SOUND TRANSIT
SERVICE INTEGRATION PLANNING
AND RIDERSHIP FORECASTING SUPPORT

WORK ORDER 1: SERVICE INTEGRATION PLANNING

SERVICE INTEGRATION PLANS FOR LINK LIGHT RAIL ALTERNATIVES

Prepared for:
Sound Transit

Prepared by:
Parsons Brinckerhoff

in association with
Nelson\Nygaard Consulting Associates

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July 22, 1998

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1. INTRODUCTION

Sound Transit has contracted with Parsons Brinckerhoff and its subcontractors, Nelson\Nygaard, Manuel Padron & Associates, RST International, and K2 & Associates, to provide planning support in the areas of service integration planning and travel demand forecasting.

Under this contract, transit networks are being developed for each *Link* light rail alternative identified for study and evaluation in the DEIS. These networks identify the integration of bus services with *Link* light rail, *Sounder* commuter rail, and *Regional Express* bus services under Sound Transit's adopted *Sound Move* ten-year plan for implementation of high-capacity transit in the three-county region of King, Snohomish, and Pierce counties. The networks identify conceptual routings and headways for the feeder bus system providing access to the *Link* light rail system at stations. The networks are being developed for the forecast year of 2010 and are intended for use in the forecasting of transit ridership for each *Link* light rail alternative. The 2010 network developed for the *Sound Move* plan provided the basis for the development of networks for the alternative. In addition to the feeder bus system, the networks include regional and local bus services operated by King County Metro, Community Transit, Everett Transit, and Pierce Transit in the region. The services operated by these agencies are considered part of the background bus system and have been updated to reflect recent bus service revisions implemented by the transit agencies and agency plans for expansion of service between 1998 and 2010.

This report describes the year 2010 bus networks developed for the forecasting of transit ridership for the Base, Pre-Base and other *Link* light rail alternatives. The Base *Link* light rail alternative provides for a *Link* light rail line extending from South 200th Street in the city of SeaTac to Northgate. Passenger access to the line would be provided from 21 stations. The Base alternative also would include a *Link* light rail line in downtown Tacoma. Five stations are included in this line. The Pre-Base *Link* light rail alternative is the same as the Base alternative, except that the northern terminus for the *Link* light rail line would be at NE 45th Street in the University District instead of at Northgate. It represents a shorter light rail line which could be constructed if funding is not available to complete the *Link* light rail line to Northgate. The other alternatives involve *Link* light rail alignment variations in various segments of the corridor. All alternatives include *Sounder* commuter rail and *Regional Express* bus routes as part of the background transit system.

This report is organized into four chapters and appendices (in a separate volume). This chapter serves as the introduction to the report. The service guidelines used for the restructuring of bus service to provide access to the *Link* light rail stations are presented in Chapter 2. These guidelines were developed in cooperation with the area transit agencies. Chapter 3 describes the feeder bus networks developed for each of the two *Link* light rail alternatives identified to date. Chapter 4 identifies the feeder bus facility requirements at stations. These requirements reflect the number of bus bays needed for layover and

passenger transfers at stations. The report includes three separate appendices. Appendix A contains a summary description of the modifications to the 2010 *Sound Move* bus network under the Base *Link* light rail alternative network. Appendix B contains a summary of the modifications to the 2010 Base *Link* light rail alternative bus network under the various *Link* light rail alternatives. Appendix C contains the spreadsheet tables used to estimate bus facility requirements for each station under the Base and various alternatives.

2. SERVICE INTEGRATION GUIDELINES

2.1 INTRODUCTION

The implementation of the *Sound Move* program will dramatically change the pattern of transit service in the region. As Sound Transit creates new trunk routes, whether bus or rail, some King County Metro, Pierce Transit, Community Transit, and Everett Transit routes will need to be redesigned to work together with the new regional network. Since the *Sound Move* lines will replace existing lines in each corridor, each of the three agencies now operating regional service (Pierce Transit, Community Transit, and King County Metro) will be able to redeploy some of their service hours to create improved bus networks in their areas.

This report suggests guidelines for planning these service changes. These guidelines are required specifically for the *Link* light rail element of *Sound Move*. The Federal process for funding that project requires that light rail be analyzed together with its connecting bus network, and that the bus network be designed based on consistent guidelines.

At the same time, nothing in the guidelines is specific to light rail in any technical sense. The same planning considerations will apply wherever a new service is created, regardless of its mode. For this reason, the guidelines presented in this report may be useful as a starting point for Sound Transit and the other transit agencies, as they work together to implement other elements of the *Sound Move* program. The mandate of "seamlessness" applies to all of these elements, not just *Link* light rail.

It is important to stress, however, that the ideas presented in this report are guidelines, not mandates. Although these guidelines will be used to develop bus networks for *Link* light rail modeling, the actual redesign of transit service will be done by the region's five transit agencies (including Sound Transit). Each agency will have final authority over the design of its own routes, so the final service design may in some cases reflect the differences in values between the agencies. At the same time, the regional mandate of "seamlessness" is a common value that all the agencies will need to participate in achieving. These guidelines may assist in clarifying that common value, while still respecting each agency's role in determining the best service for its own constituents.

2.2 SERVICE INTEGRATION GOALS AND OBJECTIVES

Goal

The overarching goal of service integration is to achieve the highest possible transit ridership within given financial resources. Ridership on the *Link* light rail line is not as important as the overall system ridership and cost-effectiveness. For this reason, this process begins with the following goal, which was developed in discussion with representatives of the five agencies.

"Provide the maximum possible mobility for BOTH regional and local trips."

This process does *not* intend to reduce local mobility for the sake of increasing regional mobility. Instead, it seeks to develop networks that improve both.

Objectives

In a January 29, 1998 meeting with planning staff of Sound Transit, Community Transit, Everett Transit, King County Metro, and Pierce Transit, the above goal was developed. In addition, the following objectives were refined in service of the goal:

- Minimize Total Door-to-Door Travel Times;
- Maximize Cost Effectiveness Per Hour;
- Maximize Reliability;
- Maximize Access to Regional Services;
- Minimize Negative Impacts on Existing Riders;
- Minimize the Inconvenience of Transferring.

The guidelines presented in this paper arise mostly from the need to resolve conflicts among these six worthwhile objectives. For example, it may be possible to dramatically improve cost-effectiveness while increasing the door-to-door travel time for a relatively small number of people, and this may be worthwhile. The guidelines offer some ways to sort through these tradeoffs.

2.3 EXISTING AGENCY GUIDELINES AND POLICIES

Service integration issues have arisen frequently in the Puget Sound region, long before Sound Transit was created. The region's transit agencies have a wealth of experience in dealing with a variety of service design situations. This experience – especially where it has been formalized as policy – should be explored as a key source for service integration guidelines.

This study therefore began by considering the existing service design policies of the four agencies, as expressed in their Six Year Plans or other policy documents. Meetings with planning staff in the four agencies provided further insight into each agency's approach to service integration.

All four of transit agencies operating in the Sound Transit region have service standards for performance, measuring productivity, cost per rider, etc., and well-developed public outreach strategies. However, in terms of their approaches to service design, the policy statements of the agencies are quite different, and all deserve consideration.

Everett Transit

Everett Transit, as a municipal agency, has a relatively straightforward task of local circulation, and has not developed specific service design policies. Instead, they have relied on

performance measures to stipulate service design, a common practice in municipal transit operations.

Community Transit

Community Transit (CT) has relatively few formal policies that govern service design. However, the CT Six Year Plan articulates several ideas that are worth noting, and interviews with CT staff have raised several others:[1]

- CT has several goals that support the idea of service integration, though they are not integration guidelines. These include:
  - *"Integrate and/or operate future high capacity solutions with existing services."*
  - *"Coordinate Community Transit's services with other transportation providers to enhance regional mobility."*
- CT has a coverage standard, which is that 80% of residents within CT's boundaries should have access to some kind of transit service.
- CT does not isolate service design as an issue in its objectives. However, CT has an objective of *"Service Quality,"* and states: *"Service quality comprises: availability, reliability, and passenger comfort."*

CT's emphasis on passenger comfort is especially notable. CT tends, more than the other agencies, to think of passenger comfort as an overriding consideration in the service design process. The most important impact of this concern for the purposes of service integration is that CT goes to great lengths to avoid imposing transfers on its passengers, especially commuters. For example, CT runs direct commuter service from almost every part of Snohomish County to downtown Seattle, and separate sets of commuter routes (often in the same corridors) to the University District and to Boeing's Everett plant. This design reflects a strong commitment to one-seat service, and CT staff's assessment that the demand for these services is sufficiently high to justify the operation of parallel routes.

CT staff emphasizes that the agency has a satisfied ridership base on its current services, especially commuter services. While agency goals support service integration, the resistance to imposing transfers on current passengers at CT is much stronger than that of the other agencies. In particular, CT staff believes much of its ridership would object to deviating its downtown commuter services into Northgate for connections to *Link* light rail, even if this could be done without adding travel time and even if the revenue hours saved could be invested in additional commuter frequency or service span.

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1 Sources for this discussion are the *Community Transit Six Year Transit Development Plan 1996-2001*, Chapter III, and discussions with CT staff.

King County Metro and Pierce Transit

Pierce Transit and King County Metro have detailed service design guidelines that follow a very similar approach.[2] Because they are so similar, this chapter discusses them together

Both guidelines distinguish land use patterns that affect transit – including both development type and development density. Pierce Transit distinguishes between its "urban core," defined as densities above 6,000 persons per square mile, and less dense areas. King County distinguishes between Urban Centers (major suburban or urban nodes), Manufacturing Centers, and Activity and Residential Areas. In this last category, King County further breaks out subcategories based on density.

Then, for each category, the guidelines specify:

- Service Design Pattern: for example, direct service to downtown as opposed to local circulators to a transit center or a grid pattern of routes.
- Service Span: the hours of the day, and days of week, that the service operates.
- Frequencies: optimal headways are specified by time of day, and day of week.
- Coverage: typically, coverage is described with a statement such as "*X % of the population shall be within a Y-mile walk of service*" (Community Transit also has a guideline of this type, though it does not specify a walking distance).

The following approaches are common to both the King County Metro and Pierce Transit guidelines:

- Headway, Coverage, and Service Span *all* vary with density: that is, at higher densities, routes should be more frequent, run longer hours, *and* be closer together. King County Metro specifies that walking distances of ¼ mile are the goal only for the 90% of residents living at densities above 7,500 persons per square mile. This approach is not universal in the industry. Many agencies use a common walking distance standard for all urbanized areas and reflect density differences only with frequency and service span.
- Service Design patterns also vary with density: Pierce Transit expresses this fact by describing a series of service types (arterial routes, urban routes, suburban routes, etc.) and the quality of service required on each. The King County standards describe the type of service design that suits each development type.

Pierce Transit's guidelines also include two useful ideas, which though not stated in King County Metro guidelines, clearly affect service design in King County as well. These are:

[2] Sources for this discussion are the *Pierce Transit Six Year Plan* (1996) and the *King County Metro Six Year Plan* (1995), Appendix E, as well as discussions with staff at both agencies.

- Route Duplication: Except on approaches to a major transit center, there should be no more than one route per arterial;
- Route Anchors: When possible, terminal points at both ends of a route should be located at major activity centers to ensure passenger traffic in both directions of operation.

Finally, it is worth noting that although Pierce Transit and King County Metro have similar guidelines, their actual patterns of service are quite different. King County, for example, has historically emphasized one-seat ride service, just as CT does, while Pierce Transit has always been more oriented around providing convenient transfers. However, these patterns now appear to be converging. King County Metro's recent restructurings, especially of suburban service, have reduced direct one-seat service and instead focus on providing frequent feeder service to very frequent trunk lines.

The Six Year Plan at King County Metro envisions further reliance on transfers in the future. Pierce Transit staff, meanwhile, has tried to reduce the number of transfers they require, often by through-routing key routes. Pierce Transit staff also recommends maintaining downtown Tacoma as a hub for its local bus service.

Conclusions from Review of Agency Guidelines

From this review of existing guidelines, several ideas are especially relevant to the Service Integration Guidelines:

- Density affects the pattern of service, not just the frequency of service. One issue that often arises in regional transit planning is that people expect local bus service to take them to their *nearest* regional transit station. In high-density areas, where routes tend to run in high-frequency grid patterns, this expectation is often realistic. In suburban areas, however, local routes need to meet at major nodes so that they make local connections, and for this reason, suburban feeder service may not serve the nearest station to a given point of origin. For example, Portland's *MAX* system provides cross-town lines at virtually every station in the core areas of Portland, but in suburban areas, bus routes converge on only four of 11 stations.
- Local routes need strong destinations at both ends, to provide better utilization along the entire route. *Link* light rail stations will provide more of these "anchors" than exist today. The *Regional Express* bus and *Sounder* commuter rail systems will provide many others.
- Duplication is to be avoided, but there is significant room for interpretation about what counts as duplication, since resolving a duplication usually means forcing a transfer on passengers who currently have through-service. The tolerance for duplication, and conversely for transfers, varies from one agency to another. However, all three of the pre-existing large agencies rely on transfers for at least some of their local and off-peak circulation, and all three provide at least some direct intercity commuter service to multiple destinations in the same corridor, rather than requiring peak commuters to use a trunk-and-feeder structure.

- Directness is a critical issue, and deviations in particular tend to irritate through-riding passengers unless they clearly serve large numbers of people. It is critical to judge deviations carefully, and to weigh the impact of the deviation on through passengers.

2.4 PROPOSED SERVICE INTEGRATION GUIDELINES

Clearly, no regionwide set of service integration guidelines will be fully consistent with the values, policies, and practices of all four of the pre-existing agencies. However, the mandate of regional seamlessness requires some effort to define common ground in the area of service integration, even though the agencies may approach the issue in different ways.

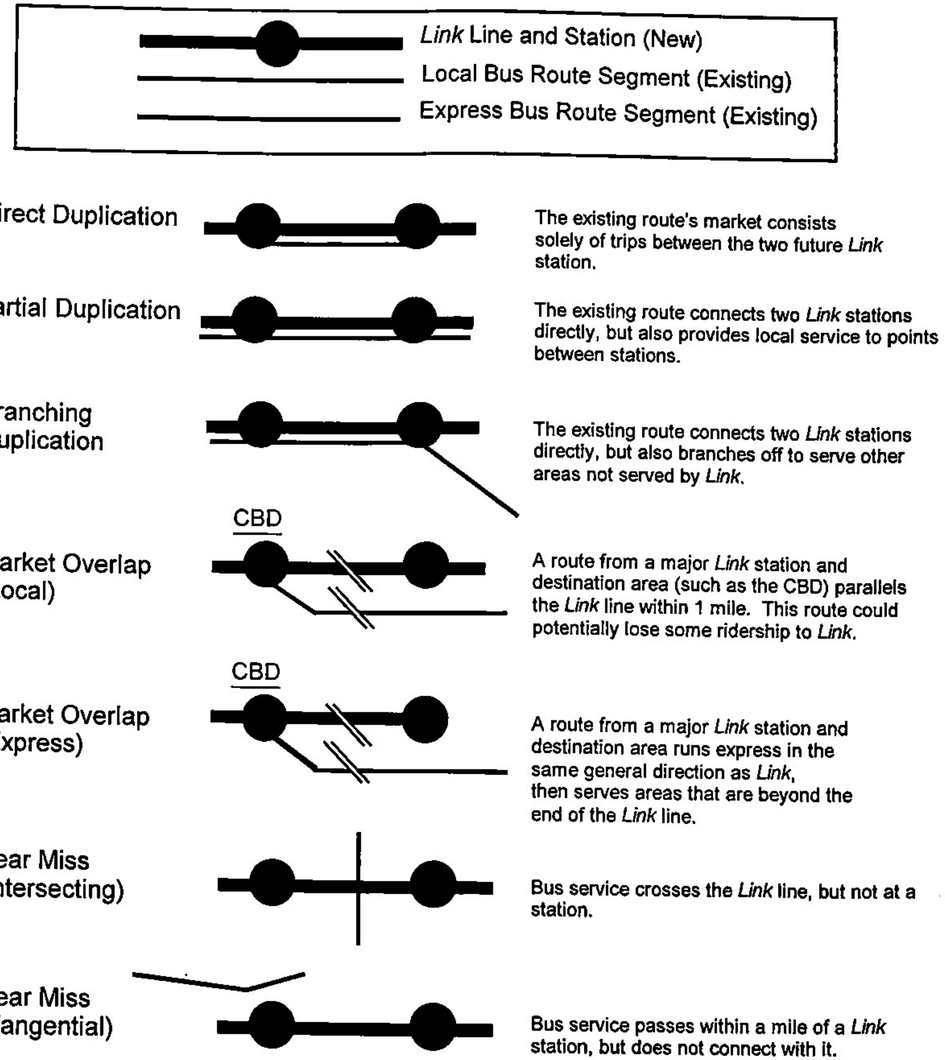
The appearance of *Link* light rail service can have any of several effects on existing transit lines. Figure 1 on the next page summarizes these effects. In brief, the situations are:

- Total Duplication: the new *Link* light rail service provides a connection that is now provided by an existing route, and *the existing route has no other purpose apart from this connection.* In this case, the existing route can be eliminated and its hours re-deployed.
- Partial Duplication: the new *Link* light rail service provides connections that are now served by an existing route. However, the existing route serves other important markets that the new *Link* light rail route will not serve.
- Market Overlap, which denotes "borderline" states of duplication: existing routes connect the catchment areas of different *Link* light rail stations at speeds which could compete with the regional service.
- Near Misses: an existing route, in its current form, comes close to a planned *Link* light rail station but does not serve it directly. Often, it is easy to change the bus route to serve the station, but there are some cases where this is not appropriate.

The service integration guidelines must provide some indication of how to respond to each of these cases. The guidelines must also address the issue of "redeployable hours," that is, how to model service resources that are made available by the elimination of services that duplicate the new regional transit line.

The guidelines that follow discuss of the situations in Figure 1 in turn, and conclude by addressing the issue of redeployable hours.

Figure 1
Situations Addressed by Service Integration Guidelines



Direct Duplications

DEFINITION

A direct duplication occurs when all of the following are true:

- A bus route runs directly between two *Link* light rail stations;
- *Link* light rail will operate at a speed, frequency, service span, and reliability that is the same or better than that of the bus route;
- Virtually all of the boardings on the duplicative segment are for travel from one *Link* light rail station area to another.

A typical example would be a nonstop express service between the University District and downtown Seattle, both ends of which will be served by Sound Transit with a better travel time and greater reliability.

RECOMMENDED ACTION

In this case, the following action is recommended:

- Delete the duplicating route;
- Reallocate the hours saved to provide new mobility opportunities in the same subarea (see "Redeployable Hours" below).

Exceptions may be made if:

- The *Link* light rail line lacks the capacity to handle the ridership from the duplicating route; OR,
- The two stations are so close together that when station access time is taken into account, *Link* light rail is slower than the bus service for travel between surface destinations in the two station areas (this typically also means that little service is saved by the eliminating the duplication). Adjacent stations in the downtown tunnel are an obvious example of this situation.

Partial Duplications

DEFINITION

A partial duplication occurs when all of the following are true:

- A bus route runs directly between two *Link* light rail stations;
- *Link* light rail will operate at a speed, frequency, and service span that is the same or better than that of the bus route;
- At least some of the ridership on the bus route is for travel to areas between *Link* light rail stations. These trips cannot be served faster via *Link* light rail when walk time and station access time are taken into account.

In general, a partial duplication refers to a bus route running on the same street where *Link* light rail also runs, but making frequent local stops.

RECOMMENDED ACTION

A partial duplication requires a partial solution. Any of several strategies may be appropriate depending on the extent of the duplication:

- Headways on the partially duplicating route should be set so that they are appropriate to the purely local demand along the street, assuming that passengers who can use *Link* light rail will do so. This typically means that some expensive peak service can be removed from the duplicating route, while leaving sufficient service to meet the local demand.
- If the duplication continues for several miles, and makes turns from one street to another, then it may also be appropriate to redesign routes so that the local service on different segments is provided by different routes, often producing a simpler route structure. For example, existing Route 7 currently duplicates the proposed *Link* light rail line by running from downtown to Capitol Hill and then along Broadway Avenue East to the University District. Local service is along streets running from downtown to Capitol Hill, and along Broadway Avenue East, but these two segments no longer need to be part of the same bus route.
- On the other hand, a bus route should generally be straight and continuous where a street is straight and continuous, even if it runs alongside the *Link* light rail line for several miles. This could be the case along Rainier Avenue South or Martin Luther King, Jr. Way South, depending on the *Link* light rail alignment chosen.

Branching Duplications

DEFINITION

A branching duplication occurs when all of the following are true:

- A bus route runs directly between two *Link* light rail stations;
- *Link* light rail will operate at a speed, frequency, and service span that is the same or better than that of the bus route;
- The bus route continues to areas away from the *Link* light rail line;
- At least some of the ridership on the bus route is for travel to areas that are not near the *Link* light rail line.

RECOMMENDED ACTION

If the branching duplication is caused by a route that branches off to serve areas away from the *Link* light rail line, the obvious solution is to delete the duplicative portion, so that the branching portion is truncated to end at the station, or perhaps continue onto a different route. However, exceptions should be made if any of the following are true:

- The *Link* light rail line lacks the capacity to handle the ridership from the duplicating route.
- *Link* light rail, combined with the branching segment, offers a slower travel time to major destinations than the existing route.
- The two stations are so close together that when station access time is taken into account, *Link* light rail is slower than the bus service for travel between surface destinations in the two station areas (this typically also means that little service is saved by the eliminating the duplication).
- The branching segment itself functions as a trunk with feeders, so that some riders on those feeders would now be two transfers away from downtown Seattle and other major *Link* light rail destinations.

If a branching duplication is turned into a truncated "feeder" route, some compensatory improvement should be provided to persons on the feeder portion, who now have to transfer to complete what was previously a one-seat ride. This compensation can come either in the form of faster travel time (counting the transfer delay), or greater frequency. Both of these can be modeled by considering the total travel time including wait time (an expression of frequency) and transfer delay.

In some cases, the compensatory improvement may come in the form of new direct service to other major destinations. For example, if a truncated route can be connected to another route that leads to other attractors, affected riders may see the direct access to these new destinations as compensation for the loss of direct, no-transfer service that the previous route provided. However, this is a much smaller compensation than those discussed above.

Market Overlap (Local)

DEFINITION

Local market overlap may occur where bus routes run parallel to the *Link* light rail line within one mile. In practice, lines within ½ mile or less are the primary concern. These routes connect the *Link* light rail station areas, though not necessarily the stations. They may therefore duplicate *Link* light rail for some trips that they serve, though not for others.

For example, a bus route may run from station A to a point three blocks from station B. To the extent that the bus route carries riders between the station areas, it is potentially duplicating the *Link* light rail line even though it does not serve both Link light rail station sites directly.

RECOMMENDED ACTION

Local market overlaps require corrective action only if the existing bus route is clearly carrying significant ridership from one station area to the other. Various sources may be consulted to suggest this, including development patterns, the position of the route in relation to others, and passenger counts, if available. If a local market overlap is significant, the parallel route may

warrant some reduction of service, or consolidation with a route that is further away from the *Link* light rail line.

Market Overlap (Express)

DEFINITION

Express Market Overlap is a particular issue for the *Link* light rail element of the *Sound Move* system. Unlike the other elements of *Sound Move*, the *Link* light rail service ends far short of the edge of the region. Many bus routes from core areas of Seattle run nonstop along the freeway paralleling the *Link* light rail line. Beyond the end of the *Link* light rail line, these routes leave the freeway to serve park-and-rides and/or local activity centers and residences. These areas beyond the end of *Link* light rail could be served by express service from the outermost accessible *Link* light rail station, instead of running express service all the way from downtown.

RECOMMENDED ACTION

In these cases, the obvious possibility is to delete the express portion between the outermost accessible *Link* light rail station and the route's Seattle destination, and to instead run service from the outlying area to the appropriate *Link* light rail station. Such a change can save resources, but generally should not be considered unless *all* of the following are true:

- Total travel time, including access time, wait time and transfer time as weighed by the model, is improved, *on average*, for existing riders: that is, virtually all existing riders reach their destinations faster even if they must transfer to do so.[3]
- *Link* light rail has the capacity to handle the express bus passengers.
- Substantial operating cost savings can be achieved, and can be reinvested in ways that enhance mobility in the area served by the existing express route. For example, one obvious possibility is to reinvest saved hours into greater frequency and/or service span on the same route, offering compensatory improvements for the very passengers impacted by the transfer.
- Reliability gained due to the shorter trip outweighs the reliability lost due to obstacles in accessing the *Link* light rail station.

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3 "On average" means that travel time benefits to different destinations should be weighted according to the number of existing trips traveling to each destination. Some of the express passengers may be traveling to destinations that are on the *Link* light rail line, but not at the *Link* light rail station areas that the express route currently serves, and these people will achieve a higher travel time benefit if their service is redirected to *Link* light rail. If there are enough of these people, the deviation may be justified even if other riders get only minimal travel time savings.

Near Misses

DEFINITION

Whenever a bus route passes within a mile of a *Link* light rail station without serving it, we have a *near miss.* A near miss can occur because a bus route crosses the *Link* light rail line between two stations, or because it passes near a station tangentially.

RECOMMENDED ACTION

Near misses invite the question: should we deviate the bus route to make a *Link* light rail connection?

The answer is generally no if any of the following are true:

- The bus route connects to *Link* light rail at another station, so that trips from that bus route can logically connect to *Link* light rail in either direction. For example, a route may serve two *Link* light rail stations but "near miss" one or more other stations in between them. This is acceptable, since riders from the route can still access *Link* light rail conveniently in either direction.
- The increase in one-way running time caused by diverting the bus route to the station is greater than the walking time from the closest stop on the existing route to the station entrance (often pedestrian amenities can make this walk acceptable, while a bus deviation would be impractical).
- The time lost (in person-minutes) for riders riding through the area is greater than the time gained (in person-minutes) for riders wishing to connect with *Link* light rail.

In practice, then, deviations are easiest to justify on segments where the bus route loads are low, not counting any riders who turn over at the "near miss" point. Most commonly, routes that are near their endpoint are the easiest to change to serve a *Link* light rail station.

Use of Redeployable Hours

The preceding guidelines indicate how *Link's* new regional transit services will replace some of the services now operated by the pre-existing agencies. As a result, these agencies will have hours that they can redeploy to improve mobility in their areas, either by creating new routes or by improving the frequency and/or service span on existing routes.

No guideline can usefully cover all the ways that redeployable hours could be used. As with other service design decisions about non-*Link* routes, the final authority rests with whichever agency now operates the service whose hours can be redeployed. The following considerations, however, appear to follow from the mandate of "seamlessness," and from the goal of maximizing mobility for both regional and local trips.

- Redeployable hours should not be used in ways that *create* any of the situations identified in these guidelines (Duplications, Market Overlap, or Near Misses).
- Redeployable hours should be used in ways that provide useful access to the Sound Transit system (bus or rail).
- Improving frequency and service span on existing service corridors, where demand warrants, is recommended as a high priority, especially because it increases system simplicity. For example, a bus route that always connects with *Link* light rail at the light rail line's frequency or better can be marketed as providing "every train connections." This eliminates the fear of being stranded that is often part of the fear of transferring, and makes the bus route a more "seamless" extension of the *Link* light rail service.
- New routes should be created with redeployable hours only if they are the only way to provide access to the regional system from a particular area.

The following chapters apply these guidelines in developing bus networks for modeling.

3. *LINK* LIGHT RAIL ALTERNATIVES – BUS NETWORKS

This chapter describes the 2010 bus networks developed for the forecasting of transit ridership for the Base, Pre-Base and other *Link* light rail alternatives. The Base *Link* light rail alternative provides for a *Link* light rail line extending from South 200th Street in the city of SeaTac to Northgate. The alternative also would include a *Link* light rail line in downtown Tacoma. The Pre-Base *Link* light rail alternative is the same as the Base alternative, except that the northern terminus for the *Link* light rail line would be at NE 45th Street in the University District instead of at Northgate. It represents a shorter light rail line which could be constructed if funding is not available to complete the *Link* light rail line to Northgate. The other alternatives involve *Link* light rail alignment variations in various segments of the corridor. These segments are:

- Segment A Northgate to University District
- Segment B University District to Westlake Station
- Segment C Westlake Station to South McClellan Street
- Segment D South McClellan Street to Boeing Access Road
- Segment E Tukwila
- Segment F SeaTac

All alternatives include *Sounder* commuter rail and *Regional Express* bus routes as part of the background transit system.

The Base bus network was developed by modifying the 2010 network developed by Sound Transit for the *Sound Move* Regional Transit System Plan. This network consists of bus routes operated by King County Metro, Pierce Transit, Community Transit, and Everett Transit and the proposed *Link* light rail, *Sounder* commuter rail, and *Regional Express* bus services. The bus routes in the network were updated to reflect recent changes by the transit agencies and planned improvements and service levels. This was accomplished by comparing the bus routes in the 2010 network with existing bus routes and planned improvements identified in the local transit agencies' respective Six-Year Plans.

Appendix A (in a separate volume) contains a summary description of the modifications to the 2010 *Sound Move* bus network under the Base *Link* light rail alternative. Appendix B (in a separate volume) contains a summary of the modifications to the 2010 Base *Link* light rail alternative bus network under the various *Link* light rail alternatives. The routes modified in each network are identified by transit agency, route number and name, type and description of the revision (i.e., routing change, headway change, stop change, etc.), and peak and off-peak headways.

3.1 DEFINITION OF SERVICE AREA FOR *LINK* LIGHT RAIL SYSTEM

Under the *Link* light rail alternatives, bus services within the service area of the *Link* light rail system would be restructured to eliminate duplication and improve access to the regional *Link* light rail services. The restructuring of service under each alternative was developed using the service integration guidelines in Chapter 2 above, and input primarily from King County Metro staff.

The primary service area for the *Link* light rail system under each alternative extends from the King County/Snohomish County line south to South 272nd Street, and from Puget Sound east to Lake Washington (further south, roughly to 108th Avenue SE). The network of bus routes serving this area provides for regional connections to the *Link* light rail system and connections for other local and regional travel.

Within this area, some communities will have bus service oriented to *Link* for trips to downtown Seattle. Other communities will have express bus or commuter rail service for trips to Seattle but will still desire access to *Link* for trips to other destinations served by it. The bus network within the following communities is designed to provide frequent and direct connections to the *Link* light rail system for travel to downtown Seattle:

- Shoreline and Seattle north of 125th Street, except for portions of the Aurora Avenue North and Greenwood Avenue North corridors;
- Seattle north of the Lake Washington Ship Canal and east of Meridian Avenue North;
- The Broadway corridor and First Hill;
- The Rainier Avenue South and Martin Luther King, Jr. Way South corridors from South McClellan Street south to Renton, plus all areas between the Rainier Avenue South corridor and Lake Washington;
- Tukwila and SeaTac;
- Some areas of Renton and Kent.

Outside these communities, but within the larger service area of the *Link* light rail system as defined above, connections to *Link* light rail are designed primarily to serve destinations other than downtown Seattle. For example, Ballard will continue to have direct bus service to downtown Seattle that will be much faster than transferring to the *Link* light rail system. Cross-town service is provided from Ballard via connections to the *Link* light rail system, but this *Link* light rail connection would only be logical for trips from Ballard to destinations outside downtown Seattle, such as Capitol Hill.

For access to downtown Seattle, the Green River Valley and most areas south of South 272nd Street will have access to *Sounder* commuter rail, *Regional Express* bus or King County Metro express bus service.

Most areas on the Eastside will have direct, all-day service to downtown Seattle via *Regional Express* bus or King County Metro routes. Under the Base network, all-day express service for trips to downtown Seattle from areas north of Lake Washington, including all of Snohomish County, would be provided by the *Regional Express* bus routes connecting at Northgate. There are two such *Regional Express* bus routes, one from Everett, Lynnwood, and Mountlake Terrace, and another from Woodinville, Bothell, Kenmore, and Lake Forest Park. Both routes would terminate at Northgate for all-day connections to *Link* light rail. During peak hours, express service to downtown Seattle from many of these areas would continue to be operated by Community Transit and King County Metro.

3.2 BASE *LINK* LIGHT RAIL FEEDER BUS NETWORK

This section provides a description of the bus system providing connections to the *Link* light rail system under the Base network. A map showing the potential bus routes is enclosed with this report.

Shoreline and Seattle North of 125th Street

Under the Base network, all-day, direct feeder bus access would be provided from most of this area to the Northgate *Link* station. From Northgate, *Link* would provide connections to major destinations in Seattle and to Sea-Tac Airport. The feeder bus routes also would connect at Northgate with routes operating to many other parts of north Seattle not served by *Link* light rail. This represents a major increase in local mobility within the city of Shoreline and north Seattle. For example, trips from any part of Shoreline to the Lake City area of northeast Seattle will be possible with a convenient transfer at Northgate, at frequencies far better than what is available today. Two of the Shoreline feeder routes would be at 15-minute service throughout the day:

- Route 315 serves 15th Avenue NE from Northgate to NE 185th Street, and via North 185th Street and NW Richmond Beach Road to Richmond Beach. This route links major areas of dense residential and commercial activity within Shoreline, while also serving as a rail feeder.
- Route 310 is a large two-way loop linking Northgate to Shoreline Community College, then providing east-west cross-town service within Shoreline on 175th Street, and also linking this cross-town corridor back to Northgate via 28th Avenue NE and 30th Avenue NE. This route provides extensive new opportunities for frequent local travel within Shoreline and the far northern areas of Seattle, while also providing fast and frequent *Link* light rail connections from the entire loop.

Two other important feeder routes complete the Shoreline/North Seattle all-day network. Route 317 extends from Northgate via Meridian Avenue North to serve Aurora Village and downtown Edmonds. The route has been revised slightly to operate along 205th Street west of Aurora Village for better coverage of the neighborhoods to the south. Route 377 currently operates from Northgate to Mountlake Terrace and Lynwood. This route has been rerouted from 15th Avenue NE to operate along 5th Avenue NE between Northgate and NE 175th Street, also deviating to serve an existing park-and-ride lot location on 1st Avenue NE between NE 145th Street and NE 155th Street.

Cross-town service operating between Aurora Village, Lake Forest Park, Kenmore, and Bothell would continue under Route 316 with 30-minute all day service. Currently, Route 340 operates between these communities and continues through the Eastside along the I-405 corridor. With the implementation of *Regional Express* bus service on I-405, Bothell would become the logical endpoint of this line, providing connections to local and express services serving many parts of the Eastside and south Snohomish County.

The express routes that currently enter I-5 at NE 130th Street, or points north, are assumed to continue to operate in the express mode to downtown Seattle. These routes would not be diverted to Northgate because travel times would be higher with a transfer in mode from bus to the *Link* light rail system. The guidelines call for retaining routes to the CBD unless a travel time improvement can be achieved for existing passengers by diverting them to *Link* light rail.

Seattle from 125th Street to the Lake Washington Ship Canal

In the area from 125th Street to the Ship Canal, the Base network provides a grid of routes wherever the geography permits. Consistent with King County Metro's plans, all north-south routes west of Green Lake are improved to service of 15 minutes or better throughout the day. These routes are intersected by three east-west routes: Route 75 on Holman Road NW and North 105th Street (serving the Northgate *Link* station); Route 48 on NW 85th Street (serving the Roosevelt *Link* station); and Route 44 on NW Market Street/45th Street (serving both University District *Link* stations). In addition, the network provides a 30-minute service route, Route 69, which extends west from the Roosevelt *Link* station, circumvents Phinney Ridge via 85th Street, then operates across Ballard from 5th Avenue NW to 24th Avenue NW, and terminates in central Ballard. This route functions more as a Ballard/Greenwood circulator than as an *Link* light rail feeder route, though it does contribute to the mix of services from the Greenwood area to the Roosevelt *Link* station.

To the east of I-5, the Base network provides service every 15 minutes all day on four north-south routes. These are Routes 67 (Roosevelt Way NE/5th Avenue NE), 73 (15th Avenue NE), 63 (25th Avenue NE), and 65 (35th Avenue NE). All of these routes have high ridership potential, and all converge naturally on the Pacific Street *Link* station. In many cases, the loss of direct service to downtown Seattle from some of these areas under King County Metro's North Area restructuring plan is compensated for under the Base network by higher frequencies

and new direct service to Northgate. Many of the regional connections provided at Northgate do not exist today.

In addition, several routes provide east-west connections from the *Link* light rail system to the edge of Lake Washington, so that each neighborhood has access to the nearest Link light rail station. These routes operate all-day, 15-minute service from the Roosevelt *Link* station east along NE 65th Street and NE 75th Street (formed by a new two-way loop configuration for Route 71). Less frequent service is operated by Route 76 from the Roosevelt *Link* station to the Inverness area. Feeder routes also operate from the Pacific Street *Link* station to Magnuson Park, via NE 55th Street (Route 74), to Laurelhurst (Route 32), and to Northgate via Sand Point Way NE (Route 75).

The Base network has an extremely high frequency of service along 15th Avenue NE between NE 65th Street and the Pacific Street *Link* station. Through the combination of Routes 48 and 73, this corridor would have a service frequency of four minutes during peak periods, seven minutes during midday, and ten minutes during evenings and on weekends.

Finally, the Wallingford area would continue to have service to downtown Seattle operating via the Fremont Bridge. Cross-town service would be operated every 15 minutes along both 45th Street and along a routing from the Pacific Street *Link* station to Fremont via 40th Street, Wallingford, and North 34th Street. The latter routing would provide convenient feeder access from the Pacific Street *Link* station to south Wallingford and the Gasworks Park area. This route also continues to Magnolia.

Magnolia, Queen Anne, Denny Regrade, and South Lake Union

The neighborhoods north and northwest of downtown Seattle (south of the Lake Washington Ship Canal) would continue to have direct service to downtown, mostly at improved headways consistent with King County Metro's plans. Service would be improved to every 15 minutes all day on the radial route to Magnolia and also on all Queen Anne routes except Route 2.

Because of the close spacing between Routes 1, 2, and 13, these routes provide overlapping service. To maximize the frequency that can be provided, the Base network provides for a high frequency of service on Routes 1 and 13. On Route 2, a shuttle is provided operating 30-minute service, terminating at Denny Way, where connections to many other routes are available. Route 2 express service during peak hours remains unchanged. Serving east Queen Anne, Route 4 is eliminated and its frequency is merged into Route 3.

Mobility for these neighborhoods is also improved by increasing the frequency of service on Route 8 to 15-minute headways throughout the day. This route operates from the base of Queen Anne Hill (connecting to all Queen Anne and Magnolia routes) east along Denny Way to Capitol Hill, and then south along Martin Luther King, Jr. Way.

Capitol Hill, Montlake, Central District, Squire Park, Leschi, Madison Park, Judkins Park, Mt. Baker, and First Hill

Most radial routings from downtown Seattle to these neighborhoods to the east remain largely unchanged under the Base network. However, consistent with King County Metro's plans, service on almost every route is improved to 15 minutes or better all day. Several of the most important cross-town routes, including Route 9 on Broadway Avenue East and Route 48 on 23rd Avenue, have 10 minute service all day. The result is a local grid system providing improved local circulation, while also providing frequent connections to the *Link* light rail system.

The most significant change affecting the greater Capitol Hill area is the elimination of Route 7, which currently operates along Broadway and then through downtown. Instead, a very frequent Route 9 (every 10 minutes all day, every 5 minutes during peak periods) will offer easy access from all points on Broadway Avenue East and 10th Avenue East to nearby *Link* light rail stations.

With the improvements to Routes 8 and 48, the Base network also downgrades Route 43 to peak-only service because it duplicates other routes along its entire length. Route 43 is designed to provide radial service to the 23rd Avenue East corridor north of East Madison Street, but the high-frequency connections available to Routes 48 and 11 will make this direct service unnecessary during off-peak periods.

Route 12, which serves 19th Avenue East to Interlaken Park, is restructured as a feeder route ending at the First Hill *Link* station, rather than continuing downtown. As with Route 2 on Queen Anne Hill, Route 12's market overlaps with a nearby route – Route 10 – which is just four blocks to the west (on 15th Avenue East). In order to maximize frequencies on major corridors, secondary routes like Route 12 are reduced to shuttle service that provide *Link* light rail access, but do not continue to downtown Seattle. Almost all Route 12 riders can walk to either Route 10 or Route 48.

Of the remaining route improvements to these neighborhoods under the Base network, consistent with King County Metro's plans, Route 4 is eliminated, and its frequency merged into Route 3. Route 4's coverage area in the Judkins Park neighborhood is served instead by Route 8, at much higher frequencies. Route 11 is reoriented to operate along the full length of Madison Street from Madison Park to Colman Dock. This routing provides greater clarity, makes a direct connection to the First Hill *Link* station, and also provides high-frequency service to Colman Dock.

Finally, the outer southern ends of Routes 14 (Mt. Baker) and 27 (Yesler/Leschi) are extended to connect with the McClellan Street *Link* station. These improvements provide new opportunities for trips to/from SeaTac and other southern points on the *Link* light rail system, to the Leschi/Mt. Baker area.

Downtown Seattle

In general, the Base network assumes the current pattern of north-south bus flow through downtown[4]. The primary streets used for bus flow are: 1st Avenue, 2nd Avenue, 3rd Avenue, and 4th Avenue. 1st Avenue is used for buses serving West Seattle and southwest Seattle to the south, and Ballard to the north. 3rd Avenue is used for trolley buses, and for diesel buses that overlap trolley bus markets and therefore need common stops with trolley buses. The couplet of southbound 2nd Avenue and northbound 4th Avenue are used for most other routes, including most long-distance regional services. These routings are assumed to continue under the Base network. However, consistent with King County Metro's plans, the Base network attempts to minimize the volume of north-south flow, and increase opportunities for east-west travel, by placing more routes on east-west alignments. Route 10 (now detached from Route 12) is combined with Route 43 to provide through service along Pike and Pine Streets from I-5 to the Pike Place Market. Route 11 (Madison Park) is reoriented to operate the entire length of Madison Street, operating through downtown on the Madison/Marion couplet and ending at Colman Dock. These frequent east-west services will dramatically improve access to the Seattle waterfront, while also reducing the high volumes of buses that must travel north-south streets through downtown.

South of Downtown Seattle to South Spokane Street

The industrial area south of downtown Seattle is served with 30-minute or better service on every major north-south arterial, except for Airport Way South which has 60-minute service. One arterial, 1st Avenue South, would have an extremely high frequency of service through a combination of West Seattle routes and routes to South Park and Burien. The high frequency of service on 1st Avenue South will help serve demand generated by the new baseball and football stadiums south of Pioneer Square.

Rainier Valley and Beacon Hill

Beacon Avenue South, north of South Myrtle Street, continues to be served direct to downtown by Route 36, renumbered Route 1; the outer end of this route also connects to the Othello Street *Link* station. Rainer Valley areas are served by high-frequency cross-town routes, which provide very frequent connections to the *Link* light rail system for service to downtown. Route 9 on Rainier Avenue South would operate ten-minute service during midday and virtually match the *Link* light rail frequency during peak periods. As on Capitol Hill, this eliminates the need for Route 7 to provide direct service to downtown from the Rainier Avenue South corridor. Route 48 provides similar service along the Martin Luther King, Jr. Way South corridor south of South McClellan Street, connecting with the *Link* light rail system at the McClellan Street and Henderson Street *Link* stations.

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[4] The City of Seattle's Transit Initiative will examine downtown routings in greater detail.

Feeder routes connect the Beacon Hill and Seward Park areas to *Link* light rail. These routes include the cross-town route, Route 50, which continues west to South Seattle Community College and White Center.

An extensive feeder network extends south of South Henderson Street to the neighborhoods to the southeast, such as Skyway and Bryn Mawr, and also serves the Waters Avenue South segment of Route 7/9. Many of these routes continue through Renton and beyond.

West Seattle, White Center, Fauntleroy, Delridge, South Park, and Georgetown

These neighborhoods retain their current direct services to downtown, but, consistent with King County Metro's plans, with dramatically improved service frequencies. All-day, 15-minute service is provided in the Admiral, Delridge, and Fauntleroy corridors. The high frequency service to the Fauntleroy ferry eliminates the need for close schedule coordination with the ferry schedule.

The South Park area is served by a radial route from downtown, but this route continues to the Boeing Access Road *Link* station for connections to other *Link* light rail destinations.

King County Metro has established a major transfer point at White Center (15th Avenue SW and SW Roxbury Street). Service to this hub is increased significantly under the Base network. Timed transfer scheduling at this location may also be appropriate. Peak express services to downtown from White Center (via the Myers Way Park-and-Ride lot) are assumed to continue under the Base network.

Burien

Under the Base network, the *Regional Express* bus Route "H" provides express service from the Burien Transit Center to the north and south to the SeaTac Airport *Link* station. Additional local routes provide connections to the South Boeing Access Road and North SeaTac *Link* stations. The existing Burien circulator is combined with Route 155 to provide direct service to the *Link* light rail system from all parts of Burien. This route also continues east from the *Link* light rail station to serve Southcenter and southern Renton to Fairwood. In addition, Burien continues to have peak express service to downtown via White Center.

Tukwila

All of Tukwila has feeder bus service connecting to the *Link* light rail system at either the Boeing Access Road, Tukwila, or North SeaTac *Link* stations. Most of the feeder routes would operate at 30 to 60 minute service during the midday, so timed transfer connections should be considered, especially at the Boeing Access Road *Link* station, where many of the routes would converge.

Southcenter Mall would remain an important transit center. In addition to routes serving it today, it would be served by Route 199, which would operate every 15 minutes from Southcenter to the North SeaTac *Link* station.

Route 174 would continue to operate from downtown Seattle through Tukwila. This route is designed to provide local coverage along East Marginal Way South into Seattle, and is not likely to have a travel time in competition with *Link* light rail. Passengers from south of the Boeing Access Road *Link* station on Route 174 will probably find it faster to transfer to *Link* light rail to complete their trip downtown. On the other hand, the route would continue to provide important connections between the Seattle industrial destinations along East Marginal Way South and residential areas of Tukwila and SeaTac.

Renton

The existing all-day express service to Renton via Route 101 could be replaced by a system of feeders intended to provide convenient access from all parts of Renton to the *Link* light rail system at the Henderson Street *Link* station. This decision will depend upon the travel times of *Link* through South Seattle. Routes 105 and 143 serving northeast and southeast Renton are extended via Martin Luther King, Jr. Way South to the Henderson Street *Link* station, achieving travel times comparable to the current freeway service during peak hours, and at much higher frequencies. From Renton to the Henderson Street *Link* station via Martin Luther King, Jr. Way South, these routes combine to provide 15-minute all day headways.

The two major feeder routes that extend south from Renton are extended to the Henderson Street *Link* station via existing reasonably fast routings. The current route serving Talbot Road South and 108th Avenue SE south from Renton is combined with the Renton Avenue South route from Renton to South Henderson Street, so that passengers can ride through from southern Renton to the *Link* station. Likewise, the current Lind Avenue SW route is extended into South Henderson Street via Rainier Avenue South for direct *Link* light rail connections.

Renton enjoys excellent circumferential service via *Regional Express* bus to the Sea-Tac Airport *Link* station and to Bellevue. *Regional Express* bus also offers high speed service from Renton to Kent, Auburn, and Puyallup, and north to Bellevue and beyond.

SeaTac

The city of SeaTac has three *Link* stations supported by very frequent local service along International Boulevard South (Hwy 99). The combination of Routes 161, 174, and 199 between SR 518 and South 188th Street will produce an approximate all-day headway of seven minutes in this segment, providing easy access to the corridor's many employers and activity centers from any of the *Link* light rail stations.

Feeder routes serve the McMicken Heights district of SeaTac, connecting with *Link* light rail at several stations. Direct service from Sea-Tac Airport through McMicken Heights to Southcenter is provided by Route 155.

Kent

The Kent Transit Center is served by all-day routes that connect to the *Link* light rail system, Route 156 to the South SeaTac *Link* station and Route 161 to the Sea-Tac Airport and North SeaTac *Link* stations. During the midday, these routes to the *Link* light rail system will provide the fastest trip between Kent and downtown Seattle. During peak periods, *Sounder* commuter rail, served by feeder bus routes timed to meet the trains, will be the fastest trip.

Des Moines

Des Moines has feeder service to the South SeaTac *Link* station. Route 188 serves all of the city's high density areas and major activity centers. Because of the concentrated density along this route, 15-minute service is provided throughout the day A feeder route operating 60-minute service is provided to the lower density areas of Des Moines. Finally, Des Moines continues to have hourly service extending north along 1st Avenue South to Burien, and eventually to Seattle, although this long and low frequency route is intended primarily for local trips, and will not be the route of choice for Des Moines-Seattle trips.

Pacific Highway Corridor and Federal Way

From its downtown transit center at South 320th Street and I-5, Federal Way will have nonstop service to both SeaTac (for *Link* light rail and I-405 corridor connections) and to downtown Seattle. Therefore, it is expected that most of the local service in Federal Way will continue to be oriented around this hub, rather than feeding into a *Link* light rail terminus some distance away. However, the Pacific Highway South corridor is so continuously developed that high-frequency service is critical, both to feed *Link* light rail and to meet local circulation needs. The new Route 199 would operate from South Federal Way via the Federal Way hub at South 320th Street, then continue north on Pacific Highway South/International Boulevard to feed the *Link* stations at South SeaTac and North SeaTac. From there, it would operate nonstop via SR 518 to Southcenter, thereby, meeting a longstanding request for direct service to Southcenter from Federal Way.

Some other areas of north Federal Way will also have direct service to the *Link* light rail system. Route 192 will originate at the Federal Way hub and operate locally via neighborhoods east of the freeway and Star Lake Park and Ride (thus providing midday access to cars parked there) and terminate at the South SeaTac *Link* station.

Peak express services that currently operate on I-5 from Federal Way are generally retained, because they would be faster than transferring to the *Link* light rail system. This remains true as far north as the Star Lake Park-and-Ride at 272nd Street. North of that point, however, peak

express services on I-5 are eliminated and passengers routed to the nearest *Link* light rail station.

3.3 PRE-BASE *LINK* LIGHT RAIL FEEDER BUS NETWORK

Under the Pre-Base network, the *Link* light rail line and station locations are the same as the Base network except that the *Link* light rail line would terminate at NE 45th Street in the University District. With the northern terminus at NE 45th Street, there would be no Roosevelt or Northgate *Link* stations. The Pre-Base feeder bus network is the same as the Base network for the portion of the service area north of the Ship Canal. The Pre-Base network also would include the addition of several express bus routes to downtown Seattle. Following is a description of the changes to the Base network with the *Link* light rail line terminating at NE 45th Street. A map showing the potential bus routes is enclosed with this report.

Without the *Link* light rail line to Northgate, Route 41 would continue to operate high frequency, non-stop service from downtown Seattle to Northgate. Because of the high frequency on this route, the entire local route network north of 125th Street would remain largely unchanged. The only difference would be that the routes would feed into Route 41 instead of the *Link* light rail system.

In addition to the change to Route 41, the Pre-Base network does not provide for an increase in frequency of service on Route 315 to 15 minutes all day. This service improvement would not be needed because express service would continue to be operated within the 15th NE corridor under the Pre-Base network. Route 77 would operate peak period express service to downtown Seattle and Route 78 would operate peak period express service to the University District. However, many of the Shoreline improvements would remain under the Pre-Base network, such as the Route 310 high-frequency circulator/feeder loop. Other peak period express services that would remain include Route 312 serving Lake City Way NE and Route 355 serving outer Greenwood, both of which are eliminated in the Base network. In northeast Seattle, the only major change is that Route 71 would continue to operate as it does today, primarily serving NE 65th Street. It would continue south to the Pacific Street *Link* station under the Pre-Base network, instead of to the Roosevelt *Link* station.

3.4 SEGMENT A ALTERNATIVES

The variations in Segment A (Northgate to NE 45th Street) occur primarily in the vicinity of the Roosevelt *Link* station.

Roosevelt Way NE Option

All routings shown for the 12th Avenue NE option in the Base network are equally valid for the option that places a station under Roosevelt Way NE.

8th Avenue NE Option

If the Roosevelt *Link* station is placed in an aerial alignment over 8th Avenue NE, the network would be identical to that in the Base scenario except that Routes 71 and 76 would be extended west from Roosevelt Way NE to end at the 8th Avenue NE location. However, Route 67, which runs along the Roosevelt/12th couplet, would not deviate to serve the station. See Chapter 4 for more information about station configurations.

3.5 ALTERNATIVE B1B: ROY ST. STATION

Alternative B1B is identical to the base alternative except for the addition of a station at Broadway Avenue East and East Roy Street.

This station provides the opportunity for a new east-west route that would enhance the grid pattern of services. Proposed Route 49 would run from Lower Queen Anne generally via Mercer Street, Eastlake Avenue East, Lakeview Boulevard East, Belmont Avenue East and East Roy Street to Roy St. *Link* station, then via East Aloha Street, 23rd Avenue East to East Madison Street. This new crosstown route, with 12 minute headways, would provide new access to *Link* from the east side of Volunteer Park, and from the developing South Lake Union area and Queen Anne Hill.

Given the east-west service provided by Route 49, Route 14's Summit segment can be reduced to a shuttle running between the route's current terminus (Bellevue Place East and Belmont Avenue East) and Convention Place *Link* station. Most of this route is well-served by east-west routes crossing at either Belmont Avenue East, East Denny Way, or East Pine Street. The southern part of Route 14 (Mt. Baker) is retained, and becomes part of Route 70. Midday headways on the Eastlake portion of Route 70 are reduced from 10 minutes to 15 minutes to reflect the competition from the Eastlake *Link* station, and to match the headway of the Mt. Baker segment.

The Mercer Street crosstown service replaces the currently planned Route 49, which runs from Magnolia across Queen Anne Hill to Westlake. In the Base Network, this route combines with Route 31 to provide 15-minute service between Magnolia and the University District. In Alternative B1B, Route 31 would have 15-minute service along its entire length, since Route 49 would not serve Magnolia.

A map showing the conceptual bus network changes is enclosed with this report.

3.6 ALTERNATIVE B2: SEATTLE CENTER/SOUTH LAKE UNION

The B2.1 alignment eliminates the Base network's stations at Pacific St, Capitol Hill, and First Hill, and creates stations at Campus Parkway, Eastlake, South Lake Union and Seattle Center.

Because no service is provided to Capitol Hill, the existing service pattern for this area must be restored. Route 7 is restored between the University District and downtown Seattle, at 10 minute headways. Since Route 7 is not needed to serve Rainier Valley, this route would run only east-west through downtown on Pike/Pine, ending at 2nd Avenue and Pike Street like existing Route 43.

Route 9's high-frequency service (5-8 minute headways) continues to be needed through the Rainier Valley, as in the Base alternative, but only as far as East Aloha Street at the north end of the Broadway business district. However, an extension of this route would be built to connect Capitol Hill with the South Lake Union *Link* station. This extension would proceed west from the East Aloha Street terminal via East Roy Street, Belmont Avenue East, Lakeview Avenue East, Eastlake Avenue East, Mercer Street/Republican Street to the South Lake Union *Link* station. The route would continue west to Lower Queen Anne. This new segment will provide a new crosstown route generally following Mercer Street from Queen Anne to Capitol Hill. While the more frequent Route 8 on Denny Way will continue to be the primary service for this connection, the new Mercer crosstown would provide better access to the redeveloping South Lake Union area.

Given the east-west service provided by Route 9, Route 14's Summit segment can be reduced to a shuttle service running between the route's current terminus (Bellevue Place East and Belmont Avenue East) and Convention Place *Link* station. Most of this route is well-served by east-west routes crossing at either Belmont Avenue East, East Denny Way, or East Pine Street. The southern part of Route 14 (Mt. Baker) is retained, and becomes part of Route 70. Midday headways on the Eastlake portion of Route 70 are reduced from 10 minutes to 15 minutes to reflect the competition from the Eastlake *Link* station, and to match the headway of the Mt. Baker segment.

The Mercer crosstown service also eliminates the need for Route 49, which (as currently planned in the north area restructuring) runs from Magnolia across Queen Anne Hill to Westlake. This service currently combines with Route 31 to provide 15-minute service between Magnolia and the University District. Instead, this 15-minute headway would be provided on Route 31 alone.

Also on Capitol Hill, Routes 10 and 12 are combined into a single route, eliminating the need for a separate Route 12 service into downtown from the relatively weak 19th Avenue East segment. Proposed new Route 10 would run from the Coleman dock via Madison Street, 15th Avenue East, East Aloha Street, 19th Avenue East, East Galer Street to the existing turnaround at the northeast corner of Volunteer Park. This routing would combine the most productive parts of Routes 10 and 12 into a single route. The route is routed via Madison Street instead of Pine Street for better access to Coleman Dock. Route 7 continues to serve Pine Street west of Broadway Avenue.

Route 60 from White Center, Georgetown, and Beacon Hill is reoriented north of First Hill to run via Boren Avenue to the South Lake Union *Link* station. This route will provide a direct connection to First Hill from Mercer Street, allowing passengers from the north to bypass downtown Seattle to reach the hospital area. Route 60 currently runs north of First Hill along Broadway Avenue East to East Mercer Street, but with the very high frequencies on Route 9, it will be easy for Route 60 passengers to transfer to reach this segment.

Finally, all transfer connections planned for the Pacific Street *Link* station in the Base Network are shifted to the Campus Parkway *Link* station in the B2.1 network.

A map showing the conceptual bus network changes is enclosed with this report.

The B2.2 bus network varies from the B2.1 network only in that the Pacific Street station remains and is not replaced by the Campus Parkway *Link* station.

3.7 ALTERNATIVE C1: E-3 BUSWAY AND BEACON HILL TUNNEL

This alternative routes *Link* south out of downtown via the E3 Busway, turning east at South Lander Street and passing under Beacon Hill to the McClellan Street *Link* station. Stations are provided on the Busway at Royal Brougham and Lander Street, while the Base Network's I-90/Rainier station is eliminated. Alternative C1B includes the Beacon Hill *Link* station.

Very little change in bus service is needed in this alternative. However, the Lander Street *Link* station provides the opportunity to improve connections between Rainier Valley and West Seattle. Route 50 provides this connection further south, but is oriented toward Delridge and White Center.

To provide direct access from West Seattle to the Lander Street *Link* station, Route 5/5A is revised to operate via 4th Avenue South instead of 1st Avenue South. Passengers from West Seattle can ride in on Route 5 and walk one block east from 4th Avenue South to the Lander Street *Link* station. Of course, connections are also available along 4th Avenue South to Routes 136/137, which may be useful to some Rainier Valley *Link* riders to reach industrial destinations south of Lander. These routes are unchanged from the base network, but acquire new value with a Lander Street *Link* station.

A map showing the conceptual bus network changes is enclosed with this report.

3.8 ALTERNATIVE C2.4: I-90 ROADWAY/RAINIER AVENUE TUNNEL

This alternative provides no stations from International District to McClellan Street except one at Dearborn Street near 14th Avenue South. No connecting bus service is envisioned at this station, and the network would be identical to the Base network.

3.9 SEGMENT D ALTERNATIVES

Alternative alignments along Segment D apply to the area between Columbia City and Henderson Street *Link* stations. No changes to the Base network are required to accommodate any of these alternatives.

3.10 SEGMENT E ALTERNATIVES

Alternatives E2 and E3 delete the Boeing Access Road and Tukwila *Link* stations from the Base alternative, and replace them with stations at Longacres (also a *Sounder* commuter rail station) and Southcenter.

Of all of the alternatives to the Base network, Alternatives E2 and E3 require the most sweeping changes to bus services. These changes affect all of Tukwila, but also have impacts in South Park, Burien, Renton, SeaTac, and Kent. A map showing the conceptual bus network changes is enclosed with this report.

Tukwila, Burien, SeaTac

In the Base network, all of Tukwila is covered by routes converging on Boeing Access Road *Link* station. This station also has bus connections to Burien, South Park, and SeaTac.

The elimination of Boeing Access Road *Link* station requires that many of the routes serving it be extended to the Henderson Street *Link* station, despite the costly duplication that this produces along Martin Luther King Jr. Way South. Henderson Street becomes the end of the line for routes to Burien (Route 132), Riverton/24th Ave South (Route 127), Central Tukwila/40th Avenue S (Route 124), and Interurban Avenue South (Route 122). In addition, Route 199 – the high-frequency route covering Pacific Highway South from Federal Way to Southcenter in the Base network – is rerouted to continue north on Pacific Highway South through the Boeing Access Road area to Henderson Street. This route no longer needs to serve Southcenter from Federal Way since *Link* provides faster connections to Southcenter from South SeaTac *Link* station for these trips.

Services that approach the Boeing Access Road area from the north in the Base alternative are generally not extended to Henderson Street, since this connection serves a limited number of useful trips. Instead, these services (Route 18 from South Park, 174 from East Marginal Way South, and 150 from Airport Way South) pass through the Boeing Access Road area and end at Metro's South Base, which is located on East Marginal Way South just south of SR 599.

Express services to Gregory Heights, which were routed to North SeaTac *Link* station in the Base Network, must run into downtown Seattle in Alternatives E2 and E3 because the running time on *Link* via Southcenter is now too long to make these feeders competitive.

Renton, Kent, Auburn

Some Renton and Kent services are improved to take advantage of the Southcenter and Longacres *Link* stations. Service along Lind Avenue SW in Renton and 84th Avenue South in Kent is routed into Longacres and Southcenter, instead of running all the way to Henderson Street as in the Base network. Renton's local high-frequency circulator, Route 110, is also extended to connect with *Link* at Longacres.

Finally, the Southcenter *Link* station would connect to a high-frequency local bus route down the Green River Valley, linking Southcenter, Kent, and Auburn and providing midday access to all of the valley's *Sounder* commuter rail stations. This proposed Route 154 would run every 15 minutes all day. It would generally follow West Valley Highway between Southcenter and Kent, while using Central Avenue South and Auburn Way North between Kent and Auburn.

3.11 SEGMENT F ALTERNATIVES

Segment F alternatives consider several alignments for *Link*, including routings through Sea-Tac Airport or along International Boulevard, but most of these alternatives have no impact on bus service.

4. FEEDER BUS FACILITY REQUIREMENTS AT STATIONS

This chapter identifies the bus facility requirements at stations. Most stations outside of downtown Seattle will include facilities for bus layover and transfer of passengers from bus to rail. Layover facilities will be required for buses on terminating routes to park between trips. Locations for bus layovers can be provided on the station site, in the immediate vicinity of the station, or along the segment of the route to or from the bus turnaround point. Layover areas may range from special facilities (such as pull-out bays on the street adjacent to or near the station) to off-street facilities on the station site.

For the purpose of identifying bus facility requirements at stations, it was assumed that layover would occur at the station. Typically, where facilities for layover are provided on-site, the bays for layover also are used for passenger transfers. One parking bay for layover and transfer of passengers would be provided for each route terminating at each station. Additional bays would be needed for transfer of passengers on through-routed feeder routes. It was assumed that one bay can accommodate up to ten buses per hour. However, routes with a high frequency of service are usually assigned their own bay because all routes may be present and laying over at once. Also, routes with peak frequencies of ten minutes or less are usually assigned two bays because layovers are often longer than the headways, which results in the presence of more than one bus at a time.

The bus networks were reviewed to identify the feeder bus routes serving each station. The number of bus bays needed for layover and passenger transfers were then estimated based on the number of terminating routes and through routes serving each station and the service frequency and buses per hour for each route. Appendix C (in a separate volume) contains the spreadsheet tables used to estimate bus facility requirements for each station. The number of buses serving each station and estimated number of bus bays needed for each station are presented in Table 1. Following is a description of bus bay requirements by station.

4.1 BUS BAY REQUIREMENTS BY *LINK* LIGHT RAIL STATION

Northgate

This station may require up to 20 bus bays. Of the 16 routes converging at this station, most operate at very frequent headways, and therefore need their own separate layover bays. Other routes are so frequent that they require two bays because layovers are longer than their headways.

Roosevelt

Up to ten buses may be present at the same time at the Roosevelt *Link* station, assuming that this station is located near Roosevelt Way NE or 12th Avenue NE, not at 15th Avenue NE, in

which case the addition of high-frequency Route 73 would increase the number of buses. Because routes approach the station from many different directions, it is likely that on-street bus bays may be sufficient to accommodate most needs at this location.

NE 45th Street

A total of 9 bus bays would be desirable at this station. This assumes that trolley buses will continue to lay over a few blocks away, as they do now (an assumption that decreases the number of layovers but correspondingly increases the number of times buses depart or arrive). A particularly high volume of buses may occur on 15th Avenue NE between NE 45th Street and NE Pacific Street. This segment could carry more than 60 buses per hour, or more than one per minute. Given the high volumes of boarding and alighting that occur at every stop in this area, and the frequent congestion on this street, transit treatments may be needed on this segment of 15th Avenue NE to prevent bus congestion. Double-length bus stops are probably needed at every stop on 15th Avenue NE between NE Pacific Street and NE 45th Street, to ensure that two buses can board and alight passengers at once. The other area of concern is NE 45th Street from the west, where volumes of 49 buses per hour are estimated. Though this volume is much lower than on 15th Avenue NE, the street is far more congested because it provides freeway access.

Pacific Street

The Pacific Street *Link* station would ideally have 17 bus bays under the Base network and 20 under the Pre-Base network with the *Link* light rail line terminating at NE 45th Street. This station presents the most difficult access problem on the *Link* light rail line. There is potential for up to 20 buses to converge at this station at the same time, a volume that will be difficult to accommodate because of the lack of available land in the area.

Campus Parkway (Alternative B2.1 Only)

The B2.1 alternative would create a Campus Parkway *Link* station instead of a Pacific Street *Link* station. This location would need to handle volumes similar to what are expected at Pacific Street, with up to 23 buses present at once.

Capitol Hill

A maximum of ten buses is likely to converge on the Capitol Hill *Link* station. However, there would be no buses laying over here. Bus transfers could be accommodated through on-street bays along Broadway Avenue East and on East John Street at the station access points, so that multiple buses from different routes can converge, if necessary. If this is not possible, it may be necessary to shorten Route 60 back to terminate at First Hill. This would result in more balanced bus volumes on Broadway Avenue East.

First Hill

Bus volumes serving the First Hill *Link* station will be relatively low. However, one trolley layover is needed for the truncated Route12. A total of six bays would be required.

Roy Street (Alternative B1B Only)

A new Roy Street *Link* station will be served by on-street stops, with a maximum of eight buses present at once. This is greater than the existing volumes only because we presume that Route 60 would be extended one block to reach the station, and because of the proposed new east-west service along Roy-Aloha.

Eastlake (B2 Alternatives Only)

Route 70's stops on Eastlake Avenue East would be the only bus access to this station. No special facilities are required.

South Lake Union (B2 Alternatives Only)

This station would be served by up to six buses at once, mostly passing through quickly. Only Route 60 would terminate here.

Seattle Center (B2 Alternatives Only)

Bus routings and volumes in this area are the same as in the Base alternative, though in that alternative there is no station here. Only five buses are likely to be present at once in the immediate station area.

Royal Brougham and Lander Street (C1 Alternatives Only)

Both of these stations would share the 5th Avenue South busway with several regional routes. These would be the only immediate connections, with up to five buses (total of the two directions) present at once. However, nearby stops on 4th Avenue South would provide additional bus connections, especially if the Lander Street *Link* station is built.

Beacon Hill (Alternative C1B Only)

Existing stops on Beacon Avenue South, 15th Avenue South, and South McClellan Street would be sufficient to serve this station.

Dearborn Street (Alternative C2.4 Only)

No buses serve this station.

I-90 or Poplar Place

Existing stops on Rainier Avenue South would be sufficient to serve this station.

McClellan Street

The McClellan Street *Link* station will have major north-south bus volumes, with the high-frequency Routes 9 and 48 serving the station. Routes 8, 14, and 27, which operate 15 minute service, all terminate at the station, requiring significant layover space. A total of 11 bays would be desirable.

Rainier Square (Alternatives D3.3.1 and D3.3.2 Only)

Existing stops on Rainier Avenue South would be sufficient to serve this station.

Columbia City

Bus impacts at the Columbia City *Link* station are minor compared to most other stations. Route 9 intersects the major east-west cross-town Route 50 at this station, and the Route 38 feeder would terminate here. In all, up to seven bays would be required.

Alaska Street (Alternatives D1.1 and D1.2.1 Only)

Existing stops on Martin Luther King Jr. Way South and South Alaska Street would be sufficient to serve this station.

Edmunds Street (Alternative D3.3.1 Only)

Existing stops on Martin Luther King Jr. Way South would be sufficient to serve this station.

Graham Street (Alternatives D1.1, D1.2.1, D3.3.1 and D3.3.2 Only)

Existing stops on Martin Luther King Jr. Way South would be sufficient to serve this station.

Othello Street

Bus volumes at the Othello Street *Link* station are low. Route 1 intersects Route 9 at this station, but no routes terminate. No more than seven buses would be present at once, and this assumes bunched buses on Route 9 during peak hours, a likely but not a routine occurrence. On-street bus bays would satisfy the requirements at this station.

Henderson Street

The Henderson Street *Link* station is a major terminal point and transfer point. Every route serving the station terminates there, and many of the routes operate at frequent headways. Up

to 14 buses could be present at once. This estimate assumes some sharing of layover bays among the infrequent routes arriving from the south. If every route had a separate bay, a total of 17 bays would be required. The E2 alternative, which does not include a Boeing Access Road *Link* station and therefore sends several additional feeder routes to Henderson Street would raise the need at this station to 22 bays.

Boeing Access Road

The Boeing Access Road *Link* station is a logical point for timed-transfer connections, with multiple infrequent routes converging from many directions. For this reason, separate bays would be required for each route serving the station, regardless of frequency, with up to ten bays desirable.

South 144th Street

This station would be served by three routes operating at 30-minute headways. None of these routes would terminate at the station, so four to five on-street bus bays should be sufficient.

Longacres

This joint *Link* light rail and *Sounder* commuter rail station would require six bays for the King County Metro bus routes passing through. However additional bays may be necessary to serve other *Sounder* commuter rail feeder needs. It is important to retain enough space so that employer-sponsored shuttles, for example, can access the station conveniently.

Southcenter

Southcenter would be a major bus transfer center with timed connections among many routes to ensure both local and regional mobility, as well as easy access to the mall itself. As a result, up to 11 buses may be present at once in this location.

North SeaTac and North Central SeaTac

Six on-street bays would be required at the *Link* station, except in the E2 alternative which would require seven. These include westbound stops on Military Road South and double length north-south stops on International Boulevard South, where the overlap of Routes 161, 174, and 199 could cause frequent bunching of buses. One of the southbound stops would be sufficient as the layover bay for Route 161, which is the only route terminating at this station.

South Central SeaTac

The only route terminating at this station is *Regional Express* bus Route "N" from Tacoma. All other routes are through-routed. Assuming a site on International Boulevard South (or that buses from International Boulevard South deviate into a Sea-Tac Airport station), as many as

seven buses may be present at once. If the configuration of the transit center combines buses arriving from different directions into a single facility, the number of bays could be reduced to five or six.

South SeaTac

The terminal station at this location would require a large bus facility with 13 bays to accommodate terminating routes, and to provide for timed transfer connections among infrequent routes. The E2 alternative reduces the need to 12 bays, since some service is shifted from this station to Southcenter. The potential service area for feeder access consists of Des Moines, Kent, and portions of Federal Way.

Table 1
Summary of Bus Bay Requirements at *Link* Light Rail Stations

Station	Alternative	Buses per Hour Peak	Buses per Hour Base	Desirable Minimum Bays Layover	Desirable Minimum Bays Pass-thru	Desirable Minimum Bays Total	Recommended Total (with contingency)
SEGMENT A							
Northgate	All except Pre-Base	81	62	15	1	16	19
Roosevelt	All except Pre-Base, A2.1	48	38	4	4	8	10
Roosevelt	A2.1 (8th Avenue)	35	26	5	2	7	9
SEGMENT B							
NE 45th Street	All except Pre-Base, B2.1	131	71	0	7	7	9
NE 45th Street	Pre-Base	152	91	0	7	7	9
NE 45th Street	Alternative B2.1 only	119	68	0	7	7	9
Pacific St	All except Pre-Base, B2.1	79	61	11	4	15	17
Pacific St	Pre-Base	87	64	13	4	17	20
Campus Parkway	Alternative B2.1 only	103	79	12	7	19	23
Roy Street	Alternative B1B only	40	27	1	6	7	8
Capitol Hill	All except B2 Alternatives	54	28	0	8	8	10
First Hill	All except B2 Alternatives	34	22	1	4	5	6
Eastlake	B2 Alternatives only	12	8	0	2	2	2
South Lake Union	B2 Alternatives only	24	18	1	4	5	6
Seattle Center	B2 Alternatives only	32	24	0	4	4	5
SEGMENT C							
I-90	Base, Pre-Base, C2.3, C2.5	24	16	0	4	4	5
Royal Brougham	C1 Alternatives only	36	8	0	4	4	5
Lander Street	C1 Alternatives only	36	8	0	4	4	5
Beacon Hill	Alternative C1B only	24	18	0	4	4	5
SEGMENT D							
McClellan Street	All	62	44	3	6	9	11
Rainier Square	Alternatives D3.3.1 and D3.3.2 only	24	16	0	4	4	5
Columbia City	All	32	22	1	5	6	7
Alaska Street	Alternatives D1.1 and D1.2.1 only	18	16	0	6	6	7
Edmunds Street	Alternative D3.3.1 only	18	16	0	6	6	7
Graham Street	All except Base and Pre-Base	14	12	0	4	4	5
Othello Street	All	36	28	0	6	6	7
Henderson Street	All except E2 options	56	41	14	0	14	16
Henderson Street	E2 options	68	51	18	0	18	22
Boeing Access Road	All except E2 options	9	7	4	4	8	10
SEGMENTS E-F							
South 144th Street	All except E2 options	12	10	0	4	4	5
Longacres	E2 options	16	16	2	3	5	6
Southcenter	E2 options	24	21	5	4	9	11
North SeaTac	All except E2 options	27	20	2	3	5	6
North Central SeaTac	E2 options	21	15	2	3	5	6
South Central SeaTac	All except E2 options	37	30	1	5	6	7
South Central SeaTac	E2 options	33	26	1	5	6	7
South SeaTac	All except E2 options	29	24	7	4	11	13
South SeaTac	E2 options	27	22	6	4	10	12

* The calculations and assumptions used to determine the minimum number of bays required and recommended per station were as follows: the first step was to determine the number of routes terminating per station area per approach, since a bay must be provided for each route terminating at the station. The second step was to calculate the number of bays needed to serve passengers who are transferring on through routes served at that station. Bays for through routes were calculated based upon 10 buses per hour per bay (Transportation Planning Handbook, Institute of Transportation Engineers, 1992, pp. 434). In the University District additional bays for pass-through routes were estimated only for the incremental increase above existing bus volumes.