiting to Seneca Street. The proposed Alaskan Way roadway configuration provides an all-day transit priority lane northbound along Alaskan Way to Columbia Street and southbound along Alaskan Way between Columbia Street and Yesler Way. This route serves mostly commuters and has a higher number of buses traveling northbound in the mornings and southbound in the evenings. Currently, this southwest transit pathway accommodates approximately 530 daily bus trips, with approximately 50 buses an hour in the peak direction.		

4.2 EFFECTS ON THE ENVIRONMENT AND OTHER WATERFRONT USERS

4. TRAFFIC IMPACTS

Historic Streetcar | **Modern Streetcar** | **Rubber Tire Transit**

B. IMPACTS TO OTHER TRANSIT SERVICE
CONTINUED

Operating 3 to 4 streetcars an hour is not anticipated to significantly impact other transit operations because any interaction with other transit services occurs between Yesler Way and Columbia Street. Because the streetcar would operate along the inside lane, this would not interfere with the ability for other transit service to operate along the waterfront.

The northbound curb side bus stops would be located north of Columbia Street, so there is no conflict with the King County Metro southwest transit pathway.

C. IMPACTS TO NONMOTORIZED TRAVELERS

Bicyclists would use a 12-foot two-way cycle track located on the west side of Alaskan Way. This facility would cross Alaskan Way and connect to the existing Elliott Bay Trail on the east side north of Pine Street. Some bicyclists will ride in the street, including those traveling to the new Elliott Way surface street instead of continuing on Alaskan Way. Sharrows, painted symbols on the street indicating where bicyclists should ride, would be retained.

Bicyclists and other nonmotorized wheeled forms of travel would need to take extra caution when traveling parallel or across streetcar tracks.

Pedestrians would generally not be impacted by waterfront transit options except accessing stations, which is described under Station Design.

4. TRAFFIC IMPACTS

D. IMPACTS TO GENERAL PURPOSE TRAFFIC

Historic Streetcar / **Modern Streetcar**

The assumed frequency of streetcars would not significantly impact the travel time of other vehicles. Vehicles following transit service would experience some travel time delay when streetcars serve a station. With a median station, it is possible, although rare, that a streetcar could be stopped at a station and a vehicle could be attempting to park. This would block traffic for approximately 20 seconds or less and is only an impact if the direction of travel traffic signal is green.

Streetcars would have some impacts on parking throughout the alignment. These impacts would be fewer on Alaskan Way than those of rubber tire transit because stations would be located in the median. However, streetcar service would have more impacts to parking on Yesler Way. This is because parking would need to be removed on one side of the street to provide safe bicycle facilities.

Rubber Tire Transit

The assumed frequency of rubber tire transit would not significantly impact the travel time of other vehicles. Vehicles following transit service would experience some travel time delay when buses serve a stop. While buses serve a bus stop, vehicles would be blocked for approximately 20-40 seconds.

Throughout the alignment, approximately 1 to 2 parking spaces would be removed to accommodate in-lane bus stops where on-street parking is provided.

5. UTILITY CONFLICTS

Historic Streetcar / **Modern Streetcar**

Alaskan Way is a primary utility corridor. Although there would be utility conflicts with providing streetcar along the waterfront, none of the utility conflicts are seen as a critical obstacle to streetcar operations. Utility repairs could cause a disruption in service if utilities are located under the track bed. Construction of a streetcar alternative would require additional technical assessment and interagency coordination to address any utility conflicts. Streetcars would parallel Seattle City Light's high voltage line which exchanges power between Washington State and California State. Construction of a streetcar system would likely require design approaches to limit heat impacts to underground power lines.

Rubber Tire Transit

There would be minor utility conflicts associated with bus stop construction; the bus shelters and amenities would be attached to sidewalk or curb extension areas and utilities could be located beneath these facilities.

4.3 COSTS

This chapter summarizes operations and maintenance costs, and capital costs for each of the transit alternatives.

1. COST ASSUMPTIONS

	Historic Streetcar	Modern Streetcar	Rubber Tire Transit
A. HEADWAY ASSUMPTIONS	15 minutes	15 minutes	10 minutes
B. SYSTEM LENGTH	1.6 miles from Main Street to Broad Street. 2.1 track miles to be constructed	1.6 miles from Jackson Street to Broad Street. 2.2 track miles to be constructed	1.8 miles from Jackson Street/3rd Ave to Broad
C. TRAVEL TIME	32 minutes (15 southbound/17 northbound)	30 minutes (14 southbound/16 northbound)	37 minutes (17 southbound/20 northbound)
D. SERVICE HOURS PER VEHICLE	Assumed to be similar to South Lake Union streetcar Monday-Thursday: 15 hours/day; Friday-Saturday: 17 hours/day; Sunday: 9 hours/day Annual Total: 5,356 hours	Assumed to be similar to South Lake Union streetcar Monday-Thursday: 15 hours/day; Friday-Saturday: 17 hours/day; Sunday: 9 hours/day Annual Total: 5,356 hours	Assumed to be similar to South Lake Union streetcar Monday-Thursday: 15 hours/day; Friday-Saturday: 17 hours/day; Sunday: 9 hours/day Annual Total: 5,356 hours
E. NUMBER OF VEHICLES	It was assumed that 3 vehicles would be available regularly to serve this route, and 2 would be out-of-service for maintenance or held in reserve. The historic streetcar could operate 10-minute headways with 4 vehicles in service.	It was assumed that 3 vehicles would be operating to maintain the proposed 15-minute headways and a spare streetcar could be shared with the First Hill line. An additional vehicle would be needed for 10-minute headways.	It was assumed that 5 vehicles would be needed to maintain 10-minute headways and 1 would be out-of-service for maintenance or held in reserve. An additional vehicle would be needed for 8-minute headways.
F. OPERATIONS + MAINTENANCE ASSUMPTIONS	Costs assumed the same headway for peak and off-peak service. Operating costs were assumed to be similar to the South Lake Union streetcar with the addition of a full day of service for 1 vehicle per day at $165 per hour. Costs could be slightly higher	Costs assumed the same headway for peak and off-peak service. Operating costs were assumed to be similar to the South Lake Union streetcar with the addition of a full day of service for 1 vehicle per day at $165 per hour. 1 driver per vehicle was assumed.	Costs assumed the same headway for peak and off-peak service. Fully loaded service hour costs for a battery operated vehicle were assumed to be between $56 per hour for a non-profit operator and $116 per hour for a local transit agency operator,

4.3 COSTS

1. COST ASSUMPTIONS

	Historic Streetcar	Modern Streetcar	Rubber Tire Transit
F. OPERATIONS + MAINTENANCE ASSUMPTIONS CONTINUED	with the need to fabricate some replacement parts or availability of other replacement parts. **Option A** It was assumed that 2 on-board personnel (driver and conductor) would be required on each vehicle at an additional cost of $90,000 per operator per year.	Intentionally left blank	such as King County Metro. One driver per vehicle was assumed.
E. CAPITAL COST ASSUMPTIONS	It was assumed that the single track section north of Lenora Street would not be improved. The cost to construct track was assumed to be similar to the First Hill streetcar. The marginal cost, which removed roadway related construction costs from the First Hill bid tabs, was assumed to be approximately $7.83 million per track mile. **Option B** The existing stations on the single track segment of the alignment would need to be demolished and reconstructed as low floor platforms. It was assumed that the cost to construct low platform stations would be similar to the First Hill streetcar stations.	It was assumed that the single track section north of Lenora would not be improved. The cost to construct the track was assumed to be similar to the First Hill streetcar. The marginal cost, which removed roadway related construction costs from the First Hill bid tabs, was assumed to be approximately $7.83 million per track mile.	**Option A** Fees for bus storage are assumed to be included in the operation and maintenance cost.

4.3 COSTS

2. OPERATIONS + MAINTENANCE COSTS

C. OPERATIONS + MAINTENANCE

Historic Streetcar

Option A

The operating budget including two on-board personnel per vehicle would be approximately $3.5 million per year.

Option B

Approximately $3.3 million per year, including a full day of service for an additional vehicle.

Modern Streetcar

Approximately $3.3 million per year, including a full day of service for an additional vehicle.

Rubber Tire Transit

Option A

Approximately $1.5 to $3.1 million per year depending on operator.

Option B

Approximately $3.1 million per year.

Previous historic streetcar maintenance barn

South Lake Union streetcar maintenance barn

King County Metro Atlantic base bus parking

4.3 COSTS

2. CAPITAL COSTS

	Historic Streetcar	Modern Streetcar	Rubber Tire Transit
A. VEHICLE COST	**Option A: Lower Investment** Approximately $1.4 million to reactivate the streetcars, upgrade the electrical system and retrofit the vehicles to have 2 doors on each side. **Option B: Higher Investment** Approximately $14.8 million to make the same modifications as option A and also convert to a 750 volt DC power system, automate the doors and install wheelchair lifts.	Approximately $11.3 million.	**Option A** Approximately $4.2 million. **Option B** Approximately $5.4 million.
B. MAINTENANCE BASE COSTS	Both options would require a maintenance facility, which would likely be located under Elliott Way or elsewhere in proximity to the alignment. A 2004 King County Metro study estimated that the approximate cost would be between $16.9 to $23.4 million (when adjusted from 2004 to 2013 dollars). The low end estimation includes inflated costs for design, construction and track ($10.4 million) and uninflated costs for site acquisition ($6.5 million); the high end estimation includes the costs estimates with inflation for construction, site acquisition, design and track.	The First Hill Streetcar Charles Street base vehicle maintenance facility was approximately $8 million to construct. The waterfront streetcar would be able to use this facility, but would require some additional storage space and some existing site functions would need to be relocated off-site. The cost to relocate some functions and acquire additional space would be approximately $3 million to $10 million. An additional study would need to be conducted to determine a more detailed cost estimate.	A new facility for waterfront rubber tire service would likely not be needed. Transit service could be contracted privately or with an existing transit agency. The cost for storing vehicles is typically captured as part of an administrative cost charged by the operating company or agency.

4.3 COSTS

2. CAPITAL COSTS

	Historic Streetcar	Modern Streetcar	Rubber Tire Transit
C. SYSTEM COSTS	**Option A** Approximately $16.7 million to construct track and stations between the south terminus and Pine Street. **Option B** Approximately $16.7 million to construct track and build stations along the alignment.	Approximately $17.5 million to construct track and stations.	Approximately $1.7 million to construct bus stops and purchase 2 charging stations.
D. TOTAL CAPITAL COSTS	**Option A** Approximately $35-41 million. **Option B** Approximately $49-55 million.	Approximately $32 to $39 million.	**Option A** Approximately $6 million. **Option B** Approximately $7 million