

I-405 Corridor Program

White Paper: Bus Rapid Transit Line Concept Ten-Year Program Implementing the First Phase of the I-405 Corridor Program Recommendations

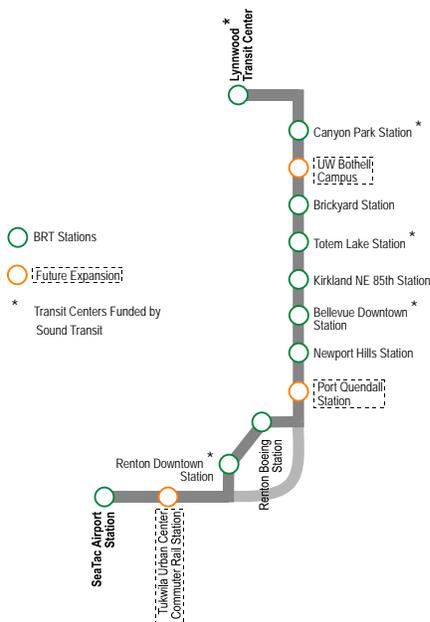
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August 2003



FINAL DRAFT



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The I-405 Plan recommended that all-day, high-speed Bus Rapid Transit (BRT), with buses coming every 10 minutes, be provided in the I-405 corridor. Dedicated HOV lanes, and direct access ramps would allow BRT buses to travel at high speeds with a high degree of reliability. Attractively designed buses and stations would make the passengers feel comfortable in riding the BRT buses. BRT fares would be collected off-vehicle, similar to other high capacity transit. The BRT stations would be located along I-405 at key communities in South Snohomish County, and East and South King County. Most BRT passengers would access BRT buses from park-and-ride lots or feeder buses. King County Metro and Snohomish County Community Transit would provide the feeder services, while Sound Transit would continue to provide express bus services in other corridors.

PURPOSE OF WHITE PAPER

This white paper describes components of the proposed Bus Rapid Transit line in the I-405 corridor. Several transportation agencies including the Washington State Department of Transportation, the three-county Regional Transportation Investment District (RTID), Community Transit, Metro, and Sound Transit are working to develop transportation improvement plans for the next 10 years and beyond. Decisions will soon be made about how much public funding for transportation improvements should be raised by the public in the Puget Sound region. The critical issues are (1) how much should public agencies in the region invest in transportation improvements, including roads, and transit facilities and services, and (2) how willing is the public to tax themselves to fund those improvements. In response, this paper defines a Bus Rapid Transit line designed for the entire length of the I-405 corridor, which reflects the substantial financial constraints likely to apply to the corridor during the next ten years. This BRT line would be an initial step toward completing transit investments identified in the I-405 full vision.



BRT in Brisbane, Australia



BRT in Bogotá, Columbia

This white paper is prepared for the I-405 Executive Committee. Public transit agency staff participated in the process to develop the I-405 BRT implementation plan and contributed to this report. No agency, including King County, Sound Transit or Community Transit, has yet endorsed levels of funding needed to implement the I-405 BRT line. Although these agencies support the general concept of the BRT as described in the I-405 Corridor Program EIS, no decision has yet been made to implement or fund the BRT line for the I-405 corridor. The I-405 Executive Committee is expected to make a decision on the I-405 implementation program this summer and recommend actions to the RTID, the Sound Transit Board and the King County Council.

WHAT IS BUS RAPID TRANSIT?

BRT is a term typically used in the transit industry to describe high frequency bus service that incorporates capital facilities designed to increase travel speed, reliability, and passenger convenience and comfort. BRT combines the flexibility of bus routes with distinctive features more commonly associated with rail transit.

A 2001 Transportation Research Board (TRB) publication describes BRT as more than just special buses or improved bus stops. It is a complete rapid transit system that combines flexible and new technologies to improve customer convenience and reduce delays. The TRB publication identifies a menu of components that together create a BRT system.

Service - direct service that operates all day in both directions, running frequently enough that riders no longer need schedules. BRT service should be well integrated with local and express connecting bus service allowing travel to multiple destinations with minimal transfer delay.

Sampling of BRT Systems in the U.S.

Silver Line - Boston's first bus rapid transit service is currently under construction. "The Silver Line represents the most advanced Bus Rapid Transit (BRT) technology in the world...When completed in 2010, the Silver Line will link Downtown and South Station, offering a one-seat ride from Dudley Square to Logan Airport and serving 60,000 riders a day."

City of Phoenix Public Transit Department

- Several existing express route will be converted to BRT routes in Phoenix. "Commuting to downtown Phoenix in mid-2003 is going to be a whole new experience for current express bus riders and thousands of Phoenix residents who aren't taking the bus now. The transformation of the existing express service into Bus Rapid Transit (BRT) is based on the simple concept of fast, convenient, and comfortable commuter bus service."

Euclid Corridor Transportation Project - A BRT line from Public Square in downtown Cleveland to the Stokes/Windermere Red Line Rapid Transit station in East Cleveland.

"The idea of Bus Rapid Transit is to provide the quality of rail transit, while benefiting from the flexibility of buses. Euclid Avenue will be served by a unique, aerodynamic, 60 foot Euclid Corridor Vehicle, which will be quiet and environmentally friendly." Construction of the BRT line is expected to begin in 2004 and be completed by the end of 2006.

There are many successful examples of BRT systems in other Countries: Curitiba, Brazil; Lyons, France; Nagoya, Japan and Leeds, UK.

Route Structure – a single service pattern with limited stops. The degree to which a route is local -- stopping every few blocks, versus regional -- stopping every few miles, affects travel time and its ability to take advantage of mainline and access treatments designed to improve transit speed and reliability.

Fast and Reliable Environment - whether operating on an exclusive right-of-way or operating in an HOV or other shared lane, some form of exclusivity is required to allow buses to maintain speed and reliability from point to point and to get in/out of the high-speed corridor to reach stations. Access approaches can include:

- **In-line stations:** Stations within the freeway right-of-way eliminating the need for the bus to deviate off the corridor/roadway. Passengers must walk to and from the corridor from adjacent neighborhoods and parking facilities.
- **Direct access on/off ramps:** Special dedicated ramps that allow the bus to leave the corridor and serve riders using nearby park-and-ride lots and transit center facilities with a minimum of deviation and delay.

Vehicles - distinctive and easily identified from buses providing other transit service. Although the exact amenities have not been determined, the design of the I-405 trunk line buses will reduce dwell times and improve rider comfort with such features as:

- **Low floor design** with wide aisles that take less time to board and accommodate disabled passengers.
- **Multiple doors** designed to reduce dwell times in conjunction with fare collection strategies that allow multi-door use.

Alternative fuel technologies that reduce noise and pollution.

Distinctive color scheme and graphics for identification.

- **Intelligent on-board systems** that help passengers use BRT.

Stations – comfortable, conveniently located and integrated with the system and into the communities where they are located. Stations can vary from enhanced bus shelters to transit centers like the Bellevue Transit Center. In freeway-based applications, stations outside urban centers are often co-located with park-and-ride lots. Given the desirability of locating passenger facilities in pedestrian-oriented urban centers that are not usually located near freeways, BRT buses may need to travel some distance to reach passengers at an off-corridor station. To get there, the system can include:

- **Operations in mixed traffic:** buses often must navigate regular mixed traffic in order to arrive at stations. This can be the most time-consuming portion of an average trip, more so during congested traffic periods.
- **Priority operations:** Arterial HOV lanes, queue jumps for buses, non-HOV turning restrictions and signal prioritization allow buses to quickly navigate local streets to get to/from stations and rapidly return to the BRT corridor running way.

Fare Collection – BRT fare collection procedures make it fast and easy to pay, which allows for reduced dwell times at stations. Off board or electronic “Smart Card” fare collection allows passengers to enter and exit through multiple doors.

Intelligent Transportation System – technologies that improve customer convenience, provide speed and reliability, and distinguish BRT from regular bus service.

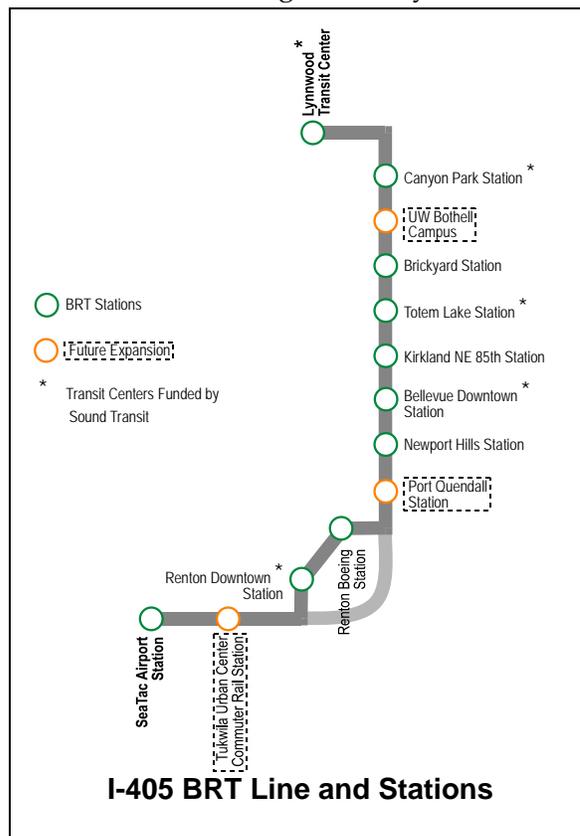
STRENGTH AND WEAKNESSES OF BRT

BRT’s greatest strengths are its flexibility and ability to provide high quality “rail-like” transit service, which is usually less expensive than traditional fixed guideway technologies. BRT can also be developed incrementally. If resources do not allow for completion of a portion of the transit-way or other facility that provides exclusivity, the bus can still operate in mixed traffic until funding is available to complete the missing link or direct access. BRT programs often build facilities that also speed existing transit along the corridor.

BRT’s strengths may also be its weaknesses. Flexibility of BRT may lead to an operating condition where high speed bus operations are compromised. This is often the case where constructing exclusive bus-ways is difficult and costly in high-density centers. BRT buses may have to operate on local arterials without exclusive right-of-way.

Travel on HOV lanes within the freeway right-of-way help increase speed and reliability, but transit’s success depends on serving pedestrian-oriented centers, which are not located in a freeway environment.

The transit investments would help improve travel conditions for other modes such as carpools and vanpools and perhaps even allow single occupant vehicles to “buy” in if capacity exists under the High Occupancy Toll concept. However, the transit investments to promote other travel modes can increase risks of lower transit operating speeds and reduced reliability because other modes can take too much of the capacity.



PROPOSED I-405 BRT - INITIAL 10 YEAR TRANSIT INVESTMENT (OPTION C)

This section describes the initial 10 year transit investment from the I-405 Corridor Program recommendation. The general concept is to provide frequent, convenient, and comfortable two-way, all day bus service for the I-405 communities between the Lynnwood Transit Center and SeaTac Airport. Buses would share HOV lanes or High Occupancy Toll lanes on I-405 and use direct access ramps and/or inline stops to reduce the time it takes to pick-up and/or drop passengers. Riders would access the I-405 service at a limited number of locations, often at park-and-rides or at transit centers where they can transfer to and from local bus routes.

OPERATION OF THE I-405 BRT LINE

During weekdays, BRT buses will travel every 10 minutes in both directions on the I-405 BRT Line from early morning to late evening. The BRT buses will travel at the speeds of the high occupancy vehicles. It is hoped that BRT buses can achieve top speeds of 50 to 55 miles per hour on the HOV lanes. Frequent service is the key element for success, allowing commuters and others to travel at their convenience, not the bus system's schedule. Riders will not need to consult transit schedules on the BRT at any time except for weekend and evening travel. The I-405 BRT line will integrate with existing transit services provided by Sound Transit, Metro, and Community Transit.

BRT STATIONS

The initial, ten-year I-405 BRT plan includes the following stations from the north to the south:

- Lynnwood Transit Center
- Canyon Park Station at SR 527 (Station located on existing interchange ramps)
- Brickyard Station at NE 160th Street (In-line station)
- Totem Lake Station at NE 128th Street (Direct access with in-line station)
- Kirkland Station at NE 85th Street (Station with direct access)
- Bellevue Downtown Station at NE 6th Street (Station with direct access)
- Newport Hills Station at 112th Avenue SE (In-line station)
- Renton Boeing Station at N 8th Street (Station with direct access)
- Renton Downtown Station
- SeaTac Airport Station

BRT LINE ROUTING

Lynnwood Transit Center

The Lynnwood Transit Center is the north terminal of the I-405 BRT Line. Buses will depart the Lynnwood Transit Center and park-and-ride via arterial streets and enter I-5

using general-purpose ramps at SW 196th Street. The I-405 BRT line will travel to I-405 and then merge to the center HOV lane and back again to make its first stop at Canyon Park Station.

Canyon Park Station

The Canyon Park Stations will be located on the I-405 ramps to and from SR 527. A pedestrian bridge over I-405 connecting the stations with the Canyon Park Park-and-Ride lot will be constructed under the current Sound Transit Program. The Canyon Park Park-and-Ride lot is proposed to be expanded by 400 stalls to accommodate increased parking demand. Departing the Canyon Park Station, the I-405 BRT bus will travel south on the HOV lane. It will stop at the Brickyard Station, located just south of NE 160th Street.



I-405 HOV Lanes

Brickyard Station

The Brickyard Station will be located in the Brickyard Park-and-Ride lot. The station will be accessed from the I-405 HOV lanes via a new direct HOV/transit ramps. This station and access concept assumes that there will not be freeway-to-freeway direct HOV ramps from westbound SR 522 to southbound I-405 and northbound I-405 to eastbound SR 522. (These direct HOV ramps are estimated to cost about \$320 million.) BRT buses will approach the park-and-ride using the HOV lanes and direct access, and other Metro or Sound Transit buses from SR 522 have to travel on the general-purpose lanes or shoulder HOV lanes on I-405. Passenger will board at the park-and-ride lot. After loading passengers, the bus will turn around at the park-and-ride lot and quickly return to the I-405 HOV lane via the new HOV ramps.

An alternative concept examined in the planning process was a new inline station, which would be located in the median of I-405. To build the station, the I-405 median would be widened to provide acceleration and deceleration lanes, as well as passenger platforms. A pedestrian bridge over the southbound I-405 lanes would provide access for the Brickyard Park-and-Ride lot to the BRT station. The in-line station concept is tied to the \$320 million freeway-to-freeway HOV access ramps.

The Brickyard Park-and-Ride lot is planned to be expanded to accommodate more users. It is proposed that an additional 750 parking spaces be added to the existing park-and-ride lot. After picking up transit riders at the Brickyard Station, the bus will travel south on the HOV lane to the Totem Lake Station.

Totem Lake Station

The Totem Lake Station is located on the ramps to/from NE 128th Street in Kirkland. The current Sound Transit program plans to construct a new street crossing over I-405 at NE

128th Street with HOV ramps and bus shelters. This station is within walking distance from the Kingsgate Park-and-Ride lot. After a stop at the Totem Lake Station, the bus can quickly return to the I-405 HOV lane.

NE 85th Street Station

From Totem Lake, the BRT bus will exit the HOV lane at NE 85th Street in Kirkland using the new HOV-only off-ramp, which connects the I-405 HOV lane with a new park-and-ride lot, to be constructed along I-405 in the vicinity of NE 85th Street. A BRT station will be provided at the park-and-ride lot. The bus will turn around after boarding passengers, and return to the HOV lane via the new HOV-only on-ramp.

The new NE 85th Street Park-and-Ride lot is proposed to contain about 500 stalls in a structure. The existing Houghton park-and-ride lot at NE 70th Street could be either eliminated or reduced in its size after completion of the NE 85th Street park-and-ride structure.

Bellevue Downtown Station

The BRT bus traveling on the HOV lane from the NE 85th Station will exit to the Bellevue Downtown Transit Center via the direct access ramps at NE 6th Street, currently under construction and funded by Sound Transit.

The Bellevue Downtown Transit Center was upgraded last year with Sound Transit funds. Many riders are expected to exit the BRT bus at the Bellevue Downtown Station. At the station, those traveling to other destinations will transfer to other Metro or Sound Transit buses while passengers from other Metro and Sound Transit buses will board the BRT bus.

The BRT bus will return to the I-405 HOV lane via the NE 6th Street HOV ramp. There will not be a park-and-ride lot in the Bellevue downtown.



Bellevue Downtown Station

Newport Hills Station

From the Bellevue Downtown station, the BRT bus will stop at the Newport Hills Station. This is an in-line station located in the median of I-405, adjacent to the existing Newport Hills Park-and-Ride lot on 112th Avenue SE. This station design will be similar to the Brickyard Station. The bus riders from the park-and-ride lot will use the 112th Avenue SE overpass to the in-line station.

The existing Newport Hills Park-and-Ride lot is proposed to be expanded by 400 parking spaces.

Renton Boeing Station

From the Newport Hills Station, the BRT bus will travel on the I-405 HOV lane to Renton. It will exit at North 8th Street in Renton. A new HOV access interchange will be

constructed at North 8th Street, south of the Park Avenue interchange. This interchange is the main access to the Renton Boeing Plants from I-405. In the vicinity of the North 8th Street/Park Avenue intersection, there will be a Renton Boeing BRT Station. This station is located within walking distance to various Boeing facilities.

Renton Downtown Station

A short distance from the Boeing Station, the BRT bus will arrive at the Renton Transit Center by traveling on Park Avenue. The Renton Transit Center has been upgraded and a park-and-ride structure was completed under current Sound Transit program funds. Although the location has not been identified, an additional 400 parking spaces is planned in the Renton area to support the I-405 BRT operation.

From the Renton Downtown station, the I-405 bus will travel on Rainier Avenue toward I-405. There will be new HOV ramps at SR 167/ Rainier Ave interchange on I-405. The I-405/ SR 167 interchange will be re-configured with direct ramp connections for general purpose and HOV vehicles. The existing loop ramps will be eliminated. The general purpose vehicle access to and from North Renton to I-405 will be significantly modified. For those vehicles, access to I-405 will be provided from Lind Avenue and Talbot Avenue. Only transit and carpool vehicles will be allowed to access I-405 from Rainier Avenue.

SeaTac Airport Station

The BRT bus will return to the I-405 HOV lane from Rainier Avenue through the HOV on-ramp in the median of I-405. The last stop of the BRT bus is the SeaTac Airport Station. A location of the SeaTac Airport station has not been determined. It will be necessary to coordinate with the Port of Seattle to locate an inter-modal station at the SeaTac Airport.

Future Expansion of I-405 BRT Service Areas

I-405 BRT service could be expanded to areas other than those station areas listed above as funds for transit improvements become available. Possible new station areas for future I-405 BRT service areas include:

Cascadia Community College/University of Washington Bothell Campus

Port Quendall at 44th Street

Tukwila Urban Center/Commuter Rail Station

At the UW Bothell Campus, the issue is physical constraints to provide a space for the BRT station or HOV ramps on I-405. Several options have been identified.

There may not be a need for a BRT station at Port Quendall area in Renton in the near future because the proposed developments at the Port Quendall site may not take place for some time.

I-405 Bus Rapid Transit Line Concept

The Tukwila Urban Center area, particularly around the Southcenter Mall, will experience significant growth in retail and residential developments. It is expected that the Urban Center area will become one of the major destinations along the I-405 Corridor for transit riders. However, a more in-depth study is needed to determine how the I-405 BRT could provide service to the Tukwila Urban Center. A solution would need to be found where the BRT buses would not have to deviate significantly from I-405.

It is expected that the two stations mentioned above will increase the ridership of the I-405 BRT line.

I-405 BRT BUSES

I-405 BRT buses may have the following vehicle characteristics:

- Low floor with wide doors for convenient boarding,
- Reduced noise and air pollution,
- On-board customer information systems to assist passengers as to when and where to depart and transfer, and
- Unique identity through distinctive color and graphics.

A wide variety of vehicle types are commercially available for the I-405 BRT line. An assumption has been made that a cost of a bus for the I-405 BRT line is \$600,000.

NEW STATIONS

The BRT Line includes construction of new stations or upgrades to the existing facilities along the corridor, to improve the waiting environment and facilitate transfers between regional and local bus routes.

Example of BRT Buses



I-405 Bus Rapid Transit Line Concept

Stations will be comfortable, conveniently located and integrated with the system and into the communities where they are located. Stations will vary from enhanced bus shelters to elaborate transit centers like the Bellevue Transit Center. Stations along the I-405 BRT line will be co-located with park-and-ride lots and/or existing transit centers. The BRT stations will have a distinctive look that includes enhanced shelters, waiting areas with seats, customer information system, vending and other amenities that add customer convenience and comfort.



FARE COLLECTION

Fare collection procedures will make it fast and easy to pay to reduce dwell times at stations. Off board or electronic "Smart Card" fare collection will be implemented to allow passengers to enter and exit through multiple doors.



EXPRESS SERVICES FROM PARK-AND-RIDE LOTS

The proposed I-405 BRT program includes a minimal expansion of the commuter express bus services from park-and-ride lots located along I-405 to provide direct service to employment concentrations that are not served by the I-405 trunk line.



Examples of BRT Stations

HIGH OCCUPANCY VEHICLE FACILITIES

The I-405 BRT program includes the capital facilities designed to support express transit services, carpools and vanpools. Particularly, freeway-to-freeway HOV ramp connections are important in providing competitive travel times for transit riders and carpools. While some HOV facilities are not directly used by the I-405 BRT buses, they are integral to the system of HOV lanes for the region. The SR 167/I-405 direct HOV ramps are proposed to be implemented in the next 10-year program. (The estimated cost of the ramps is \$80 million.)

Future Expansion of Freeway-to-Freeway HOV Connections

The 10-year implementation program as described above does not include several freeway-to-freeway HOV ramps. The following is a list of the potential freeway-to-freeway HOV ramp connections:

- I-5/I-405 connections at the Swamp Creek Interchange

I-405 Bus Rapid Transit Line Concept

- SR 522 to I-405 direct HOV ramp (The estimated cost of this ramp is \$320 million.)
- SR 520/I-405 connections
- I-90/I-405 connections
- I-5/I-405 connections in Tukwila

It is assumed that these improvements will be provided after the completion of the initial 10-year program. Although the proposed BRT line can initially operate without those HOV connections, transit operations, including I-405 BRT, and carpool and vanpool vehicles will greatly benefit by having them in their systems.

BRT RIDERSHIP FORECAST

Mirai Associates prepared preliminary ridership forecasts for the BRT line for 2014 and 2030 and compared them with projected 2014 ridership on the existing Sound Transit express bus routes. The forecasts were made using EMME/2 software with the Puget Sound Regional Council's mode split model. The transit network on the Eastside was adopted from one coded as a part of the I-405 Corridor Program. The model has two durations of time: AM peak three hours and off-peak hours, which covers about 11 hours. An assumption was made that the transit ridership during the PM peak three hours is the reversal of the AM peak hours. Mirai made manual adjustments based on the existing ridership counts. To obtain a total of the weekday BRT riders, the forecasted volumes for AM peak hours, PM peak hours, and off-peak hours were added.

2014 BRT RIDERSHIP FORECASTS

To prepare 2014 ridership forecasts, an assumption was made that the level of BRT service (frequency) described in this white paper would be fully implemented and the proposed facilities such as stations, access and park-an-ride expansions would be completed by 2014. Furthermore, the model assumed that the BRT buses would travel at high speeds on I-405. To simulate this condition, it was assumed that I-405 would have two HOV lanes in each direction with an HOV definition of two or more occupants in order to guarantee free flow condition for the BRT operation. This assumption does not imply that a policy decision has been made. Rather, this concept was chosen to develop conservative transit ridership forecasts.

Average Weekday Riders (2014)

The transit model predicted the passenger boardings and alightings at each I-405 BRT station during an average weekday in 2014, which is shown in **Table 1**.

Table 1. 2014 Boardings and Alightings on the I-405 BRT Line

Stations	I-405 BRT From Lynnwood to SeaTac			I-405 BRT From SeaTac to Lynnwood		
	Boardings	Alightings	Total	Boardings	Alightings	Total
Lynnwood Station	390	0	390	0	440	440
Canyon Park Station	120	40	160	20	160	180
Brickyard Station	210	30	240	50	180	230
Totem Lake Station	280	70	350	80	290	370
NE 85 th Station	180	160	340	130	230	360
Bellevue Station	730	570	1,300	570	690	1,260
Newport Hills Station	30	150	180	180	30	210
Renton Boeing Station	60	50	110	40	50	90
Renton Downtown Station	290	190	480	140	290	430
SeaTac Airport	0	1,040	1,040	1,140	0	1,140
Total	2,290	2,290	6,250	2,350	2,350	6,900

The average weekday ridership on the I-405 BRT line is a sum of all boarding passengers (boardings) at the stations. In 2014, it is expected that it will carry about 4,640 riders. (It is a sum of 2,290 riders for the line from Lynnwood to SeaTac and 2,350 riders from SeaTac to Lynnwood.) The Bellevue Downtown Station is the busiest station among all stations in the I-405 BRT line with nearly 2,560 people boarding and exiting the I-405 BRT line in both directions. The second busiest station is the SeaTac Airport Station where 2,180 people will be using the station.

What do these ridership forecasts really mean? One way to analyze these forecasts is to compare the I-405 BRT ridership forecasts with those of "No Action". The No Action assumes that Sound Transit, King County Metro and Community Transit will continue their existing services and make improvements to their transit system with the plans that have funding commitments from each agency.

If the I-405 BRT line is funded and implemented by 2014, the existing two Sound Transit routes, ST 535 and ST 560, will be replaced with the new BRT line. A model was developed to forecast 2014 ridership on those routes, which is termed the 2014 No Action transit forecasts in contrast with the I-405 BRT forecasts.

I-405 BRT vs. No Action

The transit model forecasted that ST 535 and ST 560 express routes would generate a total of 3,470 riders (boardings) during weekday in 2014. The weekday ridership increase in the 2014 I-405 BRT line over the No Action condition is about 1, 170 riders, which is an increase of 34 percent, as shown in **Figure 1**.

It is reasonable to assume that most of these riders are new riders. However, it is possible that the increased ridership would be due to attracting existing riders from other transit routes to the I-405 BRT line. Also, the increase of the riders over No Action should be cautiously used because ST 535 and ST 560 serve the areas where I-405 BRT will not. For example, ST 535 serves the Bothell Park-and-Ride lot on SR 522 and ST 560 serves South Bellevue Park-and-Ride lot, whereas the I-405 BRT would serve neither park-and-ride lot.

It should be noted that the increase in transit ridership due to the BRT would have positive impacts to other transit routes. This study did not examine such impacts in detail.

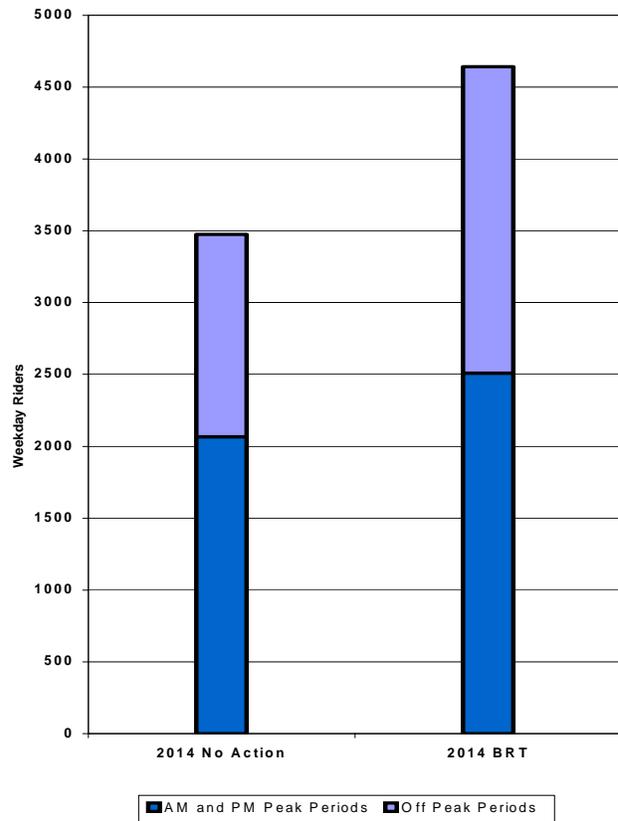


Figure 1. 2014 No Action and BRT Ridership Forecasts

Rider Access to Stations

The I-405 BRT riders generally use three ways to access the BRT stations: 1) walking (walk and ride), 2) driving (park and ride), and 3) taking other buses (bus to BRT transfer). Although some will ride bicycles to a station and others may be dropped off from a car at a station (kiss and ride), the model used for this study does not have the capability to estimate the riders accessing in these modes. **Table 2** shows percentages of station access modes for 2014 in terms of primary access modes.

Table 2. Percent of Access Modes Among BRT Riders at Each Station

	Park and Ride	Walk and Ride	Bus Transfer	Total
Lynnwood Station	47%	2%	51%	100%
Canyon Park Station	41%	0%	59%	100%
Brickyard Station	77%	8%	15%	100%
Totem Lake Station	35%	14%	51%	100%
NE 85 th Station	41%	17%	42%	100%
Bellevue Station	0%	31%	69%	100%
Newport Hills Station	69%	3%	28%	100%
Renton Boeing Station	11%	89%	0.0%	100%
Renton Downtown Station	26%	49%	25%	100%
SeaTac Airport	0%	63%	37%	100%

2030 BRT Ridership Forecasts

As I-405 BRT line operation matures, it is expected that ridership on the I-405 BRT line will increase from 2014 into the future. Mirai developed a 2030 transit demand forecast model assuming that the I-405 BRT line implemented in 2014 will continue to be operational in 2030.

The model showed that the I-405 BRT line would generate a total of 9,700 riders during a weekday. This is an increase of 5,060 weekday riders in 16 years, as shown in **Figure 2**.

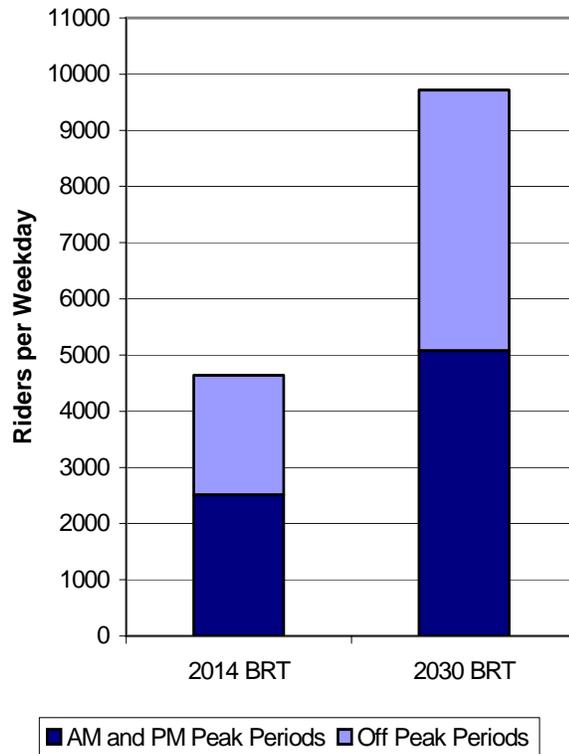


Figure 2. 2014 and 2030 No Action and BRT Ridership Forecasts

BENEFITS OF I-405 BRT

Speed and Reliability

I-405 BRT is designed to provide high levels of customer convenience. The BRT buses will travel at top speeds of 50 to 55 miles per hour on the HOV lanes for almost the entire length of the BRT line. The speed of BRT buses and the degree of reliability that the I-405 BRT will provide to its riders will largely depend on the operating conditions of the HOV lanes, as the BRT buses will travel on the I-405 HOV lanes for most of the length of the BRT line. An assumption was made that the state would provide conditions where transit can travel at a “free-flow” speed.

All-Day, Frequent Service

I-405 BRT will provide 10-minute, high frequency service during morning, midday and evening periods. When boarding BRT, passengers will not need to have a service schedule. They just need to come to the station. The average wait time at the station will be less than five minutes. The I-405 BRT is expected to operate nights, Saturdays and Sundays with reduced frequencies.

Lower Operating Costs

The TRB publication cited earlier, concludes that BRT can be the least expensive mode of rapid transit to operate at the demand levels present in many U.S. corridors. BRT drivers are highly productive at moving transit passengers, due to relatively high operating speeds and the ability to tailor service to demand. Without track or overhead wires, dedicated running ways are easy and inexpensive to maintain. Vehicles can be stored in existing transit garages and can be operated and maintained by existing transit agency staff or contractors.

POTENTIAL DRAWBACKS OF I-405 BRT

Limited Walk-and-Ride Opportunities

The I-405 HOV lanes provide high speeds and high degrees of reliability for the BRT line. However, not many people live in the vicinity of the BRT stations to take advantage of good transit services. Except for the Bellevue Downtown and the Renton Downtown stations, most transit riders would not be able to walk to the stations from their residences. Since most BRT riders would not be able to walk to the BRT stations, the success of the I-405 BRT line will depend on two factors: adequate supply of parking spaces at the stations and high levels of local buses feeder services to the stations from the neighborhoods.

Use of HOV Lanes

High speeds and reliability of I-405 BRT operation will be the result of the transit/HOV facilities provided in the I-405 corridor. As opposed to rail, the BRT bus must share the running way with other vehicles. Unless the HOV lanes are separated by barriers, SOVs often encroach into the HOV lanes. As the volumes of the vehicles that will use the HOV lane increase, the speeds of the BRT bus will decrease. At the same time, the reliability will equally suffer. It is possible in the near future that the speeds of the BRT bus would not be able to operate above the “free-flow” speeds.

High Frequency Service vs. Productivity

It is proposed that I-405 BRT would operate at 10-minute frequencies all day. A question is whether there will be enough transit riders during the midday period to operate I-405 BRT productively. It is possible that some of the BRT bus runs might have to be terminated before they reach the north and south terminals. The most frequent services may have to be provided between the Renton Downtown station and the Totem Lake Station.

I-405 BRT COMPONENTS AND FUNDING NEEDS

The I-405 transit component was developed in the I-405 Corridor Program, a 30-year look at comprehensive corridor improvements. Transit is an integral element of the package of improvements recommended in the Corridor Program. Since funds are not available to complete the full I-405 vision, a group of agency staff involved in transit planning refined earlier recommendations into two transit options with price tags from \$515.5 million to \$1.436 billion. The difference is the inclusion of a number of freeway-to-freeway HOV connections and the number of new routes and service levels.

The following sections briefly describe the funding assumptions for the 10-year BRT programs, Option A and Option C, compared with the 30-year full program.

TRANSIT SERVICE

The initial operation of the I-405 BRT with 10-minute, all day service between Lynnwood and SeaTac Airport requires a total of 100,000 annual platform hours. (Platform hours include in-service and deadhead time.) The I-405 BRT line will replace the existing Sound Transit Express service routes with 40,000 annual bus hours. Thus, 60,000 net new annual hours are needed for I-405 BRT, which is shown in **Table 3**.

Option C includes an additional 40,000 annual bus hours to support express service to and from the park-and-ride lots located in the I-405 corridor.

A total annual operating cost for the net new transit services including BRT and express services is 100,000 net bus platform hours, which is \$8 million per year. The total cost of the BRT and express services for the 10-year program is \$80 million.

Table 3. Transit Service Costs

Service Type	Full Program	Option A	Option C
I-405 BRT	65,000* hrs	65,000* hrs	60,000** hrs
Park-and-Ride Supportive Express Service	280,000* hrs	165,000* hrs	40,000* hrs
Local Bus Service	655,000 hrs	170,000 hrs	-
TOTAL	1,000,000 hrs	400,000 hrs	100,000 hrs
Estimated Annual Cost	\$56.0 Million	\$22.4 Million	\$8.0 Million

Notes:

* "Hours" = platform service hours, including deadhead hours.

** I-405 BRT will operate with a total of 100,000 hours, comprised of 60,000 new hours and 40,000 existing hours.

BUS PURCHASE AND TRANSIT BASE COSTS

To operate the I-405 BRT Line, 19 new BRT buses will be needed. An additional 20 regular coaches will be needed to provide the park-and-ride express services, as shown in Table 4.

Table 4. Bus Purchase and Base Expansion Costs (in millions)

	Full Program	Option A	Option C
BRT Buses	71 buses	53 buses	19 buses \$11.4 *
Standard Buses	144 buses	72 buses	20 buses \$7.4
TOTAL	215 Buses	125 Buses	39 buses \$18.8
Bus Base			\$13.7 **
Combined Cost	\$95 ***	\$54 ***	\$32.5

Notes:

* The cost assumptions for buses were: BRT Buses = \$600,000 with Hybrid and articulated; Standard Buses = \$370,000. These costs do not include bus replacement, which would happen outside the 10-year window.

** The cost assumptions for bus base expansion were: \$350,000 per new bus, which is the proportional cost of the base capacity needed to house and service one additional bus.

*** These cost estimates do not include the need for bus bases.

BRT STATIONS

The I-405 BRT stations will have shelters and other passenger amenities. The existing transit centers are constructed at a cost of \$1 million each compared to the new required transit centers being developed under the Sound Transit program will be allocated \$2 million each, as shown in **Table 5**.

Table 5. BRT Station Costs (in millions)

Location	Full Program	Option A	Option C
Sea-Tac Airport Station	\$2	\$2	\$1
Tukwila Transit Center	\$10	\$0	\$0
Renton Transit Center	\$2	\$2	\$1
Renton Port Quendall	\$10	\$0	\$0
Bellevue Newport Hills/112 th Ave Station	\$10	\$10	\$2
Bellevue Transit Center	\$2	\$2	\$1
Kirkland NE 85th Street Station	\$10	\$5	\$2
Kirkland Totem Lake Station	\$2	\$2	\$1
Brickyard Station	\$0	\$0	\$2
Bothell/UW Campus	\$10	\$10	\$0
Bothell Canyon Park Station	\$10	\$10	\$2
Lynnwood Transit Center	\$2	\$2	\$1
Total	\$70	\$47	\$13

Note:

* BRT transit station costs include the following items: shelters, waiting areas, customer information system, fare collection system, customer services such as newspaper vending machines, bank ATMs, etc., and public restrooms. The station costs do not include land, parking and access costs, which are provided in the following tables.

HOV DIRECT ACCESS, IN-LINE STATION AND FREEWAY-TO-FREEWAY CONNECTIONS

Several stations in the I-405 BRT line will be located on or adjacent to the park-and-ride lots along I-405 and connected with the HOV lanes via direct access ramps. With the current Sound Transit funds within the I-405 corridor, direct HOV/Transit access ramps

are being planned, programmed, or constructed at the following locations: Totem Lake in Kirkland, Bellevue downtown, and north Renton area (N. 8th Street).

Two new in-line stations (Brickyard and Newport Hills) are proposed in Option C, where BRT buses will arrive at the stations without getting off from I-405. As these stations are located in the median of I-405, they will require a wider median on I-405.

The most expensive capital cost item in Option C is the freeway-to-freeway HOV ramps at the SR 522/I-405 interchange. As discussed in the previous section an alternative station and direct HOV access at Brickyard in addition to the proposed in-line station. These ramps are expected to cost about \$320 million. **Table 6** shows both the costs of the freeway-to-freeway with the right-of-way needs for the in-line stations and HOV direct access ramps without the inline station under Option C.

Table 6. Direct Access, In-Line Station and Freeway-to-Freeway Connection Costs (in millions)

Location	Full Program	Option A	Option C
I-5 interchange at Swamp Creek freeway HOV ramps	\$178	\$180	\$0
SR 527/Canyon Park Access	\$103	\$10	\$0***
Bothell NE 195 th /Bothell UW Campus access	\$107	\$50	\$0
SR 522 interchange freeway to freeway HOV ramps	\$39	\$0	\$0
Brickyard Park-and-Ride (NE 160 th Street)	\$0	\$40	\$70*
Kirkland NE 128 th Street/Totem Lake access	\$0	\$0	\$0***
Kirkland NE 85 th Street	\$37	\$40	\$55
SR 520 interchange freeway to freeway HOV ramps	\$0	\$0	\$0
Bellevue Downtown/ NE 6 th Street access	\$0	\$0	\$0***
I-90 interchange freeway to freeway HOV ramps	\$190	\$183	\$0
Newport Hill/112 th St SE (In-line station)	\$31	\$20	\$20
Renton NE 44 th Interchange- HOV Direct Access and Arterial Improvements	\$31	\$30	\$0
Renton N 8 th Street access	\$0	\$0	\$0***
Renton SR 167 interchange freeway to freeway HOV ramps	\$66	\$100	\$85
Renton Rainier Ave Direct Access	\$0	\$30	\$40
Renton SW 27 th Direct Access to SR 167	\$0	\$20	\$0
Tukwila Access	\$121**	\$30	\$0
Tukwila I-5 interchange freeway to freeway HOV ramps	\$65	\$100	\$0
Total	\$970	\$833	\$270

Note:

* This cost assumes a direct access to the Brickyard park-and-ride lot from I-405 and does not include the SR 522 HOV direct access ramp..

** This cost assumes a direct access to Commuter Rail Station.

*** This project is funded under the existing Sound Transit program.

PARK-AND-RIDE CAPACITY EXPANSION

Except for the Bellevue Downtown and SeaTac Airport Stations, all stations in the I-405 BRT Line will provide free parking spaces for park-and-ride passengers. The existing parking lots at Canyon Park, Brickyard, and Newport Hills, and an unidentified location in Renton will be expanded. A new parking lot will be constructed in the vicinity of NE 85th Street. A total of 2,350 spaces with a \$120 million cost, are shown in **Table 7**. These spaces will be added to the system capacity of the park-and-ride lots in the I-405 corridor under Option C.

Table 7. Park-and-Ride Lot Capacity Expansion and Costs (in millions)

Location	Full Program	Option A	Option C
Canyon Park	300-500	300	400 (\$15*)
Brickyard	750-1000	750	750 (\$25*)
Kirkland 85 th Street	300-500	300	500 (\$50**)
Redmond & vicinity	500	500	0
Mercer Island	300	300	0
Bellevue Newport Hills	800-1,100	800	500 (\$15*)
Renton & vicinity	400	400	400 (\$15*)
Tukwila & vicinity	0	0	0
Kent & vicinity	300-500	300	0
Burien	500-700	500	0
Total	4,100-5,500	4,100 (\$161)	2,550 (\$120)

Notes:

* This costs is for new parking spaces only.

** This cost comprises the full cost of a new parking structure including replacement of 200 existing stalls. A decision about the future use of the Houghton park-and-ride lot has not been made. If it were sold for non-park-and-ride use, the revenue could be applied against this cost.

SUMMARY OF THE I-405 BRT SYSTEM

Table 8 summarizes the totals generated in the previous tables. The table compares each program element for the I-405 Full Program, Option A and Option C.

Table 8. Summary of the I-405 BRT Elements and Costs (in millions)

Transit Program Element	Full Program	Option A	Option C
Service			
Transit Service Expansion	\$56.0 /year	\$22.4/year	\$8.0/year (\$80 for 10 years)
Capital			
Bus Purchases and Transit Base	\$95	\$54	\$32.5
BRT Stations	\$70	\$47	\$13
HOV Direct Access, In-Line Station and Freeway-to-Freeway	\$970	\$833	\$270
Park-and-Ride	\$161	\$161	\$120
Total	Not Applicable**	\$1,436 *	\$515.5

Note

* The total includes other items such as arterial HOV improvements, which are not shown in this table.

** The total cost under the Full Program was not shown because it is a 30-year program and the cost of the transit service expansion should not be compared with the Options A and B, which are 10-year funding programs.