THE FUTURE FOR TRANSIT IN THE SAN FERNANDO VALLEY

A Presentation to the

VALLEY TRANSIT SUMMIT

by

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EXECUTIVE SUMMARY

As it becomes more and more apparent that the schedule for a meaningful East-West San Fernando Valley rail line is now decades in the future, if it will -- or should -- ever be built at all, the time has come to begin to make decisions as to what can be done to improve transportation options for the Valley residents, workers, and businesses here and now. These transportation decisions should be based on what can be done, and done quickly and effectively, rather than focusing on heavily promoted projects with little useful transportation purposes, that the area cannot afford in any case.

The current San Fernando Valley public transit network has become less and less useful to the residents, workforce, and institutions in the Valley. For at least the better part of two decades, most of the focus on Los Angeles County transit improvements has been on expensive rail projects that would have provided almost no meaningful transportation or economic benefits. It now appears that there will not be any East-West Valley rail line for decades, if ever, and that the funds that could have been used for improvements in the Valley and in other areas of the County were squandered on marginal rail projects in the central area of the County -- projects that were planned poorly and then implemented even more poorly.

"Rubber Tire" Guideway projects, such as the "Surface Metro" system in Curitiba, Brazil, can be of real value to the Valley -- *but only as part of a comprehensive transportation/transit strategy and plan*. Other vital components of such a plan should include:

- Expansion and improvement of the existing fixed route bus system

- An emphasis on innovative transit solutions to better serve today's "every trip going from and to a different place" Valley travel patterns, including:

  - Circular small bus/van services to serve as feeders and distributors to the "line haul" segments of the system and to provide better neighborhood accessibility
  - Smart shuttle and subscription transit services
  - More emphasis on provision of transit services with minimum governmental involvement in service provision -- but with technical and *limited* financial assistance

to help jump start entrepreneurial transit services for the transit-dependent by the transit-dependent
- •• An expanded high-occupancy vehicle (HOV)/high-occupancy toll (HOT) lane network, including, to the extent possible, better interconnectivity between HOV/HOT lanes on intersecting freeways and expanded lane entrances and exits
- •• Changes to laws and regulations to encourage employers and business to encourage their employees and customers to make more use of transit
- •• Increases in ridership through implementation of a fare pricing strategy
- •• Most important, the implementation of all of the above, and other elements, as components of an integrated transportation system offering ease and economy of use a "seamless" appearance to riders

This paper presents an overview of the current Valley transit situation and recommendations for improvements in three parts:

- The Current Transit Situation in Los Angeles County and the San Fernando Valley

- The Curitiba Bus System and Differences Between Curitiba and Los Angeles County

- The Potential to Convert the Burbank/Chandler Rail Line Into a "Rubber Tire" Guideway (including an appendix discussing the application of Curitiba busway concepts to Los Angeles)

THE CURRENT TRANSIT SITUATION IN LOS ANGELES COUNTY AND THE SAN FERNANDO VALLEY

First, some basic truths about transportation and public transit in the U.S., and particularly in Los Angeles County:

- Mass Transit is largely the means of transportation of last resort, used predominantly by individuals and classes who are transportation-disadvantaged due to economic status, age, and/or physical condition. Largely because Mass Transit is publicly financed, and because many of the users have little real political power, the bus transit system in Los Angeles has been described as, "Third class service for third world riders."

  This condition is far more advanced in Los Angles than in almost any other U.S. city. The use of mass transit, particularly MTA bus service, by White riders, is far lower in Los Angeles than in anyplace else in the U.S.

- Mass Transit cannot, of and by itself, make any significant contribution to reducing overcrowding on freeways and surface streets. Carrying well under 5% of daily trips in the

County, even a doubling of mass transit usage over the next decade would not even keep up with the expected growth in trips from the population and economic growth.

Any strategy predicting that mass transit improvements will result in improvements to existing surface travel conditions for any significant group of current automotive travelers is doomed to failure before it begins. At best, Mass Transit can slow the rate of decline somewhat and make some contributions to more comprehensive transportation improvements.

- Improvements in Mass Transit can, however, significantly improve mobility for the transit-dependant by providing improved access -- serving more trip origins and destinations, more frequently, over longer hours of service, with higher travel speeds and a higher ride quality, at a lower cost to the rider. Such transportation improvements can be of vital importance to the upward mobility of such residents by providing access to jobs, schools, medical services, and social, cultural, and religious events.

  In short, transit is not a significant factor in decreasing surface transportation traffic congestion. It can be a major factor in increasing mobility for a significant portion of the community.

- Mass Transit has virtually no measurable impact on air quality. A strategy to improve air quality by attempting to convert current automobile riders into transit users will produce little, if any, impact on air quality -- particularly if it is targeted towards upper income drivers, who generally drive the "cleanest" cars.

  Mass Transit's primary air quality impact is in keeping very old, very dirty autos off the streets. Where Mass Transit options do not exist, marginally transit dependent riders are forced to drive, using the only vehicles they can afford -- largely older, worn out vehicles in very poor mechanical condition. Such vehicles can be 100 or even a thousand times dirtier than current technology automobiles.

- Mass Transit in the U.S. is, at present, almost entirely a taxpayer-subsidized, government-operated service, with only the most productive transit operators covering more than one-third of the total cost of providing services from operating revenues

- The least expensive transit ride to operate is that for the most transit-dependent riders. By definition, these riders are transit-*dependent* -- they have no real choices and, therefore, will put up with extremely overcrowded, unreliable service, with multiple slow transfers, transit operated at the convenience of the operator, with high fares, and objectional ride quality.

  The most expensive transit ride to operate is that for choice riders. The service must be of high quality -- going from where the rider is to where (s)he wants to go, when (s)he want to go, with little or no wait time for transit vehicles to arrive, traveling at high rates of speed, with guaranteed seats, at low fares, at close to 100% reliability, and free from objectionable service conditions. If the transit operator does not offer all of the above, then the choice rider will likely exercise his/her choice for the automobile. Choice riders will simply not use transit unless it provides a significantly better transportation solution in at least one key area that is of vital importance to the rider and unless it does at least passably well in most other areas important to the rider.

As a result, service to choice riders can be ten times, or even, in a few cases, a hundred times, more expensive to the taxpayers to operate than service to the transit-dependent. In such a circumstance, if the primary objective is to increase transit ridership, it is obvious that the most cost-effective and productive way to do so is to concentrate first on serving the transit dependent. This can be done by improving the quality of service and by decreasing the price of service to the customer. As service improves in quality, more marginally transit dependent riders will begin to be attracted to transit. If service improves sufficiently, eventually marginal choice riders will also shift to transit.

- The Los Angeles County Metropolitan Transportation Authority's Long-Range Transportation Plan is widely (and correctly) viewed as a bad transportation plan that cannot be implemented -- and, to the extent that implementation is attempted, MTA's ability to do it successfully, based on past experience, is highly questionable.

  Currently, the Plan's problem focus is largely on financial limitations. In brief, the financial situation is not as bad as it seems -- it is worse -- and MTA is taking no effective steps towards improvement. (For those few individuals that believe that improvements in MTA's financial situation may result in the East-West Valley line being constructed any earlier than MTA is now predicting, there are some very large financial skeletons in MTA's closet that have not yet been publicly addressed.)

  The principal problem is *not* lack of revenue -- MTA is one of the "richest" governmental transportation agencies of its type in the world. The problem is that most of the resources are being directed towards projects that have little or no valid transportation purpose, at the expense of projects that even MTA's own analysis show are far more productive and cost-effective. In MTA's 1995 Long Range Plan ("A Plan for Los Angeles County: Transportation for the 21st Century," March 1995), virtually every rail line studied was badly beaten by every other project considered in terms of mobility improvements and cost-effectiveness of mobility improvement (most of the rail projects did beat some bikeway projects). Despite this, the Plan projected spending over 60% of transit subsidies for rail projects, which, in the final year of the Plan, when the maximum amount of rail lines would be in service, would carry fewer than 20% of the County transit trips. From MTA's own Plan, bus was almost ten times as cost-effective in carrying passengers than rail.

- One of the great challenges facing transit planners today is that travel patterns have changed radically and are continuing to change. The old emphasis on travel to the central business district in the morning and back in the evening is simply at odds with the real world of Los Angeles. Unfortunately, virtually all of our transit planning over the past several decades has been on how to better serve downtown.

While the Los Angeles CBD is currently the largest single area of employment in the greater Los Angeles urbanized area (UZA), it contains fewer than 6% of total UZA. While it is projected to continue to grow, it is attracting fewer than one in thirty of new jobs in the UZA, which means that its significance as a job site will continue to fall in the future. All the emphasis on renewing downtown Los Angeles, and the huge public sector expenditures to support this city planning approach, can only limit the extent of the decline. There will always be a downtown, but its importance as the center of the City will continue to decline over time.

In the Valley, while there are certainly many residents that work "downtown," there is far more employment in the Valley proper and in other non-CBD areas, such as Hollywood, the West Side, Pasadena, and around LAX. Within the Valley proper, the high job concentrations are in Warner Center, Glendale, Burbank, along Ventura Blvd., and in the Van Nuys Government Center area, to name just a few. To see how difficult it is to provide good access to all of these, try to connect more than two high transportation destinations with a single transportation line -- while not impossible, the limitations of service design are obvious.

Los Angeles is simply far more spread out, both in residency and job patterns, than any other U.S. UZA. The following graph is a comparison of UZA populations and their CBD commercial square footage in 1980, the year that the passage of Proposition A, the original ½¢ sales tax referendum committed Los Angeles County to build a rail system. It shows that for every U.S. City *except* Los Angeles, the UZA population was an almost perfect predictor of commercial square feet in the UZA[1].

However, when the results of that close to perfect regression line were applied to the greater Los Angeles metropolitan area, the result was a 335% error rate -- it predicted that, based on the UZA size, the Los Angeles CBD have 348 million square feet, while there were only 80 million.

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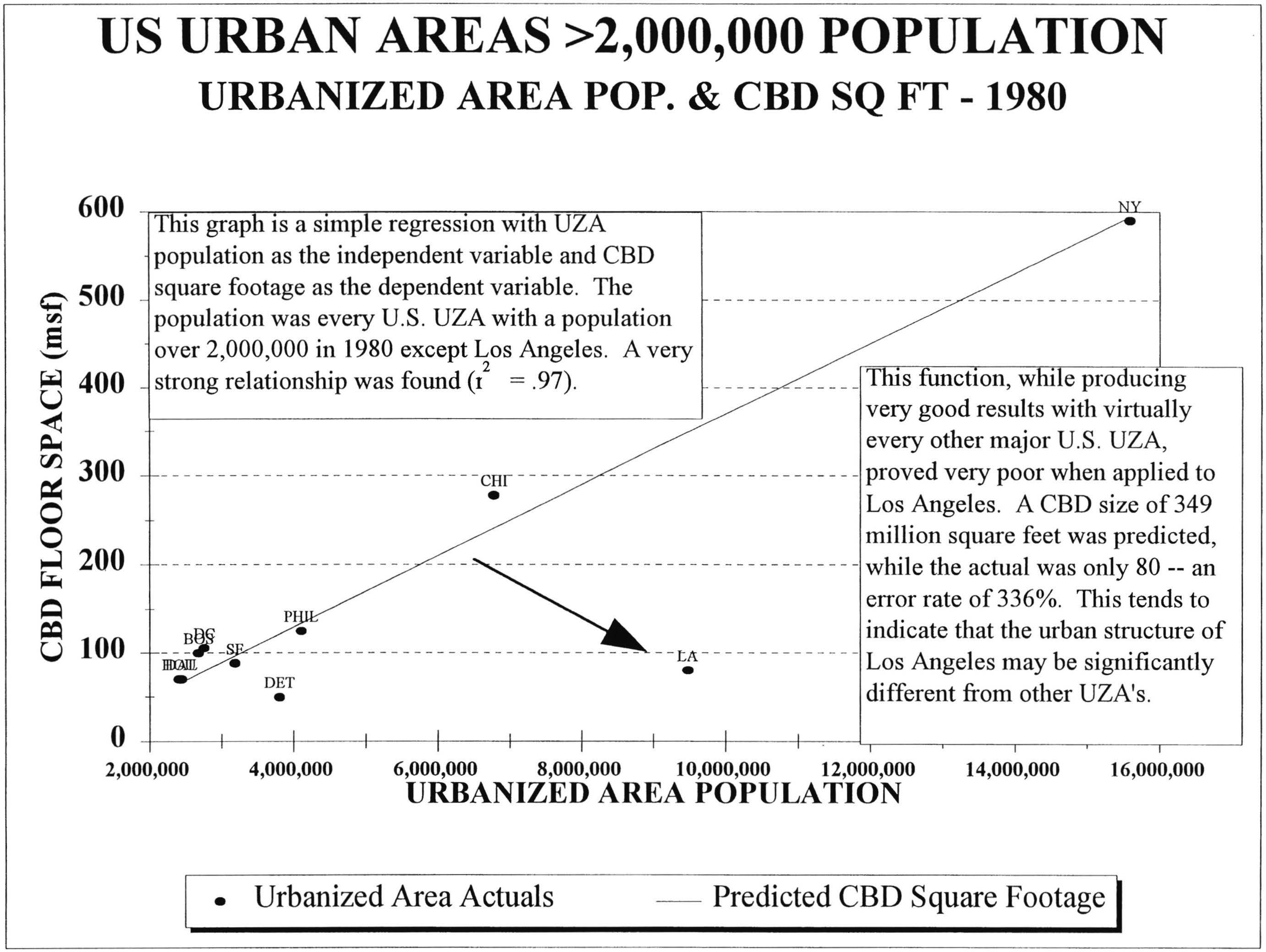
1 For the statisticians, a simple regression analysis produced a coefficient of determination (r^2) of .97, which can be interpreted as meaning that the UZA population is an extremely good predictor of the CBD commercial square footage, explaining approximately 97% of its value by itself. While the "real" predictive value is not quite that high, for various reasons I will not go into here, both simple logic and application of the "eyeball" test ("From the graph, it looks like a good relationship to me.") strongly support the validity of the population:CBD square footage hypothesis.


US URBAN AREAS >2,000,000 POPULATION
URBANIZED AREA POP. & CBD SQ FT - 1980
This graph is a simple regression with UZA population as the independent variable and CBD square footage as the dependent variable. The population was every U.S. UZA with a population over 2,000,000 in 1980 except Los Angeles. A very strong relationship was found (r^2 = .97).
This function, while producing very good results with virtually every other major U.S. UZA, proved very poor when applied to Los Angeles. A CBD size of 349 million square feet was predicted, while the actual was only 80 -- an error rate of 336%. This tends to indicate that the urban structure of Los Angeles may be significantly different from other UZA's.
CBD FLOOR SPACE (msf)
600
500
400
300
200
100
0
NY
CHI
PHIL
DC
BOS
SF
DET
LA
2,000,000
4,000,000
6,000,000
8,000,000
10,000,000
12,000,000
14,000,000
16,000,000
URBANIZED AREA POPULATION
Urbanized Area Actuals
Predicted CBD Square Footage

The problem is not that Los Angeles has a small downtown -- in absolute terms, the 1980 CBD size was seventh largest. The problem is one of density -- compared to the average of its peers, for every 100 people in other who want to travel to downtown, there are only 23 in Los Angeles. This obviously makes implementing a classic, 1960's-style, suburb-to-downtown subway system somewhat than a meaningful contribution to the Los Angeles transportation system -- especially since, since 1980, the important of the Los Angeles CBD to the UZA has declined considerably.

- Despite what its promoters have been saying for decades, rail is not necessarily faster than bus -- in fact, in many cases, it is significantly slower when total travel time is taken into account.

  To give a very real example of bus vs. rail transit for Valley residents, consider a trip from Universal City to the main elevator lobby of the County of Los Angeles Hahn Administration Building in the Los Angeles downtown Civic Center. A rider, like myself, who used to make this trip by using buses on Line 424-Ventura Blvd. to downtown express, found it took from 17 to 27 minutes to make this trip by bus. At the time I usually made it, just before the morning rush hour, it took 19 minutes by the MTA schedule.

  After the Red Line is completed to the Valley, the current plan is for the 424 to terminate at Universal City and all riders will transfer to the Red Line to complete their trips. The travel time from Universal City *will increase to 39 minutes* -- for my trip, it would take over twice a long.

  The reasons that the Red Line trip is slower are the times required for (for the 20 minute trip difference):

••	The bus to travel to the bus:rail transfer station	1 minute
••	The walk from the bus drop-off point to the station entrance	1
••	The walk from the station entrance to the station platform	2
••	The wait for the train to arrive and depart[2]	3
••	The longer distance the train travels over that of the bus[3]	6
••	The slower speed of the train[4]	3
••	The walk from the station platform to the station entrance	2
••	The longer walk from the rail station than from the bus stop	2
	Total Increase	20 minutes

While the Red Line is likely to be faster than the 424 for certain trips to certain locations at certain times of day, the Red Line is likely to, at best, no faster than the 424 for most future riders, even considering future slowdowns in Hollywood Freeway travel speeds.

This is not at all an unusual situation -- rail is slower than bus for many common trips, especially in Los Angeles, where the time to access the train and get from train stations to travelers ultimate destinations can be so important.

- One of the most common myths about transit in Los Angeles is, of course, "No one in Los Angeles uses transit."

The truth is, the MTA/Southern California Rapid Transit District bus system is the most overcrowded of all major U.S. bus systems, by far, and has been every year since the Federal government began collecting data in the late 1970's. The following graph shows average passenger load -- the average number of riders on each bus.

The "winning margin" is even more impressive when one considers that MTA operates an extremely high level of service in the mid-day, evening, "owl," and weekend/holiday periods -- MTA actually carries more passengers on its buses during off-peak periods than many major transit operators do during their peaks.

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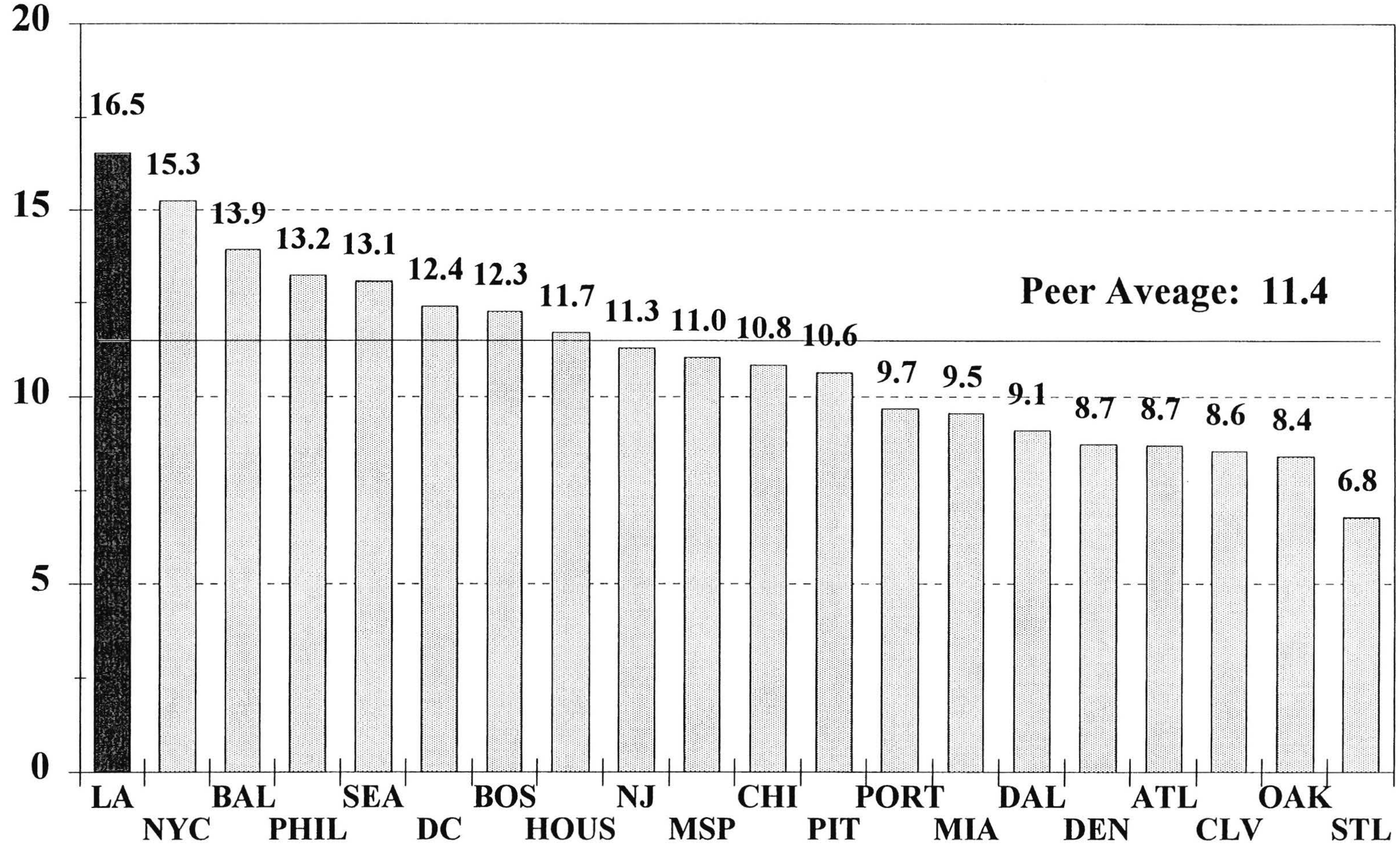
2 With a peak period "headway" (time between trains) of six minutes, the average wait for a train to depart will be half that, or three minutes.

3 The Red Line travel distance is 11.9 miles, vs. 9.5 miles for the 424 buses on the Hollywood Freeway.

4 The Red Line travel time is calculated based on an average operating speed of 27 miles per hour, which is probably faster than it will actually achieve. The 424 operated at approximately 34 mph on the trip described.

"TOP 20" BUS TRANSIT OPERATORS -- 1995
AVERAGE PASSENENGER LOAD



What is actually going on here is not so much that MTA bus service is so highly utilized as MTA is simply not providing very much service to the residents of its service area, relative to its peers. It is particularly deficient in peak-period service.

- Another "myth" is that MTA fares are too low -- especially after the Consent Decree in *Labor/Community Strategy Center et al v. MTA* forced MTA to roll back much of its proposed fare increase. However, as the following graph shows, on a cost-of-living-adjusted basis, MTA has one of the lowest subsidies per passenger mile in the industry. In other words, the taxpayer's share of moving a bus rider one mile is significantly lower than all but two of its peers (and the New York City Transit Authority's low score, and much of Honolulu's advantage, appears to be due, in large part, to flukes in the cost-of-living-index).

- In Los Angeles, Rail covers a far lower portion of the cash costs of modal service than does bus. Costs include operating costs and the cash for debt service payments for outstanding debt utilized to build rail lines, buy buses, etc., which, while it is cash out the door, is generally ignored by rail proponents.

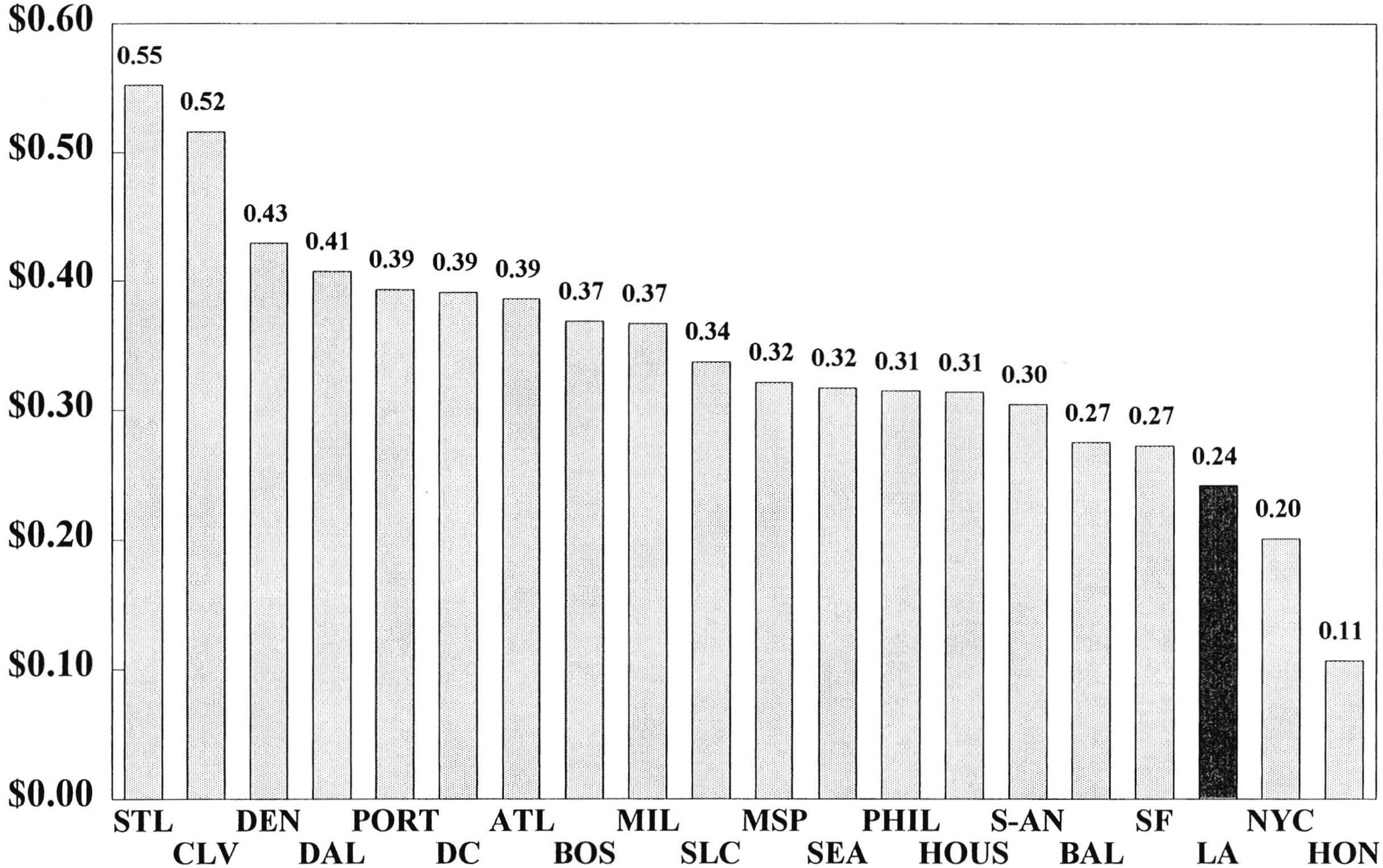
  While the recovery ratio shown for the Red Line will likely increase significantly as it is expanded and ridership increases far faster than cash costs, the Blue Line has been operational since 1990 and is cannot carry significantly more riders. While the Green Line has only been operating for a little more than a year and has substantial unused capacity, it is simply unlikely that Green Line ridership will increase significantly.

  Actually, on a practical basis, the recovery ratios shown for the rail lines are significantly overstated. Until recently, the costs of ticket sales and fare inspection on the rail lines exceeded the cash collected. MTA is probably still "losing money" on Green Line fare collection.

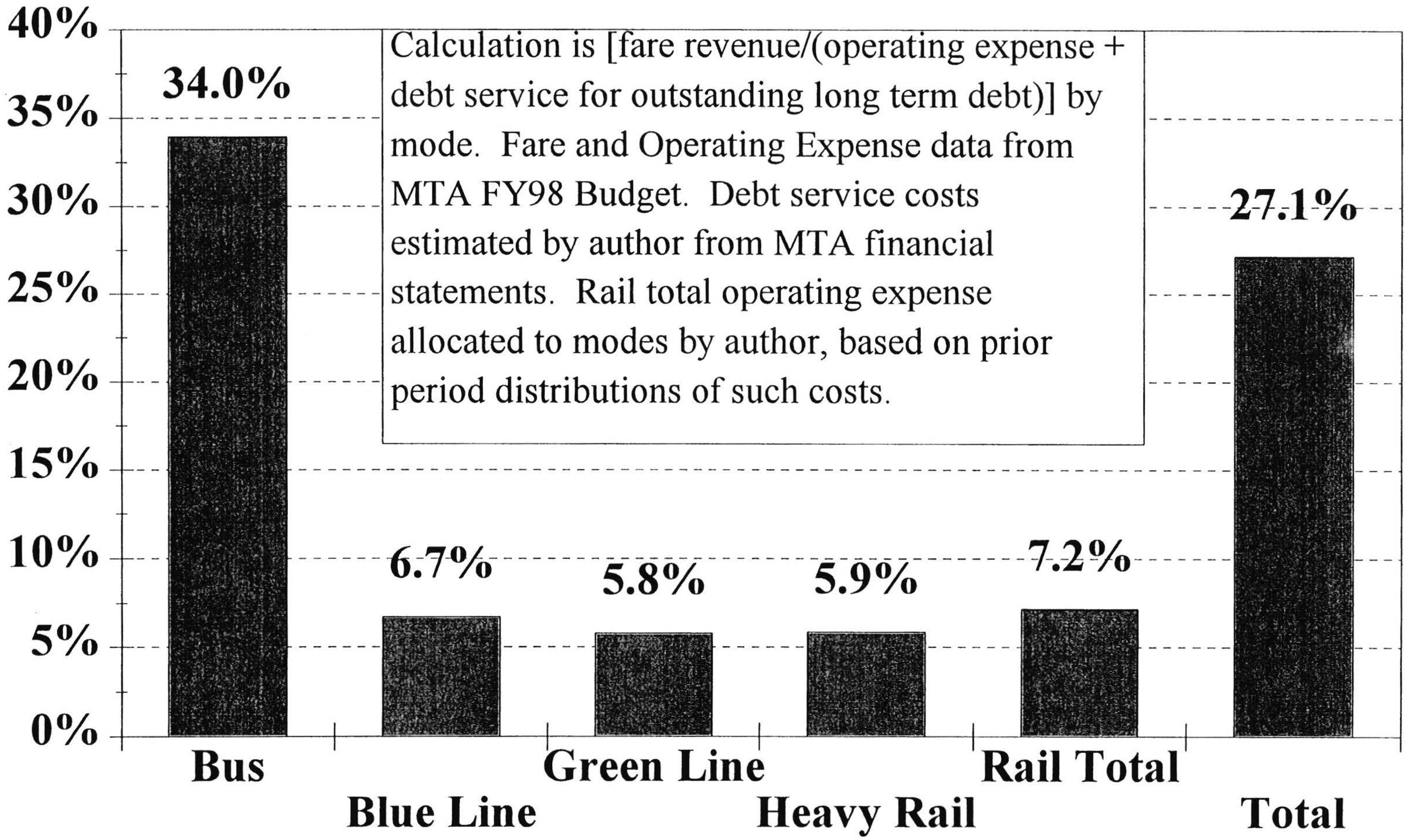
- One of the biggest problems in Valley Transit is that, on many measures, ridership is lower in the Valley than on the other side of the hills and, therefore, the Valley does not get as much bus service hours allocated.

  The next graph shows the average passenger load for various Valley and Los Angeles Central area lines. While several of the Valley lines -- particularly the two main express lines from the Valley to and from downtown, the 420 and 424, and some of the main East-West lines -- have high utilization of the service operated, there are many Valley lines that simply have far less ridership than many of the central area lines, many of which are among the most heavily utilized bus lines in the nation. Many Valley lines actually have high ridership compared to national standards, but simply cannot compare to lines such as the 20-Wilshire and 204-Vermont, which in past years have been the number one and two heaviest utilized bus transit lines in the nation.

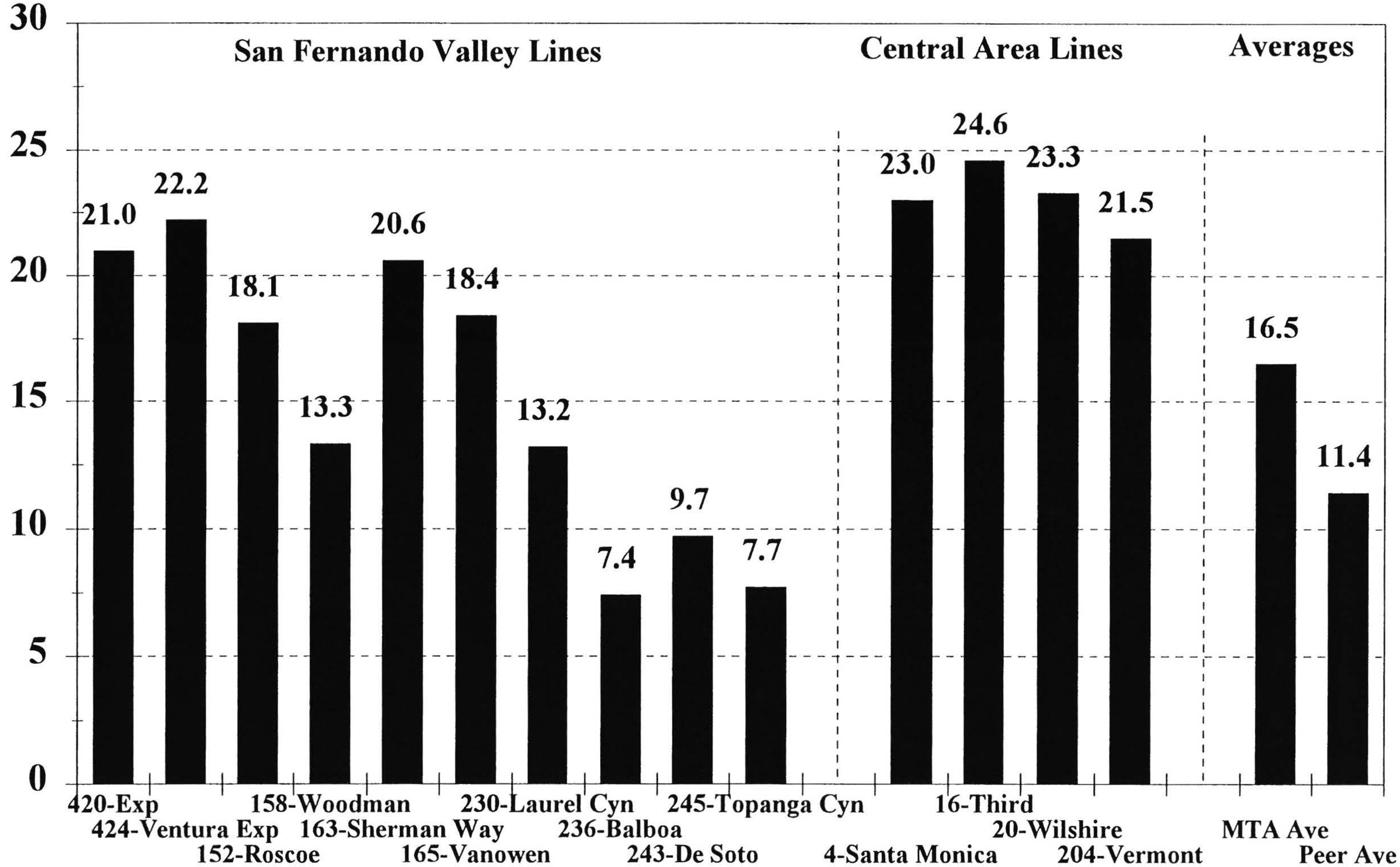
"TOP 20" BUS TRANSIT OPERATORS -- 1995
COST OF LIV ADJ SUBSIDY/PASSENGER-MILE



LA Co. METRO TRANSPORTATION AUTHORITY MODAL FARE/CASH EXPENDITURES -- FY98



AVERAGE PASSENGER LOADS
MTA BUS LINES -- Fiscal Year 1996



Many of the Valley North-South lines are simply too short -- the "flat" section of the Valley, where conventional bus transit can be operated, is only about seven miles wide -- to develop high levels of ridership.

As a result, in an area as chronically underserved for bus transit as Los Angeles, when decisions have had to be made between reducing bus service -- and MTA has reduced the service miles it operates by almost 20% since 1991 -- the Valley has often fared less well than other areas with higher existing ridership. The graph on the following page showing the ten year time series for Line 424 (Ventura Blvd.-Downtown Los Angeles Express) demonstrates the results. Bus trips, hours of service, and riders are all significantly down, with much of the decline over the past year.

For many of the local lines in the Valley, the level of service has fallen to the point where transit is simply not viable as a transportation option for many users. Many lines operate on hourly headways during most of the day, with service that stops service very early in the evening on weekdays, and little weekend/holiday service. Since the basic Valley route structure is a "grid" of intersecting North-South and East-West lines at approximate one mile intervals, there are large numbers of trips that require a transfer between two (or even three) buses. Since it is impossible to schedule the North-South and East-West lines to provide for easy transfers at all intersections simultaneously, it is easily possible for a round trip passenger who requires two buses each way to spend two hours -- or more -- simply waiting for hourly headway buses to arrive.

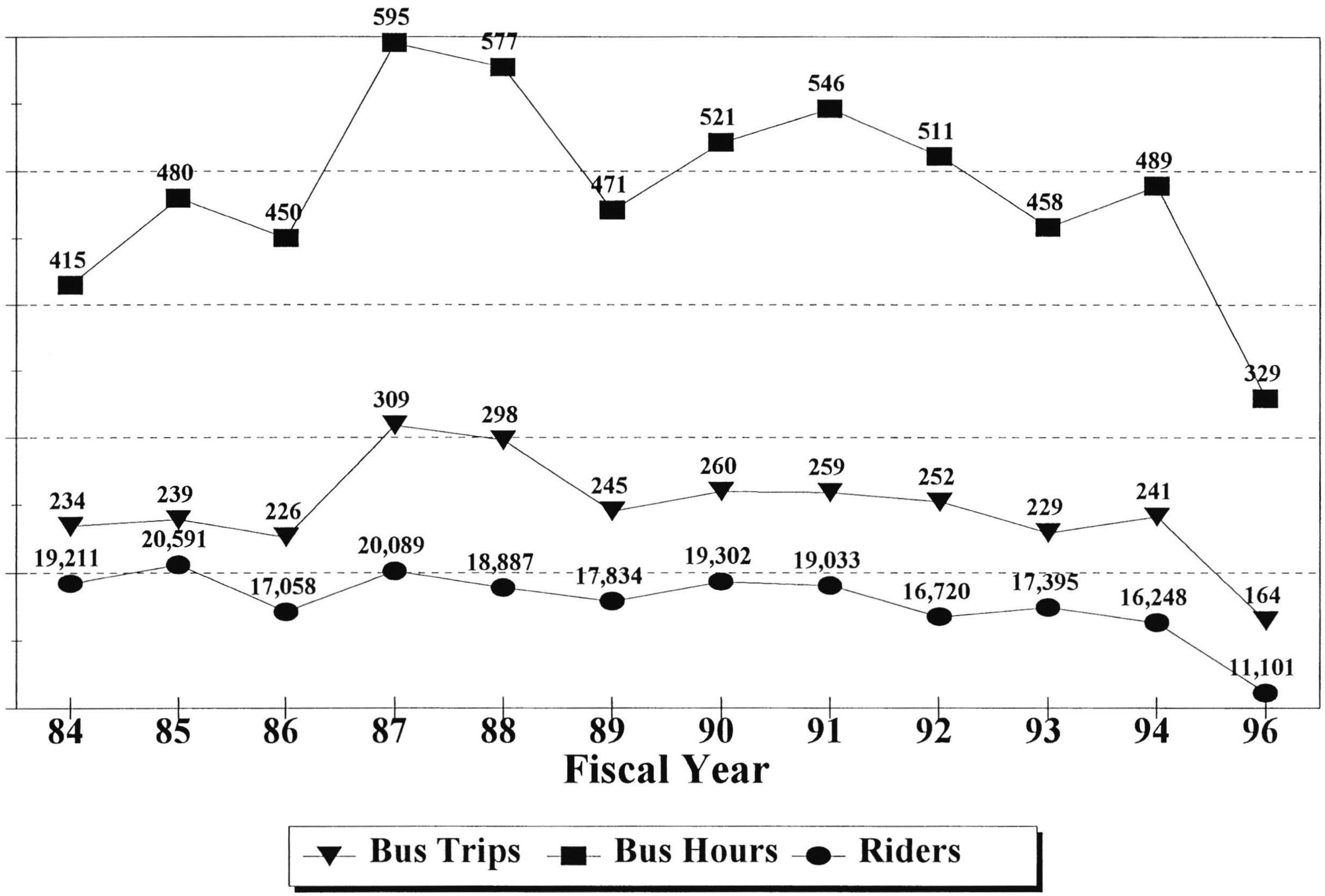
The short hours, many lines with the last run at approximately 7:00 p.m. or even earlier, mean that many potential passengers cannot use transit for home-to-work trips because they cannot get home at night on the bus.

The impact of these problems are compounded when their effects are compounded. For example, because the long transfer times between many lines, it can be difficult for many individuals to make their transfers to the last run on a second line after the end of their normal work day. And if a bus runs late, or a run is missed on a line, the result can be an additional hour of delay for the next bus on the second line -- or a long walk home.

It is dangerous to overall simplify solutions to the current shortage of transit usage in the Valley, but one option that should be considered is simply adding a significant amount of service to the existing bus lines -- cutting headways to no more than 30 minutes and running later at night and more often on weekends.

Another well-proven technique is "timed transfers" -- in brief, all buses in an area arrive at a common point at the same time to allow passengers to make cross-connections. While MTA has attempted to implement such facilities in the recent past, it has run into problems -- in one example in the Valley, neighborhood opposition prevented such a schedule that had the potential to greatly reduce total transit time for many existing and potential transit riders.

Line 424 Ventura Blvd-Downtown L.A.
Weekday Bus Trips/Bus Hours/Ridership



THE CURITIBA BUS SYSTEM AND DIFFERENCES BETWEEN CURITIBA AND LOS ANGELES COUNTY

Recently, there has been a great deal of interest in applying lessons learned from the extremely impressive and successful bus transit system in Curitiba, Brazil to the Valley, particularly the express busway "Surface Metro" system, which Curitiba has developed as its heavy-duty, main line transit guideway instead of a subway system. As a member of the Curitiba study tour, and a long-time "rubber tire" transit advocate for Los Angeles County, I was extremely gratified to witness first hand what could be achieved by the application of relatively small amounts of money -- virtually none derived from taxes -- in an inspired and effective way. There are undoubtedly many valuable lessons from Curitiba that can, and should, be applied locally.

However, the reasons that the Curitiba bus system has been as successful as it has is that it has been carefully customized to the existing conditions in Curitiba. There are many extremely significant economic, political, geographic, and cultural differences between Curitiba and Los Angeles County, and any attempt to apply Curitiba technologies and methodologies to the San Fernando Valley without recognition for these differences is doomed to failure from the start.

It is important, therefore, to understand some of the more important differences between these two areas:

- Curitiba's transportation and transit systems are not stand-alone networks, they are vital, integrated components of the overall urban plan for the area. To cite just one example, the shaping of Curitiba's urban form has been well structured to work with transit, and transit to make the shaping of the city work. Along much of the alignments of the busways, zoning mandates high-rise residential construction, which is largely forbidden in other areas of the city. As a result, the busways have a high, built-in ridership within a few blocks, and the residents of the high-rises receive excellent transportation to most of the important destinations in Curitiba.

  I invite the reader to contrast the Curitiba urban form to that of the San Fernando Valley.

- Current day Curitiba is the product of an excellent city plan, began at a most auspicious time in the development of the area, and executed in an excellent manner. Again, the history and practical politics of Southern California are simply very different from those in Curitiba.

  - Curitiba has grown from a relatively compact regional center city of 361,000 in 1960 to 2.1 million in 1990, with projections for the year 2000 of approximately 2.8 million (population figures for the metropolitan area, including areas outside of the City of Curitiba proper). The original master plan was adopted in 1966, when most of the growth, and future form, of Curitiba, had yet to be. The practical implication of the city plan, therefore, focused the development of the *majority* of the city within a single political generation.

- •• An important factor in the development of Curitiba, compared to that of Los Angeles, has been the *lack* of the many protections built into U.S. and California statutes and case law. Quite simply, in Curitiba, projects do not have to wait for years to start while environmental impact statements are prepared and lawsuits heard in court.
- •• The Mayor who is given much of the credit for the development of the current structure of Curitiba (and who is currently the Provincial Governor and regarded as a leading candidate for the Brazilian Presidency) was originally placed into office by a military *junta.* An experienced architect and city planner with advanced concepts for the City, he had both outstanding ideas and the means to implement them. He was and is a true man of the people, with the ability to build excellent two-way communications with the populace. He developed a "band of brothers" (and sisters) to continue the planning and development of what he began. The success of his methods have been evidenced by his subsequent majorities in free elections, which would make Boss Tweed Hall envious.

  In short, Curitiba had the benefit of the leadership of a philosopher-king at a critical point in its history, with both outstanding ideas ready for implementation, and far fewer legal and political restrictions in implementing them than is the case in the U.S.
- •• Most important, not only was an excellent plan developed for Curitiba, it was actually followed. The rapid rate of growth of the past thirty years has meant that the planners had a very large canvas to paint -- and what a masterpiece they produced.

- In Curitiba, transit does not require major taxpayer financial assistance, it actually makes money (which is mainly reinvested into the transit system). Over its entire history, the Curitiba transit system has received virtually no taxpayer funding. This simple fact alone has made the development of the Curitiba bus system fare easier and simpler than would ever be the case in the U.S.

There are huge differences between Curitiba, in the period of the implementation of its transit system as it now exists, and Los Angeles County today. In Curitiba, we had the world champion parents who adopted an 18-month old child, who raised it with loving devotion to an outstanding child development plan, and the result was an Rhodes Scholar Olympic gold metal athlete. In Los Angeles and the San Fernando Valley, we have an overweight fifty-year old, who has smoked far too many cigarettes and consumed far too much alcohol for decades, who now has seriously high blood pressure and emphysema.

Bringing Los Angeles up to Olympic gold metal/Rhodes Scholarship levels at this point is so highly unlikely a result that it is an objective not worth pursing. We can, however, with intelligent application of proper techniques, and with the patient swearing off some old, very bad habits, make a significant improvement in the patient's condition that will lead to a healthy, productive life.

THE POTENTIAL TO CONVERT THE BURBANK/CHANDLER RAIL LINE INTO A "RUBBER TIRE" GUIDEWAY

The current MTA plan for transit improvements in the San Fernando Valley has three main elements:

- Conversion of the Burbank/Chandler East-West rail corridor -- which was first planned to be utilized for a light rail line, then a subway heavy rail line, and most recently as a non-surface level (but not necessarily entirely subway) heavy rail line -- as a "Rubber Tire" busway

- Improvement of the existing fixed route bus system

- Introduction of more non-traditional transit modes, including Smart Shuttles, circulator bus service, etc.

Close integration of the planning and operation of these is a vital part of the plan, as is integration with the other transportation modes in the area, including Metrolink services and the Red Line to North Hollywood.

I support the above concepts as the basis for Valley transit improvements. However, there is much work to be done to determine the details of what will should be implemented.

In my opinion, one the greatest potential mistakes that could be made would be to repeat the err of rail advocates in Los Angeles and other areas in the U.S., that of overpromising the impact of a single, high-visibility element of the overall plan, while de-emphasizing the all-important underlying basic, but far less glamorous, bus and related elements. At the same time, however, the public must be offered something that it can believe in and support -- and educating large elements of the populace in the details of a long-range transportation plan is far beyond the capabilities of the public sector policy makers and professional managers. The problem, therefore, is determining how to provide a simple to understand symbol that can help build public enthusiasm and support for a transportation plan without promising results that cannot be achieved. The problem is particularly severe in Los Angeles, where the public that has been thoroughly conditioned to believe the worst about any transportation plan for Southern California.

In this section of the paper, I will attempt to point out some of the practical aspects of the development of a workable transit plan for the Valley, based on the above elements, with the principle focus on the use of -- and the avoidance of the misuse of -- the Burbank-Chandler corridor.

Relative Importance of the Elements of the Valley Transit Plan

While all three of the above main points have much to offer the Valley, the relative priorities of each must be well understood in advance of plan implementation.

Of the three, the Burbank-Chandler guideway, while it has very important "glamor" and public interest potential, is actually the least important of the three -- and cannot be successfully implemented until the other two elements are significantly improved or inaugurated.

The heart of the Valley transit network for the foreseeable future will be conventional, fixed route, standard size buses. The non-conventional transit element will take years to build to its full potential and, even then, is unlikely to carry more than a fraction of the ridership of the fixed route buses.

There are two principle concerns the implementation of the guideway:

- It will be very difficult to convert it into transit corridor that will provide significant speed advantages over existing fixed route bus service for East-West travel in the Valley and, without speed advantages, it will not be attractive to potential riders. As we shall see, it can be maddeningly difficult to achieve speed improvements without major capital expenditures and/or disruptions of existing surface traffic patterns and community life.

- Because only a small portion of the Valley housing stock is within easy walking distance of the guideway, and because there are only limited travel destinations within easy walking distance of the guideway, the guideway will be close to useless without an extremely strong feeder/distribution network. There is no point in offering riders a savings of even ten or fifteen minutes on a trip from one end of the Valley to the other on the guideway if riders waste an hour on each end of their trips in getting to and from the guideway.

  Without a fast, efficient collection/distribution network, it would be very easy for travel times with the busway to exceed the existing ones. At present, many transit trips in the Valley require two buses, one North-South and East-West. However, unless the potential rider's trip origin or destination are within relatively easy walking distance of the guideway, the same trip could require *three* buses -- one North-South to reach the busway, one on the busway, and the final North-South to reach the final destination. If there is no improvement to the existing one hour headways on the North-South routes, then the wait times for the North-South buses could easily exceed any time saved by faster East-West travel on the busway.

Potential Guideway Operational Methodologies

To illustrate the problems with implementation of a guideway on the Burbank-Chandler right-of-way, I will discuss a "low end" and "high end" implementation of a guideway in this corridor.

"Low End" Burbank-Chandler Guideway

At the low end of the continuum of possibilities -- and costs -- I will present a low cost, simpler solution with far fewer capital costs which, of course, means a lessor contribution to improvements in Valley transportation.

The central problem is how to generate faster transit trips by use of the guideway. Ignoring the feeder/collector system trips for the moment, trip time reduction for riders on the guideway portion of the total trip will depend largely upon two factors, (1) faster bus operating speeds, and (2) shorter headways to reduce bus wait time. Let us calculate potential time savings, using generous assumptions that will likely increase the benefit, for purposes of comparison.

At present, the East-West lines in the Southern portion of the Valley, where the guideway would operate, have operating speeds of approximately 14 to 17 mph. If the maximum speed on the busway is limited to 35 mph, and if there are stops approximately every mile to two miles, then it is highly questionable if the average speed of bus travel will reach 25 mph on this type of guideway[5].

For a five mile trip, the difference in bus travel time at 15 mph and 25 mph is 20 minutes vs. 12 minutes -- a savings of eight minutes. For a ten mile trip[6], the savings is 40 minutes vs. 24 minutes, or a 16 minute savings. In all likelihood, the "real world" actual travel speed savings will be lower.

The savings from more frequent service can be much more significant. The impacts on specific individual riders and rides can vary significantly, so I will use the "average" wait time in this somewhat simplistic calculation.

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[5] To give a comparison, the fully built-out Red Line will, at best, barely reach an average operating speed of 25 mph. At best (for the bus guideway), the distance between Red Line and busway stations will be roughly similar, as will the "dwell times" at stations to load/deboard passengers, but the Red Line does not have to cross through and signalized intersections and has a top speed between stations of over 55 mph, compared to 35 mph for the bus guideway.

[6] While it is extremely difficult to predict average trip lengths of a prospective transit guideway system, I believe that the average guideway trip length will be well under ten miles.

The Long Beach-Los Angeles Blue Line is approximately 21.6 miles long -- almost exactly the same as the proposed guideway from Burbank to Conoga Park, measured along the "dogleg" -- and has an average trip length of approximately 8.4 miles, which is by far the longest of any U.S. light rail system. This 8.4 mile value is largely driven by a very high percentage of "end-to-end" Blue Line riders which is unlikely to be duplicated on the Valley guideway.

The average wait time for transit service operating on a sixty minute headway is half of the headway, or 30 minutes. If service is approximately doubled to every thirty minutes, then the average wait time drops to fifteen minutes. If service is approximately tripled to a twenty minute headway, the average wait time becomes ten minutes, a savings of 20 minutes over the hour headway wait time.

These "guideway" time savings are significant -- up to approximately 36 minutes for a ten-mile trip from the combination of higher operating speed and lower headways -- even more for longer trips. It must be realized that, while these "guideway" time savings can be very important to potential riders, there would be little or no benefit to many riders unless the guideway access time is reduced. If existing North-South bus headways remain at 60 minutes, the average wait time of 30 minutes would largely negate the 36 minutes savings calculated above.

As a practical matter, this is likely to mean that the busway would be unlikely to be used for shorter trips unless the trip origin and/or destination happened to be along the guideway itself. The longer trip, the larger the time savings from the guideway portion and, therefore, the higher the likelihood that a rider would accept the penalties of accessing the guideway.

The details of the operation of a "Low End" Burbank/Chandler bus guideway will include:

- First, two bus lanes must be paved for buses to operate on and arrangements made for getting through various obstacles, such as crossing various river channels and drainage canals

- Stations must be provided at various points, chiefly major arterial streets. I would currently estimate a range of approximately 20 to 40 stations. Fortunately, the existing guideway is fairly wide for most of its length, ranging from 64 to over 100 feet wide just West of the Hollywood Freeway (HW170) to 36 feet for most of its length to a minimum of slightly under 30 feet in the most restricted areas I observed[7]. This should allow the implementation of two twelve-foot wide lanes and stations with two side loading platforms at least six feet wide at all important points along the line. In some locations, particularly along Chandler between the Hollywood Freeway and Ethel Avenue and along Oxnard/Topham between White Oak and Victory, there are actually several locations where a limited amount of park-and-ride slots could be constructed (although neighborhood opposition and some difficulties in enforcing transit-rider-only use should be expected). Another possibility -- one that makes very strong transit sense -- is the placement of timed-transfer facilities along the

[7] These measurements are based on the author's field observations, based on distances between physical barriers, such as curbs and chain link fences, that appear to bound the MTA owned property. However, the actual width of the guideway real estate may differ from what these physical barriers would appear to indicate.

guideway (although neighborhood opposition to such suggestions would likely be even stronger than for park-and-ride lots).

- The guideway currently has approximately 38½ crossings of major arterial streets[8], all at grade. There will be no change to the vertical alignment of the guideway for the "low end" option, which means that all arterial crossings will be signalized crossings.

  This will significantly limit the number of vehicles that can be operated. If for example, the guideway is operated with five-minute peak headways in each direction, there will be twelve buses in each direction each hour -- up to 24 crossings of each crossing arterial each hour (some number of the crossings in each direction will occur at the same time, so the effective interruptions of arterial traffic will be slightly fewer than the full 24), or approximately one every two-and-one-half to three minutes. This level of interruption of existing signaling patterns on arterials is almost certain to cause major traffic flow interruptions on most of these arterials.

  If the level of service were to double, we would be approaching 35 to 40 or more signal preferences affecting each street crossed. Any significant increase over this and a point is reached where the crossing traffic never receives a Green.

  This high number of signal preference crossings of arterials is not only a traffic flow problem, it is an important safety issue. The Blue Line was designed to operate at a high rate of speed through a relatively dense urban area with many non-grade separated street crossings. As a result of the way it was designed, the Blue Line, in its first four years of operation, had as many fatalities as all other light rail lines in the United States *combined* -- and it is drawing away. While the "low end" busway speed will be far lower than the Blue Line mid-corridor operating speed of 55 mph, we must not repeat this mistake ever again.

- Because of the limitation of peak hour/peak direction vehicles, there is a limit on the number of passengers that can be carried.

  In Curitiba, service on the busiest busways is operated with 80-foot double-articulated buses capable of carrying 270 passengers with headways as low as 45 seconds.

  In Los Angeles, we have seen that the headways are unlikely to be under five minutes, peak period, peak direction.

  The absolute maximum load per bus will be under 120, even if 80-foot buses are operated, which is questionable. There are two main differences between Curitiba and Los Angeles.

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[8] The "half" crossing is where the existing rail guideway leaves the center of Chandler, crossing the Westbound lanes only.

First, it is somewhat questionable if large numbers of Southern California riders will accept the degree of overcrowding that we observed in Curitiba for long trips. More important, however, the Consent Decree in *Labor/Community Strategy Center v. MTA* requires MTA to operate buses with a peak load factor (the ratio of total passengers at the peak load point of each line to the number of seats on the bus) of no more than 1.2:1 by 2002. The Curitiba loads of 270 were achieved on buses with 57 seats, a load factor of 4.74. If we assume 100 seats on an 80-foot double articulated (which is highly unlikely), the maximum number of passengers would be 120.

Therefore, in the Valley, the absolute maximum number of passengers past the peak load point in an hour would be approximately 1,440 (twelve buses an hour, each with 120 passengers) in each direction. The *practical* maximum is somewhat less -- not the least of which because it may not be desirable, or possible, to operate 80-foot double articulated buses in Los Angeles..

While the 1,440 peak point/peak direction riders is a considerable amount of riders for any bus line, it is simply not enough to have a major impact on transportation and traffic conditions in the Valley.

- There are a fair number of non-arterial streets that cross the guideway. Many or all of these may have to be shut off for safety reasons. This will have two main impacts:

  - It will interrupt "local" surface traffic in the neighborhoods that the guideway transits. While this will have little or no impact along long sections of the guideway, there are some areas where some short trips will change radically. Trips that were formerly direct, straight-line on a neighborhood street, with only a stop sign to slow them, will require a turn to parallel the guideway, travel to the next arterial, a wait for the signal to turn green, crossing the guideway on the arterial, travel back to the origin street along the guideway, and then resuming the original trip direction on the trip origin street.
  - The closing of "minor" cross streets will funnel more automobile traffic on to the arterials and will lead to greater traffic on the streets paralleling the guideway.

  While the cumulative impact of these disruptions of existing traffic patterns is unlikely to be large in the greater scheme of things, the disruption to specific individuals and neighborhoods can be far more important -- and is not unlikely to cause concern and organized opposition.

- For safety reasons, it may be necessary to erect barriers along the guideway to keep pedestrians and other unauthorized individuals and objects off the guideway. (As a general rule, the need for such barriers will increase as the speed of travel on the guideway increases. Speed of guideway travel will also be the major factor in determining the number of non-arterial cross streets that must be closed off.) At an extreme, such barriers could be similar to those along the Long Beach-Los Angeles Blue Line in the mid-corridor section -- a fence made of metal bars taller than a child's height.

There are many areas along the guideway where there would likely be little opposition to such barriers -- indeed, there are miles of existing chain link fences along the guideway separating it from various residential backyards and commercial/industrial sites. However, in some areas, most particularly along Chandler between Burbank and Ethel, such barriers, and the construction and operation of the guideway itself, could spit neighborhoods and significantly restrict pedestrian traffic across the guideway. Even if pedestrian over/underpasses were to be provided -- a not-inexpensive proposition -- the impact on local communities is likely to become a major rallying point of opposition to the guideway.

Such opposition should not be unexpected -- it was precisely this type of problem in exactly this neighborhood that led to organized and effective work by local community groups to oppose the original plan to use the Burbank/Chandler right-of-way for light rail. Most observers believe that this was a major factor in the demise of this plan and in the reformation of the rail line through this neighborhood as a subway.

- The stations, with some possible exceptions, are likely to be of existing, conventional bus stop design -- low level boarding, no pre-payment, simple shelters provided only. While the Curitiba "tube" stops work extremely well in Curitiba, there would simply not be the number of boarding passengers at each station to justify the expense of building and operating high platform boarding, pay-upon-entering, "tube" stations and buses along this guideway. (Details of the technical problems of strict application of Curitiba-style "Surface Metro" busway operations to Los Angeles are presented in the Appendix.)

  In certain locations with high boardings, it could be productive to have "Curitiba-type" prepaid boarding, which can significantly lower station dwell time. However, it should be noted that there would be no time savings for such practices at the end of the line stations, because the buses are, or can be, available for boarding for several minutes prior to the beginning of their runs. The end stations are likely to be among the heaviest used stations on the guideway during peak periods. Therefore, I doubt if there will be any stations under this scenario where such methodologies are worthwhile, although this is an issue that should be studied in detail for each station.

- There is likely to be a requirement for a "local" bus line to parallel the guideway to deliver riders to intermediate points along the guideway not served by the guideway buses. If the distances between stations are well in excess of one mile, then the need for such service increases significantly.

In summary, therefore, it is somewhat doubtful if a "low end" bus guideway along Burbank/Chandler is worthwhile, even if could be implemented over the expected level of community opposition. The time savings on the guideway is likely to be largely offset by the time penalty of the additional transfer for many passengers unless there are significant reductions in North-South bus route headways and other effective improvements in Valley transit service. The problem of coordination of traffic signals at the over three dozen arterial crossings -- allowing the guideway buses to operate at a higher rate of speed while, at the same time, not interfering with traffic on the arterials -- will be a very difficult technical challenge.

"High End" Burbank-Chandler Guideway

At the other end of the continuum, I will present the type of guideway that is the dream of transit planners, not limited by the practical difficulties of the existing infrastructure. While, in many cases, full implementation of this type of guideway will be clearly impossible, I believe that it would be useful to readers to know what an "optimum" transportation solution would look like.

In summary, the "high end" guideway is totally grade separated, allowing a high rate of vehicle speed, provided with special on and off ramps and special interchanges with existing and proposed HOV lanes and freeways, and designed to be utilized by the maximum number of high occupancy vehicles of vehicles of all types, minimizing the number of transfers required to complete most common trips.

(I will point out practical difficulties in many locations in the following. In general, most of the difficulties in implementing the "low end" guideway discussed above would exist for the "high end" guideway and these discussions will not be repeated.)

- The guideway will be totally grade separated. Depending upon the specific area, the grade separation methodology will consist of a combination of elevated and subsurface guideways and "at-grade" sections that are totally protected, with no crossing traffic of any type at any location.

  (All of the "low end" difficulties with neighborhood impact will be increased, plus many additional problems will be generated. If the alignment is raised, then the result would be berms similar to that the Ventura Freeway (HW101) rests on, plus overpasses at crossing arterial streets. This would be a major interference with existing neighborhood conditions, to say the least, as well as expensive to construct. Subway construction would result in a less disruptive end result, but would be far more expensive to build. Either would result in major construction projects disrupting living conditions for extended periods of time in the neighborhoods.)

- There will be special guideway on and off ramps from surface streets every mile to two miles. This will allow many riders to make single vehicle transit trips, using the guideway for high speed travel in the middle section of their trips.

  This type of guideway plan allows one vehicle to serve both the neighborhood feeder/distributor function *and* the "line haul" function, minimizing or eliminating transfers.

For example, a bus could start at the North end of the Valley, traveling South on an arterial such as, for example, Tampa, enter the guideway and proceed to Burbank, where it would operate through the Burbank central area streets as a local bus, distributing its passengers.

(In some areas along the guideway, this would require property takes to construct and would increase the problems noted above.)

- There will be direct interchanges between the guideway and the Golden State (I-5), Hollywood (HW170) and San Diego (I-405) freeways going directly to the HOV lanes. This will greatly improve the transit times to destinations outside of the Valley.

  (Such connections would require major reconstructions of all of these freeways. The HOV lanes are all in the centers of the freeways, which have no central medians. The type of access being recommended would require the freeways to be widened to allow another (entrance/exit merge) lane to be added on each side. The geometry of the actual bus guideway to perpendicular freeway HOV lane ramp will be most challenging.)

- Since the guideway will be totally grade separated, the only limitation on the number of vehicles using it is the roadway capacity. As a practical matter, this means that well over 1,000 vehicles, peak hour, peak direction, can be handled[9]. Depending on the mix of buses vs. smaller vehicles, the peak ridership carried past a point could possibly exceed 10,000 per hour, peak direction.

  The guideway will be open to all MTA transit buses, plus LA-DOT Commuter Express and DASH buses, other recognized transit operator buses, plus Smart Shuttle and Subscription Buses and Vans, and other types of transit and paratransit vehicles.

  Depending upon the amount of unused capacity, it may be opened to some "civilian" HOV users. This could mean, for example, that HOV-5 could be a cutoff point. The basic rule will be, the greatest good for the greatest number, which means that the highest occupancy vehicles will always have the highest priorities.

  All user vehicles must be operated by legal entities and individuals that are specifically licensed to operate on the guideway and have been given special guideway operations and safety training. Licensed user vehicles will have electronic identification. Any unauthorized vehicles using, or attempting to use, the guideway will be picked up by electronic and closed circuit television/recording at each entrance and violators will be subject to heavy penalties.

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[9] The El Monte Busway/HOV lane currently handles over 60 buses and 1,200 car/vanpools per hour at speeds averaging 55 mph at peak. The maximum number of vehicles per hour for general purpose freeway lanes is approximately 1,700, and this is at far lower travel speeds.

Depending on demand, it may be possible to operate the guideway as a general use HOV lane and HOT lanes. However, the main point is to allow the highest occupancy vehicles to gain the maximum speed advantage and to operate the guideway in a safe manner at all times. While their may be some temporarily underutilized capacity in the early years of operation, I am more concerned that the benefits would soon attract sufficient users that a single lane in each direction may not prove sufficient for the demand.

(These regulatory actions will be a necessary inconvenience and will undoubtedly result in certain problems and disputes over who should be granted access.)

- Guideway stations will be "off line" -- the stations will *not* be on the main travel lanes, but rather on special protected lanes off to the sides. Vehicles in the main travel lanes will be totally unaffected by other vehicles making station stops. This will allow "express" bus operation (say, for example, direct, non-stop service from the Chatsworth Metrolink station to Warner Center), limited and "skip-stop" mainline service, and allow Smart Shuttles and subscription buses to use the guideway for high speed travel for the middle portion of their trips.

  This configurations will also allow neighborhood circulator and distributor buses to take their passengers directly to the station platform for transfer to "line-haul" buses for the guideway portion of their trips.

  Stations will be large enough to allow multiple vehicles in the station at a time. They will also provide enough space to serve as transfer points between buses. For example, if a passenger boards a collector bus that enters the guideway, but has a final destination different than that of the "collector" bus, (s)he could transfer, at a guideway station, to a bus going to where (s)he wants to go.

  (This type of station would result in a requirement for at least a 60-foot total guideway width, which is far wider than the 36-foot guideway in many portions of the Valley. Elevating a 60-foot wide structure over a 36-foot guideway would be an even larger neighborhood eyesore than mentioned above. Building a "rubber tire" subway guideway in this manner would be even more challenging.

  The in and out access lanes to the stations, to allow buses to safely stop and get up to speed for merging back into the through lane, will be rather lengthy, compounding the problem of the additional guideway width.)

- There are a number of other potential problems that must be addressed, including the noise generated by such a guideway and the localized exhaust emissions. While these concerns are not inconsequential, they have reasonable remedies and, given the larger import of the problems mentioned above, I will not bother with detailed analysis at this point.

The type of guideway outlined above has a passenger capacity at least equal to any rail line in the U.S. and a significantly higher speed of passenger travel. It has the capability of producing considerably more peak period transportation than the Ventura Freeway[10]. For many Valley residents, it would mean that transit would approach and often exceed the speed of travel of the single-passenger automobile. By widening the types of transit available to Valley residents, it could significantly improve the transportation options available to large numbers of people and businesses.

Real World Compromises

The problems of full implementation of the "high end" guideway are so major and many that it will be simply impossible to overcome them in the practical political environment of Los Angeles, no matter how large the potential benefits. In the real world, what we are likely to see is a guideway that is somewhere between the extremes, probably far closer to the "low end" option.

For example, while full grade separation is unlikely, it would probably be possible to grade separate a limited number of key arterial crossings.

Similarly, while achieving full signal preemption at all arterial crossings would likely produce an unacceptably high level of interference with Valley traffic flows, intelligent application of proven techniques is likely to provide a relatively high speed of transit travel with minimal notice of drivers on surface streets in the area.

The bus guideway that is likely to result will probably be usable only by designated fixed route transit operators and will likely require a high degree of transfers to other surface bus lines. No direct connectivity to freeways or HOV lanes is likely to result.

Most likely, the biggest constraint will be the well known "NIMBY" factor -- not in my back yard. There is no way to implement a meaningful transit guideway along this corridor without disadvantaging some residents along its length. The key question will be if meaningful mitigation techniques, fairly and honestly applied, will be sufficient to overcome the very real concerns of affected residents.

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10 This is not imaginative speculation. On the San Bernardino Freeway, which has four general-purpose lanes, the El Monte Busway/HOV lane carries almost six freeway lanes of traffic at peak -- far more than the four general purpose lanes combined.

APPLICATION OF CURITIBA TRANSIT SOLUTIONS TO LOS ANGELES

(This paper was originally prepared to discuss the possibility of use of the Exposition right-of-way between the University of Southern California and Santa Monica as a Curitiba-style busway. However, the vast majority of the discussion is directly applicable to the use of any Los Angeles guideway for this purpose.)

Curitiba has one of the most effective and most highly utilized transit systems in the world. There are undoubtedly many lessons that can be learned from Curitiba that can be applied to many other urbanized areas, including Los Angeles. However, in attempting to apply the lessons of Curitiba, we must always keep in mind that one of the main reasons that the Curitiba transit system works so well in Curitiba is that it has been cleverly and effectively created and adapted over a period of decades to work near-optimally within the unique culture, economy, and legal system of Curitiba. Extreme care must be taken in attempting to apply what has worked so well in Curitiba to other cultures, economies, and legal systems where the values and standards may be significant different without taking these differences into account.

Also, we must also keep our eye on the desired result, which is to improve people's lives by improving their transportation system and, through transportation system improvements, contribute to the overall improvement of the urban area in which they reside. We should focus on technologies only as solutions to problems and opportunities for improvements, not as ends in and of themselves.

There is a great deal of interest in the Curitiba busway network. While this is certainly understandable, it must be remembered that it is only one element of a total urban transit system. Without the other components -- the feeder and interdistrict routes in particular -- bringing riders to the transit centers, the busways would be far less viable. We must avoid the error of attempting to transfer only one component of a successful system and expecting to achieve the "system" productivity for that component operating on its own.

The busways have extremely high capacity (see Attachment for details) -- higher than any Los Angeles street or highway utilized for bus service (except, in some respects, the service on the El Monte Busway), far higher than the Long Beach-Los Angeles Blue Line, higher than the Red Line outside of the Central Business District (CBD). Only the Red Line in the CBD has the ability to clearly exceed (in theory) the capacity of the heaviest busway line -- and even in that case, it is not impossible to construct a Curitiba-style busway that could exceed the capacity of the CBD Red Line.

However, that is not the point. If busway-type operations are to be utilized, the great advantages are the low capital cost (compared to rail, especially subway) and the far faster time from conception to operations. These advantages could allow multiple busway-style high-capacity, high-speed transit lines to serve the Los Angeles CBD, connecting it with then many non-CBD urban centers in Southern California (for example, Glendale, Santa Monica, and/or Pasadena) and with core city, suburban, and exurban residential areas.

APPLICATION OF CURITIBA BUSWAY TECHNOLOGY AND OPERATIONS TO LOS ANGELES

While Curitiba busway technology has applicability to Los Angeles, there is a need for changes to meet the differing local requirements.

Buses

The use of bi-articulated, 81-foot buses in Curitiba is driven by the extreme demand for transit capacity on their five high-capacity bus guideways. The bi-artics offer close to the absolute maximum capacity in a single bus vehicle[11], but there are tradeoffs that must be considered before deciding upon their use for Los Angeles.

First, the bi-artics in Curitiba are operated with five very wide (rail transit-type) doors, 57 seats, and a total capacity of 270. From our observations of their operations, it is clear that these buses are frequently operated at close to or over that remarkable maximum capacity.

Dividing the 270 total load by the 57 seats produces a peak load ratio of 4.74. This is unacceptably high by U.S. and even Los Angeles load standards. While SCRTD/MTA buses have had, by far, the highest average passenger loads of any major urban bus system in the United States every year since the Federal government began reporting statistics in the late 1970's, load factors approaching those on the busways are simply not known or possible in the U.S. -- U.S. riders are simply extremely unlikely to put up with this type of service, particularly for longer trips, if they have any viable options at all.

At the present time, MTA's "official" maximum load factor standard is 1.45 -- which means about 62 passengers on a typical 43-passenger 40-foot bus (this load standard is frequently violated on the street, with 1.6 and 1.7 factors being not uncommon on heavily utilized lines). For express-type bus service, the official standard is a peak load of 1.0 -- although, again, violations of this standard are common -- I have personal experience of my bus line (Route 424 -- Downtown-San Fernando Valley via Ventura Blvd.) frequently exceeding 1.25 on weekends.

More important, under the terms of the Consent Decree from the *Labor/Community Strategy Center v. MTA* settlement, MTA must reduce the *actual* (not policy) peak load factor to 1.2 by 2002 (in steps by time period).

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11 Technically, it would be possible to construct a double-decker bus with more passenger carrying capacity than the bi-artics used in Curitiba. There *are* double-decker single articulated buses, but these are not designed for main line transit use. The problems and time delays of getting large numbers of passengers up and down from the top level during frequent stops makes double-decker technology ill-suited for our instant purposes.

Therefore, it is clear that any discussion of maximum loads on a Los Angeles high capacity busway must be based on far lower maximum load factors than those in Curitiba.

What this means is that we should first plan on greatly increasing the number of seats over the 57 in the Curibita vehicles. In the U.S., 60-foot single articulated bus generally have two or three doors and approximately 65 to 73 seats. If it is possible to utilize bi-artics in Los Angeles, we could probably be realistically talking about approximately 90-100 seats at the absolute most, depending primarily upon the number of doors and wheelchair tie-down locations. The Curitiba bi-artics have five wide doors, primarily to provide for rapid boarding and deboarding of the extreme loads carried. However, given that we would be working with far lower loads, we can likely get by with four, or perhaps even three, doors. The space not devoted to doors will translate to more seats.

If we assume 90 seats on a bi-artic, this translates into a (1.2 ratio) peak load of 108; 100 seats would produce a peak load of 120.

However, before we assume the use of bi-artics, we need to consider the likely peak ridership. There is a tradeoff between maximizing the load on each vehicle -- which is desirable in the reduction of operating costs -- vs. frequency of service. Greatly simplifying the process, let us assume that the peak capacity of a bi-artic is 120 and 40-foot buses max out at 52. If the peak hour, peak direction ridership past the peak load point is 750[12], then we would need six bi-artics or 14 40-footers per hour. This translates into a ten-minute headway using bi-artics and a four-minute headway with 40-footers.

Frequency of service is a prime determinate of the attractiveness of a transit system to potential riders. With a (reliable) four minute headway, most riders would not even bother to consider the published schedule, they would just go to the bus stop and wait for the next bus. With an average wait time of two minutes and a maximum (scheduled) wait time of four minutes, wait time becomes

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[12] This peak hour, peak direction, peak point load factor would be roughly equivalent to a bus line with average weekday ridership of approximately 10,000. By contract, the most heavily utilized MTA bus lines (the 20 Wilshire and the 204 Vermont) currently carry over 40,000 per average weekday. However, the type of service that would be operated on busways would likely tend to be more express-type, longer trip length service, which generally has fewer passengers boardings per unit of time, but passengers who ride for longer distances, thereby producing high average passenger loads.

While this is actually a fairly high figure for most bus lines, we would expect a considerably higher number for a dedicated busway of the type we are considering. If peak hour, peak direction peak ridership past a point would reach 2,500, this line would be regarded as extremely successful -- this is approximately what the Long Beach-Los Angeles Blue Line peak hour, peak direction load works out to at the peak load point.

a very minor consideration. A ten-minute headway, however, is long enough to cause some portion of the potential ridership to begin to make decisions based on wait time.

The impact on the non-peak schedule is far more important. If we assume that the headway will be doubled during the mid-day period (it would not be unusual for the headways to triple for a line of this type, if the sole criteria was ridership demand), we are now talking twenty-minute headways for bi-artics vs. eight-minute headways for 40-footers. This is a far more serious difference that will impact a large number of potential riders, particularly "choice" (non-transit dependent) riders.

The trade-off is very complex, but it involves making a decision between running very large buses with heavy loads at wide headways, vs. large buses with low loads at higher frequencies than would be required by demand, vs. running smaller buses at shorter headways.

Before any commitment is made to a specific bus type, we need to carefully consider the above and other related operational considerations. The bus length possibilities for this service could include "standard" 40-footers, 60-foot artics, and 80-foot bi-artics.

Bus Specification/Procurement

There are several concerns related to the specification and procurement of bi-artic buses.

First, if Federal funding is involved, buses must have a minimum 60% U.S. (cost) component and final assembly must be performed in the U.S. The Curitiba 80-footers are Volvo's. Volvo is no longer assembling buses in the United States.

There are several bus manufacturers that are currently capable of manufacturing 60-foot artics in compliance with the Federal procurement requirements including, at least, Neoplan, New Flyer, and NABI.

If there are no Federal dollars in a bus purchase, then the above requirements do not apply (although there is not unlikely to be political pressure to buy U.S. manufactured or final assembled buses). Since MTA is committed to far more capital expenditures than it could possibly receive Federal financial participation for, the possibility of a non-Federally funded procurement should not be dismissed. (However, without getting into the details of MTA's financial situation, there is considerable question how well MTA will be able to fund its *current* commitments, let alone any new capital projects.)

In any event, based on past experience with non-U.S. assemblies and parts suppliers, MTA would likely want to have the major assemblies in the buses, the mission critical ones that require the majority of inspection and maintenance, such as engines, transmissions, axles, etc., to be supplied by "standard" U.S. suppliers that it -- and the maintenance staff -- is already familiar with, and has a large U.S. business base in place.

If the buses are designed to use high-platform boarding, like the Curitiba cars, then there would be no requirement for wheelchair lifts to meet the requirements of the Americans with Disabilities Act (compliance with the requirements is shifted to the stations). However, if a high-platform design decision is made, then the guideway buses could not be utilized on any other routes and it would be difficult, if not impossible, to use any other buses on the guideway.

"Compromise" boarding -- high platform *and* low "step" boarding -- could be technically possible. A dual-platform boarding bus could have a "traditional" step entrance at the front door, with a lift (or possibly a ramp) and a farebox, and high-platform boarding at the rear doors. This would allow the guideway buses to be used off the guideway -- although not very well. It would also provide for a means of deboarding passengers at other than a guideway bus stop if it became necessary to do so; for example, if there was a breakdown between stations.

I assume that any buses purchased for L.A. use would be air conditioned.

Operating/Maintenance Facilities

If larger buses are to be utilized, there must be at least one operating and maintenance facility that can handle them. This is a lot more complicated than might first be thought, although it is certainly not a deal breaker.

Larger buses are more difficult to move around operating yards and are more difficult to park. Backing artic's is far more difficult than backing 40-footers -- and backing 40-footers is not easy. Since artic's take up so much more space to park, the capacity of the yards, expressed in number of buses, is reduced.

In order to inspect and maintain buses, there must be either bus lifts or pits. MTA currently has no lifts that can take 80-foot buses. There are some facilities that do have pits that could probably be usable.

Most articulated buses are "pullers[13]" -- that is, the driven wheels are the ones at the rear of the front section -- the middle of three axles on single artics and the second (from the front) of four axles on bi-artics. The reason for this design is that powering the rearmost wheels can lead to "jack-knifing" a bus around a flex hinge in certain situations. However, there are "pusher" artics with interlocks designed to prevent this problem. Since, in "puller" artics, the engine, transmission, etc. are not in the traditional location for bus "cradle" at the rear of the bus, servicing and "pulling" of these assemblies for rebuilds requires different techniques and facilities than are now used.

Service islands, brake inspection areas, and bus washers would also likely need substantial changes.

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[13] I am not aware of the configuration of the Curitiba buses.

Maintaining 80-foot buses at existing maintenance bays could be troublesome. Most MTA maintenance facilities are, in essence, a series of side-by-side garages designed for 40-foot vehicles to be backed (or sometimes driven) in. 80-foot vehicles will simply not fit in 40-foot garage slots. If 80-footers are parked in a 40-foot bus bay, then the bus will be sticking out quite a ways, probably interfering with traffic flows. Without going into a lot of detail, there would need to be quite a few changes to any MTA yard where 80-footers would be operated -- and even if 60-footers were to be operated.

The artic "hinge" is a complex assembly that can require specialized maintenance. While MTA does have experience with such devices (on the Blue/Green Line rail cars), there is no such current bus capability.

Exposition Guideway

From several trips down the Exposition rail guideway from USC to Santa Monica, it appears that the conversion to a bus guideway could be technically possible and a useful transportation improvement, but there are many challenges.

The basic, and most costly, requirement would be to pave over the rail track to provide a two-lane bus guideway[14] and ways to get through crossing arterial streets with minimum mutual interference. There would also have to be provision for stations (see below). The other major requirement would be for proper traffic signaling. Ideally, the bus guideway would be given signal pre-emption at the major streets where provisions are not made for separated guideways (I assume that there would not be problems gaining prioritization at the non-arterial crossings -- in some cases, it appears only stop signs will be required, although I'd prefer either totally eliminated them or, depending on the circumstances, solutions up to and including four-quad gates for safety). This type of prioritization would be mechanically simple, using either bus-mounted "flasher" or fixed guideway-located initiators. The former provides the advantage of fewer critical assemblies being potentially accessible by members of our volunteer decorator committees and related entities. Gaining *political* approval for signal preemption is likely to be far more challenging.

The current rail guideway is single track with many breaks where the rail has been removed. The guideway is generally physically separated from the roads it often parallels. In many sections, it is completely separated from *all* roadways. There are generally a limited number of crossing streets

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[14] It would be technically possible to operate a one-way bus guideway, with the direction changing depending on the peak direction, with the return trips made on surface streets. This would mean, of course, that travel in the peak direction would be far faster than travel in the other. However, having two different bus stops in each direction based on the time of day would be very confusing for riders. Also, time-of-day lane direction changes inevitably lead to safety problems.

East of the San Diego Freeway (I-405), generally no more than approximately one every quarter mile (with a few exceptions). There are also some fairly long sections without any crossing streets, which could allow safe operating speeds as high as 60 mph.

The use of this guideway for bus immediately West of I-405 appears to be a major problem. The right of way narrows to a point where it appears just barely possible to fit in two ten-foot lanes[15], if that. In some of the blocks, there have been buildings erected on one or both sides, so a guideway would have two ten-foot lanes with building walls on one or both sides. There are also more cross streets. The choices appear to be the application of large quantities of dollars to widen and improve the guideway for several blocks, plus blocking several fairly busy cross streets where the busway would be an almost totally "blind" cross, or to operate on surface streets.

Once Pico is crossed going West to downtown Santa Monica, things begin to get better until the track leaves Olympic at approximately 22nd street. In this final section, there are so many problems -- including a newly erected building in what used to be the guideway -- that it is probably not worthwhile to continue to pursue a separate guideway solution. From this point on, it will probably be preferable to proceed down Olympic, or another surface street or street pair, to the Santa Monica terminus. Since the buses would already be on Olympic, using it into the Santa Monica CBD would avoid two turns, but there may be better streets for patron accessibility. Most likely, this final section would be run as a loop on parallel streets in opposite directions.

There are several areas where there appears to be commercial use of the right-of-way, ranging from cars parked on the tracks to what appears to be long-term storage of everything from construction materials to large vehicles. (I assume that MTA real estate professionals are aware of these uses and that proper measures have been taken to preserve these sections for transit use.)

The single biggest challenge appears to be where the guideway crosses through the intersection of Robertson, Venice, and Exposition -- the first two being major arterials. Although the rail crossing signals are still there, the rail track itself has been paved over, both on these streets and for a long block West of the intersection. There is also extensive commercial use of the right-of-way just West of the intersection.

If we attempted to stick with street running, this would undoubtedly be the site of the biggest conflict with traffic engineers. For example, if we assume a four-minute headway, then there would

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[15] Competent bus operators should not have problems operating buses on straight ten-foot lanes *in traffic moving in the same direction*. However, it should be remembered that the standard bus width is 102" -- eight and one half feet -- and this does not include the mirrors on each side. Two ten-foot lanes in opposite directions would not be possible without the use of German "guided bus" or similar technology (this is a simple idea that could work here, but would need a lot more study than I'm qualified to give it).

be thirty buses per hour coming through this intersection -- and traffic on both arterials and the other surface street would have to halted to let the buses through. This problem is be serious enough to almost mandate construction of a flyover for the buses. If a flyover is not acceptable to local residents, then the only other alternative would be to start digging down. Without a clear path through this intersection, this busway either isn't going to happen or we will be creating one of the worst bottlenecks and traffic safety hazards in the history of Los Angeles -- and that's saying something. There are other major arterials with big problems that should also lead to consideration of changing the vertical alignments, but this one is by far the worst.

Immediately West of this intersection is a section of approximately three miles with no crossing roads at all. This section alone could cut the end-to-end travel time by more than five minutes over those of parallel surface streets. However, it goes through a residential area that is likely to result in the biggest NIMBY problems, even though the actual impact on the residents is rather low, especially when compared to other sections of the guideway.

By my count, there are 16 crosses of arterials (depending on who's definition of an "arterial" is utilized), from East to West, starting at Figueroa and Exposition by USC and the Colosseum:

- Vermont
- Normandie
- Western
- Crenshaw
- La Brea
- La Cienega
- Jefferson -- three times between La Cienega and Washington
- Washington
- Venice/Roberson/Exposition
- National
- Sepulveda
- Pico
- Bundy
- Olympia

To obtain the absolute maximize busway travel speed (and safety), it would be necessary to provide grade separation for each of these crossings. The ideal solution would also require that all "minor" cross streets be closed off rom crossing. However, while I believe that it likely be wise to provide grade separation and/or related improvements at some of the above, the marginal improvement of doing grade separations at all sixteen crosses and closing off all the minor streets may not be a worthwhile investment for the return that would be achieved. This is a matter for detailed study -- and clever utilization of cheaper ideas.

For example, at present, the guideway crosses and recrosses Exposition West of where Jefferson turns South. Since the guideway would have to be paved in any case, rearranging the alignments of the guideway and Exposition in this segment as part of this work would eliminate these two crosses entirely at relatively minor cost and without any future impact on automotive traffic.

There are three bridges on the right-of-way, one over Ballona Creek (near where Jefferson Blvd. turns South off the Exposition rail right-of-way), another crossing over National Blvd., and the third over Motor Avenue. All are single track rail bridges approximately 20 feet wide. From my casual inspection, all appeared to be in fairly good physical condition with no major rust or other deterioration evident. It may be possible to convert these to two-lane busway use without starting over from scratch[16]. Putting in an ADA-compliant station at National and/or Motor will be a minor technical challenge, given the vertical alignment -- as would a Venice/Robertson station for a flyover or underpass.

The conversion of the rail guideway down Exposition Blvd. proper in the Easternmost section will require some interesting solutions. The rail guideway is a series of islands in the middle of this six-traffic-plus-two-parking-lanes (all ten-foot wide) boulevard. Moreover, the center island has numerous trees, which will be extremely difficult -- probably impossible -- to save.

The street is a bit narrow for adding what will amount to two extra traffic lanes when the stations are considered. The center island is approximately 27 feet wide, which means that we should not have any problem at all in putting in the two lanes, even after provision for barriers for guideway separation. However, if we add two side-loading stations directly opposite each other, we'd clearly overload the available width and would have to start taking property. One alternative is off-set side-loading stations (to avoid serious "kinks" in the roadway, they would have to be offset fairly far, at least 100+ feet, perhaps on opposite sides of the major arterials where stations will be located). The other alternative, which I prefer at this point, would be center loading platforms (a single center load platform can be somewhat narrower than the sum of two side loading platforms). However, even with a single center loading platform, we're going to be quite tight unless we start eliminating or narrowing lanes (that latter not likely to produce much, even if it is possible at all, which is questionable). I enclose a design for a design that would use a series of single, center platform stations, which would lower the cross section width over a series of two separate, non-offset, side loading platforms.

The sidewalks areas are also narrow -- only about seven feet from the curbs to the (mainly residential) lot lines. There is simply nothing here to take without getting into the front yards of a lot of people. We could remove parking to give us our necessary station width -- this may be the

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16 It would likely be a good idea to have someone with "P.E.," rather than "CPA," after their name take a look before things progress too much further.

most workable solution, but, as usual, must be done carefully. It may be necessary to take some property on one or both sides to fit everything in without eliminating traffic lanes and/or parking.

One of the most important, and most challenging, aspects of creating a busway will be traffic safety. If we go with the "center island" configuration near and immediately West of USC, this will likely be the biggest problem area.

The safest configuration would be a completely separated guideway. This is also the most unlikely. Next best is to have as much separation as possible, by minimizing the number of crossing streets, and here we do have some luck. On the remaining crossings, the next best safety would be provided by structuring railroad-style protective crossings with four-quadrant gates. This is extremely unlikely to be achieved (as would be protected crossings with two-quad gates).

The next best would be the prohibition of left turns from Exposition across the busway. While I strongly recommend this, it should be recognized that this will be met with extreme disfavor by the local residents and City traffic engineers -- and with good reason. The preferred response to "no left turn" restrictions for drivers who have to cross the road is a series of turns is that will result in the driver being able to cross the original road on a perpendicular street. This is objectionable to most drivers when the optimum path is right one block, left one block, left one block and cross. Due to the specifics of the Exposition right-of-way, we are talking about taking people *many* blocks out of their way in the extreme cases.

The absolute minimum acceptable safety provisions for the crossings will be dedicated left turn lanes on both Exposition *and the cross streets* with full protected signaling, including special signaling for the buses on the busway (in other words, pretty much what now exists on Washington Blvd. for the Blue Line). This, however, will require a radical rework of both the traffic flows on and crossing Exposition and the traffic signaling all along this corridor and the crossing arterials. This is a major piece of work and is may not be viewed entirely favorably by LA-DOT personnel (for some good reasons), who are likely to need a bit of encouragement from on top. It would also eliminate existing traffic lanes -- however, this may not be that much of a problem on Exposition, judging from my casual observations of peak traffic.

Finally, in this section of the guideway, there are a large number of cutouts through the central island where minor streets make "T" intersections with Exposition. These will absolute have to go, which will mean that drivers, mainly local residents, that formerly were able to make left turns across Exposition to enter, or to make left turns onto Exposition from, these side streets, will now have to find other routes.

What we *don't* want to see is a large increase in U-turns on Exposition, so the imposition of no U-turns restrictions on Exposition -- and enforcement thereof -- appears to be an absolute requirement. Unfortunately, perfect resolution of this problem is not possible in the real world, and there will undoubtedly be a variety of problems of all types caused by this traffic restructuring.

The reason that I am spending so much time on this is that I was responsible for safety on the Blue Line for several years. The Blue Line is, by far, the most unsafe light rail line in North America. In its first four years of operation, it had the same number of fatalities (24) as every other light rail line in the United States *combined* -- and it is now pulling away from the rest. It averages approximately one train vs. auto collision a week. The vast majority of these occur on the high speed mid-corridor section and involve vehicles making improper crossings, mainly turns, across the guideway. This is a very similar environment to what we are talking about on Exposition.

The main difference between the Blue Line and an Exposition busway is that none of the Blue Line fatalities have involved Blue Line passengers. When two 44-ton rail cars hit a 3,000 pound car, the usual result is very little damage to the Rail Car and very few serious injuries to its riders -- and the complete destruction of the other vehicle, often involving massive trauma inflicted upon its occupants. On an Exposition busway, the bus passengers have a far lower mass advantage (standard 40-foot buses weigh in a bit under 30,000 pounds dry, longer buses have roughly proportional weights) and passengers are far more likely to be subject to rapid, uncontrollable, injury-causing movements -- particularly those who are standing. Buses also do not have rails to keep them traveling on the straight and narrow after a collision and are far more subject to overturning and secondary collisions.

Even with the best possible protection of the guideway, there will be deliberate actions and errors of drivers that will cause problems. The good news is that the buses will be traveling a lot slower than the Blue Line's 55 mph in the mid-corridor section and have far shorter stopping distances than do rail cars[17]. The bad news is that this is not sufficient for complete collision avoidance and that there will be problems. Our job will be to design a guideway that is as safe as can reasonably be.

Stations

While we were all impressed by the Curitiba "tube" busway stations, they may not be applicable to Los Angeles conditions. At a minimum, substantial modifications would likely be required.

The high platform (Red/Blue/Green Line-style) boarding provides an extreme reduction of station dwell time. We observed close to 100 passengers entering and exiting bi-artic buses through the five doors in little over 15 seconds. With standard "U.S." bus boarding procedures, we're lucky if we can get one passenger up the stairs and past the farebox/operator in three seconds. As far as deboarding goes, we generally can't get anywhere close to one per second per door -- and we can't board and deboard through the front door at the same time.

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[17] However, rapid stops in buses can in themselves cause injuries to passengers, particularly elderly and other potential "eggshell" plaintiffs.

space required for the ramp to reach the required elevation via acceptable rates of incline would require moving the station proper several dozen feet off the major cross street.

- Since the station end opposite the major cross street has no use (other than an emergency exit -- and there may not be any requirement for this), the station entrance and exit will both have to be on the same end, facing the cross street. This makes the tube "circle" arrangement, which reduces the effective cross-section available for entrances/egress, problematic, at least at the entrance/exit proper. Part of this issue involves ramp access -- which, in the absence of lifts, are required by law -- and/of stair entrance. If access is by ramp only, and this works, then there is less of a problem. If *both* ramps and stairs are required, then a broader entrance would be necessary. Either the entrance has to be wider to provide for both, or there has to be a high platform where the ramp and stairs would be merged into a single (narrower) entrance to the tube proper. The entrance could also we widen by adopting a Quonset hut, rather than "full circle" tube, alignment. Another possibility would be a "square" station entrance proper blending into a "tube" cross section. (I'll leave such matters to those with a bit more training and experience in design. As you know, I am an accountant, this would be a matter of taste, and there is no accounting for taste.)

- With no attendant, there would likely have to be paid boarding area management physical arrangements other than the simple single horizontal bars at each and turnstiles used in Curitiba. There are two separate ways to go, each with advantages and disadvantages:

  - If we go with a "barrier" system (one that would not require fare inspection), then there would have to be security bars that would be more extensive and effective than the Curitiba arrangement. However, even if we turned the area into a prison-like level of security (which I find offensive and extremely undesirable), we would still have the problem of a person in the paid area simply opening the exit door for "friends" -- a technique that is well known to anyone who has ever watched the back doors of bases at many locations in Los Angeles.

    With such arrangements, the boarding passenger would have to "pay" through a farebox-style machine to enter[19]. There would be numerous problems with such arrangements, including security, maintenance, and servicing of the fare collection devices. Also, while this method would work well for passengers boarding with

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[19] There are many obvious problems with this arrangement -- to give just one, what would prevent a patron who is not eligible for any discount fares to enter by paying a discount fare? There would be no operator or attendant charged with ensuring that proper payment is made or any way, other than perhaps review of security tapes, to determine what fare was paid.

tokens or currency/coins, the question of how passengers boarding with passes and transfers would get through the gates would have to be resolved.

In such a system, fare collection would be extremely dependent upon the inherent honesty of system patrons, because there would not be much in the way of other fare security arrangements.

•• If we went to a non-barrier system, similar to that used on the Blue, Green, and Red Lines, many of these problems would be simplified, but others would replace them. The barriers would disappear, which I believe would be very desirable from both system design and ascetic viewpoints. There would be a proof of payment system required for entry into the paid station area. For pass and transfer passengers, there is no problem -- the pass or transfer is the proof of payment. However, for token and currency boarding passengers, we'd now need not a farebox, but a ticket vending machine. While, in the former example, we would be basically assuming that anyone who got past the "farebox" must have paid the proper amount, in our barrier-free system, each passenger is required to have a proof-of-payment -- it is not sufficient for the machine to merely receive the payment, it must issue a receipt[20].

Another problem would be the number of machines required at each station -- on the rail lines, there are at least two TVM's at each station. The number of machines required is a balancing act between the number of passengers who will be buying tickets at one time vs. cost of extra machines vs. the problems that occur if there are no working machines at a station where passengers are attempting to board -- and these things require a lot of maintenance, especially if some riders figure out that they get to ride for free if the TVM's aren't working.

Of course, if we go to self-service, barrier-free paid areas, there will be an absolute requirement for fare inspection on the line. Because of differences in load levels and other factors, I believe that the costs of fare inspection on a bus guideway would likely be far higher than that on rail lines (on a cost per passenger basis to achieve similar levels of inspection). When one considers that, on the Los Angeles rail lines,

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[20] Fareboxes cost in the order of several hundred to several thousand dollars, depending primarily upon the features desired, while ticket vending machines run close to $100,000 or more. The costs of "pulling the fares" every day and maintaining the fareboxes or ticket vending machines would be an expensive process.

Also, there would be a requirement for data communications between the TVMs and central control. On Los Angeles rail lines, the standard security arrangements are closed circuit television (CCTV) monitoring of the TVMs and an intercom between the TVMs and Central Control to answer patron questions re ticketing issues. These are not inexpensive items, either for initial capital or operations and maintenance.

it is only fairly recently that the cash fares collected began to exceed the cost of collecting the cash, this could be a bit of a financial problem.

- With unattended stations, certain technological security improvements are likely to be desirable, including:

    - CCTV monitoring of the "paid" and other passenger areas and the TVMs (it may be possible to cover both the TVMs and passenger areas with a single CCTV camera, which would greatly decrease both capital and operating costs)
    - Emergency signal, operable by passengers, with intercom -- remotely accessible by security to listen in to what's going on at stations (with signs to that effect)
    - Public address system at stations
    - Public (pay) telephone

The above mentioned problems with using the stations as paid boarding areas cause me to believe that traditional, pay-on-boarding may be more desirable. This is mainly a matter of the boardings per station -- if we are commonly boarding dozens of passengers per bus per station, then attended stations may begin to be justifiable at some locations. However, as stated above, I believe that the Curitiba levels of boardings are extremely unlikely to exist at Los Angeles, with the possible exception of a few stations with heavy loading patterns where the use of attendants may be justified.

You will also note that busway lanes are running "backwards" in my diagram -- on the left side of the two-lane busway. With center loading platforms -- which appears to be the only way to get stations in place in the Exposition Blvd. "island" in the section of roadway west of USC[21] -- there are only two ways to get this to work. The first is what is shown, reversing the lanes. The second is to put the doors on the left sides of the buses. This presents a wide variety of problems, including the extra cost of the custom work and figuring where to put the farebox so that passengers can get at it while the operator can monitor it.

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[21] There are two separate problems here. One is that the existing rail line is in the middle of the street and I have assumed that it will be desirable to run the busway lanes there.

A different option is to locate the busway lanes on one side of the street, most likely the North side. This would involve paving over the existing center island and moving the general use lanes over. However, even if this was done, there would still be a second problem, fitting in two side boarding stations into a rather narrow road cross section without taking general use street lanes or parking (indeed, it looks like there will be problem even fitting in a single central boarding station). While there are other station arrangements that can be utilized, as discussed above, the "wrong way" lane/center loading station arrangement has certain benefits that may cause it to be adopted.

While either of these methodologies will solve the "center platform boarding" problem, I have opted for the former because I am assuming that, outside of this section of Exposition Blvd., we will use side loading platforms, primarily because their use makes bus to bus transfers without crossing a street possible.

ATTACHMENT
COMPARATIVE MAXIMUM MODAL CAPACITIES

			Light Rail		Red Line	
	Busway	El Monte	LB-LA Blue	Maximum	Branch	CBD
Minimum Headway	45 seconds	15 seconds	5 minutes	3 minutes	6 minutes	3 minutes
"Trains"/Hour	80	240	12	20	10	20
Cars/"Train"	1	1	2	3	6	6
Crush Load	270	63	230	230	301	301
Passengers Past a Point Per Hour	21,600	15,120	5,520	13,800	18,060	36,120
Average Speed	21	52	21	21	24	21
Index	453,600	786,240	115,920	289,800	433,440	758,520

COMPARATIVE ACTUAL USABLE MODAL CAPACITIES

	Busway	El Monte	LB-LA Blue	Maximum	Branch	CBD
Minimum Headway	45 seconds	≈1 minute	6 minutes	3 minutes	6 minutes	3 minutes
"Trains"/Hour	80	49	10	20	10	20
Cars/"Train"	1	1	2	3	6	6
Average Load	200	31.2	69	70	100	150
Passengers Past a Point Per Hour	21,600	1,529	1,380	4,200	6,000	18,000
Average Speed	21	52	21	21	24	21
Index	453,600	79,498	28,980	88,200	152,000	378,000

MODAL CAPACITIES

Modal capacity, as this term is utilized in this context, refers to the ability of a guideway transit system to provide transportation to passengers, measured in two ways, (1) passengers carried past a point in an hour, and (2) passenger miles produced per hour..

The formula for modal capacity can be divided into two parts.

In the first part, if one multiplies the number of "trains" per hour (for this purpose, a bus is considered as a "train") times the number of cars per train times the passengers load, the result will be the number of passengers that can be carried past a point on the transit guideway in an hour. For bus, the number of cars per train in always one; for rail, the "consists" can vary widely from one car to over a dozen.

The second step is to multiply the product of the first step by the average operating speed. This recognizes that a mode that moves people faster produces a higher quantity of transportation. The final product is an index that, technically, is the number of passenger-miles produced per hour over a guideway that is at least as long, expressed in miles, as the speed of the guideway, expressed in miles per hour.

This formula was then applied in two ways: (1) the *maximum* capacity, which assumes the highest number of trains per hour, the longest possible consists, and the maximum ridership at all times on all cars on all trains[22], and (2) the *actual* results achieved based on actual data (or forecasts, for modes not yet operational).

Each of the modes is discussed below in turn.

CURITIBA BUSWAY

This is the "express bus" network in Curitiba, operating on the five high speed guideways. In particular, the results shown are for the line running Southeast from the central business district (CBD) to Boqueirào, which we were informed was the heaviest used busway.

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[22] "Crush" load means the maximum number of passengers that can "legally" be put on a train car. It is possible to cram in slightly more people than the crush load maximum, but this is highly undesirable from a passenger comfort viewpoint, let alone the safety requirements. As a practical matter, it is fairly rare for rail crush loads to be violated, particularly in Los Angeles, partly because urban transit trains are designed to operate with a large number of standees, partly because rail operations are generally more subject to safety inspection, and because the rail loads are just not that heavy at the current time with an incomplete rail system, even with the current bargain fare structure.

MTA has many bus lines that operate with loads that are larger than the legal maximums every day of the year and have for decades.

Our understanding was that bi-articulated buses departed every minute from Boqueirào to the CBD during peak, with buses added at Carmo, the next major stop, to bring the headway down to 45 seconds[23]. We were also told that the average operating speed on the busways was 33-35 kilometers per hour (kph). The midpoint, 34 kph, is equal to 21 miles per hour.

The bi-articulated busway buses are shown in "Curitiba Development With Quality of Life" as capacity of 270 passengers (page 21). I used this as the busway bus "crush load." From my observations of these buses in service in the downtown area and at the stations towards the ends of the lines, I decided to use an actual average load of 200. This is admittedly an arbitrary number based on limited data and may be too high or too low.

EL MONTE BUSWAY

The "actual" data is from Caltrans (1992).

The guideway itself can handle a far greater throughput of vehicles than the 240 (15 second headway) shown. Caltrans reported 1,213 high occupancy vehicles sharing the lane with the 49 buses, which produces an average headway for all vehicles of slightly under three seconds. Even after adjusting for the longer length of buses and bus operating characteristics, it appears that an average headway of five seconds (720 buses an hour) is "doable" and is actually well below the absolute maximum traffic. There are two limiting factors, however: (1) the "docking" capacity all along the guideway would have to be increased many times over, and, (2) more important, where would all these riders be coming from?

For the "maximum" capacity, I used a 145% load factor, which was the MTA *local* bus load standard pre-Consent Decree. The *actual* MTA express bus standard, however, is 100%, partly because of a desire to provide a greater degree of comfort for riders taking longer (distance) trips, partly because standees on express buses pose significant safety hazards in the event of accidents or evasive actions.

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[23] For technical reasons, what may be going may be more buses than what we have assumed. If the departures from Boqueirào are actually every 60 seconds, then to add buses at Carmo, they may be "splitting" the 60 second headway, resulting in a 30-30-60 pattern. This would produce 90 buses an hour, but, more important, would show that the line can handle a 30 second headway, which means that the line could actually operate 120 buses an hour if there is a need.

There is at least one other possibility, that as buses are added at Carmo, buses dispatched from there to produce even 45 second spacing. However, this would require some fairly fancy footwork in dispatching at Carmo -- although not necessarily fancier than what is laid out above.

BLUE LINE

The "actual" is current standard, except that the average passenger load was derived from a 1993 passenger count of 62.6 at peak. This was increased to 69 to approximate the growth in Blue Line ridership since 1993[24].

230 is the published crush load on the Blue Line cars. These cars are slightly under 90 feet long and have 76 seats. (The Curitiba bi-articulated buses, which are slightly over 81 feet long, have only 57 seats, and are also considerably narrower than the Blue Line cars.)

The Automatic Train Control (ATC) system on the Blue Line, coupled with other systems, will allow operations at a minimum headway of five minutes (twelve trains per hour in each direction). At the present time, the minimum peak headway is six minutes (ten trains per hour). With changes to ATC and other systems, the Blue Line headway could be reduced, but this would pose certain operating problems, and it is not clear that there is a demand for a higher level of service.

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[24] The Long Beach-Los Angeles Blue Line currently has the highest ridership, measured by average passenger load, of any U.S. light rail line ("line" refers to a single set of tracks, as opposed to a light rail *system*, such as the Boston Green Line, or San Francisco MUNI Metro, both of which consist of several different lines which share common trackage through their respective central business districts.

One of the main reasons, if not *the* main reason, for this high Blue Line ridership appears to be the "flat fare" structure, which allow Blue Line patrons to ride as long as 21 miles end-to-end for (currently) $1.35 cash, a 90¢ token, or the "regular" (non-zone) $42 monthly pass. The express bus service from Long Beach to Los Angeles which was eliminated after the Blue Line began service (and which was faster for most passengers) had a fare (under the current fare structure) of $2.85-3.35 cash, or $2.40-2.90 total cost with the use of a token. A transportation model run by the Southern California Rapid Transit District Planning Department, which predicted the ridership with the flat very extremely accurately, forecast "zone fare" (in other words, the "bus" fare structure) Blue Line ridership of approximately half of the "flat fare" ridership.

RED LINE

The "crush load" on the Red Line cars is 301[25]. The maximum train length is six cars. The Red Line ATC allows a minimum three minute headway on the "CBD" section between Union Station and Wilshire/Vermont, where the line divides. Assuming alternating trains past Wilshire/Vermont, the Pico/San Vicente and North Hollywood extensions will each have a six minute minimum headway[26].

I utilized an average load per car of 100 for the "branch" lines and 150 for the "CBD" section. Since Red Line cars have 59 seats, these are 169% and 254% of seated load, respectively. The reason that the loads are shown as smaller for branch lines is because the "branch" lines become the "CBD" line when they reach the common stations -- where there must be space for additional passengers to board the trains. The "average" passenger loads for the branches is (more-or-less) the average of the (fairly) low ridership boarding at the end stations and the loads carried when they reach the first common station. The average load for the CBD is (more-or-less) the average of the ridership at the first common station and the end of the CBD leg.

The "CBD" speed of 21 mph is from my actual measurement. The 24 mph branch speed is MTA projection[27].

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25 The Red Line cars have a nominal length of 75 feet, compared with 90 feet for the Blue Line cars. However, Blue Line cars have operator consoles on each end, while Red Line cars only have operator stations at one end (Red Line cars are coupled in what is called "married pairs," with operator station at the ends of each *pair* -- this means that Red Line trains must have an even number of cars [2, 4, or 6], while the Blue and Green Lines can operate single car consists). The articulated hinge sections of the Blue/Green Line cars have lower passenger capacity than the non-articulated sections. The Blue Line cars have four sets of doors (which allow for a large number of standee riders) while the Red Line cars have three sets of doors. Perhaps most important, the Red Line car are wider than the Blue Line cars, which means that far more standees can be accommodated in the isles.

The rail car crush load calculation is generally controlled by the *weight* of the passenger load, rather than the space taken up by the passengers, as is true for buses, as well (assuming the California Vehicle Code is enforced).

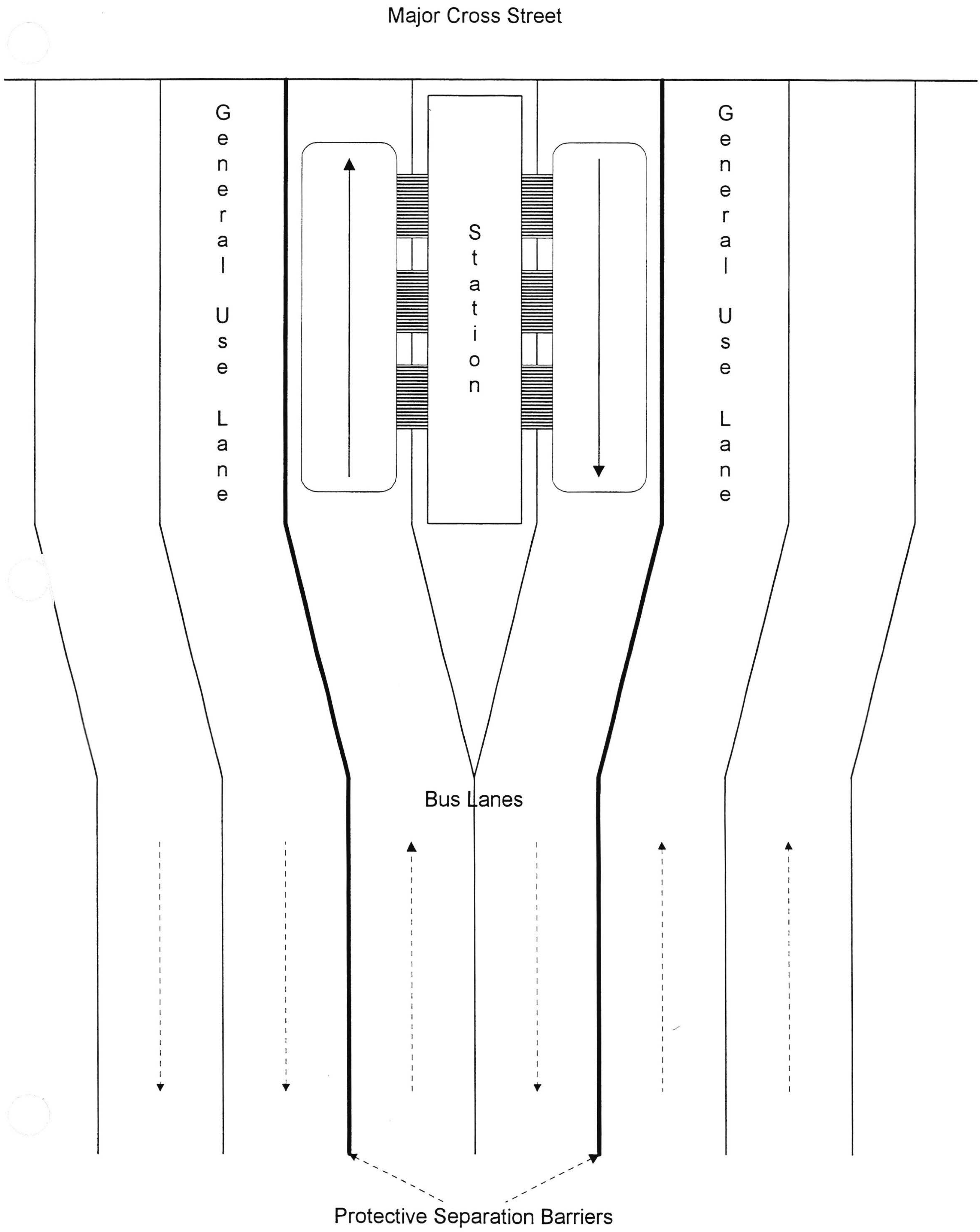
26 The last "built out" Red Line operating plan I have seen had two "routes," one from North Hollywood to Union Station and the other from Pico/San Vicente to East Los Angeles. Stations between Wilshire/Vermont and Union Station would be served by trains from both "routes" under this plan.

27 The relatively tight turns in the CBD section, coupled with speed reductions

(continued...)

[27](...continued)
designed to partially counteract excessive wheel/rail wear, have resulted in speeds slower than originally projected.

It will not be possible to be totally sure of the Red Line operating speed until actual service commences.



Major Cross Street
General Use Lane
Station
General Use Lane
Bus Lanes
Protective Separation Barriers