RideBRT

BUS RAPID TRANSIT TACOMA TO SPANAWAY

Alternatives Analysis Report

November 2019

Final

Prepared for:

Pierce Transit

Prepared by:

WSP

Pierce Transit Pacific Avenue/SR 7
Alternatives Analysis Report

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Acronyms and Abbreviations

ADA	Americans with Disabilities Act
ADT	Average Daily Traffic
APTA	American Public Transportation Association
AVL	Automatic Vehicle Location
BAT	Business Access and Transit
BEB	Battery Electric Bus
BRT	Bus Rapid Transit
CE	Categorical Exclusion
CNG	Compressed Natural Gas
DCE	Documented Categorical Exclusion
EA	Environmental Assessment
EIS	Environmental Impact Statement
FTA	Federal Transit Administration
GTC	Growing Transit Communities
HCT	High Capacity Transit
ICE	Intersection Control Evaluation
LCLIP	Landscape Conservation and Local Infrastructure Program
LOS	Level of Service
LID	Local Improvement District
LPA	Locally Preferred Alternative
LRT	Light Rail Transit
MPO	Metropolitan Planning Organization
MPTE	Multifamily Property Tax Exemption Program
NACTO	National Association of City Transportation Officials
NEPA	National Environmental Policy Act
OEM	Original Equipment Manufacturer
P&R	Park and Ride
PRD	Planned Residential Development
PSM	Parkland-Spanaway-Midland
PSRC	Puget Sound Regional Council
RCW	Revised Code of Washington
ROW	Right-of-Way
SEPA	State Environmental Policy Act
SFC	Strategic Freight Corridor
SLM	Shared Lane Markings
TC	Transit Center
TCC	Tacoma Community College
TDR	Transfer of Development Rights
TMP	Transportation Master Plan
TOD	Transit-Oriented Development
TSP	Transit Signal Priority

TVM	Ticket Vending Machine
TWLTL	Two-Way Left-Turn Lane
UGA	Urban Growth Area
v/c	Volume to Capacity
WSDOT	Washington State Department of Transportation
ZEB	Zero-Emission Bus

1 INTRODUCTION

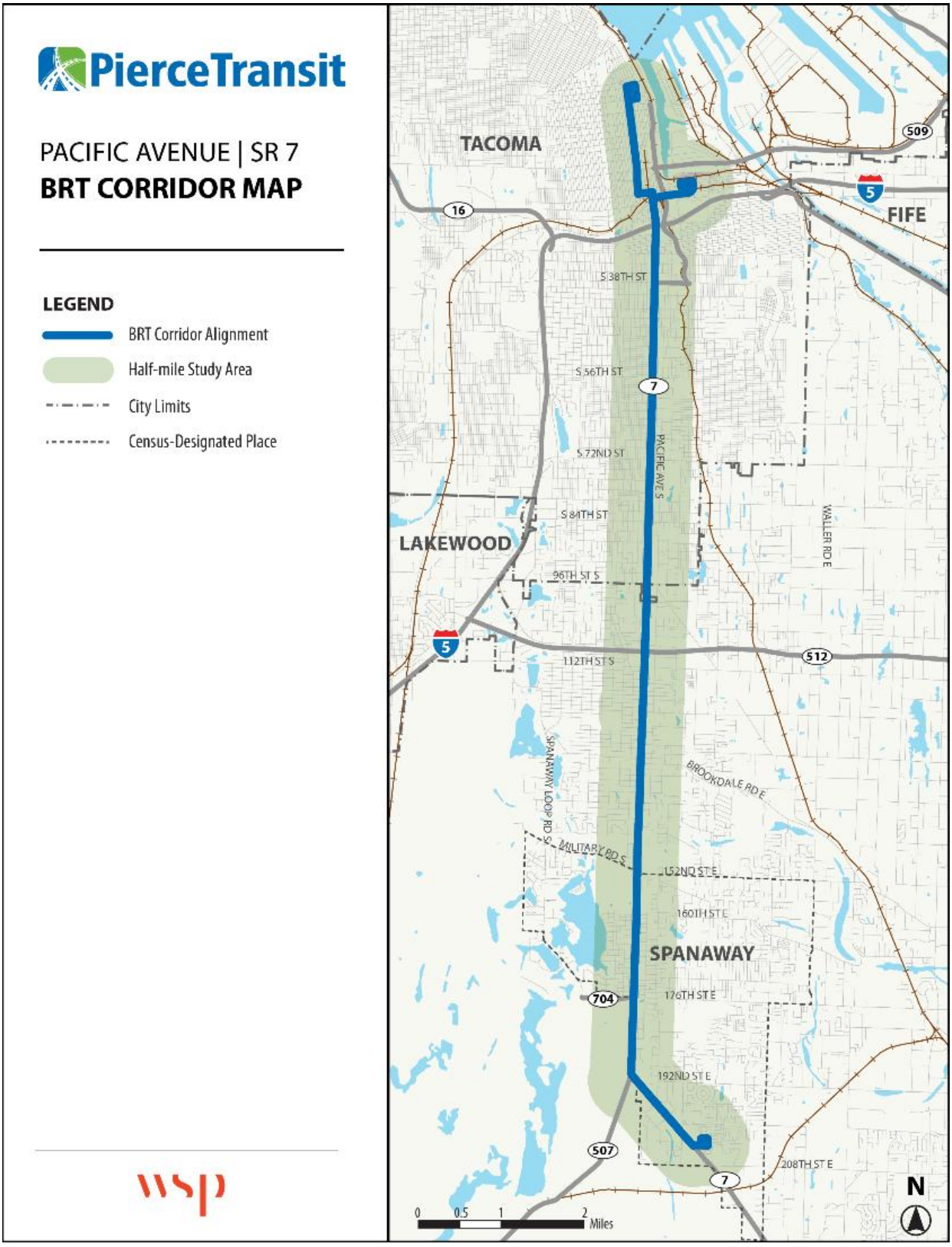
Pierce County is evaluating the feasibility of implementing high capacity transit (HCT) on the Pacific Avenue/SR 7 Corridor between downtown Tacoma and Spanaway. Pierce Transit currently serves this corridor via its Route 1 bus line, which is one of the transit system's four trunk routes and the route with the highest ridership in the County's transit system, carrying almost two million passengers annually, or 20 percent of Pierce Transit's fixed-route ridership.

Ridership along the Route 1 alignment is expected to increase between 27 percent (low estimate) and 60 percent (high estimate) by 2040, which highlights the demand for increased transit options in the corridor. Pierce Transit's Destination 2040 Long Range Plan, Sound Transit's ST3 Plan, and Puget Sound Regional Council's (PSRC) Transportation 2040 Long Range Plan all identify the Pacific Avenue/SR 7 corridor for potential HCT service.

1.1 CORRIDOR DESCRIPTION

The proposed alignment for the Pacific Avenue/SR 7 HCT is a 14.4-mile segment of Pacific Avenue S/SR 7 between the Commerce Street Transfer Center (TC) in downtown Tacoma and 204th Street E in Spanaway, entirely within Pierce County. The proposed alignment would serve the Tacoma Dome Station, which is a major transfer point for bus and rail service to locations throughout the Puget Sound area. The Study Corridor, which is the area within a half-mile of the proposed alignment, is presented on Figure 1.

Figure 1: Study Corridor and Alignment



1.2 PLANNING CONTEXT (PREVIOUS STUDIES/PLANS)

1.2.1 Puget Sound Regional Council Existing Plans and Policy

The Puget Sound Regional Council (PSRC) is a metropolitan planning organization (MPO) responsible for developing policies and coordinating decisions about regional growth, transportation and economic development planning within King, Pierce, Snohomish and Kitsap counties. A key role of the PSRC is to help communities secure federal funding for transportation. PSRC selects projects to receive more than $240 million in transportation funding each year. PSRC develops and maintains the Regional Transportation Plan, a blueprint for improving mobility, providing transportation choices, moving the region's freight, and supporting the region's economy and environment. It was last updated and adopted in May 2018.

VISION 2040

VISION 2040, adopted by PSRC in 2008, is the region's integrated, long-range vision for how and where the region should accommodate approximately 1.5 million additional people for a total population of 5 million, as well as 1.2 million new jobs for a total employment of nearly 3 million.[1] *VISION 2040*'s goals are to maintain a healthy region, promote the well-being of people and communities, ensure economic vitality, and preserve a healthy environment. *VISION 2040* refines the urban growth boundaries first established more than 20 years ago.

The *VISION 2040* strategy seeks to focus housing and employment growth into urban centers, and employment growth into manufacturing and industrial centers. The Pacific Avenue/SR 7 HCT Project is within Pierce County's urban growth boundaries and serves the core of the region's second-most populous city, Tacoma.

At the north end of the Study Corridor, PSRC has designated downtown Tacoma as a Regional Growth Center, and the Port of Tacoma as a Manufacturing/Industrial Center.

Transit-Oriented Development

PSRC's transit-oriented development (TOD) program is a continuation of its Growing Transit Communities (GTC) project funded through the U.S. Department of Housing and Urban Development's Sustainable Communities Regional Planning Grant Program.[2] The TOD program focuses on capitalizing on transit investments by growing and strengthening areas within walking distance of existing and planned transit hubs and stations. This approach recognizes that transit investments present once-in-a-lifetime opportunities to support and improve existing communities and meet regional goals through strategies to make great places for people to live and work. The TOD program seeks to create compact, mixed-use communities along the region's growing mass transit corridors. These places will support more equitable access to housing, jobs and services for many people due to their proximity to existing or planned transit.

[1] PSRC. February 1, 2017. VISION 2040. https://www.psrc.org/vision-2040-documents. Accessed March 23, 2017.
[2] PSRC. March 22, 2017. Growing Transit Communities Strategy. http://www.psrc.org/growing-transit-communities. Accessed March 23, 2017.

Transit communities included in the GTC are served by existing or planned HCT, generally either light rail transit (LRT) or bus rapid transit (BRT). Within the Study Corridor, the following nodes in Tacoma are included in the GTC Strategy:

- Theater District
- Convention Center
- Union Station
- S. 25th Street Station
- Tacoma Dome

Demographics, economics, land use, housing and housing affordability, and transportation were assessed and included in an Existing Conditions report for GTC. A TOD market study was prepared as part of the existing conditions report and a set of implementation approaches was defined. The five nodes identified in the Study Corridor represent transit communities that fall under the implementation approach "Stimulate Demand." These transit communities are smaller employment centers in older city centers with good form and activity, but they currently exhibit only a moderate demand for TOD. The recommended approach involves focusing on economic development strategies and investments to expand the local job base, fulfill development potential, and expand access to opportunity.

1.2.2 Pierce County

Pierce County Comprehensive Plan

The Pierce County Comprehensive Plan (2016) defines the County's Urban Growth Area (UGA), and the entire Study Corridor is within the UGA.[3] In addition, most of the Study Corridor is within Tacoma or is identified as a Potential Annexation Area for the city. The Comprehensive Plan includes policies and guidance for how cities, towns, and the UGA interrelate, and provides further detail on the Regional Growth Center and the Manufacturing/Industrial Center located within the Study Corridor.

Land Use Element

Several general policies have been outlined in the Comprehensive Plan that support the location of the proposed HCT alignment within the Study Corridor. These policies include:

- Designate Centers/Central Places and Transit-Oriented Corridors within the UGA characterized by intensity/density of uses sufficient to support HCT; pedestrian-oriented land uses and amenities; mixed uses and choices in housing types; transportation projects designed to achieve community development objectives of connectivity, walkability, bikeability, and transit support.
- Set mixed-use housing designations to minimum densities of 4 to 12 units per acre and maximums of 25 units, with 30 units allowed for senior and affordable housing.
- Designate the Garfield/Pacific Lutheran University area as a Central Place/Local Center.

[3] Pierce County. 2016. Pierce County Comprehensive Plan. http://www.co.pierce.wa.us/950/Comprehensive-Plan. Accessed March 23, 2017.

Housing Element

The number of residential units in unincorporated Pierce County increased by nearly 22 percent between 2000 and 2010. More than 96 percent of the housing stock was in good/average condition in 2017. The Comprehensive Plan projects a housing need over the 20-year planning period of nearly 27 percent more units. The Comprehensive Plan provides guidance for accommodating this growth as well as to supply adequate affordable housing for all segments of the community.

Economic Development Element

The economic development element identifies that 30 percent of the labor force residing in the county commutes out of the county for work. The Comprehensive Plan suggests that development patterns that allow those workers to work closer to home would reduce traffic congestion and free up personal time.

The Parkland-Spanaway-Midland Communities Plan

The Parkland-Spanaway-Midland (PSM) Communities Plan was initially adopted in 2002 and was updated as part of the Pierce County Comprehensive Plan.[4] The Study Corridor runs between the center and the south end of the PSM Communities Plan's planning area, where Pacific Avenue then marks its western border. The PSM Communities Plan calls for exploring opportunities to increase transit service in the area, including extending rail to PSM communities and ensuring commercial centers are connected to the regional rail service. The PSM Communities Plan calls for modifying the range of land uses in the area to more closely control density and housing types, with more sub-designations, allowing higher density in multi-family zones and lower-density housing in areas of open space and environmental sensitivity.

1.2.3 Tacoma

Many plans and studies have been completed in the City of Tacoma that address specific geographic areas or projects in the Study Corridor. This section summarizes those that are most relevant to the project.

Tacoma Comprehensive Plan

The City of Tacoma Comprehensive Plan was adopted in 2004 and most recently updated in 2015.[5] Following are summaries of how the Comprehensive Plan's major elements relate to the Study Corridor.

Urban Form Element

The Urban Form Element outlines several land use designations and policies that support development of an HCT alignment in the Pacific Avenue/SR 7 corridor. The relevant designations and policies include:

- Direct the majority of growth and change to centers, corridors, and transit station areas.
- Promote future residential and employment growth in coordination with transit infrastructure and service investments.
- Establish designated corridors as thriving places that support and connect Tacoma's centers.
- Establish Crossroads Centers[6] as successful places that serve the needs of surrounding neighborhoods and a wider area, and contain high concentrations of employment, institutions, commercial, and community services, and a wide range of housing options.

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[4] Pierce County. Appendix I: Parkland-Spanaway-Midland Communities Plan. http://wa-piercecounty2.civicplus.com/DocumentCenter/View/38490. Accessed March 23, 2017.

[5] City of Tacoma. 2015. One Tacoma: Comprehensive Plan. https://www.cityoftacoma.org/government/city_departments/planning_and_development_services/planning_services/one_tacoma__comprehensive_plan. Accessed March 23, 2017.

[6] Crossroads Centers are defined as commercial development focused on intersections of major arterials or highways.

- Partner with Pierce Transit in providing development incentives and programs to improve transit-orientation and walking conditions in all centers.

Housing Element

The Housing Element defines goals and strategies that would concentrate new housing in and around centers and corridors near transit and services and support the development of an HCT alignment in the Study Corridor. The goals and strategies that support implementing HCT in the Study Corridor include:

- Locate higher density housing, including units that are affordable and accessible, in and around designated centers to take advantage of the access to transportation, jobs, open spaces, schools, and various services and amenities.
- Promote transit-supportive densities along designated corridors that connect centers, including duplex, triplex, cottage housing and townhouses.
- Strive to accommodate 80 percent of the City's housing targets within and around designated centers.
- Improve equitable access to active transportation, jobs, open spaces, high-quality schools, and supportive services and amenities in areas with high concentrations of underserved populations and an existing supply of affordable housing.
- Locate new affordable housing in areas that are opportunity-rich in terms of access to active transportation, jobs, open spaces, high-quality schools, and supportive services and amenities.

Economic Development Element

The Economic Development Element focuses on policies that promote economic growth and thriving employment centers. Goals include proactively investing in transportation to grow Tacoma's economic base. These policies support HCT by calling for concentrating commercial areas in centers and along major transportation corridors. The Economic Development Element intends to ensure there is appropriate zoning and sufficient development capacity to accommodate the 2040 growth allocations.

Transportation Master Plan Element

The Transportation Master Plan (TMP) Element recognizes 28 other plans that have influenced the Tacoma Comprehensive Plan. Among the key mandates of the TMP is to accommodate future growth focused in centers in Tacoma for 127,000 new residents and 97,000 new jobs by 2040. The TMP identifies the HCT Study Corridor as a location for all-day frequent transit service and specifically does *not* recognize it as an "auto-priority" corridor. In addition to downtown, the TMP highlights Upper and Lower Pacific as

mixed-use "Crossroads" centers with land use patterns and transportation infrastructure developed in a coordinated way to support robust "20-minute neighborhoods," along what is defined as one of Tacoma's three HCT corridors.[7] Along the HCT Study Corridor, a compact mix of land uses patterns and associated policies is identified that would support TOD. These land uses include areas for mixed-use, residential and commercial development; moderate- to high-density housing; and designations of affordable housing for all income groups. Highlighted policies include a focus on pedestrian orientation/connectivity; convenient access to transportation choices, including transit, bicycle, and pedestrian facilities; efforts to reduce the size of surface parking facilities and minimum parking requirements; and a focus on high-quality design.

[7] City of Tacoma. Tacoma Transportation Master Plan. https://www.cityoftacoma.org/government/city_departments/public_works/engineering/transportation_master_plan. Accessed April 4, 2017.

Downtown Element

The Downtown Element of the Tacoma Comprehensive Plan challenges itself to "Resolve the questions of how to responsibly increase density while laying the groundwork for a long-term, high quality city environment and maintaining Tacoma's unique character." Sixteen initiatives/sub-plans are recognized as integral to the larger plan emphasizing, among other goals, increasing employment and retail and supporting the University of Washington-Tacoma downtown campus. A Sustainable City is one of four framework themes that define the City's vision for downtown; keys to achieving this vision include a transit-rich environment and walkable compact neighborhoods with a variety of housing and retail choices.

North Downtown Tacoma Subarea Plan

The North Downtown Tacoma Subarea is the northern half of the PSRC-designated Tacoma Downtown Regional Growth Center. It includes the commercial core and extends north to include Wright Park, the St. Helens neighborhood, and the Stadium District. The HCT Study Corridor encompasses the southern three-quarters of this subarea. The North Downtown Subarea Plan[8] sets growth targets of 30,000 new jobs and 30,000 additional residents by 2030, with up to 26 million square feet of new commercial and residential floor space. The Subarea Plan acknowledges that underutilized buildings and properties in the plan area "present an opportunity for development that can accommodate the future growth."

Specific actions to achieve this growth include expanding transit; continuing the Multifamily Property Tax Exemption Program; establishing an Affordable Housing requirement of 25 percent; prioritizing affordable housing loans and an affordable housing fund; identifying publicly owned properties for non-profit housing development; applying mixed-use complete streets guidelines; reducing space reserved for parking; and implementing pedestrian improvement projects.

The Subarea Plan also suggests taking advantage of the Landscape Conservation and Local Infrastructure Program (LCLIP) created by state law in 2011, which combines Transfer of Development Rights (TDR) with tax increment financing (TIF) to fund public infrastructure.

Tacoma has also created a new Code provision (TMC 13.06.100 E) that supports the designation and construction of Live-Work units, which may encourage increased population density.

South Downtown Tacoma Subarea Plan

The South Downtown Subarea is the southern half of the PSRC-designated Tacoma Downtown Regional Growth Center, which includes the Tacoma Dome area and the existing Sounder and Tacoma Link stations located near the Dome.[9] The growth target for this area is 20 million square feet of new development with 30,000 new residents and 40,000 new jobs by 2030.

The Subarea Plan for this area of downtown recognizes the greater challenges relative to the north half of the Regional Growth Center. South Downtown has experienced lower levels of development and redevelopment, despite the positive stimuli provided by the University of Washington-Tacoma campus and museums. Compared to North Downtown, South Downtown has a lower population density, a higher rate of low-income households, and higher poverty and unemployment rates.

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[8] City of Tacoma, North Downtown Subarea Plan and EIS. http://www.cityoftacoma.org/cms/One.aspx?pageId=15747. Accessed April 4, 2017.

[9] City of Tacoma. South Downtown Subarea Plan and EIS. http://www.cityoftacoma.org/cms/one.aspx?objectId=15736. Accessed April 4, 2017.

The South Downtown Subarea Plan, and its accompanying non-project Environmental Impact Statement (EIS), was funded through PSRC's Growing Transit Communities Project.

Proposed actions in the South Downtown Subarea Plan promote compact, equitable communities along HCT networks and emphasize the area's relation to transit. The Subarea Plan calls for coordinating "with transit agencies to prioritize future high-frequency transit service allocations that will help catalyze redevelopment and the creation of complete communities."

Strategies to support the development targets include "upfront SEPA [State Environmental Policy Act]," which aims to reduce developer risk by eliminating the requirement for individual project SEPA review; and "Transit Infill Review" under the Revised Code of Washington (RCW) 43.21C.420, which would be included as part of the upfront SEPA and serve to further reduce the risk of SEPA-based appeals.

The Subarea Plan also supports the use of TDR and "Density Transfers" to raise minimum heights on non-historic infill sites, and the use of city-backed grants and loans to historic property owners for seismic and other upgrades. The Subarea Plan calls for the same Live-Work Code elements identified in the North Downtown Plan, as well as the implementation of Tax Increment Financing, Development Impact Fees, and No-Protest Agreements for Local Improvement District (LID) projects in South Downtown.

Strategies also include actions focused on existing residents related to education, job training, and outreach to improve people's lives and opportunities. There is a strong affordable housing element in the South Downtown Plan – calling for 25 percent affordable housing – to ensure "equitable access to all of the benefits provided by a transit-rich, walkable, mixed-use neighborhood."

Finally, redevelopment projects are recommended as catalysts to jump-start the desired changes. More than 20 individual projects are identified in the Subarea Plan, some of which could be public-private partnerships, building in part on PSRC's GTC work.

1.3 Alternatives Analysis Process and Decision-Making

Based on a study of existing and future conditions and a project Purpose and Need Statement, an HCT mode evaluation determined that the most appropriate HCT mode for the corridor would be BRT. The mode selection was followed by an iterative design and evaluation process to determine the Locally Preferred Alternative (LPA),

As part of the Level 1 Screening Evaluation, various design options were developed and each option was measured against the project goals, as described by the Purpose and Need Statement, and was evaluated based on how well it advances each goal. A final tally rated each design alternative based on its overall support of the 12 goals for each corridor segment. The outcome of this first-level evaluation was to narrow the corridor segment alternatives and then combine them into full corridor alternatives. Subsequently, a second-level evaluation of the full corridor alternatives was undertaken to determine the preferred alternative. This second-level evaluation of the full corridor alternatives includes a higher level of analysis and more detailed evaluation than this first-level analysis and was used to inform the decision on the LPA.

1.4 REPORT ORGANIZATION

This report is organized as follows:

Chapter 2: Existing and Future Conditions. Description of the current transit, traffic, and land use conditions along the corridor, and projections for future changes in those areas.

Chapter 3: Project Purpose and Need. A statement of the reason for pursuing the project and the issues (needs) the project should address. This include goals and objectives for the project.

Chapter 4: Mode Evaluation. An analysis of potential transit modes to serve the corridor and determination of the mode that best addresses the project's Purpose and Need.

Chapter 5: Service Alternatives Evaluation. An assessment of various service options for the corridor, including service frequency and span, and coordination with other transit services.

Chapter 6: Vehicle Assessment. Consideration of vehicle options for the transit service.

Chapter 7: Conceptual Designs. Development of various design options of the corridor.

Chapter 8: First Screening of Alternatives. An assessment of the conceptual design options against the project Purpose and Need.

Chapter 9: Refined Options. Development of refined design options based on the first screening assessment.

Chapter 10: Environmental Critical Issues. A preliminary analysis of expected important environmental issues for the corridor to assist in the evaluation of refined design alternatives.

Chapter 11: Second Screening of Alternatives. A more detailed assessment of the design options against the project's goals and objectives.

Chapter 12: Public Outreach. A summary of the various public involvement activities during the study.

Chapter 13: Locally Preferred Alternative. A description of the preferred option as selected by the Pierce Transit Board of Commissioners, including an Intersection Control Evaluation (ICE) as required by the Washington State Department of Transportation (WSDOT).

2 EXISTING AND FUTURE CONDITIONS

2.1 TRANSIT

Pierce Transit, founded in 1979, has a service area that covers 292 square miles of Pierce County and includes roughly 70 percent of the county population. It provides four types of service: fixed-route, SHUTTLE paratransit, vanpools, and seasonal trolleys. Pierce Transit is one of three public transportation providers serving the Study Corridor. The others are:

- Sound Transit: plans for, builds, and operates express bus, light rail, and commuter train services in the urban areas of King, Pierce and Snohomish counties.
- Intercity Transit: provides fixed-route bus and paratransit service in Olympia, Lacey, Tumwater and Yelm, with three routes that serve downtown Tacoma.

2.1.1 Bus Routes and Key Transfers to Other Modes

Today, Pierce Transit provides frequent bus service on Pacific Avenue/SR 7 via bus Route 1. This route is referred to by Pierce Transit as a "trunk line" and is the bus route with the highest ridership in the agency's system. Pierce Transit's Destination 2040 Long Range Plan identifies Route 1 for HCT.[10]

Route 1 travels 19.6 miles on Pacific Avenue/SR 7 between Tacoma Community College (TCC) and the Walmart in Spanaway at 8th Avenue and operates every 15 minutes between 5:30 a.m. and 11:30 p.m. on weekdays. Weekend service operates approximately every 20 minutes between 6:30 a.m. and 9:30 p.m.

Bus routes that offer direct transfers to Route 1 are listed by transportation provider in Table 1.

Table 1: Public Transportation Routes with Transfers to Route 1

Route No.	Description
Pierce Transit	
2	S 19th Street – Bridgeport Way: Lakewood Transfer Center (TC) to 10th and Commerce TC
3	Lakewood – Tacoma: Lakewood TC to 10th and Commerce TC
11	Point Defiance: 10th and Commerce TC (Zone F) to Point Defiance Ferry Terminal
13	N 30th Street: Proctor Street N and N 24th Street to Tacoma Dome Station
15	Downtown to Defiance Trolley: Demonstration trolley service (from June 2 through September 3), operating between downtown Tacoma and Point Defiance Park via Ruston Way
16	UPS – TCC: TCC Transit Center to 10th and Commerce TC
28	S 12th Street: TCC Transit Center to 11th Street S and Pacific Avenue
41	Portland Avenue: Tacoma Mall TC to 10th and Commerce TC
42	McKinley Avenue: 72nd St TC to 10th and Commerce TC
45	Yakima: Parkland TC to 10th and Commerce TC
48	Sheridan – M Street: Lakewood TC to 10th and Commerce TC
57	Tacoma Mall: Tacoma Mall TC to 10th and Commerce TC

[10] Pierce Transit. April 11, 2016. Destination 2040 | Pierce Transit Long Range Plan.

Route No.	Description
63	NE Tacoma Express: 10th and Commerce TC to 39th Avenue SW and Northshore Parkway
102	Gig Harbor Express: MLK Jr. Way and Division Avenue to Purdy Park and Ride (P&R)
400	Puyallup – Downtown Tacoma: South Hill Mall TC to 10th and Commerce TC
500	Federal Way: 10th and Commerce TC to Federal Way Transit Center
501	Milton – Federal Way: 10th and Commerce TC to Federal Way Transit Center
Sound Transit	
590	Express Bus: Seattle to 10th and Commerce TC
594	Express Bus: Seattle to DuPont Station
Intercity Transit	
603/605/612	Express Bus: Olympia Transit Center to 10th and Commerce TC

In addition to the bus routes that have direct transfer opportunities to Route 1, there are several other public transportation options within or near the Study Corridor, including:

- Sound Transit: Tacoma Link
    - 1.6-mile light rail alignment serving five stations in the Study Corridor:
        - Tacoma Dome Station
        - South 25th Street Station
        - Union Station
        - Convention Center Station
        - Commerce Street Station
    - A project extending Tacoma Link 2.4 miles to the Hilltop Neighborhood, including six new stations and one relocated station in the Theater District, is currently under construction and scheduled for opening in 2022.[11]
- Amtrak Tacoma Station (1001 Puyallup Avenue, Tacoma) provides intercity rail and bus access to:[12]
    - Amtrak Cascade operates service between Vancouver, B.C., Canada, and Eugene, Oregon, with multiple train departures every day of the week.
    - Coast Starlight operates service between Los Angeles and Seattle with one train departure every day of the week.
    - Thruway bus service from Amtrak Tacoma Station is provided to serve communities without rail service.

[11] Sound Transit. Tacoma Link Expansion. https://www.soundtransit.org/tacomalinkexpansion. Accessed October 21, 2019.
[12] Amtrak. Northwest Train Routes. https://www.amtrak.com/northwest-train-routes. Accessed October 21, 2019.

- Greyhound (510 Puyallup Avenue, Tacoma) buses provide daily service north and south along the I-5 corridor between Los Angeles and Vancouver, B.C., Canada. [13] Greyhound provides service to more destinations than Amtrak trains.[14]

The existing bus routes and the key transfers to these bus routes in the Study Corridor are shown in Figure 2. A comprehensive map of the transit facilities in the Study Corridor is shown in Figure 3.

[13] Greyhound. Tacoma Current Schedules. http://bustracker.greyhound.com/stops/780879/Tacoma_WA. Accessed April 3, 2017.
[14] Depending on Greyhound bus selected, riders can travel to the following cities: Los Angeles, Bakersfield, Fresno, Stockton, Sacramento, Marysville, Oroville, Chico, Red Bluff, Redding, Weed, Medford, Medford, Grants Pass, Roseburg, Eugene, Corvallis, Salem, Woodburn, Portland, Kelso, Centralia, Olympia, Tacoma, Seattle, Everett, Mt. Vernon, Bellingham, Coquitlam, and Vancouver, B.C.

Figure 2: Bus Routes and Key Transfers

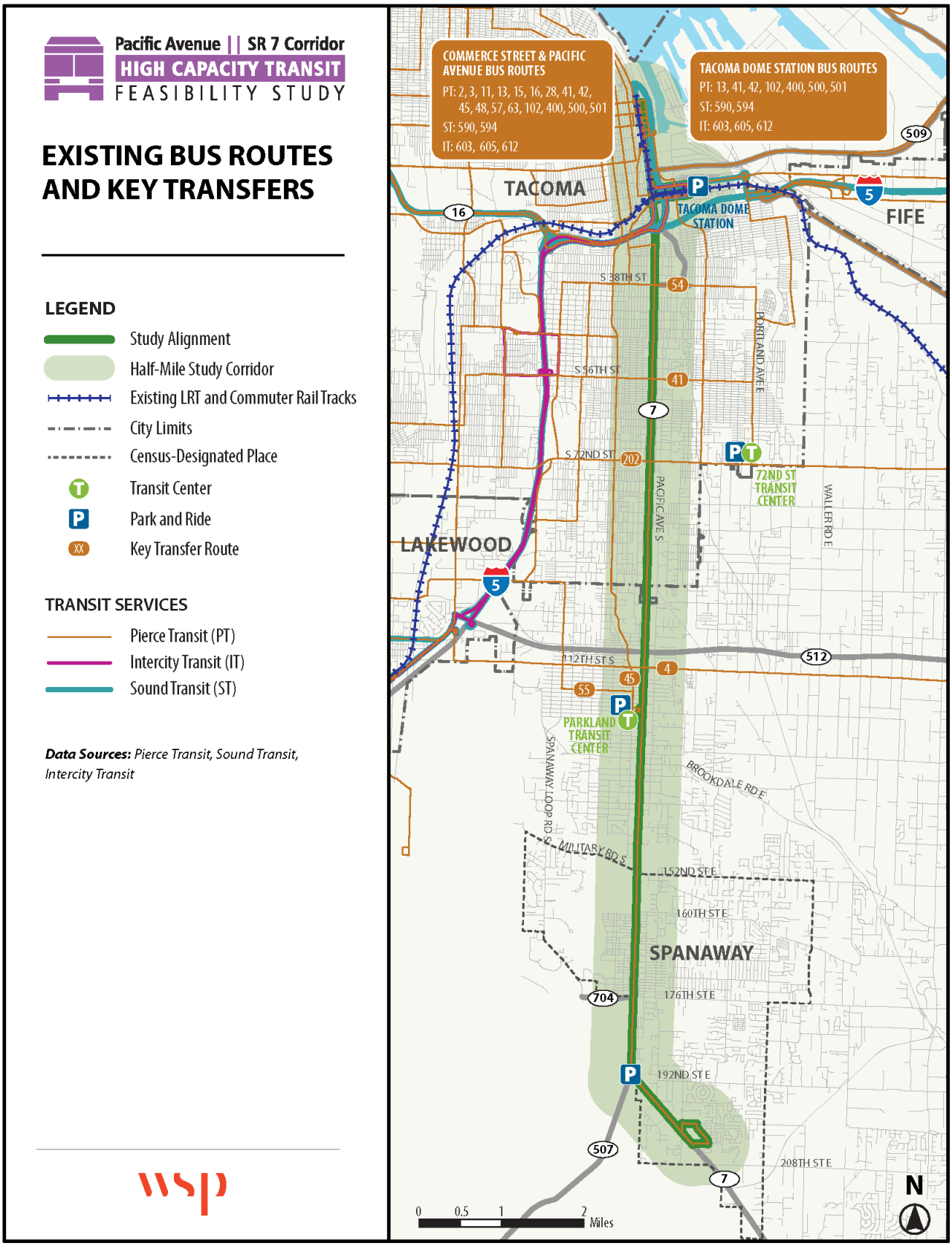
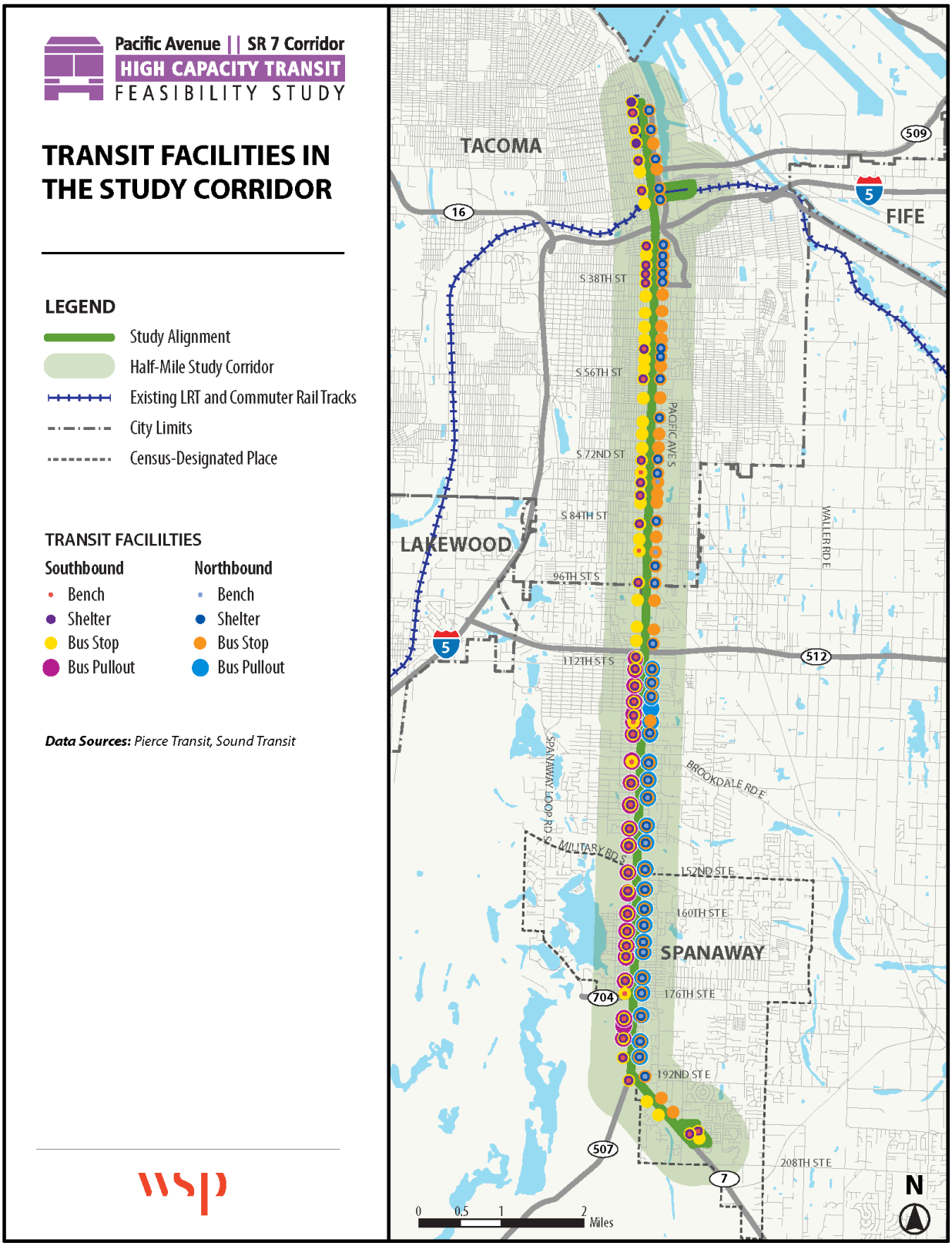


Figure 3: Transit Facilities in the Study Corridor



2.1.2 Transit Ridership by Stop

Route 1: Average Daily Boardings

In October 2016, there were more than 5,500 average daily weekday boardings on Pierce Transit's Route 1 (2,800 northbound and 2,760 southbound). Figure 4 shows the distribution of these boardings in the Study Corridor by travel direction using graduated symbols corresponding to the number of boardings by location.

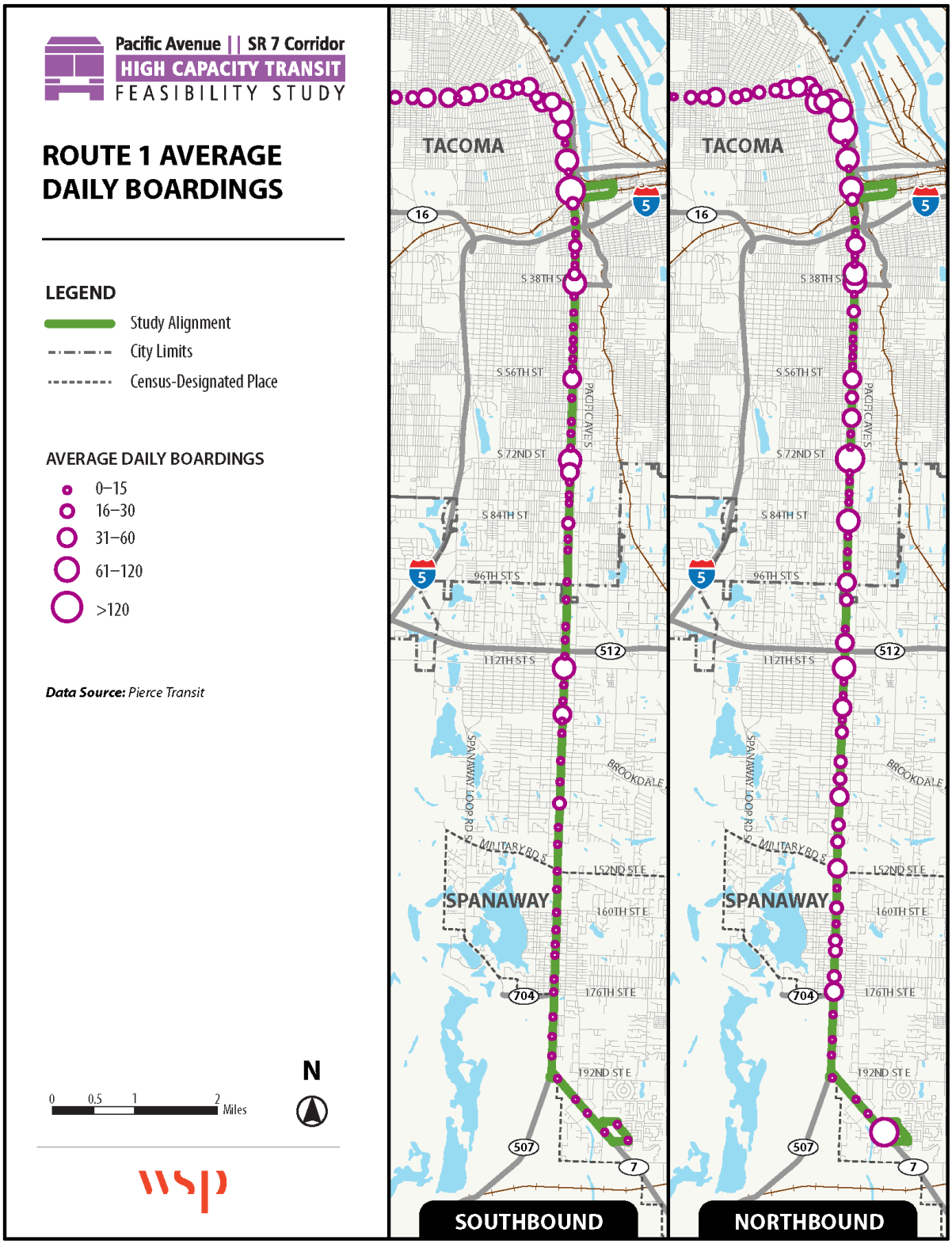
Within the Study Corridor, six stops in the northbound direction and five stops in the southbound direction averaged more than 90 passengers boarding daily; these are listed in Table 2. Three of the top boarding locations in both the northbound and southbound directions are located in downtown Tacoma.

Table 2: Highest Average Daily Boarding Stops by Direction

Direction	Stop Location	Boardings
Northbound	Mountain Highway E. and 8th Avenue E. (Walmart)	277
	Pacific Avenue and S. 14th Street	217
	Pacific Avenue and 72nd Street	142
	9th and Saint Helens Avenue*	114
	Pacific Avenue S. and 112th Street S.	106
	Pacific Avenue and S. 11th Street	92
Southbound	Pacific Avenue and S. 24th Street	193
	Pacific Avenue and UW Tacoma Campus	120
	Pacific Avenue and S. 11th Street	118
	Pacific Avenue S. and 112th Street S.	108
	6th Avenue and S. Pearl Street*	98

Source: Pierce Transit Automatic Passenger Count (APC) Data (October 2016).
* Route 1 stop is not within the Study Corridor

Figure 4: Ridership by Stop

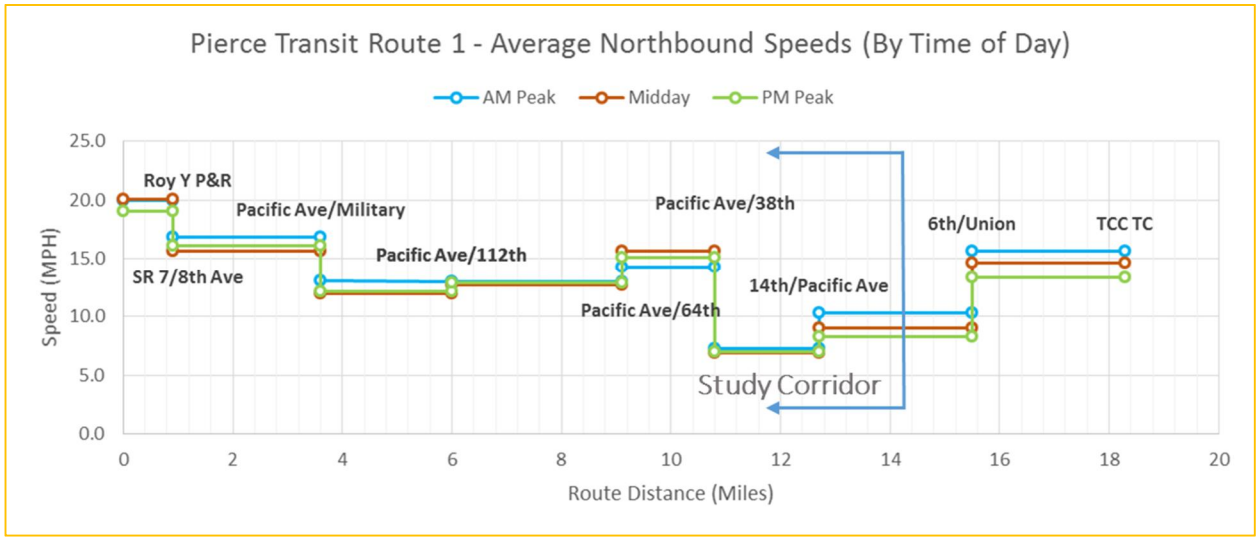


2.1.3 Transit Travel Time by Time of Day

Figure 5 and Figure 6 illustrate the average travel speeds by time of day and direction of travel for Pierce Transit's Route 1 in the Study Corridor. Table 3 lists the travel times between these same points by time of day. As these figures indicate, the northbound direction experiences very little travel time variability between the average AM Peak, Midday, and PM Peak periods. Overall, travel speeds tend to be the highest toward the start of the northbound route and the route experiences the highest delay between Pacific Avenue/S. 38th Street and Pacific Avenue/14th Street in downtown Tacoma. Travel speeds pick up again beyond S. 14th Street, which is outside of the Study Corridor. Speeds vary along the Study Corridor between a high of 20 mph in the AM Peak between SR 7/8th Avenue and Roy "Y " Park-and-Ride (P&R), to a low of just under 7 mph during the Midday period between Pacific Avenue/S. 64th Street and Pacific Avenue and S. 14th Street in downtown Tacoma.

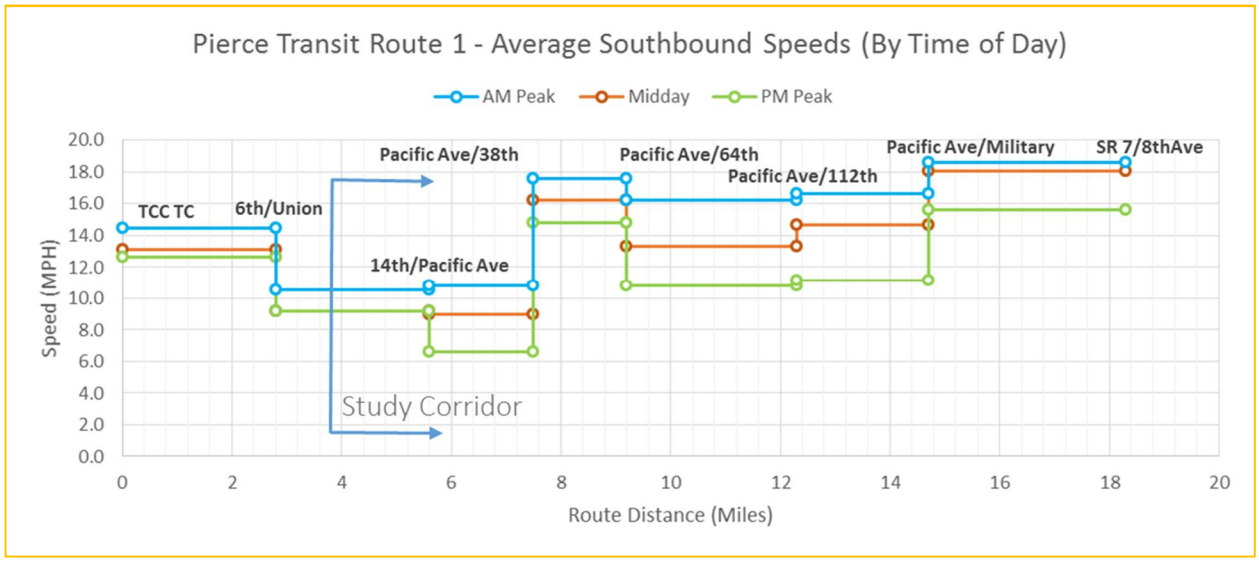
In contrast, the southbound direction of Route 1 experiences a high degree of travel time variability between times of day with a general degradation of speeds from AM Peak to Midday to PM Peak—reflecting higher congestion levels, and thus, more volatility in roadway operations during the PM Peak in the southbound direction. This impact is greatest between Pacific Avenue/14th Street and Pacific Avenue/S. 38th Street, where average speeds drop from more than 10 mph in the AM Peak to just over 6 mph in the PM Peak (leading to an approximate seven-minute or 62-percent increase in travel times in this segment), and between Pacific Avenue/S. 64th Street and Pacific Avenue/Military Road where speeds drop from just over 16 MPH in the AM Peak to approximately 11 MPH in the PM Peak (a six-minute or 51-percent increase from S. 64th Street to 112th Street, and a four-minute or 48-percent increase from 112th Street S. to Military Road).

Figure 5: Pierce Transit Route 1 - Average Weekday Northbound Speeds (By Time of Day)



Source: Pierce Transit AVL Data (October 2016)

Figure 6: Pierce Transit Route 1 - Average Weekday Southbound Speeds (By Time of Day)



Source: Pierce Transit AVL Data (October 2016)

Table 3: Route 1 Average Travel Times (in minutes), Northbound and Southbound Directions

Direction	From	To	AM Peak	Midday	PM Peak
Northbound	SR 7/8th Ave	Roy Y P&R	2.7	2.7	2.8
	Roy Y P&R	Pacific Ave/Military	9.6	10.4	10.1
	Pacific Ave/Military	Pacific Ave/112th Ave	11.1	12.0	11.9
	Pacific Ave/112th Ave	Pacific Ave/64th Ave	14.3	14.6	14.5
	Pacific Ave/64th Ave	Pacific Ave/38th Ave	7.2	6.5	6.8
	Pacific Ave/38th Ave	14th/Pacific Ave	15.6	16.6	16.2
	14th/Pacific Ave	6th/Union	16.3	18.7	20.3
	6th/Union	TCC TC	10.8	11.5	12.6
Southbound	TCC TC	6th/Union	11.6	12.8	13.3
	6th/Union	14th/Pacific Ave S	16.0	18.2	18.3
	14th/Pacific Ave S	Pacific Ave/38th Ave	10.6	12.7	17.2
	Pacific Ave/38th Ave	Pacific Ave/64th Ave	5.8	6.3	6.9
	Pacific Ave/64th Ave	Pacific Ave/112th Ave	11.4	14.0	17.2
	Pacific Ave/112th Ave	Pacific Ave/Military	8.7	9.8	12.9
	Pacific Ave/Military	SR 7/8th Ave	11.6	12.0	13.8

Source: Pierce Transit AVL Data (October 2016)

2.1.4 Transit Service Reliability (On-Time Performance)

The on-time performance standard for Pierce Transit specifies that a bus cannot be more than one minute early or more than five minutes late at a designated timepoint to be considered on-time. While there are several ways of expressing bus route travel time variability, a review of October 2016 automatic vehicle location (AVL) data on Pierce Transit Route 1 indicates that the average end-to-end times were within five minutes of scheduled times during all periods in both the southbound and northbound directions.

In addition to average travel times, a review of the 90th percentile on-time performance is an important indicator of transit service reliability. The basis for this measurement is that the 90th percentile performance shows what a rider could expect on 1 out 10 weekday trips, a reasonable tolerance for schedule unreliability for regular travelers.

The 90th percentile measure for this same October 2016 AVL data for both AM Peak and Midday periods shows actual travel times running about 6 to 10 minutes late, and AM Peak time in both directions running about 15 minutes late. A rider experiencing a 15-minute late arrival at least once a week may be significantly inconvenienced.

Furthermore, looking at the 25th percentile for the PM Peak (average travel time for the fastest 25 percent of the trips), the travel time is 60 minutes; this means that many trips travel much faster than the scheduled time. Therefore, these fast trips offset the trips that are late, creating an average travel time that is close to the scheduled time. This only serves to highlight the extreme variability of the travel time and the difficult to manage headways and schedule travel times throughout the day within the Study Corridor.

Table 4 presents a simple summary of the data discussed.

Table 4: Transit Service Reliability Pierce Transit Route 1

	Schedule time	Average Time	90th Percentile Time
AM Peak (Avg. Both Directions)	56 min	58 min	64 min
Midday (Avg. Both Directions)	58 min	59 min	68 min
PM Peak Northbound	58 min	62 min	73 min
PM Peak Southbound	67 min	68 min	82 min

Source: Pierce Transit AVL Data (October 2016)

2.1.5 Estimated 2040 Ridership

Future ridership on the Pierce Transit Route 1 was estimated using the Sound Transit 3 regional ridership model. These results are categorized by segment in Table 5. Overall, ridership along the Route 1 alignment is expected to increase between 27 percent (low estimate) and 60 percent (high estimate) by 2040. All segments show increases in ridership with the middle part of the corridor, between S. 14th Street and S. 64th Street, projected to have the greatest gains. Although the results of this analysis have a reasonable degree of accuracy at a high level, the regional model used is not designed to conduct a finer grain, stop-by-stop analysis. A more rigorous exercise was conducted as part of the Alternatives Analysis portion of this study.

Table 5: Estimated 2040 Daily Boardings for Pierce Transit Route 1 (weekday)

Route Segments	Base Year (2014)	2040 (Low)	2040 (High)
TCC Transit Center - 6th /Union	1,210	1,520	1,950
6th/Union - 14th S/Pacific Ave	1,360	1,430	1,860
14th S/Pacific Ave - Pacific Ave/38th	1,230	1,700	2,170
Pacific Ave/38th - Pacific Ave/64th	670	910	1,170
Pacific Ave/64th - Pacific Ave and 112th	510	700	890
Pacific Ave/112th - Pacific Ave/Military	540	690	760
Pacific Ave/Military – SR 7/8th Ave	360	520	590
Total Daily	**5,880**	**7,470**	**9,390**

Note: Data summarized from ST3 Plan Models. The boardings shown above for 2040 corresponds to 2040 ST3 Baseline results.

2.1.6 Future Transit Travel Time and Reliability

Based on a preliminary, high-level assessment of daily traffic volumes and corridor volume-to-capacity (v/c) ratios, there is expected to be some degradation of travel times, both for general purpose traffic and for transit, along the study corridor by 2045—particularly in the AM northbound direction. Congestion is expected to increase in both directions along the entirety of the corridor, which will likely lead to slower travel speeds and less transit reliability. Based on this relatively high-level preliminary analysis, while the roadway capacity (i.e., number of lanes) may not to need to be substantially increased in the future, it is likely that several key bottleneck locations in the corridor would need to be addressed to facilitate current and future transit speed and reliability. Field observations have shown that several intersections within the corridor currently experience peak period congestion, and these are likely to get worse in the future. A more detailed intersection analysis was done as part of the alternatives analysis process to identify these locations and develop potential improvements to facilitate improved transit speed and reliability.

2.2 Bicycle and Pedestrian

The built environment and associated conditions for people walking and bicycling varies across the 14.4-mile Study Corridor. In general, the northern portion within downtown Tacoma is more pedestrian- and bicyclist-friendly compared to the remainder of the Study Corridor, with the Corridor transitioning to a more automobile-oriented arterial environment as you move south away from downtown Tacoma, with more dispersed land use patterns and a degradation of the pedestrian environment. Downtown Tacoma presents a friendlier environment for bicycling with generally lower travel speeds on roadway and a much higher density of land uses. The City of Tacoma and Pierce County are responsible for maintaining sidewalks within their respective jurisdictions. To describe the built environment and conditions for people walking and bicycling in more detail, the Study Corridor has been divided into six segments as outlined in Table 6. The bicycle and pedestrian facilities in the Study Corridor are illustrated in Figure 7.

Figure 7: Bicycle and Pedestrian Facilities

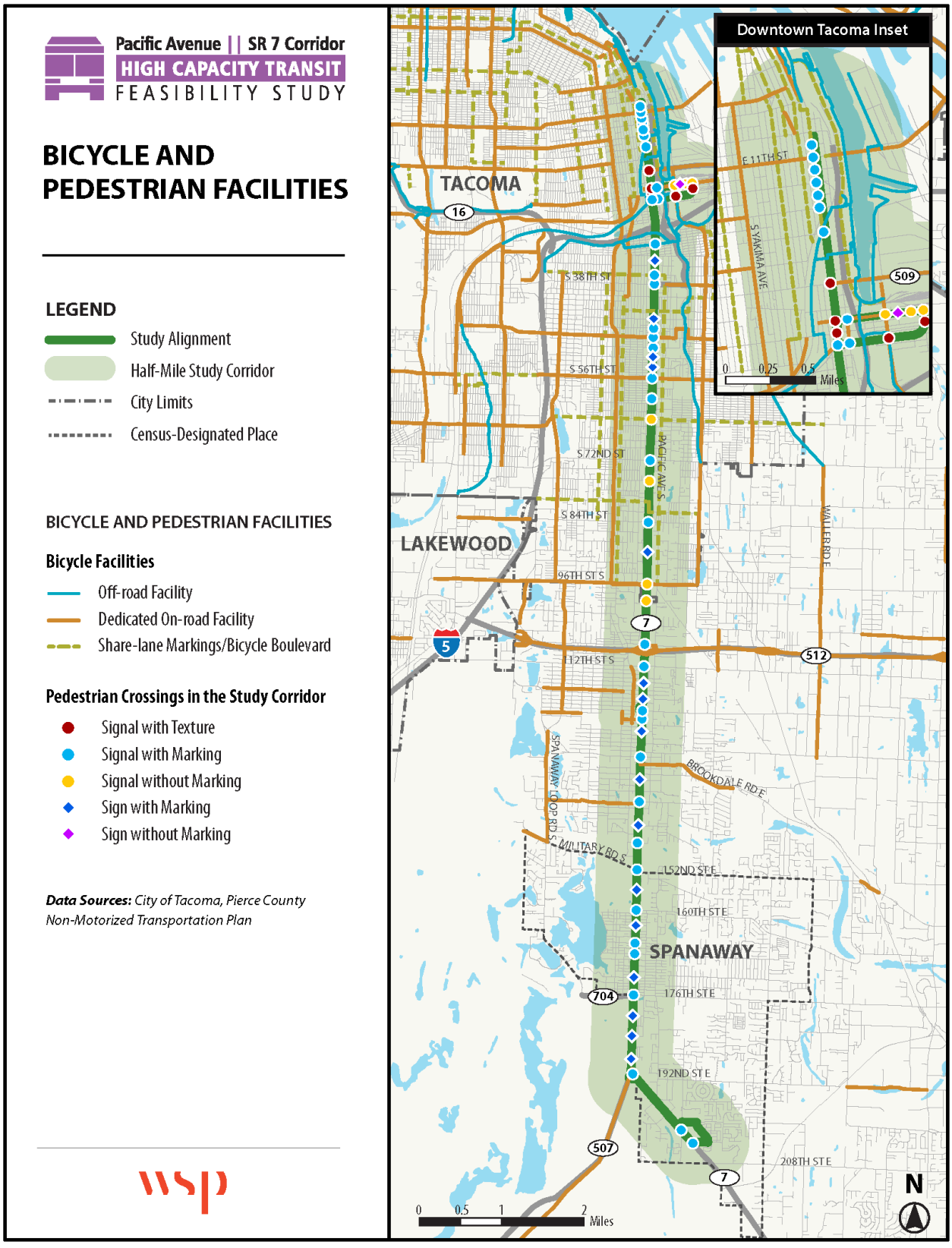


Table 6: Segments for Bicycle and Pedestrian Conditions

Segment	Roadway	Limits From	Limits To
1	Pacific Avenue	South 9th Street	Puyallup Avenue
2	Puyallup Avenue	Pacific Avenue	E 26th Street
3	E 26th Street	Puyallup Avenue	Pacific Avenue
4	Pacific Avenue/SR 7	S 26th Street	S 96th
5	Pacific Avenue/SR 7	S 96th	SR 507
6	Mountain Highway/SR 7	Pacific Avenue/SR 7	204th Street East

Segment 1 – Pacific Avenue Between South 9th Street and Puyallup Avenue

This segment is a downtown environment that is pedestrian friendly. Sidewalks on both sides of the roadway throughout this segment are generally wide and feature planting or furnishing zones, providing a buffer between pedestrians and motor vehicle traffic. Sidewalks are in good condition and feature no obvious obstructions that might affect those with limited mobility. Sidewalks in this segment feature a mix of street trees and other furnishing elements, such as benches, post office boxes and transit shelters.

Many bus stops in this segment feature bus shelters and posted information for passengers. Bus stops are in line with the roadway, featuring curb extensions where necessary. Pedestrian-scale lighting is found throughout on both sides of the street, which contributes to a more comfortable environment for people walking at night.

Most crossings feature a marked crosswalk, but the crossing styles vary from high-visibility continental crosswalk striping to a low-visibility textured surface. Most crossings feature Americans with Disabilities Act (ADA)-compliant curb ramps with a textured warning surface. Signalized intersections generally feature pedestrian walk signals.

Many intersections in this segment feature curb extensions that provide additional space for sidewalk users around intersections, shorten crossing distances for pedestrians, and reduce corner radii. However, other intersections in this segment feature wide turning radii, which increases crossing distances for pedestrians as well as turning speeds for motor vehicles.

Segment 2 – Puyallup Avenue between Pacific Avenue and E. 26th Street

This segment of the Study Corridor exhibits less pedestrian activity than Segment 1, largely due to industrial land uses. In terms of the built environment, there is a complete sidewalk network on both sides of the roadway throughout this segment, aside from the westbound direction between East G Street and the exit driveway of the Tacoma Dome Station. This section features open access between the BNSF Railway facility and the street, but provides no distinction between the pedestrian zone and vehicle zone.

Overall, sidewalks in the segment are sufficiently wide and feature occasional planting or furnishing zones to provide separation between pedestrians and motor vehicles. Sidewalk condition varies throughout the segment from sidewalks in good repair to areas with cracking and heaving that might present challenges for pedestrians with limited mobility. Some sidewalk sections in this segment feature street trees, but there is no pedestrian-scale lighting. Most (but not all) bus stops feature bus shelters and posted information for passengers.

Most crossings lack marked and/or striped crosswalks, with the exceptions being continental-striped crosswalks across S. 24th Street at A Street. Most crossings feature curb ramps. Curb ramps on the eastern portion of the segment are generally ADA-compliant, including textured warning surfaces. Signalized intersections generally feature pedestrian walk signals.

A few intersections in this segment feature curb extensions that provide additional space for sidewalk users around intersections and shorten crossing distances for pedestrians, including at E Street, D Street, and C Street.

Segment 3 – E. 26th Street between Puyallup Avenue and Pacific Avenue

The built environment of this segment becomes less pedestrian-friendly to the south of the Tacoma Dome Station. The continuity, width, and quality of sidewalks vary widely in this segment. Sidewalk maintenance is an issue at many locations, with instances of overgrown vegetation, cracks and/or obstructions within the sidewalk.

Most of this segment does not feature pedestrian-scale lighting, although there is lighting near and under the I-705 overpass, a critical location for lighting. Some sidewalk segments feature street trees. There are no bus shelters in this segment.

"A" Street and Pacific Street include continental crosswalks, but most other crossings in this segment lack any crosswalk markings. Most crossings feature curb ramps, but generally lack textured warning surfaces. Additionally, many curb ramps are oriented at the apex of the curb rather than toward the crossing area, which can be hazardous to those with limited mobility, particularly wheelchair users who are directed to the middle of the street rather than the crossing.

There are only a few signalized intersections within this segment. Those that have signals feature pedestrian signals as well. Only a few intersections in this segment feature curb extensions that provide additional space for sidewalk users around intersections and shorten crossing distances for pedestrians, including both D Street and G Street at E. 25th Street.

The segment is composed of a mix of light-industrial, commercial and residential land uses.

Segment 4 – Pacific Avenue/SR 7 between S. 26th Street and 96th Street S

As the Study Corridor continues south away from downtown Tacoma, the built environment becomes far more automobile-oriented and arterial with wider traffic lanes, a high density of driveway curb cuts, and limited opportunities for pedestrians to cross Pacific Avenue. This segment, along with Segment 5 and Segment 6, constitutes the bulk of the Study Corridor; these segments are generally not friendly environments for pedestrians or bicyclists. Higher motor vehicle travel speeds; auto-oriented street design; lower-density land uses, often with large setbacks and parking lots; and highly variable pedestrian infrastructure degrade the experience of walking and bicycling.

In contrast to segments 5 and 6, however, sidewalks in this segment are mostly continuous and land uses provide a modest increase in density. Sidewalks feature high variation in width and quality, are frequently interrupted by driveways that cut through the sidewalk, and by intersecting roadways that do not feature crosswalks. There is pedestrian-scale lighting in this segment, and most bus stops only feature a post marking the stop. Some sidewalk sections feature street trees, which enhances the pedestrian environment.

Large turning radii at many intersections encourage high automobile turning speeds, creating safety hazards for pedestrians. There is a notable missing piece of sidewalk in the southbound direction near the I-5 interchange. A worn "goat path" demonstrates existing pedestrian use and the need for a permanent pedestrian facility.

Intersections in this segment vary widely in the existence of and quality of marked crossings. Most marked crosswalks feature continental striping, but many of these crosswalks are faded. Most marked crosswalks are at intersections, though there are several mid-block crossings. Some crosswalks feature a pedestrian refuge island, while others are merely striped across the five-lane roadway, creating a potentially hazardous condition for pedestrians.

The existence and quality of curb ramps varies greatly from intersection-to-intersection and parcel-to-parcel. Signalized intersections generally feature pedestrian signals. Curb extensions are not common in this segment.

Segment 5 – Pacific Avenue/SR 7 between 96th Street S and SR 507

Sidewalks are less frequent in this segment than in segments 1 through 4. Sidewalks are mostly absent between 96th Street and 112th Street. This, combined with the generally open access commercial properties and frequent driveways, greatly curtails pedestrian access and mobility. Where sidewalks do exist, their quality varies greatly by block and property.

Other pedestrian infrastructure, such as crosswalks, curb ramps, pedestrian signals, and bus stops, is similar to Segment 4, with high variability between blocks and parcels.

Segment 6 - Mountain Highway/SR 7 between SR 507 and S 204th Street E

This segment lacks sidewalks. There are only two marked crosswalks in this segment—near SR 507 and at the Walmart entrance—but they do not connect to sidewalks. Intersections feature pedestrian signals and there is a bus shelter at the Walmart bus stop.

2.3 TRAFFIC

2.3.1 Existing Street System Jurisdictions

The majority of the Study Corridor alignment follows Pacific Avenue/SR 7, a highway operated and maintained by the State of Washington through the Department of Transportation (WSDOT).

The alignment deviates from SR 7 at the northern end, using streets owned and maintained by the City of Tacoma. The northern end serves the Tacoma downtown area and Tacoma Dome Station. The alignment also deviates from SR 7 at the southern terminus, using 8th Avenue E, 200th Street E, Hidden Village Drive E, and 204th Street E, which are owned and maintained by Pierce County.

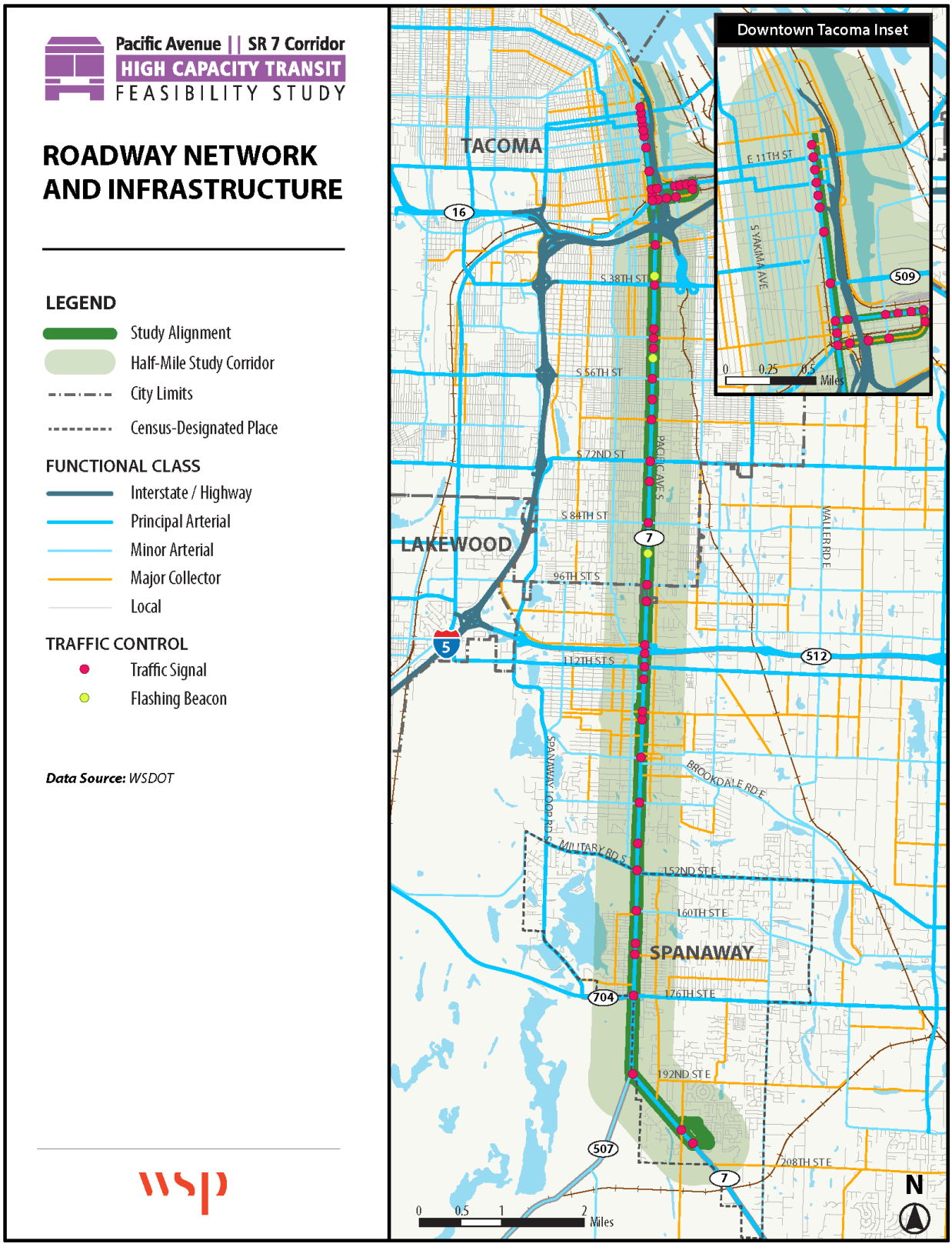
WSDOT assigns functional classifications to all roadways within their jurisdiction. They also require that cities and counties designate functional classification for the roadways within their jurisdictions. Table 7 details the functional classification designations of the roadways along the alignment as well as the jurisdictional maintenance responsibility. The functional classifications of the roadways and traffic control locations in the Study Corridor are illustrated in Figure 8.

Table 7: Study Corridor Alignment Functional Classification and Jurisdictional Maintenance Responsibility

Study Corridor Alignment	From	To	Length (miles)	Functional Classification	Maintenance Responsibility*
Pacific Avenue	S 9th Street	S 11th Street	0.15	Major Collector	City of Tacoma
Pacific Avenue	S 11th Street	S 38th Street	2.11	Principal Arterial	City of Tacoma
SR 7	S 38th Street	204th Street E	10.77	Principal Arterial	WSDOT
Puyallup Avenue	SR 7	E G Street	0.51	Principal Arterial	City of Tacoma
E G St /E 26th Street	Puyallup Ave	SR 7	0.61	Major Collector	City of Tacoma
8th Avenue E	SR 7	200th Street E	0.10	Major Collector (Urban)	Pierce County
200th Street E	8th Avenue E	Hidden Village Drive E	0.18	Local Street	Pierce County
Hidden Village Drive E	200th Street E	204th Street	0.30	Local Street	Pierce County
204th Street	Hidden Village Drive E	SR 7	0.19	Local Street	Pierce County

*Back of curb to back of curb. Source: WSDOT. Functional Classification - Map Application. http://www.wsdot.wa.gov/mapsdata/travel/hpms/functionalclass.htm. Accessed March 30, 2017.

Figure 8: Study Corridor Roadway Network and Infrastructure



The state and local jurisdictions have standard cross section requirements for each functional class of roadway. Table 8 describes the standards for the roads along the Study Corridor alignment.

Table 8: Vehicle Miles Traveled and Mileage Guidelines by Functional Classifications

	Urban Other Principal Arterial	Urban Major Collector	Local
Typical Characteristics			
Lane Width	11 feet – 12 feet	10 - 11 feet	8 feet – 10 feet
Inside Shoulder Width	0 feet	0 feet	0 feet
Outside Shoulder Width	8 feet – 12 feet	1 foot – 4 feet	0 feet – 2 feet
AADT	7,000 – 27,000	1,100 – 6,300	80 – 700
Divided/Undivided	Undivided/Divided	Undivided	Undivided
Access	Partially/Uncontrolled	Uncontrolled	Uncontrolled
Qualitative Description	• Serve major activity centers, highest traffic volume corridors, and longest trip demands • Carry high proportion of total urban travel on minimum of mileage • Interconnect and provide continuity for major rural corridors to accommodate trips entering and leaving urban area and movements through the urban area • Serve demand for intra-area travel between the central business district and outlying residential areas	• Serve both land access and traffic circulation in lower density residential, and commercial/industrial areas • Penetrate residential neighborhoods, often only for a short distance • Distribute and channel trips between local streets and arterials, usually over less than three-quarters of a mile	• Provide direct access to adjacent land • Provide access to higher systems • Carry no through traffic movement

Source: WSDOT. October 2013. Guidelines for Amending Functional Classification in Washington State. https://www.wsdot.wa.gov/mapsdata/travel/hpms/pdf/GuidelinesForAmendingFC_WaState.pdf. Accessed April 2, 2017.

Existing Roadway Condition

Pavement conditions on the corridor vary significantly, as indicated by the pavement condition information WSDOT collects for SR 7. Table 9 identifies pavement conditions on the Study Corridor alignment on a scale from good to very poor. Table 10 identifies existing characteristics of the Study Corridor alignment by section, including length, travel lanes, bikes lanes and parking.

Table 9: General Location of Pavement Condition on the Study Corridor Alignment

Study Corridor Alignment	From	To	Pavement Condition	
			Northbound	Southbound
SR 7	S 38th Street	S 40th Street	Fair-Poor	Poor-Very Poor
SR 7	S 45rd Street	S 48th Street	Fair-Poor	Poor
SR 7	S 50th Street	S 53rd Street	Poor-Very Poor	Poor-Very Poor
SR 7	S 70th Street	S 74th Street	Fair-Poor	Fair-Poor
SR 7	S 78th Street	S 80th Street	Poor	Good
SR 7	S 82nd Street	S 86th Street	Poor	Very Poor
SR 7	S 112th Street	S 114th Street	Poor	Good
SR 7	121st Street S	Garfield Street S	Poor	Good
SR 7	146th Street S	149th Street S	Poor	Fair
SR 7	149th Street S	153rd Street S	Fair	Poor
SR 7	162nd Street S	165th Street S	Poor	Fair
SR 7	167th Street S	169th Street S	Good	Poor
SR 7	170th Street S	173rd Street S	Poor	Good
SR 7	175th Street S	176th Street S	Good	Poor
SR 7	189th Street S	190th Street S	Very Poor	Fair

Source: WSDOT – Pavement Condition. January 6, 2017. Current Pavement Condition for Washington State Highways. https://www.arcgis.com/home/item.html?id=f49a4724610548c693680fa745b0a44e. Accessed April 2, 2017.

Table 10: Study Corridor Alignment Characteristics

Study Corridor Alignment	From	To	Length (miles)	Number of Travel Lanes	Bike Lanes Present	On-Street Parking
Pacific Avenue	S 9th St	S 11th St	0.15	2 NB, 2 SB, L Turn at Intersections	Y, sharrows*	Y, Parallel
Pacific Avenue	S 11th St	S 17th St	0.43	2 NB, 2 SB, L Turn at some Intersections	Y, sharrows	Y, Parallel
Pacific Avenue	S 17th St	S 21st St	0.29	1 NB, 1 SB, L Turn Lane, Transit in Median	N	Y, Parallel & Angle
Pacific Avenue	S 21st St	S 24th St	0.22	2 NB, 2 SB, Transit in Median	N	N
Puyallup Avenue	SR 7	E G St	0.51	2 EB, 2 WB, Median Turn Lane	N	Y, Parallel
E G St /E 26th St	Puyallup Ave	SR 7	0.61	1 EB, 1 WB	N	Y, parallel
Pacific Avenue	S 24th St	S 25th St	0.07	2 NB, 2 SB, Transit in Median	N	Y, parallel on west side
Pacific Avenue	S 25th St	S 27th St	0.14	2 NB, 2 SB, L Turn at some Intersections	N	N
Pacific Avenue	S 27th St	S 32nd St	0.48	2 NB, 2 SB, L Turn at some Intersections	N	N
Pacific Avenue	S 32nd St	S 38th St	0.63	2 NB, 2 SB, Median Turn Lane	N	N
Pacific Avenue	S 38th St	S 40th St	0.15	2 NB, 2 SB, Median Turn Lane	N	N
Pacific Avenue	S 40th St	S 46th St	0.39	2 NB, 2 SB, L Turn at some Intersections	N	N
Pacific Avenue	S 46th St	S 55th St	0.55	2 NB, 2 SB, Median Turn Lane	N	N
Pacific Avenue	S 55th St	S 57th St	0.13	2 NB, 2 SB, Median Turn Lane		Y, parallel on west side
Pacific Avenue	S 57th St	S 63rd St	0.35	2 NB, 2 SB, Median Turn Lane	N	N
Pacific Avenue	S 63rd St	S 65th St	0.18	2 NB, 2 SB, Median Turn Lane	N	Y, parallel at S 64th St intersection
Pacific Avenue	S 65th St	S 82nd St	1.04	2 NB, 2 SB, Median Turn Lane	N	N
Pacific Avenue	S 82nd St	S 84th St	0.12	2 NB, 2 SB, Median Turn Lane	N	Y, parallel on west side
Pacific Avenue	S 84th St	S 112th St	1.77	2 NB, 2 SB, Median Turn Lane	N	N
Pacific Avenue	S 112th St	204th St E	6.10	2 NB, 2 SB, Median Turn Lane, L Turn at some Intersections	Y, striped	N
8th Ave E	SR 7	200th St E	0.10	1NB, 1 SB	Y, striped	N
200th St E	8th Ave E	Hidden Village Dr E	0.18	1 EB, 1 WB	N	N

Study Corridor Alignment	From	To	Length (miles)	Number of Travel Lanes	Bike Lanes Present	On-Street Parking
Hidden Village Dr E	200th St E	204th St	0.30	1 NB, 1 SB, Median Turn Lane,	N	N
204th St	Hidden Village Dr E	SR 7	0.19	1 EB, 1 WB	N	N

Source: Google Maps. Accessed March 30, 2017.

* Also known as Shared Lane Markings (SLM). Road markings used to indicate a shared lane environment for bicycles and automobiles. (Definition provided by National Association of City Transportation Officials [NACTO]). Urban Bikeway Design Guide. http://nacto.org/publication/urban-bikeway-design-guide/bikeway-signing-marking/shared-lane-markings/. Accessed April 7, 2017.

Freight

The Washington State Freight and Goods Transportation System classification system is used to classify state highways, county roads, and city streets into the following five tiers of freight tonnage moved on the roadway:

- T-1 – More than 10 million tons per year
- T-2 – 4 million to 10 million tons per year
- T-3 – 300,000 to 4 million tons per year
- T-4 – 100,000 to 300,000 tons per year
- T-5 – at least 20,000 tons in 60 days

Roadways classified as T-1 and T-2 are considered Strategic Freight Corridors (SFC).[15] The following segments of Pacific Avenue/SR 7 are designated as SFCs:

- T-2: S 38th Street to SR 512
- T-1: SR 512 to Roy Y Park-and Ride
- T-2: Roy Y Park-and-Ride to south terminus

2.3.2 Future Traffic Volumes – Without Project Conditions

Average daily traffic volumes were estimated to provide a high-level assessment of the traffic conditions in the Study Corridor without the HCT project. Average daily traffic (ADT) volumes were forecast for 2025 and 2045 using Sound Transit's ST3 model and using base year ADT data from 2015.

Traffic volumes on Pacific Avenue are forecast to grow approximately 1 to 2 percent annually through 2025, except for lower traffic volume growth south of the Roy Y. Growth rates slow when forecasting from 2025 to 2045, ranging between 0.5 percent and 1.7 percent annual growth. The largest growth rates in traffic are projected for the north end of the corridor. The forecast ADT volumes for Pacific Avenue in 2045 range from 25,000 to 44,000 vehicles along the corridor. Results of the forecast traffic volumes are shown in Table 11.

Table 11: 2015 and Forecast Traffic Volumes at Key Points on the Study Corridor

Pacific Avenue Forecast Location	Base Year ADT	Forecast ADT	
	2015	2025	2045
South of Roy 'Y'	27,000	28,000	29,000
South of Military Road	38,000	42,000	44,000
South of 96th Street	20,000	23,000	25,000
South of 38th Street	19,000	22,000	26,000
South of 21st Street	15,000	18,000	25,000

Source: WSP

[15] SFCs defined by RCW 47.06A.010 as a transportation corridor of great economic importance within an integrated freight system that carried freight tonnages of at least four million gross tons annually on state highways, city streets, and county roads. Source: http://www.wsdot.wa.gov/Freight/EconCorridors.htm.

2.3.3 Traffic Congestion

Per the PSRC 4k model, general traffic congestion trends are not forecasted to change dramatically by 2025 or 2045. The major traffic flow along Pacific Avenue is expected to remain mostly directional, heading northbound in the AM Peak and southbound in the PM Peak. Table 12 below summarizes estimated future v/c ratios at five screenlines along Pacific Avenue/SR 7. For this high-level assessment, any v/c ratio less than 0.60 is considered to reflect free-flow traffic conditions, whereas v/c ratios greater than 0.60 would reflect increasing congestion, and a v/c ratio of 1.00 or greater indicates a severely congested condition. The AM Peak continues to exhibit relatively consistent v/c ratios in the off-peak direction with the peak direction exhibiting volumes approaching or exceeding the roadway's capacity—indicating the potential for high levels of congestion.

Table 12: 2025 and 2045 Traffic Congestion at Key Points on the Study Corridor

Pacific Avenue	2025 Volume to Capacity Ratio				2045 Volume to Capacity Ratio			
	AM		PM		AM		PM	
	NB	SB	NB	SB	NB	SB	NB	SB
North of S 19th Street	0.15	0.31	0.20	0.27	0.20	0.45	0.51	0.45
North of E 56th Street	0.89	0.29	0.52	0.80	0.89	0.36	0.56	0.82
North of SR 512	0.68	0.31	0.46	0.61	0.70	0.33	0.48	0.67
North of Military Road	1.02	0.33	0.62	0.94	1.07	0.30	0.60	0.98
North of 208th Street E.	0.87	0.25	0.44	0.77	0.90	0.26	0.46	0.78

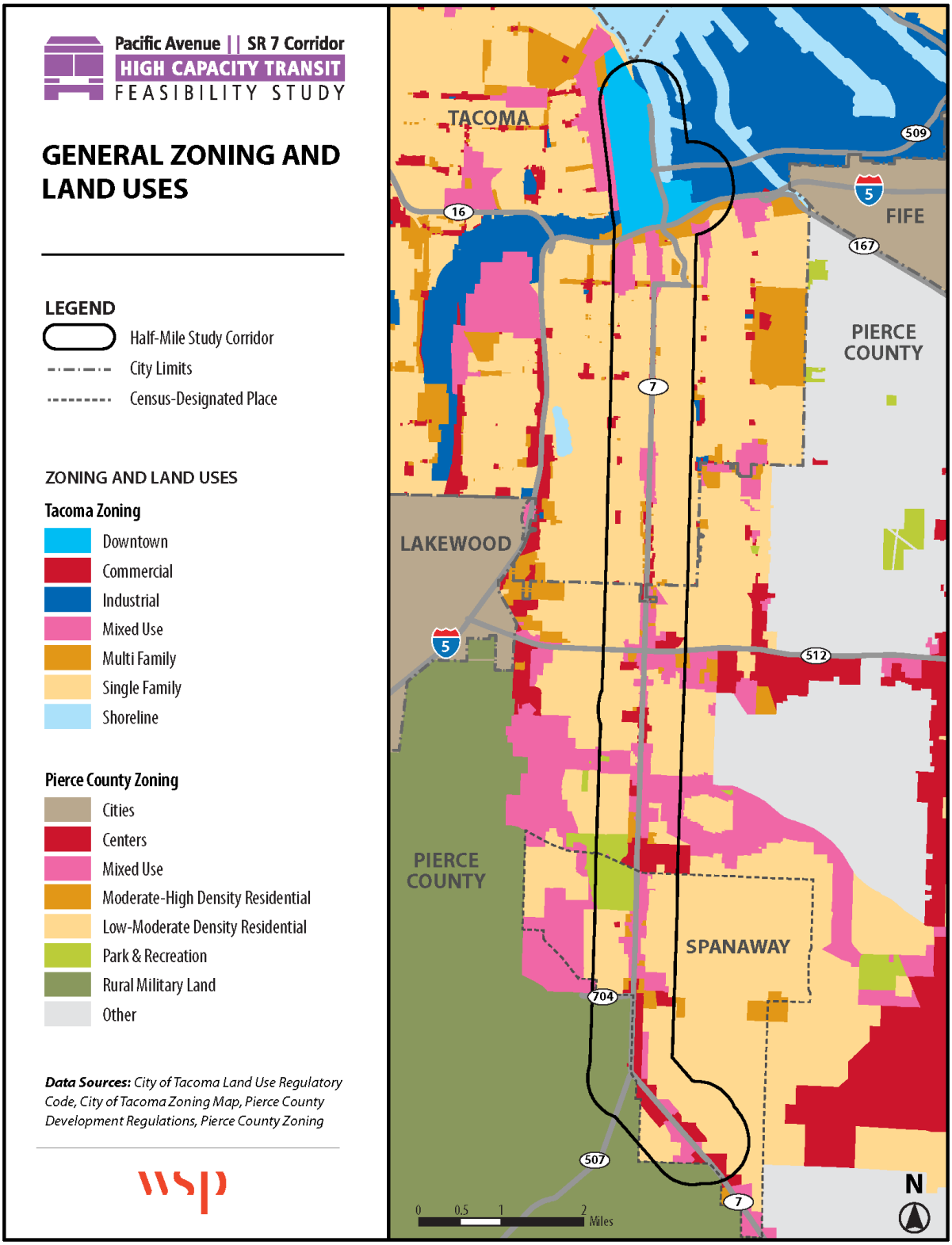
Source: DKS/WSP

2.4 Land Use

The review of current zoning and existing land use in the Study Corridor is broken into two segments: Tacoma (Downtown Tacoma and South Tacoma) and Unincorporated Pierce County (Parkland-Spanaway-Midland). Figure 9 presents the land use types in both sections with information about the current zoning and land uses within the City of Tacoma from their municipal code and zoning map,[16,17] and information about Pierce County's current zoning and land uses came from their code and zoning map.[18,19] More detailed information is included by section following the figures.

[16] City of Tacoma. March 2017. Title 13 – Land Use Regulatory Code. http://www.cityoftacoma.org/cms/one.aspx?objectId=2255. Accessed March 23, 2017.
[17] City of Tacoma. October 31, 2016. Zoning. http://wspdsmap.ci.tacoma.wa.us/samples/zoning.pdf. Accessed March 23, 2017.
[18] Pierce County. September 2016. Title 18A Development Regulations – Zoning. http://www.codepublishing.com/WA/PierceCounty. Accessed March 23, 2017.
[19] Pierce County. Zoning - Full County: Full County: Zoning. http://yakima.co.pierce.wa.us/MapGallery/index.cfm?event=displayMapInformation&id=198. Accessed March 23, 2017.

Figure 9: General Zoning and Land Uses



2.4.1 Tacoma

Tacoma's land use designations include eight residential zones. Other land use designations define different types of commercial areas, growth centers, designations for Parks and Open Space, Major Institutional Campus and Shoreline.

The Tacoma Comprehensive Plan has designated two areas as "crossroads centers," defined as a concentration of commercial and/or institutional development that serves many nearby neighborhoods and generally includes a unique attraction that draws people from throughout the city. Some residential development may already be present, and there is a goal to have more residential development at these centers. The Minimum Allowable Development Density in these centers is 25 dwelling units/net acre.

Residential densities are calculated based on underlying densities for each designation, with bonuses for Planned Residential Developments (PRD), additional bonuses for PRD Affordable Housing, and even greater bonuses for PRD with Sustainability Features. This gives the following ranges by dwelling types[20]:

- Single-Family Zone: 5.8-17.5 dwelling units/acre
- Two-Family Zone: 14.5-29 dwelling units/acre
- Multi-Family Low Density: 29-58 dwelling units/acre
- Multi-Family High Density: 43.6-116 dwelling units/acre.

Downtown Tacoma

Current Zoning: Downtown Tacoma is a PSRC-designated Regional Growth Center, which is reflected in its zoning. Beginning at the north end, the Study Corridor west of I-705 and north of I-5 is zoned Downtown, with sub-designations including Commercial Core, Mixed-Use, Residential, and Warehouse/Residential. The area along Thea Foss Waterway is a Combined Shoreline Zone, which allows a mix of uses. The Port of Tacoma area is to the east of the waterway, zoned for Maritime, Heavy, and Light Industrial use.

Existing Land Uses: Downtown Tacoma is heavily developed, although vacant and underutilized parcels and buildings remain. There are currently 45,000 jobs, including financial, health and professional services.[21] Defined areas/districts in Downtown Tacoma within the Pacific Avenue/SR 7 HCT Study Corridor include:

- St. Helens: Medium density mixed-use with retail, residential and commercial.
- Commercial Core: Center with office, government, culture, and commercial.
- UWT/Museum District: University of Washington Tacoma campus, Greater Tacoma Convention and Trade Center, several museums, plus some housing and commercial.
- Old Brewery District: The least-intensely developed area in Downtown, including a small amount of housing and commercial property and a relatively high-amount of vacant or underutilized property. This area, however, is redeveloping rapidly with changes occurring during the course of this study.

[20] Tacoma Municipal Code. http://cms.cityoftacoma.org/cityclerk/Files/MunicipalCode/Title13-LandUseRegulatoryCode.PDFAccessed April 4, 2017.
[21] City of Tacoma. One Tacoma Plan, Chapter Twelve, Downtown. http://cms.cityoftacoma.org/Planning/OneTacomaPlan/1-12Downtown.pdf. Accessed April 4, 2017.

- Dome District: Tacoma Dome; Sounder, Amtrak, Tacoma Link, Pierce Transit and Sound Transit bus stations; America's Car Museum; and the Freighthouse Square retail/restaurant center. Like the Old Brewery District, this area of the Regional Growth Center is less intensely developed.
- Thea Foss Waterway: Between the Port of Tacoma and downtown, this area is a growing mixed-use neighborhood, with parks, residential, office, and commercial property.
- Hilltop A mix of very high *and* very low-density housing.

Current zoning allows heights ranging from 90 feet in the Downtown Residential District to 400 feet in the Downtown Commercial Core. The Downtown Regional Center zoning capacity is sufficient to accommodate planned growth of 76,200 new residents and 67,900 new jobs by 2040.[22]

Proposed/Planned Zoning Changes: There are no planned rezones within this segment.

Tacoma South of I-5

There are two Crossroads Centers along Pacific Avenue in South Tacoma: Lower Pacific and Upper Pacific.

Lower Pacific Crossroads Center

Current Zoning: Lower Pacific Crossroads Center straddles Pacific Avenue between I-5 and S 40th Street with the major intersecting arterial of S. 38th Street. It is zoned Mixed-Use Center along Pacific Avenue and Single-Family and Multi-Family away from the arterial. Approximately four blocks are zoned as Other Institutional.

Existing Land Uses: A mix of commercial (23 percent), institutional (19 percent), multi-family (14 percent), single-family (13 percent), educational facilities (2 percent), and transportation/utilities (3 percent); vacant land currently accounts for 26 percent of the center.[23] Uses include the Tacoma-Pierce County Health Department, Puget Sound Hospital, and auto-oriented retail and services.

Planned Future Use: A new Pierce County building accommodating more than 1,000 employees is planned for the area.

Proposed/Planned Zoning Changes: A few partial blocks within the Study Corridor are identified as possible multi-family rezones. The nine blocks directly south of the center, along Pacific Avenue, are identified as potential rezones to a mix of multi-family (low density), multi-family (high density), and neighborhood commercial.

Upper Pacific Crossroads Center

Current Zoning: This area is centered around the intersection of Pacific Avenue at S. 72nd Street and is zoned Mixed-Use Center.

Existing Land Uses: There is a Fred Meyer shopping center, strip commercial development, and some small apartment buildings of between one and three stories. These buildings are surrounded primarily by single-family homes and a public park that was previously a private blueberry farm, where blueberries can

[22] City of Tacoma. Downtown Tacoma Regional Growth Center. http://www.cityoftacoma.org/cms/one.aspx?portalId=169&pageId=117951. Accessed April 4, 2017.
[23] City of Tacoma. Tacoma Mixed Use Centers, October 1, 2015. http://cms.cityoftacoma.org/Planning/2015%20Annual%20Amendment/Exhibit%20Section%20B%20-%20MUC.pdf. Accessed April 4, 2017.

now be harvested for free. Within the defined center boundaries, commercial uses are 48 percent, multi-family 20 percent, single-family 23 percent, and vacant land 8 percent, with 1 percent other institutional.[24]

Planned Future Use: Retail demand is expected to continue to grow as the trade area grows, with support from additional residential density in the area. The vacant land in the center provides a strong opportunity for new multi-family development.

Proposed/Planned Zoning Changes: There are no changes planned in this area.

Pacific Avenue in Tacoma outside the Crossroads Centers

Current Zoning: Outside the Crossroads Center, zoning along Pacific Avenue is primarily single-family residential with limited multi-family. There are occasional sites with commercial zoning directly along Pacific Avenue; however, the City's plan is to focus mixed-use development in the two Crossroads Centers, rather than evenly along the arterial/highway.

Existing Land Uses: A mix of single-family residential, strip commercial, and limited multi-family residential areas.

Proposed/Planned Zoning Changes: Extensive areas along Pacific Avenue are targeted for rezoning, primarily along the arterial frontage for multi-family and neighborhood commercial.

Unincorporated Pierce County

Parkland-Spanaway-Midland (PSM)

The PSM planning area encompasses 20 square miles from the Tacoma City boundary in the north to Joint Base Lewis-McChord (JBLM) in the south. The zoning throughout the PSM planning area is predominantly single-family, but the zoning abutting Pacific Avenue/SR 7 is primarily mixed-used and "center" designations, with the exception of some stretches of multi-family zoning.

Current Zoning: For the center as a whole, the current zoning has 18 percent of the land zoned mixed-use or as one of three types of centers: activity, employment and community. Most of the remaining land (78.2 percent) is zoned almost entirely single-family. There are Special Use zoning designations in areas where these exist; for example, Pacific Lutheran University (PLU) is zoned Major Institution Overlay.

Existing Land Uses: Existing uses and future plans identify commercial nodes at Pacific Avenue and the intersections of 131st Street S. and 176th Street S.[25] Currently, Pacific Lutheran University occupies a large site to the west of Pacific Avenue/SR 7 just south of the Tacoma city limits, and the entire length of the highway is a succession of strip development. More densely developed areas include the stretch between 133rd Street S and 140th Street S, which includes larger retailers, a Pierce County Library branch, smaller strip malls, and multi-family housing. At 176th Street E, a major east-west arterial that becomes SR 704, there is strip commercial development and multi-family housing.

Proposed/Planned Zoning Changes: Proposed changes in Land Use Designations would reduce the land zoned mixed-use from 13.5 percent to 4.7 percent, while increasing high-density residential from 0.9 percent to 5.2 percent. No other land use designation would change by more than two percentage points.

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[24] Ibid.

[25] Pierce County Comprehensive Plan, Effective June 30, 2016. http://wa-piercecounty2.civicplus.com/DocumentCenter/View/38483. Accessed April 4, 2017.

2.4.2 Key Destinations and Community Centers

Regional centers

- Downtown Tacoma — Tacoma is the region's second-largest city and Downtown Tacoma is a PSRC-designated Regional Growth Center. In 2010, it had 31,502 jobs and 13,360 residents.[26] Major employers include MultiCare Health Systems, CHI Franciscan Health, and City and County governments. Downtown Tacoma is home to numerous arts institutions and to the University of Washington-Tacoma campus. It is currently served by bus, light rail, commuter rail, and Amtrak.
- Port of Tacoma — A PSRC-designated Manufacturing and Industrial Center (MIC), the Port abuts downtown Tacoma and generates 29,000 jobs and nearly $3 billion in economic activity. International trade moving through the Port in 2015 totaled $52.1 billion, with an additional $5.4 billion in trade with Alaska. In January of 2017, the Port recorded a 17 percent year-over-year growth in container cargo.[27]

Government centers

- Tacoma Municipal Building — Houses the Mayor, City Manager, City Council offices, and major City departments except for the municipal court and Tacoma Public Utilities.
- County-City Building — Houses Pierce County government, including the courts, the Sheriff's Department, and the main jail.

Colleges and universities

- Bates Technical College — Founded in 1940 and now operated under the Washington State Board for Community and Technical Colleges, Bates is a two-year public technical college offering Associate's degrees in applied science, certificates in several fields, and transfer credit to four-year colleges and universities. It serves 3,000 career-track students and 20,000 community members.[28]
- University of Washington-Tacoma — A four-year undergraduate, graduate, and post-graduate campus of the University of Washington that opened in 1990. It offers degrees in a wide range of fields, and where it does not offer a full four-year program in a subject, students can transfer to another state college/university campus (or other four-year institution) to complete their degrees. It serves roughly 5,000 undergraduates in the heart of downtown Tacoma and employs almost 1,000 faculty and staff.[29]
- Pacific Lutheran University (PLU) — Founded in 1890, PLU is a private non-profit university serving 3,300 students with undergraduate and graduate degrees in a broad array of fields. [30] The Pierce County Comprehensive Plan also identifies this area as a potential center.

Stadiums and arenas

- Tacoma Dome — An indoor arena that opened in 1983, the Tacoma Dome seats approximately 17,000 people for sporting events, 23,000 for concerts, and as many as 30,000 for religious events.

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[26] PSRC. Tacoma Downtown Regional Growth Center Profile, 2010 Summary Statistics. https://www.psrc.org/sites/default/files/rgc-profile-tacoma-downtown_0.pdf. Accessed April 5, 2017.
[27] Port of Tacoma. 2014Annual Report. http://www.portoftacoma.com/sites/default/files/2014AnnualReport-web.pdf. Accessed March 23, 2017.
[28] Bates College: About Bates. http://www.bates.ctc.edu/about-bates. Accessed April 4, 2017.
[29] University of Washington Tacoma, phone call to Payroll Office, confirmed enrolment and staffing levels. April 5, 2017.
[30] Pacific Lutheran University. http://www.plu.edu/. Accessed April 4, 2017.

It also hosts a variety of expos and fairs, as well as graduation commencement ceremonies for local schools.[31]

Hospitals and medical centers

- St. Joseph Medical Center — St Joseph is a major hospital and trauma center with around-the-clock services and several associated clinics. Opened in 1891, the hospital employs 3,600 people and has 361 licensed beds. In 2016, it served more than 54,000 emergency visits, over 111,000 in-patient days, more than 238,000 outpatient visits, and nearly 4,300 births.[32]

Performing and other arts centers and meeting venues

- Broadway Center for the Performing Arts/Pantages Theater — The Pantages Theater opened in downtown Tacoma in 1913 and is now part of the Broadway Center for the Performing Arts, which also includes the Rialto and the Theatre on the Square. The complex is home to the Tacoma City Ballet, Tacoma Opera, Symphony Tacoma, Northwest Sinfonietta, and others. In 2015, the Center hosted 233,500 total visitors, including 105,000 attending outdoor events, parades, and festivals.[33]
- Greater Tacoma Convention and Trade Center — The Convention and Trade Center opened in 2004 and offers 119,000 square feet for events, with 800 nearby hotel rooms to host visitors. In addition to conferences and conventions, it hosts trade shows, social events and weddings, sports and competitions, and other meetings.[34]

Tacoma Museum District

The Tacoma Museum District comprises six museums within walking distance of each other that are covered under a single annual visitor's pass:

12.A Children's Museum of Tacoma — Founded in 1985 by Tacoma parents, the Children's Museum served nearly 170,000 people between June 2014 and May 2015, with an annual budget of $1.3 million, a "Pay as You Will" entrance philosophy (average donation $2.37), and thousands of volunteer hours.[35]

12.B Tacoma Art Museum — Founded by volunteers in 1935, the Tacoma Art Museum moved to a new purpose-built facility in 2003 that has since been expanded to provide more display space for owned and traveling exhibits.

12.C Museum of Glass — This 79,000-square-foot space and the Chihuly Bridge of Glass associated with it opened in 2002, more than a decade after the region had begun to be known worldwide as a center of the Studio Glass movement, sparked in part by Tacoma native Dale Chihuly.

12.D Washington State History Museum — This museum is a transformation and expansion of Tacoma's Union Station and is one of two museums operated by the Washington State Historical Society. Permanent and changing exhibits tell the history of the state and its people. This museum permanently houses the largest model train layout in the state.

12.E LeMay - America's Car Museum — With 165,000 square feet indoors and a 3.5-acre "show field," the Car Museum opened in 2012 to display the largest privately-owned collection of

[31] Tacoma Dome. https://tacomadome.org/. Accessed April 4, 2017.
[32] CHI Franciscan Health. https://www.chifranciscan.org/st-joseph-medical-center.html. Accessed April 4, 2017.
[33] Broadway Center for the Performing Arts. http://www.broadwaycenter.org/. Accessed April 4, 2017.
[34] Greater Tacoma Convention and Trade Center. https://gtctc.org/. Accessed April 4, 2017.
[35] Tacoma Children's Museum. https://www.playtacoma.org/. Accessed April 4, 2017.

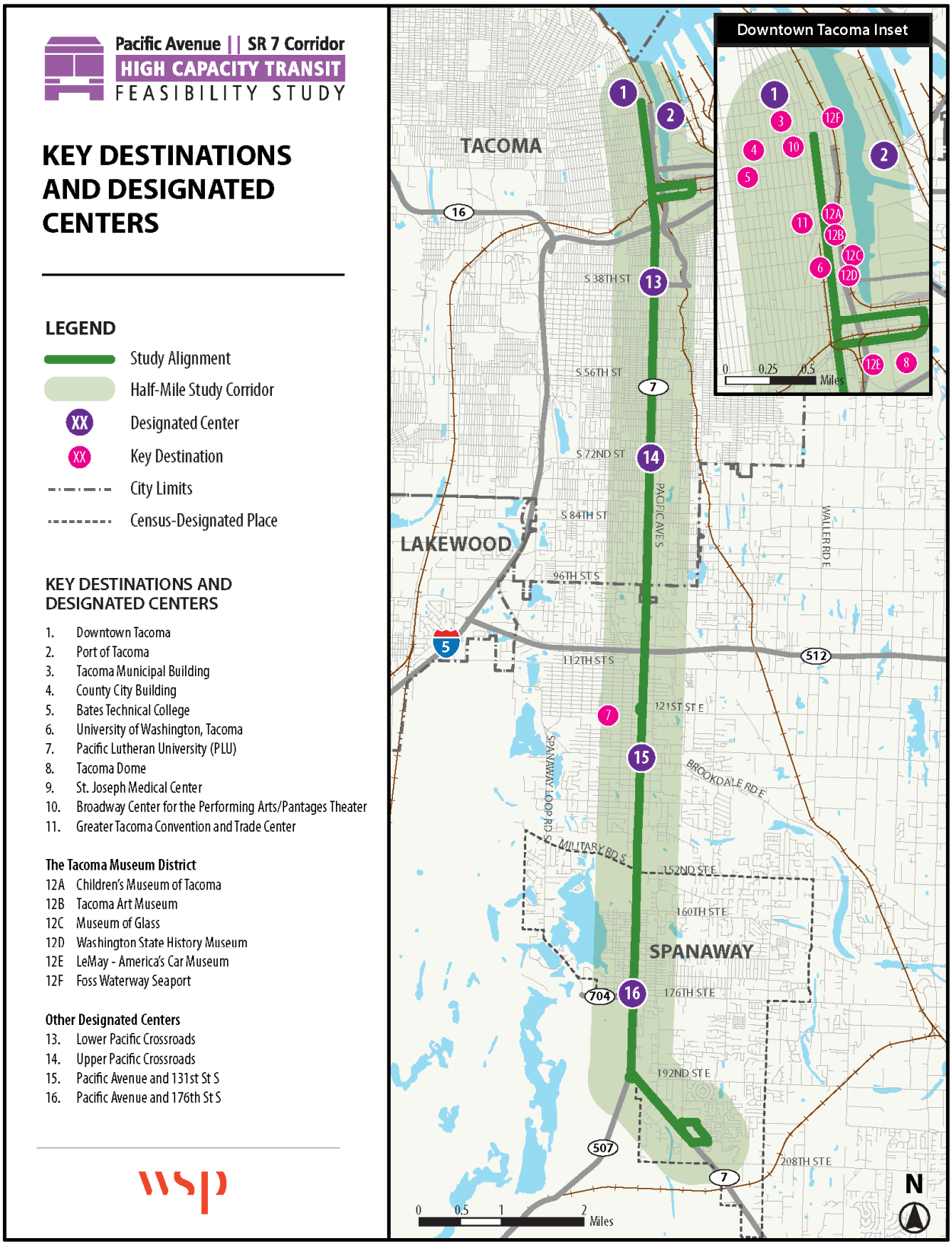
automobiles and memorabilia in the world. During the first summer, over 100,000 people visited the museum, which projects ongoing annual attendance upwards of 400,000.[36]

12.F Foss Waterway Seaport — Located at Tacoma's original deep-water dock, the Seaport is a Working Waterfront Maritime Museum. In addition to hosting museumgoers, the project has active programs for school-age children in boat-building and aquatic marine and environmental science programs. Over 20,000 visitors and students engage with the project every year.[37]

The locations of the key designations and designated centers described above is shown in Figure 10.

[36] LeMay America's Car Museum, https://www.americascarmuseum.org/about/. Accessed April 5, 2017.
[37] Foss Waterway Seaport, http://www.fosswaterwayseaport.org/. Accessed April 5, 2017.

Figure 10: Key Destinations and Designated Centers



3 PROJECT PURPOSE AND NEED

3.1 PURPOSE AND NEED

A Purpose and Need Statement is a critical element of the alternatives analysis; it documents what Pierce Transit intends to accomplish with the project (Purpose) and the problems with the current service that the project would address (Need). The Purpose and Need Statement is supported by goals that are linked to the project purpose (typically with one goal for each primary element of the Purpose Statement). In turn, each goal is supported by one or more evaluation measures that are used to evaluate specific alternatives. The evaluation measures are non-duplicative, non-distracting (e.g., only measure things that inform the ultimate decision), and easy for policymakers and the public to understand.

The purpose of the Pacific Avenue/SR 7 HCT project is presented below. The primary elements were developed by Pierce Transit in coordination with stakeholders.

Purpose Statement

The purpose of the Pacific Avenue/SR 7 HCT project is to establish a north/south HCT link in the heart of Pierce County and serving Pierce Transit's busiest transit corridor. The project will:

- Increase transit ridership through enhanced transit service.
- Deliver cost-effective service that provides capacity to meet future demand.
- Promote transportation equity in the corridor by ensuring that transit service is accessible to all populations.
- Improve multi-modal access and connectivity.
- Support a regional vision for the community as documented in land use and transportation plans.
- Enhance safety and security for transit patrons and public health overall.
- Support existing economic activity and be a catalyst for sustainable economic growth and corridor redevelopment.
- Promote environmental stewardship and sustainability.

The need for the project results from:

- High Transit Demand. In October 2016, there were more than 5,500 average daily weekday boardings on the Pierce Transit Route 1 (2,800 northbound and 2,760 southbound). There are five northbound and four southbound stops that average more than 100 boardings per day, as well as overloads or heavy passenger loads on some trips. Enhanced transit service would better accommodate this demand.
- Decreasing Transit Travel Speeds. Average bus speeds in the Study Corridor are relatively slow and have been decreasing. Current average bus speeds are as low as 6 MPH on some segments during congested time periods, and the difference in bus travel times through the corridor can vary by six or seven minutes depending on direction and time of day, which reflects a 48percent

to 62percent travel time increase. Corridor improvements are needed to mitigate these decreased travel speeds and improve transit speed through the Study Corridor.

- Poor Service Reliability. Transit service reliability is measured by on-time performance, both in the percentage of trips that are on time (defined as "no more than five minutes late") and how many minutes on average that they are late. Service reliability is important to riders, especially those who use transit to travel to work, school, appointments, or other trip purposes that are time sensitive. Route 1 has reliability problems, primarily in the PM Peak period and in the southbound direction. The 90th percentile performance shows what a rider could expect on nine out of 10 weekday trips, a reasonable tolerance for schedule unreliability for regular travelers. The 90th percentile measure for October 2016 using AVL data for both AM Peak and Midday periods shows actual travel times for both directions running about eight to 10 minutes late, and PM Peak time in both directions about 15 minutes late (times are given for service between 14th/Pacific to the end of the line at SR 7/204th Street E). The variability between travel times is particularly stark for the PM southbound direction where the average difference between the 25th and 90th percentiles is approximately 21 minutes (this is the largest difference of any time/direction). Improvements to transit travel time reliability are needed.
- High Corridor Population and Population Density. Population and related density along a transit corridor are important factors in determining the need for transit. Higher population and greater population density along a corridor typically results in a greater market or demand for transit and justifies higher levels of service and service quality. With nearly 55,000 people, the Study Corridor is home to 6.7 percent of Pierce County's population and is much more densely populated than the County as a whole, averaging nearly 3,800 people per square mile compared to 455 people per square mile for the overall County. In addition, the population in the Study Corridor is projected to grow by nearly 25 percent between 2010 and 2040. This corresponds to an increase in average corridor density from roughly 3,800 people per square mile in 2015 to more than 5,500 people per square mile on average in 2040—a density increase of more than 40 percent. This exceeds the average for Pierce County, which is projected to have a 16-percent increase in population and a 35-percent increase in average persons per square mile.
- Increased Employment. Employment is an important factor in determining transit demand, and higher levels of employment within a transit corridor can justify higher levels of service and service quality. In 2010, jobs in the Study Corridor represented nearly 10 percent of the jobs in Pierce County. In 2025 and continuing into the future, jobs in the Study Corridor will represent upwards of 11.4 to 11.9 percent of jobs in the county. In total, the Study Corridor had nearly 31,500 jobs in 2010. In 2040, jobs in the Study Corridor are forecasted to increase to just over 59,000.
- Transit Dependency. Transit dependency, as indicated by both car availability and household income level, is a strong indicator of transit need within a corridor and a high level of transit dependent populations can justify higher levels of service and service quality. Approximately 11 percent of the households in the study do not have a motor vehicle, compared to 5.8 percent for Pierce County as a whole, indicating that this Study Corridor is disproportionately transit-dependent in comparison to the overall county. In addition, the 2015 median household income in the Study Corridor is $12,000 less than the median household income in Pierce County overall. Furthermore, nearly 6 percent of the residents within the Study Corridor are unemployed, compared to 4.5 percent countywide, and more than 20 percent of residents within the Study

Corridor are below the federal poverty level. Enhanced public transit is needed to better serve the transit-dependent population in this corridor.

- Safety Concerns. In the Study Corridor along the SR 7 and Pacific Avenue study alignment, there were 2,967 recorded crashes over a five-year period between 2012 and 2016. This included 13 fatal crashes, five involving pedestrians, and one involving a bicyclist. There was a total of 137 crashes during this period that involved a bicyclist or a pedestrian. Improved pedestrian and bicycle access to transit in the Study Corridor will make travel safer for pedestrians, bicyclists and transit riders.
- Growing Transit Communities Designation. The PSRC Metropolitan Planning Organization has established a TOD Program called Growing Transit Communities (GTC), funded through the U.S. Department of Housing and Urban Development's Sustainable Communities Regional Planning Grant Program. The program focuses on capitalizing on transit investments by growing and strengthening TOD, recognizing that transit investments present once-in-a-lifetime opportunities to support and improve existing communities, and meet regional goals through strategies to make great places for people to live and work. Transit communities included in the GTC work have either existing or planned light rail station locations or other major transit nodes such as BRT station locations. Within the Study Corridor, the following nodes are included in the GTC Strategy:
    - Theater District
    - Convention Center
    - Union Station
    - S. 25th Street Station
    - Tacoma Dome
- Corridor Development Potential.
    - Transit improvements could catalyze development improvements that support higher densities of use beyond the existing conditions.
    - The I-5 to S. 38th Street segment offers proximity to downtown, access to I-5, and underutilized land. These factors suggest that the area has development potential, especially as prices rise downtown. A portion of this segment also benefits from Tacoma's Multifamily Property Tax Exemption (MPTE) Program designation.
    - A portion of the 68th Street to 80th Street segment is a designated as an MPTE area. For this reason, the 68th to 80th Street segment is likely to attract attention from multi-family developers in the future.

By providing fast and reliable transit service in the Pacific Avenue/SR 7 corridor, HCT would enhance the development potential of these areas.

3.2 Goals and Performance Measures

1. The project will increase transit ridership by reducing transit travel time, improving trip reliability, increasing service frequency, and enhancing transit's comfort, convenience and image.

    Evaluation Measures:

    a. Average weekday boardings

b. Corridor end-to-end transit travel time during weekday peak periods
c. Weekday peak-hour on-time performance (no more than five minutes late)
d. Service frequency during weekday peak and midday hours
e. Percentage of stops with shelters and rider amenities
f. Degree to which a new image is created for the transit service, as evidenced by service branding and marketing, and the attractiveness of stations and vehicles.

2. The project will provide cost-effective transit service in the Study Corridor.

   Evaluation Measures:
   a. Weekday average operating cost per boarding
   b. Total net additional annual operating cost for corridor service
   c. Weekday boardings per service hour (productivity)
   d. Farebox revenues and recovery ratio

3. The project will increase transit capacity to meet current and projected transit travel demand.

   Evaluation Measure:
   a. Projected peak hour ridership divided by peak hour vehicle capacity

4. The transit service will be accessible to all populations, including minorities, people with low-income levels, and those that are transit dependent.

   Evaluation Measures:
   a. Transit service frequency serving census tracts with above average percentages (compared to the County as a whole) of minority populations, people with income below the federal poverty level, or households with no cars.
   b. Transit stations/stops within one half mile of people living in census tracts with above average percentages (compared to the County as a whole) of minority populations, people with income below the federal poverty level, or households with no cars.
   c. Minority, low-income and transit-dependent population living within one half mile of a HCT transit station/stop.

5. The project will promote environmental stewardship and sustainability by reducing greenhouse gas emissions and supporting smart growth.

   Evaluation Measures:
   a. Greenhouse Gas Emissions
   b. PM peak hour mode split (percentage of people travelling by mode)
   c. Degree to which smart growth is supported by providing premium transit service, measured by service frequency, travel time, and reliability and establishing permanence of the transit service, measured by the level of investment in the transit infrastructure along the corridor.
   d. Area of developable land adjacent to the corridor with the potential for transit-oriented infill development (TOD), including areas having no parking or minimal parking requirements,
   e. Total average weekday emissions from transit vehicles

6. The project will improve access to the Study Corridor transit service by pedestrians and bicyclists

   Evaluation Measures:
   a. Average walking distance to stops
   b. Percentage of the corridor with minimum 5-foot sidewalks
   c. Percentage of corridor with striped bicycle lanes

7. The project will provide improved connections with other local or regional travel modes

   Evaluation Measures:
   a. Connections to other transit modes, including other Pierce Transit bus routes, Sound Transit Tacoma Link, planned Sound Transit Tacoma Link extension, Sound Transit Express routes, Sounder commuter rail, Intercity Transit Express routes, Greyhound, and Amtrak
   b. Number of park and ride spaces with access to the transit service

8. The project will have a high likelihood of funding through identified grant programs and funding sources.

   Evaluation Measures:
   a. Total estimated project capital cost
   b. Likelihood of funding through established Federal Transit Administration (FTA) programs
   c. Ability to obtain the required local match

9. Enhance safety and security for transit patrons and public health overall.

   Evaluation Measures:
   a. Stops designed with Crime Prevention Through Environmental Design (CPTED) principles
   b. Number of signalized pedestrian crossings
   c. Percentage of stops with cameras and lighting
   d. Percentage of stops within 200 feet of a signalized pedestrian crossing

10. The project will support planned local and regional growth and corridor revitalization efforts.

    Evaluation Measures:
    a. Frequency of service connecting the southern part of the corridor with downtown Tacoma
    b. Peak hour travel times between the southern part of the corridor and downtown Tacoma
    c. Degree to which the project supports accommodation of Puget Sound Regional Council Transportation 2040 regional growth allocation
    d. Degree to which the project supports the City of Tacoma's development plans for the corridor
    e. Degree to which the project supports development envisioned in the Pierce County Communities Plan (for the Parkland-Spanaway-Midland subarea)

11. The project will be consistent with adopted local and regional transportation plans.

Evaluation Measures:

a. Degree to which the project is consistent with Pierce Transit's Destination 2040 Long Range Plan
b. Degree to which the project is consistent with the Puget Sound Regional Council's Transportation 2040 Long Range Plan
c. Degree to which the project is consistent with Sound Transit's ST3 Plan
d. Degree to which the project is consistent with the City of Tacoma's Comprehensive Plan and Transportation Master Plan
e. Degree to which the project is consistent with the Pierce County Transportation Element (Chapter 12 of the Comprehensive Plan)
f. Degree to which the project is consistent with the Washington State Department of Transportation's (WSDOT) Statewide Public Transportation Plan

12. The project will minimize adverse impacts to other travel modes and adjacent property

Evaluation Measures:

a. Number of intersections that fall below acceptable level of service (LOS) standard
b. Impact of freight travel time
c. Number of properties with property impact
d. Number of properties with access impacts
e. Number of properties with off-site parking impacts
f. Number of business or residential displacements

4 MODE EVALUATION

The Purpose and Need Statement includes a series of goals for the Pacific Avenue/SR 7 HCT project. A qualitative analysis was conducted to rate each travel mode based on how well it would achieve each goal and thereby meet the project's purpose. This analysis used the technical expertise of the study team and their knowledge of typical applications and performance of each mode in similar corridors.

4.1 EVALUATION

4.1.1 Travel Modes

The study team analyzed potential new travel modes for the corridor and a No Build option, which would carry forward existing Route 1 bus service into the future. In addition to a description of the mode, typical costs based on other built projects are given for each. The costs represent full project costs, including vehicles. However, note that there can be outliers, both above and below the given cost range, due to specific project attributes[1].

- Enhanced Bus Service – improves on current service with addition of some mix of traffic signal priority, station improvements, and increased frequency.
  Typical capital cost per mile ranges from $1 million to $3 million.
- Bus Rapid Transit (BRT) – is a high-capacity bus-based transit system that generally includes some or all of the following features: unique branding, dedicated lanes, traffic signal priority, off-board fare collection, elevated platforms for level boarding, and enhanced stations (including high-quality shelters, seating, real-time bus arrival information, and other passenger amenities). Typical capital cost per mile ranges from $4 million to $20 million.
- Streetcar – is a high-capacity fixed-rail transit system that is typically operated with single car trains powered by overhead catenaries and more frequent stops than LRT. Streetcar stations would be similar to BRT stations. For this analysis, Streetcar is assumed to operate in mixed-traffic or Business Access and Transit (BAT) lanes for a large portion of the alignment. Typical capital cost per mile ranges from $45 million to $55 million.
- Light Rail Transit (LRT) – is a high-capacity fixed-rail transit system that typically operates in a separate right-of-way (ROW), powered by overhead catenaries, and has less frequent stops and higher travel speeds than Streetcar. LRT stations would typically be larger and more extensive than Streetcar or BRT stations and the alignment would be largely (if not entirely) separated from mixed traffic.
  Typical capital cost per mile ranges from $180 million to $200 million.

The following modes were not included in this analysis because their cost and service profiles were deemed to not advance the project goals or fit the context of the project corridor:

- Heavy Rail – is a mode of transit service defined by the American Public Transportation Association (APTA) as a railway system with the capacity to handle a heavy volume of traffic. Heavy rail can also be referred to as metro, subway, rapid transit, or rapid rail and is characterized by higher-speed passenger rail cars that operate on fixed-rails, with separate ROW and high-platform boarding.

- Monorail – is an electric railway of guided transit vehicles that are suspended from, or straddle a guideway formed by a single beam.
- Personal Rapid Transit (PRT) – is a public transportation mode that features small automated vehicles operating on a network of specially built guideways.
- Electric Trolley Bus – electric trolley buses can operate as regular fixed route service, Enhanced Bus, or BRT, with the only difference that the vehicle uses overhead wires to power electric motors. This technology has been used for many years, but more recently, the preferred all-electric bus option is self-powered battery buses, especially as battery technology continues to improve. Battery propulsion is less expensive that overhead wires, and avoids the visual clutter created by the overhead wires.

4.1.2 Methodology

Each travel mode was rated quantitatively by the study team on a scale from 1 (Least) to 5 (Most) by how effectively use of that mode would advance each of the goals described in Section 3.2.

The results of the evaluation are presented in tabular form in Table 13 and discussed by goal below.

4.1.3 Goal 1 Results

The project will increase transit ridership by reducing transit travel time; improving trip reliability; increasing service frequency; and enhancing transit's comfort, convenience and image.

No Build (Current Service)	Enhanced Bus	BRT	Streetcar	LRT
1	3	4	4	5

Justification: LRT has the highest capacity, speed and reliability of all the modes assessed. Additionally, LRT is a comfortable and popular transit mode, which would improve the image of transit along this corridor. Because of these reasons, LRT is most likely to meet this goal. Streetcar and BRT would all represent large improvements over existing service, reducing transit travel time, improving trip reliability, and increasing service frequency, but not to the same degree as LRT.

4.1.4 Goal 2 Results

The project will provide cost-effective transit service in the Study Corridor.

No Build (Current Service)	Enhanced Bus	BRT	Streetcar	LRT
4	4	4	2	1

Justification: Typical capital costs by mile for each HCT mode evaluated are shown below. These costs represent a typical range of full project costs (including vehicles).

Regarding cost-effectiveness, although the rail projects (LRT and Streetcar) could result in higher ridership compared to the bus modes, they are disproportionately more costly than bus options in terms of capital infrastructure and potential ROW acquisition. Considering forecast population and potential transit demand through 2045, it is unlikely that any increased ridership attainable by these rail modes would be of a magnitude that would offset these higher costs. Due to the nature of some of the BRT upgrades, particularly at stations, there would likely be a higher cost associated with BRT than with an enhanced or existing bus service. However, in this case, the potential for increased ridership on BRT, as compared to the cost increase, typically would make BRT equally or more cost-effective when compared to bus service.

Typical HCT Capital Costs by Mode

HCT Mode	Typical Cost ($M/Mile)
Enhanced Bus	$1-3
Bus Rapid Transit	$4-10
Streetcar	$45-55
Light Rail	$180-200

4.1.5 Goal 3 Results

The project will increase transit capacity to meet current and projected transit travel demand.

No Build (Current Service)	Enhanced Bus	BRT	Streetcar	LRT
1	3	4	4	5

Justification: LRT has the potential to increase transit capacity more than the other modes. Streetcar and BRT have similar capacities. Maintaining the current service would not increase capacity.

4.1.6 Goal 4 Results

The transit service will be accessible to all populations, including minorities, people with low income levels, and those that are transit dependent.

No Build (Current Service)	Enhanced Bus	BRT	Streetcar	LRT
5	5	4	4	3

Justification: Because of the frequent stop spacing of the existing service, as well as for the Enhanced Bus option, the existing service profile is the most accessible to all populations, including those that are most transit dependent. Streetcar and BRT rate slightly lower due to anticipated longer distances between stations, while LRT would be the least accessible due to even longer distances between stations. However, BRT, Streetcar and LRT have improved accessibly at transit stops due to raised platforms and level boarding.

4.1.7 Goal 5 Results

The project will promote environmental stewardship and sustainability by reducing greenhouse gas emissions and supporting smart growth.

No Build (Current Service)	Enhanced Bus	BRT	Streetcar	LRT
2	3	4	5	5

Justification: The two rail modes rate highest for this measure due to their electric power, as well as the potential to facilitate transit-oriented growth around stations. The BRT mode rates relatively high because of the potential for transit-oriented growth around BRT stations, as well as the possibility of using electric BRT vehicles for this route. Enhanced Bus service has the potential to promote environmental stewardship by making transit a more attractive option, thereby reducing motor vehicle mode share from the current condition.

4.1.8 Goal 6 Results

The project will improve access to the Study Corridor transit service for pedestrians and bicyclists.

No Build (Current Service)	Enhanced Bus	BRT	Streetcar	LRT
1	3	4	4	3

Justification: All build modes have the potential to include enhanced access to transit improvements near stops/stations in the corridor. Improvements are expected to be most notable for facilities directly accessing transit stations. Therefore, LRT rates slightly lower than Streetcar or BRT because it is expected that there would be fewer stations in the corridor, and Enhanced Bus rates lower because bus stops are not expected to be improved to the station level.

4.1.9 Goal 7 Results

The project will provide improved connections with other local or regional travel modes.

No Build (Current Service)	Enhanced Bus	BRT	Streetcar	LRT
1	3	5	5	4

Justification: All build modes would likely serve the Tacoma Dome Station and the existing Sound Transit commuter rail, regional express bus and the future Tacoma Dome Link Extension light rail service. Streetcar and BRT are rated the highest because of their ability to service a large number of riders, as well as improved speed and reliability from standard bus service. LRT is rated slightly lower than Streetcar and BRT because of the expected distance between stations that may make it necessary for many riders in the corridor to take local transit to access it. Enhanced Bus would not offer riders improved speed and reliability as compared to the other modes, making connections to other modes a less attractive option.

4.1.10 Goal 8 Results

The project will have a high likelihood of funding through identified grant programs and new funding sources.

No Build (Current Service)	Enhanced Bus	BRT	Streetcar	LRT
1	2	4	3	2

Justification: BRT rates highest in this category because it is expected to score well on the FTA Small Starts rating criteria, particularly on the Cost-Effectiveness rating and the Local Financial Capacity rating. LRT and streetcar rate lower because of their expected high capital cost and anticipated low ratings for cost-effectiveness, as well as the costs to operate and maintain them (LRT rates lower than Streetcar because it is not likely to receive funding from New Starts). However, the two rail modes would likely rate similarly high to BRT on the two FTA Small Starts Land Use measures. Enhanced Bus would not likely score well on the FTA Small Starts rating criteria because of its smaller expected benefit.

4.1.11 Goal 9 Results

Enhance safety and security for transit patrons and public health overall.

No Build (Current Service)	Enhanced Bus	BRT	Streetcar	LRT
1	3	4	4	4

Justification: All build modes are expected to result in increased transit ridership, which, when paired with walking or bicycling to access transit, could lead to better overall health. Improving access to facilities will also contribute to a safer environment for transit riders. The greatest differentiation from a safety and security standpoint can be expected from the transit stations. The two rail modes and BRT would include the most investment in stations, design elements that discourage crime through increased visibility (e.g., well lit, eliminating places to hide) and increased usage and activity. These characteristics can result in more security for the transit rider as compared to the bus stops existing today. Enhanced Bus service would include some of these upgrades to stops, but not at as high a level as the other modes.

4.1.12 Goal 10 Results

The project will support planned local and regional growth and corridor revitalization efforts.

No Build (Current Service)	Enhanced Bus	BRT	Streetcar	LRT
2	3	4	4	5

Justification: Although all improved transit modes will support growth in the corridor, Enhanced Bus is expected to provide the least amount of support due to being viewed as a less permanent transit option compared to other build modes. LRT is a stronger catalyst for development and would create the most opportunities for TOD around stations. However, LRT construction and ROW requirements could also disrupt businesses. The Streetcar mode has similar issues in terms of disruption during construction, and Streetcar stations do not generally invite the same level of development as LRT stations. Similar to Streetcar, BRT stations and service do not generally support the same level of redevelopment and growth as LRT stations because, unlike fixed-guideway transit, a bus can more easily be rerouted or even removed

in the future. Investing more significantly in the BRT stations can demonstrate a commitment to the corridor and might therefore invite more development. Enhanced Bus would support some level of growth and revitalization by improving mobility in the corridor, but would not be seen as a permanent transit option and, therefore, would generate less interest in TOD.

4.1.13 Goal 11 Results

The project will be consistent with adopted local and regional transportation plans.

No Build (Current Service)	Enhanced Bus	BRT	Streetcar	LRT
1	4	5	1	1

Justification: The Sound Transit 3 System Plan calls for "bus capital improvements for speed, reliability and convenience" in this corridor, while the PSRC Long Range Plan (Transportation 2040) calls for "BRT and transit supportive infrastructure," and all scenarios considered in the Pierce Transit Long Range Plan (Destination 2040) assume enhanced bus or BRT along Pacific Avenue/SR 7. The BRT mode is consistent with these plans, while the Enhanced Bus mode is consistent with most. The other modes are not consistent with these plans and, therefore, have the lowest rating.

4.1.14 Goal 12 Results

The project will minimize adverse impacts to other travel modes and adjacent property.

No Build (Current Service)	Enhanced Bus	BRT	Streetcar	LRT
5	5	3	2	2

Justification: Rail projects will cause traffic conflicts (if in road) or major ROW issues (if in separate ROW). BRT may have some ROW impacts and possible traffic impacts if stopping in-lane. Enhanced bus and current service have minimal impact to other travel modes and adjacent property.

4.2 DECISION

A summary of the mode evaluation ratings is shown on Table 13.

Table 13: Mode Scores for Purpose and Need Goals

	Purpose and Need Goals	No Build (Current Service)	Enhanced Bus	BRT	Streetcar	LRT
1	The project will increase transit ridership by reducing transit travel time; improving trip reliability; increasing service frequency; and enhancing transit's comfort, convenience and image.	1	3	4	4	5
2	The project will provide cost-effective transit service in the Study Corridor.	4	4	4	2	1
3	The project will increase transit capacity to meet current and projected transit travel demand.	1	3	4	4	5
4	The transit service will be accessible to all populations, including minorities, people with low income levels, and those that are transit dependent.	5	5	4	4	3
5	The project will promote environmental stewardship and sustainability by reducing greenhouse gas emissions and supporting smart growth.	2	3	4	5	5
6	The project will improve access to the Study Corridor transit service for pedestrians and bicyclists.	1	3	4	4	3
7	The project will provide improved connections with other local or regional travel modes.	1	3	5	5	4
8	The project will have a high likelihood of funding through identified grant programs and new funding sources.	1	2	4	3	2
9	Enhance safety and security for transit patrons and public health overall.	1	3	4	4	4
10	The project will support planned local and regional growth and corridor revitalization efforts	2	3	4	4	5
11	The project will be consistent with adopted local and regional transportation plans.	1	4	5	1	1
12	The project will minimize adverse impacts to other travel modes and adjacent property.	5	5	3	2	2
	Total Score:	**24**	**41**	**49**	**42**	**40**
	Average Score by Goal:	**2.1**	**3.4**	**4.1**	**3.5**	**3.3**

LRT had the lowest average score by goal due to larger stop spacing, greater property impacts, and high capital costs. Streetcar has a higher capital cost than BRT while offering similar benefits in speed and reliability, and thus had a lower average score by goal than BRT. Enhanced Bus scored well on many of the service-oriented goals with a low score for funding opportunities, which brought down its average score by goal. The No Change (Current Service) option was carried forward through to the selection of a LPA since it provides a baseline from which other options can be compared.

Based on this analysis, as well as the partnering agency and public or stakeholder input, the project team recommended BRT as the HCT mode that best meets the project goals. The BRT mode rated either a "5" or "4" for 11 out of the 12 goals. Using the numeric results of the analysis (i.e., converting the moon symbols to numbers (where "5" = "5" and "1" = "1"), the BRT mode has a total score of 49 and an average score of 4.1, which was significantly higher than the next closest modes (3.5 for Streetcar and 3.4 Enhanced Bus). It should be noted that this average score assumes that all the criteria carry the same weight or importance, which is unlikely to be the case.

BRT has been previously assumed to be the best mode for this corridor and this analysis supports that assumption. BRT is the most appropriate mode given the current and expected level of ridership and best meets the nexus of existing land use and population distribution with the goals for improved transit speed and reliability and future investment along the corridor. Enhanced stations will improve the passenger experience with transit in this corridor, and increased stop spacing and other corridor upgrades will improve transit speed and reliability as compared to the existing service. Additionally, while stop spacing will be increased from the existing service, BRT still offers an access profile that fits the context of the existing land use and population distribution.

Enhanced Bus scored a "5-" "4-" or "3" for 11 out of the 12 goals, which indicates that Enhanced Bus would support the service-oriented goals. There are relatively minor differences between a simplified BRT line that operates in mixed traffic and an Enhanced Bus option. Given the relatively good rating of Enhanced Bus, the recommendation was to consider a simplified, mixed-traffic BRT in developing the design options. This BRT variation would carry forward the benefits of an Enhanced Bus option, but defines that mode option in a manner that makes the project eligible for FTA Small Starts funding. Advancing a mixed-traffic BRT option provides a lower-cost build alternative as compared to higher-cost, more comprehensive BRT options.

5 SERVICE ALTERNATIVES EVALUATION

Based on the recommendations from the Mode Evaluation, and informed by previous studies and planning efforts, various service alternatives were developed and evaluated for a Bus Rapid Transit (BRT) mode for the new HCT alignment in the Study Corridor. The alternatives were created with the intent to study and assess potential service plan options. A final score rates each service alternative based on their overall support of the goals as described in the Purpose and Need Statement.

5.1 ALTERNATIVES CONSIDERED

Four service alternatives were evaluated. They are differentiated by stop spacing, service frequency, and whether the new service will replace or enhance existing fixed route bus service. The four alternatives are described below:

5.1.1 Alternative 1A

Alternative 1A uses BRT service operating in combination with reduced local bus service. The new BRT line runs from downtown Tacoma to 204th Street E in Spanaway, with station spacing of approximately 1/2 to 1 mile. Existing bus service (Route 1) continues to operate, but headways are reduced to 30 minutes during weekday daytimes. Service on the Route 1 outside the study corridor remains at 15-minute headways, resulting in every other trip terminating in downtown Tacoma. BRT service runs at 15-minute headways for at least 14 hours per weekday (e.g., 6:00 a.m. to 8:00 p.m.).

5.1.2 Alternative 1B

Alternative 1B builds from Alternative 1A with BRT service operating at 10-minute headways during peak periods and 20-minute headways during off-peak periods. Service on the Route 1 outside the study corridor remains at 15-minute headways, resulting in every other trip terminating in downtown Tacoma. Peak periods are assumed to operate generally from 6:00 to 9:00 a.m. and from 3:00 to 6:00 p.m.

5.1.3 Alternative 2A

This alternative is for BRT service that replaces the local service within the corridor. The new BRT line runs from downtown Tacoma to 204th Street E in Spanaway, with station spacing of approximately 1/3- mile. Existing bus service (Route 1) is replaced in its entirety within the corridor by the new BRT service. BRT service runs at 15-minute headways for at least 14 hours per weekday.

5.1.4 Alternative 2B

Alternative 2B builds from Alternative 2A with BRT service operating at 10-minute headways during peak periods and 20-minute headways during off-peak periods. Peak periods are assumed to operate generally from 6:00 to 9:00 a.m. and from 3:00 to 6:00 p.m.

5.2 EVALUATION OF ALTERNATIVES

5.2.1 Ridership Estimates

Methodology

Sketch-level ridership estimates were developed using the Regional Transit Ridership Forecasting Model developed by WSP for Sound Transit. The estimates developed at this phase are only for comparative

purposes to help differentiate between service alternatives. The current 2040 Puget Sound Region Incremental Transit Ridership Model used to develop the estimates assumed that the entire ST3 System Plan would be in place. This allows for the full potential of the BRT service to be reflected in terms of transfers to and from Tacoma Dome Link Extension light rail at Tacoma Dome Station.

Results

Results from the ridership estimates are shown in

Figure 11 below. The service alternatives with fewer stops (Alternatives 1A and 1B) had slightly faster end-to-end travel times. The ridership estimates, as shown in

Figure 11, for Alternatives 1A and 1B include ridership for both the new BRT service and the Route 1 service, which is assumed to operate with lower frequency than today. Alternative 1B, with BRT operating with 10-minute headways during peak periods and 20-minute headways during the off-peak, shows the highest ridership among the four alternatives. Alternative 1A shows slightly lower ridership with 15-minute headways. Alternatives 2A and 2B show higher ridership on the BRT service than Alternatives 1A and 1B, but without the Route 1 service, a lower overall transit ridership. Ratings were given to each alternative based on the overall estimated ridership volumes (see Table 14).

Figure 11: Relative Estimated Ridership

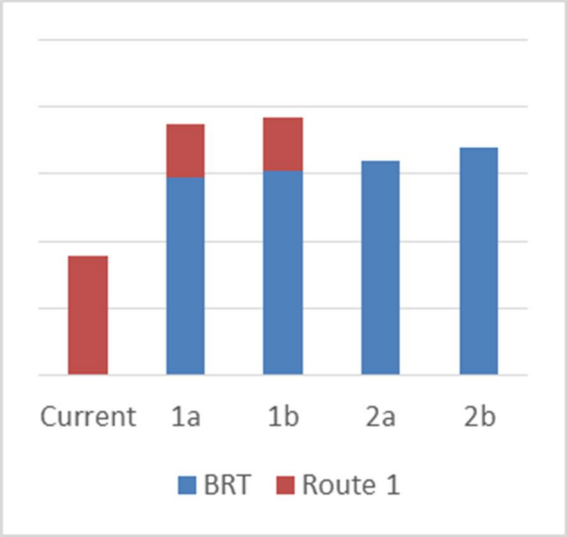


Table 14: Ratings for Ridership Estimates

Alternative	Rating
1A	4
1B	5
2A	2
2B	3

5.2.2 Operating Costs

Methodology

Estimated operating costs (Figure 12) for the service alternatives were based on unit costs provided by Pierce Transit. The study team used the per-hour cost for Pierce Transit's current-fixed route service as the basis for the BRT service since the most significant cost factor, transit operators' wages, are the same for BRT as for conventional fixed-route service. There are, however, some costs that are specific to BRT service that must be added to determine overall BRT operating costs. These are:

- Station cleaning, maintenance, and utility costs. While Pierce Transit has stations and shelters in its current system, the propensity of stations on the BRT line (every stop) must be taken into consideration. Costs in this category include routine cleaning of the stations (one full cleaning and one "quick clean" per week), station maintenance, and utility costs for lighting, security cameras, real-time arrival information signage, and other station amenities that require electrical power.
- Fare enforcement. BRT service is assumed to have an off-board fare system using ticket vending machines (TVMs) or ORCA card readers on each platform, which requires fare enforcement officers to randomly check for fare payment. Pierce Transit has indicated that although the current security personnel will also carry out fare enforcement responsibilities, there will be a need to add staff. The study team has assumed that personnel would be available to fare check during 10 percent of revenue service hours. This would equate to approximately three fare inspectors (FTEs) for the Pacific Avenue/SR 7 HCT corridor.
- Fare collection. Another aspect of off-board fare collection is the need to periodically collect the money in the TVMs at each station platform. This is often contracted service. The cost for this assumed a biweekly fare collection.
- TVM servicing and maintenance. The TVMs require ongoing servicing and maintenance.
- Real-time passenger information maintenance. It is anticipated that the BRT platforms will have information displays indicating "real-time" arrival times for buses based on their location in the system (not based on their schedule). These displays will require ongoing maintenance and servicing.
- Articulated coaches. The BRT service would likely use articulated coaches, which are 60-foot-long buses with three axles that "bend" around corners. Pierce Transit does not have any articulated coaches in its current fleet (though the agency does maintain some Sound Transit articulated buses for regional express service). Articulated buses generally have a somewhat higher per-mile operating cost than the typical 40-foot transit bus due to greater fuel usage and the need to maintain the articulated joint. For this analysis, it is assumed that the articulated coaches would add 10 percent to the average Pierce Transit operating cost per service hour. This is based on experience from other agencies that operate both 40-foot buses and articulated buses.

Estimates for the BRT-specific costs are based on typical costs from current BRT systems in the Northwestern United States, including Lane Transit District's EmX, C-TRAN's The Vine, and Community Transit's Swift.

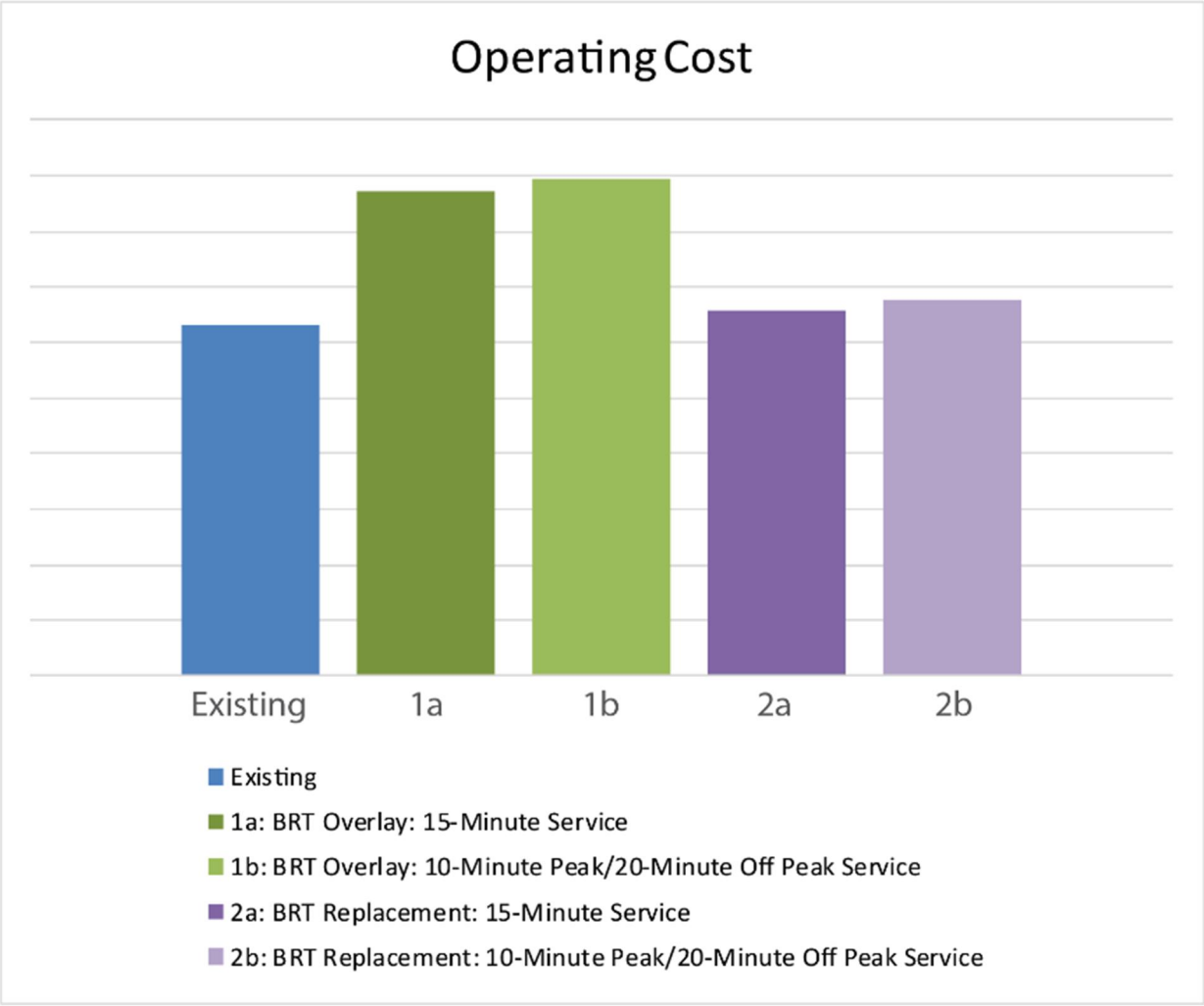
Data for the current service are based on actual hours provided by Pierce Transit. Estimates of revenue service hours for the service options are generated by the Regional Transit Ridership Forecasting Model. Since a high-level model is being used at this point, the service hours output by the model need to be considered preliminary. While the absolute numbers may change, the relative differences between the

service options should be reasonably accurate. Caution should be used in comparing the service options to current service since the current service is based on actual service hours and not a model estimate.

Revenue hours from the model were adjusted to service hours (which includes non-revenue time spent for items such as layovers and travel to and from the garage or base) based on the ratio of revenue hours to service hours of the current Route 1. The operating cost was calculated by multiplying the service hours by the per service hour cost for each service type and then adding the additional costs for non-service BRT costs, as itemized above.

Results

Figure 12: Relative Estimated Operating Costs for Service Options



As expected, the BRT overlay options (Alternatives 1A and 1B), which include continued local service, are more expensive to operate than the BRT replacement options, which do not have underlying local service. There is little difference in operating cost between the BRT options that provide 15-minute weekday

service operating 14 hours per weekday from those that provide 10-minute peak (six hours per weekday) and 20-minute off-peak service.

Based on this preliminary analysis, it appears that the BRT replacement options have similar operating costs to the existing service. This would indicate that the additional BRT non-service costs (e.g., station maintenance, fare collection and enforcement, etc.) are largely offset by the shorter BRT travel times, which allow a given LOS to be operated with fewer buses and drivers. BRT overlay options would result in additional operating costs compared to existing fixed-route service.

Based on a comparison of operating costs, the alternatives with the higher costs were ranked lower than those with lower operating costs. Table 15 illustrates the results of the operating cost ratings.

Table 15: Ratings for Operating Cost

Alternative	Rating
1A	2
1B	2
2A	4
2B	4

5.2.3 Access

Methodology

Access was determined by several factors: the total number of stations that would be constructed with a new BRT line, the estimated spacing between the new BRT stations, and the potential for bicycle and pedestrian connections and improvements to those stops. The following assumptions were used to create this methodology:

1. A new BRT line combined with existing local bus service (Route 1) would have BRT stations spaced farther apart (up to one mile apart, compared to 1/3-mile spacing for BRT stations for the replacement options), but would retain current local bus stops. This option, called a BRT overlay, would result in more transit stops than there are currently along the corridor. Fewer BRT stations, however, would also lead to fewer bicycle and pedestrian improvements, designed to improve or enhance direct access.
2. A new BRT line that completely replaces the existing local bus service (Route 1) would have more HCT stations spaced closer together than the BRT overlay option described above. All existing local bus stops, however, would be removed, which means that there would be fewer total transit stops along the corridor. More BRT stations can also lead to the possibility of additional bicycle and pedestrian amenities. For example, the Central Loop Bus Rapid Transit project in Chicago took the opportunity to develop bus island shelters for each BRT station with a protected bicycle lane running behind it. Other BRT projects, such as Albuquerque's ART BRT project, brought sidewalk improvements along the entire corridor, giving pedestrians more space to walk.

3. A single headway at 15 minutes all day provides better and more stable access for transit-dependent and low-income riders than a variable peak/off-peak headway of 10 – 20 minutes does.

To quantify some of these data points, a map was created to highlight the effect of removing existing local bus stop access, as would occur under Alternatives 2A and 2B (Figure 13). Along the route corridor from downtown Tacoma to Spanaway, hypothetical stations were placed every 1/3-mile and given a 500-foot buffer around each to account for some variability in station placement. Using existing northbound and southbound Route 1 average boarding data, an estimate of how many current local bus stops were captured within each 1/3-mile buffered BRT station was developed. A similar map was not created for alternatives that continued local existing service as that access potential would not be affected.

The results of the analysis show that the BRT replacement options with stations every 1/3-mile would capture 56 percent of all current local bus stops. It would capture 58 percent of stops with an average of 30 people per boarding and 67 percent of stops with an average of 100 people per boarding. Analysis showed that the new BRT line could capture more stations with an average of 30 or more people per boarding by concentrating stations in the downtown Tacoma area.

Although this analysis shows that there will be some local bus stops (Route 1) that are not captured by the new BRT stations, the analysis does not assess whether riders would be willing to walk the extra distance to their nearest BRT stations. Research indicates that riders are generally willing to walk anywhere from 1/4 to 1/3 of a mile to their nearest fixed route bus stop, and riders may walk longer distances for higher-quality transit modes and for commute versus non-commute trip types. In addition, the stop placement used in this analysis is preliminary. A walkshed analysis would look more deeply into this issue. Actual bus stop placement would look closely at specific activity centers and the current stop usage along the corridor.

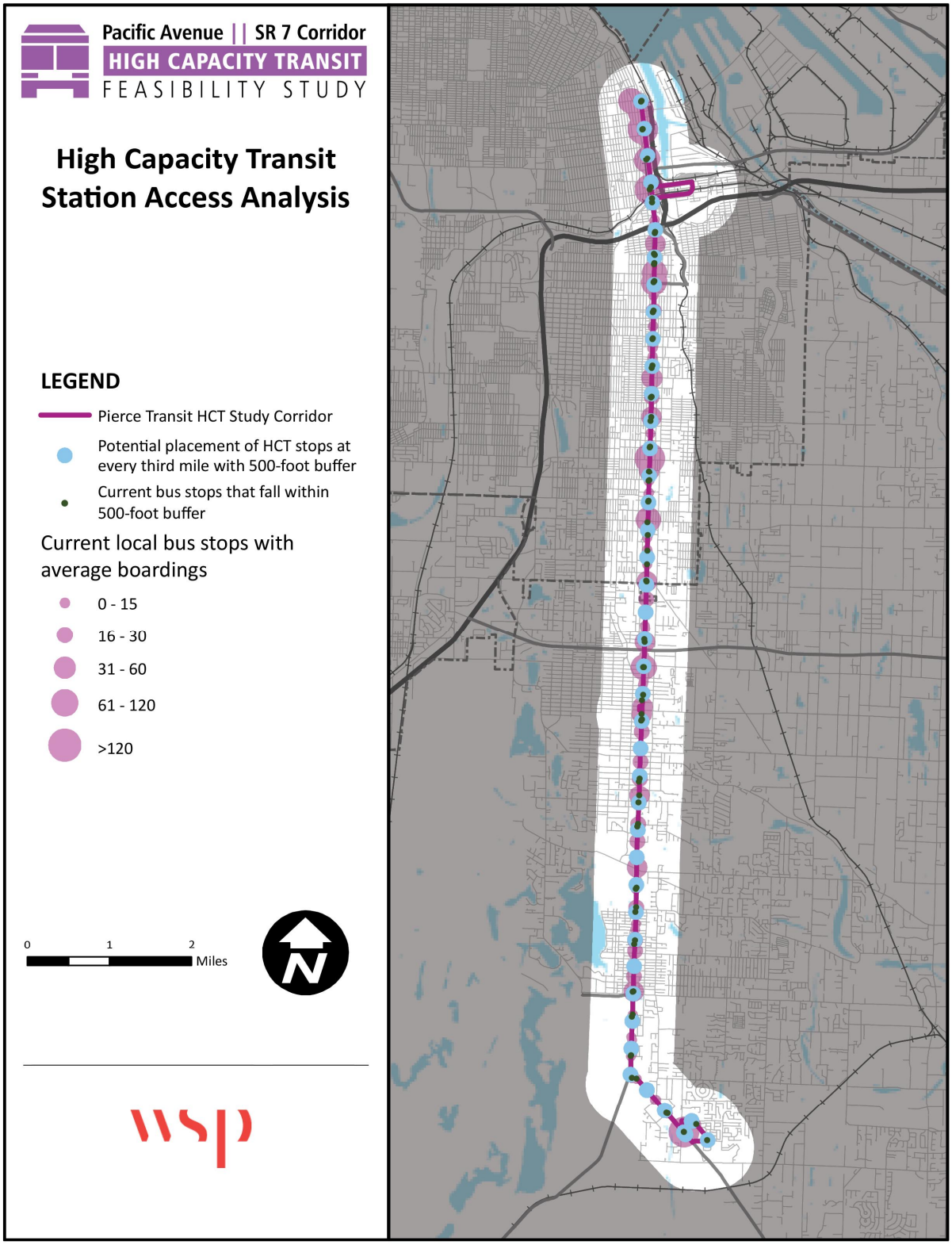
Results

Given that Alternatives 1A and 1B maintain existing local fixed route bus service (Route 1) and add the new BRT stations, they exhibit a high level of access to transit. This is somewhat offset by the fact that there are not as many BRT stations, so there would be fewer improvements to station-area pedestrian and bicycle access.

Table 16: Ratings for Access

Alternative	Rating
1A	4
1B	4
2A	2
2B	2

Figure 13: Potential BRT Stops with Current Local Bus Service Stops



5.2.4 Service Complexity

Methodology

Service complexity is based on two factors: complexity for the transit operator and complexity for the transit passenger. Complexity concerns for operators would likely be minimal between the service options since there are unlikely to be drastic changes in system design and function between the service alternatives (though, of course, as a new transit mode, the BRT service will require advanced operator training). For transit riders on the corridor, there will be some difference in complexity between the service alternatives.

The following assumptions were made when assessing the service complexity:

1. A single line is easier to understand than multiple lines running along the same route.
2. A single headway is easier to understand and deal with than a variable headway based on peak/off-peak travel times.
3. Given that the new BRT line (downtown Tacoma to Spanaway at 14.4 miles) is not proposed to run the same length as the existing local bus service line (full Route 1 at 18.6 miles), there is an assumption that complexity will increase across all service alternatives as passengers must adapt if their trip begins or ends on the portion of Route 1 not covered by the proposed BRT service.
4. Differences in running speeds between local and BRT service would potentially result in bus bunching or other operational issues.

Results

Alternatives 2A and 2B are more straightforward and would be easier for riders to understand. With these alternatives, riders will not have to determine which stop serves which line and which service would get them closest to their destination. In addition, having local fixed route and BRT service along the same corridor can add complexity in which combination of local and rapid service will reduce their overall travel time.

Alternatives 1B and 2B have varying headways on weekdays, requiring passengers to know when the headway changes. This presents a greater level of complexity as passengers cannot simply memorize clock headways that are consistent throughout the weekday daytime and must, instead, remember that headways change between peak periods and the midday period.

Another issue all service alternatives create is that the BRT service will not operate the entire length of the current Route 1, as noted previously. For an overlay service, this means that passengers must choose service lines based on speed and potential for transfers should they need to head west once reaching downtown Tacoma. For a replacement service, passengers who currently can ride a single bus to or from the current west end of Route 1 at TCC, will now be forced to transfer. However, transfer time penalties would likely be reduced in scenarios with 10-minute frequencies instead of 15-minute, assuming timed transfers are impractical. No matter which service alternative is selected, this issue creates added complexity.

As a result, 1A and 1B were rated lower than 2A and 2B (see Table 17).

Table 17: Ratings for Service Complexity

Alternative	Rating
1A	2
1B	1
2A	3
2B	4

5.2.5 Capital Costs

Methodology

Capital cost estimates were not developed for the project. Differences in capital costs between the service alternatives were assessed. Differences were found in two areas:

- Station Construction - Stations represent a significant cost item for BRT projects. Based on other regional BRT projects, station costs, including all amenities and systems such as real-time information displays, ORCA card readers, and ticket vending machines, are estimated to be $300,000 per platform. This represents the cost for a high-quality station with significant amenities, similar to the EmX stations in Eugene, Oregon, or The Vine stations in Vancouver, Washington. The BRT overlay service options (Alternatives 1A and 1B) are assumed to have stations every 3/4 mile, while the BRT replacement service options (Alternatives 2A and 2B) are assumed to have stations every 1/3-mile. Thus, the BRT replacement options would have a higher capital cost due to the need to construct more stations.
- Vehicles - Project vehicle needs are determined by the travel time and the peak frequency of the service. The options with 10-minute peak frequency (Alternatives 1B and 2B) will require more buses than the service options with a maximum frequency of 15 minutes (Alternatives 1A and 2A). In addition, the BRT options that have underlying local service (Alternatives 1A and 1B) would have fewer stops and, thus, faster travel times. This would allow the service to be operated with fewer buses than the replacement service options (Alternatives 2A and 2B) that stop more frequently. Estimated peak BRT vehicle needs for revenue service assumed that the service would be 20 percent faster than the current service for the replacement options, and 25 percent faster than current service for the overlay options. This is a rough estimate based on typical BRT travel time improvements. The BRT vehicle needs for peak revenue service are increased by 20 percent to account for layover time and include a 20 percent spare ratio to arrive at total fleet needs. The per vehicle cost assumes articulated buses and is estimated at $1.2 million per vehicle.

Service Alternative 1A, which has underlying local service and 15-minute maximum service frequency, requires fewer stations and buses. Thus, 1A is ranked as having the lowest capital costs of the four service plan alternatives. The results shown in Table 18 use Alternative 1A as the “base” with the estimated additional capital costs required for the other alternative reflected in their lower ratings.

Results

Table 18: Ratings for Capital Costs

Alternative	Capital Cost Difference	Rating
1A: BRT Overlay: 15-Minute Service	Base	5
1B: BRT Overlay: 10-Minute Peak/20-Minute Off-Peak Service	+$3.5 million	4
2A: BRT Replacement: 15-Minute Service	+$15.5 million	2
2B: BRT Replacement: 10-Minute Peak/20-Minute Off-Peak Service	+$19 million	1

The data indicate that the two overlay options (Alternatives 1A and 1B), which have significantly fewer stations, cost less than the two replacement options (Alternatives 2A and 2B), which have stations every 1/3-mile. The additional buses required to operate 10-minute peak frequency add approximately $3.5 million to the cost compared to the options that have 15-minute maximum frequency.

It is expected that this BRT project could have an overall cost of between $150 and $175 million. Thus, the difference in capital costs resulting from the service plan that is chosen could be up to 12 percent of the total project costs.

5.2.6 Cost-Effectiveness

Methodology

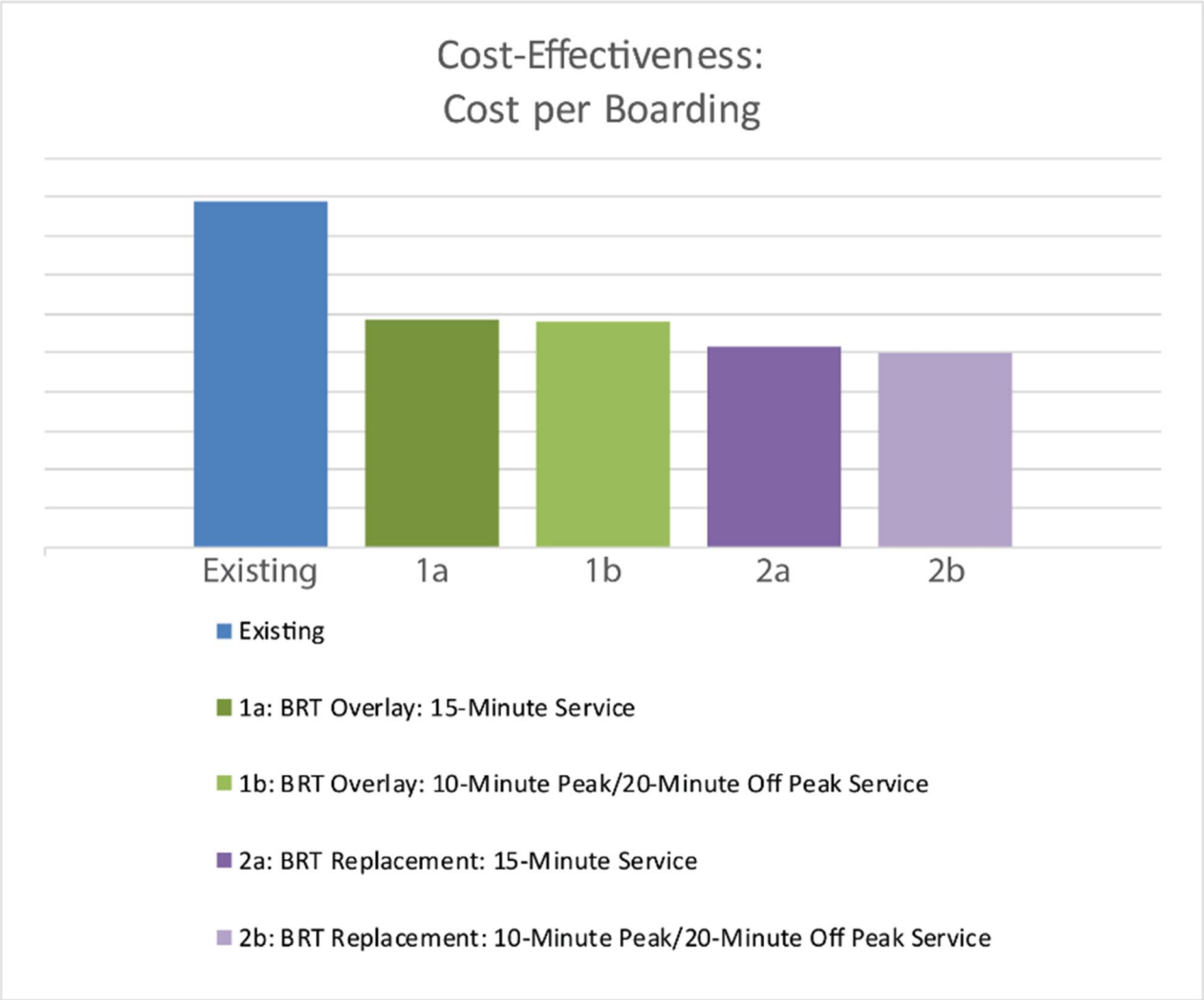
Transit agencies often determine the cost-effectiveness of service using the measure of operating cost per boarding. This performance measure incorporates the primary goal for transit agencies, which is to transport people, and the greatest constraint that they typically face, which is the operating budget. A low cost per boarding means that more people can be served within a given budget.

Ridership data for the service options were generated through the Regional Transit Ridership Forecasting Model. As noted previously, this is a high-level ridership analysis, so actual ridership numbers are only rough estimates. However, the relative ridership between the service alternatives is more accurate. The operating cost for the alternatives was based on service hour output from the model and comes with the same caveats. Data for existing service are from Pierce Transit's ridership counts and service hour tabulation, so comparisons between existing service and the service plan alternatives, which use high-level estimates, should be considered as a rough comparison only.

Results

The data show that the BRT options that replace existing service (Alternatives 2A and 2B) have a lower cost per boarding than the BRT overlay options which retain local fixed route service (Alternatives 1A and 1B) as shown in Figure 14. Although the overlay options have higher ridership, the increased operating cost associated with the continuation of local fixed-route service is proportionally greater than the ridership increase.

Figure 14: Estimated Cost per Boarding for the Service Options



All the BRT options show a significant improvement in cost per boarding compared to existing service. This has been true for most of the BRT systems that have been implemented so far nationwide.

Based on this information, the following ratings shown below in Table 19 have been assigned.

Table 19: Ratings for Operating Costs

Alternative	Rating
1A	2
1B	2
2A	4
2B	4

5.2.7 Support for Redevelopment

Methodology

Recent research has indicated that, if done in the right manner, BRT can influence real estate decisions and even attract jobs.[38,39] For the purposes of this analysis, support for redevelopment was assessed based on a combination of the number of passengers as well the as frequency of BRT corridor service (i.e., the potential for a positive impact on redevelopment increases with an increased number of stations, increased activity at each station, and higher frequency of service).

Results

The results, shown in Table 20 below, indicate that all options have the potential to positively affect redevelopment in the corridor. For the two replacement service options, Alternative 2B is rated higher than Alternative 2A due to the higher frequency of service during the peak periods. In comparing the overlay alternatives with the replacement alternatives, the overlay options have fewer stations, but they are expected to attract more ridership and the associated potential for more economic activity, including jobs and housing, which would tend to offset the effect of having fewer stations overall. Therefore, the overlay alternatives are rated similarly to the replacement alternatives for this measure.

Table 20: Ratings for Support for Redevelopment

Alternative	Rating
1A	4
1B	5
2A	4
2B	5

5.2.8 Evaluation Overview

Table 21 shows an overview of the evaluation results.

Table 21: Summary Ratings

Alternative	Ridership Estimates	Operating Cost	Access	Service Complexity	Capital Costs	Cost-Effectiveness	Support for Redevelopment	Overall
1A	4	2	4	2	5	2	4	3.3
1B	5	2	4	1	4	2	5	3.3
2A	2	4	2	3	2	4	4	3.0
2B	3	4	2	4	1	4	5	3.3

[38] http://t4america.org/2016/01/12/new-study-finds-positive-economic-development-benefits-associated-with-bus-rapid-transit-projects/

[39] NATIONAL STUDY OF BRT DEVELOPMENT OUTCOMES Final Report NITC-UU-14-650, Arthur C. Nelson, Joanna Ganning, November 2015

5.3 DECISION

The analysis of service alternatives did not show major differences between the average ratings of the four service alternatives (Alternatives 1A, 1B, 2A, and 2B). However, based on financial projections, it was determined that operating cost increases to support the options that retained local service in addition to adding BRT service may not be sustainable without additional operating revenue. Thus, the decision was made to select an option with BRT service replacing local service (Alternatives 2A or 2B). Since Alternative 2B, which has higher peak-hour frequency, is projected to have higher ridership and better support development, it was selected at the preferred service option.

It is further recommended that additional analysis be conducted to determine the most advantageous peak service period given the corridor ridership characteristics. Currently, ridership does not conform to the traditional morning and afternoon peaks.

6 VEHICLE ASSESSMENT

Motorbus options for the Pacific Avenue/SR 7 Bus Rapid Transit project considered 40-foot standard buses to a 60-foot articulated vehicle. Within these length classifications, other characteristics that were assessed include:

- Vehicle model, including the consideration of double-decker buses
- Propulsion system options, with a focus on low-/zero-emission systems
- Door configuration options, including 5-door vehicles with doors on both sides
- Other relevant potential onboard BRT-related features such as styling and passenger amenities

The analysis also included discussion of operational impacts, capacity (considering currently projected corridor ridership), community appeal, plus operations and maintenance costs.

The vehicle procurement process was also assessed in the context of four issues related to project development:

1. Project implementation schedule.
2. How sources of project funding affect vehicle selection.
3. How the possible use of alternative delivery methods could affect the vehicle element definition.
4. How assumptions regarding the physical conceptual designs included in the feasibility study affect the vehicle definition.

The last of these also includes stated assumptions regarding Pierce Transit's projected ridership demand and average vehicle load factors, which significantly affect Pierce Transit vehicles' definitions. Each of these issues affecting vehicle selection is discussed in order below.

6.1 VEHICLE CHARACTERISTICS

Although BRT vehicles are not required to have advanced propulsion and other new technology features, Pierce Transit would follow the practice of most other project sponsors in desiring to covey an image of cleaner (i.e., lower emissions), quieter, newer, and higher tech, particularly a service image that differs from existing fixed route bus services. Unique branding and image are important considerations in vehicle selection as they can help boost corridor ridership. Branding is also required for a BRT project to be eligible to receive New Starts and Small Starts funding from the FTA.

The preferred alternative will place a high priority on fleet availability and reliability. Tradeoffs between acquiring the latest vehicle advanced technology and operational reliability should be considered, based on actual operational experience of such vehicles in service. Vehicles that have a novel design and include the latest technology, which may convey a distinct and state-of-the-art image on opening day, may also have a greater risk for maintenance-related road calls and/or late departures, which would have a counterproductive long-term effect on image and service brand. Technology-related image should be adequately balanced with the reliability of a proven technology.

One key to achieving balance is to examine the total number of BRT vehicle models currently in operation delivered by each manufacturer. The number of vehicles that manufacturers have successfully delivered to BRT project sponsors is strongly correlated with reliability, because manufacturers' field service and

engineering personnel have had multiple opportunities to correct any developmental issues that have arisen in the field. This type of experience is discussed in the next section.

The complexity of vehicle designs is another consideration. For example, Community Transit in Snohomish County, Washington, has elected to acquire a fleet of double-decker buses because the double-decker buses require less maintenance and use less fuel than the articulated vehicles for roughly the same capacity. The double-decker buses also have advantages where road-space may be an issue, particularly for station locations. Moreover, Community Transit reports that double-deckers handle better in snowy and icy road conditions; articulated buses have difficulty in such conditions, particularly on grades. On the other hand, double-deckers are not appropriate for routes with low overpasses or low bridge undercrossings. An operational concern with double-decker buses is their potentially longer dwell time at stops due to passengers negotiating the stairs before deboarding and the use of only two doors (front and back) on a double-decker buses instead of three doors on an articulated bus with similar capacity. For this reason, double-decker buses tend to be used primarily on longer or express trips, such as Community Transit commuter runs into Seattle, than for corridors with frequent stops and shorter trips.

AC Transit (Oakland, California) recently conducted a pilot test using double-decker buses. The agency found that they worked well on its *Transbay* service (which has limited stops), but added travel time when used on a local route. A survey conducted by AC Transit found that riders reacted positively to the double-decker buses, an indication that they have potential benefits for branding and marketing.

Table 22 lists the most common design criteria considerations for BRT vehicles. In the U.S. market, a variety of capacities, door widths and number of doors are available, with the minimum being 32inches to a maximum of 47inches per door location. The best combination of doors, standee floor space and seats for a specific vehicle is a complex decision process highly dependent on the service option. For example, when wide doors are specified, seat capacity and standee space is lost, perhaps even a full extra seat row on one side, which is difficult if not impossible to recapture anywhere else in the vehicle.

Table 22: Range of Typical Design Characteristics of BRT Vehicles

Vehicle Feature	Design Criteria	Implications	Comments
Doors	Three to five doors (three on curb side, with possible two additional on left side)	Availability of three vehicles currently	At least two manufacturers now offer 5 doors
Capacity (range)	37 to 65 seated with up to an additional 60 standing (crush load)	Affects fleet size, service frequencies	Dependent on specific seating layout
Width	102 inches	Narrower vehicles have reduced capacity	Minimum 11-foot lane widths to account for mirrors, dynamic envelope. Guidance can narrow running lanes.
Length	40-foot, 45-foot, or 60-foot (articulated)	Maintenance facility, parts inventory and training must consider vehicles	Shorter vehicles would increase fleet size but could increase coverage area flexibility.
Height	12'10" to 14'4'" (double-decker)	Station and maintenance facility overhead clearances accordingly	Higher

Vehicle Feature	Design Criteria	Implications	Comments
Vehicle weight (range)	40,000 to 65,000 gross weight	Pavement thicknesses to station pads and running ways must be designed accordingly	Gross weight Includes full passenger load
Propulsion	Clean (ULSF), CNG, Diesel-electric hybrid or all-electric (battery or trolleybus)	Maintenance facility must incorporate accommodations for higher-voltage conditions	
Floor height	14 to 15.5 inches	Platform height matches vehicle floor height	Derived from industry availability and APTA standards
Guidance	None specified	Guidance can help narrow running way dynamic envelope widths, ensure level boarding consistency	Limited U.S. experience with guidance technology
Passenger info. systems	Voice annunciators and digital destination and interior signage	Enhances customer experience; required by ADA	Mostly standard equipment on U.S. buses now
Vehicle communications	GPS-based location, signal priority	Enhances ability to track and ensure service schedule adherence	AVL mostly standard equipment on U.S. buses now

6.2 Propulsion Options

In October of 2017 at the APTA Expo in Atlanta, Georgia, new vehicle developments were announced by transit industry suppliers that can have a bearing on future vehicle costs, availability and reliability. For example, Proterra announced the availability of a more powerful and efficient drive train, as well as a partnership to help deliver all-electric Van Hool coaches to the U.S. market. On the latter announcement, however, it remains to be seen how soon or even whether Van Hool can comply with Buy America requirements. In the past, the Belgian-based builder has elected to serve the U.S. market only if agencies either obtain waivers or if they were willing to purchase vehicles without federal assistance. In addition, Gillig, which has provided hybrid-electric vehicles to a variety of BRT projects throughout the United States, announced a new partnership with Cummins involving a new Cummins built all-electric propulsion system in Gillig buses.

Prior to the conference, New Flyer signed an agreement to deliver 35 all-electric articulated buses for BRT service in Los Angeles, California. BYD continues to be the most vertically integrated original equipment manufacturer (OEM), while continuing to offer turnkey solutions that include BYD vehicles and charging systems. Nova Bus (which is owned by the multinational firm Volvo Bus) announced their own plans to move aggressively into the zero-emission bus (ZEB) marketplace. GreenPower and El Dorado National, two other bus builders that have had success primarily in other bus markets, also confirmed their intentions to sell electric heavy-duty buses to U.S. transit agencies with booths at the Expo.

Several years ago, the United States Department of Energy established policies intended to help battery technology manufacturers lower battery costs from $500 per kilowatt-hour ($500/kwh) to $125/kwh by 2022, and to increase battery energy density from 100 watt-hours per kilogram (Wh/kg) to 250 Wh/kg by the same year. These continue to be the Department's goals, and if attained on any widespread

commercial basis in the marketplace, it could signal the coming obsolescence of virtually all other non-battery electric technologies. According to several industry reports, these prices may have already been attained; in fact, some observers have suggested that the industry will reach $100/kwh by 2020 and $80/kwh by the original departmental goal.

As agencies begin to procure and deploy battery electric buses (BEBs) on a wider scale, negotiating workable and cost-effective utility rates for recharging these vehicles will be increasingly important. One analysis for Los Angeles County Metropolitan Transportation Authority (known as simply "Metro") found that utility rate structures will likely be the single most significant cost driver for a BEB program. In some regions, demand charges can double, triple, or even quadruple energy costs.

The electric bus market is no longer simply a niche; as it grows, manufacturing volumes are likely to bring down the unit costs' differentials with more conventional bus procurements, though it has not happened yet. Most California transit agencies expect that, in the long term, they will run zero-emission vehicles. The Los Angeles procurements alone are widely expected to define this market segment, and as a few other fleets are expected also to adopt a large ZEB commitment, the transit bus industry marketplace will be reshaped, as all manufacturers are forced to develop zero-emission solutions to survive. Locally, King County Metro's recent procurement of 120 BEBs and its commitment to and analyses toward transition to a zero-emission fleet buy 2030 should help Pierce Transit in selecting similar vehicles for BRT service. The challenges and options of this vehicle choice are well-documented in King County Metro's recently published report entitled "Feasibility of Achieving a Carbon Neutral or Zero-Emission Fleet," and should help inform Pierce Transit staff in their decisions.

In anticipation of these trends, electric utilities view the electrification of transportation as a strategic priority. Electric vehicles, particularly as the range performance continues to improve, provide demand and load-balancing to utilities at precisely the times when they need it (i.e., overnight). Moreover, these synergies spread the investment cost of renewable power generation infrastructure over more electricity production, which in turn lowers the cost of electricity for all users on the grid. This is particularly attractive for utilities with regulatory mandates to invest in renewable sources. This is the same dynamic at work for Pierce Transit, which buys all its power from a utility that uses 97% carbon-free power generation.

The trend in batteries has been dramatic, with the downward capital cost declines almost as steep as those with solar panels. Batteries have gotten roughly 6 to 8 percent less expensive every year for the last decade. Most market forecasts include expectations for the trend to continue for the next decade. In addition, battery performance continues to improve. For example, the batteries that Proterra installs in its current bus orders are four times more energy dense than those installed five years ago. Proterra and other manufacturers now contend that these prices make BEBs cost-competitive with diesel, compressed natural gas (CNG), and hybrid on a total cost-of-ownership basis. Moreover, because bus OEMs serving the U.S. transit bus market design their products to be forward- and backward-compatible, primarily because they are largely assemblers of other suppliers' technologies, improved battery technology in the future could be interoperable.

The largest challenge that agencies face when transitioning to larger BEB fleets is the transition period itself, when multiple propulsion platforms need to be serviced and operated simultaneously, with impacts on route planning, staffing, training and maintenance facility accommodations. These issues would be addressed outside the scope of this study, not only with future phases of this BRT corridor's development

but also the larger network in the future via the comprehensive operational analysis and long-range transportation planning processes.

The State of Washington, RCW 43.19.648, provides requirements for propulsion systems of publicly owned vehicles. A part of that law states:

> *Effective June 1, 2015, all state agencies, to the extent determined practicable by the rules adopted by the department of commerce pursuant to RCW 43.325.080, are required to satisfy one hundred percent of their fuel usage for operating publicly owned vessels, vehicles, and construction equipment from electricity or biofuel. Compressed natural gas, liquefied natural gas, or propane may be substituted for electricity or biofuel if the department of commerce determines that electricity and biofuel are not reasonably available*

6.3 Procurement Considerations

A major consideration and critical path of any BRT project is the acquisition and deployment of vehicles that will be used. On most projects, these are new vehicles. A more detailed fleet and vehicle needs analysis must be developed for the study corridor's service characteristics. The analysis must include the broad range of vehicle attributes that have an impact on BRT system success, including:

- Vehicle comfort and passenger amenities: Use of onboard passenger Information and entertainment systems, large windows, stylish stanchions and hand holds, etc.
- Exterior styling and branding in conjunction with overall BRT specific and rest of system branding strategy (e.g., use of icons, colors and logos in branding, particularly so that service is easy to identify and use)
- Vehicle performance (including freeway and arterial top speed, acceleration, gradeability on hills etc.)
- Fleet size and reliability to ensure frequent, fast high-quality service characteristics of BRT
- Hybrid or other advanced propulsion systems
- New technologies, such as vehicle guidance systems, for level boarding
- Vehicle size, seating and door layout: Ensuring these characteristics are compatible with BRT service goals that will minimize dwell times and overall travel times, etc.

Pierce Transit should also examine the feasibility and availability of the propulsion technologies used in BRT vehicle applications and make recommendations that consider Sound Transit's ambitious "clean transportation" sustainability and greenhouse gas reduction goals. These should involve conventional as well as battery-electric and hybrid-electric propulsion, including depot overnight and "opportunity" in-route fast-charging electric vehicle technologies. Pierce Transit should also consider requiring interoperability in its procurement specifications.

Pierce Transit should also look at the feasibility and suitability of using existing vehicle contracts, such as the WSDOT statewide schedule or the one that King County Metro currently has with Proterra or New Flyer, for availability of assignable options at other U.S. transit agencies.

6.4 DECISION

Pierce Transit's initial BRT buses:

- Branded 60-foot articulated coaches.
- Three doors one side of the bus, though doors on both sides of the bus (i.e., 5-door coaches) will be reconsidered during the next design phase should the opportunity to use both left- and right-side boarding provide significant benefits to the flexibility of corridor design and station placement.
- CNG propulsion, with continued consideration of battery-powered buses for future purchases.

7 CONCEPTUAL DESIGNS

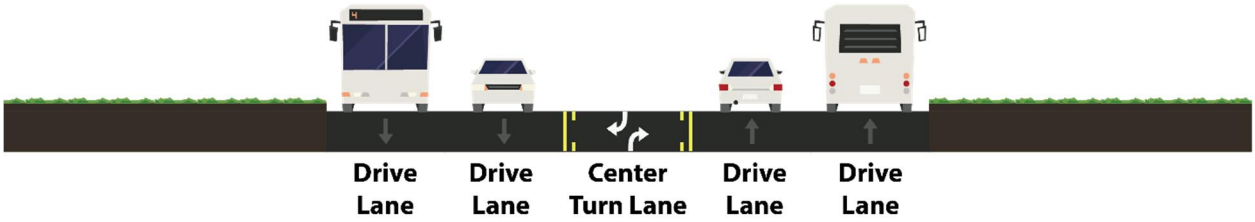
This section describes the different BRT design options that were considered for this corridor. Note that the corridor BRT alternatives, described in a subsequent section, are composed of multiple design treatments along different portions of the corridor.

7.1 MIXED TRAFFIC: RIGHT LANE

Figure 15 illustrates the most basic of the BRT design configurations—a bus running in mixed traffic in the right lane of the roadway. A typical cross section for this alternative is shown in Figure 16.

Figure 15: Mixed Traffic: Right Lane Concept

Figure 16: Mixed Traffic: Right Lane Cross Section (mid-block)



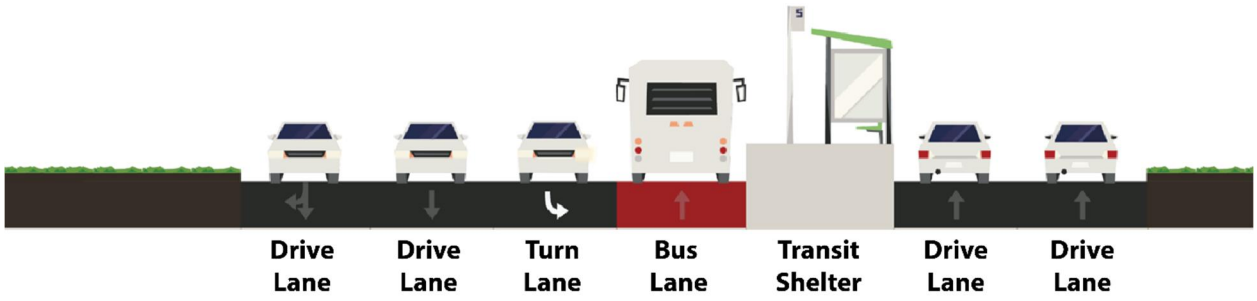
The least costly design alternative, the Mixed Traffic: Right Lane option requires little widening, if any, and can be implemented relatively quickly. Typically, this option is used in conjunction with transit signal priority (TSP) strategies and stop consolidation to achieve transit speed benefits. Existing roadway operations (such as lane widths and volume capacity) are only minimally, if at all, affected, since this option does not change the existing lane configuration. However, this design alternative comes with some negatives. Of note, mixed-traffic operation does not provide the travel time benefits of exclusive or semi-exclusive transit lanes, generally do not give the feeling of a premium service that people come to expect with BRT and may not be considered much of an upgrade over existing service. Of those considered, this option also has the least potential to encourage any sort of economic development along the route.

7.2 Mixed Traffic: Left Lane

Figure 17 shows BRT operating in mixed traffic but traveling in the left travel lane. At stops, the bus pulls out of the travel lane, as shown in the figure. A typical cross section for this alternative (at a station, where the bus is in its own lane) is shown in Figure 18.

Figure 17: Mixed Traffic: Left Lane Concept

Figure 18: Mixed Traffic: Left Lane Cross Section (at intersection and with a station)



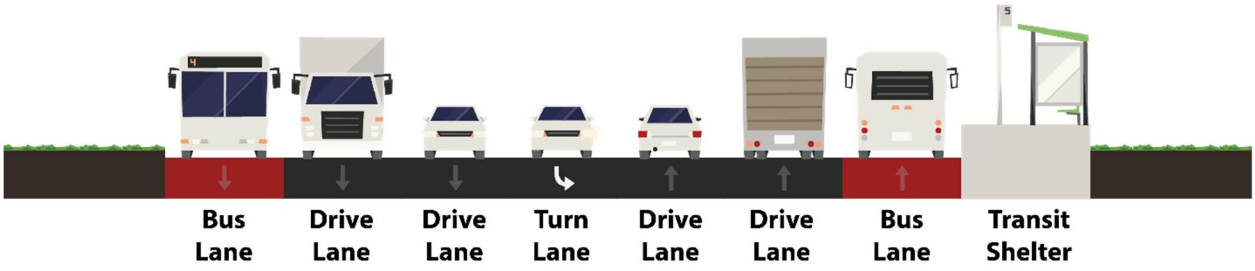
A relatively inexpensive option, the Mixed Traffic: Left Lane alternative allows the BRT service to use median stations and run in the left travel lane. This typically creates a smoother ride with less slowing and stopping associated with right-turning vehicles that slow to make a turn or stop for pedestrians to clear a driveway or street. This alternative also creates an exclusive lane in the center of the road at stations to allow BRT vehicles stopping at stations to be out of the traffic flow. Including a median lane around stations allows for further established branding and can achieve some of the travel time benefits that come with exclusive lanes options. Economic development is likely to occur around stations. Some negatives include the perceived unsafe feeling riders experience by waiting in a station located in the middle of a busy road. Some ROW will likely be needed at station locations.

7.3 Business Access and Transit (BAT) Lane

Figure 19 shows BRT operating in a curbside BAT lane. A typical cross section for this alternative is shown in Figure 20.

Figure 19: BAT Lane Concept

Figure 20: BAT Lane Cross Section (at intersection and with station)



A BAT Lane is a semi-exclusive lane for the BRT line that is also used by other vehicles for right turns into driveways or at the next intersection. This option generally exhibits high travel time benefits when implemented in a congested corridor and sets a clear brand because of infrastructure investments along the corridor. This higher level of transit investment and the "permanence" of the investment are more likely to spur economic development. This option, as opposed to the next two alternatives evaluated, also maintains the center two-way left-turn lane (TWLTL) and creates an important buffer between the sidewalk pedestrian area and general-purpose traffic lanes. However, this option also has the largest ROW footprint of all options for a similar length of treatment, meaning more potential property impacts and costs. It also increases the crossing distance for pedestrians at intersections. This is likely the most expensive option per mile of treatment. For this option, traffic enforcement will be critical to prevent general traffic from illegally using BAT lanes, which could potentially have significant negative impacts on bus travel times. Police resources may be necessary for this enforcement; however, bus lane enforcement cameras may be a potential alternative or enhancement to police enforcement. These have been employed by transit agencies outside of Washington, such as MTA NYC Transit, and may be consistent with guidance from Washington legislation for automatic traffic safety cameras.

7.4 Median Lane: Right-Side Boarding

Figure 21 shows BRT operating in an exclusive median-running transit lane with passengers boarding on the right side of the bus. A typical cross section for this alternative is shown in Figure 22.

Figure 21: Median Lane: Right-Side Boarding Concept

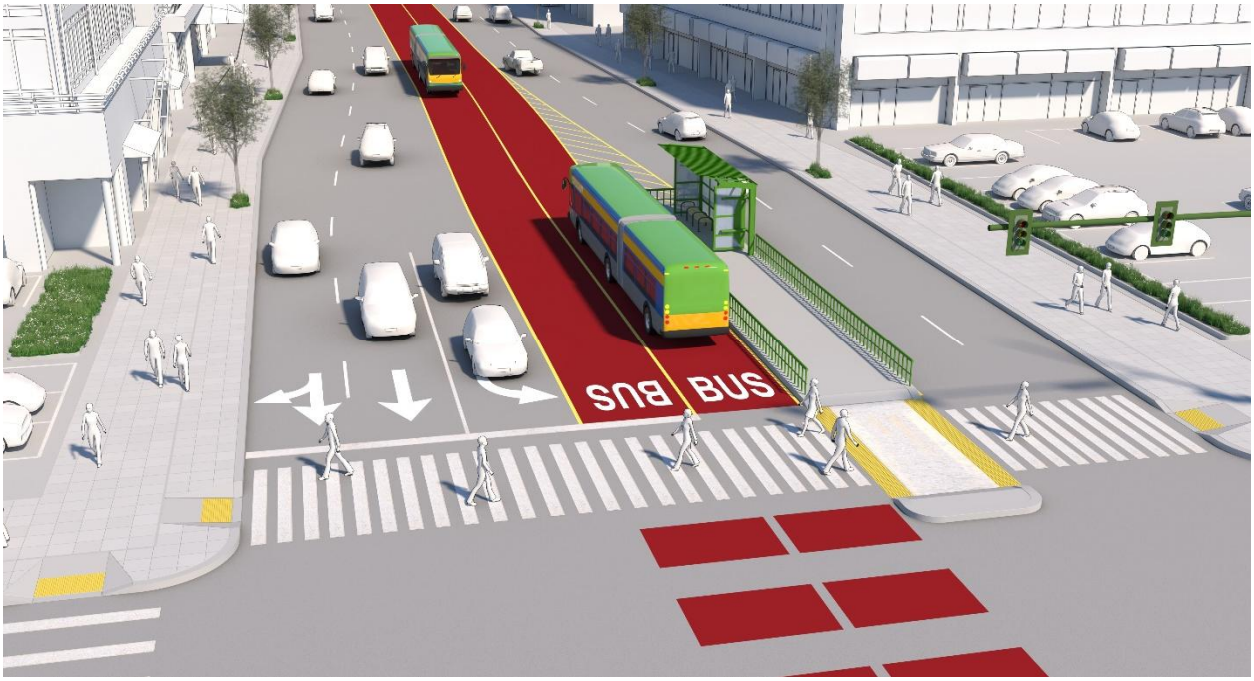
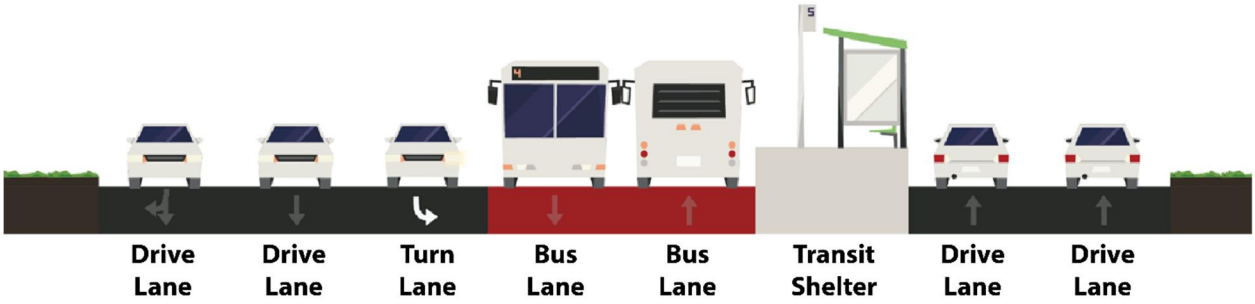


Figure 22: Median Lane: Right-Side Boarding Cross Section (at intersection and with station)



The Median Lane: Right-Side Boarding option features exclusive transit lanes in the middle of the road to maximize BRT travel time benefits. The median stations and lanes provide for a high degree of brand identity and visibility for the system at large. This option sets the strongest form of brand identity for the project and clearly establishes route permanence, which would help spur economic development. Compared to curbside BAT lanes, a lower level of capital investment would be needed. This option also avoids conflicts with right-turning vehicles and bicyclists (particularly if bicycle lanes are present). However, this option would remove the center TWLTL, requiring alternative means for gaining access to mid-block driveways—typically by making U-turns at a subsequent intersection. Median stations may also be perceived as feeling unsafe for transit riders waiting for the bus.

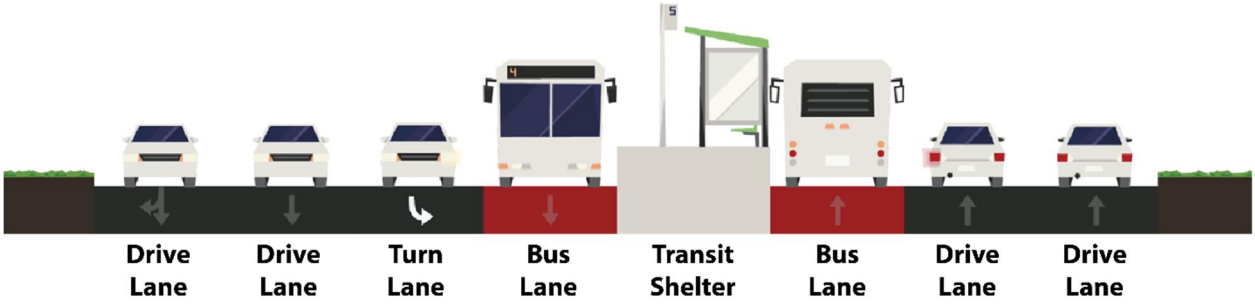
A variation of this option is to use a single, bidirectional lane in the median. This variation could be applied where widening of the roadway or removal of on-street curbside parking would have significant impacts. The single-lane option could result in delay if a bus must wait at the start of a bidirectional segment for the single-lane segment to clear. To minimize this situation, single-lane segments should be used only where needed and kept as short as possible.

7.5 MEDIAN LANE: LEFT-SIDE BOARDING

Figure 23 shows BRT operating in an exclusive median-running transit lane, with passengers boarding on the left side of the bus. A typical cross section for this alternative is shown in Figure 24.

Figure 23: Median Lane: Left-Side Boarding Concept

Figure 24: Median Lane: Left-Side Boarding Cross Section (at intersection and with station)



This option is similar to the Median Lane: Right-Side Boarding except that passengers board the buses on the left side of the vehicle rather than the usual right side. This method allows for using a single center platform for both directions of travel. This option could save capital costs and give the route an even greater degree of brand recognition and visibility, but it would require BRT vehicles that have doors on both sides of the bus (i.e., five doors). The same disadvantages described for the Median Lane: Right-Side Boarding alternative exist with this alternative, namely the removal of the center TWLTL.

A variation of this option is to use a single, bidirectional lane in the median. This variation could be applied where widening of the roadway or removal of on-street parking would have significant impacts. The single-lane option could result in delay if a bus must wait at the start of a bidirectional segment for the

single-lane segment to clear. To minimize this situation, single-lane segments should be used only where needed and kept as short as possible.

8 First Screening of Alternatives

8.1 Evaluation Criteria

The 12 goals developed as part of the Purpose and Need Statement were used as the initial Level 1 screening criteria. They are as follows:

1. The project will increase transit ridership by reducing transit travel time; improving trip reliability; increasing service frequency; and enhancing transit's comfort, convenience, and image.
2. The project will provide cost-effective transit service in the Study Corridor.
3. The project will increase transit capacity to meet current and projected transit travel demand.
4. The transit service will be accessible to all populations, including minorities, people with low-income levels, and those that are transit dependent.
5. The project will promote environmental stewardship and sustainability by reducing greenhouse gas emissions and supporting smart growth.
6. The project will improve access to the Study Corridor transit service by pedestrians and bicyclists.
7. The project will provide improved connections with other local or regional travel modes.
8. The project will have a high likelihood of funding through identified grant programs and funding sources.
9. The project will enhance safety and security for transit patrons and public health overall.
10. The project will support planned local and regional growth and corridor revitalization efforts.
11. The project will be consistent with adopted local and regional transportation plans.
12. The project will minimize adverse impacts to other travel modes and adjacent property.

8.2 Assessment

The following presents the analyses broken out by segments along the Pacific Avenue/SR 7 corridor and outlines how each design alternative within the segment rated against the 12 goals. Each option was graded using the following scale:

For the purposes of this first-level evaluation, the Pacific Avenue/SR 7 Corridor was divided into nine segments that reflect similar characteristics, as shown in Figure 25.

The First-Level Evaluation Technical Memo contains the segment-by-segment evaluation and rating of each of the initial typical five design alternatives. The roll-up of that evaluation is summarized in Table 23 and the highest-ranking design alternatives for each segment are depicted graphically in Figure 26. The ratings shown in green font in Table 23 are those design alternatives that appear to have the highest potential for each segment. Note that at least two highest-rated design alternatives are identified for each segment. Some segments have three alternatives identified (2A, 2B, 6, 7), and one segment, Spanaway (9), has five.

Figure 25: Design Alternatives Segment Map

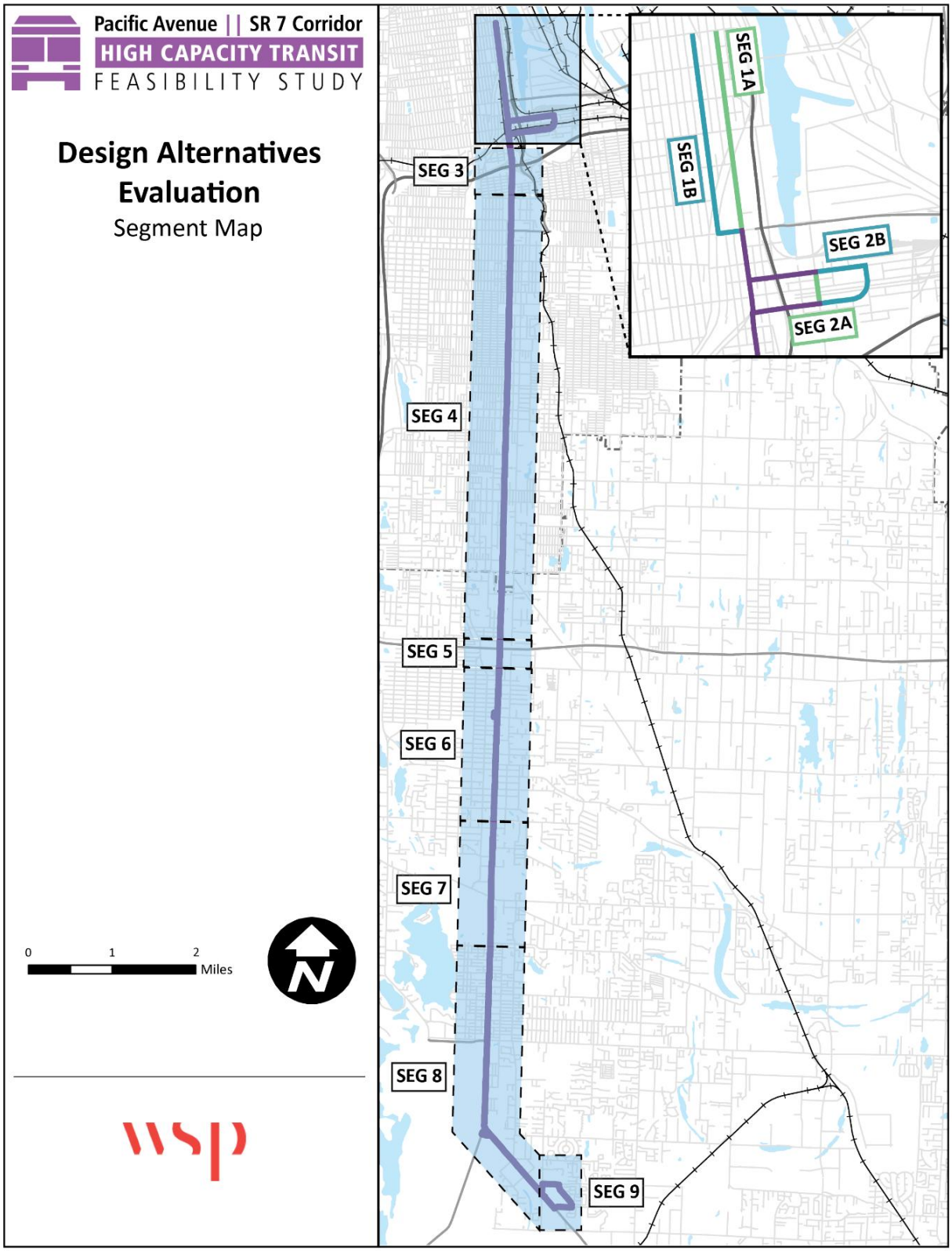
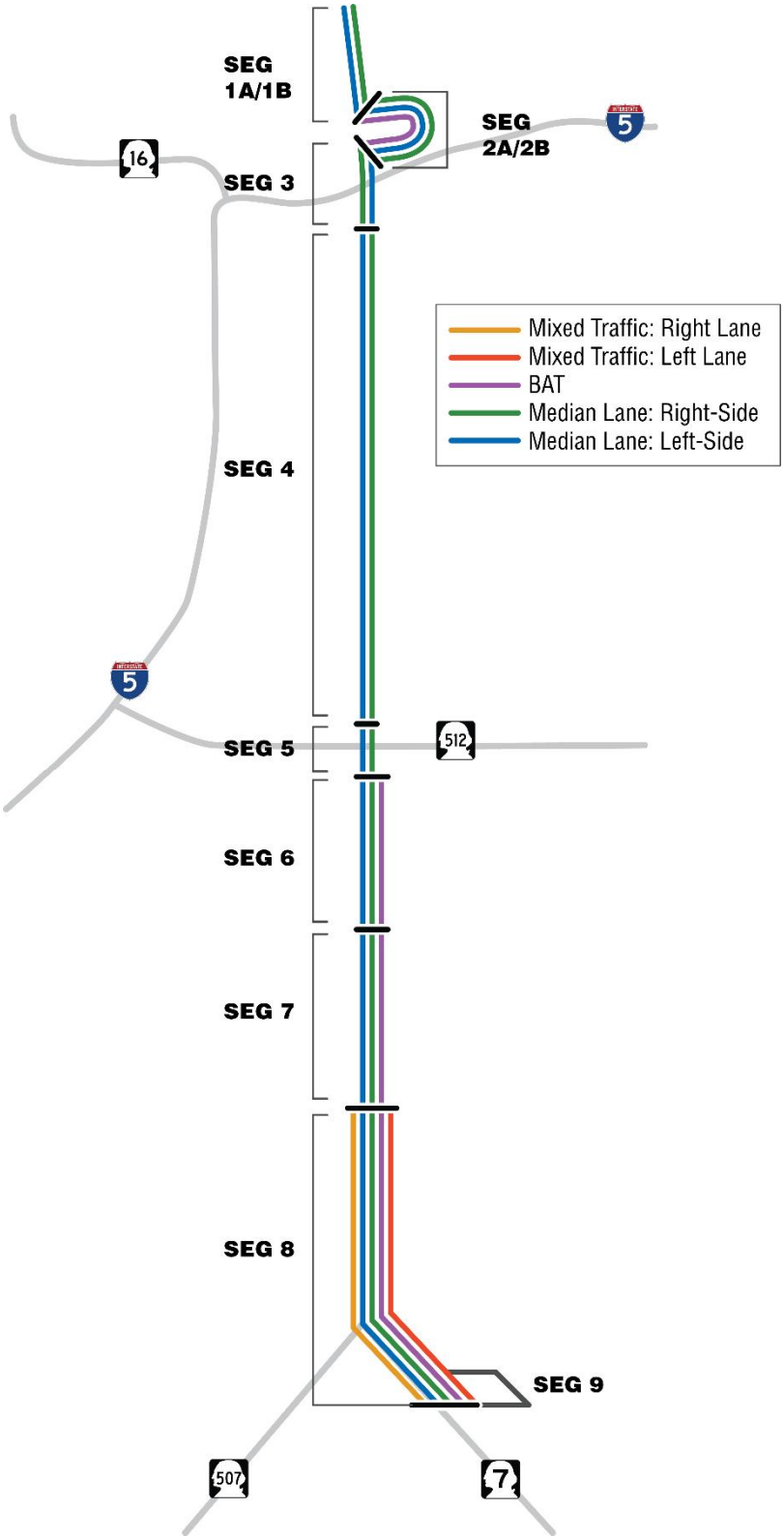


Table 23. Total Average Results of Design Alternatives by Segment

Segments		No Build (Current Service)	Mixed Traffic: Right Lane	Mixed Traffic: Left Lane	BAT Lane	Median Lane: Right-Side Boarding	Median Lane: Left-Side Boarding
1A	Downtown Tacoma (via Pacific Avenue) between S 9th Street and S 24th Street	2	3	3	3	4	4
1B	Downtown Tacoma (via Market Street) between S 9th Street and S 24th Street	2	3	3	3	4	4
2A	Tacoma Dome Station Access to E D Street between S 24th Street and S 26th Street	2	3	3	4	4	4
2B	Tacoma Dome Station Access to E G Street between S 24th Street and S 26th Street	2	3	3	4	4	4
3	Crossing I-5 (via Pacific Avenue) between S 26th Street and S 34th Street	2	3	3	3	4	4
4	S. Tacoma (via Pacific Avenue/SR 7) between S 34th Street and 108th Street S	2	3	3	4	4	4
5	Crossing SR 512 (via Pacific Avenue/SR 7) 108th Street S and 112th Street S	2	3	4	4	4	4
6	Garfield Street S/Parkland (via Pacific Avenue/SR 7) between 112th Street S and 138th Street S	2	3	3	4	4	4
7	Sprinker Recreational Center (via Pacific Avenue/SR 7) between 138th Street S and 160th Street S	2	3	3	4	4	4
8	Spanaway (via Pacific Avenue/SR 7) between 160th Street S and 8th Avenue E	2	4	4	4	4	4
9	South Terminus at Walmart Supercenter Turn-around Area	N/A					
Total Score:		**273**	**351**	**389**	**439**	**465**	**465**
Average Score by Goal:		**2.1**	**2.7**	**2.9**	**3.3**	**3.5**	**3.5**

*Figure 26: Highest Ranking Alignments by Segment**



*Segments 1A and 1B have the same ratings as segments 2A and 2B

Table 23 designates the total rating score for each design alternative. Since this scoring was not weighted (i.e., each rating criterion carried the same weight), a simple addition of the scores may not reflect the actual preference for the design alternative. With that caveat, the total unweighted scores indicate that, based on the goals outlined in the Purpose and Need Statement, the Median Lane: Right-Side Boarding and Median Lane: Left-Side Boarding were the highest-rated alternatives along the corridor. Both consistently ranked the highest for corridor segments when considering an average of all goals, although they did generally rank lower for three of the 12 goals: Goal 2 (Cost-effectiveness), 9 (Maximize safety/security), and 12 (Minimize impacts to other travel modes). Both were also the most consistent across all segments. In only one instance was one of these two alternatives not the top-ranking design.

The BAT Lane alternative was ranked highest for Segment 2B (between Pacific Avenue and the Tacoma Dome Station). It is also worth noting that the BAT Lane alternative score was equal to the median lane options' scores for Segments 6 and 7 (Garfield/Pacific Lutheran University and Sprinker Recreational Center areas).

The Mixed Traffic: Right Lane and Mixed Traffic: Left Lane alternatives consistently ranked lower than the other BRT design alternatives across all segments and goals. This is largely due to the lower travel time savings and minimal expected impact on economic development. However, these are the lowest cost options and those that have the least impact on general purpose traffic and adjoining properties.

The No Build option ranked last since it does not generally further the project goals. It represents a baseline option from which the build alternatives can be judged and can be the selected preferred option should cost or impacts of the build alternatives be deemed unacceptable.

A significant benefit of BRT is design flexibility, which allows lane configurations to be tailored to the specific needs, opportunities, or constraints of a corridor segment. For this reason, many BRT lines are designed with varying lane treatments. For example, a BRT corridor may have BAT lanes in areas where they can be installed with minimal impact or to address specific traffic delay problems, and then switch to a mixed-traffic option where there is no need to address traffic delay or if implementation of BAT lanes would have an unacceptable impact. Similarly, a median alternative option could alternate between exclusive transit lanes, left-lane mixed traffic, and a bidirectional lane depending on opportunities and constraints. It is also possible to switch between side-running and median alternative options, provided that the transition can be accomplished efficiently.

In summary, because of the relatively lower cost per mile of transit lane of the Median Lane: Right-Side and Left-Side Boarding options (as compared to the BAT Lane), the ability to brand and bring route recognition, the potential of related economic development, and an estimate of fewer property acquisition needs, the two median lane options are the highest-ranked design alternatives for the Pacific Avenue/SR 7 corridor.

8.3 DECISION

Although the median lane options are generally the highest-rated alternative for the corridor, it was recommended that the Pacific Avenue/SR 7 corridor continue to take advantage of the "mix-and-match" approach to lane treatments so that the most appropriate BRT lane configurations can be applied to each of the corridor segments. Hence, in the next level of evaluation for each segment, using the higher-rated options in Table 23 as a guide, a Curbside Alternative option (Mixed Traffic: Right Lane or BAT Lane) and

a Median Alternative option (Mixed Traffic: Left Lane or Median Lane) were advanced. The specific recommended treatments for each segment were subsequently developed as part of the concept design phase.

There were two options for median lanes, one with right-side boarding and one with left-side boarding. It is recommended that the right-side boarding option be carried forward. That option would not require the need for specialized buses. However, the left-side boarding option would result in the potential for less expensive two-sided stations, which would more than offset the additional cost for buses with doors on both sides. Should the median option be selected, it is recommended that the decision on right-side boarding versus left-side boarding be revisited during preliminary engineering.

9 REFINED DESIGNS

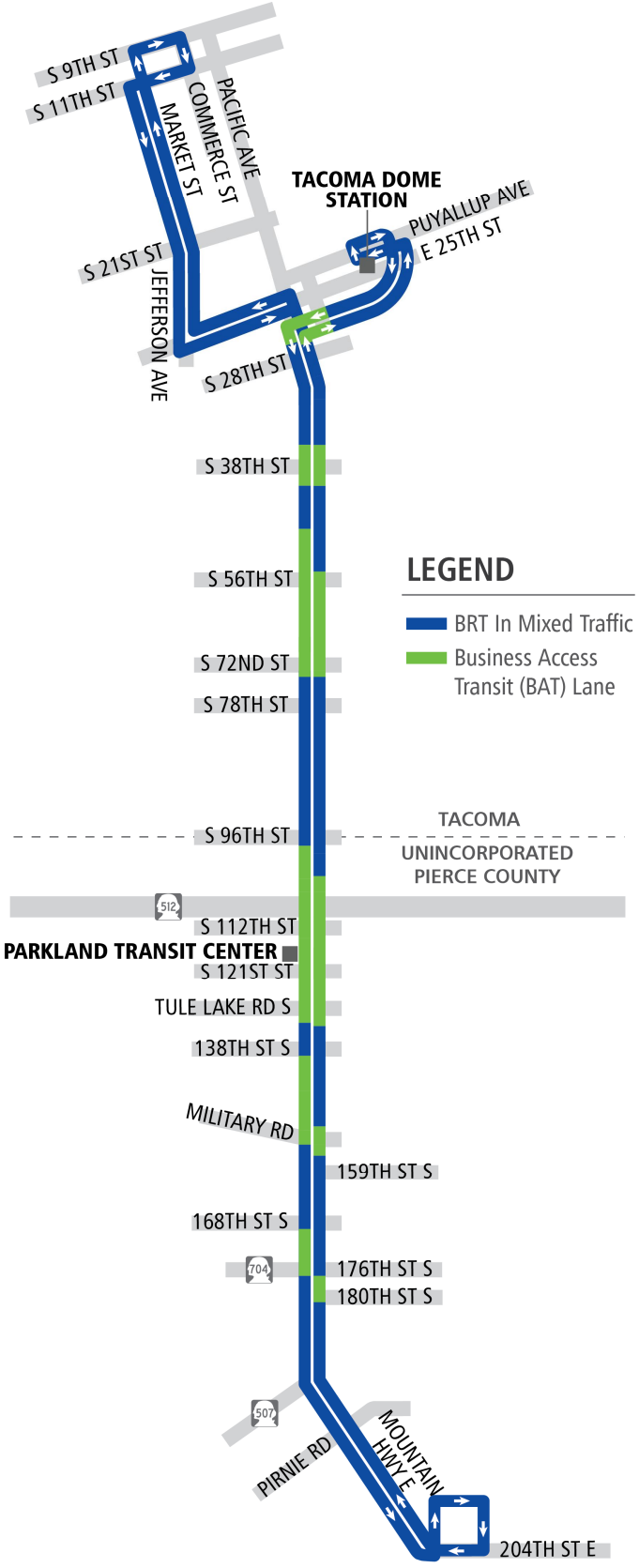
9.1 CURBSIDE ALTERNATIVES

The Curbside Alternative includes bus travel in mixed traffic in less-congested parts of the corridor and BAT lanes in congested segments, such as the SR 512 interchange area and other congested intersections, as shown in the diagram in Figure 27. For all segments, the Curbside Alternative features enhanced curbside stations with unique brand identity, off-board fare collection, low-floor buses, TSP for BRT vehicles, and no change to the existing center TWLTL.

The segments where the bus travels in mixed traffic are strategically located in areas that generally do not require significant transit priority lane treatments to maintain transit speed and reliability.

The BAT lane segments would improve bus travel time and reliability and would also add a buffer between pedestrians and vehicle traffic, except for slower-moving right-turning vehicles. The BAT lanes would not limit mid-block left-turn access as there would be no change to the existing center TWLTL. In addition, the BAT lanes would add to overall corridor vehicle capacity by taking right-turning vehicles out of the travel lane.

Figure 27: Curbside Alternative



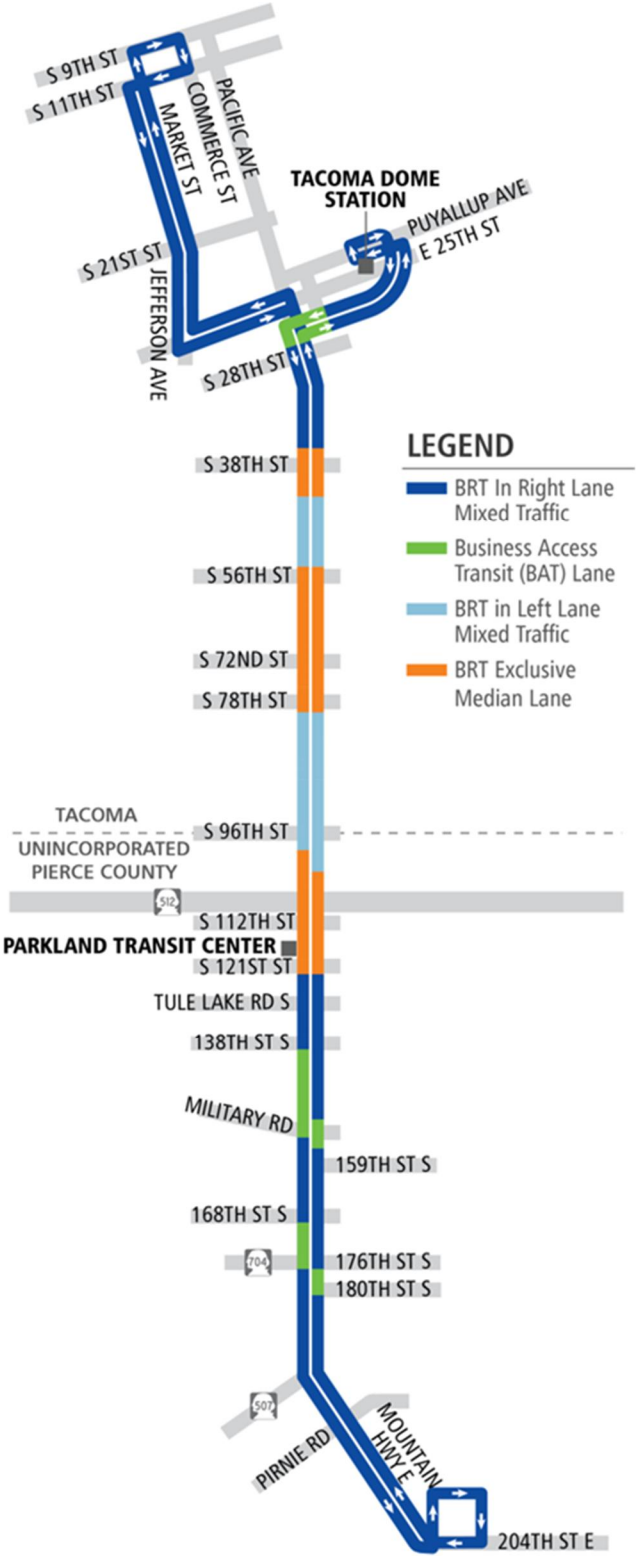
9.2 HYBRID ALTERNATIVE

The Hybrid Alternative is a combination of median and curbside transit operation. In the middle section of the corridor, from approximately S. 38th Street to 121st Street S., this alternative includes BRT in the median center lanes or mixed-traffic operation in the left lane, with the exclusive transit lanes in congested segments, such as the SR 512 interchange area and other congested intersections as shown in Figure 28. This median section features enhanced median stations with some changes to the existing left turn access. At the southern and northern ends of the corridor, this alternative would transition to curbside BAT and mixed traffic running BRT. The entire corridor includes a unique brand identity, off-board fare collection, low-floor buses, TSP for BRT vehicles, and some changes to the existing center TWLTL.

The segments where the bus travels in mixed traffic would not require changes to the existing roadway except in the immediate vicinity of stations.

The segments where the bus would travel in dedicated median BRT or BAT lanes would have a high benefit to bus travel. The Hybrid Alternative would have more slightly more dedicated transit lanes than the Curbside Alternative for a similar cost.

Figure 28: Hybrid Alternative



10 ENVIRONMENTAL CRITICAL ISSUES

As part of the screening process, the alternatives were evaluated for how they affect a select set of environmental resources that were identified as the critical issues. Based on the existing built environment of the corridor, the resources identified as "critical" were those that would provide information on the project's potential level of adverse impacts, public or agency controversy, and those that have specific regulatory protection. The environmental critical issues that were evaluated were:

- Property and access
- Traffic
- Environmental justice populations and Title VI compliance
- Historic and cultural resources

Based on the assessment of these critical issues, neither the Curbside Alternative nor the Hybrid Alternative have environmental impacts that would significantly affect the project's delivery.

Because the project will be pursuing Small Starts funds from the FTA, the National Environmental Policy Act (NEPA) process will be required to be completed. The NEPA process has three classes of action; Categorical Exclusion (CE)/Documented Categorical Exclusion (DCE), Environmental Assessment (EA), and Environmental Impact Statement (EIS). Generally, completing a CE/DCE requires the least amount of time and effort and completing an EIS requires the most. As shown in Table 24, a project's class of action depends on the type of work/action that is proposed and the following three main factors: impacts, public and agency controversy, and the number of alternatives/options being evaluated.

Table 24. NEPA Class of Action Summary

Factors	NEPA Class of Action		
	DCE	EA	EIS
Impacts	Known, Not Significant	Unknown if Significant	Known, Significant
Public and Agency Controversy	Low	Moderate	High
Project Alternatives/ Options	1	1 or more	1 or more

Based on the evaluation of the environmental critical issues, the FTA has determined that a DCE would be the appropriate NEPA class of action for either the Hybrid Alternative or Curbside Alternatives. Under either alternative, the number of properties that would require some acquisition of land and the percentage of the property acquired would not make an intense impact, and in the southern part of the corridor, the addition of BAT lanes would result in improvements to general purpose traffic along Pacific Avenue/SR 7.

11 SECOND SCREENING OF ALTERNATIVES

11.1 EVALUATION CRITERIA

11.1.1 Station Locations Evaluation Criteria

The BRT line is proposed to consolidate 65 existing bus stops to 32 stations using a methodology based on metrics that reflect population, transit markets, and land use characteristics. The criteria include observed boardings at current stops, population and employment density, existing and potential land uses, and improved station spacing. Each of these metrics was ranked on a five-point system.

Daily boardings on the current Pierce Transit Route 1 were ranked based on the northbound and southbound combined ridership. A score of 1 was given for less than 20 boardings per bus stop, a score of 2 for 20 to 40 boardings, a score of 3 for 40 to 80 boardings, a score of 4 for 80 to 120 boardings, and a score of 5 for more than 120 boardings.

Access to other transit lines in the Pierce Transit network, the greater Sound Transit network, or the national network (Amtrak, Greyhound and other private bus companies at the Tacoma Dome Intermodal Transit Station) was used in station determination. Stations at intersections with cross-connecting bus routes or other transit modes were given more weight in the evaluation. Both the number and diversity of transit options were considered in assigning points to connecting services. A ranking of one point was assigned to stations with no connecting transit service, three points for one connecting transit line, four points for two connecting transit lines, and five points for more than three connecting routes or services.

Stations in proximity to activity nodes, such as commercial and entertainment districts, were given more weight in the station assessment. Some areas of note include the University of Washington-Tacoma campus, the downtown Tacoma Brewery District, the Tacoma Dome, and other designated growth centers along the corridor.

A separate TOD report evaluated the potential for new development along the corridor. Except for several outliers, all of which were selected as proposed stations, the TOD potential tends to increase as the route moves northward from the suburban/rural land uses near the southern terminus at the Walmart Supercenter in Spanaway to the highly urbanized northern terminus in downtown Tacoma and Central Business District.

The report ranked locations on a 100-point system that evaluated five major indicators, as listed below, which were adapted into a five-point system for comparison in this evaluation:

- The nature of transit service, which includes the extent of the service area, the permanence of transit infrastructure, and the variety of transit options.
- The convenience and access to transit service, including the walkability of station areas and mobility barriers.
- The existence of underutilized land, either vacant or of low value in its current state, such as underused surface parking lots.
- Market support for new development, which includes projections for population growth and development.

- Transit-supportive policy and planning, including zoning and parking reductions for new housing and office developments.

For the purposes of TOD, property along the corridor was divided into 11 market segments. These segments are listed as follows from north to south:

- Downtown Tacoma
- Waterfront
- Tacoma Dome
- From I-5 to S. 40th Street
- From S. 40th Street to S. 68th Street
- From S. 68th Street to S. 80th Street
- From S. 80th Street to 106th Street S.
- SR 512 from 114th Street S. to 121st Street S.
- Pacific Lutheran University
- From 126th Street S. to 159th Street S.
- From 159th Street S. to the end of the Study Corridor (Mountain Highway E. at 204th Street E.)

The land use density ranking uses combined population and employment within a half-mile walk proximity of bus stations, calculated with ArcGIS and categorized into five criteria. Aggregate population and employment below 2,000 was assigned a score of 1; 2,000 to 7,000 was assigned a score of 2; 7,000 to 10,000 was assigned a score of 3; 10,000 to 13,000 was assigned a score of 4; and a score of 5 was assigned for 13,000 and above.

11.1.2 Corridor Treatments Evaluation Criteria

The evaluation criteria and method of measurement are shown in Table 25. Fifteen criteria were developed based on the goals developed as part of the Purpose and Need Statement. These criteria were chosen because they not only measure key aspects related to the alternatives meeting the project goals, but also because they help differentiate between the “No Build” and “Build” alternatives.

Table 25: BRT Corridor Alternatives Evaluation Criteria

Evaluation Criteria	Method/Assumptions
Weekday Transit Ridership	From Central Puget Sound regional transit ridership model.
Reduces Peak Period Transit Travel Time (Spanaway to Tacoma Dome Station)	In minutes. Calculated from onboard systems bus data and estimates of transit travel time savings based on observed experience from implementation of different BRT and transit speed and reliability improvements.
Reduces Peak Period Transit Travel Time (Spanaway to Downtown Tacoma)	In minutes. Calculated from onboard systems bus data and estimates of transit travel time savings based on observed experience from implementation of different BRT and transit speed and reliability improvements.
Reduces Peak Period Auto Travel Times (Spanaway to Downtown)	In minutes. Based on Google travel time data and targeted traffic operational modeling.
Minimize Impacts to General Traffic Access and Circulation	Measured by change in delay to corridor traffic and ease of access to corridor businesses and residential properties.
Operating Cost per Passenger	Total route operating cost divided by projected ridership.
Improves Transit Travel Time Reliability	Based on percentage of route in bus preferential treatment lanes.
Population within 1/2 Mile Walk Shed of Stations	Existing population based on PSRC data.
Improves Pedestrian Access and Safety	Percentage of stops at signalized pedestrian crossings, level of sidewalk improvements, effects on pedestrian crossing times and distances.
Facilitates Connections to Other Transit Services	Nearby transfers, ease of transfer.
Supports Corridor Revitalization	Qualitative – benefits of enhanced transit modified by adverse effects of alternative.
Minimize Impacts to Private Property	Based on number of parcels and total square footage affected.
Weekday Boardings per Service Hour (productivity)	Daily boardings divided by daily route service hours.
Consistency with Adopted Local and Regional Transportation Plans	Includes PSRC *Transportation 2040, Sound Transit ST3 System Plan,* and *Pierce Transit Destination 2040 Long Range Plan*.
Increase in Corridor Person Throughput Potential	Based on planned headways and bus capacity.

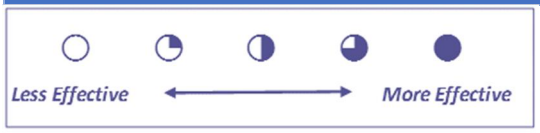
11.2 Assessment

The two BRT corridor Build alternatives were evaluated in comparison to the No Build Alternative for the 15 criteria identified previously in Table 25. Most of the criteria, such as ridership projections, operating and capital cost, transit travel time, and property impacts, were assessed using quantitative measures. A few criteria, such as support for revitalization and consistency with local plans, were assessed qualitatively.

The results of the evaluation are summarized in Table 26. The section below describes the evaluation results in more detail by each criterion.

Table 26. BRT Alternatives Evaluation Summary

Evaluation Criteria	No Build (Current Service)	Curbside Alternative	Median Alternative
Weekday Transit Boardings	3	4	5
Reduces Peak Period Transit Travel Time (Spanaway to Tacoma Dome Station)	1	4	5
Reduces Peak Period Transit Travel Time (Spanaway to Downtown Tacoma)	1	3	4
Reduces Peak Period Auto Travel Times (Spanaway to Downtown)	3	4	3
Minimize Impacts to General Traffic Access and Circulation	3	4	3
Operating Cost per Passenger	5	3	4
Improves Transit Travel Time Reliability	1	3	4
Population within 1/2 Mile Walk Shed	5	5	5
Improves Pedestrian Access and Safety	2	4	5
Facilitates Connections to Other Transit Services	2	5	5
Supports Long-Term Corridor Revitalization	1	3	4
Minimize Impacts to Private Property	5	4	3
Weekday Boardings per Service Hour (productivity)	3	4	5
Consistency with Adopted Local and Regional Transportation Plans	2	5	5
Increase in Corridor Person Throughput Potential	1	5	5
Total Score:	38	60	65
Average Score by Criterion:	2.5	4.0	4.3



The No Build Alternative does not improve transit performance and, with forecast community growth, it is expected that transit travel time and reliability would deteriorate further in the future under this alternative. In addition, the No Build Alternative does not implement community plans and does not support city and county corridor redevelopment efforts.

The Curbside and Hybrid alternatives show a distinct improvement over the existing conditions and have similar overall ratings. However, these two alternatives have different strengths and weaknesses.

While both alternatives would result in a significant improvement in transit travel time and ridership and support economic development, the Hybrid Alternative has lower transit travel time and higher transit ridership than the Curbside Alternative. Furthermore, it has the added advantage of creating a less traditional, more rail-like image for the bus service. In addition, the Hybrid Alternative creates a narrower street cross section in the areas where there are transit lanes (i.e., six lanes compared to seven lanes), which reduces pedestrian crossing distances, has less impervious surfaces, and allows more land to be dedicated for non-roadway uses.

Where median-running transit lanes are proposed, the Hybrid Alternative would eliminate left turns except at intersections. While this creates a safer street by reducing the potential for crashes involving unprotected left turns, it would make access to some businesses less direct.

The Curbside Alternative would add vehicle capacity in the areas that have added BAT lanes since those lanes can be used by right-turning vehicles as well. This would have the effect of reducing traffic congestion.

On balance, the Hybrid Alternative provides greater benefit and is recommended as the LPA.

12 PUBLIC OUTREACH

Ongoing public engagement and participation has been critical throughout the BRT planning process. Its purpose is to ensure Pierce Transit uses effective means of providing information about and receiving input on transportation decisions from the public, including low-income, minority and limited English proficient (LEP) populations, as required by Title VI of the Civil Rights Act of 1964. Title VI states that ''no person in the United States shall, on the ground of race, color, or national origin, be excluded from participation in, be denied the benefits of, or be subjected to discrimination under any program or activity receiving Federal financial assistance.''

The success of the Pierce Transit Pacific Avenue/SR 7 Corridor High Capacity Transit Feasibility Study has depended largely on participation and input from agency and institutional stakeholders, transit riders and other commuters, businesses and residents within the study area, and the public. Thus, the methods used to engage and involve these stakeholders are an important part of the overall study. A Public Involvement Plan was developed to ensure that the public is both aware of and well-informed about the project study and its potential impacts, and that the public is provided with opportunities for meaningful participation in the process.

Public comments helped build an understanding of community issues and needs that informed key study elements. Comments were received through a variety of means, including comment forms, cards, letters, email or website contact, phone calls, as well as personal contacts with stakeholders at public meeting events or face-to-face interactions.

Public engagement in open houses and electronic communication is summarized in Table 27 below.

Table 27: Public Engagement Summary

Type	Attendees/Unique Pageviews	Comments
Open House	97	10
Public Hearing	NA	31
BRT Webpage	12,245	NA
Virtual Open House	1,189	63
Bus Station Feedback Tool	912	114
BRT Email	NA	30
BRT Mailer Comment Cards	NA	24
TOTAL	**14,443**	**272**

Additionally, Pierce Transit attended more than 200 events between February 2017 and October 2019. These included open houses, presentations, community events and local festivals.

An effective method for reaching the public and offering real-time, interactive engagement opportunities has been through two project-specific websites. The first was established in 2017 as part of the High Capacity Feasibility Study, especially to notify the public of upcoming open houses. It was then that an

"online open house" format was created, which enabled the public to view the presentation boards from each of the series of open houses; access the study as each of the chapters or tasks were finalized; and participate in surveys regarding mode, vehicle type, potential station locations, and other topics. The initial website went live on June 26, 2017, as www.piercetransit.org/hct-feability-study/. It was later transitioned to www.RideBRT.org on August 6, 2018.

Printed matter and other informational brochures or collateral have also been continuously produced and updated throughout the project. Pierce Transit's most common tool is a 4.5" X 7" rack card, produced full color on heavy glossy paper stock. They have been produced as two-sided, four-panel (meaning it opens like a book), and even six-panel, based on the amount of information the agency wanted to convey at the time. These rack cards were then placed on all Pierce Transit buses and SHUTTLE (paratransit) vehicles, as well as at most transit centers and stations. The agency's vast distribution list includes civic buildings, libraries and other places throughout the service area where printed information on Pierce Transit routes and services is readily available to the public.

The final piece of the puzzle was periodically producing two-sided, full color 8.5" X 11" "Fact Sheets" on both the HCT Feasibility Study and BRT project. These were written in English and Spanish as a high-level executive summary of the project, including milestones and how to get involved. In general, these were updated every three to four months, based on new information that the agency wanted to share with the public. However, unlike the rack cards, the Fact Sheets were produced to distribute one-on-one or wherever Pierce Transit directly interacts with its customers, such as open houses, community outreach tables, or other well-attended events. The latest or most current Fact Sheet (English and Spanish) has been continuously posted online as an Adobe PDF document as well.

Pierce Transit's social media channels, especially Facebook and Twitter, played an integral role in the agency's communication with the public about the HCT Study and the subsequent BRT project. The agency shared information early and often about the project and the process, online and at in-person open houses, and provided opportunities for people to offer feedback at various project milestones. In 2019, Pierce Transit hired a dedicated digital content/social media expert, so this method of communication will play an even more important role as the project moves into development and construction.

13 INTERSECTION CONTROL EVALUATION

13.1 WSDOT ICE BACKGROUND

On Washington State facilities with proposed modifications to channelization achieved by constructing new pavement, WSDOT policy requires an Intersection Control Evaluation (ICE) to select the most appropriate intersection control type and for approving all reconstruction of conventional traffic signals. This report process allows the decision to be made between reconstructing intersections with traffic signals or with roundabouts. The final ICE report is signed by the Region Traffic Engineer and the State Traffic Design and Operations Manager.

WSDOT prefers roundabouts and will only install a traffic signal when a roundabout is deemed to be infeasible. Roundabouts generally reduce fatalities and serious injuries; improve the flow of traffic, especially during the off-peak periods; require less long-term maintenance than signals; and reduce tailpipe emissions. However, roundabouts may increase project cost associated with ROW acquisition at the intersections, where property values are generally higher and, in the case of this project, roundabouts have not been designed to provide transit preferential treatments through intersections because of space limitations.

The report involves a five-step process meant to screen and evaluate alternatives to determine the best possible intersection type and design.

Step 1: Background and Project Needs
Step 2: Feasibility
Step 3: Operational and Safety Performance Analysis
Step 4: Alternatives Evaluation
Step 5: Selection

The ICE report requires an alternatives evaluation between a roundabout and traffic signals on each intersection that would be modified by the project. The report considers the following criteria:

- ROW requirements
- Environmental concerns
- Pedestrian access and circulation
- Safety
- Access
- Traffic operations and level of service
- Transit operations

13.2 SUMMARY OF ICE REPORT FINDINGS

As the report began, 19 intersections were evaluated (nine in the City of Tacoma section and 10 in the unincorporated Pierce County section of the corridor) and modeled for performance. For seven intersections, consensus was reached between Pierce Transit, WSDOT and local agencies that roundabouts are not feasible and that the project should move forward with rebuilding traffic signals for the following reasons:

- Roundabout design is constrained by the lack of available space and could not be designed to address the capacity needs of the corridor, plus didn't perform significantly better than a traffic signal.
- Roundabouts made impacts on buildings that would have required a full property acquisition, which is contrary to the goals of the project to avoid full acquisitions.

Of the 19 intersections that were affected, the ICE analysis recommends rebuilding 15 intersections with traffic signals. For the remaining four intersections, the ICE report recommends rebuilding the intersections with roundabouts. Roundabouts are planned to be constructed at the following intersections:

- S. 76th Street
- 121st Street South
- 138th Street South
- 146th Street South

The LPA assumed roundabouts at these four locations.

14 LOCALLY PREFERRED ALTERNATIVE (LPA)

The Pierce Transit Board of Commissioners, in collaboration with the City of Tacoma and Pierce County, adopted an LPA on July 9, 2018. This action specified the mode, route alignment, and project termini. On April 8, 2019, the Pierce Transit Board refined the LPA by identifying a preferred concept design and station locations.

14.1 MODE, ALIGNMENT, TERMINI

The route for the project is shown in Figure 29. The alignment is in a generally north/south orientation between Spanaway to the south and the Commerce Street Transfer Center area in downtown Tacoma to the north. A majority of the route is along Pacific Avenue/SR 7, which is a Washington state highway south of S. 38th Street. At the south end of downtown Tacoma, the BRT service (unlike the current Route 1) will deviate to serve the Tacoma Dome Station, which is a major transit center with connections to other bus service and Sounder train service to Seattle. In the future, the Tacoma Dome Station will also include connections to Tacoma Link light rail. In downtown Tacoma, the BRT service will primarily operate on Jefferson Avenue and Market Street (they merge at S. 21st Street), terminating at the Commerce Street Transfer Center, which provides connections to many of Pierce Transit's bus routes.

14.2 LANE CONFIGURATION

The lane configurations used by the BRT service are shown in Figure 29. These include:

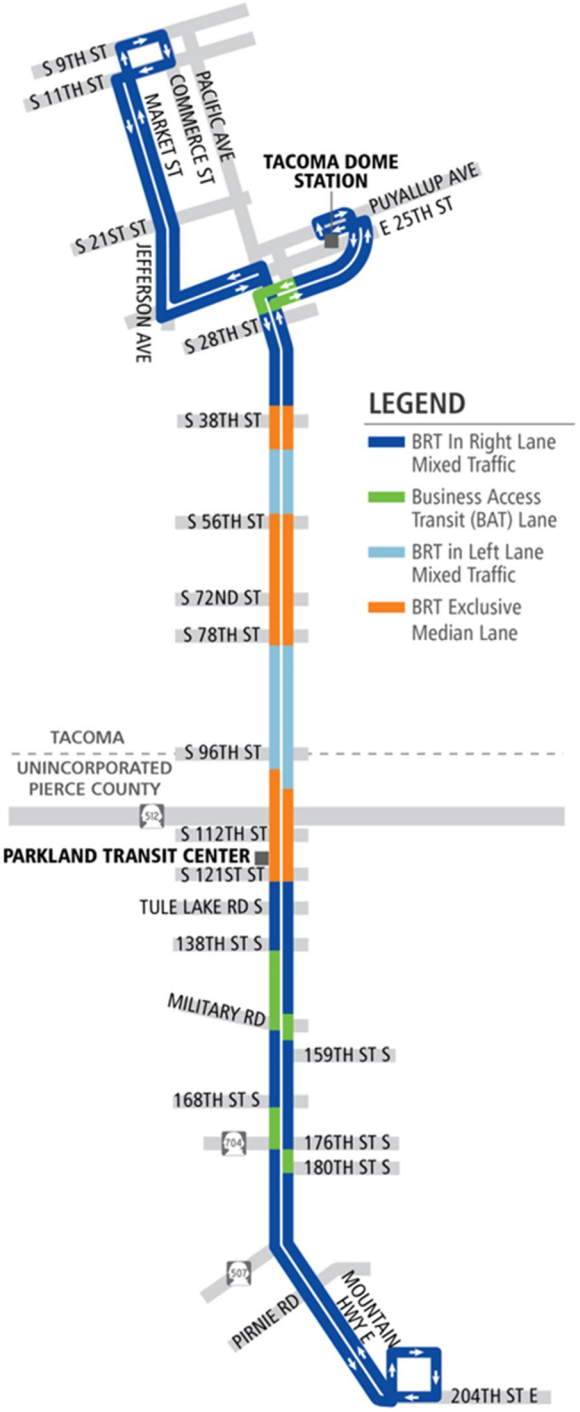
Mixed Traffic, Right Lane: This lane configuration is similar to what is used along the corridor today, with the bus operating in the right general purpose lane. Stops are general in the travel lane to eliminate delay for the bus getting back into traffic.

BAT Lanes: BAT lanes are used by the BRT buses and other vehicles turning right into driveways or at the next intersection. The BRT service can operate continuously in the BAT lane through intersections, but other vehicles can only use the lane for right turns. These lanes are added to the existing travel lanes on Pacific Avenue/SR7.

Median Transit Lanes: In this lane configuration, the BRT service will operate in median transit lanes, with stations also located in the street median. These lanes are exclusively used for transit and replace the current TWLTL that exists at the street. Signalized pedestrian access is provided to the stations.

Mixed Traffic, Left Lane: In segments between the median lane operation, the bus would travel in the left general purpose lane on Pacific Avenue/SR 7. Stops would be in the median of the street, but out of the travel lane. This lane configuration allows the bus to travel between the median lane segment without having to weave to the curbside lane and then back to the median transit lane.

Figure 29: BRT Route with Lane Configurations



14.3 STATIONS

There are 29 station pairs along the route, as well as a stop at the Tacoma Dome Station and at the route termini in Spanaway and the Commerce TC, for a total of 32 stops in each direction. The stations are shown in Figure 30. The average distance between stations is approximately 0.46 miles.

Figure 30: BRT Stations