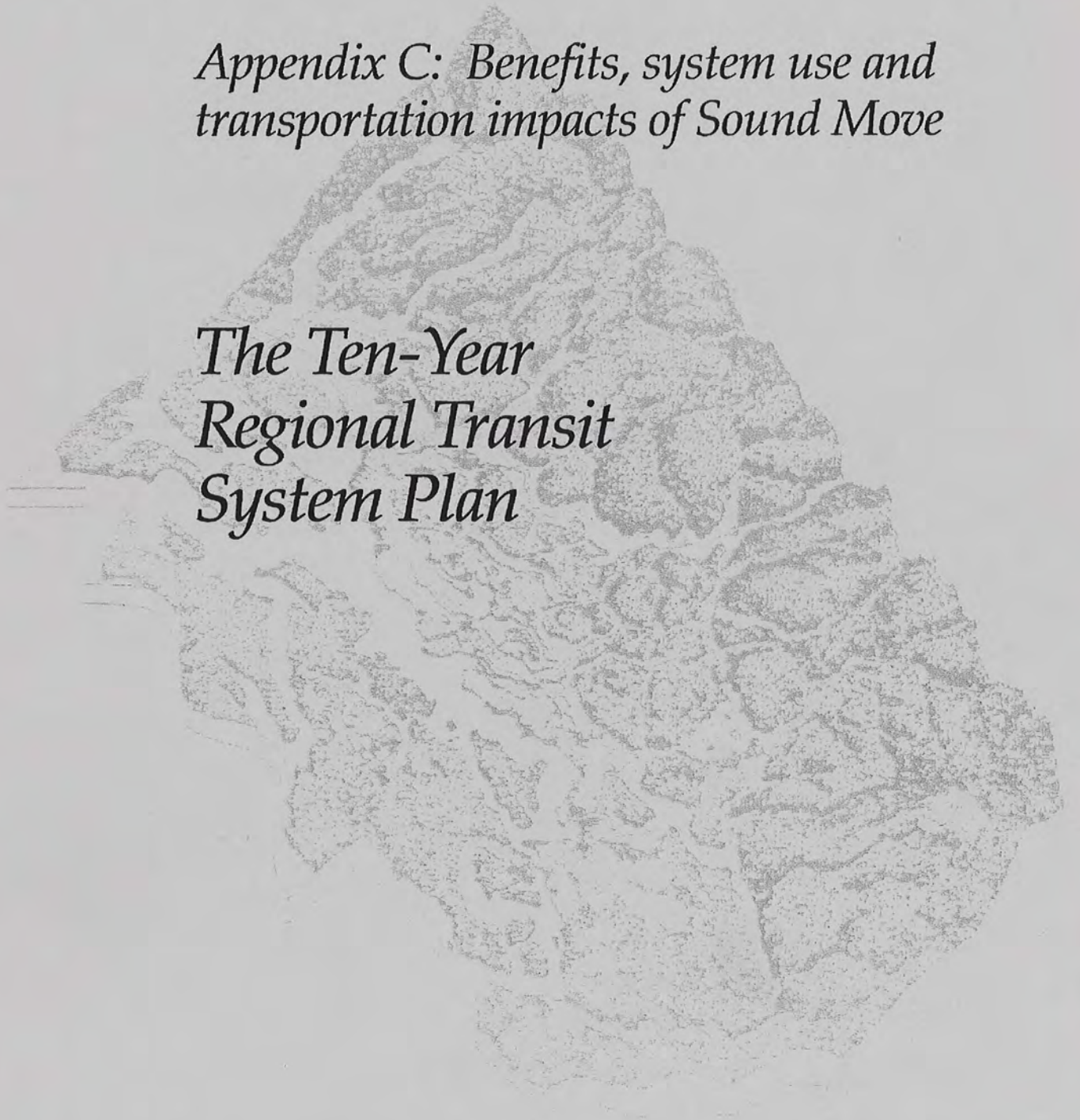
Sound Move

Launching a Rapid Transit System for the Puget Sound Region

Appendix C: Benefits, system use and transportation impacts of Sound Move

The Ten-Year Regional Transit System Plan



As adopted May 31, 1996

Sound Move

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Introduction

Voters in the central Puget Sound region are being asked to make a major financial investment in transportation improvements proposed in the Ten-year Regional Transit System Plan. This report provides the region's citizens with an assessment of various benefits the region can expect from this investment.

Transportation improvements are undeniably linked to the growth, development, quality of life and economic vitality of a region. Sound Move proposes a range of different types of transit improvements to improve mobility and provide a solid basis for meeting the anticipated growth in transportation demand in our region well into the 21st century. In investment terms, Sound Move proposes to expand and diversify our region's portfolio of transportation investments.

Since improved transportation is such an important part of maintaining the livability and vitality of the region — and because the RTA system plan offers a broader range of improvements than traditional transit plans (including HOV Expressways and region-wide transit system coordination) — this analysis goes a step beyond an ordinary approach to analyzing benefits.

Rather than simply looking at the narrow range of direct benefits that can be thoroughly documented or conservatively projected this report provides a broader discussion of community and regional benefits that can be expected from this investment.

As with road and highway construction, transit investments create value within a community that goes beyond where projects are built and how much concrete is poured. Personal mobility, regional connections, the availability of transportation alternatives, and impacts on the growth patterns, quality of life and the economic well-being of the region are all values that must be considered in deciding on a transit investment, as they traditionally are in decisions on road investments.

Table 1 shows many of the broader performance measures which can be difficult to quantify yet deserve consideration.

Only by considering these indirect benefits along with the traditional measures of transit improvements and their costs can the citizens of our region have the complete picture necessary to make an informed decision. Such consideration forces a look at the longer-term benefits and regional impacts of the proposed system, not just a limited look at the direct transportation benefits at the end of the 10-year construction period. Many of the benefits — such as development patterns or shifting travel patterns — will not be realized until well after the proposed system is in place and functioning.

Data and methodology used to analyze direct benefits of the transportation improvements in this proposal have been declared appropriate following rigorous scrutiny by an independent Expert Review Panel appointed by, and accountable to, the state of Washington. The entire contents of this report will be subject to Expert Review Panel review.

Table 1: Measures of performance by type

Transit measures	Other measures	
Transit ridership (e.g., passenger trips and boardings)	New businesses attracted to the region	Safety benefits of locating HOV in center of roadway
Additional transit passenger trips	Increased commercial activity	Increased connections between, and to/from regional economic centers
Time savings (to users)	Reduction in highway delay for private and commercial vehicles	Reducing or controlling sprawl into currently undeveloped, natural areas
Value of travel time savings benefit (to users)	Construction and related employment	Property value in areas near transit investment
Subsidy per passenger trip and per passenger mile	Increased rail freight mobility	Enhancing the pedestrian environment and allowing more trips to be made without car
Farebox recovery ratios (OR/OE)	Attaining Commute Trip Reduction Act goals	Increased opportunities for local mobility due to reallocation of bus service
Transit system productivity	Transportation benefits during special events (reduced parking, reduced congestion, travel time savings)	
Vehicle miles reduced	Vehicle operating and cost savings	
	Tourist spending	
Improvements in transit system reliability	Reduced parking demand (and value of parking costs saved)	

Benefits of RTA investments in the regional transit system

Background

The three-county district represented by RTA has been studying ways to increase transportation capacity for several years, because:

- population, employment and travel growth have strained our existing highways and arterials to capacity
- future growth will make congestion worse — congestion and delays will spread to more hours and more roads each day
- due to cost, environmental impacts, community opposition and lack of available right-of-way and funding, new highway construction is unlikely within the RTA District
- the existing bus system is largely stuck in the same traffic jams as private vehicles, so the RTA wants to extend exclusive and semi-exclusive rights-of-way to new transit services that have very high capacity, and at the same time benefit many existing bus routes
- transit's capacity potential is very great, for example: a light-rail line can provide the same peak-hour people-moving capacity as a 12-lane highway at only 25 percent to 33 percent of the cost, and in a much narrower space
- unlike most other metropolitan areas, the central Puget Sound region has its travel channeled into only a few major corridors by the same hills, mountains and water that make this such a desirable place to live. These constraints make transportation solutions relatively more expensive than in many other parts of the U.S.

Transit passenger trips

There are about 2.5 million persons living in 1.1 million households within the RTA District. **Table 2** shows the intentionally conservative estimates for daily and annual ridership for Sound Move. These estimates include only those transit riders using regularly scheduled, regular fare bus and rail lines within the RTA District boundary (dial-a-ride, subscription bus, school bus, etc. are excluded).

The Transportation System Management (TSM) forecast reflects transit ridership growth due to population and employment increases, completion of the state Transportation Department's core HOV system and those transit service increases that can be paid for within existing transit agency tax sources. The TSM alternative was originally studied along with the RTA's 1995 Phase I transit proposal and was presented in the *Regional Transit System Master Plan Technical Appendix* (February, 1995). The methods and data used in this TSM forecast are completely consistent with the current RTA ten-year system plan analysis. Although on a broad basis the TSM alternative is consistent with the six-year plans of local transit agencies, it is not intended to specifically represent those plans since they do not cover the period through year 2010.

Highlight:

About 258,000 trips are made each day on the fixed-route transit system in the Puget Sound Region. If all of those trips were instead made in single-occupant vehicles it would create a line of cars almost 650 miles long. The year 2010 daily transit ridership represents a line of cars more than 950 miles long.

Definitions:

- **Boardings** —*Transit boardings* represent the number of times a passenger *steps into* any transit vehicle.
- **Passenger trips** (or transit trips) — *Trips* represent the complete 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, trips can consist of more than one transit boarding.
- **Transfers** —*Transfers* are the movement of passengers between vehicles and routes to complete their trips. Transfers explain why the *average* transit trip consists of more than one boarding, and are a good measure of how well integrated the individual routes making up a transit system are.

  Transfer rates are an indication of how the individual elements of a transit system complement each other. Nationwide, and indeed worldwide, higher transfer rates are strongly and positively correlated to higher transit ridership.
- **Passenger miles** — Passenger miles are a measure of service that a transit line or route is providing to its customers. It is a function of the average length of a trip made by passengers. For example, 100 passengers traveling ten miles each result in 1,000 passenger miles. Likewise, it would take 500 people to travel the same 1,000 passenger miles if their average trip length was only two miles.

Table 2: Ten-year total transit trips

	Existing	2010 TSM (previously studied)	2010 RTA forecast	Forecast with incremental Commute Trip Reduction ridership
Daily transit trips*	258,000	323,000	389,000	439,000
Percent change from existing	N/A	+25%	+ 51%	+ 70%
Daily transit boardings	335,000	428,000	555,000	625,000
Annual transit trips	75 million	98 million	117 million	131 million
Annual transit boardings	98 million	130 million	167 million	187 million
Transfer rate	1.3	1.32	1.43	1.43

* Transit trips and boardings included here apply only to the fixed-route, scheduled-service parts of the transit system. Demand-responsive, school bus, custom/subscription bus and van services are excluded.

Highlight:

It's claimed that transit carries a relatively small portion of all trips in the region: depending on how "trips" are counted between 3 and 8 percent.

But, the same could be claimed about the regional highway system. After five decades and many billions of dollars of investment, the region's interstate highway system (I-5, I-90 and I-405) carries only about 10 percent of all trips.

The bottom line is that the region's economy needs a balanced, well-functioning transportation system — including roads and transit — to remain competitive.

Forecast methods

The RTA's forecasts are based on:

- a thoroughly documented modeling/forecasting methodology developed over a five-year period, and specifically designed to avoid the systematic biases which contributed to over-forecasts of transit ridership in other parts of the country during the 1980s
- a methodology reviewed by the state's independent Expert Review Panel, appointed to ensure that RTA methods are reasonable and comply with commonly accepted engineering, forecasting and planning practices
- adopted regional population and employment forecasts.

The transit ridership evaluated throughout the remainder of this report is based on the formal ten-year forecast, and excludes the presumption that transit could serve a larger share of the transportation market due to people shifting travel modes because of the Commute Trip Reduction Act. The impacts of CTR are outside the RTA's formal travel demand forecasting process. The ridership also excludes the success of cities and counties in achieving state Growth Management Act goals and ridership beyond the 2010 horizon.

The forecasts of HOV ramp use and benefits come from a recent state Transportation Department technical report.

Highlight:

A recent study by the Federal Transit Administration concluded that the annual local, state and federal subsidies to the transit system in Washington, DC returns $3.2 billion in measurable benefits each year. These benefits include congestion relief, times savings for individuals and freight, and transportation cost savings for households near transit stations.

The 2010 ten-year transit ridership forecast includes the effects of population and employment growth, the effects of transit improvements (including reinvesting local bus service made available by the regional express routes), the six-year plans of the transit operators within the RTA District and completion of the HOV lanes in the three-county area. The forecast reflects putting in place a ten-year transit system plan, including:

- twenty regional express bus routes,
- twelve HOV ramps providing direct access to center HOV lanes, serving:
  - — the RTA's new regional express bus routes,
  - — existing services provided by Community Transit, Everett Transit, Pierce Transit and King County-Metro,
  - — carpools and vanpools
- a commuter rail line from Everett to Lakewood,
- a light-rail line in Seattle from 45th Street to S. 200th Street via Sea-Tac Airport, and
- a light-rail line in Tacoma from 9th Street to the Tacoma Dome commuter rail station.

Highlight:

The estimates in this report represent the transit ridership on average weekdays and, in the case of annual values, include average weekends. If the RTA investment does even a moderately better job of serving special events, this would add another two million trips per year.

Table 4: Summary of transit boardings

	Weekday boardings	Annual boardings
Light rail	107,000	32.6 million
Commuter rail	12,600	3.2 million
Regional express bus	54,000	15.8 million
Total	**173,600**	**51.6 million**

Table 3: Travel time savings by mode

	Carpools and vanpools	Bus riders	Rail riders	Total
Daily Time Savings (minutes)	380,000	350,000	1,050,000	1,780,000
Annual Time Savings (million hours)	1.6	1.5	5.1	8.2
Annual Value of Savings (millions of 1995 $)	$19.2	$18.0	$61.2	$98.4

Travel time savings

Table 3 illustrates the combined travel time savings for the region achieved by the investments included in Sound Move.

The value of the *time savings alone* that result from the efficiencies inherent in the RTA transit system improvements amount to $32 per year for every person living in the RTA District in the year 2010.

Table 5: Travel times and number of transfers between selected centers

PM peak-period travel times (includes time on vehicle plus transfer time)

Origin center	Trip	Existing bus	2010 RTA	RTA time savings
Snohomish County	Everett to downtown Seattle	131[1]	60	71
	Everett to downtown Seattle to Kent	203[2]	85[3]	118
North King County	Downtown Seattle to Columbia City	29	13	16
	Downtown Seattle to Puyallup	84[1]	54	30
	Downtown Seattle to Everett	75	67	8
	Downtown Seattle to Capitol Hill	16	5	11
South King County	Auburn to Tacoma Dome	80[1]	21	59
	Kent to Columbia City	66[1]	30[3]	36
	Renton to Federal Way	78	47	31
East King County	Bellevue to Federal Way	101[1]	64	37
	Bellevue to Sea-Tac Airport	78	49	29
	Canyon Park to Bellevue	61[1]	26	35
Pierce County	Puyallup to downtown Seattle	108[1]	54	54
	Downtown Tacoma to downtown Seattle	58	58	0
	Lakewood P&R to Auburn	70[1]	38	32

[1] This trip requires a transfer between bus routes. [2] This trip requires two transfers between bus routes.
[3] This trip would require a transfer between rail lines (at some times of the day).

Transit ridership on RTA routes

Table 4 summarizes the average weekday light rail, commuter rail, and regional bus boardings for 2010, assuming Sound Move is completed.

After the ten-year plan is completed, 44 percent of all transit passengers in the region will make all or part of their trips using an RTA service.

Travel time and number of transfers between selected centers

Comparing travel times for two different transit systems is a deceptively simple-sounding way of evaluating the value of a transit investment — especially when the two systems are very different. Such a comparison is affected by the introduction of an HOV expressway system, electric light rail, and commuter rail. These new elements, paired with fare integration, will significantly change the way many people make their transit trips in the future. In reality, it is exceedingly difficult to fairly express the relative advantages and disadvantages of each system strictly using tables. However, for consistency with previous planning, **Table 5** compares existing transit travel to future transit travel times on RTA services.

Transit impact by major corridor

Table 6 shows the portion of all travel through the region's major highway corridors that will be carried in transit vehicles during rush hours.

Highlight:

The region is in the process of developing and implementing strategies for achieving state Commute Trip Reduction Act goals — a 35 percent reduction of "vehicle miles of travel" consumed by workers traveling to/from major employment sites during peak hours.

To the extent that the RTA program can provide an alternative way to meet this aggressive goal (rather than forcing employers to find their own solutions) the daily and annual transit ridership could be as high as 439,000 and 131 million, respectively. This represents a 70 percent increase over today's ridership levels.

Table 6: Peak transit share of all travel, by corridor, 2010*

Corridor	Share of all trips made in carpool, vanpool, bus or train
I-5 North	40 percent
I-5 South	40 percent
I-5/Pierce County	25 percent
Cross lake	30 percent
I-405 North	30 percent
I-405 South	30 percent

* These numbers illustrate the importance of transit in the major corridors at the most congested times of the day.

Additional ridership benefits, not included in the Table 6, may be expected from travel to and from special events. Rail transit has proven more attractive than expected for single site, high-traffic special events. This includes sporting events and other high-attendance public events.

The Tacoma Dome, the Kingdome, the new baseball stadium at the south end of Seattle's downtown, the Puyallup Fairgrounds, the Bellevue Convention Center, the Washington State Convention & Trade Center and the University of Washington are all within walking distance of major transit stations included in Sound Move. While this region is perhaps less familiar with transit's effectiveness in mitigating traffic associated with these types of events, other regions have found transit to be essential in delivering significant percentages of event attendees without the serious congestion and parking impacts experienced here.

Transit trips to selected centers

Table 7 presents the percentage of work and college trips made by transit riders to a set of selected regional centers. This 1990 data is from the U.S. Census Journey-to-Work survey compiled by the Puget Sound Regional Council (PSRC).

Percentages include ridership on fixed route, fixed schedule transit service. Excluded are paratransit, dial-a-ride, carpools/vanpools, etc. The range shown for future transit mode shares comes from two sources. The low end of the range comes from the RTA's own conservative forecasting for the year 2010. The high end of the range comes from the PSRC's recent travel demand forecasting supporting its Metropolitan Transportation Plan (MTP). The MTP is an update of the transportation element of Vision 2020, the region's adopted growth strategy.

Table 7: Activity center mode splits

Percentage of work and college trips by transit

Center	1990 transit %	Range of future transit %
Downtown Everett	2%	5% to 30%
Northgate	7%	8% to 16%
University District	18%	22% to 52%
Downtown Bellevue	5%	7% to 47%
Downtown Seattle	34%	45% to 60%
Downtown Tacoma	3%	6% to 37%
Average	**13%**	**17% to 45%**

The values shown are for PSRC's preferred implementation strategy (Note: these are year 2020 projections). Results for the other PSRC strategies would be in the range shown. The transit mode shares projected by the PSRC are significantly higher in part because their forecasts are not constrained by FTA guidelines in the same way as the RTA's. This is particularly true when looking at the effect of a regional rail system on land use and regional policies to reduce both congestion and vehicle emissions. The PSRC makes a deliberate effort to forecast these effects.

Benefits in addition to transit ridership of Sound Move

The RTA believes that only a broader interpretation of transit system benefits can account for the new transit systems (and the popularity of those systems) in the following west coast cities:

- San Diego, CA
- Los Angeles, CA
- San Jose, CA
- San Francisco, CA
- Sacramento, CA
- Portland, OR
- Vancouver, BC

As an example, Tri-Met in Portland concluded that "Investment in new development adjacent to MAX already exceeds the cost of the project by fivefold."

Highlight:

If the RTA investment in bus service, rail systems and HOV direct access ramps affects the regional economy sufficiently to increase personal income by as little as one-tenth of one percent (.001), that increase can be conservatively estimated to be $85 million per year.

If the RTA's economic benefit increased employment one-half of one percent (.005), that increase would be worth $425 million each year.

This increase represents only <u>personal income</u>, and excludes any additional affect on regional commercial activity.

Table 8 presents the varied benefit measures benefit with an estimated dollar range for each. The value ranges might be compared, for example, to the ten-year system plan cost per year of approximately $200 million (in local tax dollars). The variety of benefits is wide and far-reaching.

Table 8b presents a wide range of additional measures which are worthy of consideration when evaluating a regional transit investment. These measures are either more qualitative in nature or difficult to quantify. For that reason, the RTA has not made a formal dollar-value estimate of the benefits. Nonetheless, these measures bring up significant potential benefits worthy of additional public discussion and research.

In addition to the number of riders and the associated costs, there are many other aspects of Sound Move that deserve attention. These issues are presented as questions and answers in **Table 9.**

Table 8: Annual value of regional benefits from investing in Sound Move

Measures	Low-range estimate ($M/yr)	Mid-range estimate ($M/yr)	High-range estimate ($M/yr)
Travel time savings for system users	78	98	118
Parking cost savings for system users	10	13	16
Reduction in vehicle miles traveled (auto operating cost savings)	15	19	23
Travel time savings for drivers of private vehicles	16	20	24
Reduction in required employer-provided parking	12	14	17
Increased mobility for commercial vehicles	11	13	16
Construction and related employment	64	80	96
Increased property value in areas near transit stations	Under study	Under study	Under study
Bus service replaced by RTA, available for reinvestment	20	25	30
Improvements in transit system reliability	5	7	9
Total	**231**	**289**	**349**

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Table 8b: Additional measures of regional benefits worthy of consideration (and further research)

Increased commercial activity from new businesses attracted to the region due to improved transportation
Value of retaining existing employers in the region due to transportation improvements
Increased rail freight mobility
Aid to the region's employers in achieving the Commute Trip Reduction Act goals
Transportation benefits (reduced parking, congestion, and travel time savings) of transit carrying a higher share of trips to special events
Vehicle ownership and insurance savings
Increased tourist expenditures
Air quality and other health benefits
Safety benefits of locating HOV lanes in center of road
Increased connections between and to/from regional economic centers
Reduction or control of suburban sprawl into currently undeveloped, natural areas
Enhanced pedestrian environment allowing more people to engage in activities without a car
Improvements in road system reliability
Increased opportunities for local mobility due to reinvestment of bus service
New people-moving capacity in the region's most congested corridors
Preservation of transit travel times via dedicated ROW, while roads become more congested
Integrating the four-operator, multi-county transit fare systems
Improving transit as a travel option for both "choice" and "dependent" riders during a period in which the region's roads become more congested

Table 9: Other issues related to benefits of Sound Move

Questions	Answers
Is the RTA Ten-Year System Plan part of a comprehensive approach to regional mobility?	**Yes** — the RTA ten-year system plan is consistent with the region's adopted Metropolitan Transportation Plan, and puts in place a large part of the transit component of that plan.
Will the RTA Plan improve transit travel times in the region's congested corridors?	**Yes** — the bus, HOV and rail investments improve travel times in all major corridors, especially compared to future congested speeds. Because much more of the transit system will operate in protected rights-of-way, transit speeds and travel times will be preserved at the same as the roadway system becomes much more congested and auto travel gets slower.
Will the RTA plan provide additional capacity in congested corridors?	**Yes** — the plan significantly increases people-moving capacity in all major, congested corridors.
Are the new RTA services and facilities being integrated into the existing transit system and fare structure?	**Yes** — the plan enriches the existing network of express bus routes, enhances service coordination at rail stations and new transit centers, and provides significant new funding for fare integration. The RTA plan allows the local bus operators to reinvest 400,000 hours of bus service each year.
Is the RTA plan part of an integrated regional growth management strategy?	**Yes** — a "high-capacity transportation" system has always been regarded as essential to the success of growth management in this region.
Does the RTA serve major centers of economic activity? Does it improve access to jobs?	**Yes** — RTA services (bus and rail) will connect centers with over 700,000 jobs. All major special events locations are connected by RTA services.
Does the RTA plan improve access to opportunities and activities, for individuals facing special challenges to their mobility?	**Yes** — all RTA services and stations will be fully accessible to people with disabilities. All major employment and special event locations will be served by the RTA. The regional express bus system also includes supplemental ADA funding.

Benefits of RTA investments in the HOV Expressway system and regional express bus service

The state Transportation Department's Office of Urban Mobility has estimated that the direct access HOV ramps included in the RTA ten-year plan will serve slightly more than 200,000 people on an average day. Forty-two percent of these trips will be on buses — to a great extent the RTA's regional express bus routes — with the remainder in carpools and vanpools.

The HOV Expressway system will also offer significant time saving advantages for both carpool and vanpool users and passengers on the region's bus systems. **Table 10** shows benefits achieved through the HOV Expressway investments.

The HOV Expressway system, the bus services that will use that system, and the person trips served will benefit nonusers as well. Vehicle trips made in the HOV Expressway segments — including those made by express buses — will be removed from general purpose traffic lanes, freeing up capacity on the region's highways. As capacity shifts, general purpose vehicle speeds will increase, making for faster trips for both personal trips and commercial vehicles. Some people will shift their travel modes to take advantage of the attractive, competitive alternative to the car offered by the HOV Expressway system, further increasing travel time advantages for general purpose traffic. **Table 11** summarizes these travel time benefits.

Highlight:

One full 40-foot bus is equivalent to a line of cars stretching

- ***six city blocks, if traffic is moving at 25 m.p.h., or***
- ***4.5 city blocks if traffic is moving at 15 m.p.h..***

Table 10: Travel time savings for HOV Expressway system users

	Carpools and vanpools*	Bus passengers	Total for RTA ten-year plan
Daily time savings (min.)	380,000	350,000	730,000
Annual time savings (mil. of hours)	1.6	1.5	3.1
Annual value of savings (mil. of 1995 $)	$19.2	$18.0	$37.2

* Though included here, carpool and vanpool users are not counted in the transit ridership discussed throughout this appendix.

As individuals switch to carpools, vanpools and buses from single-occupant vehicles, and as time savings accrue for all highway system users — and as these benefits spread out to vehicles on arterials and local roads — there will be regional economic benefits that can be estimated. These benefits included reduced operating costs for automobiles. These benefits are summarized in **Table 12.**

As people experience travel time savings moving around the region, and as some find improved, faster transit to be an attractive option to their private auto, employers will also benefit. **Table 13** summarizes just one of these benefits — reduced employer-provided parking.

Table 11: Peak-period travel time savings for drivers

Peak vehicle-miles reduced per day	300,000
Daily reduction in peak-period delays (person hours)	6,700
Annual reduction in peak-period delays (millions of person hours)	1.7
Annual value of savings	**$20 million**

Table 12: Auto operating cost savings

	Mode shift savings
Annual vehicle miles of travel	125 million
Auto operating cost savings	$19 million
Parking cost savings	$13 million
Total savings	**$32 million**

Table 13: Benefits to employers

Reduction in demand for employer-provided parking spaces	14,000
Annual cost per parking place	$1000
Savings	**$14 million**

Additional benefits of the HOV Expressway system

Developing an HOV Expressway will have several important regional benefits, including:

- **Connecting regional economic centers** — The RTA will connect many of the region's vital economic centers. While many will be connected by the electric-light rail and commuter rail systems, an even larger number will be connected by an HOV system significantly enhanced by the RTA's investment. Regional economic centers receiving direct benefit of the HOV Expressway system and the express bus route services are listed in **Table 14**. The centers shown will be connected to all others via bus routes using the HOV Expressway system.
- **Reliability of the regional bus system** — It is difficult to forecast and place a dollar value on the improved transit and HOV system reliability that the HOV Expressway system will create. Since the current HOV system isn't continuous, and direct access to the lanes is rare, vehicles that might otherwise make their entire trip in an HOV lane actually make a large portion of that trip in general purpose lanes. This means that for significant parts of their journeys, buses and HOVs are subject to the delays, breakdowns and gridlock common on the region's highways. The HOV Expressway system, along with completion of the HOV core lanes by the state, will create a seamless system of exclusive transit/HOV rights-of-way, where HOV's can get out of the congestion caused by general purpose traffic. The potential improvement to bus service is so dramatic that completing the HOV system has been a major goal of the region's transit operators for a decade.
- **Safety effects of direct access to HOV lanes** — Changing lanes ranks among the most hazardous vehicle movement on a highway. The RTA's direct access ramp elements will eliminate, to a great extent, the current system's indirect access to the "wrong" side of the freeway which forces buses and HOVs to weave through traffic to get to HOV lanes. The ramps will also help eliminate the multiple unsafe lane changes to get on and off the highway. While reduced accidents, and the cost of those accidents can't be forecast, it is nonetheless a direct benefit of the RTA's investment. The value of this safety benefit would be difficult to overstate. While difficult to quantify, the safety aspect of the direct access ramps will make a real difference in the lives of the approximately 200,000 people who will use them on an average day. These people will not have to experience four to six lane changes each that it commonly takes to reach and then exit the center HOV lanes.

Table 14: Centers connected via bus routes using HOV Expressway

Economic center	Center employment (2010)
Auburn	10,000
Bellevue	58,00
Dupont	7,000
Eastgate	10,000
Everett	35,000
Federal Way	18,000
Issaquah	8,000
Kent	21,000
Kirkland	8,000
Lakewood	5,000
Lynnwood	18,000
Overlake	27,000
Puyallup	8,000
Redmond	11,000
Renton	35,000
Seattle	209,000
Sumner	6,000
Tacoma	51,000
SeaTac	26,000
Tukwila	26,000
Totem Lake	10,000
Northgate	14,000
Bothell	9,000
University District	19,000
Total	**650,000**

Highlight:

Based on US Dept. of Energy data, American Public Transit Association estimates the fuel efficiency comparisons of public transit compared to the average car to be:

- ***one bus with seven passengers is equivalent to one car***
- ***one full bus equals six cars***

Using the regional express bus routes

The regional express bus routes would typically operate in an express mode. Most of them would operate frequently (every 15 minutes during rush hours), and would operate all day, every day.

The total annual ridership on these routes is **15.8 million**. The average weekday boardings total 54,000. In addition to the ridership on these routes, the RTA transit investments free up hours of bus service for reinvestment in local routes. The RTA and local bus operators would work together to determine the locations of these reinvestments after RTA services are in place. The potential ridership gains from these additional local bus services are substantial. Assuming that the reinvested bus service is equal in productivity to the present Pierce Transit local routes and King County-Metro suburban routes, the estimated 400,000 hours of service would carry approximately six million additional riders per year.

Regional express bus route ridership, by route

The bus routes shown in Sound Move are an example of a regional express bus system that responds to each subarea's priorities. These routes were defined with enough detail to estimate costs and ridership for final plan adoption, but the routes will be refined as they are put in place. The community involvement process, and subarea priorities at the time the routes are implemented will affect the way the actual routes are initiated. For this reason, the detailed ridership forecasts simply illustrate the general service plan. It is essential to have flexibility when developing the scope and schedules of new regional express bus services so that the routes can respond to actual customer demand.

Because of the cost factors surrounding new all-day express bus routes, the RTA will put regional express bus routes in place incrementally. This will allow initial service levels to build to full service over time (an average of three years). During this time, the RTA will review route ridership as it is established and grows. It will allow bus service resources to be retargeted if a bus route fails to prove reasonably attractive to riders. This retargeting will respect the needs and priorities of subareas from whose budget the service funding is drawn. The incremental approach will allow the RTA to effectively balance the dual goals of offering efficient services and delivering services promised in Sound Move.

Table 15: Regional express bus route forecasts

RTA regional express bus routes	Annual boardings (millions)
A. Everett - Aurora Village	0.4
B. Everett - Mountlake Terrace - Seattle	1.3
C. Everett - Bothell - Bellevue	1.2
D. Lynnwood - Bothell - Bellevue	0.8
E. Woodinville - Northgate	0.5
F. Issaquah - Bellevue - Northgate	1.7
G. Redmond - Bellevue - Seattle	2.2
H. Bellevue - Renton - SeaTac	1.4
I. Redmond - University District	0.5
J. Federal Way - Auburn - Renton - Bellevue	0.7
K. Puyallup - Auburn - Renton - Bellevue	0.7
L. SeaTac - West Seattle - Seattle	1.3
M. Tacoma - Federal Way - SeaTac - Seattle	0.6
N. Tacoma - Seattle	0.6
O. Dupont - Lakewood - Seattle	0.2
P. Tacoma - Auburn	0.1
Q. South Hill - Dupont	0.6
R. Lakewood - Tacoma	0.3
S. Mid-Pierce County - Tacoma	0.2
T. Lakewood - Puyallup	0.5
Total	**15.8**

Benefits of RTA investments in commuter rail and electric light rail

There are several well-established reasons for the RTA to consider rail as a significant component of a regional transit plan:

- since rail usually travels in its own right-of-way, it offers a high-speed alternative to cars
- trains operating in their own right-of-way are extremely reliable since they are not subject to congestion, accidents, breakdowns or bad weather delays.

Not all of the benefits that urban areas derive from a rail system can simply be stated as some form of "count" or another — such as the number of rail users or, the number of rail riders who would have been in cars had the rail system never been built. Another good measure of the benefits of rail might be the listing of "Preferred Cities for Corporate Relocation" recently published by the Urban Land Institute. The Institute's *Land Use Digest 2* listed the ten cities receiving the most corporate reallocations for both 1994 and 1995. In both years, nine of the ten cities have either long-established rail systems or new ones undergoing expansion.

Rail boardings

Table 16 shows the estimated rail boardings by line for Sound Move.

With 105,000 boardings, the Seattle-SeaTac light-rail line would carry well over three times the current ridership of Portland's MAX line.

A range of commuter rail ridership is shown. The range is due to a degree of uncertainty that remains regarding the following factors:

- the breakdown between peak- and off-peak direction service, and
- the degree of through-routing of the service between the two lines to the north and south of downtown Seattle.

While the range shown here is for informational purposes, **all the ridership-related numbers used elsewhere in this document (including the measures of productivity) reflect the low end of the range**. The RTA has made use of the "worst case" commuter rail forecasts to ensure that all the estimates and calculations are conservative.

Table 16: Rail station boardings

Line	Daily boardings	Annual boardings
Seattle-SeaTac light-rail line	105,000	32.0 million
Tacoma light-rail line	2,000	0.6 million
Everett-to-Seattle commuter rail*	2,400 - 3,200	0.6 - .8 million
Lakewood-to-Seattle commuter rail*	10,200 - 14,000	2.6 - 3.6 million
Total	**119,600 - 124,200**	**35.8 - 37.0 million**

* All calculations of commuter rail productivity use the low end of the range shown.

O&M costs, fare revenue and operating subsidies

Fares

Fare revenue forecasts assume continuing the present transit fares to 2010, with fare increases only matching the inflation rates assumed in the financial plan. Based on the ridership forecasts, the fare revenues upon completion of the ten-year plan would be:

- Light rail = $20 million/year
- Commuter rail= $5 -7 million/year
- Regional express bus= $13 million/year

These annual fare revenues are expressed in constant 1995 dollars.

Net operating cost

The net operating cost subsidy is the annual operating and maintenance (O&M) cost, minus fare revenues.

System efficiency

Table 17 reflects the farebox revenues and O&M costs of the RTA plan by mode.

The farebox recovery ratios (operating revenue per operating expense ratios) shown in **Table 18** exceed those established as minimum acceptable levels by the RTA Board; 40 percent and 20 percent for the rail and bus systems, respectively.

Table 17: Net operating cost

	Annual riders	O&M cost	Fares
Light rail	32.6 M	$38 M	$20 M
Commuter rail	3.2-4.4 M	$21.7 M	$5- $7 M
Regional express bus	15.8 M	$40.5 M	$13 M

Table 18: Farebox recovery

Light rail	53 %
Commuter rail	23 - 32%
Rail system combined	**42 - 45%**
Regional express bus routes	32%
System total	**38 - 40%**

Cost effectiveness

Table 19 reflects the annual O&M cost of the RTA ten-year plan per additional rider over the cost of the existing transit system.

O&M cost of the regional express bus system by route

The RTA regional express bus routes would typically operate with limited stops. Most of these routes are different from today's express routes in that they would run quite frequently — every 15-30 minutes during peak periods and every 30-60 minutes during the rest of the day — and would operate in two directions, all day, every day (including weekends). The total estimated annual ridership on these new routes is 15.8 million boardings. As shown in **Table 18**, the 20 all-day regional express bus routes would have an average farebox recovery ratio of about 32 percent.

For individual routes this recovery ratio would range between 15 percent and 50 percent (this compares to system farebox recovery ratios for the region's four transit operators ranging from 5.6 percent to 23.4 percent according to the Federal Transit Administration report: *1994 Transit Profiles for Agencies in Urbanized Areas Exceeding 200,000 Population*). Comparing route-level forecasts to system-level statistics could easily lead to misleading conclusions because:

Table 19: Annual O&M cost of the system plan per additional rider

Year 2010	
Additional passenger trips compared to today's system	42 million
Additional transit boardings compared to today's system	69 million
Cost per additional passenger trip	$2.40
Cost per additional boarding	$1.45

- System-level operating revenue per operating expense (OR/OE) ratios typically include more operating revenue than fares alone — for example, advertising revenue. RTA regional express route estimates represent farebox revenues, only. No other operating revenues are included.
- Many reporting methods also omit some operating expenses which the RTA has included (e.g., a 15 percent add-on for ADA supplemental service). These various supporting costs are very often excluded when transit system bus operators present route level information, complicating direct comparisons.

Due to the cost factors surrounding new all-day express routes, the RTA will put the regional express bus routes in place incrementally. This will allow a buildup from initial service levels to full service over time. During this period, the RTA will conduct a systematic review as route ridership is established and grows. **Table 20** presents the annual boardings and O&M costs for the regional express bus system, by route.

Highlight:

Among US cities with populations over 1 million, cities with rail systems have transit mode splits — the share of all trips served by transit — 120 percent higher than cities with bus-only transit systems.

Sources: 1990 US Census and Federal Transit Administration Section 15 reports

Table 20: Regional express bus route forecasts

RTA regional express bus routes	Annual boardings (millions)	Annual O&M cost (millions)
A. Everett - Aurora Village	0.4	$1.6
B. Everett - Mountlake Terrace - Seattle	1.3	$2.9
C. Everett - Bothell - Bellevue	1.2	$1.8
D. Lynnwood - Bothell - Bellevue	0.8	$1.5
E. Woodinville - Northgate	0.5	$1.7
F. Issaquah - Bellevue - Northgate	1.7	$3.7
G. Redmond - Bellevue - Seattle	2.2	$3.3
H. Bellevue - Renton - SeaTac	1.4	$3.2
I. Redmond - University District	0.5	$1.9
J. Federal Way - Auburn - Renton - Bellevue	0.7	$2.0
K. Puyallup - Auburn - Renton - Bellevue	0.7	$1.4
L. SeaTac - West Seattle - Seattle	1.3	$1.3
M. Tacoma - Federal Way - SeaTac	0.6	$1.2
N. Tacoma - Seattle	0.6	$4.6
O. Dupont - Lakewood - Seattle	0.2	$2.8
P. Tacoma - Auburn	0.1	$0.9
Q. South Hill - Dupont	0.6	$1.9
R. Lakewood - Tacoma	0.3	$1.3
S. Mid-Pierce County - Tacoma	0.2	$0.6
T. Lakewood - Puyallup	0.5	$0.9
TOTAL	**15.8**	**$ 40.5**

Note: The RTA cost estimates include a 15% add-on for ADA supplemental service.

Comparing the capacity of rail systems and highways

This section provides a consistent, conservative and understandable calculation of capacity for the highways and rails. This is a comparison of practical highway capacities with practical rail capacities. Comparisons are not made of "theoretical" maximum capacities that have not been experienced or sustained, in the case of highways, or might not be achievable, in the case of rail.

Capacity is defined as the highest number of vehicles that can be accommodated by a lane as a stable flow of traffic according to the Transportation Research Board's *Highway Capacity Manual.*

Highway engineers usually describe highway operation in terms of levels of service (LOS), ranging from LOS A to LOS F. LOS F represents "breakdown flow" and is usually referred to as the failed condition. According to the *Highway Capacity Manual,* "the boundary between LOS D and LOS E describes operation at capacity. Operations at this level are extremely unstable. . . . At capacity, the traffic stream has no ability to dissipate even the most minor disruptions. Any incident can be expected to produce a serious breakdown with extensive queuing. . . . Maneuverability within the traffic stream is extremely limited, and the level of physical and psychological comfort afforded to the driver is extremely poor. Average travel speeds at capacity are approximately 30 m.p.h.."

Highlight:

Compared to a peer average (including Tri-Rail, BWI Airport, Northern Indiana, Penn DOT, Staten Island and Caltrain) for commuter rail operating expenses, the RTA commuter rail system will have a 14 percent to 19 percent lower average cost per trip.

The *Highway Capacity Manual* also states that "the LOS E boundary . . . has been generally been found to be the critical density at which capacity most often occurs. This corresponds to . . . a capacity of 2,000 pcphpl [passenger cars per hour per lane] for 60-mph and 70-mph design speeds." Thus, the actual number of vehicles per lane is less than 2,000 per hour if the traffic includes vehicles larger than passenger cars (i.e., trucks).

Using the 2,000 vehicles per hour per lane as the standard for sustainable capacity, the practical person-carrying capacity of a lane can be determined by multiplying the number of vehicles by the average occupancy of a vehicle on the highway.

A survey of western U.S. cities shows that the average vehicle occupancy (AVO) on highways range from around 1.1 persons per vehicle to 1.3. In 1990, Puget Sound area counts showed average vehicle occupancies at 21 locations along the region's highways ranging from 1.05 to 1.24 in the morning and from 1.06 to 1.4 in the afternoon (these counts and the U.S. Census report that average occupancy dropped in the region between 1980 and 1990).

Based on current Puget Sound region information, average vehicle occupancy over an entire day does not appear to exceed 1.25 (give or take a couple hundredths of a person) — though there aren't enough comprehensive counts or surveys to allow a definitive calculation. The state Transportation Department sometimes uses the 1.25 value for highway performance analysis.

Assuming there is an average of 1.25 persons per vehicle, the average person-carrying volume on an average freeway lane is 2,500 people per hour, as shown in **Table 21**.

This translates into a six-lane highway with a practical person-carrying capacity of 15,000 people per hour, or twelve-lanes capable of accommodating 30,000 people per hour.

The passenger carrying capacity of a rail system is a function of the number of rail vehicles in a train, the number of passengers carried in each vehicle and the number of trains that operate per hour in each direction.

Table 21: Highway lane capacity

(LOS E capacity per lane)		(Average vehicle occupancy)		(Persons per lane per hour)
2,000	x	1.25	=	2,500

Table 22: Peak-use rail system capacity

Passengers Per Train		Trains Per Hour		Passengers Per Hour		Two Directions		Passengers Per Hour
750	x	20	=	15,500	x	2	=	30,000

The RTA light-rail system will accommodate six-car trains. The capacity of each rail car, including standing passengers, is 125 people (this number is consistent with experience in many U.S. cities and does not exceed vehicle capacity recommended by the Federal Transit Administration for use in federally-supported planning studies). Thus, six-car trains would each be capable of carrying 750 passengers.

With modern signaling, the RTA rail lines will be capable of a peak-use level of service of at least one train every three minutes. This translates into 20 trains per hour, per direction, and yields a peak system capacity as shown in **Table 22**.

A rough comparison, shown in **Table 23**, can then be done between the current capacity of the region's highways and the proposed rail system.

Highlights:

A recent Federal Transit Administration study concluded that households in communities with a variety of commercial activities within walking distance of rail stations save an average of $250 per month in car ownership costs. Nationwide this savings totals $20 billion per year.

Table 23: Current highway and proposed rail system capacity

Highway					Rail	
Number of highway lanes		Persons per lane		Total highway capacity	Equivalent one direction rail capacity	Equivalent two direction rail capacity
6	x	2,500	=	15,000	15,000	N/A
12	x	2,500	=	30,000	N/A	30,000

System reliability

Reliability is one measure of a transportation system's performance. It plays an important role in influencing how a person chooses to travel (auto, bus, rail, bicycle, etc.). System reliability basically evaluates how many transit vehicles arrive on time, or within a limited deviation from a published schedule.

System reliability has dropped significantly in the central Puget Sound region's transportation network in the last decade. Single-occupancy vehicles are experiencing a high degree of unreliability because of traffic congestion.

Traffic congestion in the central Puget Sound corridor has increased rapidly in the last ten years, and it now affects travel on most-major freeways, expressways and arterials. Hours of congestion have also increased, with stop-and-go traffic a commonplace experience at midday and on weekends in many places. Traffic congestion is expected to get worse as travel demand continues to rise.

The reliability of public transportation is experiencing a decline similar to general automobile traffic in many corridors where high-occupancy vehicle (HOV) lanes are not available. For example, bus operating speeds on urban arterials in the Seattle have dropped 22-46 percent between 1962 and 1992. Even with HOV lanes, traffic pinch-points have substantially reduced reliability. The three types of transit featured in the RTA ten-year system plan (light rail, commuter rail, and regional express bus routes on HOV lanes) will provide greater reliability than the current public transportation system.

The light-rail system will provide significantly greater reliability than all other types of public transportation in the region. The light-rail system will operate in exclusive rights-of-way (a mix of tunnels, priority surface and aerial alignments).

Since the commuter rail system will run entirely on existing and improved freight railroad tracks — with a high degree of grade separation and fully protected at-grade crossings (with signals, crossing arms, etc.) — it should operate very reliably.

Finally, the regional express bus system will be more reliable than current bus service (though it will be less reliable than the light rail and commuter rail systems because it must still deal with general traffic congestion). These new regional bus services will use HOV lanes wherever available. The RTA will also work closely with local jurisdictions to develop transit priority treatments at critical "pinch points" on regional express bus routes to allow faster and more reliable service.

Overall, Sound Move should offer greater system reliability than is currently available.

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