

Tacoma Extension Feasibility Study



MARCH 2004

Prepared For: Puyallup Tribe of Indians

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Executive Summary

Sound Transit's Tacoma Link light rail line started operation on August 22, 2003. Based on its success, the Puyallup Tribal Council voted to appropriate \$41,000 to study extending the line from the Tacoma Dome Station to the Tribe's Cascades Casino complex south of I-5, now under construction. The route would extend from the existing Tacoma Dome Station to the east and south of I-5 to the vicinity of the Puyallup Tribe's casino site, a distance of approximately one and a half miles.

The Tribe's new casino will be three stories high, with structured parking for about 3,000 vehicles. It will include six restaurants, a dance club, and gaming facilities for a total of 150,000 square feet. There will also be a 3,500-seat event center, featuring weekly performances. Up to 2,500 people will be employed by the casino.

This study had a limited scope of work directed at determining the feasibility of alternative routes.

The study examined the following route alternatives:

- East 28th Street
- East 29th Street
- East 32nd Street
- Bay Street

All the alternatives presented in this study begin at the existing track on East 25th Street at G Street and use a common segment on Puyallup Avenue that could be extended north to meet the Central light rail line as envisioned in the Sound Move Long Range Plan. Three of the alternatives then use Portland Avenue to go south of I-5, then east to the casino site along either East 28th, East 29th, or East 32nd Streets. One alternative uses Bay Street.

Study Conclusions

All the alternatives presented in this study are feasible, but have various tradeoffs.

- All the alternatives provide a direct connection to downtown Tacoma with travel times from the Tacoma Dome Station to the Casino from six to ten minutes.
- The two major route differences are how they get under I-5, either via Portland Avenue or via Bay Street. This is a heavily trafficked area due to the Port of Tacoma truck traffic and the expanded Casino. A more detailed traffic study would need to be done to compare traffic impacts of the alternatives, both during construction and operation.
- The alternatives using the Portland Avenue route under I-5 would require modification to the undercrossing configuration (using an additional bay for vehicular traffic). They would also require widening of the roadway between Puyallup Avenue and I-5. This necessitates purchase of private property.

- The Bay Street alternative would not require modification to I-5 structures but would require an analysis of traffic in the area of the on and off-ramps planned to be improved to handle the Casino traffic. This analysis would need to be coordinated with the Tribe, Washington State Department of Transportation (WSDOT) and the City of Tacoma.
- All the alternatives would require close coordination with the City of Tacoma, Puyallup Tribe, and WSDOT. All would require at a minimum an airspace lease for the undercrossing of I-5. The East 28th Street and Bay Street alternatives would require use of WSDOT right-of-way.
- Adding Segment F to the East 28th, East 29th, and Bay Street alternatives brings the station significantly closer to the Casino entrance and meets the Tribe's design criteria of no more than a 150-foot walk. Adding Segment F adds 850' of trackway.
- The optional stations serve La Quinta Inn (East 27th Station) and Lower Portland Avenue Business District (East 31st Station).
- The cost of all the alternatives is similar and ranges from \$40 to \$55 million (at the level of analysis performed for this study) with Bay Street being the least cost and East 32nd Street being the highest cost. Adding Segment F brings the cost estimates for the other alternatives closer to East 32nd Street.

Next Steps

After providing this report to the Sound Transit Board of Directors, the Puyallup Tribe, and other partners and stakeholders, potential next steps include gauging support for extending Link to the Casino and evaluating possible funding sources for both further study and potential future construction.

Further studies would take a closer look at traffic impacts, modifications to the I-5 structures, utility impacts,- and ridership forecasts.

1. Introduction

Sound Transit's 1.6-mile Tacoma Link light rail line started operation on August 22, 2003. Based on its success, the Puyallup Tribal Council voted to appropriate \$41,000 to study extending the line from the Tacoma Dome Station to the Tribe's Cascades Casino complex south of I-5, now under construction. The route would extend from the existing Tacoma Dome Station to the east and south of I-5 to the vicinity of the Puyallup Tribe's casino site, a distance of approximately one and a half miles.

The Tribe's new casino, known as Cascades Casino, is a large facility. (See Figure 1.) This facility will be three stories high, with structured parking for about 3,000 vehicles. It will include six restaurants, a dance club, and gaming facilities for a total of 150,000 square feet. There will also be a 3500-seat event center, featuring weekly performances. Up to 2,500 people will be employed by the Casino. (The existing casino on the site will eventually be demolished.)

1.1 Scope of Study

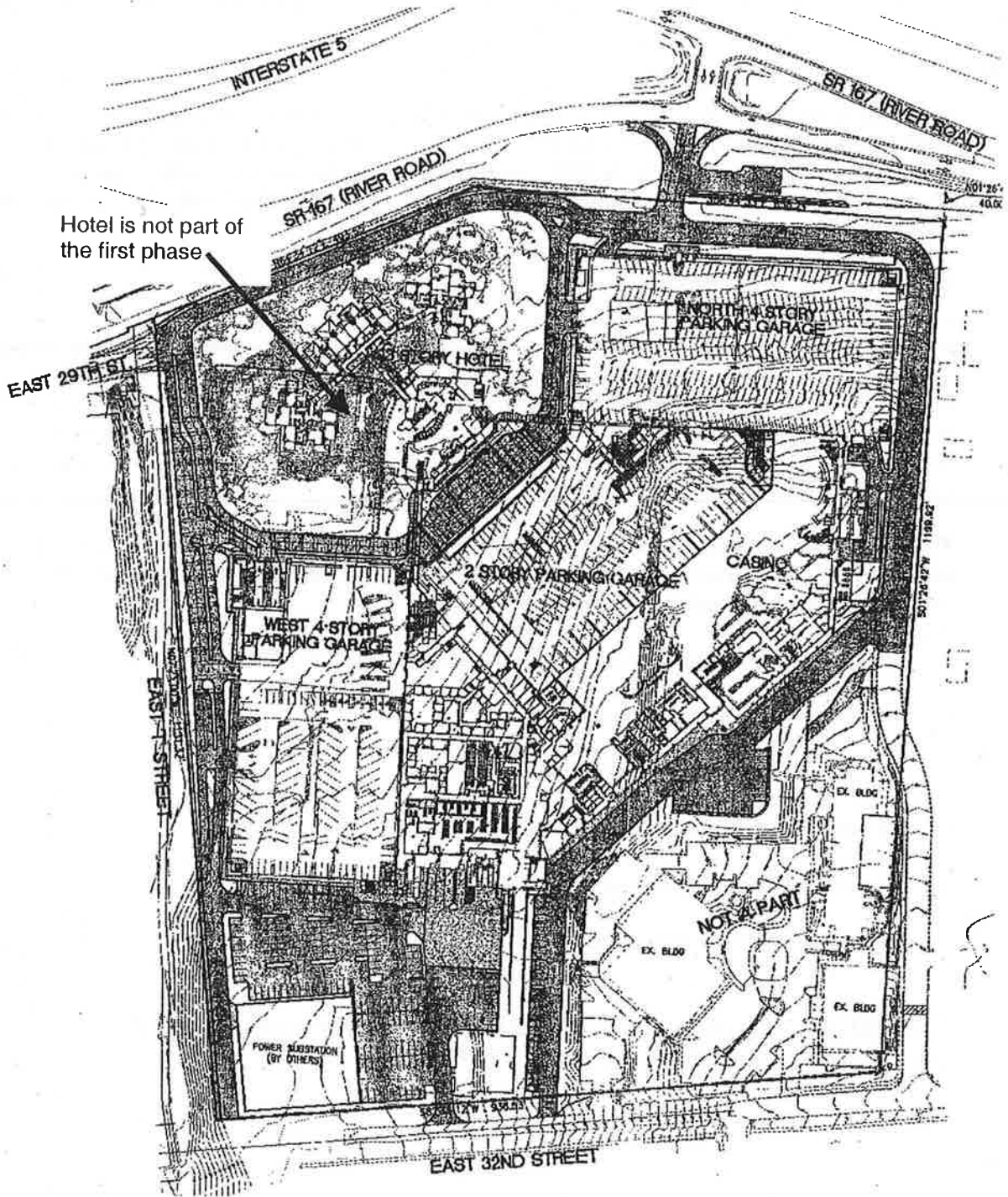
This study is the result of the Sound Transit Board of Directors accepting a contribution from the Puyallup Tribe of Indians to fund a feasibility study. In a letter dated November 6, 2003, Bill Sterud, Puyallup Tribal Council Chairman, stated that the Tribe wished to fund a study on "the extension of light rail to the East Side of Tacoma." He went on to say, "The extension will provide great benefits to our community, the new convention center, Tacoma's downtown hotels and merchants, as well as providing better downtown access to our Eastside neighborhoods."

The Tribe contributed \$41,000 to fund the study. No additional Sound Transit funds were used. Sound Transit staff conducted the study with consultant assistance. The study scope was limited to the following:

- Coordinate with Tacoma City staff, County staff and the Tribe
- Develop up to five route alternatives
- Prepare simplified traffic engineering study
- Environmental review of alternatives
- Operational analysis and system needs
- Order of magnitude cost estimate

This study does not address funding methods. Potential ways of paying for the extension would need to be explored in future work.

Figure 1 Cascade Casino Complex Site Overview



1.1.1 Project Goals

Based on the letter from the Tribe, Sound Transit developed the following goals for the light rail extension to Cascades Casino:

- Connects Downtown Tacoma and the new Cascades Casino development
- At a minimum, serves peak hours of operation of Casino facility
- Meets minimum design criteria such as turning radii and grades
- Is designed to existing Tacoma vehicle/Portland streetcar standards except for any track on Puyallup Avenue, which is assumed to be consistent with Tacoma Link/Central line upgrade standards. (This is because continuing up Puyallup Avenue would be the probable route to Federal Way and north to the Central line, as shown in the adopted Long Range Plan. It is assumed that the line to the Casino is a spur line because it doesn't fit with the current adopted Long Range Plan).

In addition to the above goals, this study discusses the extent to which the route alternatives would conform to the Sound Transit Long Range Plan and the extent to which they would facilitate possible future expansions for example, to connect with the City of Puyallup.

2. Route Alternatives

Sound Transit staff and consultants identified several possible routes to extend Tacoma Link to the Casino. On January 28, 2004 Sound Transit met with stakeholders (staff representatives of the Puyallup Tribe, City of Tacoma, and Pierce County) to review and screen optional routes. Based on input from City, County, and Tribal staff received at that meeting, four alternative routes between 25th Street at Tacoma Dome Station and the general vicinity of the casino site were identified for feasibility level analysis.

These routes consist of the following segments A through F (See Figure 2):

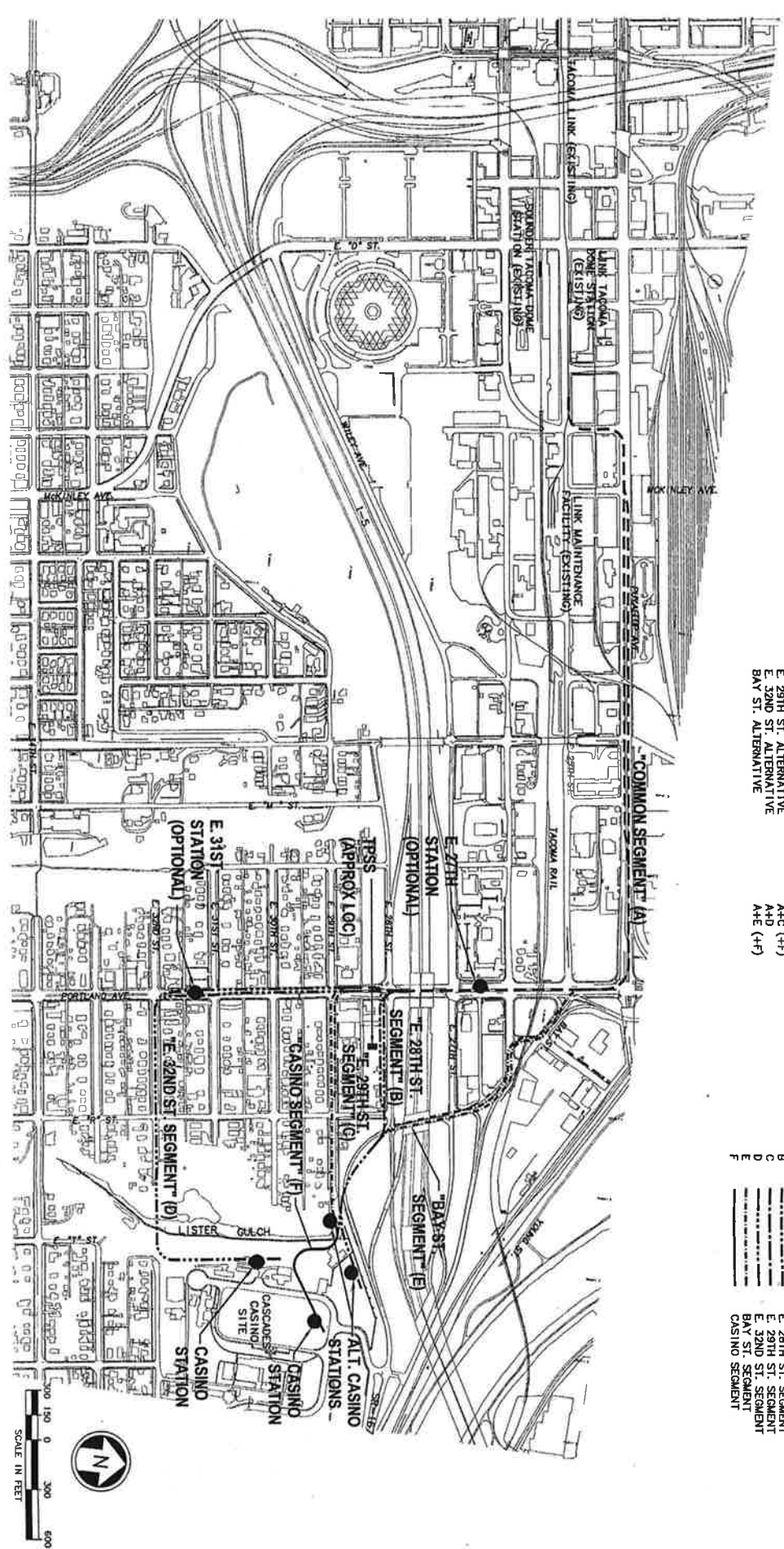
- A. Common Segment
- B. East 28th Segment
- C. East 29th Segment
- D. East 32nd Segment
- E. Bay Street Segment
- F. Casino Segment

The segments are combined to form the following four route alternatives:

| Alternative Name | Segments Used |
|------------------------------|-------------------|
| East 28 th Street | A+B (+F optional) |
| East 29 th Street | A+C (+F optional) |
| East 32 nd Street | A+D |
| Bay Street | A+E (+F optional) |

All of the alternatives begin with a common segment starting at the existing track on East 25th Street. This common segment (Segment A--mostly along Puyallup Avenue) is described first below, followed by the additional segments that make up a complete route alternative. Three of the alternatives (East 28th, East 29th, and Bay Street) have an alternative terminus station at the Casino. This additional segment (F - Casino segment) would provide a station at the front entrance to the Casino.

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ALTERNATIVES:

ALTERNATIVE NAME:
 E. 28TH ST. ALTERNATIVE
 E. 29TH ST. ALTERNATIVE
 E. 32ND ST. ALTERNATIVE
 BAY ST. ALTERNATIVE

SEGMENTS USED:

A+B (+F)
 A+C (+F)
 A+D
 A+E (+F)

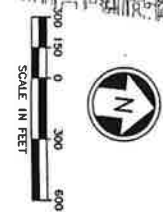
SEGMENT LEGEND:

A
 B
 C
 D
 E
 F

SEGMENT NAME:

COMMON SEGMENT
 E. 28TH ST. SEGMENT
 E. 29TH ST. SEGMENT
 E. 32ND ST. SEGMENT
 BAY ST. SEGMENT
 CASINO SEGMENT

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|--|--|--|--|---|--|
| <p>Prepared By: A. MORGAN</p> <p>Checked By: J. BAILEY</p> <p>Approved By: A. MORGAN</p> | | | <p>Scale: 1" = 300'</p> <p>Frame: TACOMA-EXHIBIT-1</p> <p>Control No. 03/03/04</p> | <p>TACOMA LINK LIGHT RAIL CASCADES CASINO EXTENSION FEASIBILITY STUDY SEGMENT ALTERNATIVES PLAN</p> | <p>Project No. FIGURE 2</p> <p>Sheet No.</p> <p>Rev.</p> |
|--|--|--|--|---|--|



2.1 Design Criteria

This section describes the design criteria used in developing the route alternatives and in evaluating them. All alternatives assume the existing Tacoma Link vehicle would be used on the extension. This section also details the assumptions made for this study.

The Link design vehicle and related characteristics used in this study is the Inekon-Skoda Low Floor Streetcar. Inekon-Skoda vehicle design criteria can be found in Appendix 1. The manufacturer's specifications for the U.S. version of this vehicle call for a 66' minimum turning radius. Track design in Puyallup Avenue will use the Seattle Light Rail vehicle (LRV) design standards. The Seattle LRV has a minimum turning radius of 82'. Turning radii used in this study are 82 feet to 100 feet.

Streetcar alternative station platform lengths must be designed to accommodate the design vehicle and vehicle configuration. The Inekon-Skoda car has a total length of 66 feet, with approximately 38 feet from outside of front door to outside of rear door. It runs as a single vehicle and cannot be coupled into a two-car train. Station platforms on this extension are assumed to accommodate a single streetcar, with canopies of minimal extent, development, and identical design. Maximum grades for stations are assumed to be 2%.

The Puyallup Tribe has expressed a desire for the maximum walking distance of 150 feet from a terminal station to a Casino entrance. (This is the same standard the Casino is using for visitors who arrive via automobile.) Total distances of greater than 150 feet could be mitigated with moving sidewalks or other pedestrian circulation elements. The costs and feasibility of those elements are not included in this study.

For all alternatives, embedded track construction is assumed with no ballasted track. In-street running track has rails flush with the top of the pavement, with the travel lane shared with rubber-tired vehicles. This may also be referred to as 'shared corridor'. This is similar to the track currently running in Commerce Street. Dedicated raised curb track is similar to single track currently in East 25th Street and to single and double track currently in Pacific Avenue.

In-street operations are assumed to be similar to bus operations, with little to no phase separation, and minor to no special signaling where signals exist for non-streetcar traffic operations or when streetcar movement is counter to traffic movements.

Utility impacts for streetcar design criteria are seen to be minimal, with an assumed 12 to 18 inches impact depth. Trackway construction is envisioned to be cast in place reinforced concrete slab at an approximate thickness of 12 inches, dependent on soil parameters. Streetcar loads at a 12 inch depth are comparable to HS-20 truck loads. Design criteria for Seattle Light Rail Vehicle (LRV) in East 25th Street, East 'G' Street, and Puyallup Avenue require that utility impacts are examined to a depth of 36 inches. Utility owner requirements for access to facilities under the trackway may require utility relocation.

2.1.1 Assumptions

- **Commonality to All Segment Alternatives**

All segments are at-grade. No new aerial or other structures are required for the trackway or platforms. The Tribe's current design for the East 32nd Street bridge at East 'T' Street, currently at a 90% design level, may need modification to accommodate rail loads and alignment.

- **Planned Changes**

The Puyallup Tribe, together with WSDOT and the City of Tacoma, has identified proposed traffic improvements in the vicinity of the Casino site. These include new signalization at the East 27th and Bay Street intersection, at the East 28th and East 'R' Street intersection, and at the north Casino entrance from River Road. This last signal is not on any alternative alignments considered by this study. These proposed improvements also include a realignment of East 'R' Street to reduce offset at the new East 28th Street signal, a northbound lane on Bay Street under I-5 (from 2 lanes to 3 lanes), a realignment of the Bay Street curve from East 'R' Street to near the Casino site, and restriping for an additional westbound to southbound turn lane from East 27th Street to Portland Avenue. Other proposed traffic improvements for the Casino project can be found in Appendix 2. No other traffic or other improvements affecting the study alternatives have been made available.

If changes are necessary to proposed signalization as negotiated to date between the Puyallup Tribe, Washington State Department of Transportation (WSDOT), and the City of Tacoma in order to accommodate the Link extension, it may detrimentally impact the Casino improvement schedule. The Puyallup Tribe has expressed the need for urgency in determination of a LINK alignment in the event that it would need to be coordinated with the Casino construction.

2.2 Segments Considered but Not Included

Early in the evaluation of alternative routes, the authors of this study, with guidance, feedback, and input from The Puyallup Tribe and the City of Tacoma, considered but discarded segments that proved to be infeasible, too costly, or not in line with overall goals. These segments and their positive and negative aspects are briefly discussed here. Light rail (streetcar) routes considered the beginning of the extension to be near the intersection of E. 25th Street at E.'G' Street, as the existing track approaches the Tacoma Link Operations and Maintenance Facility.

2.2.1 East 25th Street

East 25th Street was originally considered with Puyallup Avenue as one of two potential routes to head east toward the Casino site. Puyallup Avenue was considered to have less traffic, business, and utility impacts, and was considered the likely route to continue north along SR99 as identified in Sound Transit's Long Range Plan for connection to the Seattle Central Link light rail system. Puyallup Avenue was also considered to provide the light rail system with more visibility in the community since it is a major arterial whereas East 25th Street is a local street.

2.2.2 East 'L' Street and the Drainage Corridor or 'Gulch'

I-5 runs east-west through the study area and is on raised fill with three overcrossings (Portland Avenue, Bay Street/SR167, and the drainage corridor or 'Gulch') and one undercrossing (East 'L' Street). An additional overcrossing occurs at the BNSF tracks at the western end of the Puyallup River Bridge. This overcrossing was not considered since it is too far east, beyond the Casino site. The need to cross the I-5 alignment in an existing physical corridor resulted in the consideration of four route segments, each one using an existing over or undercrossing.

The extended grades on East 'L' Street, from 8% to 13%, proved to be at or above the upper limit of the design criteria for a steel wheeled vehicle. The need to significantly modify or reconstruct the existing bridge over I-5 for track and streetcar loads was seen as a comparatively high and undesirable cost and schedule impact.

I-5 and SR 167 span with three-bay bridges the drainage corridor that lies colinear with East 'T' Street. The center bays are occupied by a pair of buried 60" and 72" drainage pipes. A track profile using one set of bays through all the bridges would require extensive retained cuts, pumped drainage system, and would result in a below-grade terminal station in the Lister Gulch area adjacent to the Casino site. Comparative impacts were seen to be undesirable in terms of cost, maintenance, and diminished visibility of the station.

2.2.3 Diesel Multiple Unit (DMU) on Tacoma Rail Track

Use of the Tacoma Rail track was considered to take advantage of the existing track for possible cost savings. Alignment possibilities included a turn out track on East 25th Street from the Tacoma Link track to the Tacoma Rail track using an electric vehicle, or sharing the Sounder platform or constructing a new platform at the Sounder's Tacoma Dome Station using a diesel vehicle. A new spur track was considered at the Tacoma Rail – BNSF ownership border to allow the vehicle to run on an independent track to a Casino station alongside the existing BNSF track. The study team determined that the DMU Colorado Rail Car met Federal Railroad Authority (FRA) requirements for crash-worthiness, and so that vehicle was considered.

This alternative appeared to have lower costs than the other alternatives with limited traffic, construction, property, and utility impacts. However, it would also have had less economic benefit, and required extensive coordination with BNSF and WSDOT.

This alternative was dropped by the Tribal Council, since it met neither the original stated goals of the study nor Sound Transit's Long Range Plan. It would have also placed the Casino Station approximately 800 feet and across River Road from the front door of the Casino, required sharing of the Tacoma Rail or other operator's maintenance facility for daily and regular maintenance, added a third type of vehicle to the Sound Transit rail fleet, and required a transfer at the Tacoma Dome Station for patrons using the Tacoma Link system.

2.3. Final Route Alternatives by Segment

2.3.1 Common Segment A: Puyallup Avenue to Portland Avenue to East 25th and Bay Streets

All alternatives would start with the Common Segment.

- Track Configuration

From the existing track alignment west of East 'G' Street, new single track would turn north on East 'G' Street for one block, running in the center of the street and turn east at the existing signalized intersection to run in the center of Puyallup Avenue with raised curb dedicated track. Identified intersection crossings would be flush with the pavement. Raised curb single track would transition to double track, also in a raised curb section, in the existing two way left turn lane and run from approximately East 'I' Street to East 'N' Street. The two way left turn lane would be eliminated. The transition back to single track would take place within the existing triangular area formed at the roadway 'Y' as Puyallup Avenue approaches Portland Avenue. Single track would turn south onto Portland Avenue as flush track through the existing signalized raised fill intersection. This single track would head south on Portland as a raised median to Bay Street.

This segment has approximately 1,750 ft. of single track and 2,350 ft. of double track, for approximately 4,100 feet total alignment length. All of the double track is anticipated to be raised curb dedicated, except at the Puyallup Avenue and East 'L' Street intersection. All of the single track is anticipated to be raised curb dedicated except in East 25th and East 'G' Streets (approximately 400 feet), and through the Portland Avenue intersection.

East 25th Street and East 'G' Street have 80' wide rights of way, with Puyallup Avenue and Portland Avenue at 100' each. This alignment segment crosses two existing short line tracks serving Tacoma Plywood and possibly other businesses on East 25th Street. Only one of these tracks appears to be in service. Future design and coordination of the alignment will require mitigation of this freight rail intersection.

- Stations

This segment has no stations identified.

- Grades

Grades for this segment are minimal; from 0% along Puyallup to 4% at the Portland Avenue / Puyallup Avenue raised intersection.

- Structures

No structures or modifications to existing or planned structures are required for streetcar operations.

- Right of Way Requirements

With the city's stated preference to maintain 12' lanes in Portland Avenue coupled with high traffic volumes on this arterial, the need for additional right of way along Portland Avenue to accommodate traffic volumes at target levels of service could be required. For this study, and for this segment, 20 feet of additional right of way will

be assumed to be required on Portland Avenue from Puyallup Avenue to East 25th Street, to accommodate single track raised curb. This results in a total linear right of way length of 270 feet, for an approximate area of up to 5,400 square feet.

City/Tribe Considerations

The Puyallup Tribe has expressed interest in supporting this potential Sound Transit Link access route to King County in the interim until Sound Transit secures funding to include this segment in their future system expansion. The City of Tacoma staff have pointed out that this route has less potential utility impacts and less delivery truck access requirements over East 25th Street, as well as increased right of way width, wide existing lanes, low traffic volumes, and greater visibility for the streetcar system. City of Tacoma staff also expressed concerns about streetcar operations in Portland Avenue between Puyallup Avenue and East 25th Streets due to existing and forecast levels of service and traffic volumes.

2.3.2 Segment B: East 28th Street

Segment B would be combined with Segment A to complete the route to the Casino. It has an optional additional station at Portland Avenue and East 27th Street/Wiley Avenue to serve La Quinta Inn. It could also be combined with Segment F to bring the route even closer to the Casino entrance.

Track Configuration

Segment B is raised curb single track in the center of Portland Avenue from East 25th Street to East 28th Street; where it turns east at East 28th Street as flush in-street with the existing signal; and transitions to double track in Puyallup Tribe property south and adjacent to East 28th Street. This study chose to locate the double track in Tribal property in order to minimize traffic impacts in East 28th Street, the on-ramp to northbound I-5, and SR167. The approximately 840 feet of double track transitions back to single track just west of the proposed realigned and signalized intersection at East 'R' Street, moving adjacent to and with the eastbound traffic lane through the intersection. The single track would then run in Puyallup Tribe property, following the WSDOT limited access boundary to a terminal station either near Lister Gulch at East 'T' and East 29th Streets, or continue on to connect with the Casino Segment with a terminal station at or near the front door of the Casino. A terminal station at East 'T' and East 29th Streets would be approximately 400 feet from the current planned location of the Casino front entrance.

This segment, from Portland Avenue at East 25th Street, including the Casino Segment, has approximately 2,755 feet of single track and 840 feet of double track, for approximately 3,595 feet total segment alignment length. When combined with the common segment on Puyallup Avenue, this alternative has a total alignment length of approximately 7,695 feet. All of the single track is envisioned to be raised curb dedicated except through signalized intersections. All of the double track is anticipated to be dedicated raised curb.

Portland Avenue right of way is approximately 110 feet wide from East 25th Street to East 26th Street, under the Tacoma Rail over-crossing, and approximately 115 feet wide from East 26th Street to the WSDOT limited access boundary near I-5. Under I-5 and within the WSDOT limited access boundary, Portland Avenue is approximately 90 feet wide back of sidewalk to back of sidewalk.

- **Stations**

This alignment has either a terminal station just west of Lister Gulch at East 'T' and East 29th streets, or a terminal station at or near the front door of the Casino served by a partial loop track (Segment F). A terminal station at East 'T' and East 29th Streets would be approximately 400 feet from the current planned location of the Casino front entrance. Segment B affords the option of a station location between East 26th and East 27th Street/Wiley Avenue, to serve La Quinta Inn. With the stated configuration, this would be a single side platform. Existing grades in Portland Avenue are approximately 2% at this potential station location.

- **Grades**

Grades for this segment are minimal; from 2% in Portland Avenue to 0% under I-5 to approximately 2% in East 28th Street. Existing grades at a station site in Portland Avenue at La Quinta Inn are approximately 2%.

- **Structures**

Given results of future traffic analyses and city requirements in Portland Avenue, at least one additional bay in the I-5 overcrossing may need to be taken for vehicular travel lanes. The existing overcrossing is a three-bay structure, with the center bay open for Portland Avenue travel lanes, and the two outside bays taken with slope retention. The existing slope retention would require modification by adding a retaining wall should additional traffic lanes be required. No structural modifications were considered for the Tacoma Rail overcrossing. Streetcar single track width requirements were considered to be taken from slight lane width and sidewalk width reductions.

A station or tail track location crossing Lister Gulch near the Casino drive west entrance at East 29th Street may require modifications to existing fill or culvert that currently protects a 60" sanitary sewer and 72" storm sewer than run co-linear with Lister Gulch and under the SR167 and I-5 structures.

- **Right of Way Requirements**

With the city's stated preference to maintain 12' lanes in Portland Avenue coupled with high traffic volumes on this arterial, the need for additional right of way along Portland Avenue to accommodate traffic volumes at target levels of service could be required. To support cost estimates for this study, and for this segment, an additional 20 feet of right of way will be assumed to be required from East 25th Street to East 28th Street. This right of way will accommodate single track raised curb plus a station at East 27th Street/Wiley Avenue (at La Quinta Inn) and related travel lane shift approaching the station. This results in a total linear right of way length of 840 feet, for an approximate area of up to 16,800 square feet. Administrative costs only have been assumed for right of way where the alignment runs in Puyallup Tribe property.

- **City/Tribe Considerations**

City of Tacoma staff expressed concerns about streetcar operations in Portland Avenue between East 25th and East 28th streets due to existing and forecast levels of service and traffic volumes related to the Port of Tacoma and I-5 ramp traffic, particularly truck traffic.

2.3.3 Segment C: East 29th Street

Like Segment B, Segment C would be combined with Segment A to complete the route to the Casino. It also has an optional additional station at Portland Avenue and East 27th Street/Wiley Avenue. It could also be combined with Segment F to bring the route even closer to the Casino entrance.

- Track Configuration

Segment C is raised curb single track in the center of Portland Avenue from East 25th Street to East 29th Street, where it turns east at East 29th Street as flush in-street track with the existing signal, and transitions to double track in-street in East 29th Street. The approximately 1,250 feet of double track transitions back to single track to a terminal station just west of Lister Gulch at East 'T' and East 29th Streets, or continues on to connect with the Casino Segment F with a terminal station at or near the front door of the Casino. A terminal station at East 'T' and East 29th Streets would be approximately 400 feet from the current planned location of the Casino front entrance.

This segment, from Portland Avenue at East 25th Street, including the Casino Segment, has approximately 2,730 feet of single track and 1,070 feet of double track, for approximately 3,800 feet total segment alignment length. When combined with the common segment on Puyallup Avenue, this alternative has a total alignment length of approximately 7,900 feet. All of the single track is envisioned to be raised curb dedicated except through signalized intersections. All of the double track is anticipated to be in-street shared corridor.

Portland Avenue right of way is approximately 110 feet wide from East 25th Street to the East 26th Street, under the Tacoma Rail over-crossing, and approximately 115 feet wide from East 26th Street to the WSDOT limited access boundary near I-5. Under I-5 and within the WSDOT limited access boundary, Portland Avenue is approximately 90 feet wide back of sidewalk to back of sidewalk. From the WSDOT right of way boundary to East 29th Street, Portland Avenue right of way is approximately 110 feet wide.

- Stations

Stations would be the same as alternative Segment B.

- Grades

Grades for this segment are minimal; from 0% under I-5 to 2% to 4.5% in Portland Avenue to approximately 3.5% in East 29th Street. Existing grades at a station site in Portland Avenue at La Quinta Inn are approximately 2%.

- Structures

Structures would be the same as alternative Segment B.

- Right of Way Requirements

Right of way requirements on Portland Avenue are the same as for East 28th segment.

- **City/Tribe Considerations**

As mentioned, the City of Tacoma staff have expressed concerns about the effects of streetcar operations on traffic level of service in Portland Avenue. In addition, the Tribe has expressed concerns about East 29th Street construction impacts to the Tribal police offices and Casino traffic.

2.3.4 Segment D: East 32nd Street

Like Segment B and C, Segment D would be combined with Segment A to complete the route to the Casino. It also has an optional additional station at Portland Avenue and East 27th Street/Wiley Avenue (at La Quinta Inn). In addition, it has a second optional station at Portland Avenue and East 32nd Street.

- **Track Configuration**

Segment D is raised curb single track in the center of Portland Avenue from East 25th Street to East 29th Street where it transitions to either double track shared corridor or dedicated raised curb, adjacent to and on either side of the existing median. It continues up the hill to East 32nd Street, where it turns east as flush in-street with a new signal, and transitions to single track raised curb in the center of East 32nd Street. The approximately 1,140 feet of single track raised curb track continues to just east of the proposed bridge at East 'T' Street, then turns north with an active signal alongside the Casino access drive serving East 32nd Street. The single track would then run in Puyallup Tribe property, to a terminal station at the Casino parking garage. The alignment on Casino property will need to consider locations of planned Casino infrastructure, including the location of the planned power substation. At this writing, no information on exact location or size of this facility and surrounding facilities was provided by the Tribe.

This segment, from Portland Avenue at East 25th Street to East 32nd Street to the Casino parking garage has approximately 3,340 feet of single track and 1,540 feet of double track, for approximately 4,880 feet total segment alignment length. When combined with the common segment on Puyallup Avenue, this alternative has a total alignment length of approximately 8,980 feet. All of the single track is envisioned to be raised curb dedicated except through signalized intersections. All of the double track is anticipated to be shared corridor, flush with pavement.

Portland Avenue right of way is approximately 110 feet wide from East 25th Street to the East 26th Street, under the Tacoma Rail over-crossing, and approximately 115 feet wide from East 26th Street to the WSDOT limited access boundary near I-5. Under I-5 and within the WSDOT limited access boundary, Portland Avenue is approximately 90 feet wide back of sidewalk to back of sidewalk. From the WSDOT limited access boundary to East 29th Street, Portland Avenue right of way is approximately 110 feet wide, and 60 feet wide from East 29th Street to East 32nd Street. East 32nd Street right of way is 80 feet wide.

- **Stations**

This segment has an optional East 27th Station identical to Segments B and C. This alignment also affords the possibility of a neighborhood station in Portland Avenue, either north of East 31st Street or between East 30th and 31st streets adjacent to an existing pedestrian signal. With the stated configuration, this would be a center

platform. Existing grades in Portland Avenue are approximately 2% at this potential station location.

- **Grades**

Grades for this segment are minimal; from 0% under I-5 to 2% to 4.5% in Portland Avenue to approximately 4.3% in East 32nd Street. Existing grades at station sites in Portland Avenue at La Quinta Inn and near East 32nd Street are approximately 2%.

- **Structures**

As explained under segments B and C above, given results of future traffic analyses and city requirements in Portland Avenue, at least one additional bay in the I-5 overcrossing may need to be taken for vehicular travel lanes. Changes to the Tacoma Rail overcrossing are not anticipated.

The Puyallup Tribe's proposed bridge across Lister Gulch near the Casino driveway south entrance at East 32nd Street may require modifications to accommodate streetcar loads and alignment. The design of this bridge, at this writing, is at 90% completion.

- **Right of Way Requirements**

Right of way requirements on Portland Avenue are the same as for East 28th segment.

Additional right of way will likely be required to accommodate the curve from Portland Avenue to East 32nd Street.

- **City/Tribe Considerations**

The Puyallup Tribe sees advantages in having the rail access to the Casino on East 32nd Street, away from the main traffic access to the Casino front door and in serving this East Tacoma neighborhood. The alignment on Casino property will need to consider locations of planned Casino infrastructure, including the location of the planned power substation. At this writing, no information on exact location or size of this facility was provided by the Tribe.

City of Tacoma staff expressed concerns about streetcar operations in Portland Avenue between East 25th and East 28th Streets due to existing and forecast levels of service and traffic volumes.

2.3.5 Segment E: Bay Street

Like Segments B, C and D, Segment E would be combined with Segment A to complete the route to the Casino. It has no other stations.

- **Track Configuration**

Segment E continues from Segment A's single track in Portland Avenue, and with an anticipated train-only signal, crosses Portland Avenue at Bay Street flush with pavement, and in the Bay Street triangular area formed at the roadway 'Y', or 'gore area', transitions to shared corridor double track, flush with pavement. The double track continues along the roadway, running with traffic, passing under the Sounder/Tacoma Rail track box culvert, under I-5, through the realigned and

signalized intersection at East 'R' and East 28th Streets (as proposed by the Puyallup Tribe for Casino development), transitioning to single track through this intersection, and onto Puyallup Tribe property. The single track would then run in Puyallup Tribe property, following the WSDOT limited access boundary to a terminal station either near Lister Gulch at East 'T' and East 29th streets, or continue on with Segment F to a terminal station at or near the front door of the Casino. A terminal station at East 'T' and East 29th Streets would be approximately 400 feet from the current planned location of the Casino front entrance.

This segment, from the turn from Portland Avenue at Bay Street including the Casino Segment F, has approximately 1,660 feet of single track and 1,550 feet of double track, for approximately 3,210 feet total alignment length. All double track is anticipated to be shared with vehicular traffic, flush with pavement. When combined with the common segment on Puyallup Avenue, this alternative has a total alignment length of approximately 7,310 feet.

Bay Street right of way is 80 feet wide from Portland Avenue to East 26th Street where it splits into a 'Y' to feed and offload SR 167/River Road, except for the 30 feet clear through the new box culvert under the Tacoma Rail tracks and approximately 36 feet clear under I-5. Charlie Burnham, of DEA, designer for Sounder, reports that it is 16'-6" from the crown of Bay Street to the bottom of girders at the Tacoma Rail box culvert.

It must be noted that at the writing of this study, this section of Sounder track structure was discovered to have recently experienced differential settlement in the box culvert area. It is as yet unknown what, if any, mitigation will be undertaken to address this discovery. Should this alignment alternative be selected, it may be prudent to explore widening of the box culvert should mitigation include structural modifications that would facilitate widening.

Another option would be to avoid the Tacoma Rail/Sounder undercrossing by altering the Bay Street segment such that instead of turning east on Bay Street at Portland Avenue, it continues south on Portland to 26th Street and turns east on 26th to meet Bay Street.

Stations

This alignment has either a terminal station near Lister Gulch at East 'T' and East 29th Streets, or a terminal station at or near the front door of the Casino with connection to the Casino Segment F. A terminal station at East 'T' and East 29th Streets would be approximately 400 feet from the current planned location of the Casino front entrance.

Grades

Grades for this segment are minimal; from 4% at the Portland Avenue / Bay Street intersection to 0% along Bay Street to 2.2% along the WSDOT right of way boundary to East 'T' Street. Existing grades at a station site near East 'T' Street facilitate less than 2% grade.

- **Structures**

Bay Street has 30 feet clear through the new box culvert structure under the Tacoma Rail tracks. Assuming the Overhead Catenary System (OCS) wires can be supported under the existing structure, negating the need for OCS poles through the structure, 28 feet width is required for the dynamic envelope of a double track in-street running configuration. This leaves two feet total for pedestrian access, which is not seen to be acceptable. (Note: there is currently no pedestrian access through this tunnel.)

The Puyallup Tribe's proposed Casino improvements include adding a northbound lane under the I-5 overcrossing. With the assumption that the streetcar OCS lines can be supported from the underside of the structure, alleviating the need for OCS poles, required trackway and dynamic envelope width for in-street running is 28 feet, or two wide lanes. Current channelization plans by the Puyallup Tribe may need to be modified to allow a 3-lane roadway width should this alternative be selected. Modifications to the existing WSDOT slope retention and sidewalk may be needed to achieve 3 lanes.

A station or tail track location crossing Lister Gulch near the Casino drive west entrance at East 29th Street may require modifications to existing fill or culvert that currently protects a 60" sanitary sewer and 72" storm sewer than run co-linear with Lister Gulch and under the SR167 and I-5 structures.

- **Right of Way Requirements**

Additional rights of way in the I-5 / SR167 WSDOT limited access area and in Puyallup Tribe property are envisioned to be required for this segment. In these cases, administrative costs only have been assumed for this right of way.

- **City/Tribe Considerations**

Tribal staff expressed concerns about impacts to the agreement with the City of Tacoma and WSDOT regarding Bay Street channelization and signal improvements proposed for Casino operations.

2.3.6 Segment F: Casino

This segment would be combined with the Common Segment A and either Segments B--East 28th, C--East 29th or E--Bay Street to form a complete route that would end with a station at the Casino front entrance.

- **Track Configuration**

Segment F continues from Segments B, C, or E with raised curb single track in partial loop to a terminal station at or near the front door of the Casino, running adjacent to, but outside of the Casino driveway.

The total alignment length of this segment is 850 feet, all single track.

- **Stations**

This alignment has a terminal station at or near the front door of the Casino. This would be a single side platform. Existing grades are approximately 0% at this potential station location.

- **Grades**

Grades for this segment are dependent on the final grading for the Casino site. Based on existing mapping topology, approximately 7% grades could be encountered as the radius track approaches the tangent track section at the station.

- **Structures**

Track crossing Lister Gulch near the Casino drive west entrance at East 29th Street may require modifications to the existing fill or culvert that currently protects a 60" sanitary sewer and 72" storm sewer than run co-linear with Lister Gulch and under the SR167 and I-5 structures.

- **Right of Way Requirements**

Minimal to no right of way requirements are anticipated as this segment is wholly on Puyallup Tribe property.

- **City/Tribe Considerations**

The Tribe has expressed a strong desire to bring the streetcar to the front door of the Casino.

3. Comparison of Alternatives

3.1 Study Constraints

This section describes the constraints for the feasibility study in the areas of traffic analyses, utilities, structures, soil conditions, and ridership.

Traffic analyses are simplified and are to be further developed in subsequent levels of analyses. This study will address when a phase will likely be required at a signalized intersection, but will not determine the details of the phase. The need for active signaling at an intersection or crossing will be identified, but not the extent of the signaling (full signal or train-only signal). It must be noted for future analyses that city traffic staff have expressed the desire for no signal pre-emption when the train is able to move with traffic in order to minimize impacts on levels of service for existing or planned signalized intersections. City staff have stated that anticipated degradation of levels of service with additional phasing or cycle times is unacceptable. Traffic volumes have been used to make assumptions about mitigation needs, but no modeling or other technical analyses have been performed. No Level of Service calculations have been performed. Subsequent analyses will need to determine type of trackway in the identified alternative corridors (such as shared corridor, dedicated raised curb, etc.), based on more detailed traffic analyses.

Utilities reviewed in this study were limited to city-owned wet utilities (water, storm, and sanitary sewers), as provided by the City of Tacoma. Other utilities were requested, such as power, telecoms, and gas, but none were made available by the city. Utility mapping provided by the city indicates approximate locations, with no offsets or profiles made available. This study will state the presence of city-owned wet utilities along the alternate routes, but will not make assumptions as to offsets, depths, or structures. No structural as-built plans were requested or provided as part of this study.

This study assumes existing soil conditions along all alternatives are adequate for trackway, vehicle, station, traction power substation, and other LINK streetcar related loads and conditions, including vibration and lateral loads.

For all alternatives, restriping and repositioning of signage and signals along the alignment would be required. Other traffic mitigation elements may be required, as determined by future analyses and by the city.

No ridership projections were developed for this study. The study includes a review of rider markets served.

3.2 Rider Markets Served

The purpose of the extension is to connect downtown Tacoma with the new Cascades Casino complex. This would enable those living, working and visiting downtown to use rail transit to access the Casino. Casino passengers could transfer from Link to local buses in downtown. With the connection to the Dome Station, a Link extension also enables riders from the Casino to transfer to commuter rail; and local, express, and inter-city buses.

Table 1 and shows that two vehicles are required for 20-minute service except as noted for Bay Street alternative and three vehicles would be required for 10-minute service. Trains will pass on Puyallup Avenue.

Table 1: Operations Analysis

| One-way Times in Minutes | | | | |
|---------------------------------|---------|----------|----------|----------|
| | via Bay | via 28th | via 29th | via 32nd |
| To 29th/T streets | 6 | 8 | 8 | 9.5 |
| To Casino entrance (Segment F) | 7 | 9 | 9 | X |

| Round Trip Times in Minutes | | | | |
|------------------------------------|---------|----------|----------|----------|
| | via Bay | via 28th | via 29th | via 32nd |
| To 29th/T Sts | 18 | 22 | 22 | 25 |
| To Casino entrance (Segment F) | 20 | 24 | 24 | X |

| Fleet Requirements for 20-minute service | | | | |
|---|---------|----------|----------|----------|
| | via Bay | via 28th | via 29th | via 32nd |
| To 29th/T Sts | 1 | 2 | 2 | 2 |
| To Casino entrance (Segment F) | 2 | 2 | 2 | X |

| Fleet Requirements for 10-minute service | | | | |
|---|---------|----------|----------|----------|
| | via Bay | via 28th | via 29th | via 32nd |
| To 29th/T Sts | 2 | 3 | 3 | 3 |
| To Casino entrance (Segment F) | 3 | 3 | 3 | X |

3.4 Environmental Review

The environmental review for this feasibility study identified whether there were any fatal flaws under any of the alternatives considered. Traffic impacts are described in the Traffic impacts section of the report so are not repeated here. Utility impacts are described in the Utilities section of the report so are not repeated here.

The majority of the facilities would be in City right-of-way, WSDOT right-of-way, or on Tribal property. Some additional right-of-way would be needed along Portland Avenue. Private property acquisitions for the alternatives using Portland Avenue (East 28th, East 29th, and East 32nd) are limited to the area along Portland Avenue between Puyallup Avenue and I-5, and in addition for the East 32nd alternative to the Portland Avenue/East 32nd Street intersection. A 20-foot strip was assumed along Portland Avenue between Puyallup Avenue and I-5. Since the buildings along this portion of Portland Avenue are set back from the road, it appears that this additional right-of-way could be accommodated within existing parking and yard areas. An area at the intersection of Portland Avenue/East 32nd Street would possibly be needed to accommodate a track turn and transition. This area is currently designated as parking. Thus, no structures would need to be demolished.

Adverse impacts to existing land use plans are not anticipated. Property and business access impacts could occur along Puyallup Avenue and on East 32nd Street for that alternative due to the exclusive median (restricting left turns), and possibly along Portland Avenue south of East 29th Street if left turns are prohibited. Other than these locations, access impacts are anticipated to be very limited.

None of the alternatives would detrimentally impact any known historic or archeological resources. However, given the location of the alternatives it is possible that archeological resources may be encountered during construction. The environmental analysis necessary for the project would need to examine available maps and reports at the State Historic Preservation Office and include appropriate mitigation measures.

The only identified wetland in the area is located in the area of the T Street "Lister" Gulch beginning at East 29th Street and extending south. There is also a tributary stream located in this area. The Wetland Delineation Report prepared by Barghausen Consulting Engineers, Inc. for the Puyallup Tribe stated that the wetland system would be classified as a Type II Wetland requiring 100-foot buffer under the City of Tacoma code. The tributary would be classified as a Type 4 Water using the Washington State water typing system set forth in the Washington Administrative Code. As long the track and station facilities are constructed on existing or newly constructed roadways in this area, it is assumed that wetland and stream impacts would be minimal. For the Casino Segment, modifications may be necessary to Lister Gulch. If so, there may be impacts to the wetland or stream. For the East 32nd Street segment, should modifications be necessary to the new bridge/roadway planned over Lister Gulch for the addition of light rail, there may be impacts to the wetlands and/or streams.

No parks would be detrimentally impacted by any of the alternatives.

Negative aesthetic impacts are not anticipated from any alternative. The East 32nd Street alternative could be designed to avoid impacts to the existing median with its urban design features on Portland Avenue.

Although the existing Tacoma Link line has not resulted in noise impacts during operation, noise should be analyzed for the extension. Noise impacts are of most concern in residential areas and other sensitive sites such as hotel locations. The East 32nd alternative passes through the most residential areas. A noise and vibration analysis should be conducted during the design phase to identify any sensitive receptors, impacts, and mitigation measures.

Construction impacts to traffic flow are likely along the roadways with existing or projected heavy traffic. For the East 29th Street alternative, impacts to Tribal police emergency response time may also occur since the police station is located on East 29th Street. Should the project proceed, recommendations would need to be developed to minimize construction impacts.

Other environmental issues, such as air quality, energy, hazardous materials, public services, and earth resources are not anticipated to present any fatal flaws.

3.5 Traffic Impacts

Please see the discussion under Study Constraints for the level of traffic analyses used in this study and anticipated by future analyses.

3.5.1 Common Segment A: Puyallup Avenue to Portland Avenue to East 25th/Bay Streets

The elimination of the two way left turn lane in Puyallup Avenue will likely necessitate additional signalized crossings between East 'G' Street and Portland Avenue and 'U'-Turn allowances. The existing flashing light at East 'L' Street and Puyallup Avenue should be evaluated for upgrade to full signalization. With raised curb trackway in Puyallup Avenue, McKinley Avenue through East 'N' Street and all properties between will be right turn only, unless signals are added at designated intersections. The need for additional phasing at the Portland Avenue signal is to be determined in a later phase of analysis. The city has stated the preference to maintain 12' lanes in Portland Avenue. This need, coupled with high traffic volumes in Portland Avenue, could result in the need for additional right of way along Portland Avenue to accommodate traffic volumes at target levels of service.

No impacts to on-street parking are anticipated.

Existing and forecast volumes at the Portland/Puyallup intersection, as generated by the City of Tacoma, are presented in Appendix 4.

- Pedestrian Impacts

Existing sidewalks would not be impacted with this segment. Pedestrian crossings of Puyallup Avenue will need to be addressed. Current marked and signalized pedestrian crossings are at East 'G' Street and at Portland Avenue. The existing flashing light at East 'L' Street and Puyallup Avenue should be evaluated for upgrade to include pedestrian crossing signalization.

- Bus Transit Impacts

Impacts are likely to Pierce Transit's bus turning movements into the Tacoma Dome Garage due to trackway location and possible signal phase changes at the East 'G' Street and Puyallup Avenue intersection. Transit impacts are seen to be most significant during construction in East 'G' Street.

3.5.2 Segment B: East 28th Street

An additional phase at the existing Portland Avenue / East 28th Street intersection will likely be required to allow train movement onto East 28th to/from Portland Avenue. An additional phase at the existing Portland Avenue / East 27th Street intersection will be required to allow the train to clear separate from traffic turning across the tracks. Rechannalization, potentially through additional bays under I-5 will likely be required to maintain 12 foot travel lanes in the current and proposed configurations on Portland Avenue. No additional signals are envisioned to be required on Portland Avenue, since the train will move with traffic. At the East 'R' Street crossing, the train can likely move through the intersection with through traffic.

No impacts to on-street parking are anticipated.

- **Pedestrian Impacts**

Existing sidewalks are not anticipated to be significantly impacted with this segment.

- **Bus Transit impacts**

Impacts to bus transit are seen to be minimal with this segment.

3.5.3 Segment C: East 29th Street

Signal phase changes at East 27th/Portland Avenue intersection and rechannelization on Portland Avenue would be required as described for the East 28th Street segment.

Active signalization, perhaps a train-only signal, will likely be required at the Portland Avenue / East 29th Street intersection to allow train movement across opposing traffic.

No additional signals are envisioned to be required on Portland Avenue, except at East 29th Street, since the train will move with traffic. The train will run with traffic in East 29th Street.

Moderate impacts to on-street parking on East 29th Street are anticipated, depending on forecasted traffic volumes and lane configurations.

- **Pedestrian Impacts**

Existing sidewalks are not anticipated to be significantly impacted with this segment.

- **Bus Transit impacts**

Impacts to bus transit are seen to be minimal with this segment.

3.5.4 Segment D: East 32nd Street

Signal phase changes at East 27th/Portland Avenue intersection and rechannelization on Portland Avenue would be required as described for the East 28th Street segment.

Active signalization, perhaps a train-only signal, will likely be required at both the Portland Avenue / East 32nd Street and East 32nd Street/Casino access drive intersections to allow train movement across opposing traffic. No additional signals are envisioned to be required on Portland Avenue, since the train will move with traffic, unless a pedestrian signal is required at a station near East 32nd Street. The train will run with traffic in East 32nd Street. At the writing of this study, the Tribe's planned channelization of East 32nd Street is as yet undetermined.

Moderate impacts to on-street parking on East 32nd Street are anticipated, depending on forecasted traffic volumes and lane configurations.

- **Pedestrian Impacts**

Existing sidewalks are not anticipated to be significantly impacted with this segment.

- **Bus Transit impacts**

Impacts to bus transit are seen to be minimal with this segment.

3.5.5 Segment E: Bay Street

An active signal at the Portland Avenue / Bay Street turn will be required. To minimize impacts to Portland Avenue traffic, this signal is envisioned to be a train-only signal, stopping all northbound traffic until the train has adequately cleared the intersection.

Southbound traffic could likely be unimpeded by train movement. At the merge area of

northbound (westbound) SR 167 traffic to Bay Street, passive signing could be provided to require vehicular traffic to yield to train movement. The signal proposed as part of the Casino project at East 27th and Bay Streets could be used, with likely no re-phasing, to allow train movement through the intersection, with traffic. The signal proposed as part of the Casino project at East 28th and realigned East 'R' Streets would be used, likely with re-phasing, to allow train movement through the intersection as it transitions from double track to single track, and from street right of way to Puyallup Tribe property.

No impacts to on-street parking are anticipated.

- **Pedestrian Impacts**

Existing sidewalks are not anticipated to be significantly impacted with this segment. Bay Street has 30 feet clear through the new box culvert structure under the Sounder tracks. Assuming 28 feet width is required for the dynamic envelope of a double track in-street running configuration, two feet total for pedestrian access remains, which is not seen to be acceptable. There is currently no pedestrian access allowed in this tunnel and, unless structural modifications can be made, pedestrians should continue to be prohibited from walking through this structure, and signage should be provided to route them to Portland Avenue (approximately one block away). Any new signals should include pedestrian signal heads as well.

- **Bus Transit Impacts**

Impacts to bus transit are seen to be relatively minor and primarily to northbound movement on Portland Avenue, when these lanes are held to allow train movement to/from Bay Street. The frequency and duration of this hold will be dependent on headway and operational meet points.

3.5.6 Segment F: Casino

Active signalization, perhaps a train-only signal, will likely be required at the Casino drive intersection to allow train movement across opposing traffic.

- **Pedestrian Impacts**

Existing sidewalks are not anticipated to be significantly impacted with this segment.

- **Bus Transit impacts**

Impacts to bus transit are seen to be minimal with this segment.

3.6 Future Expansion

This section looks at the degree to which the alternatives aid or fit with planned or possible future expansion of the system. (Alternatives are compared in this section rather than segments because future expansion relates to whole alternatives.)

Note: Sound Transit has begun a Phase 2 planning process designed to look at future expansion of the regional transit system. Phase 2 would require a public vote to provide funding. The Board has directed staff to proceed with the planning, environmental and community involvement work necessary to support the Board's ability to:

- Update the Long-Range Vision and the environmental analysis upon which it is based, and

- Develop a set of Phase 2 investments to enhance and expand the High Capacity Transit system being implemented as part of Sound Move.

Staff has initiated a planning process that would enable the Board to adopt a Phase 2 Plan by spring 2005. As of this writing, a consultant has been hired and work is beginning. The Board has not identified a date for when it intends to take a Phase 2 Plan to the citizens for a public vote.

3.6.1 Comparison of Alternatives

All the alternatives begin with Common Segment A on Puyallup Avenue. This segment is assumed to be built to the Central Link (Seattle Line) standards. The Sound Move Long Range Plan identifies State Route 99 as the light rail route connecting Seattle and Tacoma. Puyallup Avenue is Route 99. Therefore, constructing along Puyallup Ave. would facilitate the future planned expansion of the Link light rail system to cities north of Tacoma.

All the alternatives terminate in the vicinity of River Road. All of them could potentially be expanded along River Road in the direction of the City of Puyallup. Downtown Puyallup is approximately 7 miles from the Casino. Most of the area between the Casino and the City of Puyallup is outside the Urban Growth Area and so is rural land that is planned to remain rural. Therefore, there would likely be no stations until the line reached the City of Puyallup.

- East 28th Street

Future expansion would be as described above.

- East 29th Street

Future expansion would be as described above.

- East 32nd Street

In addition to expansion to the Central Link (Seattle) Line and to Puyallup, this alternative reaches the farthest south in the City of Tacoma and could potentially be expanded further south on Portland Avenue. However, this area is currently and in the future planned for relatively low-density development. Therefore, such expansion is less likely.

- Bay Street

Future expansion would be as described above.

3.7 Land Use and Economic Development

This section examines generalized impacts of the alternatives on land use and economic development. Areas discussed include economic development activity, business access impacts, and private property acquisition needs. The Traffic Impacts section explains impacts to property access. These impacts can affect business activity. The Route Alternatives Chapter describes the Right of Way Requirements for each alternative. This section mentions acquisition needed from private property owners. (Alternatives are compared in this section rather than segments because land use and economic development occurs as it relates to an alternative as a whole.)

3.7.1 Comparison of Alternatives

All alternatives would promote additional economic activity in the areas served by the light rail. Because the Casino has deferred the construction of a hotel, connections to the downtown hotels and La Quinta Inn (not served with the Bay Street alternative) are promising. In addition, the connection between the Convention Center (now under construction) and the Casino would be attractive. Casino visitors could easily visit the Dome District and downtown Tacoma without having to park in those areas.

- **East 28th Street**

This alternative could promote additional economic activity in the vicinity of the East 27th Street station. However, this area is currently zoned and functions as an industrial area. Generally industrial areas are not as affected by transit as commercial or high-density residential areas would be. Property access impacts would occur on Puyallup Avenue due to the removal of the two-way left turn lane. The tracks on East 28th Street are assumed to be located on Tribe property. This may affect future development potential of this property. Property acquisition may be required on Portland Avenue between Puyallup Avenue and I-5 to widen the roadway. However, it appears that this can be accommodated within the yards or parking areas with no impacts to structures. Therefore, land use impacts would be minimized.

- **East 29th Street**

As with the East 28th Street alternative, this alternative could promote additional economic activity in the vicinity of the East 27th Station. Property access impacts would occur on Puyallup Avenue due to the removal of the two-way left turn lane. The single-track portion on East 29th Street would be in a median in the center of the street. Along this block, mid-block left turns would be prohibited. Property acquisition would be required on Portland Avenue to widen the roadway. However, it appears that this can be accommodated within the yards or parking areas with no impacts to structures. Therefore, land use impacts would be minimized.

- **East 32nd Street**

As with the East 28th Street alternative, this alternative could promote additional economic activity in the vicinity of the East 27th Station. This alternative would have an additional station on Portland Avenue at East 32nd Street and so would promote additional economic activity in the Lower Portland Avenue Business District. Property access impacts would occur on Puyallup Avenue due to the removal of the two-way left turn lane. The single-track portion in the median on East 32nd Street would limit left turns between Portland and the Casino facility. As with the other alternatives above, property acquisition would be required on Portland Avenue between Puyallup Avenue and I-5. Property acquisition would also likely be required to accommodate the curve from Portland to East 32nd Street. This acquisition also appears that it could be accommodated in a parking area with no impact to structures.

- **Bay Street**

This alternative would not have stations between Tacoma Dome Station and the Casino. Therefore, it would have less economic benefit than the above alternatives. Property access impacts would occur on Puyallup Avenue due to the removal of the

two-way left turn lane. This alternative would have no private property acquisition impacts.

3.8 Utilities

For all segments, only information on wet utilities was obtained. Requests to the city were made for information on other city-owned and private utilities, but none was received.

3.8.1 Common Segment A: Puyallup Avenue to Portland Avenue to East 25th/Bay Streets

A 66" sanitary sewer, a 12" storm sewer, and a 6" cast iron water line are in the Puyallup Avenue right of way. No city-owned wet utilities are shown to be in the raised fill intersection in Puyallup Avenue, and in Portland Avenue to East 25th Street. Utility impacts in East 'G' Street and Puyallup Avenue are anticipated to be greater than other rights of way in the streetcar alternatives due to Seattle Light Rail vehicle design requirements.

3.8.2 Segment B: East 28th Street

In Portland Avenue, from East 25th Street to East 28th Street, existing wet utilities include an 8-inch ductile iron WSDOT storm drain, a 36 inch to 42 inch WSDOT storm drain, a 42 inch to 48 inch steel water line, and an 8 inch cast iron water line.

In East 28th Street, existing wet utilities include a 12-inch WSDOT storm sewer, and a 6 inch cast iron water line.

A 60" sanitary sewer and 72" storm sewer pass under East 29th Street at Lister Gulch (East 'T' Street), collinear with the gulch, and continue north under the SR167 and I-5 structures.

3.8.3 Segment C: East 29th Street

In Portland Avenue, from East 25th Street to East 29th Street, existing wet utilities include an 8-inch ductile iron WSDOT storm drain, a 36 inch to 42 inch WSDOT storm drain, a 42 inch to 48 inch steel water line, and an 8 inch cast iron water line.

In East 29th Street, existing wet utilities include a 30-inch storm sewer, a 6-inch sanitary sewer, and a 12 inch cast iron water line.

A 60" sanitary sewer and 72" storm sewer pass under East 29th Street at Lister Gulch (East 'T' Street), collinear with the gulch, and continue north under the SR167 and I-5 structures.

3.8.4 Segment D: East 32nd Street

In Portland Avenue, from East 25th Street to East 29th Street, existing wet utilities include an 8-inch ductile iron WSDOT storm drain, a 36 inch to 42 inch WSDOT storm drain, a 42 inch to 48 inch steel water line, and an 8 inch cast iron water line. South of East 29th Street, existing wet utilities in Portland Avenue include a 12-inch storm sewer and an 8-inch cast iron water line. In East 32nd Street, there is a 15-inch storm sewer and a 6 inch cast iron water line.

3.8.5 Segment E: Bay Street

A 12" sanitary sewer, a 54" storm sewer, a 36" to 42" WSDOT storm sewer, and a 12" cast iron water line are in the Bay Street right of way. A 60" sanitary sewer and 72" storm sewer pass under East 29th Street at Lister Gulch (East 'T' Street), collinear with the gulch, and continue north under the SR167 and I-5 structures.

3.8.6 Segment F: Casino

A 60" sanitary sewer and 72" storm sewer pass under East 29th Street at Lister Gulch (East 'T' Street), collinear with the gulch, and continue north under the SR176 and I-5 structures. Existing or planned utilities on the Casino site will need to be coordinated or mitigated to accommodate the track on the Casino property.

3.9 Constructibility

3.9.1 Common Segment A: Puyallup Avenue to Portland Avenue to East 25th/Bay Streets

This segment is all at-grade, with a majority in rights of way that will likely allow construction activities to proceed with little to no traffic impacts. Acquisition of additional rights of way along Portland Avenue are seen to be needed prior to construction start up to minimize traffic impacts. Utility impacts are seen to be light, even with the Seattle LRV standards adhered to from East 25th Street to Portland Avenue. No new or modifications to existing structures are anticipated. This segment has no stations identified.

3.9.2 Segment B: East 28th Street

Modifications to the existing I-5 structure at Portland Avenue may be required to accommodate the required travel lanes with the addition of the raised curb single track.

It may be prudent to combine construction of the streetcar alignment with proposed street and signal improvements to minimize overall duration of traffic impacts as well as to efficiently combine construction activities.

3.9.3 Segment C: East 29th Street

Issues are as described under East 28th Street.

3.9.4 Segment D: East 32nd Street

Issues are as described under East 28th Street.

3.9.5 Segment E: Bay Street

Modifications to existing structures may be required to accommodate the required width for double track, in-street running, and planned traffic lanes. These include the Bay Street undercrossing of the Sounder/Tacoma Rail tracks, and the Bay Street undercrossing of I-5. Modifications to the existing WSDOT I-5 undercrossing slope retention and sidewalk may be needed to achieve 3 lanes.

Double track in-street construction in Bay Street will likely impact traffic, and may require a construction detour.

It may be prudent to combine construction of the streetcar alignment with proposed street and signal improvements to minimize overall duration of traffic impacts as well as to efficiently combine construction activities.

It must be noted that at the writing of this study, this section of Sounder track structure was discovered to have recently experienced differential settlement in the box culvert area. It is as yet unknown what, if any, mitigation will be undertaken to address this discovery. Should this alignment alternative be selected, it may be prudent to explore widening of the box culvert should mitigation include structural modifications that would facilitate widening.

3.9.6 Segment F: Casino

It may be prudent to combine construction of the streetcar alignment with proposed street, signal, and Casino site improvements to minimize overall duration of traffic impacts as well as to efficiently combine construction activities.

3.10 Other Agency Coordination

Based on the experience of the Tacoma Link and Central Link projects, coordination with other agencies can be particularly time-consuming. It is expected that the airspace agreement with WSDOT, necessary for all alternatives, may be on the critical path.

3.10.1 Common Segment A: Puyallup Avenue to Portland Avenue to East 25th/Bay Streets

Coordination with other utility providers, including Tacoma Power, Puget Sound Energy, and private telecom providers will be needed.

3.10.2 Segment B: East 28th Street

Extensive coordination with WSDOT will be required for intersections, signals, and roadways leading to and in the WSDOT limited access area. A WSDOT airspace agreement will be required to pass under I-5. Coordination with other utility providers, including Tacoma Power, Puget Sound Energy, and private telecom providers will be needed.

3.10.3 Segment C: East 29th Street

Issues are as described under East 28th Street segment.

3.10.4 Segment D: East 32nd Street

Issues are as described under East 28th Street segment.

3.10.5 Segment E: Bay Street

This alternative will likely require more extensive coordination with WSDOT than other segment alternatives due to potential WSDOT right of way use as the alignment transitions from Bay Street onto Puyallup Tribe property. All alternatives crossing the I-5 alignment will require coordination for intersections, signals, and roadways leading to and in the WSDOT limited access area. A WSDOT airspace agreement will be required to pass under I-5. Coordination with other utility providers, including Tacoma Power, Puget Sound Energy, and private telecom providers will be needed.

3.10.6 Segment F: Casino

This alternative will likely require the least coordination with outside agencies as the entire segment is on Puyallup Tribe property.

3.11 Systems needs

This section identifies and reviews the various systems elements including track and signal needs, traction power, and communications.

3.11.1 Track and Signal Needs

- Common Segment A: Puyallup Avenue to Portland Avenue to East 25th/Bay Streets

From the existing track alignment west of East 'G' Street, new single track would turn north on East 'G' Street for one block, running in the center of the street and turn east at the existing signalized intersection to run in the center of Puyallup Avenue with raised curb dedicated double track. The transition back to single track would take place within the existing triangular area formed at the roadway 'Y' as Puyallup Avenue approaches Portland Avenue. Single track would turn south onto Portland Avenue as flush track through the existing signalized raised fill intersection.

There are existing traffic signals at 'G' Street and 25th Street; 'L' Street and Puyallup Avenue (flasher); and Puyallup Avenue and Portland Avenue.

At limited signals, Train to Wayside Communications (TWC) loops will be installed to call for signal priority. A streetcar driver will make a request as the LRV leaves a passenger station. This initial request will request all signals to the next station stop. As the LRV approaches a signaled intersection the signals will change as the LRV approaches. If an LRV is delayed, a new priority request can be made at an intermediate loop for priority status of the remaining signals before the next passenger station. The signal calls will be via a control button on the LRV console, the same as is presently accomplished by the existing Tacoma Link LRV's. The TWC loops will be interfaced to the traffic signals to begin timing cycles. Should it be determined that signal priority is not desired, the TWC loops could be installed for future use as needed.

- Segment B: East 28th Street

This segment continues from Segment A with raised curb single track in the center of Portland Avenue from East 25th Street to East 28th Street, where it turns at East 28th Street as flush in-street track with the existing signal, and transitions to double track in Puyallup Tribe property south and adjacent to East 28th Street. The approximately 650 feet of double track transitions back to single track just west of the proposed realigned and signalized intersection at East 'R' Street, moving adjacent to and with the eastbound traffic lane through the intersection. The single track would then run in Puyallup Tribe property, following the WSDOT limited access boundary to a terminal station either near Lister Gulch at East 'T' and East 29th Streets, or continue on with Segment F.

In addition to the signals discussed above, there are existing traffic signals at Portland Avenue and East 26th Street, and at Portland Avenue and the I-5 frontage road (East 27th Street) just north of I-5.

TWC loops will be installed to call for signal priority as described above.

Segment C: East 29th Street

This segment continues with raised curb single track in the center of Portland Avenue from East 25th Street to East 29th Street, where it turns at East 29th Street as flush in-street with the existing signal, and transitions to double track in-street in East 29th Street. The approximately 1,250 feet of double track transitions back to single track to a terminal station just west of Lister Gulch at East 'T' and East 29th Streets, or continues on with a partial loop to a terminal station at or near the front door of the Casino.

There are existing traffic signals at Portland Avenue and East 26th Street; Portland Avenue and the I-5 frontage road (East 27th Street) just north of I-5 and Portland Avenue and East 28th Street.

TWC loops will be installed to call for signal priority as described above.

Segment D: East 32nd Street

This segment continues with raised curb single track in the center of Portland Avenue from East 25th Street to East 29th Street where it transitions to either double track shared corridor or dedicated raised curb, adjacent to and on either side of the existing median. It continues up the hill to East 32nd Street, where it turns as flush in-street with a new signal, and transitions to single track raised curb in the center of East 32nd Street. The approximately 1,140 feet of single track raised curb track continues to just east of the proposed bridge at East 'T' Street, then turns north with an active signal alongside the Casino access drive serving East 32nd Street. The single track would then run in Puyallup Tribe property, to a terminal station at the Casino parking garage.

There are existing traffic signals at Portland Avenue and East 26th Street; Portland Avenue and the I-5 frontage road (East 27th Street) just north of I-5; Portland Avenue and East 28th Street; and Portland Avenue and East 30th Street (pedestrian only). There will be new traffic signals at Portland Avenue and East 32nd Street, and at East 32nd Street and the Casino access drive.

TWC loops will be installed to call for signal priority as described above.

Segment E: Bay Street

This segment continues from the single track in Portland Avenue, and with an anticipated train-only signal, crosses Portland Avenue at Bay Street flush with pavement, and in Bay Street, transitions to shared corridor double track, flush with pavement. The double track continues along the roadway, running with traffic, passing under the Sounder/Tacoma Rail track box culvert, under I-5, through the realigned and signalized intersection at East 'R' and East 28th Streets transitioning to single track through this intersection, and onto Puyallup Tribe property. The single track would then run in Puyallup Tribe property, following the WSDOT limited access boundary to a terminal station either near Lister Gulch at East 'T' and East 29th Streets, or continue on with a partial loop to a terminal station at or near the front door of the Casino.

In addition to the signals discussed above, there are considered to be existing traffic signals at two intersections as East 'R' Street approaches East 28th Street.

TWC loops will be installed to call for signal priority as described above.

- **Segment F: Casino**

This is a single track segment and is not planned to have any signals.

- **General**

At all points where tracks transition from single to double track, or from double track to single track switch protection will be necessary. It is mandatory to protect single track segments to assure that LRV's cannot operate in opposed directions within those segments.

3.11.2 Traction Power

- **Traction Power Substation (TPSS)**

It is recommended that one TPSS be added in Tribal property along East 28th Street to service the extension. The siting of the TPSS will move east or west depending upon which of the extension alignments is selected. The TPSS will be a single-ended unit with a one megawatt transformer-rectifier unit. A new Tacoma Power service will be required.

The existing Tacoma Link TPSS at East 25th Street near the I-705 overpass consists of two 750 megawatt transformer-rectifier units. If one transformer-rectifier unit fails the other unit can power the existing system with 3 LRV's in operation. With the addition of one or two cars for the extension, one existing transformer-rectifier unit may not support the load, particularly if an LRV is accelerating at the casino end of the line. Additionally, a fire in the existing TPSS may render the entire TPSS out of service, and a one megawatt TPSS on East 28th Street will be able to move LRV's in the downtown area of Tacoma, although at a reduced level of operation.

During final design it is recommended that a traction power load flow simulation study be performed to determine level of service allowable during power outage conditions.

- **OCS**

A fixed tension, simple catenary system is recommended for the extension. A section break is recommended at the beginning of the extension to be able to electrically isolate the existing Tacoma Link system from the extension. The section break, with bridging normally open disconnect switches, would be located along 'G' Street between East 25th Street and Puyallup Avenue.

Round tapered tubular poles are recommended along the route. In double track segments the poles would be located between tracks. In some situations it may be possible to utilize eye bolts, attached to building structures, to support the catenary in place of tubular poles.

3.11.3 Communications

The existing Tacoma Link passenger stations do not have communications facilities. There is a communications link between the TPSS and the Operations and Maintenance Facility(OMF) in the form of a 25-pair cable to monitor the status of the TPSS.

For the extension it is recommended that the new TPSS also be monitored from the OMF. Additionally, since the Tacoma Link system is expanding with the addition of one, two, or three passenger stations, a Public Address system and a passenger assistance telephone system should be considered. This would necessitate retrofitting the five existing Tacoma Link passenger stations.

At this time a Supervisory Control and Data Acquisition (SCADA) system is not recommended.

3.11.4 Passenger Stations

The existing Tacoma Link passenger stations have been provided with a power service connection with Tacoma Power, a power distribution center with distribution panels, lighting, and special art lighting services. The extension stations should contain the same amenities. As discussed under Communications above, a public address system and a passenger assistance telephone system should be considered.

3.12 Cost Estimate

The capital cost estimates presented here are order of magnitude cost estimates for the purpose of comparing among the Tacoma Extension alternatives. Capital cost estimates are intended to provide a consistent basis for cost comparisons among light rail transit routes. Given the very limited engineering performed for the study, these costs have comparative value only. Estimates developed under this methodology do not contain sufficient accuracy to support the development of project budgets. No schedule has been developed. The project schedule will impact costs, both due to inflation and other schedule demands. If the project proceeds, once sufficient engineering is complete, a project budget would be developed that would reflect Year of Expenditure costs.

Costs presented here are in 2004 dollars.

Costs represented here include construction, vehicles, design, construction management, right of way acquisition, administrative costs, and third party agreements (such as utilities). Excluded from the estimates are improvements outside those described in the study (e.g. betterments, such as urban design amenities along the streets traversed by the routes).

Table 2: Feasibility Level Capital Cost Estimates

| Alternative | Cost in Millions (2004\$) |
|------------------------------|----------------------------------|
| East 28 th Street | \$45 – 50 |
| East 29 th Street | \$45 – 50 |
| East 32 nd Street | \$50 – 55 |
| Bay Street | \$40 – 50 |

The range presented above represents uncertainty and the difference between the alternatives with and without Segment F, the Casino Segment. The Bay Street alternative has a wider cost range than the other alternatives (\$10 million) because if

Segment F is not included, it will be possible to serve it with just one new light rail vehicle (assuming 20 minute headways). If Bay Street were built to include Segment F, it would require two new vehicles for 20 minute headways and would be more costly. The other alternatives all require two vehicles.

Operating costs were not estimated for this study. They would need to be included in a future study. A fare structure was also not determined for this study.

4. Evaluation Matrix

In the following evaluation matrix, the segments were combined into alternatives. Summary information is presented comparing the alternatives.

Table 3: Tacoma Link Extension Evaluation Matrix

| MEASURES | ALTERNATIVE | | | |
|-------------------------------------|---|--|--|---|
| | 1. E. 28th Street | 2. E. 29th Street | 3. E. 32nd Street | 4. Bay Street |
| Route Length | Including optional Casino Segment F | 1.5 miles | 1.7 miles (F not applicable) | 1.4 miles |
| | Excluding optional Casino Segment F | 1.3 miles | 1.7 miles (F not applicable) | 1.2 miles |
| Casino Station Distance from Casino | Including optional Casino Segment F | at front entrance | 150 feet or less (F not applicable) | at front entrance |
| | Excluding optional Casino Segment F | 400 feet | 150 feet or less (F not applicable) | 400 feet |
| Markets Served | Serves downtown Tacoma, Dome District, La Quinta (optional), Casino | Same as E 28th | Serves downtown Tacoma, Dome District, La Quinta (optional), East Side neighborhood (optional), Casino | Serves downtown Tacoma, Dome district, Casino |
| Operational Analysis/Service Level | Travel Time Tacoma Dome Station to Casino | 8-9 minutes | 9-10 minutes | 6-7 minutes |
| | Headway/ frequency | 20 minutes | 20 minutes | 20 minutes |
| Environmental Structure Impacts | Schedule Reliability | degree of signal priority will affect reliability. | degree of signal priority will affect reliability. | degree of signal priority will affect reliability |
| | Fatal flaws? | no | no | no |
| Traffic impact analysis | Intersections | Moderate impact. | Moderate impact. | Moderate impact. |
| | Travel Lanes | Minimal impact | Minimal impact | Minimal impact |
| Structure Impacts | On-street parking | No Impact | Moderate Impact. | No Impact. |
| | Truck Delivery impact | Slight comparative impact on Puyallup | Same as E 28th | Same as E 28th |
| Operational Structure Impacts | Modifications to I-5 overcrossing configuration | Same as E 28th | Same as E 28th | Does not require modifications to Tacoma Rail overcrossing of Bay St. |
| | Intersections | Moderate impact. | Moderate impact. | Moderate impact. |

Tacoma Link Extension Evaluation Matrix

| | | ALTERNATIVE | | | |
|---|--|--|--|---|---|
| MEASURES | | 1. E. 28th Street | 2. E. 29th Street | 3. E. 32nd Street | 4. Bay Street |
| Transit Impacts | Bus Transit Impacts | Minimal impacts to Tacoma Dome Station bus turning movements | Same as E 28th | Same as E 28th | Same as E 28th |
| | Ease of Transfer and Connectivity to Transit | Transfers at Tacoma Dome and E 27th stations | Same as E 28th | Same as E 28th plus E 31st Station | Transfer at Tacoma Dome station only |
| Future Expansion | | Puyallup Avenue is route to north (SeaTac) in adopted Long Range Plan. Expansion to east (City of Puyallup) would be possible. | Same as E 28th | Same as E 28th | Same as E 28th |
| Land Use/ Economic Development | Economic Development | Direct connection to downtown. Additional optional E. 27th Station is located in industrial district | Same as E 28th | Direct connection to downtown. Greatest potential due to optional E. 31st Station in Portland Business district | Direct connection to downtown. Less potential than E 28th, E 29th and E 32nd due to only 2 stations |
| | Business Access impacts | Access impacts to businesses on Puyallup | Access impacts to businesses on Puyallup | Access impacts to businesses on Puyallup and Lower Portland | Access impacts to businesses on Puyallup and Bay St. |
| | Right-of-Way needs | Possibly on Portland Ave and on Tribe property | Possibly on Portland Ave | Possibly on Portland Ave and at Portland/32nd intersection | Additional rights of way in the I-5 / SR167 WSDOT limited access area and in Tribe property |
| Utilities | | Moderate impacts in E. 'G' Street and Puyallup Avenue | Same as E 28th | Same as E 28th | Same as E 28th |
| Constructability, including risk | | Minimal comparative risk. | Minimal comparative risk. | Minimal comparative risk. | Minimal comparative risk. |
| Project Schedule Impacts | Impacts to Schedule Due to Coordination | WSDOT Airspace lease required. | WSDOT Airspace lease required. | WSDOT Airspace lease required. | WSDOT Airspace lease required. Extensive coordination with WSDOT, Tribe and City required due to planned improvements to Bay St. requiring possible redesign. |
| Costs | Capital Costs | \$45 – 50 million | \$45 – 50 million | \$50 – 55 million | \$40 – 50 million |
| | Operating Costs | Future study | Future study | future study | future study |



5. Conclusions

The four alternatives are all feasible. They all have challenges associated with design and coordinating with other agencies. The merits of the four alternatives are discussed below.

5.1 Relative Merits of the Alternatives

- All the alternatives provide a direct connection to downtown Tacoma with travel times from the Tacoma Dome Station to the Casino from 6 to 10 minutes.
- The two major route differences are how they get under I-5, either via Portland Avenue or via Bay Street. This is a heavily trafficked area due to the Port of Tacoma truck traffic and the expanded casino. A more detailed traffic study would need to be done to compare traffic impacts of the alternatives, both during construction and operation.
- The alternatives using the Portland Avenue route under I-5 would require modification to the undercrossing configuration (using an additional bay for vehicular traffic). They would also require widening of the roadway between Puyallup Avenue and I-5. This necessitates purchase of private property.
- The Bay Street alternative would not require modification to I-5 structures but would require an analysis of traffic in the area of the on and off-ramps planned to be improved to handle the Casino traffic. This analysis would need to be coordinated with the Tribe, Washington State Department of Transportation, and the City of Tacoma.
- All the alternatives would require close coordination with the City of Tacoma, Puyallup Tribe, and WSDOT. All would require at a minimum an airspace lease for the undercrossing of I-5. The East 28th Street and Bay Street alternatives would require use of WSDOT right-of-way.
- Adding Segment F to the East 28th, East 29th, and Bay Street alternatives brings the Casino station significantly closer to the Casino entrance and meets the Tribe's design criteria of no more than a 150-foot walk. Segment F adds 850' of trackway.
- The optional stations serve the La Quinta Inn area (East 27th Station) and Lower Portland Avenue Business District (East 31st Station).
- The cost of all the alternatives are similar and range from \$40 to \$55 million (at the level of analysis performed for this study) with Bay Street being the least cost and East 32nd Street being the highest cost. Adding Segment F brings the cost estimates for the other alternatives closer to East 32nd Street.

5.2 Next Steps

Potential next steps include:

- Provide this report to the Sound Transit Board of Directors, the Puyallup Tribe, and other partners and stakeholders, such as the City of Tacoma and Pierce County.
- Gauge support for extending Link to the Casino complex.

Tacoma Extension Feasibility Study

- Evaluate possible funding sources for further study and potential future construction.

Future studies should cover the following:

- Impacts on traffic and structures on Portland Avenue and on Bay Street
- Operating costs and appropriate headways
- Ridership and potential fares
- Impacts to utilities
- Project schedule for construction

These future studies would be conducted as part of conceptual engineering. Environmental review would then follow, addressing an appropriate range of alternatives.

Appendix 1

Skoda Vehicle Design Criteria





ST LINK SYSTEMS PROJECT TEAM

ST Link Tacoma Line

*Systems Engineering
Preliminary Engineering Design Report*

(Excerpt)

Document Number: LTK.ST.0599.002

June 11, 1999

3.4 WAYSIDE INTERFACE

| | |
|------------------------------|----------------------|
| Track gauge | 56-1/2 in. (1435 mm) |
| Rail | Ri 59N |
| Special work | AAR 115 RE |
| Minimum horizontal curve | 82 ft. (25 m) |
| Minimum vertical curve crest | 820 ft. (250 m) |
| Maximum vertical curve sag | 1150 ft. (350 m) |
| Maximum gradient | 7% |
| Platform height | 9.5 in. (241 mm) |

3.5 PERFORMANCE CRITERIA

| | |
|--------------------------------|---|
| Operating voltage | 525 – 925 Vdc |
| Acceleration rate (nominal) | 3.0 mphps (1.34 m/s ²) |
| Deceleration rate (average) | 3.0 mphps (1.34 m/s ²) |
| Emergency brake rate (average) | 5.0 mphps (2.24 m/s ²) |
| Maximum speed (minimum) | 30 mph (48 kph) |
| Wayside noise | 65 dBA – stationary 75 dBA – operating |
| Electromagnetic emissions | TBD |

3.6 GEOMETRIC CRITERIA

| | |
|----------------------------|-----------------------------------|
| Vehicle length | 66 ft (20.13 m) |
| Vehicle width | 8.0 ft (2.46 m) |
| Floor height above TOR | 14 in. (350 mm) |
| Height | 12 ft (3.7 m) |
| Pantograph operating range | |
| With platform | 15 ft to 23 ft (4.57 m to 7.0 m) |
| Without platform | 13 ft to 20.5 ft (4.0 m to 6.3 m) |

3.7 VEHICLE CRITICAL REQUIREMENTS

The following are critical basic requirements for the Tacoma car:

- Standard gauge
- Vertical curves -- 250 m crest, 350 m sag, minimum
- Horizontal curves – 25 m, minimum
- Pantograph operating height 15 feet to 23 feet
- Parking brake to hold on 7 % grade
- Operate on 7 % grade
- Length of 66 feet
- Anticlimber and end-structure
- Minimum buff-end strength: 1.1g (AW0)
- Minimum emergency brake rate 5.0 mphps
- Minimum top operating speed – 30 mph
- Double-ended, two-sided
- Low-floor, minimum 50 % with 2 doors per side in low section
- ADA compliant loading using 10" high platform
- Two wheelchairs and two bicycles per car
- Clearance envelope less than that of Central Line car
- Air conditioning, floor heat
- Line voltage 750 Vdc + 20 %, - 30 %
- Safety design of door control
- No motion sensing and emergency brake critical circuits
- Sanders
- Wheel spin/slide correction
- Minimum 2 independent propulsion systems
- Dynamic, friction disc and track brakes
- Resilient wheels
- Provisions for Operators radio
- Train-to-wayside communications (TWC)
- One ground brush per axle or per independent stub axle
- All documents in English: specifications, proposals, drawings and manuals



Appendix 2

Proposed traffic improvements for the Casino project



DATE: December 16, 2003

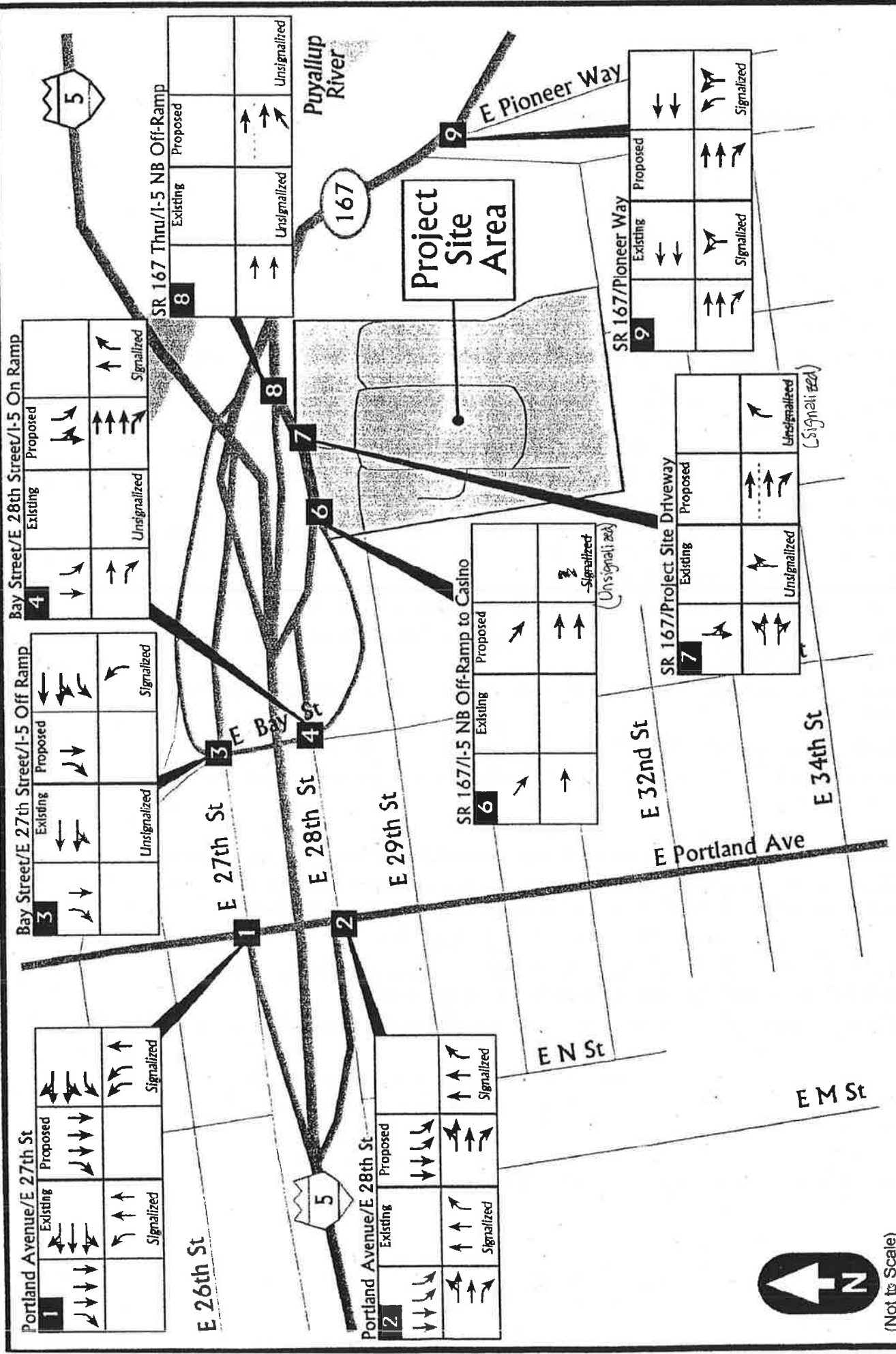
TO: WSDOT

FROM: Chris Bicket, P.E.
Transportation Engineering Northwest, LLC

RE: Cascades Casino – Preferred Scenario A-7 Improvements Summary Memo - Draft

This memorandum summarizes the roadway improvements for the Preferred Scenario A-7 of the proposed Cascades Resort & Casino in the Puyallup Tribe of Indians land in Tacoma, Washington, as sponsored by WSDOT and supported by the City of Tacoma. Existing and proposed channelization improvements are illustrated in the attached conceptual channelization graphic. The improvements would include the following:

- Portland Avenue modifications would include lane striping, overhead directional signage, signal modifications at East 27th & East 28th Sts, and extension of the northbound right turn lane at East 28th south to East 29th St.
- East 27th St would be widened from 2 to 3 lanes at its approach to Portland Ave.
- The I-5 southbound off-ramp at East 27th St/Bay St would be widened from 2 to 3 lanes at its approach with Bay St.
- The I-5 southbound on-ramp west of Portland Avenue would be reconfigured from 1 to 2 lanes.
- Bay St at its intersections with East 27th St and East 28th St would be signalized.
- Bay St between East 27th St and East 28th St would be widened from 2 to 3 lanes to accommodate 2-way traffic.
- East 28th St would include new overhead signage and would be widened from 2 to 4 lanes to accommodate 3 thru lanes and 1 right-turn only lane at its approach with Bay St.
- Bay St would be realigned from E 28th St to the Casino entrance including 2 travel lanes, with a new traffic signal at the I-5 northbound off-ramp split/Bay St intersection.
- East R St would be realigned between E 28th St and E 29th St.
- The I-5 Northbound off-ramp would be widened to accommodate 2 lanes, with a new SR167 thru lane/structure splitting off of the Bay St approach lane.
- The SR167/Project Site Driveway would be modified/restricted to right-in/right-out access only.
- East Pioneer Way/SR 167. (An existing City project would construct the northbound approach reconfiguration, while the Tribe's mitigation would be to replace the eastbound right-turn only lane).
- Traffic signal interconnection, illumination modifications/installation, storm drainage and other utilities and components associated with the above improvements.



Cascades
Casino

Conceptual Channelization

Transportation
Engineering
NorthWest, LLC



(Not to Scale)

Appendix 3

Tacoma Operations Analysis



Tacoma Operations Analysis
Table 2

Run Times

| | via Bay Street | | | via 28th Street | | | via 29th Street | | | via 32nd Street | | |
|--|----------------|--------------|-----------------------|-----------------|--------------|-----------------------|-----------------|--------------|-----------------------|-----------------|--------------|-----------------------|
| | run time | signal delay | cumulative dwell time | run time | signal delay | cumulative dwell time | run time | signal delay | cumulative dwell time | run time | signal delay | cumulative dwell time |
| op Tacoma Dome Portland/Puyallup intersection Portland/27th St intersection Portland/28th St intersection ar Portland Avenue Station ar 31st Street Station | 0 | 60 | 0 | 228 | 60 | 0 | 0 | 228 | 60 | 0 | 228 | 60 |
| | 289 | | 348 | 111 | | 479 | 92 | | 348 | 56 | | 424 |
| ar 29th & T Streets Station | 0 | 349 | 05:49.0 | 0 | 479 | 07:59.0 | 0 | 460 | 07:40.0 | 0 | 555 | 09:15.0 |
| | | | say: 6 minutes | | | say: 8 minutes | | | say: 8 minutes | | | say: 9.5 minute |

| | via Bay Street & Loop | | | via 28th Street | | | via 29th Street | | |
|--|-----------------------|--------------|-----------------------|-----------------|--------------|-----------------------|-----------------|--------------|-----------------------|
| | run time | signal delay | cumulative dwell time | run time | signal delay | cumulative dwell time | run time | signal delay | cumulative dwell time |
| op Tacoma Dome Portland/Puyallup intersection Portland/27th St intersection Portland/28th St intersection ar Portland Avenue Station | 0 | 60 | 0 | 0 | 60 | 0 | 0 | 60 | 0 |
| | 344 | | 404 | 228 | | 228 | 228 | | 228 |
| Ar Casino Loop Station | 0 | 404 | 06:44.0 | 166 | 534 | 08:54.0 | 147 | 515 | 06:35.0 |
| | | | say: 7 minutes | | | say: 9 minutes | | | say: 9 minutes |

AM PEAK

| Portland and Puyallup | | Existing | | Existing | | Existing Capacity | | Enter | | Exit | | Enter | | Exit | |
|--|-------|--------------|------|----------|------|-------------------|-------|-------|-----------|-----------|-------------------|-------|------|-----------|-----------|
| Leg/Approach | Enter | 2003 Count | Exit | Enter | Exit | Existing Capacity | Enter | Exit | V/C Ratio | V/C Ratio | Existing Capacity | Enter | Exit | V/C Ratio | V/C Ratio |
| West | 646 | 1089 | 443 | 1600 | 1600 | 3200 | 1600 | 1600 | 0.40 | 0.28 | 3200 | 1600 | 1600 | 0.40 | 0.28 |
| East | 596 | 1247 | 651 | 1000 | 1000 | 2400 | 1000 | 1400 | 0.60 | 0.47 | 2400 | 1400 | 1400 | 0.60 | 0.47 |
| North | 738 | 1922 | 1184 | 1600 | 1600 | 3200 | 1600 | 1600 | 0.46 | 0.74 | 3200 | 1600 | 1600 | 0.46 | 0.74 |
| South | 1218 | 2080 | 862 | 1600 | 1600 | 3600 | 1600 | 2000 | 0.76 | 0.43 | 3600 | 2000 | 2000 | 0.76 | 0.43 |
| Total | | 6338 | | | | | | | | | | | | | |
| Portland and Puyallup w/3 lane bridge | | | | | | | | | | | | | | | |
| Leg/Approach | Enter | 2023 Volume | Exit | Enter | Exit | Existing Capacity | Enter | Exit | V/C Ratio | V/C Ratio | Existing Capacity | Enter | Exit | V/C Ratio | V/C Ratio |
| West | 870 | 1466 | 597 | 1600 | 1600 | 3200 | 1600 | 1600 | 0.54 | 0.37 | 3200 | 1600 | 1600 | 0.54 | 0.37 |
| East | 803 | 1679 | 877 | 1000 | 1000 | 2400 | 1000 | 1400 | 0.80 | 0.63 | 2400 | 1400 | 1400 | 0.80 | 0.63 |
| North | 994 | 2588 | 1594 | 1600 | 1600 | 3200 | 1600 | 1600 | 0.62 | 1.00 | 3200 | 1600 | 1600 | 0.62 | 1.00 |
| South | 1640 | 2801 | 1161 | 1600 | 1600 | 3600 | 1600 | 2000 | 1.03 | 0.58 | 3600 | 2000 | 2000 | 1.03 | 0.58 |
| Portland and Puyallup w/ 4 lane bridge | | | | | | | | | | | | | | | |
| Leg/Approach | Enter | 2023 Volume | Exit | Enter | Exit | Lane Improvement | Enter | Exit | V/C Ratio | V/C Ratio | Lane Improvement | Enter | Exit | V/C Ratio | V/C Ratio |
| West | 870 | 1466 | 597 | 1600 | 1600 | 3200 | 1600 | 1600 | 0.54 | 0.37 | 3200 | 1600 | 1600 | 0.54 | 0.37 |
| East | 803 | 1679 | 877 | 1400 | 1400 | 2800 | 1400 | 1400 | 0.57 | 0.63 | 2800 | 1400 | 1400 | 0.57 | 0.63 |
| North | 994 | 2588 | 1594 | 1600 | 1600 | 3200 | 1600 | 1600 | 0.62 | 1.00 | 3200 | 1600 | 1600 | 0.62 | 1.00 |
| South | 1640 | 2801 | 1161 | 1600 | 1600 | 3600 | 1600 | 2000 | 1.03 | 0.58 | 3600 | 2000 | 2000 | 1.03 | 0.58 |
| Portland and Puyallup w/3 lane bridge | | | | | | | | | | | | | | | |
| Leg/Approach | Enter | *2006 Volume | Exit | Enter | Exit | Existing Capacity | Enter | Exit | V/C Ratio | V/C Ratio | Existing Capacity | Enter | Exit | V/C Ratio | V/C Ratio |
| West | 749 | 1263 | 514 | 1600 | 1600 | 3200 | 1600 | 1600 | 0.47 | 0.32 | 3200 | 1600 | 1600 | 0.47 | 0.32 |
| East | 691 | 1446 | 755 | 1000 | 1000 | 2400 | 1000 | 1400 | 0.69 | 0.54 | 2400 | 1400 | 1400 | 0.69 | 0.54 |
| North | 856 | 2229 | 1373 | 1600 | 1600 | 3200 | 1600 | 1600 | 0.53 | 0.86 | 3200 | 1600 | 1600 | 0.53 | 0.86 |
| South | 1413 | 2412 | 1000 | 1600 | 1600 | 3600 | 1600 | 2000 | 0.88 | 0.50 | 3600 | 2000 | 2000 | 0.88 | 0.50 |
| Portland and Puyallup w/ 4 lane bridge | | | | | | | | | | | | | | | |
| Leg/Approach | Enter | *2006 Volume | Exit | Enter | Exit | Lane Improvement | Enter | Exit | V/C Ratio | V/C Ratio | Lane Improvement | Enter | Exit | V/C Ratio | V/C Ratio |
| West | 749 | 1263 | 514 | 1600 | 1600 | 3200 | 1600 | 1600 | 0.47 | 0.32 | 3200 | 1600 | 1600 | 0.47 | 0.32 |
| East | 691 | 1446 | 755 | 1400 | 1400 | 2800 | 1400 | 1400 | 0.49 | 0.54 | 2800 | 1400 | 1400 | 0.49 | 0.54 |
| North | 856 | 2229 | 1373 | 1600 | 1600 | 3200 | 1600 | 1600 | 0.53 | 0.86 | 3200 | 1600 | 1600 | 0.53 | 0.86 |
| South | 1413 | 2412 | 1000 | 1600 | 1600 | 3600 | 1600 | 2000 | 0.88 | 0.50 | 3600 | 2000 | 2000 | 0.88 | 0.50 |
| *Estimated project opening | | | | | | | | | | | | | | | |
| 2% Growth for 10 years followed by 1% for 10 years | | | | | | | | | | | | | | | |