Seattle Streetcar Network and Feasibility Analysis

Prepared for:

Seattle Department of Transportation

Prepared by:

Parsons Brinckerhoff

in association with

Nelson Nygaard Consulting Associates

& URS Corporation

June 30, 2004

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Executive Summary

In February of 2004, the Seattle Department of Transportation began a study designed to respond to the City Council's request for information that would "support decision-making about a proposed new route in South Lake Union, and about proposed extensions of the Waterfront Streetcar." In addition to providing information about the South Lake Union route and potential Waterfront Streetcar extensions, the report takes a preliminary look at what a future streetcar network could look like.

Background

More than a dozen North American cities have streetcar systems that have either been expanded or begun operation in the past 15 years. In addition, at least twice as many other cities have new systems or new lines under active planning. The primary advantages of streetcars are the ability to add a visible rail system at a minimum capital investment, and the ability to create a circulator that connects into a high capacity transit network without requiring additional extension or expansion of the more expensive high capacity mode. Streetcars are also popular because they are a good fit for densely developed, pedestrian-oriented, urban neighborhoods. Successful new systems in neighboring cities of Portland, Oregon and Tacoma, Washington further encourage the implementation of streetcars in this city.

As part of this report, other cities with streetcar systems in place were researched. From this research it is possible to derive common characteristics of streetcar lines and the conditions that contribute to successful streetcar implementation.

Streetcar Characteristics

Streetcar service typically operates in mixed traffic in high-density areas. Service is frequent, generally between 10 and 15 minutes between cars. Stop spacing is relatively short, as opposed to high capacity transit where, to achieve maximum speeds, spacing is much greater. Average operating speed is consistent with other vehicles in the street as streetcars typically travel in the roadway with other vehicles, rather on dedicated rights of way.

Other key streetcar characteristics include:

- Streetcars provide a visible and easy-to-understand routing, which attracts new users. In fact, in cities where bus lines have converted to streetcars, ridership has increased from 15% (Toronto) to 500% (Tacoma). In Memphis, 83% of streetcar riders do not otherwise use public transit, suggesting that streetcars could attract riders that similar bus services cannot.
- Streetcars attract both a visitor market and a local user market to transit. The Toronto Transit Commission estimates that 60% of streetcar riders are "choice" riders, that is, those who have a car, but choose to take the streetcar instead.

- Streetcars generally serve local neighborhood circulation needs. Streetcar stop spacing is often closer than light rail or bus rapid transit, as streetcar service is designed for making neighborhood connections and connections to higher capacity services, rather than providing the high speed or high capacity service themselves.
- In comparison to other fixed rail transit (e.g. light rail, monorail) streetcars cost far less to construct.
- Streetcars often attract private funding. Private property owners have contributed to capital costs through various means, including the formation of a Local Improvement District (e.g. Seattle Waterfront Streetcar; Portland Streetcar), thus reducing the public's share of the capital cost.
- Streetcars have contributed significantly to the economic development of their neighborhoods. Portland has seen more than $1.3 billion in private investment since planning began for its initial line.

Based on these characteristics, research suggests that the following conditions contribute to maximizing the success of a streetcar line.

- A service area that includes a mix of uses or a variety of markets. While commuters are an important part of the market, tourists, visitors, residents and workers making trips to local destinations fill out the ridership during the non-commute times.
- Desire to accelerate and organize planned development.
- Property owners willing to contribute to the success of the streetcar.
- Demand is present for relatively short trips where vehicle speed is not a critical factor.
- Demand is present for connections to the high capacity network. Streetcars work well as a neighborhood collector to feed the larger network.
- Streetcar streets are not severely congested, and limited competition for street space exists.
- Demand for high frequency service, but without the capacity demands that would support light rail transit.

Evaluating Potential Streetcar Routes in Seattle

In evaluating potential streetcar routes, the study began with the routes identified by the City Council as being of interest, then slightly broadened the scope to look at some additional routes that could contribute to a streetcar network. The study then conducted a more detailed analysis in order to provide information that would support decision making about the South Lake Union route or potential extensions of the Waterfront Streetcar. Some preliminary information about a potential extension of the South Lake Union route that would serve the University of Washington is also included.

Priorities for Implementation

The proposed streetcar line connecting the newly developing South Lake Union and Denny Triangle neighborhoods with the retail core and major transportation node at Westlake Center is the single most promising line for a new streetcar line in central Seattle. This line not only meets all criteria for a successful streetcar corridor, but it could be built without being dependent on, or interrupted by, any of the major construction projects anticipated in the Center City area.

The extension of the existing Waterfront Streetcar from the Chinatown/International District Station along the S. Jackson Street corridor to 12th Avenue S. is another promising corridor for future streetcar service, which could be extended to 23rd Avenue S. The line would connect tourist and entertainment destinations along the waterfront, through Pioneer Square, into the busy Chinatown/International District and beyond. The route meets many of the criteria for success, but currently lacks the added incentive of a defined relationship with private property owners or other outside funding. In addition, timing may be affected by the Alaskan Way Viaduct and Seawall Replacement Project. In addition to extending the streetcar line to the east, future land use changes could justify an extension of the Waterfront Streetcar to the south and the north, but such extensions cannot be planned in any detail until the Alaskan Way Viaduct and waterfront planning are complete. Parts of this study may help inform those planning processes.

Another potential streetcar route that appears promising is to extend the proposed South Lake Union line north to serve the Eastlake neighborhood and destinations in the University district, including the University of Washington medical campus, and/or connecting to the regional transit system at NE 45th Street and Brooklyn Avenue NE.

Table 1. Summary of Potential Future Streetcar Corridors

Corridor	South Lake Union from Westlake to Yale	South Lake Union from Yale to the UW	Chinatown/ International District/ S. Jackson Street	Waterfront North to Interbay	Waterfront to SoDo and/or T-46
Demand/ Market	20,000 new workers and 17,000 new residents anticipated by 2020 in South Lake Union. High demand for recreational and visitor travel to lakefront. Additional growth anticipated for Denny Triangle.	Connections between proposed South Lake Union Streetcar and UW. Connections between campus and research facilities, including biotech campus. Direct connection via streetcar from downtown.	High-density employment and housing in Chinatown/International District, especially west of 12th Avenue S. Major tourist and recreational destination. Connections to regional transit and Amtrak.	W. Thomas Street pedestrian bridge opens new opportunities for waterfront travel. Amgen employs 2000. Potential new mixed-use neighborhood.	Major mixed-use development potential at T-46. Growing redevelopment throughout the south waterfront. Potential visitor connections at cruise terminal.
Land Uses	Newly developing area, with extensive housing and commercial expansion planned.	Recreational opportunities along lakefront. Employment & educational markets connecting SLU and UW.	Redevelopment potential as well as existing dense land uses. Highest density closest to International District Station.	Currently "single loaded" relatively industrial development with redevelopment or intensification potential.	"Single loaded" development on one side of freight tracks. Significant potential, but no definite land use plans for T-46.
Connections to Other Modes	Connections to major multi-modal hub at Westlake.	Creates single continuous alignment between Westlake hub and campus. Potential connections to Light Rail at UW.	Connections to major regional hub at International District Station.	Potential connection to the future monorail station at Blaine Street.	Monorail connection at Royal Brougham Way. (Could be distance depending on streetcar routing.)
Dependencies	None	Requires basic South Lake Union Line to be in place.	None for short line operation. Maintenance facility site in Pioneer Square or Chinatown/ International District needs to be identified.	Requires connections to operating Waterfront Streetcar line – need Alaskan Way Viaduct reconstruction completed.	Need infill development at T-46 and beyond. Requires completion of Alaskan Way Viaduct construction and operational Waterfront Streetcar line.
Potential Implementation Order (1-5)	1	2	2	4 to W Thomas St. or Amgen 5 Beyond (unless development occurs sooner)	5 (unless development occurs sooner)

1. INTRODUCTION

In February of 2004, the Seattle Department of Transportation began a study designed to respond to the City Council's request for information that would "support decision-making about a proposed new route in South Lake Union, and about proposed extensions of the Waterfront Streetcar." In addition to providing information about the South Lake Union route and potential Waterfront Streetcar extensions, the report takes a preliminary look at what a future streetcar network could look like.

This report was funded through a federal grant, with King County Metro providing technical and financial assistance.

Section 2 describes what a streetcar is, identifies conditions that support successful streetcar development, and provides information about streetcar projects in other cities.

Section 3 provides background information on other transportation planning in Seattle, reviews routes for a potential future streetcar network, provides ridership estimates for a South Lake Union streetcar and potential Waterfront Streetcar extensions, and describes streetcar construction techniques, streetcar vehicles, and typical streetscape treatments.

Section 4 provides technical and environmental information about a South Lake Union streetcar and potential Waterfront Streetcar extensions and describes maintenance base requirements.

Section 5 is a discussion of operating and maintenance cost estimates, as well as capital cost estimates. The section also describes funding options.

In addition, there are several appendices to this analysis. Appendix A is a list of peer city contacts. Appendix B is a series of detailed alignment drawings for the South Lake Union and Waterfront Streetcar extensions. Appendix C is a comparative table of bus ridership on King County Metro bus routes. And Appendix D is an analysis of potential Section 4(f) resources for the Waterfront-North Alignment.

2. STREETCARS AND NETWORKS

This section describes the characteristics of streetcars, compares streetcars to other transit modes, identifies conditions that support successful streetcar routes, and describes streetcar projects in other cities.

2.1 Streetcar Characteristics

Streetcar service is a unique mode of transportation that is well suited to specific environments and needs. Table 2 compares streetcars to light rail, monorail and bus technologies.

Key characteristics of streetcars include:

- **Streetcars generally attract at least 15-50 percent more riders than bus routes in the same area. In many cases, the difference in ridership is much higher.** Based on recent North American examples of streetcar implementation, there is a clear ridership boost that could be attributed directly to the implementation of streetcar replacing bus service in a given corridor. In Toronto, on routes where streetcar service replaced a nearly identical bus service, ridership increased between 15-25 percent. A particularly dramatic example could be found in Tacoma, where streetcar service is running on a future light rail transit (LRT) alignment. Transit ridership in the streetcar corridor increased by over 500 percent compared to the bus route that ran previously. The route charges no fares and offers free parking, conditions that were present on the previous bus route as well. San Francisco experienced a three-fold increase over bus ridership in the corridor since opening its new streetcar line.
- **Streetcars often attract private funding.** Property owners are often willing to financially contribute to a streetcar system because they realize the value that a streetcar brings to their property and to the neighborhood. In Portland and other cities, private owners were willing to "tax themselves" either through fees, benefit districts, or other forms of exactions to receive the benefits of a fixed streetcar system. In Portland, an Local Improvement District (LID) provided 17 percent of the project's capital cost. Seattle's existing Waterfront Streetcar was partially funded through a Local Improvement District, which provided 32 percent of the total capital cost. For the proposed South Lake Union line, property owners are proposing to fund more than 50 percent of the cost through an LID.
- **Similar to other street-running modes, streetcars are generally focused on serving a neighborhood, not just moving through it rapidly.** While streetcars could benefit from many of the same treatments that would be given to improve speed on other transit modes such as signal preemption, queue jumps, longer stop spacing and exclusive right of way, modern streetcars typically have minimal priorities over other vehicles and are often designed to operate in mixed flow with vehicular traffic. Streetcar stops are generally spaced closer together than light rail or bus rapid transit, because streetcar service is designed for local circulation and connections to higher capacity services rather than providing high speed or high capacity service themselves.

- **Streetcars provide a visible and easy to understand routing which attracts new users.** Rail systems in general provide a physical presence on the street that is easy to comprehend. Riders could stand at a stop and literally see where the line comes from and where it is going. Visitors and occasional users are more inclined to use them, since there is less confusion about the streetcar than about taking one of many possible bus routes.
- **Streetcars attract both a visitor market and a local user market to transit.** The fact that streetcars are easy to "understand" and often operate in areas with high visitor populations, helps attract visitors as well as local riders. Modern streetcar operations often use "vintage-style" vehicles, or may actually use rehabilitated vehicles from earlier eras (such as the existing Waterfront Streetcar in Seattle). Some systems use very modern, but distinctive vehicles. All of these vehicle types help attract visitors, as well as local riders, to transit.
- **Streetcars catalyze and organize development.** Throughout their history, streetcar lines have been an organizing principle behind new development. Streetcars could help create dense pedestrian environments where access to local streetcar stops is possible by foot. Historically, bus routes are added once an area has developed and the demand is in place.
- **A number of cities with more recent streetcar investments credit the streetcar with catalyzing infill development.** Since the decision to build the streetcar was made, over $1.3 billion in new development has occurred around Portland's streetcar line including retail, office and housing. In Memphis, 4000 residential units have been built within a block of the streetcar in a formerly underused industrial area. Although it is difficult to know whether development would have happened at the same pace without the streetcar investment, it appears that the streetcar line provided a "focus" which organized development and assured the transit focus of new development along and spreading out from the streetcar corridor.
- **Streetcar costs are higher than bus infrastructure, but lower than light rail.** The cost for streetcar construction is approximately $20-$40M per mile and $2.5-3M is typical for each car. This price compares to $50 to $75M per mile for LRT implementation at-grade (higher if grade separated) and between $3-4M for a light rail vehicle. Electric trolley buses, by comparison, cost about $900,000 for an articulated vehicle, and $2-4M per mile for electric wire design, engineering and installation and up to $3-7M per mile if repaving is needed to accommodate heavy bus vehicles at high frequencies.[1]
- **Streetcars in the U.S. generally operate in "single car operation" and cannot be considered "high capacity transit" except at very high frequency.** Although there is a range of streetcar types operating today, the most common streetcars generally have capacities in the range of an articulated bus – around 60 to 70 seated passengers and a maximum of 110 passengers (seated and standing). Unlike LRT service, streetcars are generally not strung together in "trains" with a single operator, but rather, operate as single cars on the track. Therefore, streetcars cannot be considered high capacity transit based on the number of people who could be served at one time with one operator.

[1] Bus costs do not include maintenance facilities or other start-up costs associated with operating a new mode of service.

Table 2. LRT, Monorail, Streetcar, and Bus Technology Comparison

Characteristic	Light Rail	Monorail	Streetcar	Bus
Capacity	Highest capacity mode. Cars hold approximately 80 passengers each and could be strung together in up to 4-car train sets.	Medium to high capacity. Each train set could carry approximately 200 passengers.	Medium capacity, generally comparable to an articulated bus. Seated capacity ranges from about 60 to 70 passengers.	Low to medium capacity, depending on size of bus, which could range from shuttle to articulated coach. Seated capacities range from less than 20 passengers for the smallest shuttles to about 60 passengers for an articulated bus.
Flexibility	Not Flexible – high investment cost requires much longer life span to recover fixed costs.	Not Flexible – fixed guideway system with high investment cost requires long life span to recover fixed investment.	Medium flexibility – track and wire could be relocated for lower cost than a light rail investment.	Highest flexibility – buses are relatively easy to move, even if new wire is required.
Operating environment	Generally requires dedicated ROW for optimal operations.	Elevated guideway	Could operate in street or on dedicated ROW.	Could operate in street or on dedicated ROW.
Ability to Attract Choice Riders	High – rail services attract at least 15-50% more riders than equivalent bus routes and 25-75% more choice riders in route-by-route comparisons.	High – rail services attract 15-50% more riders than equivalent bus routes and 25-75% more choice riders in route-by-route comparisons.	High – rail services attract 15-50% more riders than equivalent bus routes, and 25-75% more choice riders in route-by-route comparisons.	Low – Standard bus services tend to attract fewer choice riders than rail services. Special event service may attract more riders.
Optimal markets	In-city and regional commutes and longer distance routes where speed and capacity are at a premium.	In-city commutes and other trips; stop spacing approximately every ¾ mile; guideway is elevated so not affected by traffic congestion.	Circulator and connector to regional services. Closer stop spacing, reliability and visibility are more important than high speed or high capacity. Mixed uses including tourist and recreational areas.	Local and longer distance commuter trips or other trips that are repeated frequently. Also well suited to areas where travel demand patterns are not yet established.
Capital Costs	Higher capital costs - $50 to $75 M per mile for at-grade systems only. Grade separated system costs could exceed $150M per mile.	Higher capital costs - $116 M per mile (total development costs)	Medium capital cost - $20 - $40 M per mile.	Lowest capital cost of $2-$4 M per mile for overhead wire. If repaving is required, additional capital costs between $3M and $7M per mile may be required.
Operating Cost	Highest operating cost. Ranging from $200 to $250 per hour.	Annual operating cost for planned Seattle monorail is $25 M per year (cost per hour not available).	Medium operating cost – ranging from $100 to $150 per hour	Lowest operating cost per hour. Large operators average about $100 per hour.

2.2 Conditions for Successful Streetcar Implementation

Given the characteristics of streetcars and their comparison to other modes, it is possible to develop a set of conditions for successful streetcar implementation. The conditions below are based on comparing streetcars to other modes and on researching streetcar systems in other cities in North America. A summary of the peer cities' information is provided in Table 3. While it is not necessary to have all of these conditions to implement a streetcar system, the most successful operations would tend to have the most conditions in place:

- **Demand for relatively short trips where speed is not a critical factor.** Streetcars are an especially good application for point-to-point trips in a dense mixed-use environment. These trips do not necessarily need to be fast, because the distances are not great, and there may be no time advantage to using a faster mode. For example a car may be slightly faster, but if time is lost finding and paying for a parking space, the total trip time may be the same.
- **Demand for connections to the high capacity network and neighborhood circulation.** Experience in other cities points out the role of streetcars as neighborhood circulators working in concert with regional transit. In Toronto and Tacoma, boardings at regional transit stops served by streetcars have increased by over 25 percent where streetcars replaced bus service. In Tacoma, there was a signficant increase in boardings on Sounder's regional commuter rail service after the opening of their streetcar line. Many cities with streetcars reported that passengers who now ride streetcars after transferring from regional routes had previously been reluctant to transfer to buses for their distribution trip.
- **Lack of extreme congestion on streetcar streets and limited competition with high capacity services.** Where streetcars operate in mixed traffic, reliability would be vastly improved if there is less congestion on the street and limited opportunities for traffic to impede the movement of the streetcar. In addition, because streetcars operate within the traffic lane and generally stop in traffic, streetcar operations should be separated from other higher capacity or high frequency routes operating on the same street to minimize competition for space between the modes.
- **Demand for high frequency service, but without the capacity demands required for light rail.** Streetcars are generally not connected into multi-car trains and therefore do not offer the high capacity of a multi-unit light rail train. Streetcar systems operating around the country typically run no less frequently than every 15 minutes, and should be designed to operate reliably at that frequency. For a streetcar system, adding frequency, rather than increasing vehicle size, is the means to meet increased demand.
- **Mixed uses or a variety of markets.** Streetcars are especially good at serving multiple user markets on a single line, rather than being focused on a single market, such as commute trips. Short workday trips could be served along with trips for recreation, errands, and tourist activities.
- **Presence of tourists and occasional users.** Streetcars encourage visitors and other occasional users to take transit, especially if the streetcar connects local and regional destinations.

- **Desire to accelerate planned development.** A streetcar alone cannot catalyze development in an area that does not meet the economic criteria for change. However, in areas that are likely to develop, a streetcar could accelerate and organize the development, ensuring that it would be transit-oriented from the start.
- **Property owners willing to contribute to the success of the streetcar.** Property owners who are willing to participate in all aspects of the streetcar, especially in its financing, would be more willing to ensure its success, and to orient development to take advantage of the streetcar infrastructure.

2.3 Streetcar Experience in Other Cities

Over a dozen North American cities have streetcar systems that have either been expanded or initiated operation in the past 15 years. In addition, at least twice as many other cities have new systems or new lines under active planning. The primary attractions to streetcars are the ability to add a visible rail system at a minimum capital investment, and the ability to create a circulator that connects into a high capacity network without requiring additional extension or expansion of the more expensive high capacity mode. Streetcars are also popular because they are a good fit for densely developed, pedestrian-oriented, urban neighborhoods.

Table 3 provides basic streetcar operating information for several peer cities and the text below describes experiences in Toronto, Memphis, Tacoma and Portland. (Appendix A is a list of all of the peer cities contacted.) It should be noted that no two cities are exactly alike. When using peer information to project results in a different city, it is important to understand all of the issues that make the cities different, as well as alike.

Figure 1. Photo of a Toronto Streetcar

Toronto, Canada

Toronto has the most extensive network of streetcars in North America. Figure 1 above is a photo of its typical streetcar. The Toronto Transit Commission has 11 streetcar routes, 10 of which run through downtown in mixed traffic. During the 1960s there was considerable interest in abandoning the streetcars in favor of bus service. However, the streetcar system has not only been preserved but has been significantly expanded, with four lines opening in the last decade.

Toronto officials cite three key factors contributing to the success of the expanded streetcar network. These factors are present in Seattle as well:

- The continuing strength of downtown as a regional employment, retail, and cultural center;
- The increasing role of downtown as a residential center, and;
- Streetcars work very well with a walkable, mixed-use downtown, in which transit does not need to be fast, but it does need to serve a variety of shorter trip markets.

Toronto's existing network and new extensions helped support the transition of the industrial areas along the lakeshore to redevelop with residential, recreational and cultural uses. The lakeshore area is now active with local residents, making both work related and other types of trips, as well as with the many tourists and visitors from other neighborhoods who come to shop, or recreate in the lakeshore area. Similar to what would be expected in the South Lake Union area with the development of the new park, the streetcar serves a significant number of recreational trips, and also serves as a significant recreational destination for the entire region.

A key finding from Toronto's experience is that streetcar service generates more ridership than what equivalent bus service generated in the same corridor. For example, in 1997 the transit agency opened a new streetcar line on Spadina Avenue. This line directly replaced a local bus route that was one of the most heavily used and productive in the system. With no appreciable change in service levels or travel speed, ridership increased by approximately 15 percent with the implementation of streetcars.

One reason for this change is that streetcars clearly attract a wider rider market than bus service in Toronto, including a higher percentage of riders who are not transit dependent. The Toronto Transit Commission estimates that 60 percent of streetcar riders are "choice" riders - that is, those who have a car, but choose to take the streetcar instead. While it is difficult to know exactly why streetcars are so popular, the following feedback was provided from recent rider surveys:

- Residents value the streetcars and consider them an important part of the city's image and heritage.
- Streetcars are popular with Toronto visitors who might not otherwise ride transit.
- Riders like the fact that streetcars don't have to pull out of traffic and then remerge back into traffic at every stop. Riders perceive this as taking too much time and as "letting the traffic control the bus."
- Streetcars provide a smoother ride, with less jostling than buses. Riders report being able to read or work on the streetcar but not on buses.

Figure 2. Photo of a Memphis Streetcar

Memphis, Tennessee

As part of a downtown revitalization effort, Memphis converted a failing downtown pedestrian mall into a streetcar line using vintage streetcars (see Figure 2 above). Buses running down the mall were considered, but rejected as incompatible with high pedestrian volumes. The initial streetcar line began service in 1993. It was 2.5 miles long, mostly double-tracked. Streetcar served the mall, but also ran beyond it on both ends to serve areas that were expecting economic development. Outside the mall the streetcars ran on the street, sharing a lane with automobile traffic. In 1997, the initial line was converted into a loop by adding a parallel line, running mostly on an old railroad track. The addition brought the total system up to a length of five track miles. All but one of the streetcars are renovated historic vehicles. As elsewhere, the antique cars in Memphis have proven reliable in regular service.

In the first full year of service, 1994, annual ridership on the Memphis streetcar system was 468,115; in 1999, it was 922,475, and in the year 2000 it rose to 941,011. By 2000, the streetcars carried almost three times more passengers per revenue mile than Memphis's buses.

A study of the Memphis streetcar line by Thomas Fox, the system's Director of Planning and Capital Projects, notes that:

- Monday through Thursday ridership is made up mainly of downtown workers and residents who use the system on a regular basis.
- Friday through Sunday ridership is more dependent on the cultural, recreational and shopping activities that occur downtown.
- Saturday is the highest ridership day, contrary to common transit experience.
- Individual day ridership peaks generally coincide with major events in the downtown area such as the Beale Street Music Festival, Memphis Redbirds (Triple A) baseball games at AutoZone Park, and cultural exhibits at the Cook Convention Center.

An on-board survey of streetcar riders in Memphis taken in 1994 found that:

- Almost half of the streetcar riders chose streetcar "for the experience" and would otherwise be making their trip by car.
- 83 percent of streetcar riders did not ordinarily use public transit, suggesting that streetcars could attract riders that similar bus services cannot.

Ridership has grown for a variety of reasons, the most important of which is the gradual growth and diversification of development in the areas served by the streetcar. Since 1990, residential population along the line has expanded from fewer than 1,000 to more than 5,000 people. Developments such as AutoZone Park (baseball), Peabody Place (entertainment retail), Gibson Guitar Factory and Museum, and numerous restaurants, clubs, and hotels, have resulted in the downtown becoming much more of a cultural and entertainment destination than it was previously.

Interestingly, Memphis is using the success of its streetcar system to plan a more regional light rail system. As planned, the streetcar system wouldconstitute the downtown circulation for the larger system, replicating the system currently in place in cities like Toronto. By starting with streetcars, Memphis city officials believe they established the market for rail transit service at a lower initial investment cost, and created the understanding of how rail could serve regional as well as local needs. Once Light Rail is built, the existing streetcar would continue to provide a functional downtown circulator that complements the regional system.

Figure 3. Photo of a Tacoma Streetcar

Tacoma, Washington

Sound Transit opened Tacoma Link in August, 2003. The 1.6 mile route was built to accommodate light rail vehicles in the future, but is currently being served by streetcar vehicles very similar to the modern cars used in Portland. The Tacoma route gives Tacoma residents and visitors a new way to arrive at the Broadway theater district,

downtown offices, Union Station, the University of Washington in Tacoma, the Washington State History Museum, the Museum of Glass, the new Convention Center (2004), the Tacoma Dome and the Tacoma Dome Station (with connections to Sounder commuter rail and regional express and local bus services). There is a parking garage with 2,400 spaces adjacent to the Tacoma Dome Station serving this multi-modal facility.

Prior to building the Link line, Tacoma operated a free bus service along the route now served by the streetcar. Annual ridership for this bus was 141,000. Annual ridership for the streetcar, which is also free and operations on the same schedule as the previous bus, is on track to reach 730,000 in its first year.

Tacoma Link has played a role in economic development for Tacoma's downtown:

- Since Tacoma began revitalizing its downtown and planning around the light rail/streetcar stops, more than 2,000 new housing units have been permitted.

- Establishments along the line have seen their business increase up to 30% since Link began operation.

Based on the success of the newly opened line, there is already interest in extending Tacoma Link to serve additional destinations.

Figure 4. Photo of a Portland Streetcar

Portland, Oregon

The City of Portland, Oregon is noted for the dramatic revitalization of its downtown core. Today, Portland's central city is one of the most admired in North America. Many things contributed to this turnaround, but one key factor was an emphasis on transit and cooperative planning for transportation and land uses. The initial success of the MAX regional light rail system and the downtown transit mall helped instigate the planning and development of a new streetcar system to operate as a downtown circulator. Figure 3 above is a photo of the streetcars used in Portland.

The Portland Streetcar operates on a 4.8-mile loop, connecting the Pearl and River districts with Downtown and Portland State University. It stops every three to four blocks, and operates at 15-minute headways for much of the day and evening. Its primary purpose is to provide short trips to residents, workers, students and visitors.

Portland primarily uses modern streetcars. The Portland Streetcar is designed to fit the scale and traffic patterns of the neighborhoods through which it travels. Streetcars are 8 feet wide and 66 feet long, about 10 inches narrower and 1/3 the length of a standard light rail vehicle. They have a low floor center section for ease of boarding.

In addition to acting as a circulator for dense inner city development, one of the goals of the project is to encourage development in neighborhoods adjacent to downtown, particularly the River District, which, until recently, was an area of undeveloped rail yards. The arrival of the streetcar system has provided an organizing theme for development of the River District. Studies have shown that property values have increased most significantly for those properties closest to the streetcar. Not surprisingly, these properties are developing ahead of those more remote from streetcar service.

Portland streetcar began service in 2001, after only two years of construction and testing. In its first year, it exceeded ridership projections by more than 10 percent, and increased an additional 10 percent its second year. The success of the initial line has spurred expansion plans; the first extension is currently under construction and several more are being contemplated.

Portland's system provides an excellent study in how urban development may be affected by the early implementation of streetcar infrastructure. Over $1.3 billion in new development has been added to the streetcar corridor since the decision to build the line. While it could be argued that the Pearl District and adjacent neighborhoods would have developed to some extent with or without a streetcar investment, the streetcar has served as an "organizing principle" catalyzing development closest to the streetcar first, and encouraging development to be transit-friendly.

Table 3. Peer Streetcar Systems

City	Agency/ Org.	Ann. Rev. Hrs.	Ann. Riders	Total Fleet	Avg. Op. Speed	Peak Headway (min.)	Year Imp.	Most Recently Opened Line	Const. Cost.	Replaced Bus or Other Mode?	Ridership Increase Over Bus Route?	Modes in System	Streetcar Connected to Other Modes?	Believe Streetcar Improves Ridership on Other Modes?	Other Points
Memphis	Memphis Area Transit Authority (MATA)	128,440	1 M	20	7.5 mph	5	1993	2004: Madison Line	$57M [5]	bus route diverted, not replaced	Ridership has been good; high percent of "choice riders"	Bus, streetcar	connects to the buses at the terminals	yes, most definitely even though the system is pretty small (i.e. downtown circulator)	The streetcar brought vitality back to downtown Memphis (see text for specific developments).
New Orleans	New Orleans Regional Transit Authority (NORTA)	77,064	6.3 M	24	9.5 mph	5	1831	2004: Canal Line	$161M	bus route	The Canal Line service too new to determine changes in ridership.	Bus, streetcar	currently have to cross a street to connect to buses, but have plans to construct a terminal	NORTA believes so, they are trying to find this out.	
Portland	Portland Street Car, Inc.	21,600	1.96 M	7	7 mph	14	2001	March 2005: Riverplace extension (under construction)	$56.9 M	bus route		Bus, streetcar, light rail	buses & light rail	yes	Exceeding ridership projections and one extension is under construction, with other planned.
San Francis-co	San Francisco Municipal Railway (Muni)	95,500	6.5 M	26 reg. + 6 special service cars	6-10 mph	6	1995	2000: Embarcadero to Fisherman's Wharf	$70M[3]	#8-Market & #32-Embarca-dero	Ridership has nearly tripled.	Bus, streetcar, light rail, cable car	yes	positive impact	
Tacoma	Sound Transit (ST) Regional Agency	15,000[2]	738,536	3	13.7 mph	10	Aug. 2003	Aug. 2003	$80.4M [6]	bus route	There has been a 500% increase in ridership.	Bus, streetcar, heavy rail	connects with the local buses, express buses and commuter rail	Sounder ridership has steadily increased resulting from many issues, including starting of Tacoma's streetcar.	The Tacoma LINK is a free service that connects downtown attractions to a transit hub and parking garage. (Previous bus service was also free.)

Table 3. Peer Streetcar Systems (continued)

City	Agency/ Org.	Ann. Rev. Hrs.	Ann. Riders	Total Fleet	Avg. Op. Speed	Peak Headway (min.)	Year Imp.	Most Recently Opened Line	Const. Cost.	Replaced Bus or Other Mode?	Ridership Increase Over Bus Route?	Modes in System	Streetcar Connected to Other Modes?	Believe Streetcar Improves Ridership on Other Modes?	Other Points
Tampa	Hillsborough Area Regional Transit Authority (HART)	17,329	420,023	8	6 mph	15	2002	2002: TECO	$53M (7)	no		Bus, streetcar	streetcar connects w/bus system at southern terminus, stations close to cruise ship docks	HART believes the streetcar and bus modes 'feed' each other.	
Toronto	Toronto Transit Commission (TTC)	875,00 8	87 M 8	248	9 mph	2-13	1861	2000: Harbourfront Streetcar	$13M (4)	bus route	Ridership has increased 15% over the previous bus route	Bus, streetcar, LRT, and heavy rail	there is close integration between bus, streetcar & rapid transit systems	Most TTC customers transfer at least once each trip, often between modes. Thus, higher ridership on streetcar lines equal higher ridership overall.	All else being equal, streetcars attract more riders than an equivalent bus route. Customers seem to prefer the permanence of a streetcar line, among other intangibles.

Notes:

1. Beginning in June 2004 (up from 1.2 miles of track).
2. Operational hours: the streetcar is free
3. 1998 dollars
4. Includes cost for approximately 1 km of double track, along with two intersections.
5. The last line was built to support modern light rail vehicles; the others are single-wire conducting tracks. The total cost includes $6.6M for bridge construction, $2M for acquisition of 4 trolleys, $7M for engineering and project management, $350K for right-of-way acquisition, $13.5M for utility relocation, $2.5M for vehicle renovation and procurement (4 trolleys), $3.1 for special track and rail, and $1.8M for construction of 7 stations, $5.3M for traction power & catenary.
6. Cost includes everything (design, overhead, vehicles, maintenance, etc.)
7. Includes eight streetcar vehicles, a maintenance facility, stations, and track.
8. Includes street-running LRT and streetcar. TTC does not maintain separate statistics.

3. A STREETCAR NETWORK FOR SEATTLE

This section describes initial work done to identify a streetcar network for the City of Seattle, and provides an overview of several of the identified routes. Table 4 summarizes information about those routes.

3.1 Transportation Planning Context in Seattle

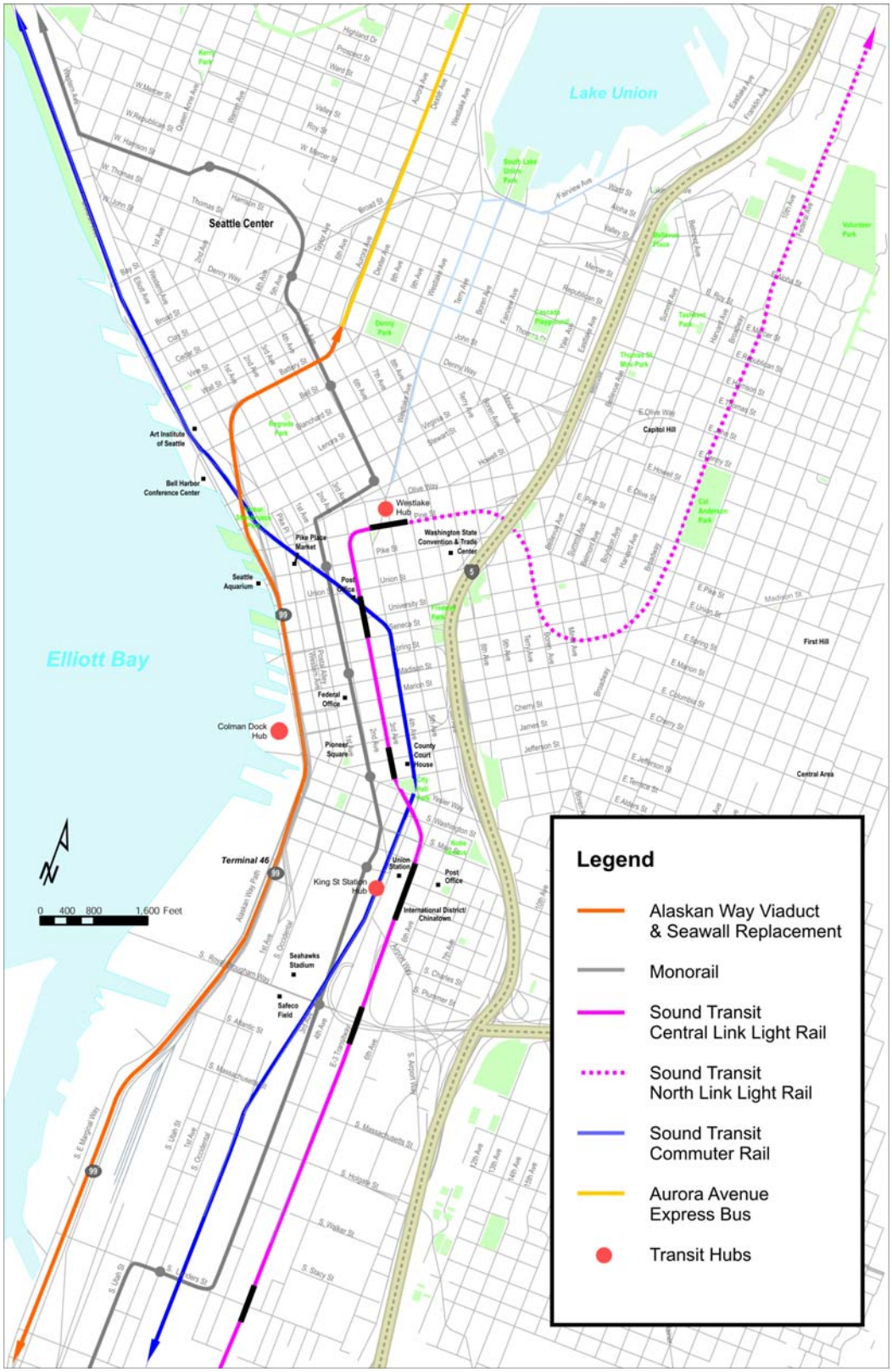
Streetcars are only one mode being developed as part of a major, multi-modal system approach to improving transit service in Seattle. Other transit and transportation projects are shown on Figure 5 and summarized below:

- The new Central Link Light Rail system would operate into downtown Seattle and would extend south to Beacon Hill, Rainier Valley and Tukwila. It would share the Downtown Seattle Transit Tunnel with bus routes. Construction began in 2004 and would continue into 2009. For a two-year period during construction, all of the buses that currently utilize the tunnel would operate on surface streets downtown. The next phase would extend light rail north via First Hill, Capitol Hill, and the University District.
- The Green Line monorail would provide new rapid transit links from downtown Seattle to West Seattle, and to Interbay and Ballard via the 15th Avenue NW corridor. Current plans indicate construction would begin in 2005 and would continue into 2009.
- Washington State Ferries plans a renovation and redesign of the Colman Dock, the primary portal to Seattle from fast-growing Kitsap County. Currently, nine million riders pass through this ferry terminal each year.
- King Street Station is being rehabilitated to accommodate planned increases in Amtrak rail service as well as Sounder commuter rail service between Tacoma/Lakewood and Everett. With this planned increase in service, King Street Station would become the third busiest railroad station west of Chicago, after Los Angeles and San Jose, California.
- Washington State Department of Transportation (WSDOT) and the City of Seattle would replace the Alaskan Way Viaduct and Seawall, which narrowly survived the Nisqually Earthquake of 2001 and not sustainable in its current form. The project is not yet fully funded, and alternatives including a replaced Viaduct tunnel and surface boulevard are being considered. Assuming funding becomes available, construction could begin as soon as 2007 and could last up to 11 years depending on the alternative and the construction phasing. During construction, the existing Waterfront Streetcar would not be operable in its current configuration.

- The City of Seattle is currently developing an Urban Village Transit Network (UVTN), which defines bus, rail and monorail services that would provide high capacity links throughout the entire city. These UVTN routes would operate at least every 15 minutes through an extended 18-hour service day and would maintain standards for speed and reliability. Streetcar lines would need to be planned to complement the UVTN network by either becoming the UVTN line in a corridor, or avoiding conflicts with UVTN routes.

Once completed, these projects would form the backbone of transit service in and through downtown Seattle. This revitalized transportation network would support plans for substantial growth in Seattle's mixed use downtown. The Center City area is currently home to 235,000 workers and 57,000 residents in 38,000 housing units. Growth targeted for the area by 2015 would result in about a 25 percent increase in jobs and a 20 percent increase in housing units. The Denny Triangle, South Lake Union and the downtown commercial core are expecting the greatest increases in employment growth. Significant residential growth is expected in Belltown, the Denny Triangle, First Hill and South Lake Union. A streetcar line, or network of lines, could play an important role in the transportation system by providing local service and connecting to the regional system.

Figure 5. Planned and Funded Transportation Developments in Central Seattle



3.2 Developing an Initial Streetcar Network for Seattle

Based on the attributes described in Section 2.2 for successful streetcar implementation, a number of potential streetcar routes were evaluated for central Seattle. Table 4 identifies each of the potential corridors and shows how conditions on the corridors compare to the attributes for successful implementation of streetcar service. Because conditions change over time, this list should be reviewed and updated as future decisions about streetcar network implementation are made.

Figure 6 shows routes reviewed as part of this study. Figure 7 shows routes reviewed in more detail in this section and in Sections 4 and 5. Figure 8 shows the routes from Figure 7 in the context of other planned transportation improvements.

The following sections describe the opportunities offered in each corridor and potential routing through the corridors. It should be noted that while these three corridors all have potential for future streetcar routes, the South Lake Union line is the only line that is not dependent upon other projects such as the Alaskan Way Viaduct and Seawall Project. Implementation of the other lines would be dependent on making a connection to a post-viaduct Waterfront Streetcar, establish a new maintenance facility, and/or on identification of private and public funding.

One of the most significant transportation developments planned for Central Seattle is the replacement of the Alaskan Way Viaduct and Seawall. During Viaduct construction, the Waterfront Streetcar, at least from the intersection of S. Main Street to at least Pine Street, would likely need to be temporarily shut down for up to 11 years.

During Viaduct construction, automobiles that currently use the Viaduct would be rerouted via temporary facilities and/or through central Seattle, creating conflicts with buses and other street operating transit and creating significant congestion in the entire central corridor.

Potential for operating streetcar service during Viaduct construction exists. It would be possible to build a streetcar line on Western or 1st Avenues, which would extend streetcar service from Pioneer Square to a terminus near Broad Street. For a streetcar on 1st Avenue to be useful as mitigation during construction, the monorail must be operating, because it would replace many of the buses currently operating on 1st Avenue, which would reduce conflicts between buses and streetcars on 1st Avenue. To be a reasonable mitigation, the streetcar line would need to operate very frequently, perhaps as often as every 5 minutes. This would require acquisition of new streetcars, preferably low floor modern cars that could speed boarding and manage crowds better than the current antique cars. A new maintenance facility would also need to be constructed.

The concept of running on Western or 1st Avenues during Viaduct construction is appealing, because this line could be retained after construction and continue to operate even after the Waterfront Streetcar line is replaced. This connection between the Chinatown/International District, Pioneer Square, and Downtown would provide enhanced mobility and therefore probably higher ridership than a connection via the Waterfront Streetcar line, and would provide useful local transit circulation. A streetcar line on Western or 1st Avenues would also be better able to reach Uptown Queen Anne, because the grade on these streets climbs more gently than the grade between the north Waterfront and Uptown Queen Anne.

Depending on the final Viaduct configuration, decisions on whether the Waterfront Streetcar tracks are in mixed traffic or in their own right-of-way, and the extent to which single track sections are used, should be made after considering the UVTN performance characteristics.

Figure 6. Streetcar System Options Reviewed

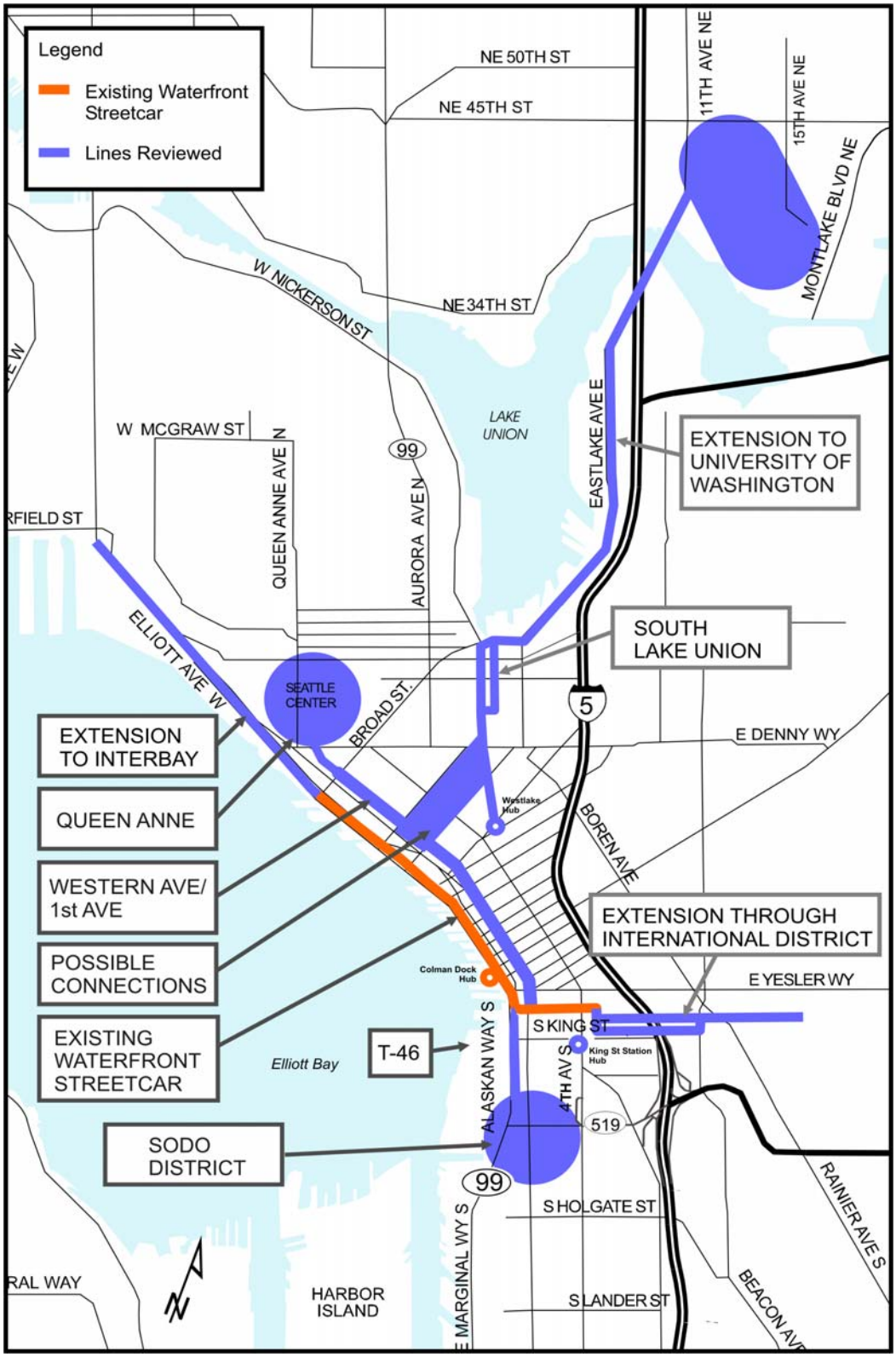


Figure 7. Three Lines Reviewed in Detail

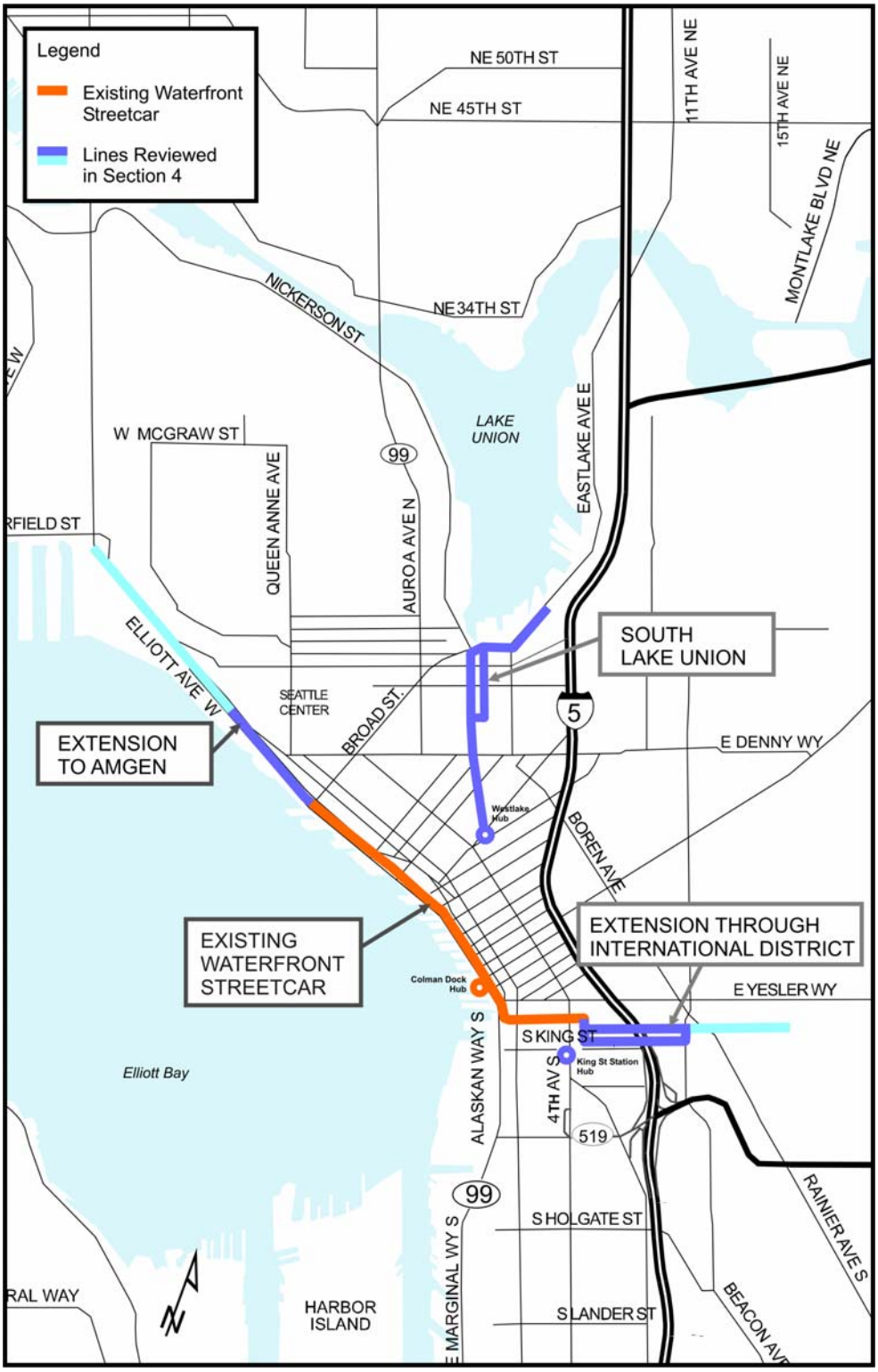


Figure 8. Three Lines with Planned Transportation Developments

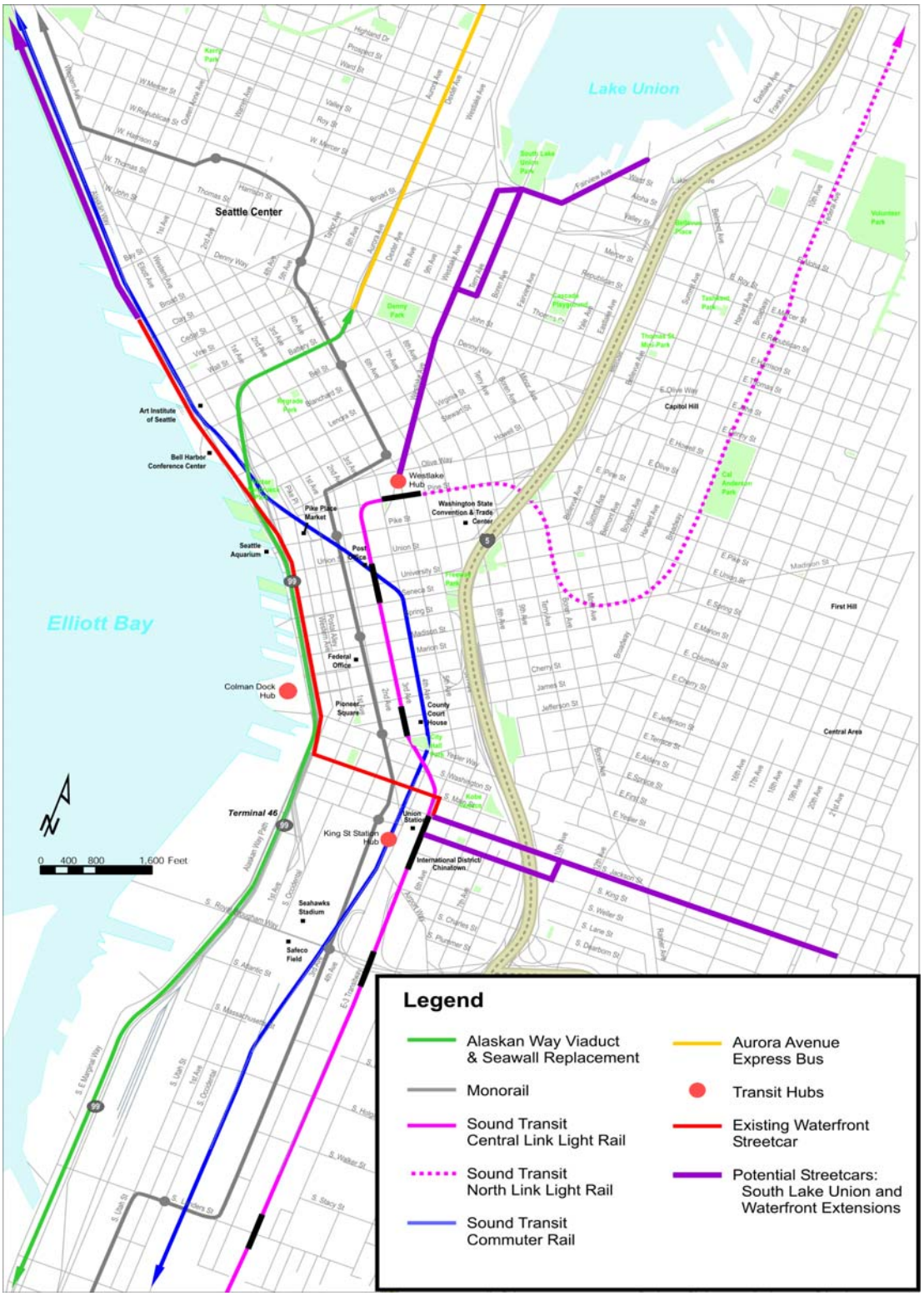


Table 4. Potential Future Streetcar Corridors

Attributes	South Lake Union from Westlake to Yale	South Lake Union from Yale to the UW	Chinatown/International District / S. Jackson Street Corridor	Waterfront North to Interbay	Waterfront to SoDo and/or T-46
Possible Termini	Westlake and Yale	45th and Brooklyn or UW South Campus	12th Avenue (initial) 23rd Avenue S. (future)	W. Thomas St., Amgen, and/or Interbay Area	T-46 Starbucks Center
Demand/Market	Need for service for connecting regional transit (LRT, monorail, bus) with major new employment and housing. (20,000 new jobs and 10,000 new dwelling units by 2020). High demand for recreational and visitor travel to lakefront park and lakefront businesses. Growth in jobs and housing are also anticipated for the Denny Triangle.	Connections between the proposed South Lake Union Streetcar and University of Washington. Connections for biotech workers, students and faculty traveling between the main medical campus and SLU biotech campus. Direct connection via streetcar from downtown to campus for students and staff. Would also serve Eastlake neighborhood.	High-density employment and housing, especially west of 12th Avenue. Tourist and recreational destination. Connections to regional transit (LRT, bus, monorail and commuter rail) and Amtrak.	W. Thomas St. pedestrian bridge opens new opportunities for waterfront travel for Queen Anne Hill and adjacent neighborhoods. Amgen currently has 2000 employees.	Major mixed-use development potential at T-46, but no definite plans at this time. Growing redevelopment throughout the south waterfront, with particular emphasis on employment opportunities. Potential visitor connections at cruise terminal and sports stadia.
Land Uses	Newly developing area, with extensive housing and commercial expansion planned.	Recreational opportunities extending along lakefront. Employment and educational markets connecting SLU and UW. Eastlake neighborhood is mixed-use.	Redevelopment potential as well as existing dense land uses. Highest density closest to International District Station.	Relatively industrial development at present with redevelopment or intensification potential; most redevelopment potential would likely be east of the streetcar tracks.	Significant and interest, but no definite land use plans for T-46.
Connections to Other Modes	Connections to major multi-modal hub at Westlake (light rail, monorail, and bus).	Creates a single continuous alignment between Westlake hub and campus. Potential connections to light rail at the University of Washington.	Connections to major regional hub at International District Station and King Street Station (light rail, monorail, bus, commuter rail, Amtrak.	Potential connection to Colman Dock (ferries) and potential connection to monorail stations.	Connection to Colman Dock (feries); monorail connection at Royal Brougham Way. (Could be quite some distance depending on streetcar routing.)
Financing Potential	Excellent – property owners have agreed in concept to forming a Local Improvement District that would contribute $25M to capital costs.	Development along the line could be a potential source of support.	Development along the line could be a potential source of support.	Amgen could participate if directly served. New development potential in Interbay could be potential for LID. Much of the route is adjacent to public or railroad property.	Significant potential for participation if new developers at T-46 and south to Starbucks Center.
Traffic Conflicts	Area traffic planning would calm traffic on Fairview Ave. N. and Valley, benefiting streetcar. Possible use of rail bank would separate streetcar and traffic.	Would replace the Route 70 bus on Eastlake, minimizing overhead wire conflicts.	Potential conflicts on S. Jackson Street below 12th Avenue S., with high traffic and bus volumes.	No traffic conflicts, but potential right-of-way limitations may make double-track streetcar difficult.	No traffic conflicts, but potential right-of-way limitations may make double-track streetcar difficult.
Dependencies	NONE	Requires basic South Lake Union Line to be in place.	None for short line operation. Maintenance facility site in Pioneer Square or Chinatown/International District would need to be identified.	Requires connections to operating Waterfront Streetcar line – likely need Alaskan Way Viaduct completed.	Need infill development at T-46 and beyond. Requires completion of Alaskan Way Viaduct replacement and operating Waterfront Streetcar line.
Known Issues/ Advantages	Most promising short-term line in the system, with a ready source of revenue and high potential for success.	Connects research centers located in the South Lake Union area and at the University of Washington, as well as connecting several dense, mixed-use neighborhoods.	Possible to operate stand alone line from Pioneer Square to Chinatown/International District during Alaskan Way Viaduct construction.	Proximity to parkland may be an issue. Right-of-way constraints may not allow for double-track operations which limits reliable frequencies.	
Potential Implementation Order (1-5)	1	2	2	4 to Amgen 5 Beyond (unless development occurs sooner)	5 (higher if development occurs sooner)

South Lake Union

The proposed streetcar line connecting the newly developing South Lake Union neighborhood and South Lake Union Park with Denny Triangle and the major transportation hub at Westlake Center is the single most promising line for a new streetcar line in central Seattle. This line not only has all of the attributes of a successful streetcar line, also has the advantage of being constructible without being dependent on any of the major construction projects anticipated in the Center City area.

The proposed South Lake Union streetcar begins at the intersection of Olive Way and 5th Avenue in downtown Seattle. It extends north through the Denny Triangle neighborhood to the South Lake Union neighborhood and terminates at the Fred Hutchinson Cancer Research Center. The line connects these important destinations with the regional transit hub at Westlake Center, which would be a major connection point for light rail, buses and monorail. The length of the proposed streetcar line is 1.3 miles in each direction (2.6 track miles total). (Appendix B includes detailed alignment drawings of this proposed line.)

Goals and Opportunities

The route would connect the retail core, Denny Triangle, and South Lake Union. Denny Triangle and South Lake Union are undergoing the kinds of growth and land use development that are consistent with the dense, mixed-used conditions described in Section 2.2 as being supportive of successful streetcar routes. According to the Puget Sound Regional Council (PSRC) projections, employment will increase by 51% in South Lake Union and by 44% in the Denny Regrade (which includes the Denny Triangle). Housing is also increasing in South Lake Union and the Denny Triangle, with a variety of housing styles and price ranges being built or planned.

A sample of the development that has occurred or is occurring in South Lake Union and Denny Triangle includes: Cornish College of the Arts, the new Federal Courthouse, a new biotechnology research campus for the University of Washington, facilities for other biotechnology and biomedical employers (including Seattle Biomedical Research Institute, Children's Hospital and Rosetta Inpharmatics/Merck), international headquarters for NBBJ Architects and Tommy Bahama. Under construction on the boundary between South Lake Union and the Denny Triangle is a mixed-use development that will include a full-service grocery store, a service that is always high on the wish list of urban dwellers. The northern terminus of the proposed route is anchored by the continued expansion of the Fred Hutchison Cancer Research Center, with 3,000 employees.

Neighborhood Plans

South Lake Union:

The South Lake Union neighborhood plan calls for increased transit service, and for transit service to the new SLU Park that incorporates special treatment at Park stop(s). The South Lake Union Approval and Adoption Matrix calls for exploring shuttle/circulator connections with Downtown and Seattle Center, and for improving transit connections to commuter rail.

Denny Triangle:

The Denny Triangle neighborhood plan calls for maintaining and improving direct (transit) connections to and from South Lake Union and for developing alternative modes to provide additional "auto-less" access to Denny Triangle.

Alignment: Initial Line

Figure 9 shows the South Lake Union streetcar proposed alignment. The proposed streetcar line would operate in two directions on Westlake Avenue between Olive Way and W. Thomas Street, and would operate as a one-way "couplet" on Westlake and Terry Avenue N. between W. Thomas and Valley Streets. The streetcar would generally operate in mixed flow in an in-street operation, traveling in the lane closest to the curb. Stations/stops would be provided at corner curb bulbs located within the parking lane. Parking removal is expected to be minimal, as the streetcar would travel in the first travel lane rather than the curb/parking lane for the majority of the proposed alignment.

Along Valley and Fairview Avenue N., the alignment would likely take advantage of the rail bank area to the extent possible, with double track streetcar service operating in that area. The line would be designed with a potential extension to the University of Washington in mind, and reenter the street on Fairview Avenue N. at approximately Yale Avenue N., to allow for a straightforward extension of the line to the north.

This alignment works well with proposed traffic modifications in the South Lake Union Transportation Study. Two-way operations on Westlake are assumed, at least south of W. Thomas Street, as are the improvements on Valley and Fairview Avenue N., all of which would enhance, but would not be required for, streetcar operation.

Stations would be approximately 1000 feet apart, with stops at most major intersections to provide good pedestrian access and connectivity with other transit stops.

Alignment: Future Connections to the University of Washington

A natural extension of this route would be to the University of Washington campus, facilitating movement between South Lake Union biotech research and manufacturing facilities, including the UW's proposed new South Lake Union biotech research campus (2,200 new employees) and the University of Washington main campus. Possible termini include the University of Washington medical school and/or the intersection of NE 45th Street and Brooklyn Avenue NE. Additionally, connections to the high capacity transit system would be possible at both ends of the line: Westlake and the UW. The University of Washington has expressed support for this extension. If the line is extended to the University, the streetcar would be designed to complement or replace heavily used trolley bus Route 70, which connects the major transit node at Westlake Center and South Lake Union with the UW campus, and could also complement or partially replace the Route 66 Express. At that point, the South Lake Union Streetcar would become an urban village transit network (UVTN) line and would be required to operate at a minimum of 15 minute frequencies over an 18-hour day, with standards for speed and reliability.

Connections to the Waterfront Streetcar

There has been significant discussion about the opportunities to connect the South Lake Union Streetcar line with the existing Waterfront Streetcar line to create an immediate streetcar network. The logic behind connecting the streetcar lines is that they will be able to share a maintenance

facility, which should reduce overall costs. Mobility would also be enhanced between South Lake Union and the waterfront.

A number of connection possibilities between the waterfront and South Lake Union were studied. The possible connections include routes along:

- Bell, Blanchard or Battery Streets to Western Avenue or 1st Avenue.
- 5th Avenue between Westlake Avenue and 5th Avenue at S. Jackson St.

It would not be possible to connect the South Lake Union alignment directly to the existing waterfront via Bell, Blanchard or Battery Streets due to the steep grades and presence of existing structures. The waterfront streetcar would need to be relocated to Western Avenue or 1st Avenue, at least north of University Street, where it could then return to the waterfront. In the case of Bell, Blanchard or Battery streets, some right-of-way acquisition would be required as well as partial roadway reconstruction along two city blocks.

A connection along 5th Avenue, between Westlake Avenue and 5th Avenue at S. Jackson St., is also possible. This connection would be approximately one mile long. 5th Avenue also has the narrowest right-of-way through downtown. The impacts of adding streetcar operations to 5th Avenue through the retail, commercial and governmental core on this relatively narrow avenue would be far reaching and would require much further analysis.

These connecting lines would be quite long and expensive, in many cases longer than the South Lake Union line itself. If it were decided to relocate the existing waterfront streetcar to either Western Avenue or 1st Avenue during reconstruction of the Alaskan Way Viaduct, these connections would be possible but may not be economically prudent when compared to the cost of an economical maintenance facility in the South Lake Union area. In addition, it could be decided that the two lines may not use the same types of streetcar vehicles.

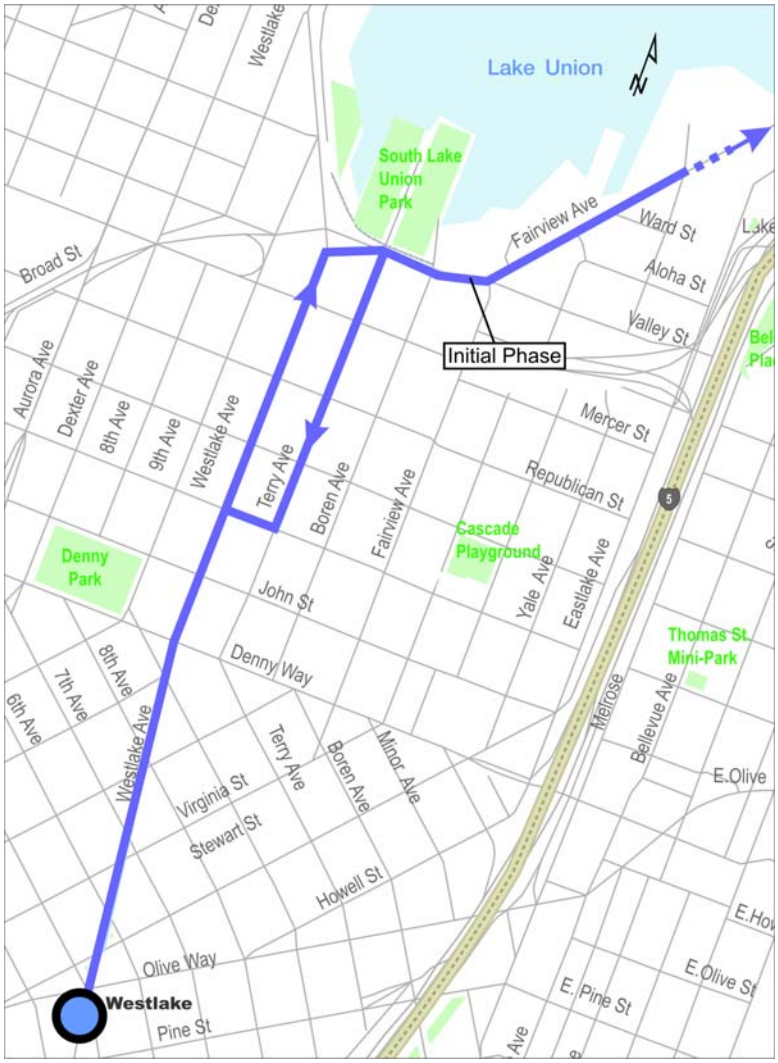
Ultimately, the Waterfront Streetcar line is facing a shut down during Viaduct construction. Assuming the Waterfront Streetcar line, as it currently exists, would be shut down for several years, it would appear premature to commit to significant new investments related to the Waterfront Streetcar line and connections until after reconstruction of the Alaskan Way Viaduct. After Viaduct reconstruction, an ultimate, longer-term plan for streetcar service in Seattle could include other options for connecting existing and future lines and locating a permanent maintenance facility to manage all of the streetcar maintenance in the system.

Operating Plan

For purposes of this plan, the initial operating plan was assumed to be 15-minute service throughout the day for a 15-hour service day. By build-out, the service demand is likely to increase to 10-minute service all day for an 18-hour day, with at least 15-minute service. Ultimately, with an extension to the University, service would be required to be no less than every 10 minutes throughout the day, 7-days per week. Peak headways could increase to every 5 minutes should demand require additional service. The double track system would be designed to handle frequencies of every 5 minutes with high reliability.

Table 7 provides estimated ridership and Table 9 provides operations and maintenance cost estimates for opening and future year operations.

Figure 9. South Lake Union Proposed Alignment



Maintenance

The line would be maintained at a temporary maintenance facility within the South Lake Union corridor. Providing a maintenance facility on the corridor would eliminate the need for an immediate connection to the Waterfront Streetcar line and its maintenance facility, which may be out of service during Viaduct construction. Ultimately, as additional lines and extensions are contemplated, a single streetcar maintenance facility may be developed. Locating a temporary maintenance facility in South Lake Union would minimize costs, accelerate the opening of the South Lake Union line by not requiring a connection to the Waterfront Streetcar line, and would allow the streetcar network to develop "naturally" as demand builds and conditions for success are met in other locations. The temporary maintenance facility would need to be able to support light maintenance for the vehicles. Heavy maintenance, such as paint, body and major component repair could be completed off-site by trucking the streetcar body or components to a major repair facility, either a King County Metro facility or a light rail repair facility as appropriate. Maintenance base requirements are detailed in Section 4.3. Opportunities to coordinate maintenance base location with bus layover space should be explored.

Existing Bus Service

Current transit service in the area is provided by Metro routes 8, 17, 26, 28, 66, and 70 (71, 72, and 73 at night and on Sundays). Route 8 is the Denny Way crosstown route that connects Capitol Hill and Queen Anne every 30 minutes during most time periods. Route 17 travels between downtown and Ballard via Westlake Avenue every 30 minutes. Routes 26 and 28 connect downtown with Fremont and other neighborhoods and, combined, operate every 15 minutes on Dexter. Route 66 Express operates every 30 minutes between Roosevelt and downtown with limited stops on Eastlake Avenue. Routes 70, 71, 72, and 73 combine to provide 15 minute frequency on Fairview Avenue N.. All of the routes listed operate more frequently during peak hours. Recent Metro bus ridership on select routes is shown in Appendix C.

Ultimately, whether or not streetcar service is implemented, a much higher level of service than currently provided by busses would be required in this corridor. The initial South Lake Union streetcar service would not replace any existing bus route. We recommend that any transfer stops be located in the manner that best facilitates transfers, but given the unique circulation service provided by this line, we would not truncate or change other routes.

In addition, the potential extension of the streetcar to the University of Washington area would create a line that has all of the characteristics of a UVTN line, including span, frequency and reliability. Because this line would be very frequent, could protentially replace the existing bus route, Route 70. Ideally, to replace the Route 70 bus, the extension would need to get to 45th Street to make all the connections that the Route 70 makes. At an absolute minimum the extension would need to get to the Campus Parkway transit hub with the frequency, reliability and span requirements of the UVTN to replace the resources of Route 70. This would not replace downtown to University District express service (existing bus and future rail), which is also in the UVTN network.

Waterfront – International District Extension

The extension of the existing Waterfront Streetcar, from the International District Station to at least 12th Avenue is another promising corridor for future streetcar service. It meets many of the conditions for success, but currently lacks the added incentive of a defined funding relationship with private property owners or outside funding, and timing may be affected by Alaskan Way Viaduct construction.

The line would connect tourist and entertainment destinations along the waterfront, through Pioneer Square and into the busy Chinatown/International District and along the S. Jackson Street corridor. The line would also serve residents and employees in this very dense corridor, providing internal neighborhood circulation as well as connections to the regional hub at the International District Station.

Goals and Opportunities

The S. Jackson Street corridor travels through dense, mixed-use neighborhoods where there is strong demand for both intra-neighborhood destinations and connection to a high capacity transit hub. While frequent bus service currently exists running east to west, the communities along the S. Jackson Street corridor have expressed interest in extending the existing streetcar to serve additional destinations. The unique, historical identity of this neighborhood, combined with important cultural destinations such as the Wing Luke Museum attract tourists, including many who also visit waterfront destinations, as well as local residents. This route would facilitate neighborhood connections to the regional transit system at the International District and King Street Stations, as well as Colman Dock.

While the first phase of this route could end at 12th Avenue S., the route could be extended along S. Jackson to 23rd Avenue S., where economic development is occurring, including Promenage 23 and Welch's Plaza. With this extension, Central Area residents and businesses would have new connections to the regional transit system and other destinations listed above. In addition to serving development at 23rd Avenue S. and S. Jackson Street, the line would provide access to the Pratt Fine Arts facility, the Langston Hughes Performing Arts Center, Washington Middle School (which serves students citywide), Douglas-Truth Library and other destinations, including housing.

Neighborhood Plans

Central Area (includes 23rd Avenue S. and S. Jackson Street):

Action T-7.13.5 includes the statement "explore opportunities for extending the waterfront trolley up S. Jackson to Martin Luther King, Jr. Way, or improve and promote route 14 trolley service."

Chinatown/International District:

The neighborhood plan calls for "a circulator route within the neighborhood (that) would facilitate movement of residents, especially the elderly." And also "extend trolley route south on 5th Avenue S. to S. King or South Weller." The International District Community Urban Design Plan suggests that extending the Waterfront Streetcar on S. Jackson would be an important component in enhancing S. Jackson Street and improving neighborhood connections.

Downtown Urban Center:

"Improve Waterfront Streetcar service speed, frequency and reliability and assess extensions to Seattle Center or BINMIC and along S. Jackson Street in the Chinatown/International District."

Alignment

The service would be operated as a double tracked couplet with westbound service operating on S. Jackson Street; and eastbound on S. King Street. The reason for operating on a couplet is to minimize impacts on South Jackson west of 12th Avenue S., where traffic volumes are high and large volumes of buses are headed to and from downtown and the International District Station. At 12th Avenue S., the S. King Street and S. Jackson Street branches would be connected, allowing for loop operations. Figure 10 shows the proposed alignment.

This relatively short extension could be built as an initial phase of a longer line. East of 12th Avenue S., the two directions would operate on S. Jackson Street, to the next logical terminus, perhaps at 23rd Avenue S., where a retail and office destination is developing and there are services such as schools and a library close by.

Operating Plan

In this developed area, service could initially be operated as a stand-alone line during viaduct construction, even if the existing waterfront line is not operational. This line could operate independent of the remainder of the waterfront streetcar service, operating every 15 to 20 minutes over a 15-hour service day, with additional service provided as demand develops. However, this independent operation would require a new maintenance facility in Pioneer Square or in the Chinatown/International District. Ultimately, this line would be operated at the same frequency as the overall waterfront operation. Service should be operated seven days a week, to accommodate both local and visitor travel demand.

Existing Bus Service

This service would likely augment, rather than replace existing bus routes in the corridor, which would continue to serve those trips that continue well beyond the potential streetcar termini. Several electric trolley bus routes travel along S. Jackson Street, including routes 7, 14 and 36. Routes 7 and 36 are among the busiest, most frequent routes in the system. The 7 provides 6 trips to Rainier Avenue S. per hour. The 14 provides 3 trips during the p.m. peak hour to 23rd Avenue S. and Mt. Baker. The 36 provides 9 trips during the p.m. peak to 12th Avenue S. and Beacon Hill. The combined total along S. Jackson Street between 5th Avenue S. and 12th Avenue S. in both directions is 36 trips during the p.m. peak. Recent Metro bus ridership data is presented in Appendix C.

South Jackson is the "UVTN" street in the Chinatown/International District, which means that streetcars would be there with very frequent bus service. Streetcars to 12th Avenue S. would not replace bus service because the bus routes would need to continue serving destinations beyond 12th Avenue S.. Extending the streetcar to 23rd Avenue S. might allow some bus service on South Jackson Street to be reduced.

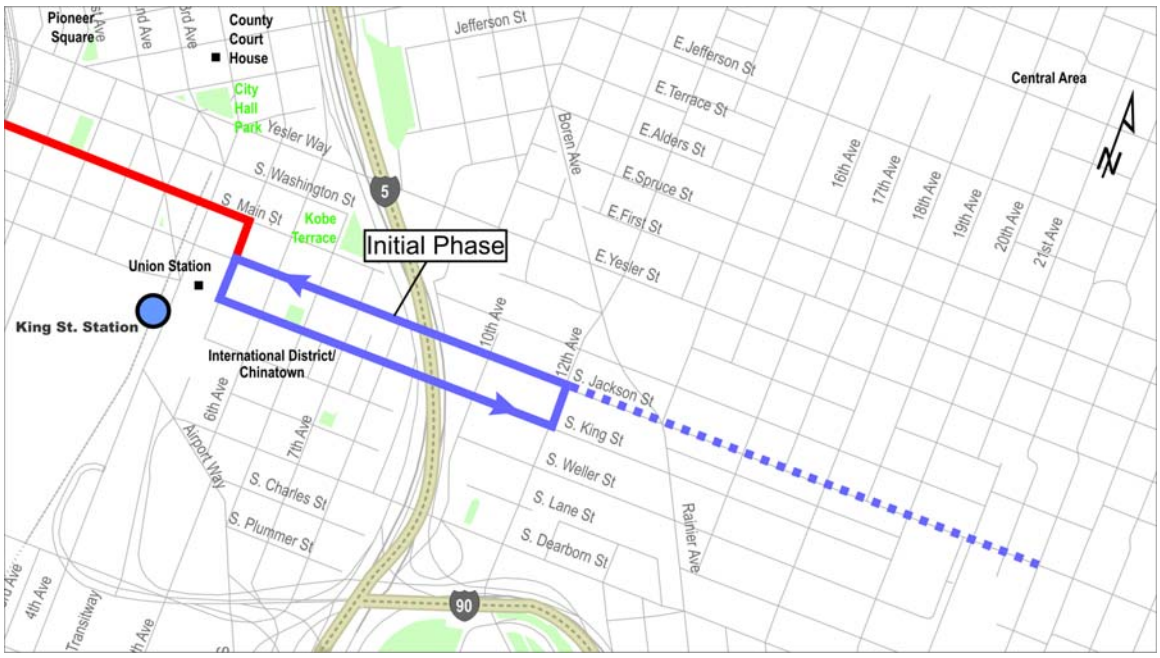
Maintenance

This potential extension of the line would increase options for future relocation of the Waterfront Streetcar maintenance facility. The current facility, located at Broad Street, may need to be relocated due to the opening of the Olympic Sculpture Park. King County is conducting a separate study to identify potential new locations to maintain the Waterfront Streetcar, but does not currently have funding to relocate the facility.

The current assumption is that during Viaduct construction, it would not be possible to operate the portion of the existing Waterfront Streetcar line between Pine Street and S. Main Street. Much of the line would be inaccessible due to conflicts in the construction zone. It is likely that only the extreme north and south ends of the line could potentially remain operable. The north portion could remain operable only if the existing maintenance facility remains in place or if a temporary maintenance facility is built. The south portion of the line could remain operable only with an extension to the east and with construction of a new maintenance facility.

The extension of the Waterfront Streetcar line from its present terminal to at least 12th Avenue S. would provide a viable segment, which could be operated with existing vehicles during Viaduct construction. The segment would connect Pioneer Square, the International District Station and the Chinatown/International District itself. This service would be very useful to visitors in the area, as well as providing basic circulation mobility to employees and residents of the Chinatown/International District. This line could operate every 15-20 minutes all day for a 15-hour service day.

Figure 10. Waterfront – International District Potential Alignment



Vehicle Issues

Any extension of the Waterfront Streetcar line, and/or any increase in frequency proposed for this line raises questions about whether the existing streetcar fleet could be used for an expanded service. The current fleet of 5 vehicles consists of well-maintained antiques. It is possible that there are matching vehicles available that could be similarly reconstructed to add to the fleet, but this is not a reliable source of expansion rolling stock. In addition, the materials on these cars require extra care, making maintenance facility design more challenging. The antique cars must be stored indoors in a climate-controlled environment. In addition, the cars are "high floor vehicles" and cannot provide accessibility for wheelchairs without boarding platforms, such as these on the Waterfront Streetcar line.

Most modern streetcar operations utilize low floor vehicles that emphasize boarding speed and accessibility. Some systems, such as Portland's, run a mix of historic and modern cars on weekends or special occasions, and do not attempt to make the historic cars accessible to wheelchair users.

For future planning, the greatest flexibility to extend and connect lines is enhanced when vehicles are interchangeable between lines. Selecting a single vehicle for all streetcar lines has the following advantages:

- Allows all vehicles to be maintained in the same way at the same shop, which is more efficient than having multiple vehicle types or shops;
- Allows passengers to learn and understand a single vehicle type, that "works the same way" on all lines.
- Allows for maximum flexibility in interlining routes and sharing vehicles.
- Minimizes the total fleet size, since spares would be based on the total system fleet, rather than maintaining spares for each type of vehicle.

Selecting a modern, low floor vehicle has these advantages:

- Minimizes operating costs since the current vintage cars require two operators per vehicle, and modern streetcars require only one.
- Maximizes boarding and alighting speed and maximizes accessibility for all riders.
- Since high-boarding platforms would not be required, stops are less intrusive and less expensive.

Should Seattle wish to continue operating an antique looking vehicle on the Waterfront Streetcar line, it may be possible to develop an antique "replica" vehicle using a customized new streetcar. In any case, the existing fleet could be used to supplement modern streetcar service, or to operate during special events. All operating costs developed in this plan assume modern streetcar operation.

Waterfront Extensions South

In addition to extending the streetcar line into the Chinatown/International District, land use changes south of South Main Street may also justify an extension of the Waterfront Streetcar to the south. Possible termini for a waterfront extension to the south include an extension to

Terminal 46, to the Pier 30 Cruise Terminal at S. Royal Brougham Way or to the Starbucks Center area.

Existing land use intensity is not continuous along this potential extension. The infill development potential at Terminal 46 could create enough continuous development to warrant a streetcar extension, as well as providing development partners to assist in paying the costs of an extension.

Although a southern extension of the streetcar could bring streetcar service to the stadium complex, the streetcar would not be a primary mode of transportation to games. Streetcars are not high enough capacity to handle the very large pre- and post-game crowds, although they could be used as a supplement to other transit improvements planned for the area.

Extensions to the south cannot be planned in any detail until Viaduct and waterfront planning are completed, including development of the ultimate design of the Waterfront Streetcar line.

Alignment

Details of a south alignment could be developed once Viaduct decisions are made and more is known about future land uses in the corridor. Whatever the alignment, a two track extension is preferred, to maintain speed and reliability at high frequency.

Existing Bus Service

A description of existing bus service and potential reconfigurations would depend on specific alignments and operating plans that would be developed once land use plans for the area are more fully developed.

Operating Plan

The operating plan would be dependent on the development plans for this area.

Waterfront Extensions North

Once Viaduct construction is completed, the Waterfront Streetcar would become operational again. To provide meaningful transit service, the Waterfront Streetcar line should be replaced with a double track line to the extent possible in order to allow for reliable operation of service every 10 minutes, which the current single-track operation does not permit.

Once the Viaduct work is complete it would be possible to extend the Waterfront Streetcar line from its current terminus at Broad Street to serve developing land uses on the north waterfront. Extending the Waterfront Streetcar line north of Broad is the only way to get direct transit service to destinations west of the existing rail road tracks, which serve as a barrier between bayside development and other transportation modes. Possible termini for a north extension of the Waterfront Streetcar line could include:

- **The Thomas Street Pedestrian Bridge** – This short extension would provide additional waterfront access for Seattle Center and the Queen Anne neighborhood via a new pedestrian bridge over the BNSF rail tracks in the vicinity of W. Thomas Street (the pedestrian bridge is currently being designed; construction is funded).

- **Amgen Campus** – This major employer has about 2000 employees on site today, with many accessing the campus from the ferry terminal, which has convenient access to the existing Waterfront Streetcar. An extended waterfront streetcar line could provide a direct connection for those employees.
- **Interbay –** Should development expand in this area in the future, the streetcar could serve as a connection between the Interbay area, the rest of the waterfront, and major regional transit facilities. A future monorail station planned for the Blaine Street area would also potentially serve Amgen and other Interbay developments, and could provide another intermodal opportunity for the streetcar.

Neighborhood Plans

Downtown Urban Center:

"Improve Waterfront Streetcar service speed, frequency and reliability and assess extensions to Seattle Center or BINMIC and along S. Jackson Street in the Chinatown/International District."

Queen Anne:

"Extend the existing waterfront trolley…to serve the BINMIC Immunex area and shoreline parks.

Alignment

The alignment of any of these extensions would continue the current Waterfront Streetcar line adjacent to the railroad right of way to a new northern terminus. Physical limitations and other restrictions, such as parkland designation, may make these extensions difficult to achieve. More study is needed to determine the viability of any of these extension options. Key questions which would help determine the viability of even a single tract extension is the width of available right-of-way, the future of the grain elevator operation, and any parklands considerations. Single tracking a short extension may be workable, but the longer the single-track section, the greater the impact on headways, travel time, and reliability, especially with limited options for passing tracks. Figure 11 shows a potential alignment for this line.

Operating Plan

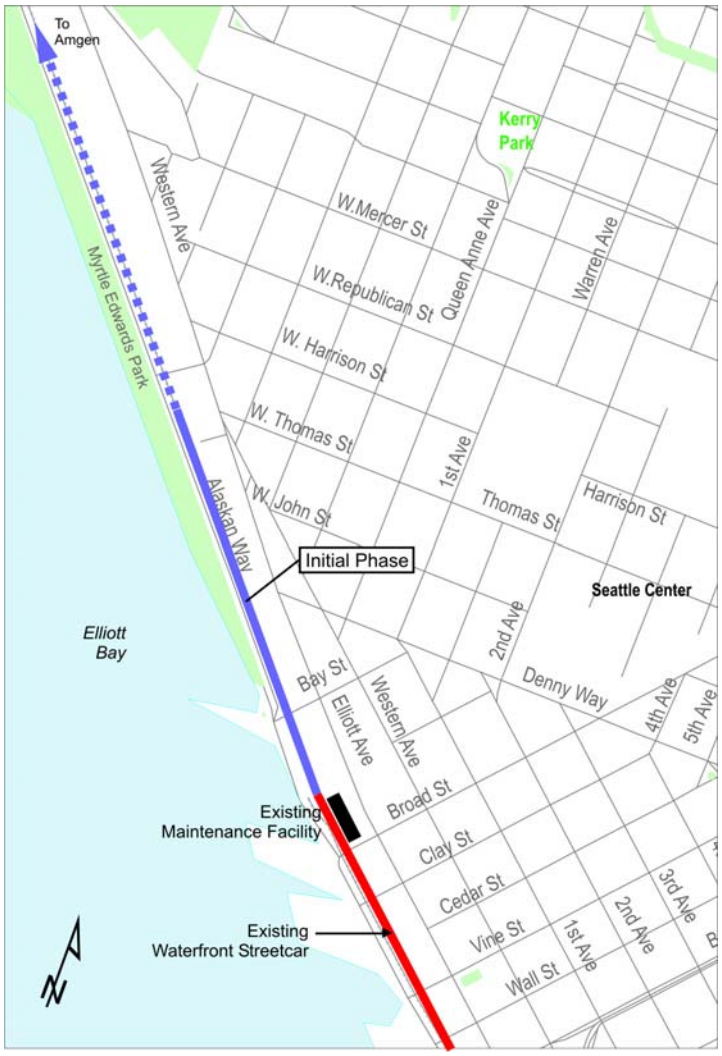
When Viaduct construction is completed, the Waterfront Streetcar should become a two-track line to the extent possible, capable of providing service at least every 10 minutes, and more frequently if required. Until demand increases north of the current terminus, it would not be necessary to extend every trip north of Broad Street. For the purposes of this plan, it is assumed that every other trip would be extended north of Broad Street, with the possibility of more frequent service during peak periods.

Existing Bus Service

North of Broad Street, the Waterfront Streetcar would travel in its own right-of-way between Myrtle Edwards Park and properties to the east of the park (including BNSF rail tracks and the Amgen development). The nearest bus routes are on Western and Elliott Avenues West. Metro provides service in the corridor on several routes - the 19, 24 and 33 (via 2nd/4th Avenues, Denny, Western and Elliott). Routes 15 and 18 local use the portion of Elliott north of W. Mercer Place.

There are a total of approximately 15 northbound trips in the p.m. peak hour south of W. Mercer Place and 21 north of Mercer Pl. There are 3 trips per hour per direction during the day south of Mercer Pl. and 9 per direction north of Mercer Place. Recent Metro bus ridership is shown in Appendix C.

Figure 11. Waterfront – North Potential Alignment



3.3 Ridership for a Seattle Streetcar Network

This section provides a summary of ridership estimates for the following potential streetcar routes:

- South Lake Union,
- a waterfront extension east to 12th Avenue S., and
- a waterfront extension north to West Thomas Street and to Amgen.

It should be emphasized that the ridership estimates developed at this stage are considered preliminary planning level estimates for comparative purposes. It should also be noted that the development of streetcar services in each of the primary corridors is based on expected changes in land use (within existing zoning), and therefore cannot be derived from current ridership on existing services, as new land uses would result in changed travel patterns and new demand for service.

Ridership estimates for potential streetcar lines were derived using the line productivity of peer cities (passengers per hour), adjusted for the operating conditions and land uses in Seattle, in the specific corridors being studied. Estimates were validated and adjusted using current King County Metro line productivity in similar environments. In estimating ridership, consideration was given to each of the factors described in the sections below.

Factors Influencing Ridership

There are a number of known factors that contribute to transit ridership. These are:

- Intensity of land use within walking distance – including both residential and employment density
- Mix of land use – residential, employment, retail, recreational
- Travel time (speed of service)
- Frequency of service
- Fares
- Connectivity to a broader network
- Legibility and information
- Comfort

Each of these factors and its influence on streetcar development is described below. It is important to note that while there is no direct mathematical relationship between all of these factors and ridership, they have collectively proven to be key factors in attracting ridership to all types of transit routes. Table 5 summarizes these factors and compares the ability of bus routes and streetcar lines to capitalize on each factor. The cumulative advantage of streetcar service explains the 15-50 percent ridership increase transit operators have noted when replacing a bus route with an equivalent streetcar line.

Intensity of Land Use – There is a direct correlation between the intensity of land use along a transit corridor and the number of transit riders in the corridor. In fact, intensity of land use has proven to be the most important factor in determining transit ridership, and has a far more direct relationship than any demographic factor studied such as income or age.

Most of the streetcar lines analyzed here are planned for areas with radically changing land use. In South Lake Union, for example, the addition of up to 10,000 dwelling units with 17,000 new residents and 20,000 new jobs by 2020 would alter travel behavior in the area, and would create a strong need for connections to the high capacity regional transit network. This intensification would generate transit demand, regardless of the mode selected.

Similarly, along the waterfront, extensions are tied to future development trends. Expansions of the Amgen facility, or developments along the north waterfront would generate enhanced transit demand. Current projections are for Interbay to add 1,400 jobs and approximately 700 residents by 2020. To the South, development of Pier 46 or other infill development would generate new demand. In the case of the waterfront extensions, streetcar service may be the only viable service that is not separated from development by the existing railroad tracks that serve as a barrier to other services.

The S. Jackson Street corridor travels through an area where development patterns are already quite dense, with additional redevelopment opportunities that would add to transit ridership.

Mix of Land Use – residential, employment, retail, recreational – While overall density is the single most important factor in estimating transit ridership, the mix of land uses is also a contributing factor. Areas that have density dominated by a single land use type may generate high ridership, but the ridership would be very directional and very peaked. For example, ridership from a residential neighborhood would generate a high number of commute trips leaving the area in the morning and returning at night, but relatively little ridership midday. A mixed-use area would attract commute trips in and out of the neighborhood as well as retail, recreational and other types of trips within the immediate neighborhood.

Both bus and streetcar lines have been proven able to attract routine trips such as commute travel, both for residents and employees. Where streetcars have an advantage over buses is in attracting occasional trips, especially for recreational purposes. The success of the current Waterfront Streetcar line in Seattle is a demonstration of a line that carries visitor and tourist travel that might otherwise be made by car.

South Lake Union and the waterfront extensions all have the potential of carrying riders for a wide range of trip types. South Lake Union offers new recreational opportunities for Seattle residents and visitors alike, as well as the promise of a vibrant mixed use neighborhood. Extensions into the Chinatown/International District and beyond would also serve dense, mixed use areas. Extending the Waterfront Streetcar to the north or south would not have the same impact at this time.

Travel Time (Speed of Service) – Travel times that are more competitive with auto travel would generate more riders. Travel times are based on the distance between stops along an alignment and the dwell times at stops, as well as the average speed between stops. Routes with more stops tend to be slower, as the transit vehicle tends to attain lower maximum speeds and lower average speed between stops.

Travel time or speed of service is directly related to conflicts from traffic. Buses or streetcars operating in their own right-of-way, similar to light rail service have the fewest intrusions from auto conflicts and operate with the fastest travel times.

There is no significant difference in travel time between bus and streetcar. Either could be designed to operate with all modern protections such as signal preemption, queue jump lanes, etc. to increase speed. Both modern buses and streetcars could be low floor and have a number of wide doors to speed boarding. Buses may have a slight advantage over streetcar in that they could easily change lanes to get around conflicts in the primary transit lane, where streetcars could be "stuck" behind an incident or double-parked car.

Frequency and Span of Service – The more frequent a transit line operates, the less time spent waiting. In addition, very frequent service, with service at least every 15 minutes, allows riders to make trips without planning in advance. This is a very important factor in estimating transit ridership, particularly for generating trips that are not routine or made at the same time every day.

Similarly, services with greater service spans tend to attract more riders, even though very late night or early morning service is not as productive as peak and midday services. Having late night service available, for example, allows a worker who might need to work late to count on the availability of transit for the trip home.

While these factors are important, there is no distinction between bus and streetcar services in this area, as either could be designed for high frequency and longer service hours.

Fares – Low or no fare systems encourage ridership by eliminating the need to put money in the farebox and by encouraging "short hop" trips that might otherwise be made on foot. The existing Waterfront Streetcar charges a fare even though it is within King County Metro's ride free zone. A section of the proposed South Lake Union line is within the ride free zone, while the remainder lies outside the zone. A policy decision would need to be made to determine whether fares would be charged on any new service in this area. It is possible to begin with no fare during an introductory period and then begin charging fares as demand develops. However, as a matter of polity, it is often difficult to add a fare to a free fare service once free fares are offered, unless a specific introductory period is well advertised in advance.

Connectivity to a Broader Network – Connectivity to the high capacity regional network is clearly a key factor in influencing transit use. Looking at ridership on the existing King County Metro system, those routes that connect to high frequency, high capacity services have significantly higher ridership than those designed strictly for local circulation.

Any transit service in the proposed streetcar corridors would connect with the regional system. However, streetcars offer two advantages over buses. In all corridors, streetcar service provides a very clear connection, allowing transferring passengers to essentially "follow the track" to know where to go to make a connection. This is more of a legibility and information advantage than a connectivity advantage, although it is important for attracting occasional and visitor trips. In addition, waterfront extensions of the streetcar offer connections that could not be replicated by bus because they offer the only opportunity for connections on the waterside of the railroad tracks.

Legibility and Information – Attracting riders is clearly easier when the line route is easy to understand, and when the customer feels comfortable knowing when the next transit vehicle would arrive and where it would be going. Recent studies show as much as a 5 percent ridership increase based on the availability of real time information alone. Both bus and streetcar systems could be designed with a high degree of real time information. However, only streetcars could provide the legibility of tracks in the street that defines the line. This is especially true in urban areas where there are many bus routes, but clearly only one streetcar track. Legibility and information have the greatest influence on attracting occasional or visitor trips, where riders do not have the time or experience to become fully familiar with a line route.

Comfort – There are many factors affecting passenger comfort, and they create an intangible factor that influences riders who have other travel mode options for their trip. Comfort may come in the form of more spacious or padded seats, bigger windows, ample standing room, and reduced motion. Any transit vehicle could be designed to maximize comfort, but here the advantage goes to streetcars, which operate on tracks, rather than buses, which experience significantly more lateral motion. Many riders describe the difference of "being able to read on the streetcar but not on the bus."

Table 5. Factors Influencing Ridership for Buses and Streetcars

Factor	How it Influences Ridership	Ridership Advantage – Bus vs. Streetcar
Intensity of Land Use	Density is the most direct influence on transit ridership – the greater the intensity of land use, the greater the ridership.	Slight advantage to streetcar, which tends to have higher carrying capacity than bus on a one for one basis.
Mix of land uses	Different land uses have different demand patterns. Mixing land uses ensures steady ridership through the day, rather than directional peaking.	Streetcar has a proven track record of attracting some types of trips that generally do not use bus transit – especially visitor- and tourist-oriented travel and weekend trips.
Travel Time	Riders are attracted to transit services that more closely match auto travel times.	Both bus and streetcar could be designed for fast service. The flexibility of bus service may give it slight advantage as buses could swerve around obstacles.
Frequency and Span of Service	Frequent service reduces wait times and allows riders to make trips without planning. Services with a longer service span are attractive to more types of trips. Longer evening service ensures riders who work late, or attend events in the evening would be able to get home.	No advantage – both bus and streetcar could be designed to run frequently.
Fares	High fares discourage ridership. Lower fares encourage ridership.	No advantage – fares could be the same for both.
Connectivity to a Broader Network	Connecting to regional services provides greatly enhanced mobility and enhances the ridership of the overall system	Slight advantage to streetcar which provides a highly visible connection to other routes.
Legibility and Information	The easier it is to understand a transit system, the more likely it is that occasional riders would use it. Real time information has been proven to increase ridership by as much as 5%.	Both bus and streetcar could be designed for quality real time information. However, streetcar has a slight advantage in that the tracks provide instant legibility.
Comfort	Roomier seats, ample room for standees, and a less "rocky ride" contribute to rider comfort and to increase ridership.	Slight advantage to streetcar, which operates on rails and therefore has less lateral movement than a bus. Riders often report they can read on streetcars but not on buses.

Ridership Experience in Other Cities

To estimate ridership for the lines on the proposed Seattle streetcar network, we have reviewed examples from other North American cities where streetcars are serving similar land uses, as well as reviewing existing bus and streetcar ridership in Seattle. Table 6 shows the range of ridership and productivity, as measured in passengers per hour, from each of the peer cities included in this analysis, as well as a brief description of the unique factors that may contribute to each city's ridership statistics.

Table 6 differentiates between the full range of peer cities, and those that have the most in common with Seattle. The density and mixture of land uses makes Portland, Toronto, Tacoma, San Francisco and New Orleans much better peers for Seattle than the remaining systems, which are either more tourist oriented, or serve less urban places.

Table 6. Peer Streetcar System Ridership and Seattle Estimates

City	Annual Ridership	Ridership (Riders/ Rev. Hour)	Factors Contributing to Ridership
Peer Cities			
Memphis	1,000,000	7.8	• Does not currently connect to a regional node • Short line serving shuttle and circulator trips
Tampa	420,023	24.3	• Less intense land use than Seattle plans • Serves tourist and local trips.
Peer Cities with Characteristics Most Common to Seattle			
Tacoma	738,536	49.2	• Free service and plentiful parking • Good connections to regional system • Less intense land use than Seattle plans
Portland	1,960,000	90.7	• Development densities are still building, some similarities to SLU plan • Good connections to regional system • Serves Portland State and large college population • Good peer for SLU with University extension
San Francisco	6,500,000	68.1	• Good connections to regional system • Serves many tourist trips between primary downtown and busy Fisherman's Wharf
New Orleans	6,300,000	81.7	• Serves large tourist market as well as mixed use neighborhoods • Well integrated to regional system
Toronto	87,000,000 [1]	99.4	• Individual routes range from very productive to less productive. Some lines serve almost entirely residential neighborhoods, others serve more mixed use trips • Good connections to regional service
	Average Seattle Peers:	77.8	
	Average for All Peer Cities:	52.3	
Estimated Seattle Ridership		**Riders/Rev. Hr.**	**Comments**
South Lake Union/Denny Triangle (as area develops more densely)		65 to 75	Based on development of South Lake Union/Denny Triangle area
Chinatown/International District to 12th Avenue S.		45 to 50	Post-Alaskan Way Viaduct Reconstruction of Waterfront Streetcar
Waterfront Extension North to W. Thomas St., or AMGEN		33 to 42	Post-Alaskan Way Viaduct Reconstruction of Waterfront Streetcar

Note:
1. Includes street-running LRT and streetcar. TTC does not maintain separate statistics.

Estimated Ridership for South Lake Union and Waterfront Extensions

Ridership estimates for three potential streetcar routes in Central Seattle are presented below. These estimates are based on known productivities from peer systems, adjusted for operating conditions in Seattle. As a further validation, ridership estimates were compared with existing bus routes operating in relatively similar operating environments.

Given the advantages offered by streetcar operations, streetcar ridership is expected to be at least 15-30 percent higher than equivalent bus service. This is a conservative assumption based on the experience identified by peer cities. Table 7 summarizes streetcar and bus ridership estimates for each corridor. Bus ridership potential is not provided for the lines operating on the north waterfront, since it is impractical to operate bus service west of the railroad tracks.

South Lake Union

South Lake Union's development projections justify a significant improvement in transit service. At build-out, the proposed line would be an ideal transit corridor, connecting a dense, mixed-use neighborhood with one of the city's busiest transit nodes. Riders are expected to include residents, employees, and visitors traveling to the shops, restaurants and recreational facilities in the district. Many of the visitors who would use this streetcar would likely not use transit and would make these trips by car instead.

At full build out, assuming the fully implemented land use currently anticipated, ridership on this line would improve, as intensity of land use increases. Ridership at build-out is expected to increase to between 65 and 75 passengers per hour, or between 1,070,000 and 1,230,000 annual boardings. This is below the current productivity of Portland's streetcar, which serves Portland State University in addition to being located in a developing area and has not yet reached its potential. If this line is extended to the University, and tied to the regional service at that node, ridership should further improve. Ultimate ridership along the entire line, extended to the University of Washington could be as much as 90 passengers per hour, carrying over 1,480,000 riders per year. This would make South Lake Union Streetcar one of the most productive lines in Seattle's transit system.

Because the streetcar is likely to be implemented before full build out in South Lake Union occurs, initial ridership, based on the existing level of development, would be substantially lower than the potential for this line. Initial ridership is likely to be between 30 and 35 passengers per hour, higher than the existing Route 17 that serves the area and connects to regional service. This translates to up to 380,000 annual boardings in the first year.

Waterfront – International District

In the case of the Chinatown/International District extension, this line could operate as a stand-alone line from Pioneer Square to 12th Avenue S. and S. Jackson or beyond during Viaduct construction; and/or could operate as an extension of the existing or replaced Waterfront Streetcar line. Each of these conditions would have a substantial impact on ridership.

For the purposes of ridership estimation, we assume that there are no substantial changes in land use in the corridor prior to the opening of a streetcar extension to 12th Avenue. Should this line operate as a separate line, disconnected from the Waterfront Streetcar line due to Viaduct construction, ridership on this line is estimated at between 17 and 20 passengers per hour, which is much lower than the current waterfront streetcar due to its more limited geographic scope. This translates to between 93,000 and 110,000 annual boardings, a relatively low total, but over a very short line.

Once this extension is connected to the Waterfront Streetcar line, productivity on the entire line should improve by expanding opportunities to connect the Chinatown/International District, Pioneer Square, and other waterfront destinations. Current ridership on the Waterfront Streetcar line is about 40 passengers per hour. Given double tracking and more frequent service, as well as the ID extension, ridership should increase to between 45 and 50 passengers per hour or over 1,240,000 riders per year on the entire expanded system of waterfront lines.

Waterfront – North Extensions

Extending the Waterfront Streetcar line to the north would increase ridership after constructon of the Alaskan Way Viaduct and Seawall Replacement Project is complete. The single track extension would serve only one significant new destination, if service is extended to Amgen, a generator that would be significant during limited hours of the day. Extending to W. Thomas Street would open up waterfront travel to neighborhoods east of that pedestrian connection.

The streetcar currently carries between 45 and 60 passengers per hour of service. Extending the line to W. Thomas Street, ridership should increase just over a million boardings per year. Extending the line to Amgen would increase ridership just over 1.1 million riders.

Table 7. Ridership Estimates

Streetcar Line/Extension	Proposed Headway	Annual Revenue Hours [1]	Streetcar Ridership Potential	Bus Ridership Potential
South Lake Union (initial operation)	15	10,950	330,000 – 380,000	230,000 – 270,000
South Lake Union (as area develops more densely)	10	16,425	1,070,000 – 1,230,000	750,000 – 860,000
Pre-Alaskan Way Viaduct Reconstruction Operations				
Current Waterfront Streetcar Line	20	12,679[1]	407,000	NA
Chinatown/International District to 12th Avenue S. (couplet using S. King and S. Jackson Streets) operating from Pioneer Sq. to ID alone during AWV construction.	15	5,475	93,000 – 110,000	65,000 – 80,000
Post-AWV Viaduct Reconstruction Operations				
New Waterfront Line - Double Tracked	10	21,900	990,000 – 1,090,000	NA
Chinatown/International District to 12th Avenue (couplet using S. King and S. Jackson Streets)	10	5,475	250,000 – 270,000	175,000 – 190,000
Waterfront with extension to W. Thomas Street Includes double tracked Waterfront Streetcar line	10	27,375	1,040,000 – 1,150,000	NA
Waterfront with extension to Amgen	20	32,375	1,070,000 – 1,133,000	NA

Note:
1. Based on 365 days of operation.

3.4 Constructing a Streetcar Network in Seattle

Constructing a streetcar network in Seattle is expected to be similar to constructing new streetcar lines in some of the peer cities previously discussed in this report. Of these examples, constructing new streetcar lines in Seattle is expected to be most similar to the conditions in Portland.

When streetcar tracks were constructed in Portland in 1999, the contractor was able to complete approximately three blocks of track construction in three weeks. In general, the following sequence was used to minimize construction time and costs:

Step 1 – Sawcut and Excavate Trackway Trench (see Figure 12)

The streetcar tracks were embedded in a concrete slab that was roughly 8 feet wide and 1 foot deep. Sawcut lines were made in existing streets and the roadway was removed to a depth of approximately 1 foot. In some cases the existing road bases were adequate to support the concrete track slab, but in other areas an additional 6-inch depth of excavation was required to install an aggregate base layer to support the track slab.

Figure 12. Construction Step 1, Excavate Trackway Trench

Step 2 – Install Reinforcing Steel and Rails (see Figure 13)

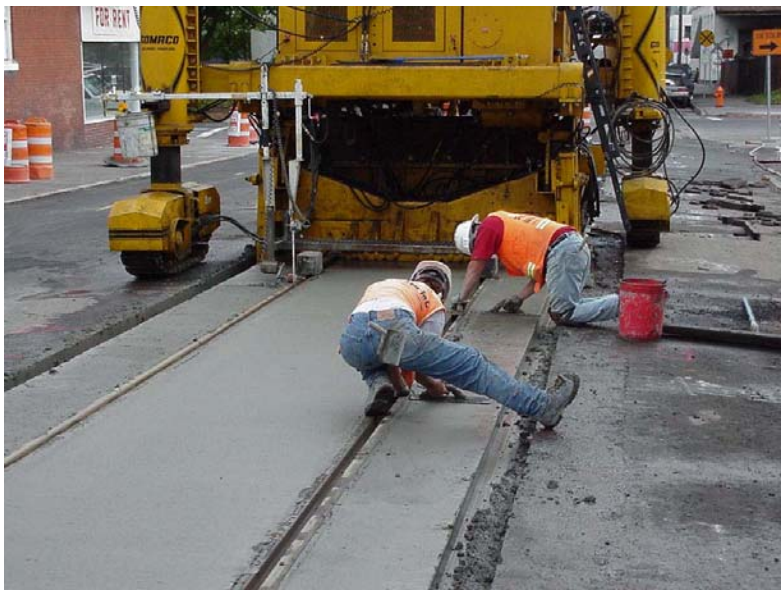
After the trackway trench was completed, track slab reinforcing steel was placed and rails were positioned to their proper alignment and profile. The rails were aligned by the use of gage ties spaced approximately every 10 feet. The gage ties held the rail in position during the subsequent concrete pour.

Figure 13. Construction Step 2, Install Rebar and Rails

Step 3 – Pour Concrete Track Slab (see Figure 14)

After a final check to ensure the proper rail alignment, the concrete track slab was poured. In most cases this concrete pour was done in a single lift and was finished with a slip-form paving machine that straddled the tracks.

Figure 14. Construction Step 3, Pour Concrete Track Slab



Step 4 – Final Paving and Striping (see Figure 15)

Once the track slab concrete was sufficiently cured, the adjacent asphalt pavement was ground to allow a minimum asphalt overlay of 2 inches next to the tracks. The overlay was then compacted, the roadway was re-striped, and the section of roadway was reopened to vehicular traffic.

Figure 15. Construction Step 4, Final Paving and Striping

3.5 Streetcar Vehicles

Streetcar vehicles used in the North America and Europe generally consist of three types:

- Modern streetcars,
- Renovated vintage/historic streetcars, and
- Modern replicas of vintage/historic streetcars.

Figures 16 through 19 illustrate examples streetcars currently in use in North America.

Currently, King County/Metro operates renovated vintage/historic streetcars along Seattle's waterfront and through Pioneer Square into the International District. Toronto and Portland operate modern streetcars and renovated vintage/historic streetcars as does New Orleans and other cities. San Francisco principally operates principally renovated vintage/historic streetcars. Tampa operates modern replicas of vintage/historic streetcars.

There are many differences between the types of streetcars. The most notable difference affecting customer use between modern and vintage/historic streetcars (whether renovated or replicas) is the boarding characteristics and vehicle floor height. Modern streetcars generally have low vehicle floors that allow level boarding from typical city sidewalks that may serve as streetcar stations/stops. Renovated or replicas of vintage/historic streetcars generally have higher vehicle floors (like the current Seattle Waterfront Streetcar) or steps in the streetcar to get from the sidewalk to the vehicle floor (like many of the King County/Metro buses). Where renovated or replicates of vintage/historic streetcars are used, special provisions such as platform ramps of lifts must be provided to meet ADA accessibility requirements.

Mixing modern streetcars and vintage/historic streetcars on the same lines within a network presents the challenges of accommodating both low floor and high floor vehicles. Maintenance facilities would also need to accommodate both if used on the same lines. These issues would need to be addressed as a Seattle Streetcar network develops.

For the purpose of this report, it is assumed that all streetcars procured for a new network in Seattle would be modern streetcars similar to (or the same as) the modern streetcars currently used in Portland and Tacoma. These vehicles are manufactured by Inekon/Skoda in the Czech Republic. Portland Streetcar, Inc., currently holds options with Inekon/Skoda for purchase of additional vehicles. Sound Transit purchased its Tacoma streetcars through Portland Streetcar, Inc. A similar opportunity may exist for future Seattle streetcar purchases.

Figure 16. Portland Streetcar

Figure 17. New Orleans Streetcar

Figure 18. Toronto Streetcar

Figure 19. Tacoma Streetcar

3.6 Urban Improvements and Safety

Typical improvements and enhancements along the streetcar alignment in an urban mixed-use neighborhood would be focused primarily in the area of the passenger-boarding platform. Throughout most of the network, the tracks would run in the street in the travel lane immediately adjacent to the parking lane. At a streetcar stop the curb and sidewalk would bulb out into the parking lane bringing the boarding platform out and immediately adjacent to the streetcar tracks. There are some unique locations, such as adjacent to South Lake Union Park and in Myrtle Edwards Park, where more custom solutions may be appropriate.

A typical platform would include a shelter for weather protection with transparent walls for visual penetration and increased security. Lighting inside the shelter or on the platform area would provide for nighttime orientation, identification and security. A bench or seating pods are usually provided. Graphics indicating fares, real time schedules and routes for the network are necessary and are located within or in close proximity to the shelter. Depending on the surrounding streetscape at each boarding platform, landscaping in the form of planters or street trees may be a desirable component.

Paving in the vicinity of the boarding platform may be treated to reflect the surrounding streetscape paving pattern or be unique to identify the streetcar stop. Figure 20 illustrates a typical streetcar platform in Portland, Oregon.

Figure20. Portland Streetcar Platform

Within the alignment right-of-way, the travel lane that includes the streetcar tracks is often highlighted with a different paving texture, pattern or color to identify the route between stops. The support poles for the overhead contact system could be decorative and/or reflect the character of the neighborhood to further identify the streetcar travel route. Banners, hanging planting baskets, system logos, etc., attached to the poles could further help to identify the travel route.

Identifiers along cross streets from adjacent activity areas should point the way to the routes and boarding platforms. Figure 21 illustrates streetcar travel lane treatment in Portland, OR.

Figure 21. Portland Streetcar Travel Lane

Certain components of the boarding platform and alignment improvements should be consistent and of a standard form and design to communicate the continuity of the network and specifically the identification of a given route within the network. Signage and symbols certainly fall within this mandate. On the other hand, paving, shelter architecture and landscaping could be unique from stop to stop and designed to fit in and reflect the scale and character of specific neighborhoods or surrounding activities.

They could be designed to fit within the guidelines of special design or historic districts without compromising the overall identity and continuity of the system.

These are generic improvements found on most urban streetcar systems and are necessary for providing for passenger safety, comfort and security and for insuring that the network would integrate within the fabric and functionality of the city. They may be as spartan or as elaborate in their expression and character as communities and neighborhoods or surrounding activities require and budgets allow.

Safety for streetcar passengers, pedestrians and other users of the street space is an important consideration. In addition to the passenger security features described above, such as lighting and visibility at stops, there are several other safety considerations when designing a streetcar system, including:

- Paint, pavement treatments and signage can be used to help motorists, cyclists and pedestrians know where to expect streetcar vehicles.
- The streetcar vehicles are well-lit and have large windows, which increases passengers' feeling of security and also helps provide "eyes on the street."

- The streetcar vehicles have dual braking systems to enhance their ability to stop and a pleasant but insistent audible warning signal that the driver can use to alert others in the street to the streetcar's presence.

In the Portland Streetcar's first year of operation, there were no injury accidents and only 11 hours of interrupted service due to accidents out of 19,600 hours of revenue service.

4. TECHNICAL AND ENVIRONMENTAL ISSUES

This section summarizes the technical and environmental issues associated with the South Lake Union, Waterfront – International District, and Waterfront – North alignments, and describes requirements for a maintenance base.

4.1 Technical Review of South Lake Union and the Waterfront Extensions

Table 8 summarizes and compares the technical issues associated with each of the three lines. Alignments and cross-sections for each of the three lines are illustrated in Appendix B.

South Lake Union Alignment

Utility Impacts

There is a 12-inch water main adjacent to the NB track along Westlake Avenue from Olive Street to Denny Way. It is assumed that this water line would need to be relocated.

There is a 20-inch, high-pressure gas main adjacent to the SB track along Westlake Avenue from 6th Avenue to W. Thomas Street. During design, options to minimize impacts would be explored.

There are overhead power lines along the north side of Fairview Avenue N. that may conflict with the proposed streetcar alignment.

There are several electrical vault accesses that may need to be reconfigured to avoid conflicts with the track slabs on Westlake. These vaults are located between Stewart Street and 8th Avenue.

Parking Impacts

Some parallel parking spots would need to be removed at proposed Streetcar platform locations since the platforms would extend the curbs into the parking lane.

There are parking areas adjacent to Valley and Fairview Avenue N. in the rail bank area that would need to be removed for the proposed Streetcar. The maps in Appendix B show two alignment options, one of which preserves more parking. Private parking lots adjacent to the rail bank area could be accessed via a one-way frontage road on the north side of the proposed Streetcar alignment.

Traffic

There are currently several driveway access points between Fairview Avenue N. and the businesses west of Fairview Avenue N.. These accesses would need to cross the streetcar tracks in the rail bank area. Movements of streetcar vehicles, automobiles and other modes of transportation would need to be coordinated at these intersections. One method of controlling

movements is to eliminate as many access points as possible and to use traffic signals at remaining access points to control movements. The addition of a one-way frontage road was proposed as a means of providing business access and consolidating access points.

The existing lane configurations at the proposed downtown terminus of the Streetcar (on Westlake at Olive Way) may need to be reconfigured to allow Streetcar vehicles to stop for extended periods of time during layovers. One option that was explored is the elimination of NB lanes on Westlake between Olive Way and Stewart and only allowing one NB lane between Stewart and 6th. This would provide enough room for creating exclusive lanes for the Streetcar so that vehicles could stop for extended periods of time and also move in both directions while entering and leaving the terminus.

Span wires support many of the traffic signals along the alignment. Introduction of a high voltage catenary wire above the streetcar tracks may require modifications to these traffic signals and associated span wires. It is presumed that the catenary wire for the streetcar would pass through signalized intersections similar to the way trolley bus wires currently pass through signalized intersections.

The northbound streetcar track crosses the southbound streetcar track at the intersection of Westlake and W. Thomas Street. The tracks also cross near the intersection of Valley and Terry Avenue N. Both of these track crossings must be controlled. The Westlake crossing could probably be controlled by traffic signals at the intersection. The Valley crossing may be visually controlled by the operators of the streetcars similar to the way passing tracks are controlled along the existing Waterfront Streetcar line.

Right-of-Way

Right-of-way would be required for up to four electrical substations, each about the size of a typical vehicular parking stall. Substation sites may require right-of-way acquisition, or may be located in existing street right-of-way.

The 90-degree corners on the Streetcar alignment may require minor right-of-way acquisition (or easements) depending on the Streetcar vehicle characteristics (turning radius), and the ultimate traffic configurations required at these intersections. Design refinements can usually mitigate these requirements.

The maintenance facility location may require right-of-way acquisition.

Basement vaults (or underground building extensions) below sidewalks may involve property easements/acquisitions.

Drainage

The City of Seattle may require detention and/or treatment of stormwater runoff from the streetcar tracks. Detention would be required where it currently does not exist or where the capacity of the existing stormwater system in the immediate vicinity is insufficient to handle the additional required detention. Treatment would be required if the stormwater would be discharged directly into a receiving water body, rather than routing through a combined sewer system to an existing wastewater treatment plant.

Structures

There is an underground parking structure wall adjacent to Fairview Avenue N. at Aloha Street that should be checked for structural adequacy if the Streetcar is placed in the rail bank area. At this point the wall is assumed to be structurally adequate and no additional costs have been assumed.

Waterfront - International District Potential Alignment (5th Avenue to 12th Avenue S.)

Utility Impacts

There is a 30-inch water main adjacent to the streetcar track on S. Jackson Street between 5th Avenue S. and 7th Avenue S. It is assumed that this water main will need to be relocated.

There is a 42-inch water main on 12th Avenue S. that will be crossed by the streetcar tracks twice (once at King and once at Jackson). It is assumed that this waterline will need to be replaced with a new waterline that is cathodically protected and installed inside a larger casing to allow future maintenance access to the waterline without disrupting streetcar service.

Streetcar power lines would cross trolley bus lines at S. Jackson, 5th Avenue S., 8th Avenue S., 12th Avenue S., Rainier Avenue S., and 23rd Avenue S.

Parking Impacts

Some parallel parking spots will need to be removed at proposed Streetcar platform locations since the platforms will extend the curbs into the parking lane.

Traffic

The overhead clearance to the Interstate 5 bridge above S. King Street is less than 18 feet. High voltage streetcar wires should be installed a minimum of 18 feet above traffic lanes. One solution to this clearance problem would be to create an exclusive streetcar-only lane adjacent to the curb. This solution would require the removal of parking adjacent to the curb and would also require a traffic signal phase (or merge lane) to allow the streetcar to re-enter the normal traffic lane somewhere east of the bridge.

Span wires support many of the traffic signals along the alignment. Introduction of a high voltage catenary wire above the streetcar tracks may require modifications to these traffic signals and associated span wires. It is presumed that the catenary wire for the streetcar will pass through signalized intersections similar to the way trolley bus wires currently pass through signalized intersections

Right-of-Way

Right-of-way would be required for up to three electrical substations, each about the size of a typical vehicular parking stall. Substation sites may require right-of-way acquisition, or may be located in existing street right-of-way.

The 90-degree corners on the Streetcar alignment may require ROW acquisition (or easements) depending on the Streetcar vehicle characteristics (turning radius), and the ultimate traffic configurations required at these intersections.

The maintenance facility location may require ROW acquisition.

Basement vaults (or underground building extensions) below sidewalks may involve property easements/acquisitions.

Drainage

The City of Seattle may require detention and/or treatment of stormwater runoff from the streetcar tracks. Detention would be required where it currently does not existing or where the capacity of the existing stormwater system in the immediate vicinity is insufficient to handle the additional required detention. Treatment would be required if the stormwater would be discharged directly into a receiving water body, rather than routing through a combined sewer system to an existing wastewater treatment plant.

Structures

There is a subsurface wall along 5th Avenue S. between S. Jackson and S. King Street that should be checked for structural adequacy. At this point the wall is assumed to be structurally adequate and no additional costs have been assumed.

Other Issues

A method for controlling streetcars that enter and depart the single track on Main Street would need to be established to avoid conflicts between streetcars at the intersection of 5th and Main.

If existing Waterfront Streetcar line vehicles would be used to serve this extension then high boarding platforms would need to be constructed. At this point platforms are assumed to be curb height platforms and no costs are included for constructing high boarding platforms.

Waterfront North Alignment

Utility Impacts

Denny Way/Lake Union Combined Sewer Overflow Project has constructed two new outfall pipes under Myrtle Edwards Park. They would not conflict with the proposed alignment.

No other utility impacts have been identified at this time.

Parking Impacts

The parking lot near the west end of the existing maintenance facility would need to be reconfigured and it is assumed that several parking spots would be permanently removed.

Traffic

The existing bike/pedestrian path along the waterfront would need to be relocated to accommodate the streetcar alignment.

Right-of-Way

Right-of-way would be required for one electrical substation, which would be the size of a typical vehicular parking stall. The substation site may require right-of-way acquisition, or may be located in existing street right-of-way.

An easement would be needed from the Port of Seattle for the portion of the alignment that crosses Port property.

Drainage

The City of Seattle may require detention and/or treatment of stormwater runoff from the streetcar tacks. Detention would be required where it currently does not exist or where the capacity of the existing stormwater system in the immediate vicinity is insufficient to handle the additional required detention. Treatment would be required if the stormwater would be discharged directly into a receiving water body, rather than routing through a combined sewer system to an existing wastewater treatment plant.

Structures

As shown, this alignment would require modifications to the existing maintenance facility near Broad Street. However, it is assumed that this extension would not be constructed until after the Alaskan Way Viaduct has been re-constructed and after the existing maintenance facility has been relocated.

The proposed platform location at W. Thomas Street should be coordinated with the proposed pedestrian bridge at W. Thomas Street.

Table 8. Comparison of the Three Lines

Issues	South Lake Union Proposed Alignment	Waterfront – International District Potential Alignment	Waterfront – North Potential Alignment
Relative Utility Impacts	◑ to ●	●	○
Relative Parking Impacts	○ to ● [1]	◑	○
Traffic	○	◑	○
Right-of-Way	○	○	●
Drainage	◑	◑	○
Structures	○	◑	○

Notes:
High = ●
Medium = ◑
Low = ○
1 Parking impacts vary depending on alignment north of Valley Street.

4.2 Environmental Review of South Lake Union and the Waterfront Extensions

Each of the three lines has environmental issues that would need to be addressed in environmental review, permitting, and construction. The comments below apply to the basic conceptual alignments for each line.

South Lake Union Alignment

Segment: Westlake to Yale

Earth – Environmental Critical Areas are designated along Valley Street and Fairview Avenue N. due to potential liquefaction risks.

Air Quality – Hot spot analyses would be needed for newly signalized intersections, including: Mercer/Terry, Valley/Terry, and Westlake/Thomas. In addition, analysis would be needed for one or more existing signalized intersections such as Westlake/Mercer, Westlake/Valley, and/or Denny/Westlake.

Water – Upgrades to the stormwater system (quantity and/or quality) would be likely in segments of the alignment.

Plants/Animals - No issues. Assuming this project would require the preparation of an EA, only a cursory evaluation of plants and animals would be required since there is no in-water work and

the drainage improvements would enhance water quality. Also, there would be no negative impacts on Lake Union. Concerning impacts to listed species, a 'no effect' letter would likely be issued as there are no listed species within the project 'action area' and actions associated with the project would improve water quality.

Environmental Health – Potential contaminated soils likely exist within the street rights-of-way of Westlake, Terry Avenue N., Valley, and Fairview Avenue N.. This condition would likely require subsurface testing prior to construction in order to plan for excavation, transport, and disposal of spoils.

Noise – Construction noise could result in short-term impacts along the alignment to sensitive receptors (i.e. the hotel at the southern terminal, condominiums along Westlake, and a hotel on Fairview Avenue N. near Valley). No night work would be permitted in the vicinity of sensitive receptors without a noise variance.

Land and Shoreline Use – The alignment is within the Denny Triangle Urban Center Village (UCV) and the South Lake Union Hub Urban Village (HUV). The alignment along Valley and Fairview Avenue N. is located within 200 feet of the Lake Union shoreline.

Land Use Zoning: DOC 2-300 on Westlake from Olive to 8th; DMC-160 from 8th to Denny; NC3-125 from Denny to Mercer; C2-40 and C2-65 from Mercer to Valley; C2-40 on Valley; C2-40 and C2-65 on Fairview Avenue N.; C2-40 on Terry Avenue N. from Valley to Mercer; IC-65 on Terry Avenue N. from Mercer to W. Thomas Street; and IC-85 and IC-65 on W. Thomas Street from Terry Avenue N. to Westlake.

Shoreline Zones: The Lake Union shoreline is designated Urban Stable (US), which would necessitate obtaining a Shoreline Master Use Permit. A Shoreline MUP is issued by the City of Seattle Department of Planning and design and is appealable to the State Shorelines Hearing Board.

Aesthetics – The new streetcar would require adding overhead wires and support poles along Westlake and Valley. Overhead wires and support poles already exist along Fairview Avenue N. (Route 70), though Streetcar may operate in separate right-of-way. View issues would need to be examined, such as views down Westlake toward Lake Union.

Light & Glare – No obvious issue.

Recreation – McGraw Square, another City park kitty-corner; a large recreation area (block bounded by Westlake, John, 9th, Denny), South Lake Union Park, and the Center for Wooden Boats are all located in close proximity to the alignment. Section 4(f) analysis of indirect impacts would likely be needed.

Historic/Cultural Preservation – McGraw Square, the existing Land Rover Dealership (historic William O. McKay Ford-Lincoln automobile dealership), the U.S. Naval Reserve Armory, the existing Shurgard storage facility (historic Ford assembly plant building), and the Schooner Wawona (a designated City Landmark) are located in the project area. A Section 4(f) Evaluation and Section 106 Review may be needed to address indirect impacts to these historic properties.

Environmental Justice – No apparent issue, though the boundaries of the Cascade Neighborhood (to the east) may encroach the project area of affect and may require analysis and public involvement.

Waterfront – International District Potential Alignment

Segment: 5th/Jackson to 12th/Jackson via S. King and S. Jackson

Earth – An Environmental Critical Area is designated on the north side of S. Jackson between I-5 and 12th Avenue S. (likely steep slopes).

Air Quality – Hot spot analysis at new signalized intersections and one or more existing signalized intersections (e.g. 5th/Jackson, 12th/King, and/or 12th/Jackson) would likely be required.

Water – Upgrades to the stormwater system would be likely.

Plants/Animals – No obvious issues.

Environmental Health – Probable contaminated soils are likely to be found in the street right-of-way, particularly east of I-5 on S. King and S. Jackson Streets. This condition likely requires subsurface testing prior to construction in order to plan for excavation, transport, and disposal of spoils.

Noise – Residential properties are located on both sides of S. King Street west of I-5 and both sides of S. Jackson Street from 10th Avenue S. to 5th Avenue S.. These residential properties would restrict nighttime construction activities and may require a noise variance.

Land and Shoreline Use – The area west of Rainier is located in the Chinatown/International District Urban Center Village (UCV) and the area east of Rainier is located in the Central Residential Urban Village (RUV). The alignment is not within a regulated shoreline area.

Land Use Zoning: West of I-5, adjacent properties are zoned IDM-75-85 and between I-5 and 12th, land is zoned NC3-65 and C1-65 on the east side of 12th.

Aesthetics – Trolley bus wires already exist on S. Jackson, and 5th, 8th and 12th Avenues S. and a new streetcar line would add new visual elements on S. King Street. This issue is a particular concern within the historic district.

Light & Glare – The existing neighborhood is already well lit, so there are no obvious issues.

Recreation – The Hing Hay Park, located on the northwest corner of 7th Avenue S. and S. King Street, would not be directly affected. This concern may require a Section 4(f) Evaluation of indirect impacts on the park.

Historic/Cultural Preservation – The International Special Review District encompasses both sides of 5th Avenue S., both sides of S. King Street, the west side of 12th Avenue S., both sides of S. Jackson Street west of I-5, and the south side of S. Jackson Street between I-5 and 12th Avenue S.. In addition, the Pioneer Square Preservation District also includes the west side of 5th Avenue S. between S. Jackson and S. King. Within these districts, the appearance and historical integrity of structures and public spaces are regulated by a citizens' board and/or the City of Seattle Landmarks Preservation Board in accordance with processes and criteria established by local ordinance.

In addition, adjacent Seattle Landmarks include: the Chinese Community Bulletin Board at 511 7th Avenue S. (south of S. King Street) (ord. 106072); the Eastern Hotel at 506 ½ Maynard Ave S. (south of S. King Street) (ord. 107750); and the Old Main Street School at 307 6th Avenue S. (north of S. Jackson Street) (ord. 106147).

Section 4(f) and Section 106 considerations (primarily indirect impacts) would need to be evaluated for properties located within the special districts as well as for adjacent landmarks.

Environmental Justice – Low income and minority communities are located along the entire alignment and would require analysis and public involvement.

Segment: 12th/Jackson to 23rd/Jackson

Earth – No Environmental Critical Areas are designated along the alignment.

Air Quality - Hot spot analyses would be required for any new signalized intersections and possibly for the intersection of Rainier, Boren, 14th, and S. Jackson Street.

Water - Upgrades to the stormwater system would be likely.

Plants/Animals – No obvious issues.

Environmental Health – Possible contaminated soils would likely be found near some commercial uses scattered along the alignment and would require subsurface testing prior to construction to plan for excavation, transport, and disposal of spoils.

Noise – Sensitive land uses along the alignment include a new apartment complex is located at 23rd/Jackson, the Washington Middle School and Seattle Vocational Institute at 21st Avenue S. and S. Jackson Street, and one possible residence near 15th/Jackson. Nighttime construction activities would likely need to be restricted near the residential units. Care to minimize noise impacts near the Middle School and Vocational Institute would be needed during classroom hours.

Land and Shoreline Use – The area west of Rainier Avenue S. is in Chinatown/International District UCV (Urban Center Village) and the area east of Rainier Avenue S. is in Central Residential Urban Village (RUV). Typical uses along S. Jackson Street are commercial/retail, with some residential and educational uses. The alignment is not located within a regulated shoreline area.

Land Use Zoning: C1-65, NC3-40, and NC3-65.

Aesthetics – Trolley bus wires already exist on S. Jackson Street (Route 14 east of Rainier/Boren; Route 7 and Route 14 to the west). A new streetcar would require the installation of additional overhead wires and support poles.

Light & Glare – No obvious issues. The area is primarily commercial or light manufacturing.

Recreation – The Dr. Blanche Lavizzo Park and the Central Park Trail are located at approximately 21st Avenue E. and S. Jackson Street. The Pratt Arts Center is located at 19th Avenue E. and S. Jackson Street. Indirect impacts on the park and the trail, including possible direct impacts since trail crosses the street, would need to be examined in a Section 4(f) Evaluation.

Historic/Cultural Preservation – No known historic or landmark properties appear to be located within close proximity of the alignment.

Environmental Justice – Low income and minority communities are located along the entire alignment, which would require analysis and public involvement.

Waterfront North Alignment

Segment: Broad Street to W. Thomas Street

Earth – The alignment is located within a designated Environmental Critical Area (liquefaction) and would require critical area review.

Air Quality – No issues as no intersections would be affected.

Water – A stormwater drainage system would be required (none currently in place) to meet the City drainage code requirements and the City's NPDES stormwater permit requirements.

Plants/Animals – No issues. Assuming this project would require the preparation of an EA, only a cursory evaluation of plants and animals would be needed since there would be no in-water work and the drainage improvements would enhance water quality. Also, there would be no negative impacts on Elliott Bay. Concerning impacts to listed species, a 'no effect' letter would likely be issued as there are no listed species within the project 'action area' and actions associated with the project would improve water quality.

Environmental Health – Contaminated soils possibly would be found along the entire alignment due to the close proximity of the BNSF mainline railroad tracks. Construction activities could also encounter potential groundwater contamination. Subsurface testing of soils and groundwater would likely be needed prior to construction to plan for excavation, transport, and disposal of spoils.

Noise – Park and recreational uses are located throughout the project area and would require noise analysis.

Land and Shoreline Use – The alignment is within the BINMIC Ballard Interbay MIC (Manufacturing/Industrial Center). In addition, it is located within regulated shoreline areas.

Land Use Zoning: IG1 and U/45.

Shoreline Zone: Conservancy Management (CM) and some Urban General (UG) designated shorelines are adjacent to the alignment, which would require obtaining a Shoreline Master Use Permit.

Aesthetics – Much of the alignment is located in a park-like setting. The introduction of new streetcar overhead wires and support poles would change corridor esthetics and would possibly alter westward views towards the waterfront.

Light & Glare – No issues noted.

Recreation – The alignment is adjacent to the Myrtle Edwards Park and would require relocation of a portion of the Elliott Bay Trail. (See the memorandum concerning Section 4(f) issues in the appendix.)

Historic/Cultural Preservation – No properties noted.

Environmental Justice – No known issues.

Segment: W. Thomas Street to Amgen

Earth – The alignment is located within a designated Environmental Critical Area (liquefaction).

Air Quality – No issues (no intersections involved).

Water – A stormwater drainage system would be required (none currently in place) to meet the City drainage code requirements and the City's NPDES stormwater permit requirements.

Plants/Animals - Assuming this project would require the preparation of an EA, only a cursory evaluation of plants and animals would be required since there is no in-water work and the drainage improvements would enhance water quality. Also, there would be no negative impacts on Elliott Bay. Concerning impacts to listed species, a 'no effect' letter would likely be issued as there are no listed species within the project 'action area' and actions associated with the project would improve water quality.

Environmental Health - Contaminated soils possibly would be found along the alignment due to proximity to BNSF mainline railroad tracks throughout the corridor. In addition, potential groundwater contamination would also likely be encountered. Subsurface and groundwater testing would likely be needed prior to construction to plan for excavation, transport, and disposal of spoils.

Noise – Park and recreational uses are located throughout the area and would require noise analysis.

Land and Shoreline Use – The alignment is located within the BINMIC Ballard Interbay MIC (Manufacturing/Industrial Center). A portion of the alignment is also within a regulated shoreline area.

Land Use Zoning: IG1 and U/45.

Shoreline Zone: The shoreline area is designated Conservancy Management with adjacent shoreline areas designated Urban General (UG). This would necessitate obtaining a Shoreline Master Use Permit.

Aesthetics – Portions of the alignment are within a park-like setting. Introduction of new streetcar overhead wires and support poles would change the aesthetics. In addition, views to the west of Elliott Bay would potentially be affected, though portions of the alignment are immediately adjacent to the very large Port of Seattle grain elevator and the alignment terminus is in an office complex setting.

Light & Glare – No issues noted.

Recreation – The alignment is adjacent to or traverses through the Elliott Bay Park (a of Seattle facility) and it is adjacent to the Elliott Bay Fishing Pier. As a consequence, relocation of the Elliott Bay Trail would likely be required. (See the memorandum concerning Section 4(f) issues in the appendix.)

Historic/Cultural Preservation – None noted.

Environmental Justice – No known issues.

Segment: Amgen North to Interbay

Earth – The alignment is located within a designated Environmental Critical Area (liquefaction).

Air Quality – Hot spot analysis at any new signalized intersections and potentially at other intersections may be required, depending on the final alignment and Port of Seattle redevelopment plans.

Water – A stormwater drainage system would be required (none currently in place) to meet the City drainage code requirements and the City's NPDES stormwater permit requirements. In addition, an over-water structure may need to be constructed in the vicinity of the existing Galer Street overpass.

Plants/Animals - Assuming this project would require the preparation of an EA, only a cursory evaluation of plants and animals may be needed since there is no in-water work and the drainage improvements would enhance water quality. Also, there would be no negative impacts on Elliott Bay. Concerning impacts to listed species, a 'no effect' letter would likely be issued as there are no listed species within the project 'action area' and actions associated with the project would improve water quality.

Environmental Health - Contaminated soils possibly would be found due to proximity to the BNSF mainline railroad tracks along the entire alignment. Potential groundwater contamination also could be encountered. Subsurface and groundwater testing would likely be needed prior to construction to plan for excavation, transport, and disposal of spoils.

Noise – Park and recreational uses are located throughout area and would require noise analysis.

Land and Shoreline Use – The alignment is within the BINMIC Ballard Interbay MIC (Manufacturing/Industrial Center). In addition, a portion of the alignment traverses regulated shorelines of Elliott Bay.

Land Use Zoning: IC-45.

Shoreline Zone: The shoreline area is designated Urban Industrial (UI) and would require obtaining a Shoreline Master Use Permit for the section of the alignment south of the Magnolia Bridge).

Aesthetics – Portions of the alignment are within a park-like setting. The introduction of new streetcar overhead wires and support poles would change the aesthetics and views of Elliott Bay to the west. In addition, portions of the alignment may be located within the new Port of Seattle redevelopment area.

Light & Glare – No issues noted.

Recreation – The alignment is adjacent to or traverses through the Elliott Bay Park (a Port of Seattle facility) and would likely require relocation of the Elliott Bay Trail. (See the memorandum concerning Section 4(f) issues in the appendix.)

Historic/Cultural Preservation – None noted.

Environmental Justice – No known issues.

4.3 Maintenance Base Requirements

In order for a streetcar network to function, there must be facilities to maintain and store the streetcar vehicles. The existing Waterfront Streetcar maintenance facility is located north of Broad Street along Alaskan Way. As new streetcar lines are added, existing facilities would need to be expanded, or new facilities would need to be added if the vehicles could not access the existing facility. Since Metro King County is undertaking a study of potential new locations for its Waterfront Streetcar maintenance facility, the discussion below will only address the maintenance base needs for the initial South Lake Union corridor. However, many of the issues identified for this facility are also applicable to maintenance facilities requirements for other lines in the network.

The maintenance facility for the proposed initial South Lake Union streetcar line would maintain and store the streetcar vehicles on a daily basis. A typical streetcar vehicle is 66 feet long and 8 feet wide, runs on standard gauge tracks, is 11.5 feet high, and is classified as a low-floor vehicle. These vehicles have support equipment (HVAC, air compressor, resistor banks) mounted at roof level. The SKODA vehicle, which is being used in Portland and Tacoma, has two trucks with a double center articulation. Each truck has two AC motors and drive units mounted on a wheel set that may or may not have resilient/bochum wheels. Unlike the current Waterfront Streetcar line vehicles, which require climate-controlled storage, these streetcar vehicles could be stored outside as long as they are in a secure area.

The maintenance required could be summarized in the following categories.

Daily Maintenance

Interior Cleaning

Space required would be included in the yard lay-up area. Interior cleaning could be accomplished as the vehicles are out-of-service for off-peak hours or non-service hours. Equipment required would include the obvious tools of the task (mops, brooms buckets, etc.). Space would be required for storage of the cleaning equipment and the chemicals necessary to complete the task.

Exterior Cleaning

There are two exterior cleaning options to consider. The first is the installation of a car wash. This self contained system sprays cleaner onto the vehicle, spaces a dwell time for cleaner reaction, brushes the exterior of the vehicle after the cleaner application and dwell, then rinses the vehicle. This option could be expensive and requires an inordinate amount of space in a storage facility for a small fleet.

The second option is to locate hose bibs and possibly mid-level platforms in the storage area for hand washing of the vehicles. The space required for this task is the same as for interior cleaning and equipment and chemical storage required to accomplish the task. Wastewater from the car wash process would need to be detained, analyzed, and treated if and as necessary prior to discharge, or reused if in a self-contained system.

Cleaning fluids and other dangerous or hazardous materials would also need to be properly stored and properly disposed consistent with applicable regulations.

Sanding

Assuming that the vehicles would use a sanding feature for traction assist for both braking traction and propulsion traction during snow or ice conditions, there are two alternatives. First, a sanding tower that utilizes an air pressure system to deliver dry sand through a pipe/hose system to a nozzle. The nozzle is then use to deliver the sand to the hopper box on the vehicle. This option could be expensive and requires a large amount of space in a storage facility for a small fleet as proposed.

The other alternative is to use bagged sand and manually fill the sanding units. The maintenance space required for this task is only that space required to store the materials for the task.

Inspections

Daily/Safety Inspections

Inspection entails a walk-around walk-through inspection to ensure safe, clean, timely operation of the vehicle. This could be performed by a mechanic or the operator of the vehicle prior to release for in-service operations. This inspection could be performed in the storage yard, and would focus on visual inspection of truck-mounted equipment for secure mounting and state of good repair of braking equipment. The walk through would look for lighting, door operations, mounted equipment (mirrors, etc…), and include a terminal brake test (verifying safe brake operation). Space required to perform this inspection would be included in the storage yard area. Aisles in the facility or yard would be spaced to allow inspectors to walk completely around each of the vehicles being stored.

Cyclical/Periodic Inspections

A typical Cyclical/Periodic Inspection or Preventive Maintenance Program (PMP) should utilize a program that is time based. Each vehicle in the fleet should be inspected on a 90-day cycle, and would be directed at improving reliability through early detection of failing components and the timely correction of minor defects that impact operations. During the inspection, the proper functioning of all systems including cab signals, event recorders, air brakes, and propulsion systems and controls are verified and defects are corrected.

On a 2-year cycle, the PMP includes truck removal for center casting inspection and also includes scheduled replacement of other major components, such as air valves, shock absorbers and the master controller. On a 5-year cycle, the PMP includes all elements above with the addition of a full truck and wheel set rebuild. Other components would also be rebuilt based on the manufacturers suggested maintenance schedule.

The space required to accomplish these tasks include a track with inspection pit for performance of inspections and a flat track to perform detrucking when required. A roof level platform (either fixed or mobile) would be required to access roof mounted equipment. Relating to the proposed fleet, two tracks, one with a pit and one flat, each one vehicle in length would be required.

Running Repairs

Running repairs are defined as repairs that could be easily accomplished by pulling the vehicle off the line (i.e. out-of-revenue service) into the facility and completing the repairs in less than approximately four hours. Examples of running repair incidents would be broken or missing vehicular glass, propulsion failure indication lights, and door system malfunctions.

The space required to accomplish these tasks include a track with a pit for conducting the repairs. A roof level platform (either fixed or mobile) would be required to access roof mounted equipment for diagnostics and repair. Relating to the proposed fleet, two tracks, one with a pit and one flat, each one vehicle in length would be required. These same tracks would be shared with inspection and preventive maintenance tasks.

Component Change-out

This category of maintenance activity has two stages. Component change-out could be required for either a repair or a cyclical maintenance item. Both are categorized as component change-outs but for entirely different reasons.

When a major component fails, it would need to be removed and replaced. Space and equipment would be allocated to perform component change-out of roof level equipment and truck-mounted equipment. Repair of the subject equipment should be contracted to qualified vendors or to a compatible facility within the King County Metro system.

When a major component has reached the end of its predictable service life, it would need to be removed, rebuilt, and/or replaced. This would relate to the 5-year cyclical inspection/preventive maintenance program, as described above.

Space and equipment could be expensive. These tasks should be accomplished at the King County Metro Central or South Base facility already being used by the existing Waterfront Streetcar or by an independent vendor.

Heavy Repairs – Accident Damage

Heavy repairs are defined as any repair that requires the vehicle to be out-of-service for a predetermined amount of time to facilitate body repair. Accident repair trains are removed from service whenever they are involved in a collision incident and the resulting repairs would consume a considerable amount of time before being put back into service. Space and equipment could be expensive. These tasks should be accomplished at the King County Metro Central or South Base facility already being utilized in support of the Waterfront Streetcar system or by an independent vendor.

Overhauls

Time- or mileage-based cyclical maintenance entails removing, rebuilding, and/or replacing all major components involved with the state of good repair of the subject vehicle. This would relate to the 5-year cyclical inspection/preventive maintenance program, which was described above. Space and equipment could be expensive and these tasks should be accomplished at the King County Metro Central or South Base facility already used for the Waterfront Streetcar system or by an independent vendor.

South Lake Union Facility Requirements

Based on the prior discussions, a maintenance facility for the South Lake Union Line should consist of a total of four (4) tracks. Two (2) tracks should be designated as yard storage tracks and should be at least two vehicles in length (approximately 150 feet). The space between track centers in the yard should be 15 feet leaving an aisle of 7 feet when vehicles are parked there.

The maintenance facility building could be a pre-manufactured steel building, modified for the specific requirements of the maintenance equipment. The building should be 100 feet by 70 feet with approximately 9,000 square feet of usable space. This includes 2,000 square feet of space located on top of the administrative and employee welfare space (restrooms, lockers, etc.).

The shop floor/work space would include two tracks, each 100 feet in length. Track #1 should be a flat track to be used for individual truck work or for roof mounted component servicing. Portable truck stands could be utilized in this area when access in required under the trucks. Track #2 should be over a pit for the length of the vehicle, about 65 feet, and could be utilized for inspections, running-repairs, and roof-mounted component servicing. The tracks should be approximately 100 feet in length to leave extra space at the front and rear of the vehicle for truck repair on the corresponding apron. An area of approximately 4,000 square feet, on two levels, should be provided for offices, employee welfare, and storage space.

The entire site dimensions, including the facilities building, the lay-up yard, parking, and required fire lane access should be approximately 200 feet by 160 feet (i.e. 32,000 square feet). The facility would be designed to accommodate up to 5 vehicles. Storage space for two additional vehicles would be required for the extension to the University of Washington.

5. COSTS, OPERATIONS, AND FUNDING

This section discusses several topics related to cost estimates and funding. Streetcar operations, maintenance, and associated costs are first described. Unit costs and order of magnitude cost estimates for the three lines are presented. In addition, funding options and revenue potential are generally described.

5.1 Streetcar Operations, Maintenance, and Associated Costs

The operating cost for streetcar service, as with any type of transit service, is driven by the number of hours and miles operated and by the cost for a unit (usually an hour) of operation. The number of hours and miles operated by any transit service are a direct result of the assumptions included in the operating plan for service. The cost per hour is unique to the operator providing the service and reflects prevailing wage rates, operator-specific overhead costs, costs specific to the vehicles purchased, etc.

Operating Costs for Streetcar and Buses

According to King County Metro, the existing streetcar service in Seattle costs significantly more to operate than an equivalent amount of bus service. The existing streetcar costs approximately $150.00 per hour, compared to about $98.00 per hour for bus service. Much of this difference could be attributed to the fact that the current antique streetcars require two staff on each car. When the Waterfront Streetcar is rebuilt following Viaduct construction, it may be desirable to replace the current streetcars with modern cars, even historic replica cars, that could be operated with a single driver; leaving the existing historic fleet to operate for special events. This would result in some substantial savings, as described below.

Even at properties that operate modern streetcars, streetcar operation tends to be more costly than bus. Generally, there are more buses in operation than streetcars, resulting in economies of scale for that mode. Streetcar maintenance is often done only partially on-site (as would be the case in Seattle) and partially by moving car bodies and components outside for heavy maintenance. The fact that a small unique fleet is being operated requires higher spare ratios and proportionally more extra board drivers than might be required by a larger fleet.

In Portland, for example, an hour streetcar service costs about $130 compared with about $85 for a fully allocated hour of bus service. In this case, the streetcar includes fully allocated administrative, marketing and other ancillary expenses that are unique to the streetcar. This 52 percent “premium” for an hour of service is the maximum that could be expected in Seattle. The premium is due to the maintenance of track-way and a unique vehicle which requires separate shop facilities, etc. as well as the lack of economies of scale that accrue to larger fleets. More likely, given the existing difference between the single operator bus and the double operator streetcar, modern streetcar service in Seattle would cost about 30 percent more than bus or $127.50 per hour of service.

Travel Speeds

Travel speed is a key variable in developing operating cost assumptions, because it determines how quickly a given vehicle could make a round trip and begin the trip again. Travel speeds includes the time required for stops as well as the speed between stops. Based on the national peer review, streetcar service is estimated to operate at 9 miles per hour, including all stops and delays. This is significantly faster than the current Waterfront Streetcar speed of about 6.5 miles per hour, based on slightly longer stop spacing, double tracking, modern vehicles and other types of protection and priority that would speed the streetcar. Speeds of nine miles per hour are very competitive with buses operating in the same environment.

The Portland Streetcar operates at 7 miles per hour, including all stops with closer stop spacing than is proposed for the proposed South Lake Union line. Streetcars in San Francisco operate at average speeds ranging from 8 to 11 miles per hour; and Toronto achieves an average speed of 9 miles per hour.

Other Operating Plan Assumptions

The conceptual operating plan for three potential streetcar lines is described above in the section entitled "Developing a Streetcar Network for Seattle." Other important operating plan assumptions include the frequency of service, and the length of the service day. Generally speaking, service is assumed to initially operate every 15 minutes, then to increase to every 10 minutes as demand increases. Services are assumed to operate over a 15-hour service day, longer than the existing Waterfront Streetcar. Layover and recovery times are allocated at the ends of each trip, to provide time to return to schedule in case of delays. At least 20 percent of the round trip running time is allocated to layover and recovery in each operating scenario.

Revenue Hours

Table 9 below shows daily and annual revenue hour requirements for the existing Waterfront Streetcar, the proposed South Lake Union Line, and the potential Waterfront extensions. It should be noted that in the post Viaduct period, when the Waterfront Streetcar line is operated with its extensions, the line could be optimized to reduce total revenue hour requirements. The information presented in this table reflects maximum costs. It should also be noted that in the case of the waterfront extensions, 10 minute frequencies could be operated at the same over-all cost as 15 minute frequencies by reducing layover and recovery times, which are quite generous under the 15 minute scenario.

Vehicle Requirements

Assumptions about operating speed and service frequency also directly affect the number of vehicles that would be required to operate the line, since the vehicle requirement is directly dependent on how long it takes a vehicle to make a round trip cycle over the line.

Vehicle fleet requirements are a combination of the peak vehicle requirement to operate service and the number of spares needed to ensure a reliable service is maintained. Generally a 20 percent spare ratio is required for a standard transit fleet, rounded up to the next largest whole number of vehicles. In the case of very small fleets, it is sometimes necessary to have a minimum of two spares on the property to ensure reliable service, especially if components are being

maintained off-site. In the case of the South Lake Union Line, 15-minute service operating at 9 miles per hour could be operated effectively with two vehicles. However, an initial four-vehicle fleet is recommended (two in service and two spares), expanding to five vehicles to operate every 10 minutes. Number of spare vehicles needed could be reduced if arrangements were made to share with another agency.

Table 10 summarizes the number of vehicles needed for each stage of service on the primary streetcar corridors.

Table 9. Revenue Hour Requirements and O&M Costs

Streetcar Line/Extension	Proposed Headway	Weekday Revenue Hours	Annual Revenue Hours [1]	Annual Operating Cost
SOUTH LAKE UNION (not including the extension to the UW)				$127.50/ Rev. Hour
South Lake Union - Initial	15	30.00	10,950	$1.4 M
South Lake Union – As Area Develops	10	45.00	16,425	$2.1 M
Pre-Alaskan Way Viaduct Reconstruction Operations				
Chinatown/International District to 12th Avenue S. (couplet using S. King and S. Jackson Streets)	15	15.00	5,475	$700,000
Chinatown/International District to 23rd Ave S.(includes 5th to 12th Avenues S.)	15	30.00	10,950	$1.4 M
WATERFRONT AND EXTENIONS – Post Viaduct				
New Waterfront Line – Double-tracked	10	60.00	21,900	$2.8 M
Chinatown/International District to 12th Avenue S. (couplet using S. King and S. Jackson Streets)	10	15.00	5,475	$700,000
Chinatown/International District to 23rd Ave S. (includes 5th to 12th Avenues S.)	10	30.00	10,950	$1.4 M
Waterfront Streetcar Extension to W.t Thomas St.	10	15.00	5,475	$700,000
Waterfront Streetcar Extension to Amgen (includes Broad to W. Thomas Streets)	20	15.00	5,475	$700,000

Notes:
1. Based on 365 days of operation.
2. For purpose of estimation it is assumed that all vehicles go in and out of service at the same time. Actual revenue hour requirements would vary slightly based on final schedule development.

Table 10. Vehicle Fleet Requirements

Streetcar Line/Extension	Proposed Headway	Peak Vehicles in Service	Total Vehicle Requirement
SOUTH LAKE UNION (not including the extension to the University)			
South Lake Union - Initial	15	2	4
South Lake Union – As Area Develops	10	3	5
South Lake Union (including UW Extension)	10	5	7
Pre-Alaskan Way Viaduct Reconstruction Operations			
Chinatown/International District to 12th Avenue S. (couplet using S. King and S. Jackson Streets & run during Viaduct construction)	15	2	3
Chinatown/International District to 23rd Ave. S. (includes 5th to 12th Avenues S.)	15	3	4
Post-AWV Viaduct Reconstruction Operations			
New Waterfront Line – Double-tracked	10	4	5
Chinatown/International District to 12th Avenue S. (couplet using S. King and S. Jackson Streets)	10	1	2
Chinatown/International District to 23rd Ave. S. (includes 5th to 12th Avenues S.)	10	2	3
Waterfront Extension to W. Thomas St	10	1	2
Waterfront Extension to Amgen (includes Broad to W. Thomas Streets)	20	1	2

5.2 Capital Cost Estimates

This section describes the cost estimating methodology used to calculate order of magnitude cost estimates for the three lines.

Cost Estimating Methodology

Conceptual Costs for constructing Streetcar alignments in Seattle have been prepared using the following methodology:

1) Alignment costs are detailed in the following categories:
   - a) Trackwork
     - Track Slab Installation (per linear foot)
     - Turnout/Track Crossing Installation (per each)
     - Ballasted Track Installation (per linear foot)
   - b) Catenary Poles and Overhead Wire (per linear foot)
   - c) Traffic Signals
     - Modified traffic signal (per each)
     - New traffic signal or full replacement (per each)
   - d) Civil/Roadway (includes modifications to streets, sidewalks, driveways, etc.)
   - e) Utilities
     - Major Conflicts
     - Moderate Conflicts
     - Minor Conflicts
   - f) Platforms
   - g) Substations
   - h) Maintenance Facility
   - i) Construction Soft Costs (Mobilization, General Conditions, QA/QC, Field Engineering, etc.)
   - j) Design and Construction Contingency Cost
   - k) Engineering and Administration Cost
   - l) Vehicles
   - m) Right-of-Way
2) Alignment costs for all of the above categories, except categories e, j, k and m, are based on costs incurred during construction of the Portland Streetcar in 1999-2001. The Portland costs would be inflated from 1999 costs to 2004 costs using RS Means

Historical Cost Indexes. The difference in the City Cost Indexes for Portland and Seattle (the cost of construction in these cities) is not significant and would be neglected.

3) Alignment costs would include all categorical information such as materials, preparation and installation.

4) Utility relocation costs could vary depending on local utility requirements (such as maintenance access requirements), utility size, utility depth, age of facility, and material used. Specific utility relocation costs would not be addressed as part of this effort, but relative utility relocation costs would be addressed by classifying utilities in an alignment (or portion of an alignment) as major conflicts, moderate conflicts or minor conflicts. Alignments with major conflicts would include a utility allowance of $500 per foot, alignments with moderate conflicts (or unknown conflicts) would include a utility allowance of $300 per foot and alignments with minor conflicts would include a utility allowance of $100 per foot. Only public utilities within 15 feet of the track centerline would be classified. Classifications would be determined as follows:

   a) Major conflicts would be defined by utility size as follows
      - Waterlines 30” diameter and larger
      - Parallel sewer lines 48” diameter and larger
      - Electrical vaults of any size

   b) Moderate conflicts would be defined by utility size as follows
      - Parallel waterlines 18”-30” diameter
      - Perpendicular waterlines (crossings) 12”-30” diameter
      - Parallel sewer lines 24-48” diameter
      - Underground Electrical Lines of any size
      - Public utilities of unknown size

   c) Minor conflicts would be defined by utility size as follows
      - Parallel waterlines smaller than 18” diameter
      - Any waterlines smaller than 12” diameter
      - Parallel sewer lines smaller than 24” diameter

5) The design and construction contingency would be assumed at 30 percent of the total construction cost. The engineering and administration cost would be 28 percent of the total construction cost and construction contingency cost.

6) An allowance for right-of-way costs would be included if it is appropriate (for maintenance facility or substations only).

Capital Cost Estimates for the Three Lines

The following tables provide order of magnitude cost estimates for each of the three lines. The conceptual costs for construction Streetcar alignments in Seattle are prepared using the unit costs shown in Table 11.

Table 11. Unit Costs for Estimating Construction Costs

Cost Category	Metric Unit	1999 Metric Unit Price	English Unit	1999 English Unit Price	2004 English Unit Price
Trackwork - Track Slab Installation	TM	$1,006.97	TF	$307.00	$350.00
Trackwork - Turnout/Track Crossing Installation	EA	$99,492.73	EA	$99,492.73	$112,500.00
Trackwork - Ballasted Track Installation [1]	TM		TF		$200.00
Catenary Poles and Overhead Wire	LM	$297.87	LF	$90.81	$105.00
Traffic Signals – New (or Full Replacement)	EA	$110,691.99	EA	$110,691.99	$125,000.00
Traffic Signals - Modified			EA		$50,000.00
Civil/Roadway [2]	TM	$449.11	TF	$136.92	$155.00
Utilities - Major Conflicts			LF		$500.00
Utilities - Moderate Conflicts			LF		$300.00
Utilities - Minor Conflicts			LF		$100.00
Drainage Allowance [3]			LF		$100.00
Platforms	EA	$28,069.93	EA	$28,069.93	$32,000.00
Substations	EA	$306,895.16	EA	$306,895.16	$350,000.00
Maintenance Facility			LS		$2,600,000.00
Vehicles (including sales tax and spare parts) [4]			EA		$3,000,000.00
Sales Tax [5]			%	8.80%	8.80%
Construction Soft Costs [6]	%	16.1%	%	16.1%	15.0%

Notes:

1 Based on contractors estimate for building ballasted track for the Portland Streetcar Gibb's Extension.

2 Includes grind/overlay of pavements, traffic control, minor road/sidewalk reconstruction, and drainage inlet modifications.

3 Allowance for possible stormwater detention and treatment facilities.

4 Vehicle costs are based on Sound Transit purchase price of Skoda streetcars for Tacoma.

5 Assumes tax only applies to 40% of construction costs (materials).

6 The figure 16.1% is actual from Portland and includes mobilization, field engineering, quality control, and general conditions.

7 The figure 15.0% will be used for Seattle estimates.

8 Utility costs do not include any costs for addressing conflicts with privately owned utilities such as gas, TV, phone, etc.

Table 12. South Lake Union Alignment

Order of Magnitude Cost Estimate

Cost Category	Unit Price	Quantity	Total Price
Trackwork - Track Slab Installation	$350.00	9800	$3,430,000
Trackwork - Turnout/Track Crossing Installation	$112,500.00	6	$675,000
Trackwork - Ballasted Track Installation	$200.00	3900	$780,000
Catenary Poles and Overhead Wire	$105.00	13800	$1,449,000
Traffic Signals - New (or Full Replacement)	$125,000.00	7	$875,000
Traffic Signals - Modified	$50,000.00	12	$600,000
Civil/Roadway	$155.00	9800	$1,519,000
Utilities - Major Conflicts	$500.00	288	$144,000
Utilities - Moderate Conflicts	$300.00	2658	$797,400
Utilities - Minor Conflicts	$100.00	3773	$377,300
Drainage Allowance[3]	$100.00	13800	$1,380,000
Platforms	$32,000.00	13	$416,000
Substations	$350,000.00	4	$1,400,000
Maintenance Facility	$2,600,000.00	1	$2,600,000
Construction Soft Costs	15.00%		$2,466,405
Sales Tax	8.80%		$665,600
SUB-TOTAL CONSTRUCTION COST			**$19,574,705**
Design and Construction Contingency Cost	30.00%		$5,872,412
TOTAL ANTICIPATED CONSTRUCTION COST			**$25,447,117**
Engineering and Administration Cost	28.00%		$7,125,193
Vehicles (includes sales tax, spare parts, etc.)	$3,000,000.00	4	$12,000,000
Right-of-Way	Not Incl.	Not Incl.	Not Incl.
TOTAL PROJECT COST (2004 DOLLARS)			**$44,572,310**
USE (2004 DOLLARS)			**$45,000,000**

Notes:

1. Private utility costs are not included in this estimate.
2. Four (4) vehicles are required to operate the line at 15-minute headways, which includes two vehicles in service and two spares. Fewer vehicles may be required if alternate arrangements for spare parts are made, such as sharing part inventories with another agency. An additional vehicle may be required to operate the line at 10-minute headways.

Table 13. Waterfront – International District Alignment

Order of Magnitude Cost Estimate

Cost Category	Unit Price	Quantity	Total Price
FROM 5TH AVENUE S TO 12TH AVENUE S			
Trackwork - Track Slab Installation	$350.00	6100	$2,135,000
Trackwork - Turnout/Track Crossing Installation	$112,500.00	1	$112,500
Trackwork - Ballasted Track Installation	$200.00	0	$0
Catenary Poles and Overhead Wire	$105.00	6100	$640,500
Traffic Signals - New (or Full Replacement)	$125,000.00	15	$1,875,000
Traffic Signals - Modified	$50,000.00	0	$0
Civil/Roadway	$155.00	6100	$945,000
Utilities - Major Conflicts	$500.00	700	$350,000
Utilities - Moderate Conflicts	$300.00	1137	$341,100
Utilities - Minor Conflicts	$100.00	4044	$404,400
Drainage Allowance	$100.00	6100	$610,000
Platforms	$32,000.00	8	$256,000
Substations	$350,000.00	3	$1,050,000
Maintenance Facility	$2,600,000.00	1	$2,600,000
Construction Soft Costs	15.00%		$1,698,000
Sales Tax	8.80%		$458,234
SUB-TOTAL CONSTRUCTION COST			**$13,476,234**
Design and Construction Contingency Cost	30.00%		$4,042,870
TOTAL ANTICIPATED CONSTRUCTION COST			**$17,519,104**
Engineering and Administration Cost	28.00%		$4,905,349
Vehicles (includes sales tax)	$3,000,000.00	1	$3,000,000
Right-of-Way	Not Incl.	Not Incl.	Not Incl.
TOTAL PROJECT COST (5TH TO 12TH)			**$25,424,453**
USE (2004 DOLLARS)			**$26,000,000**

Note:

1. Private utility costs are not included in this estimate.

Table 13. Waterfront – International District Alignment
Order of Magnitude Cost Estimate (continued)

Cost Category	Unit Price	Quantity	Total Price
FROM 12TH AVENUE SOUTH TO 23RD AVENUE SOUTH			
Trackwork - Track Slab Installation	$350.00	8000	$2,800,000
Trackwork - Turnout/Track Crossing Installation	$112,500.00	3	$337,500
Trackwork - Ballasted Track Installation	$200.00	0	$0
Catenary Poles and Overhead Wire	$105.00	8000	$840,000
Traffic Signals - New (or Full Replacement)	$125,000.00	3	$375,000
Traffic Signals - Modified	$50,000.00	0	$0
Civil/Roadway	$155.00	8000	$1,240,000
Utilities - Major Conflicts	$500.00	1578	$789,000
Utilities - Moderate Conflicts	$300.00	1137	$341,100
Utilities - Minor Conflicts	$100.00	4044	$404,400
Drainage Allowance	$100.00	8000	$800,000
Platforms	$32,000.00	11	$352,000
Substations	$350,000.00	2	$700,000
Maintenance Facility	$2,600,000.00	0	$0
Construction Soft Costs	15.00%		$1,346,850
Sales Tax	8.80%		$363,470
SUB-TOTAL CONSTRUCTION COST			**$10,689,320**
Construction Contingency Cost	30.00%		$3,206,796
TOTAL ANTICIPATED CONSTRUCTION COST			**$13,896,116**
Engineering and Administration Cost	28.00%		$3,890,912
Vehicles (includes sales tax)	$3,000,000.00	1	$3,000,000
Right-of-Way	Not Incl.	Not Incl.	Not Incl.
TOTAL PROJECT COST (12TH TO 23RD)			**$20,787,028**
USE (2004 DOLLARS)			**$21,000,000**

Note:

1. Private utility costs are not included in this estimate.

Table 14. Waterfront – North Alignment

Order of Magnitude Cost Estimate

Cost Category	Unit Price	Quantity	Total Price
FROM BROAD STREET TO W THOMAS STREET			
Trackwork - Track Slab Installation	$350.00	500	$175,000
Trackwork - Turnout/Track Crossing Installation	$112,500.00	1	$112,500
Trackwork - Ballasted Track Installation	$200.00	2000	$400,000
Catenary Poles and Overhead Wire	$105.00	2500	$262,500
Traffic Signals - New (or Full Replacement)	$125,000.00	0	$0
Traffic Signals - Modified	$50,000.00	0	$0
Civil/Roadway	$155.00	2500	$387,500
Utilities - Major Conflicts	$500.00	0	$0
Utilities - Moderate Conflicts	$300.00	0	$0
Utilities - Minor Conflicts	$100.00	1500	$150,000
Drainage Allowance	$100.00	2500	$250,000
Platforms	$32,000.00	1	$32,000
Substations	$350,000.00	1	$350,000
Maintenance Facility	$2,600,000.00	0	$0
Construction Soft Costs	15.00%		$317,925
Sales Tax	8.80%		$85,797
SUB-TOTAL CONSTRUCTION COST			**$2,523,222**
Design and Construction Contingency Cost	30.00%		$756,967
TOTAL ANTICIPATED CONSTRUCTION COST			**$3,280,189**
Engineering and Administration Cost	28.00%		$918,453
Vehicles (includes sales tax)	$3,000,000.00	1	$3,000,000
Right-of-Way	Not Incl.	Not Incl.	Not Incl.
TOTAL PROJECT COST (BROAD-THOMAS)			**$7,198,642**
USE (2004 DOLLARS)			**$8,000,000**

Note:

1. Private utility costs are not included in this estimate.

Table 14. Waterfront – North Alignment

Order of Magnitude Cost Estimate (continued)

Cost Category	Unit Price	Quantity	Total Price
FROM WEST THOMAS STREET TO AMGEN			
Trackwork - Track Slab Installation	$350.000	0	$0
Trackwork - Turnout/Track Crossing Installation	$112,500.00	2	$225,000
Trackwork - Ballasted Track Installation	$200.00	4000	$800,000
Catenary Poles and Overhead Wire	$105.000	4000	$420,000
Traffic Signals - New (or Full Replacement)	$125,000.00	0	$0
Traffic Signals - Modified	$50,000.00	0	$0
Civil/Roadway	$155.00	4000	$620,000
Utilities - Major Conflicts	$500.00	0	$0
Utilities - Moderate Conflicts	$300.00	0	$0
Utilities - Minor Conflicts	$100.00	1500	$150,000
Drainage Allowance	$100.00	4000	$400,000
Platforms	$32,000.00	1	$32,000
Substations	$350,000.00	1	$350,000
Maintenance Facility	$2,600,000.00	0	$0
Construction Soft Costs	15.00%		$449,550
Sales Tax	8.80%		$121,319
SUB-TOTAL CONSTRUCTION COST			**$3,567,869**
Design and Construction Contingency Cost	30.00%		$1,070,361
TOTAL ANTICIPATED CONSTRUCTION COST			**$4,638,229**
Engineering and Administration Cost	28.00%		$1,298,704
Vehicles (includes sales tax)	$3,000,000.00	1	$3,000,000
Right-of-Way	Not Incl.	Not Incl.	Not Incl.
TOTAL PROJECT COST (THOMAS-AMGEN)			**$8,936,933**
USE (2004 DOLLARS)			**$9,000,000**

Note:

1. Private utility costs are not included in this estimate.

5.3 Funding Options and Revenue Potential

The sections that follow describe some of the opportunities that may be available to fund streetcar projects in Seattle. As with all projects of this type, a combination of funding from multiple federal, state and local sources would be required to make this service a reality. The South Lake Union Streetcar has received some funding from federal and state sources, as noted below.

Federal Sources and Transportation Bill Reauthorization

Funding programs listed below are part of the TEA 21 legislation and are assumed to be reauthorized under SAFETEA. However, until final details of reauthorization are complete, funding programs are subject to change.

Project Earmarks/Federal Demonstration Projects

While recent federal transportation policy focuses on the devolution of spending decisions to state, regional and local entities, congressional earmarking of funds for projects still occurs, especially during the transportation bill reauthorization process. To obtain an earmark, project sponsors must raise the profile of their project and local congressional representation must be effective in advocating for the project during legislative negotiations.

A key to the federal earmarking process is local support for a project. Members of Congress have limited access to earmarked funds, and since each member is interested in returning funds to their home district for projects that are broadly popular, it is important that a proposed project have high visibility and a high degree of local support.

Earmarking can often jump start a project, by providing initial funds for environmental analysis or another specific aspect of the project development process. Earmarks are not available for operating funds.

Seattle received a $3 million FY 2004 federal appropriation for the South Lake Union Streetcar and has requested an additional $3 million for FY 2005.

Federal Transit Act Formula Funds

This federal program is devoted to funding the region's capital improvement program. Public transit operators could claim these funds for the purchase of buses, trains, ferries, vans and support equipment. Formula Funds require a 20% match.

Federal Transit Act Fixed Guideway Funds

A fixed-guideway operation must be operating for seven years before it can begin receiving allocations form the fixed-guideway funds. While these funds are not relevant for initial project deployment, streetcar projects could ultimately receive these funds.

Seattle received $1 million from this source in 2003/2004 funds and is expecting an additional $1.4 in 2006-2007 funds. Seattle is eligible for these funds through the existing monorail and has the flexibility to use the funds for other eligible projects.

Federal Transit Act New Starts/Small Starts Discretionary Program

The New Starts Discretionary Program is the primary federal funding source for new rail transit services. Projects are determined via a highly competitive process. While the funds are allocated at the Federal level, a critical component of this process is regional support and the importance of coordinated land use planning. Another critical component for New Starts funds is the ability to leverage funding for both the capital investment and ongoing operating support for a project. The Administration proposed to increase the local share requirements for new starts to 50%. Currently, transit programs have the same federal share requirements as highways (80% federal, 20% state or local).

The current SAFETEA proposal establishes a new category of new starts projects with under $75 million in federal funding as "small starts." These projects would have a streamlined evaluation process. This new category is meant to foster the development of less capital-intensive transit systems, such as Bus Rapid Transit and urban streetcar.

Congestion Mitigation and Air Quality Improvement Program (CMAQ)

Certain funds made available through the Federal Highway Administration are considered flexible funds and could be used for transit capital projects. They are the Surface Transportation Program (STP) and the Congestion Mitigation and Air Quality Program (CMAQ). Typically, STP funds are used for streets and road projects and are not available for transit. The federal CMAQ program provides funds for projects that contribute to the attainment or maintenance of federal air quality standards. CMAQ grants typically fund capital expenditures, not operations. A portion of CMAQ funds may be used to support the operating expenses for new or expanded transit service but only for the first three years of operations.

Transportation and Community and System Preservation Pilot (TCSP) Program

This innovative program of TEA-21 provides funding for projects that address the link between land use, community quality of life and transportation. It is not clear whether this program would be continued under SAFETEA, although it is worth mentioning because these funds could be a valuable element of a comprehensive funding program. The program favors projects that partner with private sector interests to make transportation and land-use connections. Transit agencies and cities are eligible recipients of these grant funds. Priority is given to projects that demonstrate a commitment of non-federal resources. Projects that make use of in-kind contributions, including funding from local and private sources, receive priority. Partnerships are encouraged and could include a broad range of traditional partners and non-traditional partners such as the general public, environmental community, businesses and other groups.

Transportation for Livable Communities

FTA has developed the Livable Communities Initiative (LCI) to strengthen the linkage between transportation services and the communities served. This program targets projects that utilize a collaborative public planning process, are transit or bicycle/pedestrian oriented, have significant local community benefits, and have been driven largely from a "bottom up" initiative. It promotes customer friendly, community oriented and well designed facilities and services. The characteristics of community sensitive transit facilities and services include readily available customer information and services, a safe and secure environment; sufficient pedestrian and bicycle access, and architecture that reflects the values of the community. There is no guarantee this funding program would be continued under SAFETEA, however if so, LCI funds could

supplement funding for a small element of streetcar projects, especially if it is developed in collaboration the business and local community.

Transportation Enhancement Activities (TEA)

TEA is a grant program under TEA-21. It is designed to fund environmental and alternative transportation projects that would not necessarily have other available funding sources. A wide variety of public agencies including cities, counties and transit operators are eligible for TEA funds. These funds are mainly used for capital projects, and cannot be used for transit operations. TEA funds are eligible for bicycle, pedestrian, transit, landscaping, public art or historic projects linked to transportation. As with other innovative programs under TEA 21, these funds are highly competitive. The evaluation criteria emphasize the same qualities as the TLC program.

State Funding Opportunities

There are no established state programs that would fund streetcar projects, but funds are sometimes available through direct appropriations. The South Lake Union Streetcar received $3 million in state funding through the efforts of Representative Ed Murray.

Local Funding Opportunities and Sources

Local funding opportunities include traditional transit funding sources such as farebox and advertising revenue, as well as options such as Local Improvement Districts.

Fares

Fare policy would be established as part of a detailed operating plan and could range from charging a fare for all streetcar trips (the Waterfront Streetcar currently charges for all trips, even though most of the route is within the ride free zone) to charging no fare. The current King County Metro adult fare is $1.50 during peak hours and $1.25 during off-peak hours. The youth fare is $0.50, and the senior and disable fare is $0.50 during peak hours and $0.25 during off peak hours. This fare structure, combined with the offering of discounted passes and ticket books, results in an average fare of $1.00 per passenger. Calculated using average fare and estimated ridership levels are presented below.

Table 15. Streetcar Fare Revenue Potential

Streetcar Line/Extension	Farebox Recovery per Year (range)	
South Lake Union (initial operation)	$333,000	$380,000
South Lake Union (as area develops more densely)	$1,070,000	$1,230,000
Pre-AWV Reconstruction Operations		
Current Waterfront Streetcar Line		$407,000
Waterfront – International District Alignment (to 12th Avenue S.)	$93,000	$110,000
Post-AWV Reconstruction Operations		
New Waterfront Line	$990,000	$1,090,000
Chinatown/International District to 12th Avenue S.	$250,000	$270,000
Waterfront with Extension to W. Thomas St	$1,040,000	$1,150,000
Waterfront with Extension to Amgen	$1,070,000	$1,133,000

Advertising and Sponsorships

Another potential funding source available for streetcar funding is transit advertising revenue. As subsidies from federal, state, and local governments become ever more scare and competitive, it is becoming common practice for transit agencies to contract with an advertising agent who would sell advertising space on transit vehicles, shelters, stations and other agency property. With what appears to be a modest investment in personnel and time, the transit authority is usually guaranteed a minimum annual revenue flow and a share of net revenues above an agreed upon minimum. In a report released by the Transportation Research Board (TRB), annual revenues transit agencies receive from advertising ranges from a low of $1,000 a year in Dayton, Ohio—where only public service ads are permitted and a nominal fee is charged—to $17 million in New York City. Another is to sell annual corporate sponsorship of individual streetcar stations, a practice already in place in the cities of Portland and Las Vegas.

Local Improvement Districts

Local Improvement Districts (LIDs) are one form of special assessment district financing created by Washington state law. They are traditionally used by city governments to finance all or part of the cost of physical improvements that are desirable for the general public, and that also provide specific benefit to adjacent property owners. The Portland streetcar and Seattle's Waterfront Streetcar were both built using Local Improvement Districts (LIDs) to fund part of the capital cost (17% and 32% respectively).

Initiating an LID

There are two ways a Local Improvement District could be initiated: by petition or by Council resolution.

Resolution

For a resolution-initiated LID, the first step is to determine the amount of support for the proposed LID. If the level of support appears adequate, a resolution is presented for City Council adoption. The resolution declares the City Council's intent to order the proposed improvement, and provides notice to people who desire to object to appear at a fixed time. The resolution contains the same information listed below for the petition method. A key difference between the two methods is that the owners of property subject to 60% or more of the total cost of the improvement (interpreted by the Washington Supreme Court to mean 60% or more of the cost that is to be borne by the property owners, not 60% of the total project cost) could divest the council of jurisdiction to proceed with a local improvement initiated by resolution. If the LID was initiated by petition, property owners could object, but there is no right of restraint by protest.

Petition

The requirements for the petition method are:

- Signatures of the owners of a majority of the area in the district;
- A description of the nature of the improvement;
- A description of the territorial extent of the area;
- The proportion of the area owned by the petitioners (as shown in King County Auditor's records);
- A statement that actual assessments may vary from assessment estimates so long as they do not exceed a figure equal to the increased true and fair value the improvement adds to the property;
- Filing of the petition with the City Clerk, followed by SDOT's determination of the sufficiency of the petition and whether the facts set forth in the petition are true. Thereafter, the notice and hearing requirements are the same as for a resolution.

Determining Assessment Amounts

By state law, the assessment amount may never exceed the amount of the "special benefit" received by the property owner from the improvement funded by the LID. "Special benefit" is defined as the difference between the fair market value of the property immediately <u>after</u> the special benefits have attached, and the fair market value of the property <u>before</u> the benefits have attached.