REPORT

TO

THE LOS ANGELES METROPOLITAN TRANSIT AUTHORITY

ON

A STUDY OF BUS TRANSPORTATION AS A MEANS OF MASS RAPID TRANSIT

FOR

LOS ANGELES

JANUARY 31, 1955

COVERDALE & COLPITTS
CONSULTING ENGINEERS
120 WALL STREET
NEW YORK 5, N Y.

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January 31, 1955

The Los Angeles Metropolitan Transit Authority
2233 Beverly Boulevard
Los Angeles 57, California

Dear Sirs:

Complying with your request as expressed in our agreement of September 1, 1954, we submit herewith our "Report to the Los Angeles Metropolitan Transit Authority on a Study of Bus Transportation as a Means of Mass Rapid Transit for Los Angeles."

We highly appreciate the co-operation given us by the members of the Authority and its staff, particularly the General Manager and the Secretary. We wish also to acknowledge the assistance and information supplied by City, County and State officials, the Highway Division of the California Department of Public Works, the California Public Utilities Commission, the Los Angeles Police Department, the Los Angeles Transit Lines and the Metropolitan Coach Lines.

Very truly yours,

Coverdale & Colpitts

Consulting Engineers

I - INTRODUCTION AND SCOPE

The scope of this report is to inform the Transit Authority:

First; whether, in our opinion, the operation of buses using freeways, highways, streets and loading zones, such facilities as are now available and such as are contemplated in the near future, will be a complete and satisfactory solution to the Los Angeles transit problem; and

Second; the extent to which bus operation might be improved by the addition of off-surface facilities for the service of congested areas.

By "complete" we mean a transit system in which all of the passenger transportation over the entire area can be conducted by buses without any auxiliary form such as rail transportation. By "satisfactory" we mean a service that will transport passengers comfortably and with such a degree of convenience, reliability, safety and speed that it will be competitive with the individual automobile. In the Los Angeles area this means a transit system capable of carrying on any route where necessary, upwards of 12,000 passengers per hour in the direction of maximum flow, at average over-all speeds not less than 25 miles and preferably in excess of 30 miles per hour; a type of transit which by diverting people from individual automobiles will relieve the freeways, city streets and highways of the equivalent number of motor vehicles. The proper development of all parts of the metropolitan area requires a reasonably easy flow of traffic between them.

For a proper understanding of this matter it is essential to consider the Los Angeles Metropolitan Area and the particular features which affect the movement of passenger traffic therein.

Los Angeles County with a population of 4,650,000 in 1953 had a habitable area on the coastal plain of 1,100 square miles and is estimated to have by 1965 a population of 6,000,000 within the same area and to continue a rapid rate of growth thereafter; the population already being estimated at over 5,200,000. The major development of the Los Angeles Metropolitan Area has occurred since the advent of the automobile and it is the only large city in the United States of which this is true. Largely because of the availability of individual automobile transportation, the population is widely scattered and the density per square mile is low, greatly different from the older cities in the East with their greater population concentrations. The ratio of automobile ownership to population in the Los Angeles area is the highest of any comparable urban area in the world and in no other such area is so great dependence placed on the private automobile as the principal means of passenger transportation. For these reasons, the streets in the area outside of the Central Business District have been specially designed to carry motor traffic and in recent years a system of freeways has been provided, and is still undergoing development, which permit rapid and convenient transit by individual automobile. The freeways and the use thereof are discussed in Chapter II of this Report. The history of the freeways has been that as they have been completed they have been used almost to capacity at certain hours of the day. Almost half of the people using these freeways travel in a period of two hours in the morning and of two hours in the evening. The resulting congestion increases the time required for trips on the freeways and impairs the latter's ability to give satisfactory transportation. As the population in the City and in those areas tributary to the freeways increases the congestion will increase and will tend to extend further from the

center of the City toward the periphery. Nonetheless, because of the relative convenience and ease of travel by individual automobile it is evident that a mass rapid-transit system in Los Angeles, to furnish satisfactory service, must be of a type superior to most systems in use in American cities. It must be fast, comfortable, convenient, reliable and safe, and to such a degree as to furnish service competitive with the private automobile. A mass transit system that might be acceptable in New York or Chicago would not be acceptable in Los Angeles.

It seems evident that for many years to come buses operating on the freeways in Los Angeles will provide, for certain areas, a good rapid-transit system. It is equally apparent that buses will be the major facility for collection and distribution of traffic carried on the main arteries, but it is equally apparent that in some areas, where there are concentrations of population, particularly in the San Fernando Valley and Pasadena, that the operation of buses on freeways, because of the congested conditions on parts of the freeways in rush hours, will not be fast enough or sufficiently reliable to entice the users of individual automobiles to give them up for mass transit facilities; and the freeways, highways and city streets will become more and more congested. The fact that the slowest trips occur in the rush hours is significant because in those hours fifty per cent of the riders must be carried and these are the very riders for whom mass rapid-transit facilities are primarily designed.

Therefore, we are approaching this problem with the idea that a service is not complete and satisfactory unless it is adapted to the entire area and is sufficiently attractive to induce present users of private automobiles to patronize the mass transit facilities and so eliminate needless congestion on the freeways, highways and city streets. Many cities

in the United States are dependent on mass transit facilities which are far from satisfactory but they are using them because of inability to finance more satisfactory facilities. We are not here considering such systems as satisfactory for Los Angeles.

It is true that Los Angeles is very much decentralized and there are many subcenters, yet it is still true that every weekday from 600,000 to 700,000 people come to the Central Business District. Our studies set forth in our Report to the Authority of January, 1954, indicate that the number of such travelers to and from the Central Business District may be somewhat less twenty years hence but will still be substantial in amount. It is evident that if the character of the Central Business District is to be maintained some form of mass transportation must be developed which will relieve the congestion on the streets and require less space for the parking of individual automobiles. The present movement of individuals in and out of the business center is equivalent to more than 400,000 automobiles a day in each direction. A mass rapid-transit system that will provide a fast, comfortable, reliable and safe ride with convenience reasonably comparable to the private automobile is likely to reduce substantially the number of automobiles on the freeways and city streets and become what might be termed an "adequate" mass rapid-transit system.

The first matter to investigate in the determination of adequacy of bus transportation is the quality of mass transit service that can be rendered by buses operating on the freeways - both those now in use and those still to be built - and to compare this service with that which can be provided by surface-free facilities either bus or rail. For instance, buses can attain a reasonable speed while operating on the freeways, but

when they are obliged to leave the freeways they then can move no faster than any other vehicle on a city street. If there were a surface-free facility available to carry the buses, either an elevated highway or a bus-subway, the over-all time required by the buses would be reduced, and the congestion on the city streets would be relieved.

A complete analysis of this problem over all routes in the Los Angeles Metropolitan Area is impossible at this time because of lack of information, but comparisons of other types of mass rapid transit are available in certain specific areas, using for the most part information gathered by us in the monorail study reported in January, 1954, supplemented by some additional data.

The areas studied are those served by the following routes:

(a) Van Nuys to the Downtown Business District.
(b) Downtown Business District to Long Beach.
(c) Downtown Business District to Pasadena.
(d) Glendale and Burbank to the Downtown Business District.

In each case we have considered the character of service rendered by existing facilities: improvements possible by providing surface-free facilities for buses, and improvements that might be furnished by a completely surface-free rail rapid-transit line.

II - FREEWAY SYSTEM IN THE LOS ANGELES METROPOLITAN AREA

An important consideration in the study of bus operation on freeways is the extent and location of the freeways to be used for this purpose, not only at the present time but in the future, as additions and extensions may be added. We conferred with representatives of the California Department of Public Works, Division of Highways to obtain the latest and most complete summary of the freeway program.

The earliest highway construction to freeway standards in the Los Angeles Metropolitan Area was on a section of the Pasadena Freeway, formerly known as the Arroyo Seco Parkway. This was completed in 1940. A section of the present Hollywood Freeway through Cahuenga Pass was also completed in the same year. Construction of freeways was suspended during World War II but was reactivated immediately thereafter. All of the present freeways are being built by the Division of Highways, Department of Public Works, State of California with gas tax funds and other motor vehicle fees.

The original plan for freeways in the Los Angeles Metropolitan Area included a very complete system of urban expressways completely covering Los Angeles County. Because of the urgent need for improvements on existing highways and the limited funds available, the Division of Highways is constructing only the parts of the proposed freeway system which will also serve to modernize the State highway routes through the area. As of September 1, 1954, $300,000,000 had been spent or authorized principally from State funds for freeways in the three-county area including Los Angeles, Ventura and Orange counties. Earlier sections of what is now the freeway system were built with funds from State, local and Federal sources. This covered less than eight miles of freeway. An additional $14,000,000 allocation came from

special Federal funds for a section of freeway considered vital to national defense. This freeway program is summarized in the table below. Rural freeways have been listed separately since they do have some intersections at grade and utilize much of the old highway facilities in their construction, thereby reducing the cost.

	Los Angeles Metropolitan Area Freeways as of September 1, 1954				
	Miles Adopted	Miles Complete	Miles Under Construction	Still in Planning	Cost to Date
Urban	256	64	32.9	159.1	$282,000,000
Rural*	115	87	12.9	15.1	32,000,000
Total	371	151	45.8	174.2	314,000,000

*Includes Santa Ana Canyon Freeway and rural portions of Golden State and Ventura freeways.

Plans for the future are based on favorable action of the legislature in continuing the present gas tax rate but do not include any estimate of Federal funds that may become available from the President's National Highway program. The Los Angeles area will have a budget of about $40,000,000 per year for the three-county district. At current construction costs the average mileage completed in each year will be 8 to 10 miles including urban and rural freeways. At this rate of construction it will take at least 17 years to complete the 174 miles of freeways still in the planning stage as shown in the above table. The program contemplates some rather expensive construction over the mountains between West Los Angeles and Sherman Oaks on the Sepulveda Freeway and several major intersections of freeways.

A special revolving fund has been set up to purchase and hold rights-of-way well in advance of the construction which will make it possible to effect savings by buying the rights-of-way while areas are relatively undeveloped.

For the purpose of this study we have assembled the following summary of the freeways as they exist at the end of 1954 and the extensions and additions that can reasonably be expected to be completed in the next five years based on present plans of the California Division of Highways. These are shown on the map - Exhibit I - at the end of this report.

Freeway	Completed September 30, 1954		Additions in Next Five Years	
	Mileage	Description	Mileage	Description
Hollywood	10.0	From Spring St. just north of Temple, west over the 4-level intersection through Hollywood to Vineland Ave. and Ventura Blvd. in North Hollywood.	-	————
Santa Ana	28.3	14 miles of continuous full freeway from Spring St. east to Pioneer plus additional sections from the Los Angeles-Orange County line to Tustin in Orange County.	6.7	Full freeway from Pioneer to Los Angeles-Orange County line and grade separations at important intersections in Orange County making full freeway for almost all of the 35-mile length. (2 additional miles of full freeway have been opened making 16 miles continuous.)
Ramona	9.8	From junction with Santa Ana Freeway just east of the Los Angeles River east to Rosemead Blvd. and a section further east through the cities of Pomona and Claremont to the Los Angeles-San Bernardino County line.	21.6	Complete to Los Angeles-San Bernardino County line. (5.2 miles of the eastern section have been opened between Sept. 30 and Dec. 31, 1954.)
Pasadena (Arroyo Seco)	8.0	From 4-level crossing to Glenarm and Arroyo Parkway in Pasadena.	-	————

Freeway	Completed September 30, 1954		Additions in Next Five Years	
	Mileage	Description	Mileage	Description
Harbor	1.7	From 4-level crossing south to Washington Blvd.	10.5 (appr.)	From Washington Blvd. south to Imperial Blvd. (0.7 miles additional have been opened south to 23rd St. since Sept. 30.)
Golden State	-	———	14 (appr.)	From Burbank south along the general line of the Los Angeles River, crossing the Pasadena Freeway, continuing southeasterly to a crossing of the Ramona Freeway in the vicinity of Soto St. and turning south to a junction with the Santa Ana Freeway and proposed Olympic Freeway.
Olympic	-	———	3 (appr.)	From junction with Santa Ana and Golden State freeways west to intersection with Harbor Freeway. Construction would be in progress west of this point but the Freeway would probably not be open.
Long Beach	2.8	From 223rd St. south to Pacific Coast Highway.	9.0	From junction with Santa Ana Freeway south to completed section at Long Beach Blvd. and Atlantic Blvd. (4.2 miles have been opened since Sept. 30 completing Freeway from intersection with Atlantic Ave. in North Long Beach south to Pacific Coast Highway.)

Freeway	Completed September 30, 1954		Additions in Next Five Years	
	Mileage	Description	Mileage	Description
Ventura Freeway (portion within LA city limits only)	-	————	17 (appr.)	From junction with Hollywood Freeway west. Entire project extends beyond city limits as limited access expressway but mileage shown is for full freeway within the city limits.
Sepulveda Freeway	-	————	13 (appr.)	From junction with Ventura Freeway south to Culver City.
Terminal Island	3.0	Short freeway and bridge connecting Terminal Island with mainland. Built with Federal assistance.	-	————
Colorado Freeway	0.4	New bridge over Arroyo Seco.	1.2	Extended bridge approaches. (All present work completed by Dec. 31.)
Totals	64.0		96.0	

Of the work listed as additions in the next five years 13.3 miles were opened by December 31, 1954, (as indicated in the foregoing table), leaving a balance of 83 miles to be built. While this figure does not represent entirely new mileage and considerable amounts have been expended for rights-of-way and construction under existing contracts, the estimated additions represent a tight scheduling of funds and unless additional revenue is found or costs drop appreciably, the actual openings may fall behind this schedule.

No other major changes are contemplated with funds currently available with the possible exception of some work on the Allesandro Freeway.

VEHICULAR TRAFFIC ON THE FREEWAYS

Except for the Pasadena Freeway and short sections of the Ramona and Hollywood freeways, which were built earlier by the City of Los Angeles, very little freeway mileage was open for use before 1950. Since that time, however, the entire Hollywood Freeway, most of the Santa Ana Freeway, most of the Ramona Freeway, a short section of the Harbor Freeway and the southern end of the Long Beach Freeway have been opened to traffic. The extensions or improved connections were completed on all of these major freeways in the year between July, 1953 and July, 1954, in which month the Division of Highways makes its annual traffic counts. While conditions are not the same for each of these counts, the increase from one year to the next serves to illustrate the rapid growth in traffic volume as new facilities are opened. The table on the following page compares the annual 16-hour traffic counts made by the Division of Highways in 1953 and 1954 respectively.

These counts are recorded hourly on the hour. On this basis they show that all the freeways except a short section of the Harbor Freeway are up to and beyond the design capacity of 1,500 vehicles per lane per hour if the 35 miles per hour speed is to be maintained. Separate counts have been made on the Hollywood and Pasadena freeways recording the vehicles by 15-minute periods. On the Hollywood Freeway a total of 8,800 vehicles per hour was recorded in the outbound direction in the evening rush hour. This is a flow of 2,200 vehicles per lane, well over the design capacity of the Freeway. On the Pasadena Freeway the flow was only slightly less, being 8,000 vehicles per hour or 2,000 per lane. Our field observations summarized in Chapter III show the effect of this traffic load, plus other factors, on the speeds attained by buses and private automobiles on the freeways.

Freeway	ane ound	Notes
Hollywood	36	Freeway completed between Hollywood Blvd. and Highland Avenue between count dates. Other counts have shown 8,800 vehicles in maximum hour outbound or 2,200 per lane and a 24-hour total of 168,000 vehicles.
Santa Ana	98	Extended from Todd Avenue to Pioneer Blvd. between count dates.
Ramona	04	Extended from Atlantic Blvd. to Rosemead Blvd. between count dates.
Santa Ana and	08	San Pedro Street to Vignes Street section opened as full freeway between count dates.
Pasadena	03	Opened from 4-level crossing to Adobe Street between count dates. Solano is north of Adobe. Another count showed 8,002 vehicles in the maximum hour or over 2,000 per lane in the evening.
Harbor	95	Not open in 1953.

POPULATION

We have shown that the freeways are already up to capacity in the hours of maximum traffic flow. As the population increases these freeways will become more and more congested.

In contrast with the rate of provision of freeways the rate of growth of population in Los Angeles County is projected as follows:

Estimated Population

1953	4,650,000
1955 (January 1)	5,241,600
1960	5,500,000
1970	6,600,000
1980	7,500,000

Note: These population estimates are taken from Report to the Authority of January, 1954, page 21 of Ruscardon Engineers' Section, except that for January 1, 1955, which is that of California Tax Payers Association.

The growth of population in other sections is as follows:

Year	Pasadena	Van Nuys	Glendale & Burbank	San Fernando Valley Area	Long Beach Area	Bellflower Area
1930	76,086	14,059	78,996	57,030	146,372	18,145
1940	81,864	28,268	116,485	110,919	170,068	30,632
1950	104,577	79,973	173,832	300,831	268,570	82,382
1953	112,100	105,214	194,070	371,277	318,468	128,441
	Los Angeles Chamber of Commerce	Ruscardon Engineers, page 23 of Monorail Report of January, 1954				

Even with a continuation of the decentralization process it is evident that the main traffic arteries will be congested long before additional arteries can be provided and the maintenance of the present average speed on the freeways will no longer be possible. Therefore, on those routes where the main stem density will exceed about 12,000 persons per hour, as explained later on page 43, some other form of rapid transit than buses will be necessary or desirable if passengers are to be induced to abandon the automobile for mass transit.

In Los Angeles Central Business District only about 31 per cent of the regular riders traveling to and from that section come by mass transit. This is in striking contrast to the experience in other cities comparable in size with Los Angeles. In other cases the number using mass transportation is roughly one-half or more of the total, as a minimum.

III - SUMMARY OF FIELD WORK

Extensive observations of actual traffic conditions on the various freeways and important highways serving the study area and on principal downtown streets were necessary to supplement the data accumulated for the Monorail Report. In addition it was necessary to examine possible rights-of-way for bus and rail facilities in downtown Los Angeles and in outlying areas not included in the Monorail study area.

1. Automobile Time-Distance Checks in the following areas:

Hollywood Freeway
From downtown Los Angeles to Van Nuys using existing freeway to Vineland and Ventura and city streets beyond - checks were made to cover both directions during all periods of the day, particularly during the rush hours.

Pasadena Freeway (Arroyo Seco)
From downtown Los Angeles to the center of Pasadena using the Pasadena Freeway for its entire length - checks were made in both directions during all periods of the day, particularly during the rush hours.

Santa Ana Freeway
From downtown Los Angeles to Washington Boulevard using the Santa Ana Freeway entirely. Most trips were to Atlantic Avenue only since this is the next major interchange beyond the junction with the Long Beach Freeway. The junction is still under construction - here again the checks were made during the entire day.

Ramona Freeway
From downtown Los Angeles to the present end at Rosemead Boulevard - checks were made in both directions during all periods of the day.

Harbor Freeway
From downtown Los Angeles to the present end at 23rd Street in the evening rush only. This is only a short section of the freeway and has not developed its full traffic potential at this time.

Huntington Drive
From downtown Los Angeles to the center of Pasadena morning rush, evening rush and midday.

Glendale & Burbank on
Various Principal Streets
From downtown Los Angeles to Glendale and Burbank during the morning and evening rush periods.

Four drivers were used to make these studies and were rotated so that a better average speed might be obtained particularly during the rush hour.

2. Checks on Present Bus Operations:

Elapsed time checks on all buses using the Hollywood Freeway for part of their route during the morning and evening rush hours and midday.

Elapsed time checks on buses from Los Angeles to Pasadena during morning and evening rush hours.

Elapsed time checks on buses using the Pasadena Freeway as part of their route during morning and evening rush hours.

Elapsed time checks on buses using the Ramona Freeway as part of their route during morning and evening rush hours.

Elapsed time checks on buses using the Aliso Street Bridge (part of Santa Ana Freeway) during morning and evening rush hours.

Elapsed time checks on buses entering and leaving downtown Los Angeles on freeway for the portion of the route on Hill and Olive streets in the downtown area.

Riding spot checks on rush hour trips on all routes using the Hollywood Freeway, the Santa Ana Freeway and the routes on city streets from Los Angeles to Pasadena.

3. Check on frequency and extent of vehicular back-up on the Hollywood Freeway west of the four-level crossing. This was conducted for five days during the morning rush hours.

4. Additional field observations of traffic conditions on all freeways in or near the downtown area to determine the location and pattern, if any, of the traffic delays occurring regularly in this area.

5. Observations as to the maximum speeds attained by buses when unhindered by traffic conditions on both level sections, and on the more severe grades over Cahuenga Pass.

6. Check on number of buses stopping at bus turnouts at the Hollywood Freeway, at Alvarado Street and Vermont Avenue. These checks included the length of stop and the boarding and alighting.

7. Observations of the present rail service to Glendale, including schedule performance, condition of equipment, and condition of right-of-way.

8. A field study of possible routings for surface-free connections from the proposed bus terminal east to the Santa Ana Freeway, and west of the Harbor Freeway.

9. A field study of possible routes for a subway for buses through the downtown section of Los Angeles, including connections to the freeway system.

10. A field check of existing and other possible rights-of-way for rail rapid transit routes to Pasadena and Glendale.

RESULTS OF FIELD OBSERVATIONS

Bus and Automobile Speeds

Average speed for private automobiles and buses were developed for all of the major freeways now open to traffic. The speed limit on the freeways is 55 miles per hour and, except during the rush hours, the traffic was moving at or near this speed. During the rush hours, however, the speed dropped to a level in some sections of the freeway which was as slow or slower than that attainable in paralleling city streets.

On the Hollywood Freeway an average speed for both bus and automobile traffic of only 23 miles per hour was observed through the peak of the evening rush hour for the section from downtown Los Angeles to Hollywood Boulevard. Automobiles are able to maintain this speed through Cahuenga Pass to the end of the Freeway at Vineland Avenue and Ventura Boulevard, but buses are slowed to 19 miles per hour by the severe grade in addition to the other traffic conditions. Speeds inbound from Hollywood Boulevard in the morning rush are much higher - 42 miles per hour - for the automobile, but not greatly higher for buses - 25 miles per hour - due to the effect of three passenger stops. Midday and evening traffic moved freely.

There is a section of the Hollywood-Santa Ana Freeway from the four-level crossing east to the Los Angeles River where the eastbound traffic is moving at 4 to 8 miles per hour during the entire evening rush hour. Present bus operations make use of this section for a short way, but are affected to the extent of several minutes' delay in less than a half-mile of route.

On the Pasadena Freeway very low speeds were observed in the evening rush northbound from downtown Los Angeles to the Avenue 26 connection to San Fernando Road. Both buses and automobiles averaged less than 20 miles per hour in this section. From Avenue 26 to Pasadena the average speed for

automobiles in the peak of the rush hour was 26 miles per hour. No buses are operated in regular service on this section of Freeway. Morning traffic moves faster and midday traffic freely.

Average speeds on the Ramona and Santa Ana Freeways are higher during the evening rush than on the other freeways, provided the Freeway is entered at First, Fourth or Seventh streets, east of the very congested area north of the Civic Center.

There is only a short section of the Harbor Freeway open to the south of the Central Business District. Average speeds in this section are less than 25 miles per hour in the evening rush hour. These speeds follow the pattern on the other freeways.

Maximum Speeds Attained by Buses on Freeways

The motor coaches now being operated on the freeways were observed at speeds in the 50-to-55 miles per hour range when traffic conditions permitted on all sections of the freeways except through Cahuenga Pass where the grades limited the speeds to 20 miles per hour on the upgrade.

Observed speeds are summarized for the various freeways in a table on the following page. These speeds were one of the sources of information used to develop the running time comparisons for each of the four study routes.

Limitations to Freeway Capacity

In making time and distance runs during rush hours it was found that conditions were different almost every day. However, delays were common enough and extended over a long enough period of time to indicate that a lower average speed would have to be scheduled for buses even though better performance might be possible on an occasional trip. On other sections of

OBSERVED SPEEDS ON FREEWAYS

Section of Freeway	Observed Speed (Miles Per Hour)				
	AM Peak Inbound		Midday	PM Peak	Outbound
	Buses*	Automobiles	Buses* and Automobiles	Buses*	Automobiles
Hollywood Freeway					
Central Business District to Hollywood Boulevard	25	42	50-55 Buses 35-40	23	23
Hollywood Boulevard to end (buses to Barham Blvd. only)	22	36	50-55 Buses 25	19	23
Pasadena Freeway					
Central Business District to Avenue 26 (San Fernando Road)	30	35	50-55	19	19
Avenue 26 to end	-	35	50-55	-	26
Ramona Freeway					
Central Business District to end	20**	35	50-55	35**	35
Santa Ana Freeway					
Central Business District to Atlantic Boulevard	-	35	50-55	30	30
Beyond Atlantic Boulevard	-	-	50-55	30	35
Harbor Freeway					
Central Business District to Washington Boulevard	-	-	50-55	-	23

*Bus operation is nonstop except on Hollywood Freeway where three stops are made.

**Buses operated from Marengo Street to Garvey Avenue only, at the time of observations.

the freeway the current traffic flow and the design and layout of ingress and egress roadways are so related as to cause a serious slowdown during rush hours. All of these factors are important to any study of possible use of freeways as routes for buses performing mass transit service and assume added importance when examination of the hourly traffic counts on the freeway shows the heavy traffic flow to be of two hours' duration. In the evening rush the peak hour is only 10 per cent greater than the second heaviest hour of travel on all freeways except Hollywood where the peak hour exceeds the next heaviest hour by about 20 per cent.

It is not the intent of this report completely to analyze traffic conditions on the freeways, other than as they control speed of movement, but the following locations and conditions limiting the free flow of traffic or the flow of bus traffic were noted:

1. Congestion at the four-level interchange.
2. Congestion at freeway junctions.
3. Congestion at "on" and "off" roadways.
4. Excessive lane changing.
5. Drivers unfamiliar with freeway layout.
6. Accidents.
7. Heavy commercial vehicles in rush hour traffic.

Congestion at the Four-Level Interchange

Observations showed delays to be frequent both morning and evening on the main roadways and interchange roadways of the four-level crossing. While the crossing itself is not the primary cause of delays, a delay which seriously impedes any of the major interchange movements can rapidly be spread to all freeway movements in the same general direction and back along the freeway approaching the interchange area.

The additional time required on rush hour automobile and bus trips through this area is a variable factor and can be allowed for only

in part by adding running time. In the case of bus operations there will usually be several buses in the rush hour which will be unable to maintain their schedule as a result of the longer delays.

Congestion at Freeway Junctions

Additional running time must be allowed for both buses and automobiles for the serious delays which are a usual condition at the junction of the Santa Ana and Ramona freeways in both directions both morning and evening. Completion of two additional lanes on the bridge over the Los Angeles River that forms the western approach to the junction is expected to improve this somewhat by providing four lanes instead of the present three to handle the six lanes of merging inbound traffic.

In considering traffic conditions on sections of freeway as yet incomplete, it was found that a similar junction is to be built between the Long Beach and Santa Ana freeways. Since the traffic on the Santa Ana Freeway alone is very heavy at the junction point, it may be that the new junction will produce similar conditions.

Congestion at Ingress and Egress Roadways

The free movement of traffic is impeded in the vicinity of access roadways whenever there is a near-capacity volume of traffic on the freeways. In the evening rush hour a condition occurs near the Central Business District where at some important points the traffic volume trying to gain access to the freeway is greater than the freeway can absorb at high rates of speed, resulting in serious slowdowns for both the entering and through traffic. On the outer sections a backup occurs on the freeway where city

streets are unable to absorb the traffic leaving the freeway as fast as it accumulates. Both of these conditions contribute to the slow rush hour speeds.

Similar delays occur on inbound trips in the morning rush hour but such delays result more in congestion on city streets approaching the freeway than on the freeways themselves.

Excessive Lane Changing

Changing lanes is currently listed as one of the prime causes of accidents on the freeways - second only to excessive speed. In addition to the lane changes incidental to passing movements on the part of individual operators, the present layout of freeways includes a number of places where many vehicles enter at one side and must move within a relatively short distance to the other side of the freeway to make the proper turn at a junction or turnoff. Much of the extreme congestion on the Hollywood-Santa Ana Freeway east of the four-level interchange is due to many such lane-change movements. Motorists entering the Freeway in this area are trying to get in position toward the left lane for the junction with the Ramona Freeway, while motorists approaching from the west are trying to maneuver to the right to use the egress roadways to the downtown streets. Average speeds as low as 4 miles per hour have been observed for extended periods on this section of Freeway. No planned surface-free routes for buses should connect with the freeways within this congested section.

Excessive lane changing is again a result of the freeway layout on the Pasadena Freeway north of the four-level crossing. In this case many vehicles from the north and east sides of downtown Los Angeles enter

the main Freeway from the right at two principal feeder streets north of the four-level crossing, but, the next two principal exit streets are on the left side of the northbound roadway. All lane changes must be completed before entering the tunnels less than one-half mile north of the last major entrance. Delays in this area slow the flow of traffic to the same or slower speed than would be expected for a major city street during the critical evening rush hours.

Drivers Unfamiliar with Freeways

Drivers who are not well acquainted with the freeways cause delays and create at times some serious traffic hazards in trying to correct their oversights at the last minute. The freeways are exceptionally well signed in advance of the turnoffs, but a basic knowledge of the City is required to anticipate the approach of the desired turnoff and allow adequate time to move to the proper lane.

Accidents

Recent statistics show the accident rate per million vehicle miles to be much lower on the freeways than on heavily traveled city streets; but when compared on the basis of miles of street or freeway, the frequency per mile of road is about the same. Accidents on the freeways have a much greater effect on the flow of traffic than those on the city streets. Any accident, even a minor one with little or no damage, if it stops just one lane of traffic in the rush hour, creates a serious delay. One lane removed from service on the Hollywood Freeway during the extreme rush hour causes 8,800 cars per hour to be funneled through three instead of four lanes. One such accident was observed on a time-distance run in the evening rush hour near Glendale Boulevard. The delay due to this accident caused traffic to back up all the way to the downtown streets and of course slowed the movement from the downtown

area to all the freeways.

Delays are aggravated by the lack of alternate routings to handle the concentration of traffic, and once a serious delay occurs, it usually persists through the rush hour until the traffic volume drops. Unless a system can be devised that will simultaneously divert traffic at a number of egress lanes to several paralleling through streets, the freeway traffic cannot be successfully rerouted around the delay. Accidents are a very important factor in determining the reliability and safety of the service.

Heavy Commercial Vehicles on Freeways

Trucks are permitted on all but a very limited section of the freeway system. During most of the day their presence has no effect on the speed of the freeway traffic, but they have a noticeable effect during the hours of maximum traffic. While these vehicles are limited by law to a lower speed than the passenger cars, the real problem is the inability of the truck to follow at a fixed distance under maximum traffic conditions. The result is to slow the entire lane to the speed of the truck or, as is more frequently the case, encourage the automobile driver to pass the truck even though traffic conditions are not suitable.

There is also the problem of speed on grades. Whenever the grade is sufficient to slow the truck noticeably, faster vehicles following in the same lanes tend to change lanes and pass. This causes frequent "traffic humps" at rush hour volumes, and slows the entire flow of traffic.

It is understood that there is a voluntary move on the part of the major truck operators to keep heavy trucks off the freeways during rush hours, particularly the evening rush hour. Extension of this move to all trucks would help relieve congestion.

USE OF FREEWAY BUS STOPS

The number of westbound buses and passengers using freeway bus turnouts at Alvarado and Vermont avenues during the maximum hour of the evening rush were as follows:

Stop	No. of Routes Serving Stop	Buses Serving Stop 4:45 to 5:45 PM			Passengers Served		
		Stopping	Passing without Stopping*	Total	Alighting	Boarding	Total
Alvarado	4	23	34	57	39	1	40
Vermont	2	15	-	15	17	12	29

*All buses are scheduled to stop. All except two used the turnout roadway.

The Alvarado Street bus turnout is served by approximately 100 outbound buses in the two heaviest hours of the evening rush. Similar service is offered inbound in the morning rush hours. These buses operate on one route of the Los Angeles Transit Lines and three of the Metropolitan Coach Lines. LATL buses will carry passengers between Alvarado Street and downtown Los Angeles if the Zone 2 (Hollywood Zone) fare is paid and passengers can transfer to and from the Alvarado Street bus route. Passengers are also carried between this stop and points to the west. Metropolitan Coach Line buses will pick up outbound and discharge inbound only, and this

is so stated in the public timetables for the three routes serving Alvarado Street. Transfers are exchanged with the Alvarado Street bus route. Since approximately 80 per cent of the buses serving the stop will not pick up passengers inbound or discharge outbound, and the remaining buses charge an extra fare, all signs adjacent to the stairways at street level which formerly directed passengers to the inbound stop have been removed. During the middle of the day only two Metropolitan routes serve the stop with a total of 11 buses per hour in each direction.

Passengers have local bus service available at Temple Street, a few hundred feet to the south. This route operates all day on closer headways, gives the same downtown delivery, charges the local fare, and takes only slightly longer to reach downtown Los Angeles.

The Vermont Avenue turnout is served by approximately 30 outbound buses in the two evening rush hours, operating on two Metropolitan Coach Line routes. Passengers may board or alight in either direction. Most of the riders to Vermont Avenue, however, find it more convenient to use either the LATL Beverly Express, which leaves the Freeway at this point to proceed west on Beverly Boulevard, or the Metropolitan Coach Line Sunset Boulevard route which leaves the Freeway and proceeds north on Vermont Avenue to Sunset Boulevard. Both of these routes connect with the Vermont Avenue streetcar route at street level. The Sunset Boulevard bus and the Vermont Avenue streetcar use the same loading zone. The only convenience offered to passengers using the Vermont Avenue turnout on the Freeway is direct service to points on Olive Street south of Olympic Boulevard.

During midday only three buses per hour in each direction serve this Freeway turnout while eight per hour load on the street and use the Freeway from Vermont to downtown Los Angeles.

No fare complications exist at this point. Stops have been provided on the Vermont Avenue streetcar route convenient to the stairways to the Freeway bus turnout.

The Western Avenue bus turnout is close to the intersection of Western Avenue and Santa Monica Boulevard. Approximately 20 buses stop outbound during the two evening rush hours, and 13 inbound during the two morning rush hours. A two-hour check made during the morning rush hours showed only five passengers boarding and ten alighting at Western Avenue from inbound buses. Connections can be made to the Western Avenue bus service. Passengers desiring to go west on Santa Monica Boulevard are served by one branch of the Hollywood-Van Nuys route which operates on Santa Monica Boulevard from the Freeway west to Highland Avenue.

The value of the Western Avenue connection is reduced by the fact that rush hour express service via the Freeway is available on Hollywood Boulevard and Sunset Boulevard, the two principal streets to the north, and on Beverly Boulevard to the south. During the midday period when the other routes do not operate via the Freeway there is no bus service on the Freeway at this stop so that the stop is used only during rush hours.

As presently used, the bus turnouts have little value to the transit riders. In each case conditions have been set up to encourage the majority of the riders living near the turnouts, or passing the turnouts in the course of their trip, to use another route in preference to the routes stopping at the Freeway bus turnout.

GENERAL CONCLUSIONS AS A RESULT OF OUR OBSERVATIONS

The conclusion is that bus service on the freeways will always be limited as to speed by the degree of congestion on the freeways, and hence trip times will be longest in rush hours where time is most valuable to the user, and there will always be an element of unreliability.

Bus turnouts as now used have little value.

IV - CAPACITY OF BUS OPERATIONS ON FREEWAYS

USE OF BUSES ON FREEWAYS FOR MASS RAPID TRANSIT

Within the next five years it is expected that sufficient additions to the present network of freeways will be open to traffic to provide at least one freeway in each direction from the center of Los Angeles, except to the west and southwest. The connection to the west, however, should be under construction and open to operation not long thereafter.

The question arises as to what extent buses will be able to make use of these freeways, and if they will thus be able to furnish adequate mass rapid transit. There are a number of ways in which buses can be operated, each with certain advantages and disadvantages, as follows:

1. Express Operation Only with No Stops on the Freeway

This is the simplest type of operation and has many precedents in other cities. It makes express service available to any area where the traffic potential between the pickup area and the delivery area is great enough to justify such transit service and provides the fastest possible ride by bus. It has the disadvantage that the economic frequency of service is dictated by the traffic potential of the pickup area for the individual route and, where local service is also necessary, the express service is sometimes limited to rush hours.

2. Express Operation with Stops at all Freeway Loading Zones

The addition of stops on the freeway makes it possible to extend the express bus service to persons along the freeway route, or reaching the freeway route on local vehicles. This is done at some sacrifice in running time on the part of passengers boarding the bus before it enters the freeway. As already

stated on page 29, little use is made of the stops on the freeway as buses are now operated.

3. Express Operation with Buses Leaving the Freeway at Intermediate Points and Returning to the Freeway After Making Stops on City Streets

This type of operation makes it possible to link intermediate commercial centers with the outlying residential areas on the one hand and Central Business District on the other. It is a necessary type of routing where the intermediate center is important and, while not located on a freeway, is near enough so that the resulting bus route is convenient for both local and through passengers. Travel time from outlying residential areas to the Central Business District would be longer, but the increase in potential traffic would make more frequent service practicable.

In actual practice the operation would probably be a combination of the three types of service. During hours of maximum travel, there would be many routes operating express with no stops, or perhaps only an important stop or two at intermediate business centers, or at important transfer points. Other buses might operate express to an outlying stop and then make all stops on the remaining section of their route on the freeway. As the traffic volume fell there would be fewer routes offering through service to the downtown area. Buses on routes which continued through service would make more stops at freeway loading zones to pick up passengers transferring from the less heavily patronized routes, which would have only shuttle service.

FREEWAY CAPACITIES UNDER IDEAL CONDITIONS

The following theoretical capacities and speeds for bus operations on freeways show the maximum obtainable under ideal conditions. No interference from other types of vehicular traffic is assumed. The capacities are shown for one lane but the figures for buses not making passenger stops are applicable to any lane of the freeway. The figures for buses making passenger stops, of course, can be applied only to the lane adjacent to the stops.

Given the exclusive use of one lane of the freeway the buses can then follow each other at a distance consistent with comfort and safety. These distances for various speeds are as follows: 30 miles per hour - 160 feet; 40 miles per hour - 250 feet; 50 miles per hour - 360 feet, and 60 miles per hour - 480 feet. These distances allow the coach to be brought to a fast stop well within the braking ability of the bus and at a low enough decelerating rate to minimize the possibility of injuring the passengers.

The theoretical maximum hourly flow, developed by relating these stopping distances, are as follows:

Speed (Miles per Hour)	Maximum Hourly Flow
30	792
40	728
50	660
60	609

When stops are added to the route there is a reduction in average speed proportional to the spacing of the stops. These lower speeds are shown on the next page for the various maximum vehicle speeds on the basis of a 20-second allowance for passenger interchange at each stop.

Not all of the buses in the maximum hourly flow can stop at the bus stops because of the 20-second allowance for passenger interchange.

The bus loading zones on the freeways will accommodate up to three buses so the theoretical capacity of the stops has been developed for one, two and three buses stopping at the same stop. If stops are to be made, it can be shown that under the above conditions as to length of stop, capacity of turnouts and maximum speed, the maximum theoretical capacity over long distances is obtained if the buses are scheduled in groups of three and make all the stops. These would be the only buses operating in this lane of freeway because further analysis shows that any other combination of some buses stopping and others passing without stopping causes conflicts at the points where the bus making the stop again enters the freeway. To eliminate these conflicts and maintain maximum speed, one of the conflicting buses must be eliminated from the schedule and the capacity will be reduced accordingly.

Theoretical carrying capacity in terms of buses and passengers per hour are summarized as follows:

40 Miles per Hour Maximum Speed	Buses per Hour	Passengers per Hour Seated	Scheduled Speed at Various Stops per Mile			
			Two per Mile	One per Mile	One in Two Miles	One in Three Miles
No stops	728	36,400	-	-	-	-
One bus stopping	146	7,300	22.0	28.6	33.3	35.3
Two buses stopping	208	10,400	22.0	28.6	33.3	35.3
Three buses stopping	243	12,150	22.0	28.6	33.3	35.3
50 Miles per Hour Maximum Speed						
No stops	660	33,000	-	-	-	-
One bus stopping	110	5,500	22.0	30.5	38.0	41.3
Two buses stopping	165	8,250	22.0	30.5	38.0	41.3
Three buses stopping	220	11,000	22.0	30.5	38.0	41.3

PRACTICAL CAPACITY OF FREEWAYS FOR BUS OPERATION

Theoretical calculations have given freeway lane capacities of over 700 buses per hour, if no stops are to be made on the freeway; and as low as 110 per lane per hour if the buses are all operated on one route making stops at all freeway loading zones handling a fair volume of passengers at these stops. These calculations are based on a lane free of other traffic and with split-second control of buses entering the freeway and operations at 40 to 50 miles per hour maximum speeds between stops. Present operations on freeways, and similar limited access facilities, have been studied to determine how much can be expected from the buses in actual practice.

1. Present Use of Freeways in Los Angeles

Buses are operated on portions of all the principal freeways now completed. The section of the Hollywood Freeway from Vermont to the four-level crossing is the most intensively used, with over 60 buses of the Metropolitan Coach Lines and Los Angeles Transit Lines using this section in the outbound direction during the peak hour of the evening rush. These buses are all scheduled to stop at the bus turnout at Alvarado Street, although the passenger traffic is small, since passengers are not ordinarily handled between this stop, and downtown Los Angeles, as explained on page 28. This small number of buses - less than 0.7 per cent of the 8,800 vehicles per hour using the freeway in the rush direction - is hardly a factor in the freeway traffic, but the buses are carrying over 3,300 passengers who would require an additional lane of freeway if they were to ride in private automobiles.

2. Buses on the Outer Drive in Chicago

The Outer Drive, extending north and south along Chicago's Lake Front, is essentially a freeway in its design. Buses have been operated on the Drive for years, serving both the North and South Sides. The heaviest volume is on the North Side where buses from three Chicago Transit Authority routes, and two suburban operators, total more than 80 in the heaviest hour. During the evening rush, six lanes are used in the northbound direction and again the small number of buses are carrying approximately 20 per cent of the persons using the facility. Buses are able to average 20-30 miles per hour on the Drive in the rush hours but in the case of the Chicago Transit Authority routes, slow speeds in the Chicago Loop and local operation on the city street section of the routes slows the over-all rush hour speeds to 10-15 miles per hour. Accordingly the only significant time saving is for passengers boarding shortly before the bus enters the Drive and alighting shortly after leaving the Drive.

3. Buses Using The Port Of New York Authority Terminal and Lincoln Tunnel

One of the greatest concentrations of buses on a single facility occurs from the Port Authority Bus Terminal in New York through the Lincoln Tunnel to a point beyond the toll stations on the New Jersey side. During the peak hour of the evening rush, 16,000 persons are handled and 360 buses are despatched from the Terminal through the Tunnel. Originally the buses were confined to one of the two Tunnel lanes, along with the truck traffic, but experience and experimentation have shown that more vehicles can be handled if each lane handles mixed traffic. Speeds are very slow, however, and average about 12 miles per hour through the Tunnel during the evening rush hour.

From the above examples it can be seen that mass transit volumes of people are being accommodated in buses on freeway-type roadways. Speeds vary with the traffic conditions on the roadway and in all cases performance of the buses is limited by the characteristics of the total traffic flow. As has been shown in Chapter III the average speeds possible during the rush hours on the principal freeways in the Los Angeles area are less than 30 miles per hour. In addition to the low speeds it has been observed that the speed of traffic on the freeways is extremely variable and buses would be subject to continuing delays as a result of this condition.

POTENTIAL BUS VOLUMES ON FREEWAYS

Before outlining a procedure for estimating the maximum capacity of bus operation on the freeways, potential passenger traffic to be handled will be examined.

Cordon counts summarized in our Report to the Authority of January, 1954, have shown that just under 700,000 persons enter the Los Angeles Central Business District during the 12 busiest hours of a typical weekday. Of this group approximately 40 per cent or 280,000 persons enter during the two peak hours in the morning and leave during the two peak hours in the evening. The extreme peak hour occurs in the evening, during which time approximately 170,000 of this group will be starting the trip outbound from downtown Los Angeles. In Chicago approximately 65 per cent of all persons entering the Loop District in the rush hour use mass transit facilities. If the same ratio were to be applied to the Los Angeles Central Business District, assuming adequate mass transit facilities, the number of persons using mass transit facilities would be 110,000, requiring 2,200 buses, if all passengers are to be given seats and if bus transportation is to be the sole form of mass transit.

With the development of the freeway system, as outlined in Chapter II, plus the Olympic Freeway, two-thirds of the buses would be able to use the freeways for some portion of their route from downtown Los Angeles. This would make a total of just under 1,500 buses entering the freeways during the maximum hour. These buses would be distributed over many routes in all directions. Most of them would be from routes using the freeways all day but a considerable number would be express buses to outlying portions of routes where the regular service does not use the freeway.

The maximum concentration on any one freeway would probably be on the section of the Harbor Freeway between the Olympic Freeway and the Hollywood Freeway, since all the buses using the Harbor, Olympic, Hollywood, Pasadena and Golden State freeways would use this section to reach downtown Los Angeles. If a bus terminal were to be provided with surface-free connections to the freeways as many as 500 buses might enter Harbor Freeway in each direction from the terminal during the peak hour. This group would be distributed over the other freeways at junctions so that, on all freeways beyond this section of the Harbor, approximately 300 buses would be the greatest peak hour concentration and this only on the freeways where the riding is heaviest. This volume would be further reduced as additional buses leave the freeways at principal interchanges.

LIMITATIONS ON THE THEORETICAL CAPACITY OF FREEWAYS

Many practical considerations serve to reduce the theoretical number of buses that can be accommodated on the Los Angeles freeways. Our previous discussion has shown that the operational problems on the freeways are principally rush hour affairs. With this in mind, the following factors serve to limit the number of buses that can be operated on the freeways.

Design

While all calculations of theoretical capacities of freeway lanes for bus operation are based on the exclusive use of a freeway lane or lanes, this is impossible to accomplish with the present freeway design. As now laid out, freeway bus stops, with one exception, are located on the right hand side of the freeway between egress and ingress lanes. Even if automobiles were eliminated from the normal traffic flow in the right-hand lane, it would still be necessary for them to cross the right-hand lane to reach the egress roadways. Bus stops are usually located in the vicinity of these ingress and egress roadways so that any modifications at this late date to separate these traffic movements would be expensive. The accelerating and decelerating lanes for each bus stop would approximate 2,000 feet in length so that if such stops were frequent these lanes would constitute almost an additional lane in each direction.

As a practical matter, buses on longer runs would operate toward the right, but not necessarily in the extreme right-hand traffic lane. In this fashion the buses would be able to move with the faster lanes of traffic, avoiding the congestion on ingress and egress roadways, except at the few places where bus stops are located. Where the bus stops are close together, it is necessary for the bus to remain in the right-hand lane because of the short distance between the end of the acceleration lane from the preceding bus stop and the deceleration lane for the next stop.

Buses operating on the Los Angeles freeways already follow this practice, and this has been the rule on most similar operations in other cities. Using the freeways in this fashion, it is doubtful whether the number of buses required by any of the bus routes studied would have any difficulty finding their places in the freeway system of traffic. Here

again the limitation on bus operation is the speed of the traffic. Additional buses, even though they can be accommodated, would tend to reduce the speed of all the traffic.

Traffic Movement on Freeways

The average speeds of bus operations would be established by the speed of the general traffic flow. The reduced speeds observed on all freeways during rush hours indicate that the freeways have already reached capacity at those periods and that the introduction of more buses in large numbers would reduce the speed still further, unless the use of buses reduces the volume of automobile traffic. Until a marked diversion from automobiles can be achieved, the slowdown and the accompanying irregularities will be a serious deterrent to the attractiveness of the service.

Riding Patterns

Theoretical capacities have been calculated on the basis of an even flow of vehicles over an entire hour. Passengers, on the other hand, do not arrive at the pickup points in such an even flow. During the evening rush hour there are variations in the rate at which passengers gather, which are directly related to the closing hours of the various offices, stores and small manufacturing plants in downtown Los Angeles. Many offices are now closing at 4:30, while 5:00 P.M. is still the most popular closing time; so that the extreme peak demand for service follows these closing times and is of a half-hour duration, after which the demand for service drops noticeably. When this pattern of demand for service is related to the theoretical maximum flow of vehicles, it is found that this maximum flow is required for only the half-hour period.

BUS OPERATIONS ON DOWNTOWN LOS ANGELES STREETS

One of the important limitations on the operation of any bus system, whether it enters the downtown area by way of freeways or city streets, is the capacity of the streets in the downtown area to accommodate bus operations. If freeway buses are to use the downtown streets to distribute and pick up passengers, operations will be limited by the capacity of these streets to handle the additional load.

Our checks on Hill Street show a maximum flow in one direction in the evening rush hour of 149 buses at an average speed of 4.5 to 6 miles per hour. To handle this number of buses, separate stopping zones with capacities of at least three buses each have been set up for the two companies operating on the same street. Traffic lights are on a one-minute cycle and a movement of four buses per cycle was found by check to be a practical maximum. Under these conditions, a volume at the rate of 240 buses per hour moving at uniform intervals is the maximum that can be expected.

Because of the large number of buses now using the street, with their slow operation, it is not practicable to consider that Hill Street has capacity available for additional bus service. The other north-south streets serving the Central Business District are Main, Spring, Broadway and Olive. Of these streets, Main and Broadway and, to a lesser extent, Spring are used intensively by existing transit routes. Olive Street is also used intensively south of Fourth Street; severe grades of over 10 per cent make it impracticable for transit use north thereof. All major east-west streets are also used to capacity by transit and other vehicular traffic. Some few additional buses can probably be accommodated on all streets. However, closer supervision than is now provided is necessary

in the downtown area, and at all points along the routes. This is necessary to insure the smoothest possible flow of buses into the downtown area and to keep these buses moving as evenly and rapidly as possible along the downtown streets. Even with such measures, the capacity of these streets would not be increased sufficiently to provide adequate routes for any large number of additional buses.

Since the number of transit passengers entering the downtown Los Angeles area is assumed to rise from its present level of one-third of the cordon count volume to a level more typical of eastern cities of one-half to two-thirds the cordon count volume, and since average speeds in the downtown streets are already low, it is obvious that the streets lack the capacity to provide for adequate bus service.

BUS OPERATION FROM A DOWNTOWN TERMINAL

The additional buses required could be accommodated by an off-street bus terminal if adequate surface-free access is provided to connect the terminal with the freeways. With suitable prepayment facilities for fare collection, buses can be more rapidly loaded and despatched than from any downtown street where several stops are made, fares collected on the vehicles and the latter are subject to street traffic delays.

Speeds would be improved by the use of a bus terminal. With the surface-free connections to the freeway, buses would be able to maintain speeds of 25 miles per hour from the terminal to the freeway as compared with the present rush hour speed of 4 to 6 miles per hour on the city streets.

The ultimate capacity of a bus terminal would be determined first, by the area that could be devoted to loading and despatching buses

and second, by the capacity of the connections to the freeways. We have shown previously that a maximum practical capacity of such a terminal should be 1,500 to 2,000 buses per hour at the peak. Such a terminal would be over twice the size of the present Port of New York Authority Terminal in New York City and would require in its ultimate development 4-lane roadways connecting it to freeways on the east and west sides of downtown Los Angeles.

In the chapters which follow we have analyzed four specific areas to be served by rapid transit facilities and have considered such service rendered (a) by buses operating on freeways and (b) by rail rapid transit. In these studies one-quarter of the bus terminal is considered as being available to the routes serving three of those study areas: Hollywood-North Hollywood-Van Nuys, Glendale-Burbank, and Pasadena. Buses would operate to these areas from the terminal by way of the Harbor Freeway, making connections at the four-level crossing with the Hollywood and Pasadena freeways and a further connection between the Pasadena and Golden State freeways. Our calculations, to be explained in detail in later chapters, indicate that under the conditions assumed between 425 and 500 buses would have to leave downtown Los Angeles during the peak hour of the evening rush hour to serve these areas. Approximately half of these buses would use the Hollywood Freeway, and the balance the Pasadena Freeway after passing the four-level crossing. This limits the capacity of one of these major freeways to approximately 250 buses in the peak hour, or, at 50 people per bus, to a total of 12,500 passengers. Further reduction in capacity would exist beyond the junction of the Pasadena and Golden State freeways since the 250 buses using the Pasadena Freeway would take different routes at this point to serve their respective areas.

The great number of buses required for our study areas indicates that even at the outset such a large bus terminal would be operating very close to capacity and allows very little space for the additional growth that should result from the tremendous population increase now taking place in the Los Angeles area.

Summary

Consideration of all the above factors affecting the passenger-carrying capacity of a bus system using the freeways indicates that limits will be established not by the freeways themselves but by the capacity of the downtown facilities, and capacities of the facilities in major outlying centers, to handle the large numbers of buses that would be required.

QUALITY OF SERVICE AS A RESULT OF OPERATING ON FREEWAYS

Among the factors that can be used to measure the quality of any transportation facility are:

Speed
Frequency
Comfort
Reliability
Safety

Speed

Utilizing the freeways gives the bus an opportunity to approach closely the speed of the automobile. With improved terminal facilities, and surface-free connections, the outbound bus might in some cases have a shorter running time than the automobile to the freeway exit. Checks show that, even in the congested evening rush hours, buses are moving with the traffic and averaging 18 to 25 miles per hour, a speed range considered standard for present type local rapid-transit service. This also exceeds

the 12 to 15 miles per hour range for express bus operation on the city streets. Non-rush hour speeds can be considerably higher, averaging better than 35 miles per hour for the freeway portion of the route.

Some improvement in the rush hour speeds can be hoped for as more freeways are built, and ingress and egress lanes improved, but will probably be limited to relief of extreme congestion, and the increase in average speeds on the freeways will be no greater than five miles per hour in the congested areas.

Frequency

As mentioned earlier, frequency is directly related to the traffic carried and the route layout. According to our calculations, the traffic potential increases as a result of more extensive freeway utilization, and better facilities for handling the buses in the Central Business District, but not enough to permit the establishment of large numbers of alternate routes from the study areas to downtown Los Angeles via the freeways. It is probable that during the rush hours some through bus service can be extended over heavy feeder routes. During most of the day, however, it will still be necessary to depend upon feeder systems which would take advantage of the available local business, as well as the through riders, by connecting with the downtown buses at local commercial centers. This is not unlike the present pattern of service.

Comfort

Buses similar to the latest type purchased by the Metropolitan Coach Lines incorporate a much improved suspension system, and a more spacious interior resulting from a wider body. The improvements in coach design, coupled with freeway operation, where the roadway surface is superior to

that of most of the city streets, and where changes in speed due to traffic congestion, traffic lights and passenger stops are fewer, will provide a more comfortable and attractive ride. Loading standards on buses allow less crowding in the Los Angeles area than in most of our large cities. Due to the above considerations, the quality of bus service in Los Angeles is improved.

Reliability

Frequent variations from schedule are one of the big disadvantages of bus operation. Since the bus is moving with the automobile traffic, it too is subject to all the delays that are part of the traffic pattern. Moving from the city street to the freeway does not free the bus from traffic delays, but merely changes the character thereof.

Our checks have shown that there is no fixed pattern or schedule for these traffic delays. Some of the principal points where congestion occurs regularly have been identified, but it has been impossible to predict when slowdowns will begin and how much they will affect the average speed of the traffic. Arrival-time checks, taken in the North Hollywood area in the evening, showed different patterns on each day checked.

In addition to the delays due to congestion, those due to accidents must be considered. The evening rush hour, when congestion is greatest, and equipment requirements on the bus routes are at their maximum, is also the period when accidents occur most frequently.

To offset these conditions, it is necessary either to provide extra buses to compensate for the delays, or to accept occasional overloads as normal.

Arrival delays in the outbound direction, which affect the connections with feeder routes, are a serious deterrent to building a strong

feeder system. The rider who has to board an already crowded bus, or wait some time for another, is easily persuaded to join a car pool or drive his own car.

Safety

Records indicate fewer accidents to passenger cars per million miles on the freeways than on city streets. This same experience should be realized by buses.

V - TO VAN NUYS VIA HOLLYWOOD FREEWAY

In the Introduction, four specific examples of bus transportation were suggested for study, the study to include the operation both with and without an off-surface facility in the congested areas.

The first of these specific examples is the route from the downtown business area to Van Nuys via the Hollywood Freeway.

ASSUMING NO OTHER FACILITIES FOR BUSES THAN THOSE NOW EXISTING

It is assumed that the buses would start at Fourth and Hill streets, proceed along Hill to Fifth Street, west on Hill to the Harbor Freeway, thence via the four-level crossing to the Hollywood Freeway which they would follow to Hollywood and thence to the end of the freeway; thence along Vineland to North Hollywood and along Chandler and Van Nuys Boulevard to Van Nuys. These distances in miles and the observed over-all speeds are given in the table following this Chapter.

To get an idea of the number of buses required, it is assumed that the potential weekday passengers on these lines amount to approximately 120,000, as developed in our Report of January, 1954. Of this number, about 24,000 travel in the direction of maximum flow of traffic in the two-hour rush period in the morning and 24,000 in the rush period in the evening, an average of 12,000 for each of the rush hours.

For 12,000 passengers per hour, and allowing for standees 50 per cent of the seating capacity, 160 buses per hour would be required, or a bus every 22.5 seconds. This assumes no diversion of riders from private automobiles, as the bus trip is 15 minutes slower than by automobile. Actually such a volume could be diverted from automobile only by a facility giving a speed comparable with the automobile speed. (See table following this Chapter).

ASSUMING A BUS TERMINAL IN THE DOWNTOWN AREA WITH SURFACE-FREE CONNECTIONS WITH THE FREEWAYS

A central terminal in the downtown business district has been proposed as an off-surface facility. Such a facility has been explained in Chapter IV, page 42. As many as 26 platforms are contemplated which would give it a capacity of 2,000 buses per hour. This terminal might also be used for a rail rapid transit terminal, or a combination of rail and bus.

Buses would reach this terminal from the freeways by means of off-surface approaches, in this case elevated roadways. These would extend east from the terminal to the Santa Ana Freeway and west to the Harbor Freeway. Under such conditions, the estimated time required in rush hours for a bus trip from the terminal at Fourth Street to Van Nuys is 63.5 minutes, a saving of 4.5 minutes as compared with buses without off-surface facilities and a terminal. Moreover, these buses would relieve the street traffic congestion.

RAIL RAPID TRANSIT

The alternative to the long-haul feature of bus transportation is modern, high-speed rail transportation which in combination with bus lines as feeders provides many advantages, particularly as to speed. Therefore, in the discussion which follows such form of transit is compared with a system dependent wholly on bus transportation.

Such a modern high-speed rail rapid-transit line from Van Nuys through North Hollywood and Hollywood to the Central Business District, generally along the route laid out in our Report of January, 1954, as an alternate to express buses on the freeways, the average speed of such a line with stations 2.5 to 3 miles apart might be 45 to 50 miles per hour, the speed between stations reaching 60 to 70 miles per hour.

Recent developments in rail rapid-transit equipment permit the attainment of such speeds.

COMPARATIVE RUNNING TIMES

	Minutes Los Angeles to Van Nuys	Minutes Los Angeles to North Hollywood
Buses without off-surface facility	68.0	45.0
Buses with an off-surface facility	63.5	40.5
Private automobiles	53.5	37.5
Rail rapid transit	30.0	21.0

PASSENGER DISTRIBUTION

To distribute passengers in the downtown area, consideration should be given to a "passenger conveyor", or a moving sidewalk, if there is found to be sufficient traffic to justify its use as a substitute for local buses. This would reduce street traffic by removal of these buses.

A conveyor from a terminal running the length of, say, Broadway from Court to Seventh Street and west on Seventh to Hope, would be about one mile in length. Such a conveyor is to be installed in 42nd Street, New York, to take the place of the present "shuttle" service from the Grand Central Station to Times Square. The cost of a conveyor has not been included in the estimates of operating costs in this report.

As an alternative to the bus terminal and its approaches, a bus subway might be built. This might be located in, say, Hill Street and run from the Santa Ana Freeway to Seventh and west on Seventh to the Harbor Freeway.

OPERATING EXPENSES

It is obvious that for a relatively small number of passengers per day, the annual costs and operating expenses for buses are less than

those for rail rapid transit, because the investment and consequently the fixed charges per passenger are less. The operating expenses per passenger, however, are higher, as one man is required to operate a bus seating 50 passengers, whereas two men operate a 6-car train seating some 360 people.

Comparative investment charges and operating expenses are as follows:

Los Angeles to Van Nuys				
	Investment	Annual Charges	Daily Potential Traffic	Operating Expenses for This Traffic
Buses	$15,310,000	$1,224,800	120,000	$10,094,400
Rail	81,750,000	6,540,000	120,000	4,943,374
Los Angeles to North Hollywood Only				
Buses	$11,800,000	$ 944,000	102,000	$ 7,005,000
Rail	49,900,000	3,992,000	102,000	1,847,226

These costs are based upon fixed charges and operating expenses for the buses and rail line as follows:

Fixed charges: These are estimated at 5 per cent interest and 3 per cent amortization on the investments. For buses, the investment consists of the cost of the buses, a proportion of the total cost of garages and a proportion of the bus terminal in the downtown business district. It was found that 385 buses would be required for the number of daily potential passengers. The cost of the buses was estimated at $22,000 each.

For the rail line, the capital investment is taken the same as that for the corresponding portion of a monorail line, as developed in our Report of January, 1954.

This does not include any allowances for damages to property owners abutting on the elevated lines, because it is not now known whether in fact such damages could ever be proved.

For comparative purpose, the operating expenses are based on the same number of daily passengers as found for this section of the rail line; namely, 120,000 per average weekday. It is extremely doubtful if buses could attract any such number.

The annual bus-miles were based on a travel pattern found for the Metropolitan Coach Line buses over this route, and the expense per bus-mile compiled from a study of the same company's costs on various lines in 1952, as reported to the Public Utility Commission, at 57 cents per bus-mile.

Usually, the operating expenses per bus-mile decrease with increase in speed. Due consideration was given to this. In the four cases considered, however, the average speeds of buses making maximum practicable use of free-ways are not enough higher than the speeds of buses operating entirely on city streets to offset the normal increase in costs since 1952.

The high-speed rail line operating expenses were taken the same as for this portion of the rail line in our Report of January, 1954, at $0.338 per car-mile.

On these bases, the costs per passenger for the 120,000 per day were:

Buses	$0.30
Rail	.305

These figures are concerned only with main line costs. They do not cover the feeder and distribution bus lines.

In none of the rail operating costs are included the ad valorem and franchise taxes, which amount to 6.5 per cent on the assessed valuation

(one half of the cost), and to 2 per cent on the gross revenue, respectively. These amount to approximately 7 cents per passenger on the rail line.

In order to estimate the variation in cost per passenger, including both fixed charges and operating expenses, with increase or reduction in the potential daily traffic, Chart 1, following this Chapter, has been prepared for the Van Nuys route as follows:

Bus- and car-miles are assumed to vary with the daily passengers.

The investment in the terminal, the portion of its cost charged to this particular route, and 25 per cent of the operating expenses are considered not to vary with bus- and car-miles. All other charges and operating expenses are considered varying with bus- and car-miles.

Similarly, Chart 2 has been prepared for the operation of buses and the high-speed rail line to North Hollywood only.

Referring to Chart 1, it will be noted that for the number of riders estimated for the buses on the Hollywood Freeway to Van Nuys, 120,000 per day, the cost per passenger is estimated at 30 cents as compared to 30.5 cents for rail rapid transit.

As the traffic increases the economy of rail rapid transit increases rapidly as compared with bus transportation, so that, at 160,000 per day, the cost per passenger becomes 27 cents for buses and 25.5 cents for rail.

Chart 1 is based upon 85 per cent of the riders traveling only between Los Angeles and either Hollywood or North Hollywood, as developed in our Report of January, 1954. This penalizes the rail line for the additional investment in the line from North Hollywood to Panorama, a distance of 7.63 miles, which would carry only 15 per cent of the riders. Chart 2 is based on the rail line extending from the Central Business District only to North Hollywood and the buses required for 85 per cent of the riders

turning back at this point as before. It will be noted that the even-cost point becomes 35 cents per passenger at about 45,000 riders per day.

In this case the costs per passenger for the estimated potential of 102,000 per day are 25.1 cents for bus and 18.2 cents for rail. At 160,000 per day these costs become respectively 22.5 and 13.5 cents.

DISCUSSION

The number of buses required for the potential passengers estimated for the maximum rush hour is 160. The practical capacity of a downtown Los Angeles street has been shown to be 180 buses per hour.

Of the 160 buses, probably about 85 per cent would be new business, or 136 buses per hour. As the number of buses on Hill Street in the maximum hour is now about 149, or almost up to the capacity of the street, the additional 136 for this route alone would congest Hill Street beyond its capacity.

Freeway capacity is not a limitation to this number of buses. Street capacity, however, is, and consequently off-surface facilities would be necessary.

The time gained between Van Nuys and the Central Business District of Los Angeles by off-surface facilities and a bus terminal is only 4.5 minutes, and the trip time is still 10 minutes longer than by private automobile. It would seem as if the time saving would not attract many more passengers to the bus than under the existing use of freeways without the off-surface facilities in the Central Business District.

However, with the freeways as they will be at the end of the 5-year period the trip time by the bus on the freeways and city streets is only 7.5 minutes longer than the trip time by private automobile. With the off-surface facilities and a bus terminal in combination with the freeways, the time required by bus is only 3 minutes longer than that required by

private automobile. Taking into consideration the advantages in the avoidance of driving and parking, that small time difference might be sufficient to attract a substantial number of passengers from automobiles. The trip time, however, is still much greater than that which a rail transit system would make possible.

It would appear that the small amount of time saving from the use of the off-surface facilities would be insufficient considered by itself to justify the expense involved in the provision thereof. The length of time required for buses to traverse the streets is a relatively small proportion of the total time involved in the long trip between the Central Business District and Van Nuys. There is, however, a substantial advantage to the City in getting the buses off the city streets and this factor alone might justify the expenditure. Off-surface facilities would be a necessity if buses alone on the freeways are to carry all the passengers who travel on public transportation with no other facility available, as the capacity of the downtown streets would be inadequate.

In contrast, the time saved by a high-speed rail line from Van Nuys to the downtown business area would be 33.5 minutes compared with buses with off-surface facilities; 38 minutes compared with buses without such facilities; and 23.5 minutes compared with private automobiles.

The saving in time by the rail line, especially for those who by virtue of location can take advantage of the full time saving, is so great as to indicate that substantial numbers of people now using automobiles could be induced to use the rapid transit facility, thus relieving the freeways and city streets of the congestion caused by the number of automobiles that are now using them.

In our report to the Authority dated January, 1954, we indicated that under certain conditions a monorail system between Los Angeles and Van

Nuys might become self-supporting. Even if it did not become self-supporting it would make a great contribution to the metropolitan area in furnishing fast transportation that would permit the development of the peripheral area without resulting congestion on the surface highways and would relieve the freeways and city streets of a substantial volume of motor traffic.

While the calculations shown are for a monorail system, we are of opinion that a conventional modern-type elevated railway could be built and operated for approximately the same costs as for the monorail system, and at the same or higher speeds.

We have shown that the time required by bus between Van Nuys and the Central Business District will, at the end of the 5-year period when the freeways in that area are completed, be only 7.5 minutes greater than the time required by private automobile. Under some circumstances this might be considered a satisfactory time comparison. In our opinion, the advantages offered by rail transit are so much greater, reducing the time required to two-thirds of that by private automobile, that buses on freeways cannot be considered a satisfactory method of rapid transit in this area. Bus transportation will lack the speed and passenger-carrying capacity necessary to fulfill our definition of "satisfactory" as set forth in the Introduction.

Comparative Running Times - Evening Rush Hour
Los Angeles to Hollywood, North Hollywood and Van Nuys

A. Present Conditions

Location	High Speed Rail Rapid Transit Line		Bus via Surface-free Route to Terminal		Bus via City Streets		Private Automobile	
	Miles	Min.	Miles	Min.	Miles	Min.	Miles	Min.
Los Angeles Downtown Terminal	0.0	0:00	0.0	0:00	0.0	0:00	0.0	0:00
Santa Monica Blvd.	-	-	5.2	14:00	5.2 (Sched. 12)	18:30	5.2	17:00
Sunset Blvd.	-	-	5.9	15:30	5.9	20:00	5.9	18:30
Hollywood Blvd.	-	-	6.2	16:30	6.2	21:00	6.2	19:30
Hollywood Hollywood & Highland (Station 6)	8.0	11:00	7.6	23:30*	7.6	28:00*	7.6	24:30
Vineland & Ventura (Station 5)	12.0	18:00	10.5	30:00	10.5 (Sched. 27)	34:30	10.5	30:30
North Hollywood Lankershim & Chandler (Station 4)	14.3	21:00	12.5	40:30	12.5 (Sched. 37)	45:00	12.5	37:30
Van Nuys Van Nuys & Van Owen (Station 2)	20.0	30:00	18.4	63:30	18.4 (Sched. 61)ø	68:00	18.4	53:30

B. With Freeways as They Will Be at the End of Five-Year Period

Los Angeles Downtown Terminal	0.0	0:00	0.0	0:00	0.0	0:00	0.0	0:00
North Hollywood Chandler & Tujonga	14.3	21:00	12.6	37:30	12.6	42:00	12.6	36:30
Van Nuys (a) Van Nuys and Van Owen	20.0	30:00	18.3	48:00	18.3	52:30	18.3	45:00

*Not on same bus route as North Hollywood.

øCommission checks show buses up to 12.5 minutes late at this point in peak of evening rush hour.

(a)Not on same bus route as Hollywood or North Hollywood.

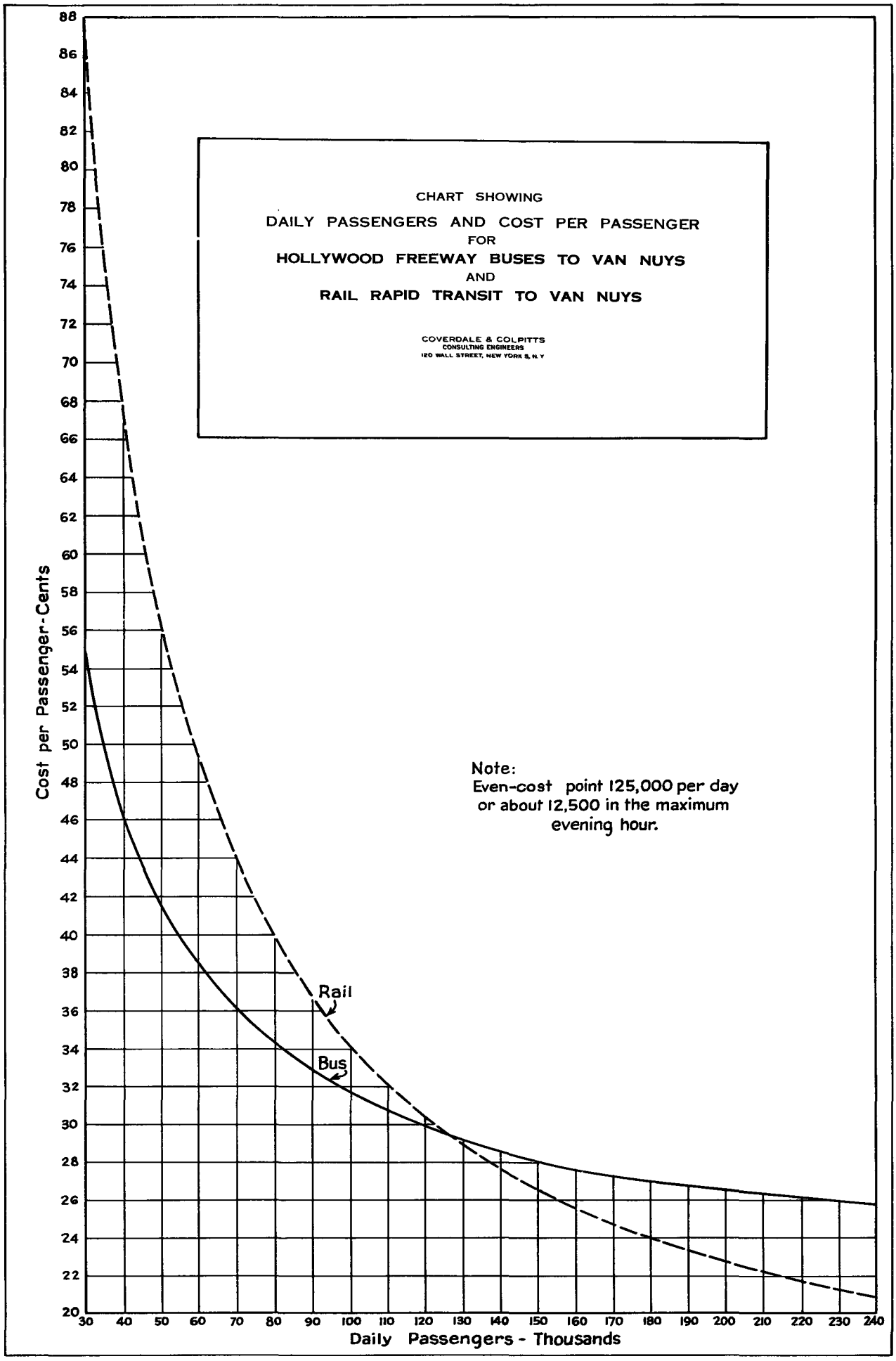
CHART SHOWING
DAILY PASSENGERS AND COST PER PASSENGER
FOR
HOLLYWOOD FREEWAY BUSES TO VAN NUYS
AND
RAIL RAPID TRANSIT TO VAN NUYS
COVERDALE & COLPITTS
CONSULTING ENGINEERS
120 WALL STREET, NEW YORK 5, N.Y.
Cost per Passenger-Cents
88
86
84
82
80
78
76
74
72
70
68
66
64
62
60
58
56
54
52
50
48
46
44
42
40
38
36
34
32
30
28
26
24
22
20
Rail
Bus
Note:
Even-cost point 125,000 per day
or about 12,500 in the maximum
evening hour.
30 40 50 60 70 80 90 100 110 120 130 140 150 160 170 180 190 200 210 220 230 240
Daily Passengers - Thousands

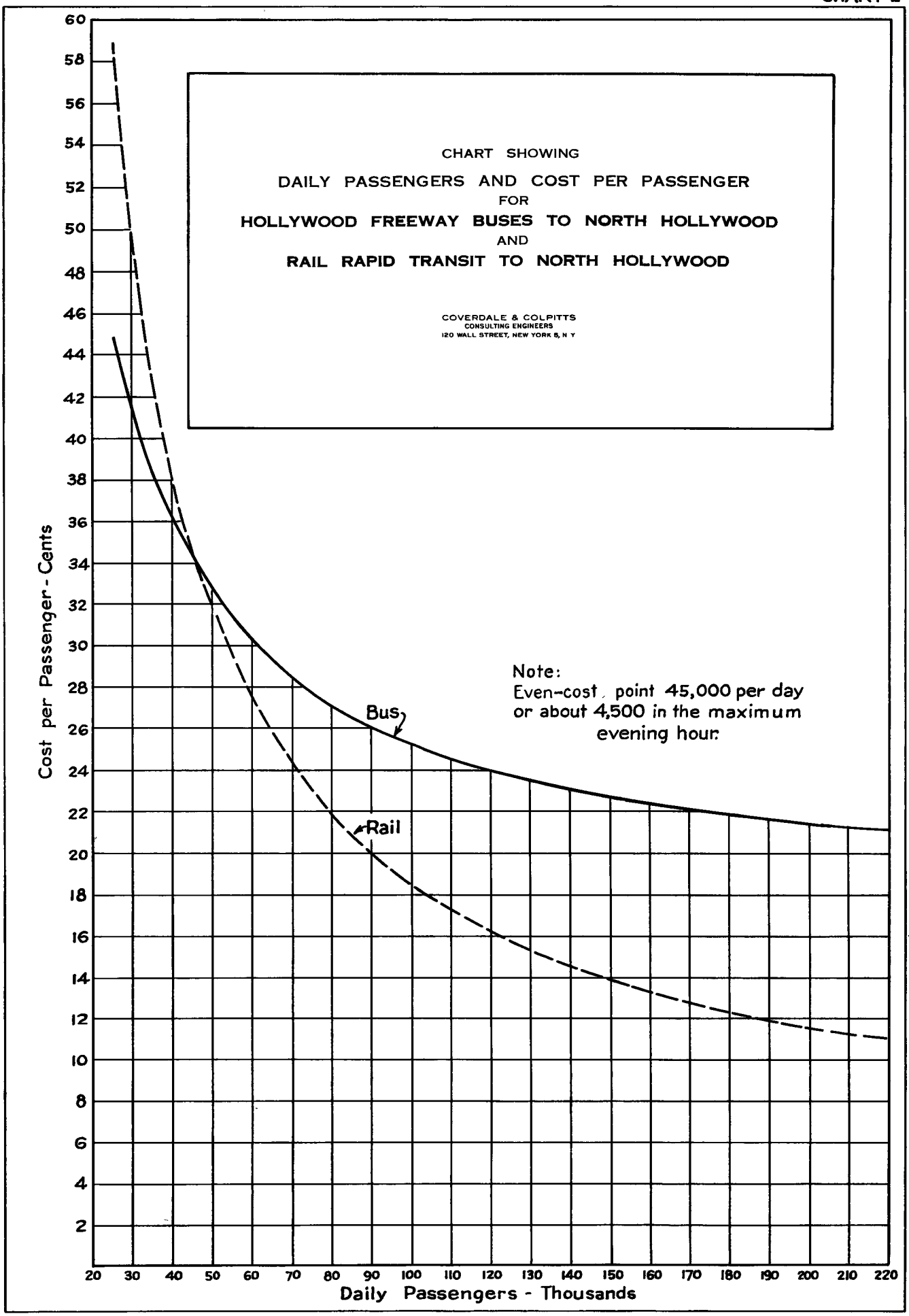
CHART SHOWING
DAILY PASSENGERS AND COST PER PASSENGER
FOR
HOLLYWOOD FREEWAY BUSES TO NORTH HOLLYWOOD
AND
RAIL RAPID TRANSIT TO NORTH HOLLYWOOD
COVERDALE & COLPITTS
CONSULTING ENGINEERS
120 WALL STREET, NEW YORK 5, N Y
Cost per Passenger - Cents
60
58
56
54
52
50
48
46
44
42
40
38
36
34
32
30
28
26
24
22
20
18
16
14
12
10
8
6
4
2
Bus
Rail
Note:
Even-cost point 45,000 per day
or about 4,500 in the maximum
evening hour.
20 30 40 50 60 70 80 90 100 110 120 130 140 150 160 170 180 190 200 210 220
Daily Passengers - Thousands

VI - TO PASADENA VIA PASADENA FREEWAY

ASSUMING NO OTHER FACILITIES FOR BUSES THAN THOSE NOW EXISTING

It is assumed that the buses would start at Sixth and Hill, proceed along Hill to Fifth Street, west on Fifth Street to the Harbor Freeway and thence to the Pasadena Freeway (Arroyo Seco) which would be followed to its end at Glenarm Street and thence north along Arroyo Parkway to Colorado Street in Pasadena, the total distance being 10.9 miles.

As buses are not now permitted to operate on the Pasadena Freeway, the following estimates are made for the purpose of illustration only.

The present bus schedule time for the trip from Fourth and Hill to Colorado Street is 46 minutes; the observed time, 50 to 60 minutes in the rush hour. This compares with 15 minutes estimated for a high-speed rail rapid-transit line and with 31.5 minutes observed for private automobiles in the rush hours. The table following this Chapter gives distances and trip times in rush hours for intermediate points, and for the discontinued Pacific Electric rail line.

To determine the number of buses required for the present passengers between Los Angeles and Pasadena, it was assumed that the buses on the Metropolitan Coach Lines would be rerouted via the Freeway. As no buses are now permitted on this Freeway, this assumption is made only for illustrative purposes. These lines are estimated to carry at the present time 12,175 passengers per weekday, or about 3,000 in the maximum hour. This means that 60 buses in the rush hour would be required, or a bus every minute.

WITH A BUS TERMINAL AT FOURTH AND HILL STREETS AND OFF-SURFACE APPROACHES

The time for buses from Colorado Street to the terminal is estimated to be 33.5 minutes, compared with 50 to 60 minutes in rush hours without the bus terminal; 15 minutes for rail rapid transit; and 31.5 for private automobiles.

RAIL RAPID TRANSIT

A high-speed rail rapid-transit line has been suggested, to be built generally along the old Pacific Electric right-of-way from downtown Los Angeles to Colorado Street, Pasadena. Such a line would have no grade crossings, being built partly as a modern elevated line and partly in open cut and would offer substantial time savings as shown in the following table.

COMPARATIVE DISTANCES AND TIMES

Distances and trip times in rush hours, Fourth and Hill streets, Los Angeles to Colorado Street, Pasadena:

	Rail Rapid Transit		Buses via Freeway with Off-Surface Facilities		Present Buses via Huntington Drive		Pacific Electric Rail Route		Private Automobile	
	Miles	Min.	Miles	Min.	Miles	Min.	Miles	Min.	Miles	Min.
Fourth & Hill Los Angeles	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sierra Vista	7.1	9.5	7.1	-	7.1	27(sch.)	7.6	28.0	7.1	33.0
South Pasadena	9.05	12.0	8.95	26.0	8.8	36(sch.)	9.2	33.0	8.95	26.5
Pasadena, Colorado and Fair Oaks	11.25	15.0	10.8	33.5	10.9	46(sch.) 50-60(obs.)	11.3	42.0	10.8	31.5

OPERATING EXPENSES

Operating Expenses are taken at 57 cents per bus-mile, as in the case of the buses for Van Nuys line, Chapter V; and at 35 cents per car-mile for rail transit, based on a hypothetical budget and considering the wages paid in Los Angeles.

Chart 3, at the end of this Chapter, was prepared as explained in Chapter V, and shows the relation in cost per passenger for bus and rail line to the number of passengers carried. In the preparation of this Chart, it has been estimated that 24,000 passengers per day would ride the rail line.

Referring to Chart 3, it will be noted that for the number of riders estimated, 24,000 per day, the cost per passenger would be 35 cents for the rail line and 25.8 cents for the buses. As the number of daily passengers increases, however, the cost per passenger would be the same at about 20 cents for 65,000 passengers per day, and thereafter with an increase in the passengers the economy of the rail line increases rapidly as compared with bus transportation, so that at, say, 120,000 passengers per day the cost per passenger for the rail line becomes 15 cents as compared with 18.5 for the buses.

DISCUSSION

The number of buses required for the potential passengers in the maximum rush hour is estimated at 67. As shown in Chapter V, this number added to the buses now operating on Hill Street would be more than the capacity of the street for buses. The other available streets are also about up to capacity in buses and trolley cars.

The time saved for the trip by high-speed rail transportation is 16.5 minutes as compared with private automobiles. This should divert

at least 20 per cent of the automobile traffic, which should materially reduce congestion on the Freeway and on city streets.

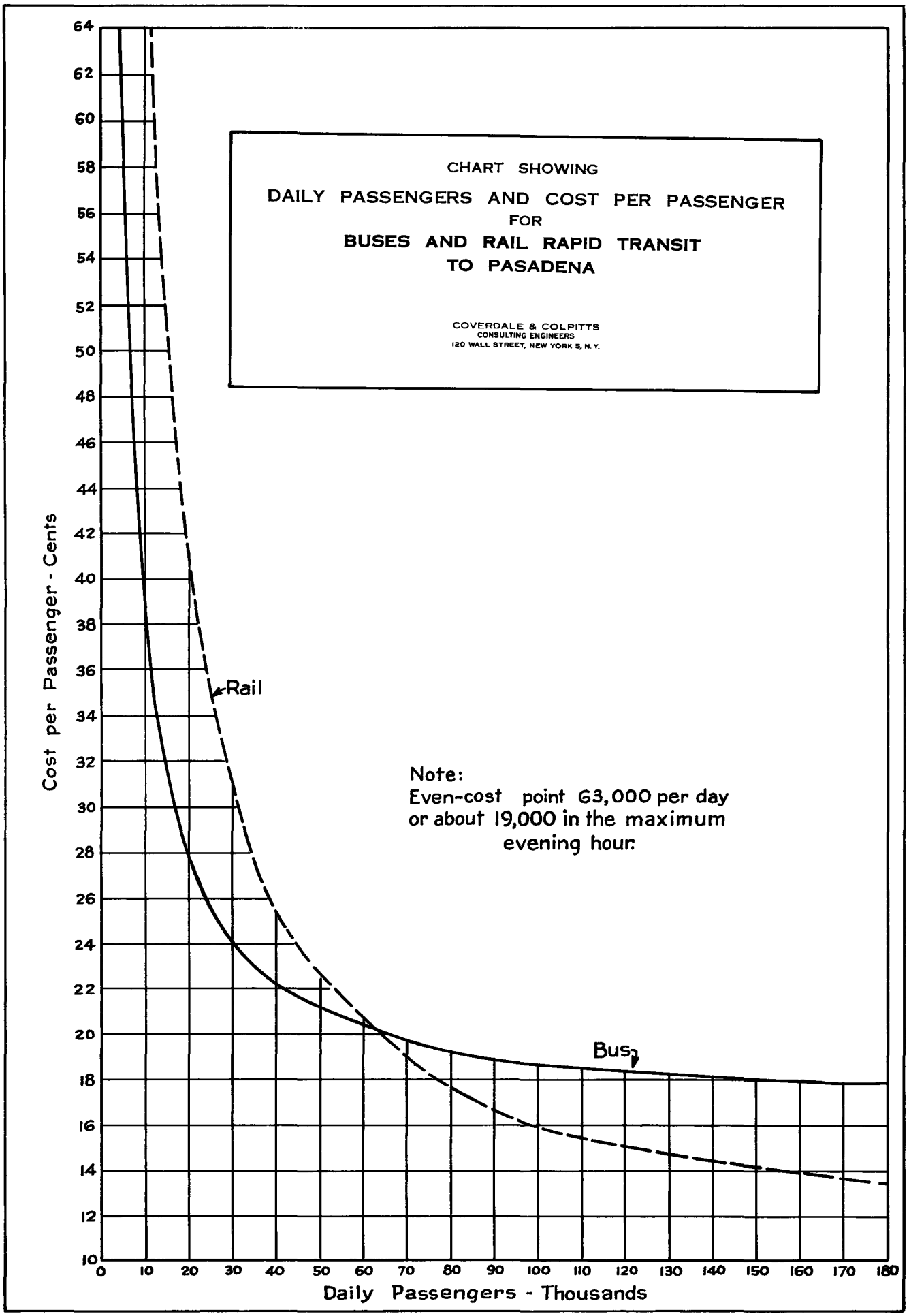
CHART SHOWING
DAILY PASSENGERS AND COST PER PASSENGER
FOR
BUSES AND RAIL RAPID TRANSIT
TO PASADENA
COVERDALE & COLPITTS
CONSULTING ENGINEERS
120 WALL STREET, NEW YORK 5, N.Y.
Cost per Passenger - Cents
64
62
60
58
56
54
52
50
48
46
44
42
40
38
36
34
32
30
28
26
24
22
20
18
16
14
12
10
Rail
Bus
Note:
Even-cost point 63,000 per day
or about 19,000 in the maximum
evening hour
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
Daily Passengers - Thousands

VII - TO LONG BEACH VIA LONG BEACH FREEWAY

The Long Beach Freeway extends from a connection with the Santa Ana Freeway near Eastern Avenue to the Pacific Coast Highway, Long Beach, a distance of 16.4 miles. From Eastern Avenue along the Santa Ana Freeway and thence to the downtown business district is a distance of six miles, making a total distance of 22.4 miles.

This freeway is planned to be completed in 1958. For the purpose of this report, it is assumed in use.

The schedule time from the Main Street terminal at Sixth Street via the Metropolitan Coach (Pacific Electric) rail line to Long Beach is 60 minutes. Applications to the Public Utilities Commission and the City of Los Angeles have been made to substitute bus operation for the rail line from the downtown business district to Long Beach. Hearings are in progress at this time. The trip time by bus as estimated by Metropolitan Coach Lines in its application to the Public Utilities Commission is 73 minutes in the evening rush hour; the average speed being 18.4 miles per hour, and 60 minutes in the midday hours at 20.3 miles per hour. The observed time by private automobile from Sixth and Hill to Ocean Boulevard, Long Beach, a distance of 23.2 miles, along Hill, Broadway, Main, Florence, Pacific and Long Beach Boulevard, was 67 minutes. As yet there is no freeway the entire distance to Long Beach.

To estimate the time and cost of operation for buses on the freeway, when completed, it was assumed that the same number of potential riders would use the buses as was found for the monorail line in our Report of January 15, 1954, a total of 93,000 passengers per average weekday, or about 11,600 in the maximum rush hour. This would require 155 buses at 75 passengers per bus, or a bus about every 23 seconds.

These passengers were assumed to start on buses from Ocean Boulevard, Long Beach, and from points about one mile from the ingress freeway ramps, and thence by the freeway to the downtown business district, as follows:

Daily passengers entering freeway at:

Pacific Coast Highway	Long Beach Blvd. Crossing	Olive Street	Imperial Highway Lynwood	Junction with Santa Ana Freeway
46,500	9,300	9,300	9,300	18,600

Stops on the freeway were assumed at:

Pacific Coast Highway
Willow Street
Long Beach Boulevard
Artesia Avenue
Rosecrans Avenue
Imperial Highway
Firestone Boulevard
Florence Avenue
Atlantic Boulevard
Downey Road
Downtown terminal

The time estimated for the bus trip from Ocean Boulevard, Long Beach, to Fourth and Hill, during the rush hours, was 51 minutes assuming freeway completed, buses making all the intermediate stops. This compares with 33 minutes by high-speed rail line, as developed in our Report of January, 1954.

An off-surface connection to a central bus terminal in the Los Angeles business district would save about 6 minutes which is relatively small compared with the total trip time.

OPERATING EXPENSES

Operating Expenses are taken at 57 cents per bus-mile, the same as in Chapter V for the Van Nuys bus line; and at 33.8 cents per car-mile as developed in our Report of January, 1954, for rail facilities.

Chart 4, at the end of this Chapter, was prepared as explained in Chapter V, and shows the relation of cost per passenger for bus and rail line to the number of passengers.

Referring to Chart 4, it will be noted that for the number of riders estimated, 93,000 per day, the cost per passenger would be 33 cents for the rail line and 36 for bus transportation. For fewer passengers, say, 75,000 per day, the cost per passenger is the same at 38 cents. For still fewer passengers, the cost is in favor of the buses, whereas for more than 93,000 per day, the comparative economy increases rapidly for the rail line.

DISCUSSION

The number of buses required for the potential passengers in the maximum rush hour is estimated at 155. As shown in Chapter V, this number added to the buses now operating on Hill Street would be more than the capacity of the street for buses. The other available streets are also about up to capacity in buses and trolley cars.

The time saved for the trip by high-speed rail transportation is 34 minutes as compared with private automobiles. This should divert a considerable number of automobile users, thus materially reducing congestion on the freeway and on city streets.

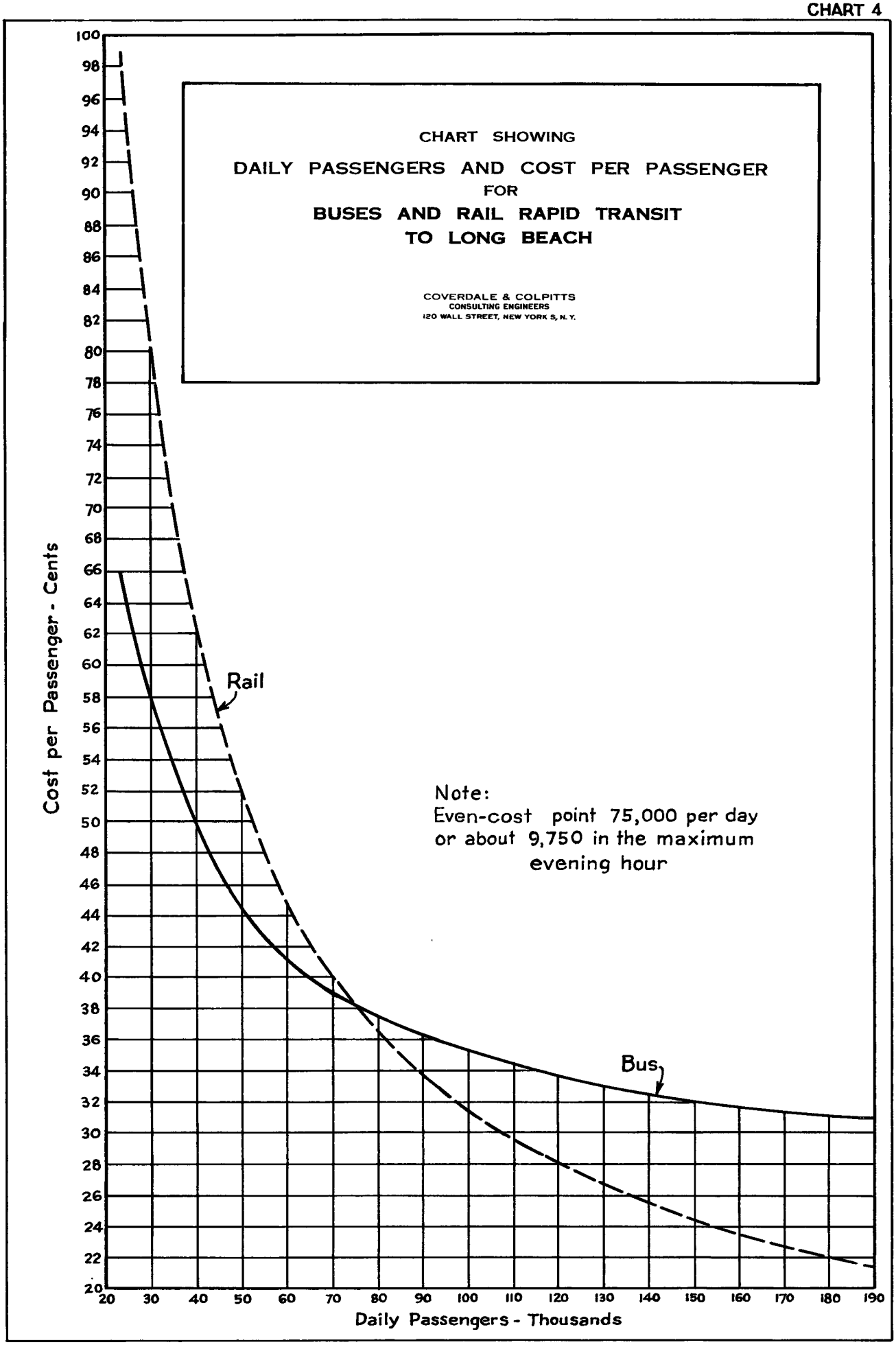
CHART SHOWING
DAILY PASSENGERS AND COST PER PASSENGER
FOR
BUSES AND RAIL RAPID TRANSIT
TO LONG BEACH
COVERDALE & COLPITTS
CONSULTING ENGINEERS
120 WALL STREET, NEW YORK 5, N.Y.
Cost per Passenger - Cents
Daily Passengers - Thousands
Rail
Bus
Note:
Even-cost point 75,000 per day
or about 9,750 in the maximum
evening hour

VIII - TO GLENDALE AND BURBANK

BUSES ON THE GOLDEN STATE FREEWAY (WHEN COMPLETED)

The Golden State Freeway, as now planned, will extend south and east across the Pasadena Freeway (Arroyo Seco) and cross the Ramona Freeway east of the junction with the Santa Ana and loop around and roughly parallel the Santa Ana Freeway to another crossing in the vicinity of Soto Street, where it will head west as the Olympic Freeway. This is a change in planning and replaces the City's plan for an east by-pass route on the west side of the Los Angeles River.

The length of the freeway from Verdugo Avenue, Burbank, to the Pasadena Freeway crossing is 11.55 miles, and from this crossing to Fourth and Hill is 2.45 miles, a total of approximately 14 miles. As this freeway is not yet constructed, the following estimates are made for the purpose of illustration only.

The present scheduled trip times by bus and trolley car, the observed time by automobile on the highways, and the estimated rail rapid transit, all in the rush hours, are as follows:

	Estimated Rail Rapid Transit		Estimated Bus on Freeway		Present Services Observed		Automobiles			
							Present Observed on Highways		Estimated on Freeway	
	Miles	Mins.	Miles	Mins.	Miles	Mins.	Miles	Mins.	Miles	Mins.
Los Angeles terminal	0	0	0	0	0	0	0	0	0	0
Glendale Broadway and Brand	7.5	14.0	9.0(a)	29	7.5	rail 29	9.1	27	9.0	25.5
Burbank at Orange	12.03	18.0	12.1(a)	30(a)	12.03	rail 51 bus 53	12.1	42	12.1	30.5

(a) Glendale buses would use freeway to Glendale Boulevard; Burbank buses to Olive in Burbank.

The number of daily potential passengers is estimated at 60,000, or 6,000 in the maximum rush hour, requiring 80 buses at 75 passengers per bus, or a bus every 45 seconds.

A high-speed rail line might follow, approximately, the present rail line for trolley cars from Los Angeles to Glendale and Burbank or it might follow another alternative line which, after a complete survey, might prove more economical and attract more passengers. For the purpose of this present study, however, a route along the present right-of-way is contemplated.

OPERATING EXPENSES

Operating expenses are taken at 57 cents per bus-mile, the same as in Chapter V for the Van Nuys bus line; and at 35 cents per car-mile as in Chapter VI for the Pasadena rail line.

The accompanying Chart 5, following this Chapter, shows the cost per passenger for various numbers of daily riders for buses on the Golden State Freeway compared with high-speed rail rapid transit. For the estimated 60,000 potential daily riders, the costs per passenger are nearly the same at 27.5 and 28.0 cents for bus and rail passengers respectively. For more than 65,000 passengers per day, the economy increases for the rail line as compared with bus transportation. For fewer daily passengers, the cost per passenger is less for buses than for rail.

DISCUSSION

The number of buses required for the potential passengers in the maximum rush hour is estimated at 80. As shown in Chapter V, this number added to the buses now operating on Hill Street would exceed the capacity of the street. The other available streets are also about up to capacity in buses and trolley cars.

The time saved for the trip by high-speed rail transportation is 14.5 minutes to Glendale and 12.5 minutes to Burbank as compared with private automobiles. This should divert a considerable number of automobile users, thus materially reducing congestion on the freeway and on city streets.

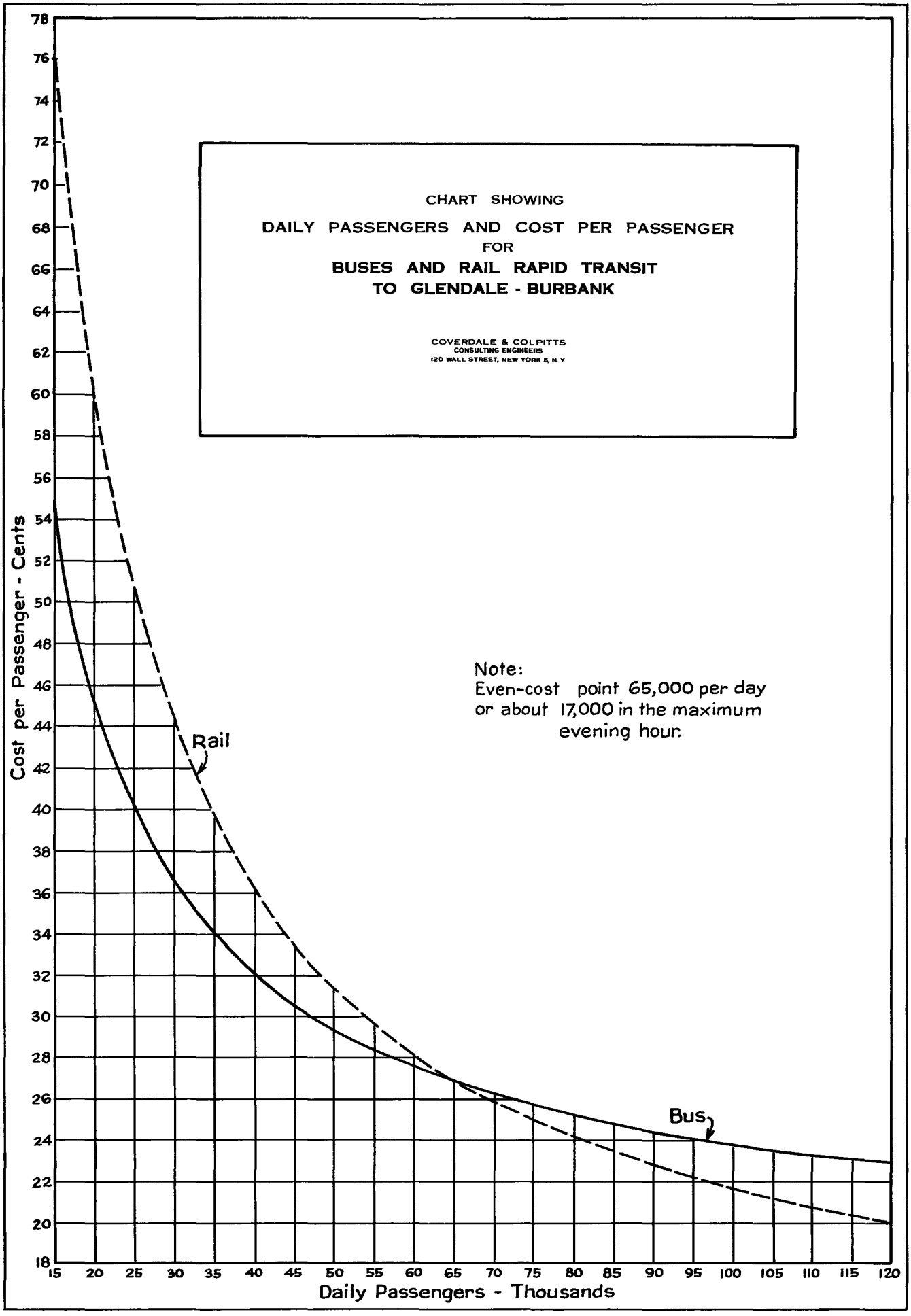
CHART SHOWING
DAILY PASSENGERS AND COST PER PASSENGER
FOR
BUSES AND RAIL RAPID TRANSIT
TO GLENDALE - BURBANK
COVERDALE & COLPITTS
CONSULTING ENGINEERS
120 WALL STREET, NEW YORK 5, N.Y.
Note:
Even-cost point 65,000 per day
or about 17,000 in the maximum
evening hour.
Rail
Bus
Cost per Passenger - Cents
Daily Passengers - Thousands
78
76
74
72
70
68
66
64
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56
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52
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48
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44
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120

IX - MASS RAPID TRANSIT IN OTHER CITIES

Large metropolitan areas such as Boston, New York, Philadelphia, Chicago and London rely chiefly on rail, bus and surface car transportation for commuter traffic, as shown by the following.

BOSTON

Boston was the first city in the United States to build a subway for mass transit purposes, and has a well-developed rapid transit system consisting of subways, elevated lines, trolleys, trackless trolleys and buses. The number of passengers carried in 1953 was as follows:

By Rapid Transit	192,341,000
By Bus, Trackless Trolley and Surface Lines	129,767,000
Total Passengers for the System	322,108,000

The speed of rapid transit trains is 17 to 18 miles per hour.

Certain statistics available for the year 1950 indicate the distribution of persons entering the Central District of the City by various conveyances between 7:00 and 10:00 A.M. as follows:

By Rapid Transit	107,950
By Trackless Trolleys and Surface Lines	102,015
Total by Mass Transit	209,965
By Automobiles, on the basis of 1.5 persons per automobile	65,953
Grand Total	275,918

The percentage using mass transit is 76 per cent.

The population of the Boston Metropolitan District is 2,369,986.

NEW YORK

New York has had a complete transportation system, both rapid transit (subway and elevated) and surface lines for many years. In 1953, the passengers carried by mass rapid transit were as follows:

By Rapid Transit	1,551,796,000
By Buses, both City and Privately Owned	1,048,943,000
Total Annual Mass Rapid Transit	2,600,739,000

The average speed of rapid transit express trains is from 22 to 24 miles per hour, of locals from 16 to 18 miles per hour.

As to persons reaching Manhattan by various types of conveyances the Regional Planning Association in 1950 gave the following as the distribution of such passengers between 7:00 and 10:00 A.M.:

By Rapid Transit	1,510,000
By Standard Railroad	239,350
Total Mass Transportation	1,749,350
By Automobile and Bus	118,400
Grand Total	1,867,750

The percentage using mass transportation is 93.5 per cent.

The population of Greater New York is 12,911,994, including the northeast New Jersey area.

PHILADELPHIA

Philadelphia has both rapid transit (subway and elevated) and surface systems. In 1953, the total number of passengers carried on mass transit facilities was:

By Rapid Transit	166,286,000
By Bus and Trackless Trolleys	555,978,000
Grand Total	722,264,000

An area-wide origin and destination survey made in 1947 showed the distribution of passengers entering the Central Business District as follows:

By Public Transportation	927,254
By Automobiles	234,756
Total	1,162,010

The percentage carried by mass rapid transit was 79.5 per cent.

The average speed of rapid transit trains is 17 to 18 miles per hour.

The population of the Metropolitan District of Philadelphia is 3,671,048.

CHICAGO

Chicago has both rapid transit (subway and elevated) and surface lines. The passengers carried in 1952 were:

By Rapid Transit	146,900,000
By Surface Lines	545,332,000
Total	692,232,000

The average speed of rapid transit trains is 22 to 24 miles per hour for express trains and 17 to 19.5 for locals. The average length of ride on rapid transit lines is 8 miles.

A cordon count covering the 12-hour period from 7:00 A.M. to 7:00 P.M. of persons entering the Central Business District showed the distribution between conveyances as follows:

By Rapid Transit	228,853
By Surface Lines	207,237
By Standard Railway Lines	132,678
Total Mass Transit	568,768
By Automobile	282,079
Grand Total	850,847

The percentage using mass transit is 67 per cent. This is interesting in comparison with Los Angeles because of the similarity in number of population.

The population of the Metropolitan District of Chicago is 5,495,364.

LOS ANGELES

The total number of passengers carried by mass transit in Los Angeles in 1953 was 260,604,000, about 38 per cent of the total carried by mass transit facilities in Chicago.

Ruscardon Engineers, as shown in our Report of January, 1954, estimated the persons entering the Central Business District of Los Angeles during a 12-hour weekday by means of various conveyances as follows:

By Automobile	470,000
By Public Transportation	211,300
Total	681,300

The percentage using mass transit facilities is 31 per cent.

The population of Los Angeles for 1955 is estimated at 5,241,000.

LONDON

London Transport with its rapid transit and bus lines carries the greatest number of passengers of any mass rapid transit system in the world. The passengers carried in 1953 were reported as follows:

By Rail	672,000,000
By Bus	3,658,100,000
Total	4,330,100,000

London Transport reports that of Londoners who go to work daily, 58 per cent travel by public transportation.

In London the average speeds are:

Trains	20.4 miles per hour
Country Buses	13.9 miles per hour
Coaches	18.4 miles per hour
Trolley Buses	11.2 miles per hour

The average trip by rail lines is 5.7 miles, 16.8 minutes, by bus approximately 2.3 miles, 11.8 minutes. From this it is seen that the London bus lines are a short-haul facility.

The population of Greater London is approximately 10,000,000. The motor vehicle registration, both passenger and commercial, is equivalent to 87 automobiles per thousand population. In Los Angeles there are 412 automobiles per thousand population.

RATIO OF POPULATION TO
MOTOR VEHICLE REGISTRATION

In Los Angeles there is one automobile to every 2.43 persons. This is the lowest ratio of any city in the world. However, certain of the areas surrounding our other large cities which are provided with rapid transit approximate these rates. For instance, in Boston in the suburbs the range is 1.7 to 2.8; in New York from 2.4 to 2.85; in Philadelphia from 2.56 to 3.15; in Shaker Heights 2.9.

CLEVELAND

The rail rapid transit line between Cleveland and a suburb, Shaker Heights, is of interest in connection with a study of mass rapid transit in Los Angeles. The Shaker Heights Rapid Transit Lines are owned and operated by the City of Shaker Heights. They consist of a double-track electric railway

mainly on private right of way and a limited number of grade crossings from Cleveland Union Terminal to the Shaker Heights area, one branch serving Shaker Heights and the other Van Aken. The distance from Cleveland Union Terminal to the end of the line at Shaker Heights is 9.79 miles, to Van Aken 9.34 miles. There are 16 stations including the two termini on the Shaker Heights route and 15 on the Van Aken route. Four of these stations are common to both routes. Free parking spaces, with a total capacity of 994 cars, are provided at 13 stations.

Trains operate on 5-minute headways in the rush hours. The time from the outer terminus in Shaker Heights to Cleveland Union Terminal is 25 minutes. The average speed is 23.5 miles per hour. The maximum number of cars per train is five during the rush hours and at other times three and four. The maximum speed for the type of car used is 42 to 45 miles per hour.

The passengers carried on a weekday range from 20,000 to 21,000, Saturdays 12,000 to 14,000, Sundays and holidays 3,000.

Passengers carried one way on an average weekday amount to 10,700, of whom approximately 50 per cent are carried in the rush period lasting approximately two hours. The population within the area served by the Shaker Heights Rapid Transit Lines including an area a mile and a half wide on either side of the line was, as computed from the 1950 census, approximately 91,000. On this basis, one out of every 8.5 persons in the area served uses the rapid transit line for one trip in each direction a day. Recent studies indicate that the Shaker Heights Rapid Transit Lines carry 34 per cent of all the regular passengers between Shaker Heights and Cleveland.

The time required to make an automobile trip from the central point in Shaker Heights to Cleveland Union Terminal is 27 to 28 minutes inbound in the morning rush period and 40 minutes outbound in the evening rush. These trip times compare with 25 minutes on the Rapid Transit Line for the same

destinations. The two bus lines serving this area require 40 minutes in the rush hour, averaging 10.5 to 12 miles per hour.

The passengers carried annually have remained almost constant from 1950 through 1954, with a slight upward trend since 1951. The number carried in 1954 was 6,634,940. The fare for the whole trip is 25 cents.

The population of Shaker Heights in 1953 was 32,000, the total motor vehicle registration was 11,000 and population per motor vehicle registration was 2.9. Since the parking spaces provide for 994 cars; if each car carries one and a half persons, the number of passengers represented by the parked cars is 1,491, or about 14 per cent of the average inbound riders.

SUMMARY AND CONCLUSIONS

FIRST:
Los Angeles is the only city in the United States of its magnitude without a surface-free, mass rapid-transit system.

SECOND:
The low density of the population and the development of the Boulevard and Freeway System have been conducive to the maximum use of the automobile for passenger transportation and the automobile has thus become the major vehicle for such service and is used to an extent far greater than in other cities of comparable size.

THIRD:
The same factors which have influenced the use of individual automobiles are favorable also to bus transportation.

FOURTH:
In large areas of the Los Angeles Metropolitan District bus transportation will always be an important and possibly a major instrument of mass transportation. Buses are essential where distances are too short to justify rail rapid transit. Buses in the Los Angeles area are already carrying considerable volumes of people at speeds comparable to those of present local rail transit systems in other cities. They have the advantage of flexibility of operation and therefore, in most cases, of added convenience by picking up and delivering passengers close to points of origin and destination. Bus transportation will be essential for many years to serve the thinly populated sections of Los Angeles and surrounding suburban communities where the large capital investment for rail service cannot be justified.

FIFTH:

The freeway system which was conceived, and in part constructed, prior to World War II, has been prosecuted actively since the end thereof. Three hundred million dollars have been spent or authorized for this purpose; 77 miles of urban freeway have been completed at the end of 1954 and 20 miles are under construction. It is anticipated that 83 miles more will be completed by 1960. The total contemplated mileage to be completed by 1971 is 256. The expansion over the next five years is expected to be carried out at an annual expenditure of 40 million dollars. At current prices this represents right-of-way and construction costs for eight to ten miles of urban freeways per year.

SIXTH:

The freeways have been loaded at peak hours almost to capacity as soon as they have become available. The congestion which occurs in the two hours of peak riding in the morning and the two hours of peak riding in the evening can be alleviated only by inducing some of the users of private automobiles to use some form of mass transportation. Extensive observations made by us as to the speeds that can be attained on the freeways result in the following:

On the Hollywood Freeway, between the Central Business District and Hollywood Boulevard, buses were observed to operate at an average rate of 25 miles per hour; and in the evening peak outbound at 23 miles per hour. At the same time automobiles inbound were averaging 42 miles per hour and outbound 23 miles per hour, the same as the buses. In midday at off-peak hours the buses were operating at an average of 35 to 40 miles per hour and the individual automobiles 50 to 55 miles per hour.

Between Hollywood Boulevard and Vineland, the end of the Hollywood Freeway, buses at the peak hours were operating at 22 miles per hour inbound

and 19 miles per hour outbound, the speed limited by the gradients in both directions; and inbound automobiles at the rate of 36 miles per hour in the morning and outbound at 23 miles per hour in the evening. In the off-peak hours buses were operating at the rate of 25 miles per hour and private automobiles at the rate of 50 to 55 miles per hour.

On the Pasadena Freeway between the Central Business District and Avenue 26 (San Fernando Road) buses were operating in the morning inbound, at the rate of 30 miles per hour and in the evening, outbound, at the rate of 19 miles per hour; compared with speeds for private automobiles of 35 miles and 19 miles respectively. At the off-peak hours inbound automobiles and buses could maintain speeds of 50 to 55 miles per hour.

Between Avenue 26 and the end of the Freeway at Glenarm Street, automobiles were able to operate inbound in the peak hours at 35 miles per hour and outbound in the evening peak at 26 miles per hour, and at the off-peak hours 50 to 55 miles per hour. There is no bus operation at the present time on this portion of Pasadena Freeway, but it is assumed that the speed of the bus operation would be close to, but slightly less than, that of private automobiles.

On Ramona Freeway buses were operating in the morning peak hours at 20 miles per hour inbound, and in the evening peak hours at 35 miles per hour outbound, whereas, automobiles, both inbound and outbound, in the peak hours were operating at 35 miles per hour. The reason for the low speed on the inbound bus is that bus operation at the present time is only on the most congested portion of this Freeway.

On the Santa Ana Freeway the bus and automobile speeds inbound in the morning are 35 miles per hour, and outbound, 30 miles per hour, as compared with 50 to 55 miles per hour in the off-peak periods.

On Harbor Freeway, at the time of our observations, a small portion only was opened, but the indicated speed for outbound automobiles in the evening peak was 23 miles per hour, and in the off-peak hours, 50 to 55 miles per hour. These speeds may be taken as indicative of those obtainable by bus.

SEVENTH:

At the present time, bus operation is conducted on the Hollywood Freeway by both the Los Angeles Transit Lines and the Metropolitan Coach Lines; on the Ramona Freeway between Union Station and Hellman Avenue, with the principal operation restricted to Garvey; and on the Santa Ana Freeway from Garnet Street to Pioneer Boulevard. On the Pasadena Freeway both Metropolitan Coach Lines and Asbury Rapid Transit Lines operate between Figueroa and San Fernando Road. Provision is made on the Harbor Freeway for the operation of buses and bus stops on the Freeway, but to date there is no regular service operating thereon.

The most extensive operation is that on Hollywood Freeway where in the rush hours 60 buses per hour are dispatched from the Central Business District to the outlying areas. The average over-all speed on the Hollywood Freeway in the neighborhood of Fourth and Hill Streets to Van Nuys was 16 miles per hour. The average speed made on the Freeway has already been shown to be from 19 to 30 miles per hour in rush hours, with a substantial fluctuation between the speeds attainable in the rush hours and the speeds attainable in the off-peak periods.

EIGHTH:

Our observations indicate that the flow of traffic on the freeways is limited by the following conditions:

a. Congestion at the four-level interchange.

b. Congestion at the freeway junctions.

c. Congestion at "on" and "off" roadways.

d. Excessive shifting of cars from one lane to another.

e. Lack of familiarity of drivers with the layout of the freeways.

f. Accidents.

g. Interference of heavy commercial vehicles in the rush hour traffic.

NINTH:

On Hollywood Freeway there are now three bus stops. Our observations indicate that these bus stops are so located as to be of very little use. Provision is made for bus stops on the Harbor Freeway, but there has not been sufficient use made thereof to indicate whether or not they will justify themselves.

TENTH:

The present buses operated on the Hollywood Freeway approximate 60 per hour, carrying approximately 3,300 passengers. The buses represent less than 0.7 per cent of the total number of vehicles, 8,800, using the freeway in the direction of maximum traffic at the peak hour. However, the 3,300 passengers they carry would require an additional lane of freeway if such passengers were to be transported in private automobiles.

ELEVENTH:

If it is assumed that an all-bus transit system could attract as high a percentage of the persons entering the Central Business District as is typical of other cities of comparable size, 2,200 buses would be required in the peak hour of the evening rush to accommodate the riders. Of these buses 1,500 would be able to make use of the freeway system as part of their route. When this number of buses is distributed over various branches of

the freeway system, present travel patterns indicate that not more than 250 buses per hour would use any one branch. Some of these buses would operate express, while others would make local stops at freeway bus-turnouts.

These buses could be accommodated on the freeways with no noticeable effect on the traffic, but would be limited at peak hours by the low speeds and congestion of the freeways.

To provide high-speed mass transit with these buses on freeways, it would be necessary to provide separate lanes for the bus traffic. This would permit a maximum theoretical flow of 220 buses per hour in local service at an average speed of 30.5 miles per hour with stops every mile, and 38 miles per hour with stops every two miles. This exclusive lane assignment is not practical, however, with the present freeway designs.

TWELFTH:

While the freeways themselves can carry a large number of buses, the number of buses that can be carried on the streets at the delivery points is strictly limited, so that it is the street capacity finally that limits the extent to which bus transportation can be a satisfactory solution to the Los Angeles transit problem. This situation can be alleviated by the provision of a central bus terminal with off-surface access for buses thereto from the freeway; or by a bus-subway with surface-free connections.

THIRTEENTH:

We have shown that slightly less than 700,000 persons enter the Los Angeles Central Business District during the 12 business hours of a typical weekday. Of this group, approximately 40 per cent enter during the two peak hours of the morning and leave during the two peak hours in the evening. Of this 700,000 persons, about 31 per cent only use mass transit

facilities, and the balance enter and leave by private automobile. This is in distinct contrast to the experience of other cities of comparable size where more nearly two-thirds of all persons entering the Central Business District use mass transit facilities. This ratio itself is significant as indicating the need of some form of mass rapid transit which will induce riders to abandon the use of private automobiles and use the mass transit facilities. Such a facility can be provided by modern rail rapid transit, free of grade crossings, particularly if constructed as a facility connecting business and residential centers, with stops between two and a half and three miles apart, where an average over-all speed, including stops, in excess of 40 miles per hour can be developed.

FOURTEENTH:

In order to compare bus operation on freeways with modern high-speed rail rapid transit, four specific cases were studied, as follows:

From the Los Angeles Central Business District to:

1. Van Nuys via the Hollywood Freeway.
2. Pasadena via the Pasadena Freeway.
3. Long Beach via the Long Beach Freeway.
4. Glendale and Burbank via the Golden State Freeway.

A system of rail rapid transit, such as that studied for these areas, provided with adequate bus feeders, or adequate parking spaces to permit delivery to it by private automobile, has the promise of being able to furnish a mode of transportation that will reduce the use of private automobiles on the trip from home to business, and so relieve both the freeway and city streets of undue congestion.

The trip times for private automobiles as compared with rail rapid transit for the cases studied are as follows:

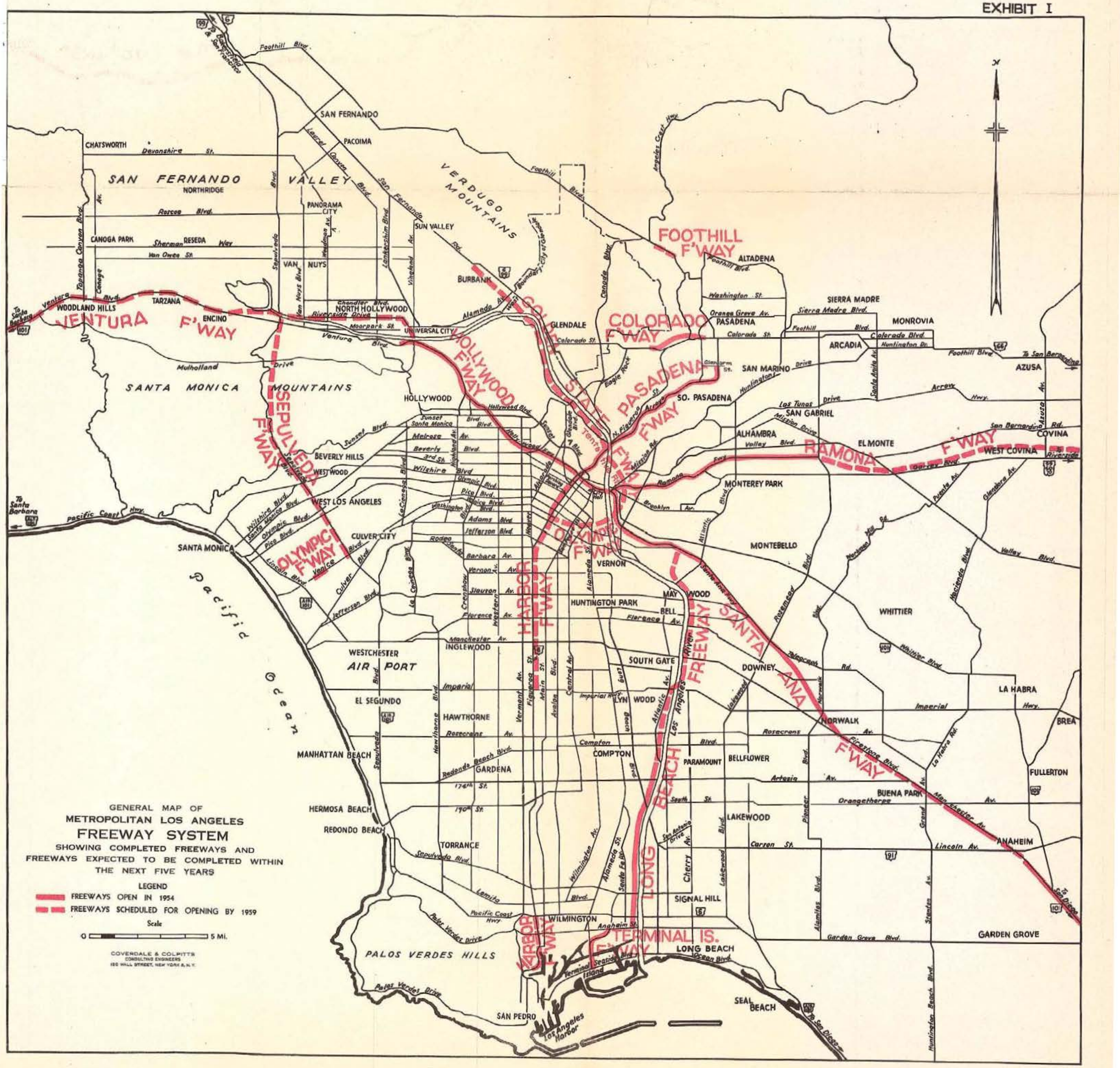
From Los Angeles Business District To	Trip Time in Minutes		Percentage of Time Saved By Rail Transit
	Via Automobile	Via Modern Rail Rapid Transit	
Van Nuys	53.5	30.0	44.0
North Hollywood	37.5	21.0	44.0
Hollywood	24.5	11.0	55.0
Pasadena	31.5	15.0	52.0
Long Beach	57.0	33.0	42.0
Glendale	25.5	14.0	45.0
Burbank	30.5	18.0	41.0

FIFTEENTH:

Buses are an essential part of mass transportation in Los Angeles. In our opinion they cannot be considered as a "complete and satisfactory" answer to the mass rapid transit problem, because on certain routes they cannot compete in speed or convenience with the private automobile sufficiently to cause the automobile riders to use the mass transit facility. On the other hand, on certain routes where the density of travel justifies it, rail rapid transit provides a service superior even to the private automobile. The essential feature of any satisfactory mass rapid-transit system in Los Angeles is that it must be such that it can divert people from the use of passenger automobiles and consequently reduce the congestion on the freeways, the highways and the city streets, and furthermore permit the growth of population in the peripheral areas without imposing a severe penalty of excessive travel time between home and business. The proper development of all parts of the metropolitan area requires a reasonable and swift flow of traffic between them.

EXHIBITS

EXHIBIT I


GENERAL MAP OF
METROPOLITAN LOS ANGELES
FREEWAY SYSTEM
SHOWING COMPLETED FREEWAYS AND
FREEWAYS EXPECTED TO BE COMPLETED WITHIN
THE NEXT FIVE YEARS
LEGEND
FREEWAYS OPEN IN 1954
FREEWAYS SCHEDULED FOR OPENING BY 1959
Scale
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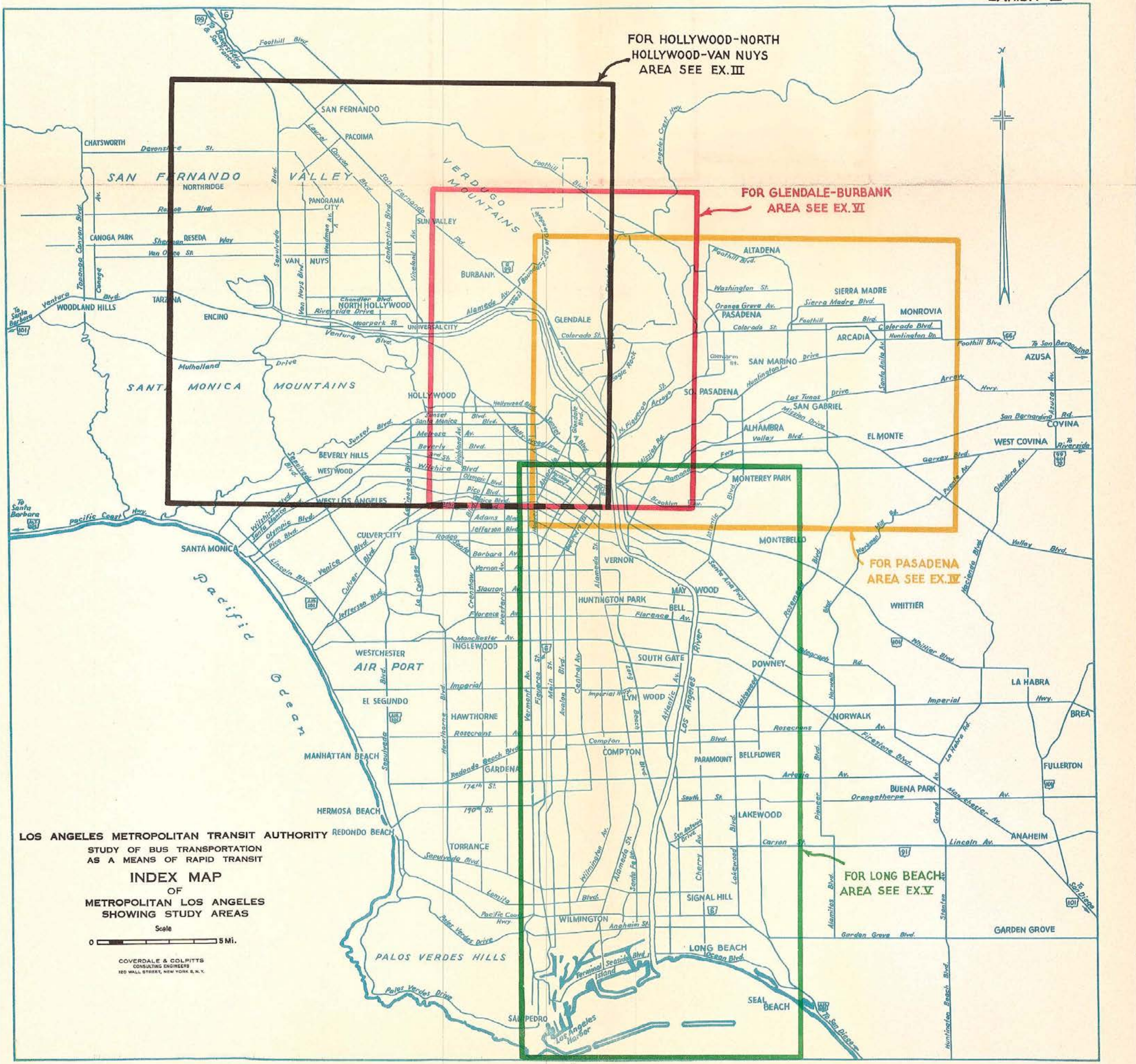
5 Mi.
COVERDALE & COLPITTS
CONSULTING ENGINEERS
VENTURA F'WAY
HOLLYWOOD F'WAY
SEPULVEDA F'WAY
OLYMPIC F'WAY
COLORADO F'WAY
FOOTHILL F'WAY
PASADENA F'WAY
RAMONA F'WAY
HARBOR F'WAY
SANTA ANA F'WAY
LONG BEACH FREEWAY
TERMINAL IS. F'WAY
SAN FERNANDO VALLEY
SANTA MONICA MOUNTAINS
VERDUGO MOUNTAINS
PALOS VERDES HILLS
Pacific Ocean
SAN FERNANDO
PACOIMA
CHATSWORTH
NORTHRIDGE
PANORAMA CITY
SUN VALLEY
CANOGA PARK
RESEDA
VAN NUYS
BURBANK
TARZANA
WOODLAND HILLS
ENCINO
NORTH HOLLYWOOD
UNIVERSAL CITY
GLENDALE
ALTADENA
PASADENA
SIERRA MADRE
MONROVIA
ARCADIA
AZUSA
SAN MARINO
SO. PASADENA
SAN GABRIEL
ALHAMBRA
EL MONTE
COVINA
WEST COVINA
MONTEREY PARK
HOLLYWOOD
BEVERLY HILLS
WESTWOOD
WEST LOS ANGELES
CULVER CITY
SANTA MONICA
MONTEBELLO
VERNON
HUNTINGTON PARK
MAYWOOD
BELL
WHITTIER
WESTCHESTER
AIR PORT
INGLEWOOD
SOUTH GATE
DOWNEY
LA HABRA
BREA
EL SEGUNDO
HAWTHORNE
LYNWOOD
NORWALK
MANHATTAN BEACH
COMPTON
PARAMOUNT
BELLFLOWER
GARDENA
FULLERTON
BUENA PARK
HERMOSA BEACH
REDONDO BEACH
LAKEWOOD
TORRANCE
ANAHEIM
SIGNAL HILL
WILMINGTON
LONG BEACH
GARDEN GROVE
SAN PEDRO
Los Angeles Harbor
SEAL BEACH
To Santa Barbara
To San Bernardino
To San Diego
To Bakersfield & San Francisco

EXHIBIT II



LOS ANGELES METROPOLITAN TRANSIT AUTHORITY
STUDY OF BUS TRANSPORTATION
AS A MEANS OF RAPID TRANSIT
INDEX MAP
OF
METROPOLITAN LOS ANGELES
SHOWING STUDY AREAS
Scale
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5 Mi.
COVERDALE & COLPITTS
CONSULTING ENGINEERS
120 WALL STREET, NEW YORK 5, N.Y.
FOR HOLLYWOOD-NORTH HOLLYWOOD-VAN NUYS AREA SEE EX. III
FOR GLENDALE-BURBANK AREA SEE EX. VI
FOR PASADENA AREA SEE EX. IV
FOR LONG BEACH AREA SEE EX. V
SAN FERNANDO VALLEY
SAN FERNANDO
PACOIMA
CHATSWORTH
NORTHRIDGE
PANORAMA CITY
SUN VALLEY
CANOGA PARK
RESEDA
VAN NUYS
BURBANK
VERDUGO MOUNTAINS
TARZANA
WOODLAND HILLS
ENCINO
NORTH HOLLYWOOD
UNIVERSAL CITY
GLENDALE
ALTADENA
PASADENA
SIERRA MADRE
MONROVIA
ARCADIA
AZUSA
SAN MARINO
SO. PASADENA
SAN GABRIEL
ALHAMBRA
EL MONTE
COVINA
WEST COVINA
SANTA MONICA MOUNTAINS
HOLLYWOOD
BEVERLY HILLS
WESTWOOD
WEST LOS ANGELES
MONTEREY PARK
SANTA MONICA
CULVER CITY
MONTEBELLO
VERNON
HUNTINGTON PARK
MAYWOOD
BELL
WHITTIER
Pacific Ocean
WESTCHESTER
AIR PORT
INGLEWOOD
SOUTH GATE
DOWNEY
LA HABRA
EL SEGUNDO
HAWTHORNE
LYNWOOD
NORWALK
BREA
MANHATTAN BEACH
COMPTON
PARAMOUNT
BELLFLOWER
FULLERTON
GARDENA
BUENA PARK
HERMOSA BEACH
REDONDO BEACH
LAKEWOOD
ANAHEIM
TORRANCE
SIGNAL HILL
WILMINGTON
GARDEN GROVE
PALOS VERDES HILLS
LONG BEACH
SEAL BEACH
SAN PEDRO
Los Angeles Harbor
Terminal Island

EXHIBIT III

HOLLYWOOD - NORTH HOLLYWOOD - VAN NUYS AREA

SHOWING LOCATION OF
PROPOSED MODERN RAPID TRANSIT ROUTES
AND
PROPOSED EXPRESS BUS ROUTES VIA FREEWAYS

LEGEND

- MODERN RAIL RAPID TRANSIT ROUTE
- MODERN RAIL RAPID TRANSIT ROUTE IN SUBWAY
- RAPID TRANSIT STATION
- RAPID TRANSIT STATION IN SUBWAY
- CONSOLIDATED TRANSIT TERMINAL
- EXISTING MOTOR BUS ROUTES OPERATING FROM DOWNTOWN LOS ANGELES
- PROPOSED EXPRESS MOTOR—BUS ROUTES OPERATING FROM DOWNTOWN LOS ANGELES VIA FREEWAYS USED FOR COST ESTIMATES
- POSSIBLE ADDITIONAL EXPRESS MOTOR BUS ROUTES OPERATING FROM DOWN TOWN LOS ANGELES VIA FREEWAYS
- ELEVATED BUSWAY
- EXISTING BUS STOP ON FREEWAY
- FREEWAYS TO BE COMPLETED IN 1959
- COMPLETED SECTIONS OF FREEWAYS

SCALE 0 — 2 Mi.

COVERDALE & COLPITTS
CONSULTING ENGINEERS
120 WALL STREET, NEW YORK 5, N.Y.

SAN FERNANDO
Foothill Blvd.
Laurel Canyon Blvd.
VERDUGO MOUNTAINS
Devonshire St.
Sepulveda Blvd.
NORTHRIDGE
Woodman Ave.
Osborne St.
Glenoaks Blvd.
San Fernando Rd.
PANORAMA CITY
Roscoe Blvd.
SAN FERNANDO VALLEY
SUN VALLEY
RESEDA
Sherman Way
Van Owen St.
Lankershim Blvd.
Canyon Blvd.
Ave.
Empire Ave.
VAN NUYS
Victory Blvd.
Kenneth Rd.
BURBANK
Magnolia Blvd.
Van Nuys Blvd.
Woodman Ave.
Whitsett Ave.
Oxnard St.
Laurel Canyon Blvd.
Lankershim Blvd.
Vineland Ave.
Hollywood Way
Olive Ave.
Alameda Ave.
Golden State Freeway
Chandler Blvd.
NORTH HOLLYWOOD
Riverside Drive
Ventura Freeway
ENCINO
Ventura Blvd.
UNIVERSAL CITY
Los Angeles River
Riverside Drive
GLENDALE
Colorado St.
Brand Blvd.
Barham Blvd.
Hollywood Freeway
Mulholland Drive
SANTA MONICA MOUNTAINS
Sepulveda Blvd.
Los Feliz Blvd.
HOLLYWOOD
Hollywood Blvd.
Sunset Blvd.
Hyperion Ave.
Glendale Blvd.
Sunset Blvd.
Santa Monica Blvd.
Melrose Ave.
Cahuenga Blvd.
Hollywood Freeway
Silver Lake Blvd.
Pasadena Freeway
Beverly Blvd.
3rd St.
Highland Ave.
Western Ave.
Vermont Ave.
Canon Dr.
BEVERLY HILLS
Wilshire Blvd.
Olympic Blvd.
Pico Blvd.
Venice Blvd.
La Cienega Blvd.
Hoover St.
Alvarado St.
Harbor Freeway
Figueroa
Olive
Hill
Broadway
Main
San Pedro
Alameda
6th
7th
Temporary Terminal
(Tentative Route)
N

EXHIBIT IV

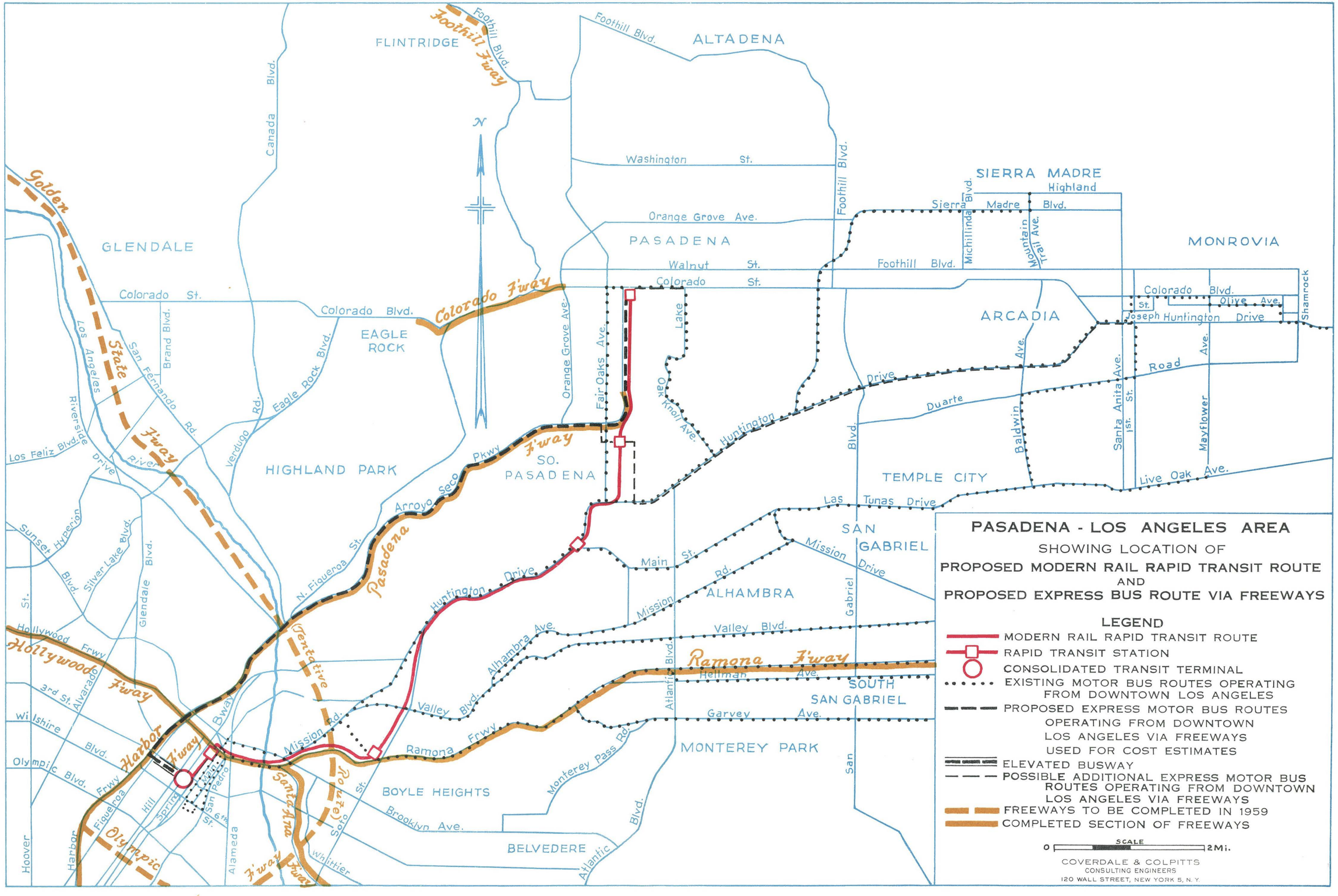
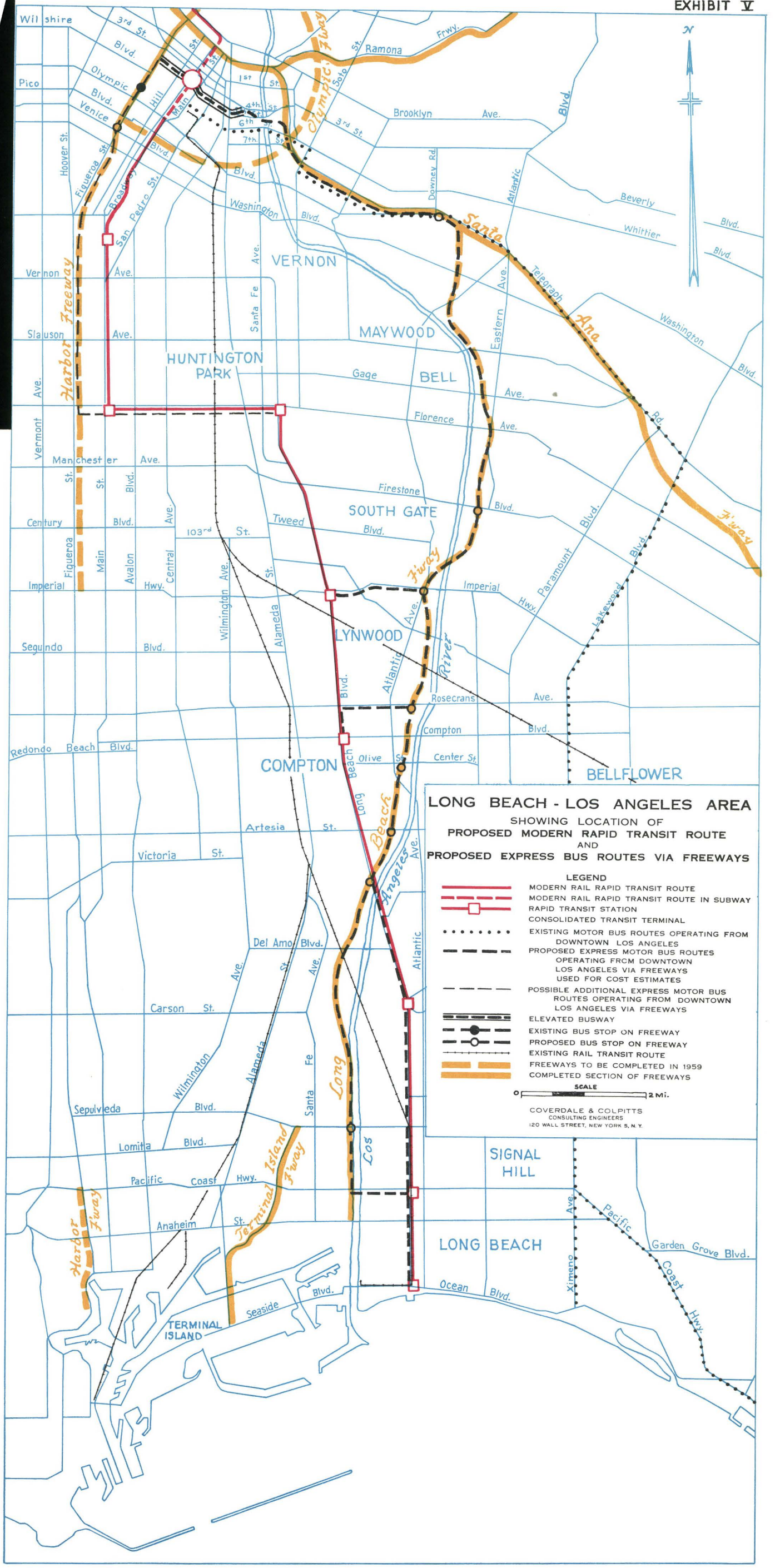

Foothill Fwy
FLINTRIDGE
Foothill Blvd.
ALTADENA
Canada Blvd.
Washington St.
Foothill Blvd.
SIERRA MADRE
Highland
Sierra Madre Blvd.
Michillinda Blvd.
Mountain Trail Ave.
Orange Grove Ave.
PASADENA
MONROVIA
Golden State Fwy
GLENDALE
Walnut St.
Colorado St.
Foothill Blvd.
Colorado St.
Colorado Blvd.
Colorado Fwy
EAGLE ROCK
Orange Grove Ave.
Fair Oaks Ave.
Lake
ARCADIA
Colorado Blvd.
Olive Ave.
St.
Joseph Huntington Drive
Shamrock
Brand Blvd.
San Fernando Rd.
Eagle Rock Blvd.
Verdugo Rd.
Oak Knoll Ave.
Huntington Drive
Duarte Road
Baldwin Ave.
Santa Anita Ave.
1st St.
Mayflower Ave.
Riverside Drive
Los Angeles River Fwy
Los Feliz Blvd.
HIGHLAND PARK
Arroyo Seco Pkwy
SO. PASADENA
TEMPLE CITY
Live Oak Ave.
Las Tunas Drive
Sunset Blvd.
Hyperion
Silver Lake Blvd.
Glendale Blvd.
N. Figueroa St.
Pasadena Fwy
Main St.
Mission Rd.
SAN GABRIEL
Mission Drive
Huntington Drive
ALHAMBRA
Gabriel
Hollywood Fwy
Hollywood Fwy
Alhambra Ave.
Valley Blvd.
Ramona Fwy
Atlantic Blvd.
Hellman Ave.
SOUTH SAN GABRIEL
3rd St.
Alvarado
Wilshire Blvd.
Valley Blvd.
Garvey Ave.
Olympic Blvd.
Harbor Fwy
Harbor Fwy
Ramona Fwy
Monterey Pass Rd.
MONTEREY PARK
Figueroa
Hill
Spring
San Pedro
6th St.
Alameda
Santa Ana Fwy
Santa Ana Fwy
Soto St.
BOYLE HEIGHTS
Brooklyn Ave.
Whittier
Hoover
Harbor
Olympic
BELVEDERE
Atlantic Blvd.
San
(Tentative)
Route
PASADENA - LOS ANGELES AREA
SHOWING LOCATION OF
PROPOSED MODERN RAIL RAPID TRANSIT ROUTE
AND
PROPOSED EXPRESS BUS ROUTE VIA FREEWAYS
LEGEND
MODERN RAIL RAPID TRANSIT ROUTE
RAPID TRANSIT STATION
CONSOLIDATED TRANSIT TERMINAL
EXISTING MOTOR BUS ROUTES OPERATING FROM DOWNTOWN LOS ANGELES
PROPOSED EXPRESS MOTOR BUS ROUTES OPERATING FROM DOWNTOWN LOS ANGELES VIA FREEWAYS USED FOR COST ESTIMATES
ELEVATED BUSWAY
POSSIBLE ADDITIONAL EXPRESS MOTOR BUS ROUTES OPERATING FROM DOWNTOWN LOS ANGELES VIA FREEWAYS
FREEWAYS TO BE COMPLETED IN 1959
COMPLETED SECTION OF FREEWAYS
SCALE
0
2 Mi.
COVERDALE & COLPITTS
CONSULTING ENGINEERS
120 WALL STREET, NEW YORK 5, N. Y.

EXHIBIT V



LONG BEACH - LOS ANGELES AREA

SHOWING LOCATION OF
PROPOSED MODERN RAPID TRANSIT ROUTE
AND
PROPOSED EXPRESS BUS ROUTES VIA FREEWAYS

LEGEND

- MODERN RAIL RAPID TRANSIT ROUTE
- MODERN RAIL RAPID TRANSIT ROUTE IN SUBWAY
- RAPID TRANSIT STATION
- CONSOLIDATED TRANSIT TERMINAL
- EXISTING MOTOR BUS ROUTES OPERATING FROM DOWNTOWN LOS ANGELES
- PROPOSED EXPRESS MOTOR BUS ROUTES OPERATING FRCM DOWNTOWN LOS ANGELES VIA FREEWAYS USED FOR COST ESTIMATES
- POSSIBLE ADDITIONAL EXPRESS MOTOR BUS ROUTES OPERATING FROM DOWNTOWN LOS ANGELES VIA FREEWAYS
- ELEVATED BUSWAY
- EXISTING BUS STOP ON FREEWAY
- PROPOSED BUS STOP ON FREEWAY
- EXISTING RAIL TRANSIT ROUTE
- FREEWAYS TO BE COMPLETED IN 1959
- COMPLETED SECTION OF FREEWAYS

SCALE 0 — 2 Mi.

COVERDALE & COLPITTS
CONSULTING ENGINEERS
120 WALL STREET, NEW YORK 5, N.Y.