Sound Transit 3

Appendix C:

Benefits, Costs, Revenues, Capacity, Reliability, and Performance Characteristics

DRAFT

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Introduction

This report details the benefits the Central Puget Sound region can expect from the fully implemented Sound Transit 3 Plan.

Transportation improvements strongly shape the growth, development, quality of life and economic vitality of a region. ST3 proposes improvements that add major new capacity in the region's most congested corridors to help serve the transportation demands of people and businesses here today as well as for more than 800,000 new residents anticipated in the next 25 years.

Replacing overcrowded and slowing bus routes with congestion-free light rail and significantly faster and more frequent bus rapid transit services will greatly improve travel for thousands of riders, particularly during peak hour commutes. The ST3 Plan will up to quintuple Sound Transit ridership from what it is today, increasing it from approximately 145,000 each weekday to between 561,000 and 695,000 daily riders. The plan will double the 350,000 boardings each weekday forecasted to follow the completion of the Sound Transit 2 plan.

With ST3, the share of all transit travel in the region on Sound Transit rail lines will grow from 17 percent today to 69 percent in 2040. This means more than four times as much transit travel will occur on vehicles that don't get stuck in traffic, regardless of time of day, day of the week, weather conditions or other factors.

Most importantly, these transit trips will be concentrated in the region's most congested corridors on bus routes and rail lines serving the region's densest downtowns and urban centers, adding critical capacity where it is most needed to support the region's economy and preserve its quality of life.

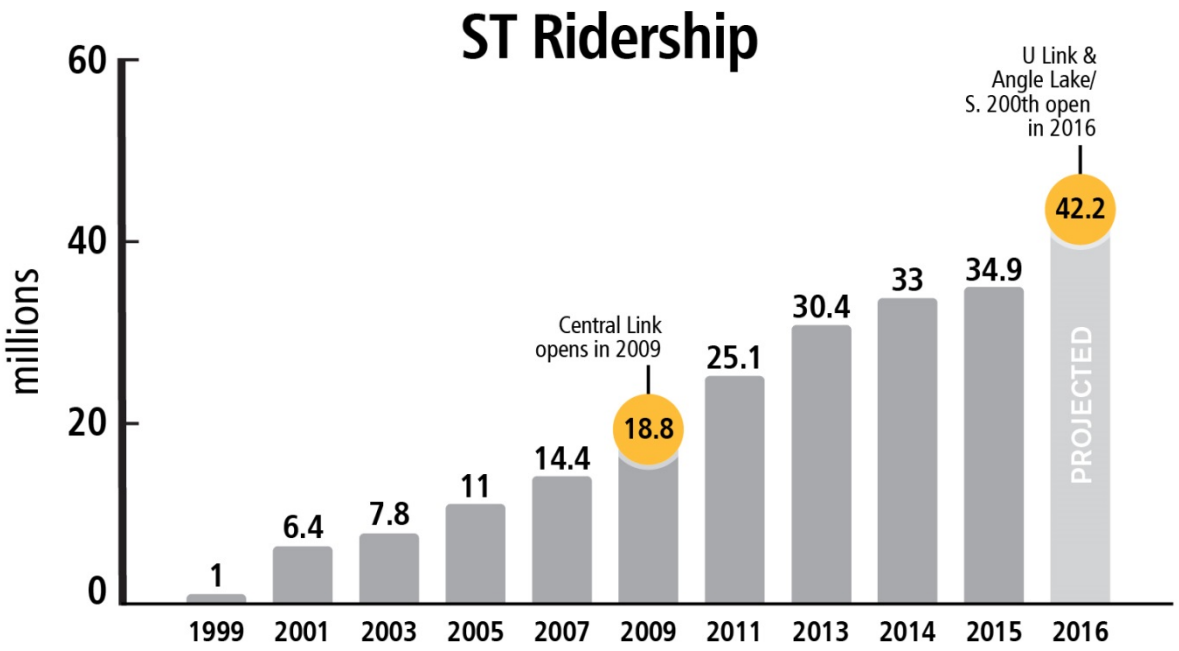
This report documents the conservatively projected travel benefits of ST3, while also discussing the plan's broader and far-reaching implications for the region's growth patterns, quality of life and economic well-being.

Both direct and quantifiable benefits, such as those from increasing the numbers of riders taking transit and reductions to travel times and costs, and broader qualitative benefits such as quality of life, are important to understanding the impact of ST3. All benefits will continue to grow over time, especially given transit's contributions in the coming decades to achieving the region's land use vision including dense, mixed-use development in walkable regional centers.

Data and methodologies used to analyze direct benefits of the transportation improvements in ST3 have been prepared in accordance with nationally accepted standards and procedures and have been subject to review by an independent Expert Review Panel appointed by, and accountable to, the state of Washington.

Background

In 1996, the year Sound Transit's Sound Move plan was approved by the voters, about 75 million individual trips were made on transit in the Sound Transit service area. By the time the region's voters had approved the Sound Transit 2 Plan (ST2) in 2008, that number had grown to 98 million trips, on Sound Transit services as well as those provided by partner transit organizations. By 2014, 117 million transit trips were being made annually. Since it was founded, Sound Transit has been increasing its market share of the region's transit system.



By 2040, as a result of completed projects in Sound Move and ST2, along with continued population growth, public transit in the Sound Transit District across all partner agencies will carry about 200 million trips a year, about 70 percent more than in 2014.

Benefits of ST3 investments in the regional transit system

Highlight: If the region's daily transit trips were all made by single-occupancy cars, the line of cars would extend about 1,100 miles. The 2040 daily ridership represents a line of cars nearly 1,800 miles long.

System reliability

Reliability means arriving at the same time every time, regardless of gridlock on the roads or snow on the ground. Reliability is a critical factor in how people plan their travel and budget their time.

Transportation system reliability has continued to decline in the Puget Sound region for several decades, both for car drivers and for transit riders whose travel times also suffer from worsening congestion in HOV lanes. This is primarily related to increases in the severity of traffic congestion and the greater likelihood of congestion occurring at any time of day or on any day of the week.

When people need to arrive somewhere by a specific time, whether to be on time for work, to catch a plane or to make a child's daycare pick-up, they know that if the trip involves one of the region's most congested corridors at peak hours they should allow a great deal of extra time to get there.

The road network is reaching saturation, where even small increases in traffic result in large degradation in travel time.

Highway reliability

Reliability on streets and highways is affected by many factors including collisions, stalled vehicles and weather conditions, but the most important factor in the Central Puget Sound region is the volume of traffic and delays caused by congestion.

Hours of delay on the central Puget Sound region's freeways nearly doubled between 2010 and 2015, increasing by 95 percent. Delay increased by 18 percent between 2014 and 2015 alone.

The following table shows WSDOT's estimates of how much time a driver needs to allow for travel between certain points in the regional system due to the unpredictability of highway travel in the region.

As detailed in Table 1, WSDOT tracks reliability on the freeways for major commutes between pairs of cities, and calculates "95 percent reliable travel times" -- that is, the amount of time a driver needs to plan for to be sure of arriving on time 19 times out of 20.

WSDOT data, compiled annually in major corridors, shows reliability on the region's highways to be steadily declining.

Table 1: Existing regional highway travel time reliability

Route Description	Existing Time at Posted Speeds	Average (Median) Peak Travel Time	Time to Ensure 95% On-Time Arrival	Additional Time for On-Time Arrival	% Additional Time for On-Time Arrival
Everett to Seattle	24 min	52 min	76 min	24 min	46%
Seattle to Everett	23 min	44 min	63 min	19 min	43%
Bellevue to Everett	23 min	47 min	62 min	15 min	32%
Overlake to Seattle	13 min	30 min	60 min	30 min	100%
South Lake Union to Ballard	10 min	19 min	27 min	8 min	42%
Bellevue to Overlake	5 min	7 min	12 min	5 min	71%
Bellevue to Issaquah	9 min	18 min	22 min	4 min	22%
Seattle to Federal Way	22 min	33 min	52 min	19 min	58%
Tacoma to Federal Way	12 min	14 min	16 min	2 min	14%
Tacoma to Lakewood	5 min	6 min	16 min	10 min	167%

Notes:

Highway times shown are from WSDOT 2015 Corridor Capacity Report, except for Ballard, which is from City of Seattle data.

Transit reliability

Sound Transit's Link light rail operates almost entirely on exclusive right of way. Most right of way is grade separated, with no interference from traffic. Even where there is no grade separation, Link light rail operates in its own right of way with specially programmed traffic signals that very seldom require trains to stop at intersections. This allows the service to maintain a very high level of reliability at all times of day.

By contrast, Sound Transit's express buses rely heavily on regional HOV lanes that are performing worse each year. Between 2012 and 2014 alone, the Washington State Department of Transportation reported major deterioration of HOV lane travel times:

- I-5 Everett to Seattle: weekday morning average HOV travel time increased 22 percent to 45 minutes. Reliable* HOV travel time increased 17 percent to 74 minutes.

- I-5 Federal Way to Seattle: weekday morning average HOV lane travel time increased 18 percent to 39 minutes. Reliable* HOV travel time increased 20 percent to 55 minutes.
- I-405 Lynnwood to Bellevue: weekday morning average HOV lane travel time increased 23 percent to 27 minutes. Reliable* HOV lane travel time increased 30 percent to 39 minutes.
- I-405 Tukwila to Bellevue: weekday morning average HOV lane travel time increased 38 percent to 22 minutes. Reliable* HOV lane travel time increased 65 percent to 33 minutes.

* Defined as the time allowance required to arrive on time 19 out of 20 times.

In 2014, about 83 percent of the region's transit travel occurred on buses operating in mixed traffic. With the completion of Sound Transit 2 (ST2) investments, 53 percent of the region's transit travel will occur on high-reliability rail lines. Shortly thereafter, the two Bus Rapid Transit lines included in ST3 will come into service, providing passengers with a higher level of reliability than existing buses due to separate lanes and other features. These investments will provide access to high-capacity transit in the near term as the region builds rail over the next 25 years.

With ST3 rail will carry 69% of the region's transit passenger miles, as shown in Table 2 below. Transit reliability is related to the portion of the trip that occurs in exclusive right-of-way. As the percentage of rail trips increases, transit reliability will also increase. This table illustrates the growing percentage of transit miles that will be traveled on reliable grade-separated rail transit.

Table 2: Percentage shares of passenger miles in mixed traffic vs. exclusive right-of-way

**Includes 2% of total transit passenger miles on Sound Transit Bus Rapid Transit*

Comparing the capacity of rail systems and highways

As the region's population continues to grow rapidly, high-capacity transit is the best and sometimes the only way to dramatically expand the region's transportation system to move significantly more people in highly congested corridors and to move those people more reliably. That is why so many regions of comparable size to that of Sound Transit rely extensively on rail transit. A two-direction light rail system occupies roughly the same amount of space as two highway lanes.

Highlight: Peak-period transit ridership on the I-5 corridor in Central Puget Sound was equal to nearly five extra lanes of capacity in 2014 (when compared to the peak efficiency of the roadway, a conservative approach to this measurement).

Highway capacity

The capacity of a single highway lane is defined as the highest number of vehicles that can pass a single point in an hour in a lane experiencing a stable flow of traffic.

Transportation planners calculate that maximum freeway capacity – up to 2,000 vehicles per hour per lane, with an average vehicle carrying 1.1 occupants during commute hours – is achieved at speeds of about 40-50 mph. When the speed falls to 30 mph, capacity can be reduced to as few as 700 vehicles per lane per hour.

Other factors affecting capacity include roadway design, collisions, disabled vehicles, spills, poor weather conditions and other events that impede normal traffic flow.

WSDOT tracks peak-period highway performance in Central Puget Sound for 40 different city-to-city commutes. Between 2012 and 2014 travel times worsened for 28 of these 40 commutes while only five improved.

Again, as travel speeds decrease due to congestion, the capacity of the freeway lanes decreases – even as demand increases. According to WSDOT annual system performance reports, particularly bad locations for congestion already affecting capacity today before the addition of 800,000 more people include:

- On I-405 at SR 169 in Renton, congestion reduces northbound capacity by 20 to 60 percent for about six hours a day;
- On I-5 at SR 18 in Federal Way, congestion reduces southbound capacity by 10 to 30 percent for about four hours a day;
- On I-5 at I-90, congestion reduces capacity in both directions by 10 to 20 percent for about 14 hours a day;
- On I-5 near Northgate, congestion reduces southbound capacity by 10 to 30 percent for about nine hours a day; and

- On I-5 at SR 18 in Federal Way, congestion reduces southbound capacity by 10 to 30 percent for about four hours a day.

Link Light Rail Capacity

The capacity of rail transit is determined by a combination of the size of the vehicles, the number of vehicles on each train and how frequently the trains run.

As with highway capacity, when speaking of rail capacity the important measure is the number of passengers that can be carried during the peak period, when the service is most in demand. This is usually referred to as "peak passengers per hour in the peak direction."

The passenger moving capacity of the ST3 light rail system is quite large, especially in comparison to a roadway of similar width with mixed traffic. Table 3 shows the capacity of the light rail system.

This table presents the hourly passenger capacity of the ST3 light rail system with varying frequencies of train service, at three different loading standards: Seated Capacity; Comfortable Capacity including some standing passengers; and a Standard Peak Capacity that might only occur during peak times for short segments. Planned peak-hour headways are between three and six minutes in each direction.

Table 3: Link light rail system capacity (passengers per hour)

Peak frequency (minutes)	4-car trains per hour (1 direction)	Seated capacity: 74 per car (1 direction)	Comfortable capacity: 150 per car (1 direction)	Standard peak capacity: 200 per car (1 direction)	Standard peak capacity (2 directions)	Standard peak capacity (2 directions, 2 tunnels)*
3	20	6,000	12,000	16,000	32,000	64,000
4	15	4,440	9,000	12,000	24,000	48,000
6	10	2,960	6,000	8,000	16,000	32,000

*Assumes construction and operation of new downtown tunnel

ST3 performance highlights

Transit passenger trips

With the ST3 Plan, transit ridership in the region including all agencies and transit services is projected to grow by 91 percent over 2014.

Transit agencies seek to develop high-capacity transit in corridors that already have high bus ridership because these areas are where population is most dense, congestion highest and transit alternatives most critical. That means that most new rail riders are people who are moving from buses. Riders graduate from crowded buses that are reaching their destinations more slowly as congestion worsens each year, even when operating in HOV lanes. Rail extensions provide the opportunity for vehicles and

operating expenses for bus services that previously ran in those corridors to serve more people in other corridors making the entire system more productive.

As the Sound Transit light rail system continues to grow, many riders are projected to shift from bus to rail, where they will benefit from the speed and reliability provided by grade separation. This continues the trend established through Sound Move and ST2, which were designed to serve the densest areas of the region. As the system expands regionally to serve urban centers further from the central core, the numbers of new riders does not grow at as steep a pace, though the distance traveled by the average rider increases.

With ST3, between 657,000 and 797,000 trips will be taken daily in the region, approximately twice the number of trips taken today. Table 4 compares regional transit ridership today with ridership projections for 2040, with and without ST3 investments.

Table 4: Regional transit ridership and transfer rate (Sound Transit & other regional transit partners)

	Existing in 2014	2040 without ST3*	2040 with ST3
Daily			
Transit Trips	390,600	601,000 - 725,000	657,000 - 797,000
Transit Boardings	563,000	975,000 - 1,169,000	1,100,000 - 1,332,000
Annual			
Transit Trips	117 million	183 - 221 million	202 - 245 million
Transit Boardings	169 million	297 - 356 million	338 - 409 million
Percent using Sound Transit (of passenger-miles)	39%	63%	75%
Percent of passenger miles by mode	Rail: 17% Bus: 83%	Rail: 53% Bus: 47%	Rail: 69% Bus: 31%
Transfer Rate	1.44	1.62	1.67

*Includes ST2 investments

Definitions

Transit passenger trips are counted with regard to boardings, trips, transfers and passenger miles. These terms are defined here.

Boardings – A transit boarding occurs any time a passenger steps into any transit vehicle.

Transit trips (or passenger trips) – A trip is a completed journey made by a person from an origin to a destination (such as home to work). Because people may transfer from one route to another to complete such a journey, a trip can consist of more than one transit boarding.

Transfer – A transfer is when a passenger changes from one transit vehicle to another (bus-to-bus, or bus-to-train for example) to complete a trip. Transfers explain why the average transit trip consists of more than one boarding, and they are a good measure of the effective integration of the individual routes that make up the overall transit system.

Transfer rate –Transfer rates are an indication of how the individual elements of a transit system complement each other, that is how complete the transit coverage is, and the range of trips that can be made on the transit network. Nationwide and worldwide, higher transfer rates are strongly and positively correlated with higher transit ridership.

Passenger miles – Passenger miles are a measure of service that a transit line, route or system is providing to its riders. For example, 100 passengers traveling ten miles each, results in 1,000 passenger miles of travel.

Transit ridership on Sound Transit by service type

The following summarizes the annual boardings and passenger miles projected for Link light rail, Sounder commuter rail, Bus Rapid Transit, and ST Express bus in 2040 with the ST3 Plan.

Table 5: Summary of Sound Transit ridership by mode (boardings)

	2014 Annual Riders	2040 Annual Riders with ST3	2040 Annual Passenger Miles with ST3
Link light rail	11.9 million	152 - 188 million	1,380 - 1,735 million
Sounder commuter rail	3.4 million	8 - 11 million	190 - 255 million
ST Bus Rapid Transit	n/a	7 - 9 million	51 - 58 million
ST Express Bus	17.7 million	9 - 10 million	79 - 91 million
Total	**33.0** million	**176 - 218** million	**1,700 - 2,139** million

Note: Annual ridership was calculated using average weekday ridership estimates multiplied by annualization factors of 320 for light rail (excluding Tacoma Link - 295), 265 for commuter rail, and 300 for all other transit services.

Highlight: In 2040, with the ST3 plan, the region's residents and visitors will travel between 1.7 and 2.1 billion miles a year on Link light rail, Sounder commuter rail, Bus Rapid Transit and ST Express buses.

Travel time savings

Looking ahead to 2040, after ST3 investments are completed, the region's transit riders are projected to save 16 to 22 million hours a year.

The following tables illustrate the expected travel time savings for the region's drivers and transit riders, achieved by the investments included in the ST3 plan.

This analysis is based on two scenarios for traffic in 2040: one with ST3 projects and one without ST3 projects. Accordingly, the numbers are estimates based on best practices. In the simplest terms, every car not driven because the driver chooses to travel by transit either reduces congestion or leaves space for another vehicle.

Table 6: Projected regional vehicle miles traveled reduction due to ST3

	Auto Vehicle Miles Traveled Reduction in 2040 with ST3
Reduction in annual vehicle miles traveled (switched to transit)	314 - 411 million
Reduction in annual trips in auto (switched to transit)	19 - 24 million

Notes:
These two measures use the methods required by the Federal Transit Administration (FTA) for estimating environmental and congestion relief benefits for FTA New Starts funding applications. They are described in detail in the most recent edition of the *Final Interim Policy Guidance - FTA Capital Investment Program* (August 2015).

Table 7: Projected travel time savings for transit riders

	Transit Riders Time Savings in 2040 with ST3
Daily Hours Saved	51,000 - 67,000
Total Annual Hours Saved	16 - 22 million

Notes: These annual time savings include savings for both existing transit riders and new transit riders.

Highlight: By 2040 the annual travel time savings for all transit riders combined is approximately 22 million hours.

Travel times and transfers between selected centers

Looking at specific trips between the region's centers is one way to understand how ST3 will benefit riders who are taking the bus today, as well as future riders who will be attracted to transit because of the improved speed and reliability they will experience on ST3 services.

Traffic congestion is slowing bus speeds. Within the Sound Transit District, bus travel times have gotten continuously slower every year due to more congestion on highways and urban roads that are serving more cars, pedestrians and bicyclists in constrained areas. Without improvements in transit, existing bus travel times would be expected to worsen in the future.

For example, the Bellevue-to-Ballard existing bus travel time is 66 minutes. The future transit travel time would be expected to be 60 minutes using the ST2 East Link investment for part of the trip, but without the ST3 light rail expansion to Ballard. With completion of the ST3 Link light rail extension the same trip is expected to take 36 minutes, with a rail-to-rail transfer in downtown Seattle -- a savings of 24 minutes (40%) over the same trip without ST3 in 2040. Rail investments also greatly reduce rider delays from factors such as traffic and weather that significantly reduce the reliability of bus services.

While most of our region's buses must travel in general purpose traffic, ST3 makes improvements to provide separation where possible. These include bus rapid transit (BRT) corridors on I-405 and SR 522 and NE 145th that will connect riders to the light rail system, as well as early deliverables that will improve bus travel times on existing bus routes as Sound Transit continues to extend the light rail system.

In certain locations, capital improvements made in the ST3 program will allow buses to bypass traffic in queue jump lanes or on highway shoulders. These improvements will be identified with further evaluation and input from WSDOT, transit partners and local jurisdictions. Travel time improvements that will result are not reflected in Sound Transit's modeling assumptions, so any increased ridership resulting from the improvements has not been incorporated in the estimates into this plan.

The following chart compares existing transit travel times to future transit travel times after implementation of ST3. Existing times represent the afternoon weekday commute. Scheduled times cannot be relied on from hour to hour and day to day because of traffic congestion on the roads.

Table 8: Projected transit travel times and transfers between selected centers

	Existing Transit Time	Expected 2040 Transit Time without ST3(1)	Expected 2040 Transit Time with ST3	Time Savings with ST3
University of Washington to Everett	73 min*	60 min*	53 min	7 min
Seattle to Mariner Park-and-Ride	55 min	52 min*	41 min	11 min
Bellevue to Ballard	70 min*	58 min*	36 min*	22 min
University of Washington to West Seattle	30 min*	37 min*	23 min	14 min
Bellevue to Issaquah	25 min	28 min	18 min	10 min
Federal Way to Stadium	61 min*	56 min*	44 min*	12 min
Tacoma to Airport	44 min	50 min	33 min	17 min

* Requires 1 bus-to-bus, rail-to-bus or bus-to-rail transfer (transfer times not included, assume about 5 additional minutes)
(1) Includes ST2 investments
Notes: Bus travel times can vary greatly. The times shown for 2040 are expected averages, after accounting for speed degradation from PSRC 2040 traffic model.

Changes in length of wait times are not reflected in travel time estimates. Typical light rail frequencies on all lines in 2040 will be at least every 10 minutes, with service more often during peak commute times. Shorter wait times and transfer times also reduce total trip times for riders.

Reliability problems that bus riders experience in traffic today may contribute to the preference for rail previously described. Since one poor experience on a bus commute may affect perceptions of that transportation service, a preference for rail and BRT may contribute positively to ridership in ways that are not reflected in forecasted estimates.

Transit trips to selected centers

Table 9 presents the percentage of commute trips made by transit riders to a selected set of regional centers. The existing transit share data is from 2007-2014 Puget Sound Commute Trip Reduction surveys and the 2006-2010 American Community Surveys. Percentages include ridership on fixed-route, fixed-schedule transit service. Excluded are paratransit, dial-a-ride, carpools and vanpools. The largest transit shares correspond to the places with highest travel volumes and employment density.

Table 9: Projected activity center mode splits

Activity Center (Destination)	Existing Transit Share of Commute Trips	2040 Transit Share of Commute Trips with ST3	Percent Change from Existing to ST3 in 2040
Everett CBD	8%	12%	50%
Lynnwood East	4%	7%	75%
Bellevue CBD	14%	20%	43%
Redmond CBD	3%	4%	33%
Seattle CBD	45%	52%	16%
University District	34%	51%	50%
Issaquah Area	4%	7%	75%
Des Moines area	2%	4%	100%
Downtown Tacoma	4%	8%	100%
Systemwide	**14%**	**20%**	**43%**

Notes: Transit shares of commute trips to these Activity Centers are estimated shares of all commute trips in vehicles (excluding bicycle-only and walk-only trips). The largest transit shares correspond to the places with highest travel volumes and employment density.

Forecast methods

The report relies on ridership forecasts prepared for the year 2040. The forecasts are based on the Puget Sound Regional Council's published population and employment forecasts; and a well-documented modeling/forecasting methodology reviewed by local and national experts and approved by the Federal Transit Administration specifically designed to avoid over-forecasts of transit ridership.

Sound Transit wants to ensure that its forecasts do not overstate system benefits. Accordingly, ridership has been presented in ranges to account for some uncertainty about how changes in the region over the next 25 years will affect travel patterns. Sound Transit's forecasts also do not consider other factors that have been shown to increase rail and overall transit ridership but which are not easily quantified. These include:

Rail bias – The demonstrated preference of people to make urban transit trips on trains they would not make on equally fast buses. Researchers have documented this preference, and link it to passengers' perceptions of rail's speed and reliability, as well as a confidence factor related to the ease of understanding inherent in routes. Passengers know trains can take them only where the tracks are laid and that if they make a mistake and go in the wrong direction backtracking is easy. Sound Transit's modeling does not take rail bias into account, assuming that buses and trains with the same service characteristics would have the same ridership.

Land use changes resulting from transit investments – Sound Transit's modeling also does not assume that land use will change because of improvements in high capacity transit. However, rail investments across the nation and world have catalyzed positive land use transformations. These result from their ability to bring large numbers of people into dense urban centers without taking up the space required for freeways, streets and parking lots, and because developers have confidence in rail's permanence and are willing to build projects around rail stations.

As two local examples, Weyerhaeuser stated their 2016 relocation to a new headquarters under construction in Seattle's Pioneer Square was based in significant part on access to light rail and other transit, and REI's anticipated move of their corporate headquarters to the Spring District in Bellevue is based in large measure on East Link service coming to that area.

While Sound Transit's projections align closely with PSRC regional plans, it is important to mention that the following PSRC assumptions require political consensus on difficult policy choices:

- Calculations assume ~~WSDOT and other~~ transportation agencies will initiate a new per-mile driving fee on all miles driven across the region. Fees would apply to all trips. This assumption achieves policy consistency with PSRC as one of the funding alternatives being considered by the Transportation Futures Task Force in preparation for the update to the Transportation 2040 Plan.
- In the future bus travel times on HOV lanes are assumed not to deteriorate. In order to assume no future reduction in bus travel times, the model assumes future policymakers will obtain the political consensus to impose new, more stringent HOV limitations to three- or four-passenger vehicles or converting the HOV lanes to bus-only lanes.

The 2040 transit ridership forecast (which includes Sound Transit 3) includes the effects of population and employment growth, and the transportation and transit projects included in the Puget Sound Regional Council's Metropolitan Transportation Plan.

Other ST3 benefits

Cost savings for transit riders

According to the U.S. Census Bureau, in 2014 the average family spent more of its disposable income on transportation than any other expenditure except housing. The average household had 2.54 people, owned 1.8 cars, and spent $9073 a year on transportation.

The most expensive cost of driving is the cost of owning and insuring a vehicle. A family that can own one fewer car because of better transit service can save thousands of dollars each year on transportation. Even a family that owns the same number of cars but drives less saves on vehicle operating costs – gas, oil, parking, tires and maintenance.

For those commuting by transit to places with high parking costs, the savings in parking alone are substantial. For example, a monthly Puget Pass good for unlimited $3.25 rides (the two-zone peak hour fare on King County Metro) costs $117. According to the Puget Sound Regional Council, the average cost of parking in the region's downtowns in 2013 was $161 a month. For a transit commuter to downtown

Seattle, where the average monthly parking cost is $215, savings in parking alone would be approximately $1,200 a year, on top of the savings on gas and other vehicle operating costs.

Operating revenue /operating expense ratio

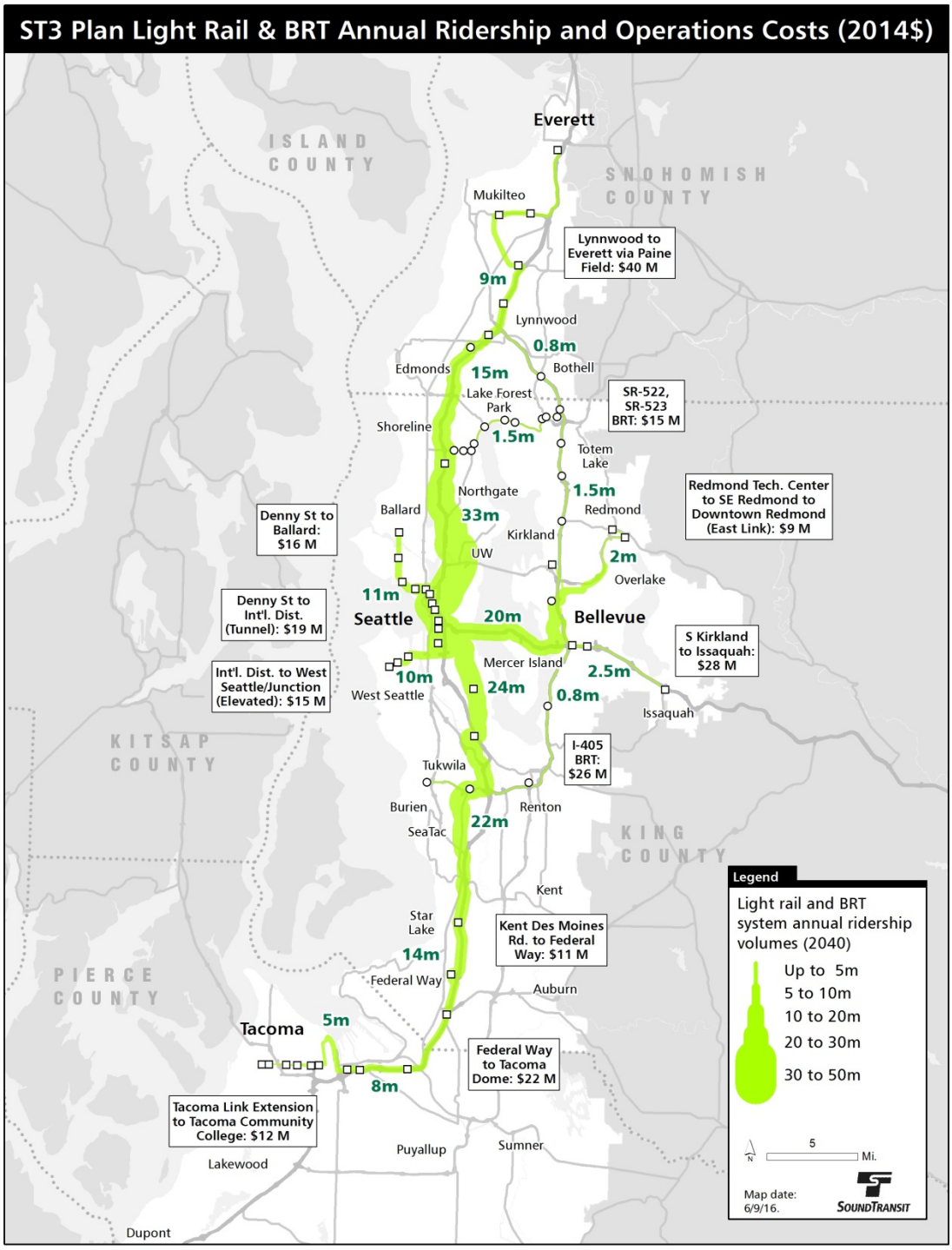
The following table shows the forecast ratio of operating revenue to operating expense by service in 2040. This ratio is the operating revenue (primarily fares) divided by the costs of operating Sound Transit's services.

Table 10: Sound Transit's total forecasted operating revenue / operating expense ratio in 2040

	2041 O&M Cost by Mode (millions of 2014$)	Total 2041 Fare Revenue by Mode (millions of 2014$)	Operating Revenue/Operating Expense Ratio
Commuter Rail	$ 77.03	$ 19.34	25%
Light Rail	$ 441.91	$ 170.04	38%
Regional Express	$ 101.42	$ 19.23	19%
Bus Rapid Transit	$ 48.99	$ 13.50	28%
Total	**$ 669.36**	**$ 222.12**	**33%**

Operating costs and ridership on each ST3 light rail extension

This map illustrates the annual transit ridership volumes in 2040 on each of the seven light rail extensions and the two BRT lines T line proposed in ST3. Annual system operating costs allocated to each of these ST3 extensions are also shown.



Cost effectiveness

Annual operations and maintenance cost of the ST3 plan per rider and per new transit rider over the cost of the ST2 plan are shown in this table.

Table 11: Annual projected cost per ST3 system rider and new rider (2014$)

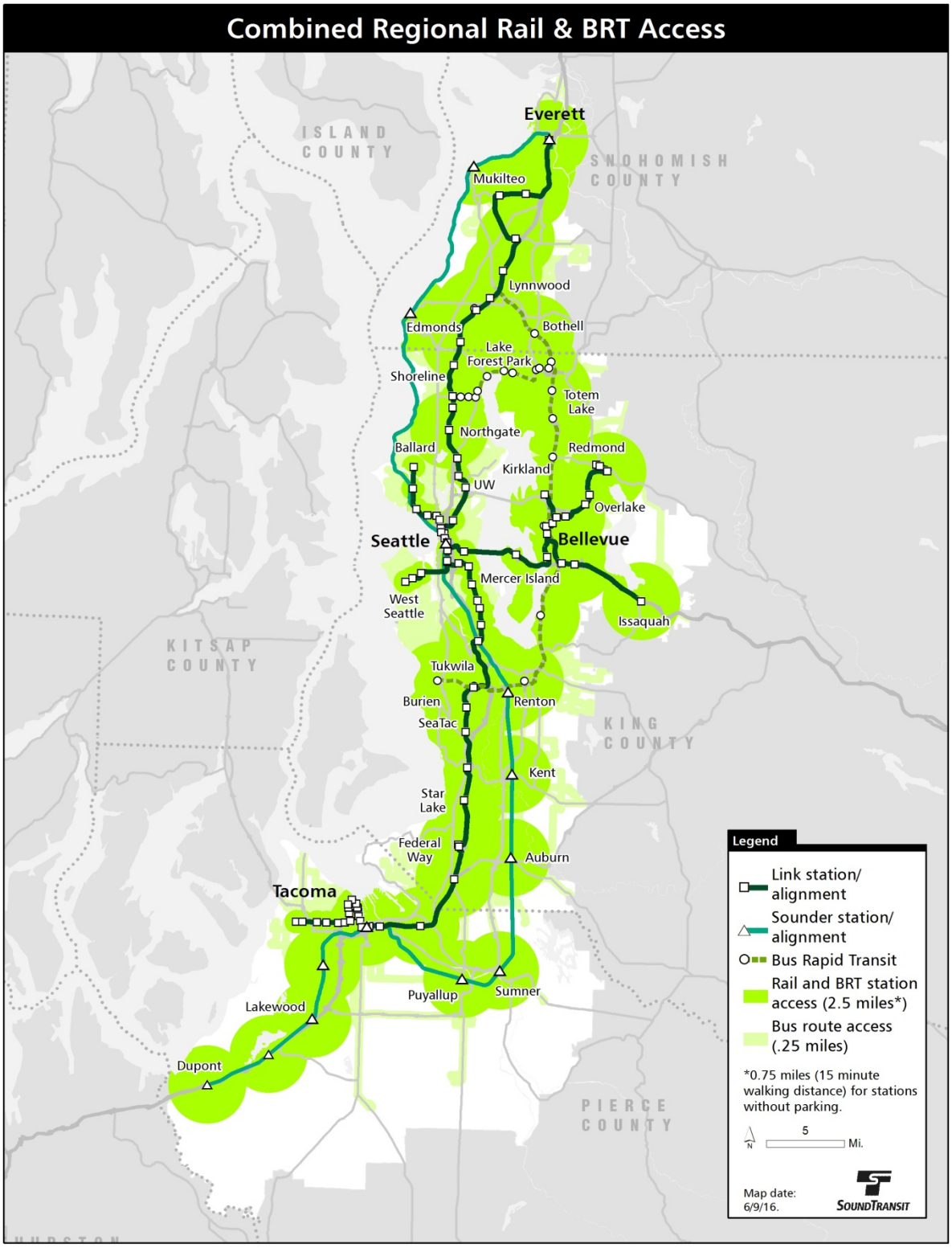
	With ST3 in 2040 (high ridership)	With ST3 in 2040 (low ridership)
Annual cost per ST3 system rider -		
ST3 transit operations	$3.98	$4.93
ST3 capital	$10.03	$12.44
Annual cost per new transit rider		
ST3 transit operations	$15.41	$19.47
ST3 capital	$38.88	$49.11
Total annual cost and ridership		
ST3 transit operations cost (millions)	$370	$370
ST3 capital cost (millions)	$933	$933
ST3 riders (millions)	93	75
New transit riders (millions)	24	19

Combined regional rail access

The reach of the regional transit investments made in Sound Transit 3 will be much greater than just the immediate vicinity of rail stations and transit centers.

Map 2 shows the access to the regional light rail and commuter rail systems when all ST3 improvements are in service. It depicts the geographic coverage of ¾-mile walk access and 2½-mile park-and-ride access to the rail stations, and the reach of existing local bus services (including average ¼ mile walk distance to the bus) that would allow access to the rail system with one transfer.

Approximately 84 percent of Sound Transit District residents and 93 percent of district employees would have convenient access to the region's high-reliability rail system in 2040.


Combined Regional Rail & BRT Access
ISLAND COUNTY
SNOHOMISH COUNTY
KITSAP COUNTY
KING COUNTY
PIERCE COUNTY
Everett
Mukilteo
Lynnwood
Edmonds
Bothell
Lake Forest Park
Shoreline
Totem Lake
Northgate
Ballard
Redmond
Kirkland
UW
Overlake
Seattle
Bellevue
Mercer Island
West Seattle
Issaquah
Tukwila
Burien
Renton
SeaTac
Kent
Star Lake
Federal Way
Auburn
Tacoma
Puyallup
Sumner
Lakewood
Dupont
Legend
Link station/ alignment
Sounder station/ alignment
Bus Rapid Transit
Rail and BRT station access (2.5 miles*)
Bus route access (.25 miles)
*0.75 miles (15 minute walking distance) for stations without parking.
N
5
Mi.
Map date: 6/9/16.
SOUNDTRANSIT

Performance Characteristics by Mode

System and service philosophy and impacts

Sound Transit's role is to provide the Central Puget Sound with a regional network of high-capacity transit services. As defined by Sound Transit's enabling legislation, high-capacity transit means service operating principally on exclusive rights-of-way and providing a substantially higher level of passenger capacity, speed and service frequency than public transit operating on highways and city streets in mixed traffic.

This role is further defined by the Puget Sound Regional Council's land use plans, Vision 2040, and Transportation 2040, which together define goals to establish a region-wide transit system that connects regional growth centers, provide seamless connections with local transit and ferries, and supports concentrated development at and around stations.

Within this framework, Sound Transit's ST3 plan will improve and expand the regional mass transit system by connecting nearly all the major cities in King, Pierce and Snohomish counties with light rail, Bus Rapid Transit (BRT), express bus, and commuter rail. Consistent with the major expansion in rail services, some existing express bus routes will be replaced with rail. Service characteristics for Sound Transit's modes are consistent with the mandate to operate high-capacity transit with frequent, fast service.

ST Express buses

ST Express operates frequent, all-day bus service on major corridors between centers, with half-hour headways or better, from about 6 a.m. or earlier until about 10 p.m. ST Express buses operate on freeway HOV facilities where they are available, including a series of freeway direct access ramps built as part of Sound Move, which improve speed and help ensure reliability.

ST Express buses serve major urban centers as well as outlying park-and-ride lots and transit centers, and they connect to Sounder and existing and future Link light rail stations. All buses carry bicycles; some serve mixed-use transit centers with commercial and residential development integrated into the center.

Sounder commuter rail

Sounder commuter rail currently operates between Everett and Lakewood. In the 2008 ST2 ballot measure, voters approved four additional Sounder round trips on the south line. The first of these began operating in 2013. A mid-day train will start in September 2016 and two peak-service trains will begin operating in 2017.

Sound Transit 3 includes funding to extend Sounder commuter rail service during peak hours from Lakewood to new stations at Tillicum and DuPont, increasing access near Joint Base Lewis-McChord. Parking will be provided at both of these stations.

The Sounder south line capital improvement program will help meet growing demand for service by increasing system capacity and enhancing service. This program will include additional parking and accessibility elements and expanding platforms to accommodate trains up to 10 cars in length, allowing

Sound Transit to run longer trains and carry more riders. In addition, track and signal upgrades and other related infrastructure will provide additional capacity. There is also funding for additional parking and accessibility elements for North Sounder.

Link light rail

Tacoma Link currently operates electrically-powered single-car trains between the Tacoma Dome Station and downtown Tacoma, and a funded expansion will extend service along Martin Luther King, Jr. Boulevard. Link light rail is a 19-mile electric light-rail line with 15 stations operating predominantly on exclusive right-of-way between Sea-Tac Airport and the University of Washington. Angle Lake Station will extend the line further south in SeaTac later in 2016, and ST2 investments will build more than 50 miles of light rail service in the region. Trains run about every six minutes during peak hours and every 10 to 15 minutes off-peak and at night.

With ST3, the light rail system will more than double again to 116 miles with over 70 stations. Currently two-car and three-car trains serve customers based on capacity needs, but station platforms will accommodate up to four-car trains for future service expansion as demand grows.

As part of ST3, Link will be extended north to Everett via the Southwest Everett Industrial Center, south to Tacoma, and east to Redmond Town Center. Additional extensions will serve Ballard and West Seattle to downtown Seattle, and south Kirkland to Issaquah via Bellevue. The technology used for these expansions will be the same as the light rail currently in operation from the University of Washington to SeaTac with exclusive and largely grade-separated rights of way.

Bus Rapid Transit (BRT)

Bus Rapid Transit (BRT) describes bus services that use features such as separated lanes, level boarding, off-board payment, higher frequency, and additional doors to provide, which combine to provide higher speed and capacity than traditional bus service. ST3 will invest in BRT in two corridors: on I-405 and SR 518 to serve the eastside, connecting from Lynnwood to Burien; and on SR 522 and Northeast 145th Street between Bothell and Shoreline (with service to Woodinville), connecting with Link light rail at Northeast 145th Street.

ST3 BRT investments will serve customers approximately every 10 minutes in the peak period and every 15 minutes off peak. On I-405 and SR 518, BRT will operate on limited-access highways primarily in lanes that are managed via tolls and/or limited to high occupancy vehicles. On SR 522 and NE 145th Street, bus access transit (BAT) lanes and features such as queue jumps will similarly allow buses to maintain a level of speed and reliability that represents a substantial improvement over buses in general purpose traffic.