

**WILSHIRE BUS RAPID TRANSIT
MORE THAN JUST A DEDICATED BUS LANE**

“It’s all about the stations and vehicles”

August 1, 2002

Timothy Nicholas Papandreou

Deputy Project Manager

Los Angeles County Metropolitan Transportation Authority

One Gateway Plaza Mail Stop 99-22-5

Los Angeles, CA 90012

Ph: 213 922 2281

Fax: 213 922 3060

Email: papandreout@mta.net

ABSTRACT

This paper examines the performance attributes of the Wilshire Bus Rapid Transit project currently being considered by the Los Angeles County Metropolitan Transportation Authority (MTA). The \$235 million Wilshire BRT project will provide enhancements to the existing Metro Rapid Bus Line #720 over a distance of 13.7 miles/22kilometers from the current terminus of the Metro Red Line at Wilshire/Western in the City of Los Angeles to Ocean/Colorado in Downtown Santa Monica. These enhancements would include up to 90 higher capacity articulated, clean air advanced transit vehicles and enhanced stations at 30 locations, fully compatible signal priority across the entire project route and peak period curbside dedicated transit lanes from Western Avenue to the Santa Monica City limits approximately 10 miles/16 kilometers. The combined BRT components will result in an approximate 21-27% increase in travel speeds over the existing Metro Rapid from 16 miles per hour (mph)/22 kilometers per hour (kph) to 20.5 mph/33 kph, almost two thirds (64%) is attributed to the BRT stations and vehicles. Another 18% is attributed to the compatible signal priority and the remaining 17% is attributed to the dedicated peak period curbside lane. This is a 75% increase in travel speeds over the previous local bus service that averaged approximately 12 mph/19.2 kph and a reduction of run time from 65-69 minutes to 40 minutes.

Introduction

Wilshire Boulevard is a highly urbanized corridor that has emerged as the spine of Los Angeles. This 17 mile/27 kilometer boulevard traverses some of the most well known cultural, shopping and employment and residential destinations in the world. The boulevard traverses the western edge of Downtown Los Angeles' Financial District, then westwards towards the Miracle Mile Museums including the La Brea Tar Pits, Beverly Hills Businesses Triangle including world famous Rodeo Drive and the Beverly Wilshire Hotel. The boulevard continues further west to the University of California at Los Angeles (UCLA) in Westwood Village-a high-density housing and employment center and finally terminating at the Palisades Park overlooking the Santa Monica Bay in Downtown Santa Monica.

The Wilshire Bus Rapid Transit project is currently being considered by the Los Angeles County Metropolitan Transportation Authority (MTA). The \$235 million Wilshire BRT project will provide enhancements to the existing Metro Rapid Bus Line #720 over a distance of 13.7 miles/22kilometers from the current terminus of the Metro Red Line at Wilshire/Western in the City of Los Angeles to Ocean/Colorado in Downtown Santa Monica (*KORVE Engineering, Wilshire Bus Rapid Transit Project Final Environmental Impact Report 2002*). These enhancements would include up to 90 higher capacity articulated, clean air advanced transit vehicles and enhanced stations at 30 locations, fully compatible signal priority across the entire project route and peak period curb-side dedicated transit lanes from Western Avenue to the Santa Monica City limits approximately 10 miles/16 kilometers.

This corridor has some of the highest employment and population densities in the nation (*KORVE Engineering, Wilshire Bus Rapid Transit Project Final Environmental Impact Report 2002*). The land uses are highly transit supportive with the buses alone carrying more than 60,000 boardings a day along the boulevard (*TMD, Final Report Los Angeles Metro Rapid Demonstration Program 2002*). A portion of the Metro Red line runs along the eastern end of Wilshire Blvd towards downtown Los Angeles. The Metro Rail Red line was shortsightedly suspended as it was being planned further west. The Metro Rapid was implemented to ease the corridors growing capacity and congestion problems. The Wilshire BRT project enhances the attributes of the Metro Rapid (discussed further) and is a very cost effective interim solution to maximizing at grade capacity with buses.

Data Collection and Analysis of Wilshire BRT project

The data was collected by riding the Metro Rapid for 8 months each work day from the Metro Rail Redline station at Western Ave to Santa Monica City pier and vice versa a total one way distance of approximately 13.7 miles (22 kilometers). The data was collected over 4 time periods:

- AM peak 7-10am

- Midday 11am-2pm
- PM peak 4pm-7pm
- Evening 8pm-11pm

There were over 20 sample runs taken from each period and averaged out to find the most typical example of this time period. The data collection included information such as:

- Travel Direction,
- Time waited for bus
- Actual time of boarding
- Station to station time and distance,
- Dwell time from doors opening to doors closing,
- Number of passengers on the bus after closing of bus doors, and
- Comments about passenger boarding or travel conditions.

The raw data was tabulated into the spreadsheets identifying the station to station bus speed, overall travel speed including the dwell time, travel time from station to station, station to station speed from end to end, average dwell time and passenger load. The data was totaled to show the actual travel time from end to end and the total dwell time. This paper will examine the AM peak period only as this has been adopted by the MTA Board for consideration. Table 1. *AM Peak Period Metro Rapid Wilshire/Western <> Ocean Colorado Running Times* was more typical of the 20 samples taken for this period and has been used as the basis of the BRT elements analysis.

Background Local Bus/Pre Metro Rapid

Figure 1. Wilshire BRT running Speed Improvement over Existing Metro Rapid shows that before the implementation of Metro Rapid, lines 18, 20 and 320 served the project area. Using previous timetables, the combined peak period average speed of this service was approximately 12 miles/19 kilometers per hour. This very similar to the current running speeds of the BRT system in Curitiba, Brazil where the inspiration for the Metro Rapid came from. Figure 2. *Wilshire BRT Travel Time: Wilshire/Western to Santa Monica Pier with BRT components* shows current peak travel times on the local bus takes approximately 65-69 minutes to complete the journey from Wilshire/Western to the Santa Monica Pier.

Current Metro Rapid Service

Since June 2000, the Metro Rapid replaced the 320 limited service with the faster more simplified system. This system included attributes such as low floor clean air 40 foot/12 meter buses, red color coded paint scheme to differentiate itself from local service, canopy style bus stops placed at each major north south intersection, station spacing approximately 1 mile/1.6 kilometers, and transit signal priority developed by the Los Angeles Department of Transportation (LADOT) using the Advanced Traffic Surveillance and Control System commonly referred to as “ATSAC”. Figure 1 shows the Metro Rapid has combined average peak period speeds of approximately 16 miles /25.6 kilometers per hour (range is between 13.9-20.5 mph/22.2-32.8 kph), an increase of approximately 25% from the 320 service. Approximately 25-33% of that increase is attributed to signal priority system designed by

LADOT and the remaining 67-75% is attributed to the Metro Rapid attributes (*TMD, Inc. Final Report Los Angeles Metro Rapid Demonstration Program, 2002*). Figure 2 shows AM Peak period average travel times from Wilshire/Western to Santa Monica Pier are approximately 50-55 minutes, a reduction of about 15-19 minutes.

Wilshire BRT Enhancements

The Wilshire BRT builds upon the current Metro Rapid successes with the implementation of several components. These components have been analyzed using existing data to see how each component is effective in increasing the transit performance of the corridor. *Table 2 Wilshire BRT Transit Corridor Mobility Improvements* shows that the Wilshire BRT achieves up to a 27% decrease in travel time from the existing Metro Rapid service today when applying the systems benefits along the corridor. This is due to a combination of project components such as:

- BRT Stations and Vehicles (vehicles, stations, software and fare prepayment),
- Compatible Signal Priority (in cities of Beverly Hills and Santa Monica), and
- Dedicated Peak Period Bus Lane (in segments between Western Ave and Santa Monica City Limit).

The Wilshire BRT components will reduce peak travel times by 10-15 minutes over the existing Metro Rapid. The most significant reduction in travel time will be from the various station and vehicle enhancements of the Wilshire BRT. With a 50% increase in vehicle capacity, a 150% net increase in boarding area, and the universal fare smart card prepayment system, a 50-65% reduction of the current dwell time can be expected. This was applied to the average dwell time of 37 seconds (ranging from 12-79 seconds) per station that varied across the project area. Table 2 shows the reduction in travel time will be significant, down between 5-9 minutes to 44-45 minutes. The most noticeable difference will be at Wilshire/Western, Wilshire/La Brea, Wilshire/Westwood, and Ocean/Colorado stations where dwell times will be reduced by more than 65% (Number of transit passengers per station trying to board/exit the vehicle).

The second component, full signal priority would be installed across the corridor with approval from local jurisdictions. From previous studies undertaken by the MTA and LADOT, Signal priority is accountable for a range between 7-15% in increasing bus speeds (*Los Angeles Department of Transportation, Transit Priority System Evaluation Report, 2000*). The decrease in travel time was applied to the segments of Beverly Hills and Santa Monica-areas with no signal priority. The average daily run times will decrease approximately 3-5% over existing Metro Rapid run times. This very low cost component would reduce peak run times by about 2-3 minutes to 42-43 minutes and greatly improve general vehicular travel too.

The third component, implementation of the Peak Period Bus lane would be installed in sections between Western Avenue and Santa Monica City limits. The travel time savings in the Peak period could be reduced approximately 5% over the existing Metro Rapid run times. This would reduce peak run times by about 2-3 minutes to 40 minutes. Although this is only a slight difference, the peak hour lane will ensure that this run time stays consistent over the forecasted period.

Travel times vary greatly across the corridor. This is greatly due to the varying capacity of the boulevard, the land uses including pedestrian activity and the street geometrics-or street layout. Los Angeles is a series of grid networks and in Beverly Hills and Santa Monica that grid is

turned on an axis. In Beverly Hills, for example three major boulevards terminate in the Beverly Hills Business Triangle causing a “junction like effect.”

In Westwood, the street network experiences great traffic congestion due to conflicts between Westwood Blvd, Sepulveda Blvd and the I-405 freeway. Not surprisingly,

Figure 3. Wilshire Boulevard Average Peak Period Bus Speeds by segments, shows that Beverly Hills and the Westwood/1-405 junction have the slowest travel speeds in the corridor. The area between the city of Beverly Hills, LA Country Club and Westwood Blvd commonly referred to as ‘Condo Canyon,’ has the fastest travel times of any segment along the corridor.

Figure 2. Wilshire BRT Travel Time: Wilshire/Western to Santa Monica Pier with BRT components shows that by combining the BRT Components, the bus speeds will increase a further 21-27% from approximately 16 miles/22.2 kilometers per hour on current Metro Rapid Service to approximately 21 miles/33kilometers per hour.

Figure 3. Wilshire Boulevard Average Peak Period Bus Speeds by segments shows that most areas improving in bus speeds particularly in Beverly Hills and Westwood. The following project components are explained to understand the methods used for calculation:

BRT Enhanced Vehicles and Stations

The BRT elements enhance the existing Metro Rapid hardware, software and physical infrastructure improvements including:

- 60 foot/18 meter articulated low floor clean air transit vehicles- with up to 50% more capacity than current 40foot/12 meter vehicles-reducing overcrowding and boarding times.
- Multiple door boarding- 3 times the entering capacity and 1/3 more exit points will mean faster entry and exit.
- Pre-paid fares utilizing the Universal Fare Smart Card technology and on board validators- .will relieve the driver from having to manually accept fares and transfers ensuring speedier boarding.
- Enhanced station shelters with information kiosks providing customers with audio-visual transit information, will mean less passenger confusion with various route information and faster boarding.

Additionally as part of the project, 4 miles/6 kilometers of Wilshire Boulevard curb lanes and select intersections will be repaired as they are causing stress on the existing vehicles and compromising transit rider comfort. A maintenance and storage facility will be built to accommodate the new vehicles-an approximate \$50 million cost.

Metro Rapid with Compatible Signal Priority

Wilshire Blvd does not have full signal priority throughout the corridor. Beverly Hills and Santa Monica do not have the compatible technology that is used by LADOT for the Metro Rapid.

These gaps make it difficult to predict accurate travel times and reduce the performance of the Wilshire Metro Rapid. The Signal Priority will ensure that the bus performance can be accurately reported allowing passengers to get accurate real time information for the next bus display or any other traffic related messages.

BRT Peak Period Lane

The BRT elements will only be able to work effectively if they are kept constant. As traffic congestion will continue over time the average travel speeds will deteriorate because of the competing road space with other vehicles. Even as more technologies will be applied, the BRT will need to maintain travel consistency to keep attracting new riders and retain existing riders. The implementation of a peak period lane would provide constant travel speeds thus ensuring a consistent travel time to the rider. Based on the TCRP (Transit Capacity and Quality of Service Manual Part2. Bus Capacity 2001) congestion adds approximately three minutes per mile(1.8 minutes per kilometer) to a transit vehicle in mixed traffic. When the transit vehicle is positioned in an exclusive lane, the delay per mile/kilometer can drop down to 1.9 minutes per mile/1.1 minutes per kilometer. The current delay due to congestion for Metro Rapid along Wilshire Blvd is approximately 1.67 minutes per mile/1.04 minutes per kilometer (*Padron, Manuel and Associates, Los Angeles Wilshire BRT Operations and Maintenance Plan.*). Using the TCRP manual formula, the exclusive bus lane would potentially reduce that delay to approximately 1.21 minutes per mile/0.75 minutes per kilometer (MDA). However there are several unique conditions to this project that would make that reduction difficult.

- **Peak period lane will be in the curb of Wilshire Boulevard-** Unlike in Curitiba where the BRT runs in the middle of the street, community opposition to that style of operation was addressed with the Board directing staff to analyze the Wilshire BRT in a curb lane operation. Operating in the curb lane will mean that the transit vehicle may be delayed by right turning vehicles as they yield to turning vehicles ahead and pedestrians. The peak hour lane would benefit the Westwood junction and Beverly Hills Business Triangle by acting as a queue jumping device and would keep the rest of the Boulevard's transit travel speeds more consistent.
- **The geometrics and the capacity of the street network vary greatly across the corridor-** In Beverly Hills, for example three major boulevards terminate in the Beverly Hills Business Triangle causing a "junction like effect." In Westwood, the street network experiences great traffic congestion due to conflicts between Westwood Blvd, Sepulveda Blvd and the I-405 freeway.

Using the delay per mile of 1.67 as a top range a slightly lower range of 1.44 minutes per mile/0.9 minutes per kilometer was applied to the corridor to address the mentioned conflicts (Average between current and formula delay results). This resulted in a travel speed of 20.6 miles per hour, an increase of 5% over the combined BRT elements and signal priority.

Issues and Future Considerations

According to MTA ridership data, approximately 2/3 of the corridor ridership is between Wilshire/Western and Santa Monica Pier and is expected to increase with the implementation of the Wilshire BRT project. The higher capacity vehicles will potentially be able to carry an additional 50% more passengers while using the same number of operators that were driving the more standard size vehicles. These cost efficiencies will be realized as more corridors are augmented with this type of service improvement.

The ridership growth demonstrates the latent demand for faster more reliable service across the Wilshire Corridor. According to the LADOT, the 2.5-minute headways would be as frequent as the Signal Priority System can handle approximately 24 transit vehicles per hour through a particular intersection. Any more frequency and the signal priority cannot be guaranteed for each vehicle. This means that the capacity even in larger articulated vehicles would be constrained, demonstrating the need to use even higher capacity vehicles along this corridor.

For a relatively low cost of \$235 million (*KORVE Engineering, Wilshire Bus Rapid Transit Project Final Environmental Impact Report, 2002*), the travel time of 40 minutes is a substantial reduction of approximately 75% from the Pre Rapid time of 65-69 minutes and a 21-27% decrease in travel time over the existing Metro Rapid bus today. The Wilshire BRT performs greatly as an interim solution to providing higher quality transit capacity along this corridor. As a daily rider myself, I have seen the change in passenger demographics during the peak hours (*TMD, Appendix C Metro Rapid Before and After Passenger Surveys page 2,3*) Initially when the program started it was mainly patronized by service workers and students. However as time and the identification of the service has progressed it is not uncommon to see at least ¼ of the passengers in the morning peak hours in professional attire demonstrating the switch of automobile users to the Metro Rapid.

Conclusion

As has been demonstrated, the tremendous latent demand for faster and more reliable transit service will mean that the Wilshire BRT will reach capacity very quickly after its implementation. Due to physical road and transit vehicle capacity, street geometrics and at grade safety conflicts with pedestrians along the Wilshire Corridor, a grade separated higher capacity transit mode will need to be pursued. It is clear from the ridership and traffic congestion levels that buses alone will not be able to handle the latent demand for faster transit service along the boulevard and serious consideration will be needed to implement the Metro Rail Red Line west towards UCLA and eventually to Santa Monica.

REFERENCES:

TCRP Transit Capacity and Quality of Service Manual Part2. Bus Capacity 2001.

Padron, Manuel and Associates, Los Angeles Wilshire BRT Operations and Maintenance Plan, (pages 3-9) MDA 2002.

Transportation Management and Design, Inc. Final Report Los Angeles Metro Rapid Demonstration Program, (Pages 2-7) TMD 2002.

Los Angeles Department of Transportation, Transit Priority System Evaluation Report, (Pages 3,4,6) LADOT 2000.

Transportation Management and Design, Inc. Appendix C Metro Rapid Before and After Passenger Surveys, (page 2,3) TMD 2002.

KORVE Engineering, Wilshire Bus Rapid Transit Project Final Environmental Impact Report, (section 1-6) Los Angeles MTA, 2002.

LIST OF TABLES AND FIGURES

Table 1. AM Peak Period Metro Rapid Wilshire/Western <> Ocean Colorado Running Times

Table 2 Wilshire BRT Transit Corridor Mobility Improvements

Figure 1. Wilshire BRT running Speed Improvement over Existing Metro Rapid

Figure 2. Wilshire BRT Travel Time: Wilshire/Western to Santa Monica Pier with BRT components

Figure 3. Wilshire Boulevard Average Peak Period Bus Speeds by segments.

Table 1. AM Peak Period Metro Rapid Wilshire/Western <> Ocean Colorado Running Times

AM PEAK Metro Rapid Wilshire/Western <> Ocean/Colorado Running Times									
Time: 8.12		Time waited for bus:							6 min
Wilshire Blvd heading west	Secs to bus stop	Distance (miles)	Station to Station speed	Dwell time secs	Overall travel speed	Pass engers	Total Travel Time secs	Comments	
Western	0	0		77		81		P&D	
Crenshaw	102	0.87	30.7	49	17.5	80	179	P&D	
La Brea	145	1.14	28.3	56	21.2	77	194	P&D	
Fairfax	177	1	20.3	49	15.5	80	233	P&D	
La Cienega	178	0.87	17.6	39	13.8	72	227	P&D	
Robertson	145	0.61	15.1	35	11.9	68	184	P&D	
Beverly	169	0.73	15.6	21	12.9	60	204	P&D	
S'Monica Blvd	177	0.61	12.4	50	11.1	57	198	P&D	
Westwood	221	2.27	37.0	54	30.2	50	271	P&D	
VA Hospital	201	1.04	18.6	39	14.7	48	255	P&D	
Barrington	145	0.5	12.4	11	9.8	41	184	P&D	
Bundy	189	0.71	13.5	12	12.8	36	200	DO	
14th	187	1.65	31.8	12	29.8	27	199	P&D	
4th	189	0.87	16.6	23	15.6	19	201	DO	
Ocean/Col.	234	0.87	13.4	0	12.2	0	257	DO	
TOTAL/ AVERAGE		13.7	20.2	37.6	15.5	56.9	194.9		
Kilometers/ TOTAL MINUTES		22.0	32.4	8.8	24.8		49.8		

Table 1 shows the AM peak period run times analysis of the Metro Rapid from Wilshire Western to Santa Monica Pier. The Total/Average tallies the total distance, average station to station speed, average dwell per station in seconds, average overall running speed, average passenger load per bus and average overall station to station run time in seconds. Kilometers/total Minutes converts all those speed averages to kilometers and totals the dwell and run times in minutes.

Table 1. AM PEAK Eastbound

AM PEAK Metro Rapid Wilshire/Western <> Ocean/Colorado Running Times									
Time:8.03am		Time waited for bus:							5 min
Wilshire Blvd heading east	Secs to bus stop	Distance (miles)	Station to Station speed	Dwell time secs	Overall speed	Pass engers	Total Travel Time secs	Comments	
Ocean/Col.	0	0		22		8		PO	
4th	174	0.87	18.0	39	16.0	11	196	PO	
14th	145	0.87	21.6	29	17.0	16	184	PO	
Bundy	274	1.65	21.7	23	19.6	23	303	PO	
Barrington	201	0.71	12.7	13	11.4	29	224	P&D	
VA Hospital	178	0.5	10.1	42	9.4	29	191	P&D	
Westwood	164	1.04	22.8	59	18.2	34	206	P&D	
S'Monica Blvd	301	2.27	27.1	45	22.7	41	360	P&D	
Beverly	179	0.61	12.3	26	9.8	45	224	P&D	
Robertson	198	0.73	13.3	29	11.7	49	224	PO	
La Cienega	149	0.61	14.7	24	12.3	50	178	P&D	
Fairfax	132	0.87	23.7	33	20.1	56	156	P&D	
La Brea	119	1	30.3	64	23.7	52	152	P&D	
Crenshaw	109	1.14	37.7	57	23.7	60	173	P&D	
Western	132	0.87	23.7	74	16.6	39	189	P&D	
TOTALS/ AVERAGES		13.7	20.7	36.1	15.4	35.9	197.9		
Kilometers/ TOTAL MINUTES		22.0	33.1	9.7	24.6		49.3		

Codes for station activity			
Code		Code	
NS	Did not stop at station (no customers)	BC	Bus at Capacity (drop off and pick up)
PO	Picked up passengers only	FB	Full Bus (drop off only)
DO	Dropped off passengers only	BPS	By passed station (bus overloaded)
P&D	Picked up and dropped off passengers	FP	Few Passengers on bus
OWFNB	Overloaded-wait for next bus	CR	Congested Road
WHL	Wheelchair Boarding	MPE	Most Passengers Exit

Table 2 Wilshire BRT Transit Corridor Mobility Improvements

*BRT elements include stations and vehicles.

** Metro Rail has an average speed of about 33 mph/53kph

Shaded stations show where the greatest impact would be seen with each improvement.

WILSHIRE BRT TRANSIT CORRIDOR MOBILITY IMPROVEMENTS							
From Western Station to	LOCAL BUS/ PRE RAPID	CURRENT METRO RAPID	METRO RAPID WITH COMPATIBLE SIGNAL PRIORITY	BRT ELEMENTS*	BRT PEAK PERIOD LANE	METRO RAIL EXTENSION**	DISTANCE BETWEEN STATIONS
Crenshaw	12.20	16.5	16.5	21.41	21.6	33	0.87
La Brea	12.05	16.3	16.3	21.15	21.4	33	1.14
Fairfax	13.80	17.9	17.9	21.53	21.7	33	1
La Cienega	13.49	17.5	19.6	23.57	24.0	33	0.87
Robertson	9.70	11.6	13.0	15.64	17.5	33	0.61
Beverly	9.90	11.9	13.3	15.97	17.9	34	0.73
S'Monica Blvd	8.98	10.8	12.1	14.48	16.2	33	0.61
Westwood	18.93	24.2	24.2	29.08	29.7	33	2.27
VA Hospital	8.76	12.0	12.0	15.60	17.5	33	1.04
Barrington	9.40	12.0	12.0	15.64	17.2	33	0.5
Bundy	10.30	13.2	13.2	15.82	17.4	34	0.71
14th	13.20	15.8	18.2	21.86	22.1	33	1.65
4th	13.89	16.7	19.2	23.00	23.2	33	0.87
Ocean/Col.	12.77	15.3	17.6	21.15	21.4	33	0.87
Average Speed	11.96	15.1	16.1	19.7	20.6	33	13.74
Travel Time	69.0	54.5	51.3	41.8	40.0	25.0	
include 60' low floor alternative fuel Articulated Vehicles, Enhanced							

Figure 1. Wilshire BRT running Speed Improvement over Existing Metro Rapid

The BRT elements stations and vehicles will have the greatest impact on travel speeds due the dramatic reduction in dwell time.

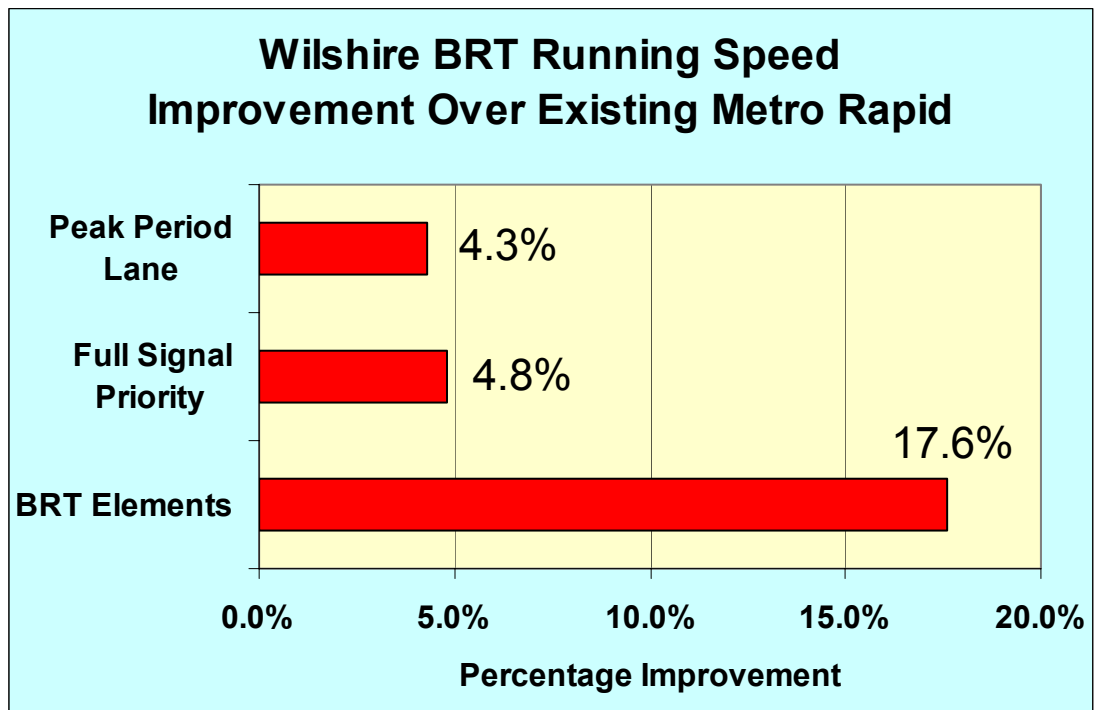


Figure 2. Wilshire BRT Travel Time: Wilshire/Western to Santa Monica Pier with BRT components

The Wilshire BRT will reduce run times from 50-55 minutes to 40-42 minutes. Almost 9 minutes is attributed to the stations and vehicles.

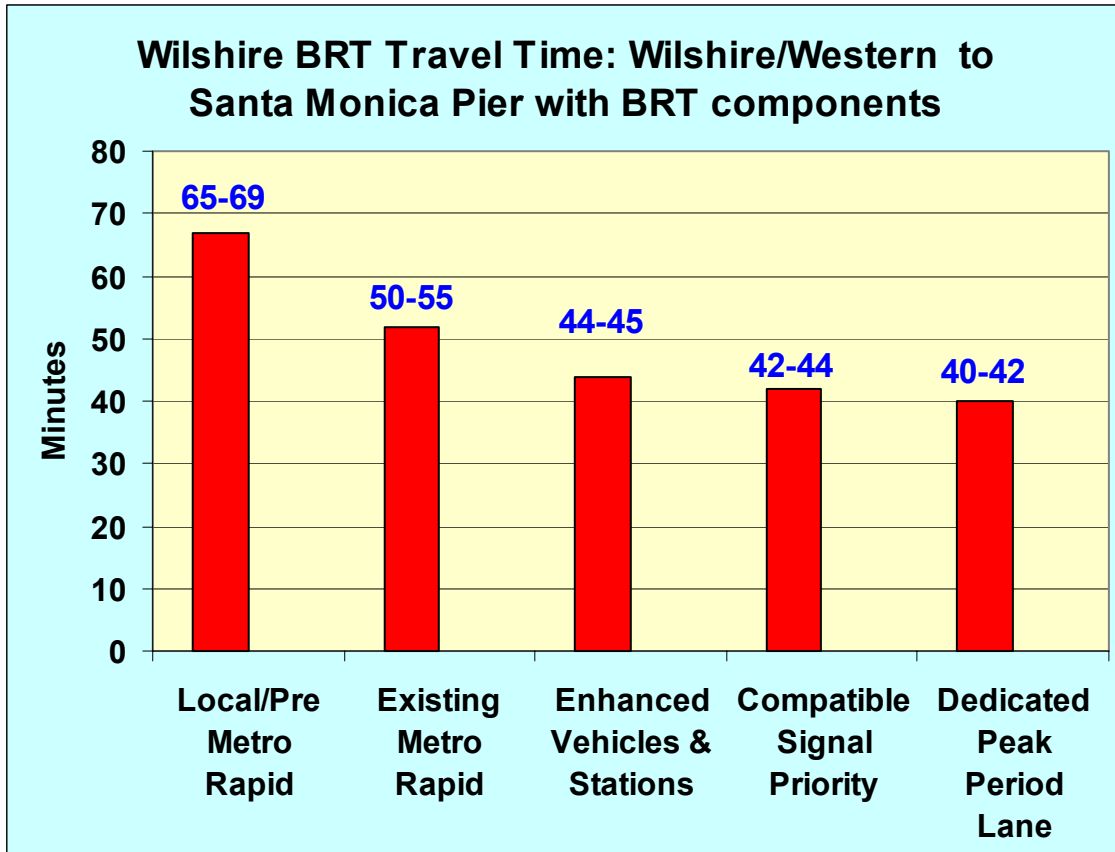


Figure 3. Wilshire Boulevard Average Peak Period Bus Speeds by segments.

Travel speeds vary greatly across the corridor, this is due in part to land uses, street capacity and street geometrics. The Westwood area and Beverly Hills business Triangle areas have the slowest speeds and would benefit the greatest with the BRT components. Average Travel speeds would improve over 25% in these areas alone.

Wilshire Bus Speeds Average Peak Period

