REPORT

ON SOME OF THE

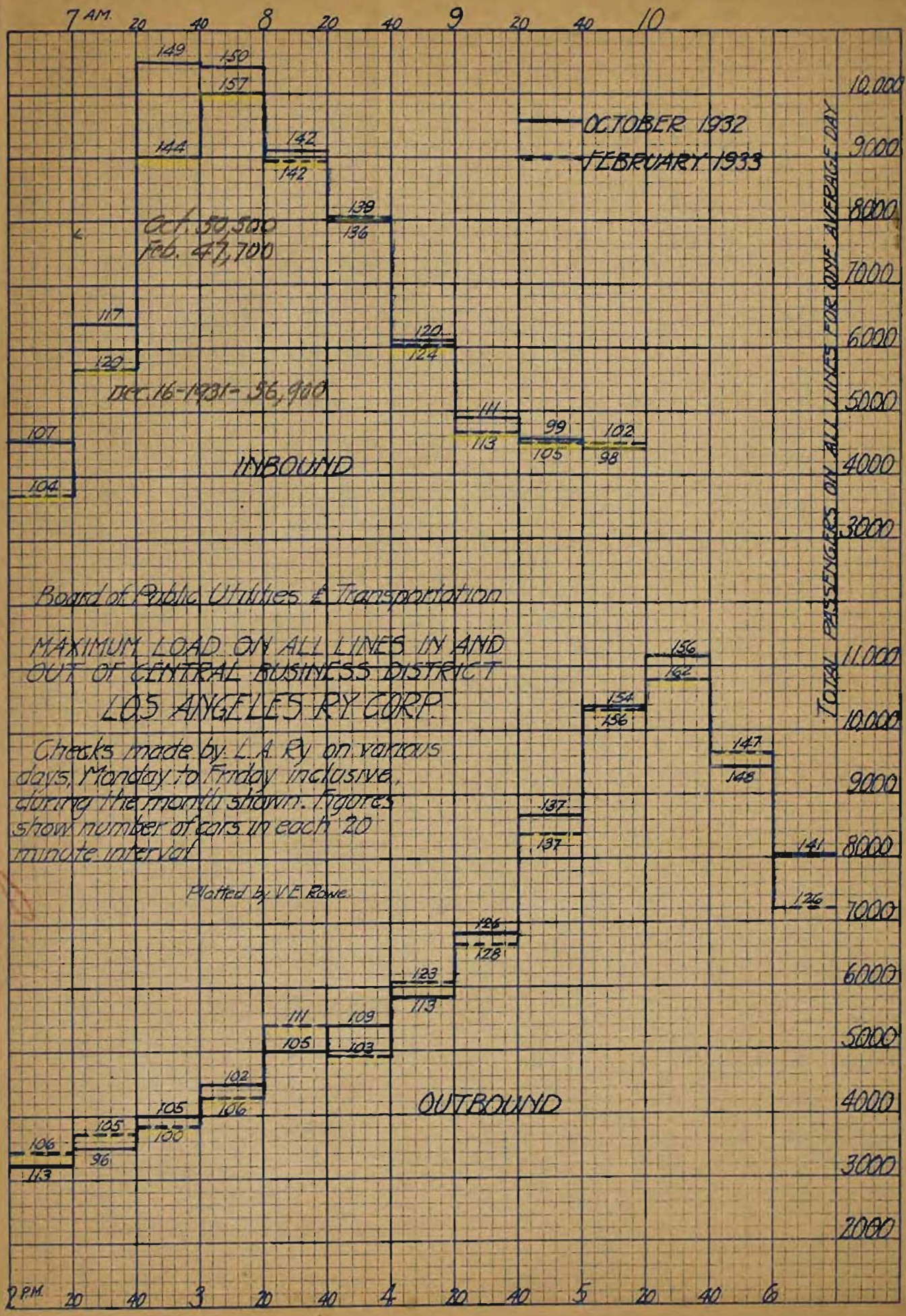
PROBLEMS OF OPERATION

OF THE

LOS ANGELES RAILWAY

BY

JOE R. ONG


7 AM. 20 40 8 20 40 9 20 40 10
OCTOBER 1932
FEBRUARY 1933
Oct. 50,500
Feb. 47,700
Dec. 16-1931 - 96,900
INBOUND
OUTBOUND
Board of Public Utilities & Transportation
MAXIMUM LOAD ON ALL LINES IN AND OUT OF CENTRAL BUSINESS DISTRICT
LOS ANGELES RY CORP.
Checks made by L.A. Ry on various days, Monday to Friday inclusive, during the months shown. Figures show number of cars in each 20 minute interval
Plotted by V.E. Rowe
TOTAL PASSENGERS ON ALL LINES FOR ONE AVERAGE DAY
10,000
9000
8000
7000
6000
5000
4000
3000
2000
11,000
10,000
9000
8000
7000
6000
5000
4000
3000
2000
2 P.M. 20 40 3 20 40 4 20 40 5 20 40 6

A

REPORT

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LOS ANGELES RAILWAY

BY

JOE R. ONG

Consulting Transportation Engineer

July 31, 1923.

TABLE OF CONTENTS

Table of Contents cont.

DETAILS OF OPERATION

TRAFFIC ANALYSES AND SCHEDULES

Table of Contents cont.

APPENDIX - CHARTS

LETTER OF TRANSMITTAL

Mr. G. J. Kuhrts, General Manager,
Los Angeles Railway Corporation,
Los Angeles, California.

Dear Sir:-

The investigation of operating conditions on the system of the Los Angeles Railway which I have undertaken at your request, has been brought to a conclusion and I have the honor of presenting to you my report on these matters.

After a preliminary survey of the situation I indicated that it appeared to me that my services could be made of most value to the company by co-operating actively with your operating staff to the end that changes and improved methods in operation might be put into effect without waiting for the formality of a report. It was gratifying to me to have you approve this procedure and I have accordingly carried out this plan.

The fullest co-operation has been extended by all departments when called upon and since most of the investigation had to do with the operating department under Mr. R. B. Hill, and in particular with the schedule office in charge of Mr. L. A. Recappe,. it is fitting that they should receive special mention for their valuable assistance.

With the single exception of my associate, Mr. John D. Ong, the entire staff for the detail work of the investigation has been recruited from Los Angeles. To these men I also desire to express my appreciation.

It has been my pleasure, with your permission, to co-operate with the engineering staff of the California Railroad Commission in preparing certain data not directly bearing on this investigation and therefore not mentioned in the report. The Commission's engineers have in turn been helpful to me in the exchange of data and in discussing various phases of the local situation.

It will be found that the report deals with some things not directly within the control of the company such as traffic congestion and suggested methods of relief. While it is true that these matters are beyond its direct control still the company and its patrons are so vitally interested and affected that it may devolve upon the company to take the initiative in bringing before the public authorities the necessity for corrective measures. I refer to non-parking regulations and restrictions in the use of the streets by automobiles so that they will not interfere with the movement of street cars which carry by far the greatest number of people into and out of the congested area.

Just as the company's total income is made up of small things - the nickels of the car rider - so is the ser-

vice which the company gives in exchange made up of many small things. This may explain why many details of operation have been discussed in the report. They all combine to make up service and if service is to be satisfactory both to the car rider and to the owners of property the details of operation must be right.

A general traffic survey on all lines of the Los Angeles Railway has been made in the course of this investigation, but the report has not been burdened with the details of tabulations and summaries of traffic checks. These, however, are all in the hands of the Superintendent of Schedules. Methods of graphic presentation of the data and the practical use of it have been outlined in the section of the report entitled "Traffic Analyses and Schedules".

One of the fundamental principles in correct schedule making is to put the service where it is needed and to eliminate unnecessary service. Practically the whole direct operating expense of a railway utility varies with the car miles or the car hours operated so it is essential to operating economies that the service be adjusted to fit the traffic, making due allowance for limitations as to minimum service and other dictates of policy.

In order to determine the "fit" between the service and the traffic, it is absolutely necessary to have accurate data relative to the distribution of the passenger

traffic to be handled. This can only be secured through systematic traffic checking and I have outlined a plan by which the desired object may be accomplished. So fully has the schedule department co-operated in the adoption of my recommendations that their importance and value have already been demonstrated in practice as I file this report.

Subsequent to the beginning of my investigation of operating conditions of the Los Angeles Railway, two other very important matters have arisen which have had a bearing on one subject which is usually included and given a very prominent part in a report of this character, namely, rerouting.

In the spring of 1923 an unsuccessful attempt was made by outside parties to establish a competing bus service in territory served by the two electric railways, and in the settlement of this question the company promised the extension of certain rail lines and the establishment of certain bus lines, as a matter of political expediency quite independent of my study of the problems of operation.

There has also been in progress for some time an independent investigation looking toward the unification and consolidation of all city transit lines, and inasmuch as the subject of rerouting is very much involved in such a study, and since that investigation has not been carried far enough for anyone to be in a position to indicate whether the Los

Angeles Railway Company will take over the city lines of the Pacific Electric, or the Pacific Electric will take over the Los Angeles Railway, or the City of Los Angeles will take over both systems, it is my opinion that the matter of rerouting should be left an entirely open subject for the consideration of those having in hand the consolidation and unification program.

I would, however, recommend that your Superintendent of Schedules continue his studies of the unbalance of traffic on different branches of split lines, similar to that indicated in the report for Line "J", which may lead to some adjustments and changes without complicating the general matter of rerouting involved in the unification study.

The California Railroad Commission in its report on service problems in 1919 dealt extensively with the subject of rerouting and, except for the double loop of the Grand-Moneta line throughout the entire length of the congested area, which loop I think should be shortened, I believe that the present routing throughout the business section may be maintained without serious consequences at least until the report on unification rerouting study is made.

In conclusion permit me to refer to one thing further relative to my recommendations. In working with

your operating organization so closely quite naturally many details were discussed and approved. It is not my desire to have particular details adhered to as fixtures if the reasons therefor shall be altered. Rather has it been my desire to have certain general principles established for the betterment of operation, understanding that details should be revised to meet changing conditions.

Respectfully Submitted,

Joe R. Ong

Consulting Transportation Engineer.

Los Angeles, California.
July 31, 1923.

GENERAL

The Transportation Problem.

Indices of Growth.

Analyses of Passenger Traffic.

Los Angeles is the most prominent city on the Pacific Coast. In it are centered the commercial activities of Southern California which has been known the country over as one of the nation's choicest playgrounds. It still enjoys this distinction and more, for many who came to play have stayed to work. Southern California's wealth in oil, in fruits and agricultural products, and the importance of Los Angeles Harbor since the opening of the Panama Canal have resulted in a large commercial development.

Los Angeles is, therefore, a rapidly growing city. With its expansion, perplexing problems have arisen, particularly the expansion of public utilities- water, gas, electric, telephone, street railway and also paving and lighting of streets, storm and sanitary sewers, fire and police protection, school facilities and all public works. Expansion in population and activity has increased the concentration in the central business area introducing other complications one of which is transportation.

The Transportation Problem

The transportation problem before the Los Angeles Railway naturally falls into two subdivisions-

(a) the present:- changes and improvements in existing operating methods and practices in order to render the best possible service even under the handicaps of congested central area, choked traffic arteries and other limitations.

(b) the future:- consolidation and unification of all city transit lines involving subway lines, general rerouting and new routes in compromise agreements with the City.

An independent investigation covering the future program of unification, including the valuation of the properties, has been in progress for some time so that this report will deal with the present and immediate future- the problem of operating the existing property more efficiently.

Those responsible for the operation of street railways and other public utilities are of necessity greatly concerned in all factors which give indications of the trend of growth. In the next few pages will be found a discussion of various charts which show graphically some of the factors having a bearing on this matter.

Indices of Growth

The increase in population from 1850 to 1920 according to the U. S. Census is shown in Chart 1, and the estimates subsequent to 1920 are based on many factors, the composite of which is the figure determined by the engineers of the Southern California Telephone Company (Bell System). This gives a figure of approximately 750,000 for July 1, 1923, and is considered reasonably accurate. The substantial character of the growth is shown by the increase in the school enrollment.

When these population figures are plotted and compared with those for the largest cities in the country it leads to the conclusion that the present annual increase increment closely parallels that of New York, Chicago and Detroit when they were cities of the same size that Los Angeles is now. (Chart 2)

Quite naturally Los Angeles thinks of its population increase in terms of what it was ten years ago and twenty years ago. From that viewpoint it is remarkable, but compared to New York, Chicago or Detroit it shows about the increase to be expected. Ten thousand represents a 10% increase on 100,000, but it takes 50,000 to make a 10% increase on 500,000.

Chart 3 shows the relation of increases for the

past six years in population, total passengers carried, and automobiles registered in Los Angeles County, all plotted on a logarithmic scale on which uniform rates of increase would show as straight lines. The population figures are as explained for Chart 1. Further details regarding passengers carried are shown on Charts 7, 8, 9 and 10.

It will be noted that the automobiles in Los Angeles County are increasing at a much faster rate than either population or passengers carried by the Los Angeles Railway. There is no question but that the greatly increased use of automobiles has materially affected the Los Angeles Railway's traffic.

Another barometer of the city's growth is the steady annual increase in postal receipts, Chart 4. Still another is bank clearings, also shown on Chart 4 on which the cycles of business are very noticeable.

Since 1918 there has been a very marked increase in the number of building permits and their value. This, perhaps, as much as any other one factor, has caused the over enthusiastic estimates of population. Reference to Chart 5 will show that the present peak in building is a part of the natural cycle as a consequence of recovering from the depression in building activities from 1914 to 1918 inclusive.

Chart 6 shows the increased use of public utilities-

electric, gas, water, as indicated by the increased number of electric and gas meters connected and in the number of water services. The kilowatt hours used in Los Angeles from all sources (except the power used by the two electric railways) is shown on the same chart.

It will be noted at once that the cycles on these utility curves are not nearly as pronounced as in Chart 5 showing building permits, or Chart 4 showing bank clearings. There is an actual increase in the use of public utilities from year to year and also a larger annual increase in the last four years compared to other years. This seems to correspond with the population curve which also shows a big increase in the last four years.

Analyses of Passenger Traffic

Chart 7 shows the analysis of passenger traffic of the Los Angeles Railway for the 13 years 1910 to 1922 inclusive. Separate curves show ticket passengers, school book passengers, free passengers, transfer passengers, revenue passengers and total passengers. The curves of transfer, revenue and total passengers have the same general characteristic although there are slight differences from year to year.

Following 1913 there was a period of actual decrease in passengers carried. Not until 1919 did the traffic exceed 1913. Since 1916 there has been an increase from year to year but the rate of increase has not been constant. In fact, the

rate of increase 1922 over 1921 was less than 1921 over 1920 which itself was a lower rate of increase than 1920 over 1919. For the first six months of 1923, the rate of increase of 1923 over 1922 is showing better than 1922 over 1921.

Chart 8 shows total passengers carried month by month from January 1917 to June 1923 inclusive, arranged so that corresponding months in the different years may be compared readily. Since October 1919 each month shows a heavier traffic than the corresponding month in the preceding year.

Chart 9 shows revenue passengers in the same way that Chart 8 shows total passengers.

Chart 10 shows the same data as Charts 8 and 9 but arranged consecutively month by month from January 1917 to June 1923, and is plotted on semi-logarithmic paper so that the rate of increase may be clearly indicated.

Chart 10 also shows the car mileage operated by months over the 6½ year period. It will be noted that the maximum mileage was operated in the 12 months October 1917 to October 1918 following which service was curtailed. This curtailment appears to have been somewhat belated since the passenger traffic fell off in 1914 and continued to fall until 1917.

Since 1918 there has been little change in the average monthly car mileage up to the latter part of 1922. The irregular sawtooth mileage curve is largely due to the difference in the monthly total of a 31 day month as compared with a 30 day month. (The strike in August and September 1919 caused low mileage those months and 28 day February always shows a low point).

Increased service now being rendered is apparent from the increase in the mileage. March, May and June 1923 show mileage in excess of any month since August 1918. The Los Angeles Railway can point to this as an indication of the genuineness of its expressed intentions to improve service, proving that better service was not a temporary flash during the bus campaign.

From the foregoing discussion and the charts therein referred to it is apparent that there has been an increase in the activities of the community that must be considered as having a bearing on the adequacy of service. Due credit must be given for rerouting and other changes effected in 1920 which improved the service without any appreciable increase in mileage.

The problem of a street railway utility is never solved for the problem is an ever changing one. Constant observation and studyare required.

TRAFFIC CONGESTION

Importance of Co-operation.

Street Parking Space.

Limited Street Area.

Forced Decentralization of Business.

Attempts to Limit Parking.

Street Car Riders' Interests.

Comparative Use of Street Cars and Automobiles.

Motor Traffic Arteries.

No Right or Left Turns.

Pedestrian Regulation.

Distribution of Street Railway Travel.

Staggered Hours.

Through Lines vs Loop Lines.

One Way Traffic.

Tandem Movement of Street Cars.

Restriction of Vehicular Traffic.

Interference by Parades.

Responsibility of Utilities.

Importance of Co-operation

There is no magic that will relieve traffic congestion. It is a matter largely beyond the control of the street railways. It requires co-operation of all interests in the community and at this particular stage of development requires a vast amount of education.

The solution of the traffic congestion problem unquestionably curtails the liberty of individuals. Thus far, the individuals owning automobiles, and merchants who (mistakenly) believe that their customers are largely automobile users have effectively blocked sincere efforts to relieve the traffic congestion by non-parking regulations.

The time was when it mattered little what kind or size of vehicle an individual used to come downtown. It mattered little where, when, in what position or for how long he left this vehicle standing in the public street. If Los Angeles had not grown since those days the individual probably would be permitted to enjoy the same liberties now.

Those days are gone. Los Angeles is no longer a small town. With its growth have come regulations for the benefit of the general public necessarily restricting the liberties of the individual. Doubtless every restrictive measure has had violent opposition. Usually education or a catastrophe swings the balance in favor of measures for

the benefit of the general public. Who would now advocate such personal liberty as would remove fireproof building restrictions and permit the construction of wooden structures in the congested business area ?

The number of vehicles using the streets has vastly increased in recent years. Exact figures for comparison are not available, but some idea of the increase in the number of automobiles in Los Angeles may be had by reference to Chart 3.

Street Parking Space

There are so many automobiles and trucks in the central business area that parking space along the curb for any significant number of them is absolutely out of the question. First come first served, is the rule, and it leaves by far the greater number to seek private parking areas as close as can be found, often several blocks away.

An alternative is to park out in the street parallel to the machine that is parked at the curb, termed "second line parking". This is now prohibited by ordinance but the ordinance is violated hundreds of times daily by parcel delivery trucks, bottled water wagons, clean towel service wagons, garbage wagons, mail trucks, express trucks and others. Not a street in the business area is wide enough to permit two lines of vehicles to park parallel to the curb

and a third line of vehicles to move in clearance with street cars. The result is that whenever a vehicle parks for even a very limited time in the "second line" all moving vehicles must turn out to pass it, blocking street cars and slowing down all street traffic. The ordinance prohibiting second line parking should be strictly enforced at once.

A great protest will immediately develop because the merchants and others will not be able to get light deliveries during business hours because the delivery trucks cannot get a parking space at the curb. Clear the congested area of all automobile parking, leaving curb space for a limited business delivery and pickup service, and for passenger cars just long enough to permit persons to board and alight.

Limited Street Area

Los Angeles has relatively a very small percentage of street area in the congested business section, perhaps a smaller percentage than any other large city. The absence of alleys forces to the streets much commercial handling that is done at alley entrances in many cities.

Various civic bodies in Los Angeles are becoming interested in street widening projects involving millions of dollars. The least expensive method of widening the street for the movement of traffic is to eliminate parking. It is ridiculous that valuable street space for a seven foot strip

along the curb from one street to the next should be given over to individuals as a public garage.

Even single line parking on certain very narrow streets greatly impedes traffic movement. Second, Fifth and Sixth Streets are so narrow that all moving traffic is thrown on the street car tracks and vehicles must be parked carefully at the curb to provide clearance for street cars.

At the present time a double line of automobiles moving eastbound in the Third Street tunnel has to be throttled into a single line at 3rd and Hill because automobiles are parked along Third Street leaving room for only one line of moving vehicles. When the Second Street tunnel is opened this year the same condition will obtain and Los Angeles will witness the spectacle of another four line traffic tunnel throttled down to a two line capacity by two rows of idle automobiles along the curbs.

Forced Decentralization of Business

Business men have mistakenly opposed non-parking ordinances thinking it drives trade away. There is not a merchant who could survive on the business he gets solely from customers that park in front of his establishment. Not enough of them could get in and out of that limited space in a business day to keep him busy. The problem has gone beyond the point of getting a place for the individual to

park at the exact location he desires for making a business call.

For a long time it has been a difficult matter, indeed almost impossible, to find parking space in the public streets while on a downtown shopping tour. This lack of parking space has been one of the factors influencing the decentralization of business and the growth of sub-centers. Perhaps the most striking example of the movement of business into the less congested portions of Los Angeles, is the development along Western Avenue.

Attempts to Limit Parking

As a result of joint recommendations by the California Railroad Commission and the Board of Public Utilities supported by numerous civic organizations an ordinance was passed in April 1920 which prohibited parking in the central congested area. Violent opposition on the part of the Broadway Merchants' Association caused the repeal of the ordinance after a short trial of two or three weeks. Merchants claimed heavy losses but failed to submit actual data in support of their contention. They failed to take into account the close of the winter tourist season and other factors that had an important bearing on the volume of business. They failed to consider that automobiles parked at the curb did not indicate customers in their stores.

After a space of three years there is perhaps a

ray of hope that the larger benefits of no parking are beginning to be realized. Early in the present year an ordinance was passed providing for alternate 20 foot and 30 foot parking and non-parking spaces. It proved a failure before the marking of the alternate spaces could be completed for the simple reason that the plan was not carefully thought out in regard to length of spaces and failed to take into account the location of fire hydrants, entrances to theatres, hotels and public buildings covered by other ordinances.

The next attempt has been the establishment of 30 foot "loading zones", two on each side of the street in each long block on the north and south streets and one on each side of the street in each short block on the east and west streets. The zones are painted red and marked "Loading Zone". Their purpose is to provide a place for commercial vehicles to load and unload making "second line parking" unnecessary.

To make this plan effective it is obviously necessary to enforce the provisions of the ordinances prohibiting automobile parking in the "loading zones". Flagrant violations are to be seen daily.

It is not altogether clear why certain sections of the public street should be practically set aside for the use of a private enterprise, the ubiquitous taxicab.

Deprived of the parking privilege they would be cruising around the streets looking for fares. But the latter alternative offers less obstruction to the movement of traffic than the former.

The Street Car Riders' Interests

The great mass of the travelling public being unorganized is never proportionately represented in hearings and investigations of the traffic problem. The automobile driver belongs to the Auto Club, the merchant to the Merchants Association and the Chamber of Commerce and so they are ably represented en bloc, but the street car riders who vastly outnumber the other groups have no means of adequately presenting their most vital interest in these matters.

In seeking relief from traffic congestion the street railway representatives, therefore, act not only for the company but also for the car riders. It is unfortunately true that too often the plans and suggestions of the company are looked upon as selfish and therefore a target for other interests. The street car rider benefits to a vastly greater degree than the company when congestion is lessened and traffic moves more freely.

The street car rider rightfully is entitled to more consideration than he has had in the past. The street car is the unit best adapted to handle mass transportation and

mass transportation is the problem in congested areas. It is idle talk to suggest that all street cars be taken off the streets and the streets given over to automobiles.

If all the street cars were removed and automobiles given the whole of the street area it is doubtful if double the present number of automobiles could be accomodated. There would still be the delay by cross traffic at intersections. The number of people who might benefit by having the cars off the streets would be a very small fraction of the number of street car riders who would be greatly inconvenienced.

Comparative Use of Street Cars and Automobiles

Very recently observations were taken of conditions at 7th & Broadway during the evening rush hour from 5 P.M. to 6 P.M. During this hour there were 191 street cars and 668 automobiles using Broadway. A very impressive total in favor of automobiles. But the automobiles only averaged 1.75 passengers per car, including the driver, while the street cars averaged approximately 75 passengers per car.

Those using street cars north and south on Broadway totaled 14,325. Those using automobiles totaled 1,169. Shall 14,325 street car riders be forced off the streets for the benefit of possibly another 1,169 automobile riders? Economically the benefits to the proportionately small number of automobile riders would not

justify the additional expense to the far greater number of street car riders involved in putting street cars in subways or elevated structures.

Motor Traffic Arteries

In June 1923 a count was made of all motor vehicles leaving the congested area of Los Angeles during the afternoon outbound rush hour from 5 P.M. to 6 P.M. to determine the relative use of different traffic arteries. This information is shown graphically in Chart 17. Two outlets to the west which may be considered fair for comparison are 7th Street and 8th Street. Both cross Figueroa without the offset found south of 8th Street, and the conditions of grade are similar.

Eighth Street is recognized as an important automobile outlet west, no car tracks and good pavement. Seventh Street is similar except there are car tracks on which there are operating 3 car lines with a very frequent service. The number of automobiles west bound on 7th Street during the hour was 804, the number west on 8th Street was 1149. Only 43% more automobiles used the street without car tracks. From these figures it would appear very doubtful if actual capacity of streets for automobile movement can be increased more than 50% by the elimination of street cars.

The elimination of street cars will not solve the problem of traffic congestion. Proof of this statement may

be had almost any day, certainly any Sunday, in scores of places in and around Los Angeles where automobile traffic is choked of itself, not a street car near on which to place the blame.

No Right or Left Turns

Between the hours of 9:00 A.M. and 6:15 P.M. both right and left turns are prohibited at 5th,6th, and 7th Streets on Broadway. There are no street cars turning at these corners so that all traffic moves straight ahead on the signals. At many other important intersections in the congested area right turns are permitted but left turns are prohibited. The movement of all traffic is materially facilitated by these regulations and it would be well to extend the regulations to other points as the congestion increases.

Pedestrian Regulation

Observation of conditions at any of the street intersections in the central business area will show an alarming disregard for traffic signals by pedestrians. An ordinance requiring pedestrians to observe traffic signals in the same manner required of vehicles was passed by the council but vetoed by the Mayor. Therefore no attempt is made to control their movements.

Pedestrians dart from the curb and get across ahead of one car only to get in front of another one going

the opposite direction. Although there is room for a person to stand between two moving street cars, motormen can never be sure that the person or persons will stand still and, properly so, cars are brought to a stop while the "jay walkers" get out of the way. There is a great deal of delay to traffic movement caused by uncontrolled pedestrian movement.

The volume of pedestrian movement at the principal intersections on Broadway, Spring and Main is very great as the following tabulations show.

Table Showing
Total Number of Pedestrians
Crossing the Streets
At Points & Times Indicated

	18 Hours 6 A.M. to 12 P.M.	6 Hours 12 Noon to 6 P.M.	1 Hour 12 Noon to 1 P.M.	1 Hour 5 P.M. to 6 P.M.
7th & Bdwy	220,981	124,946	25,435	19,966
6th & Bdwy	173,830	94,709	18,063	14,966
5th & Bdwy	185,643	102,250	20,910	16,114
6th & Spg		74,780	16,083	12,657
6th & Main		63,183	12,324	12,635

It may be noted from the foregoing table that there are more people crossing the streets in the hour from 12 noon to 1 P.M. than in the hour from 5 P.M. to 6 P.M. This is due to the combination of shoppers, clerks and office people on their way to or from lunch or on a little shopping trip during the lunch hour period. Between 5 P.M. and 6 P.M. people are generally hurrying to get home and usually take

the shortest or quickest route to their destination with the fewest street crossings possible. The location of the Pacific Electric Railway station at 6th & Main causes the pedestrian movement at that point to be heavier during the 5 P.M. to 6 P.M. hour than at the noon hour.

There is one other very noticeable difference between the noon hour pedestrian movement and that between 5 P.M. to 6 P.M. At noon about 40% of all movements are made against the traffic signal. In the evening only about 25% of it is against the signal. This may be accounted for by the fact that there are more street cars on the streets and that they move three at a time each way over the intersections. With automobiles speeding along-side the street cars the pedestrian is practically forced to wait until there is a break in the vehicular and street car movement.

The distribution of the pedestrian movements at each of the four crossings at these five points for the 12 noon to 1 P.M. hour is shown graphically in Chart 18. The thickness of the band at right angles to the direction of movement from curb to curb is proportional to the number of pedestrians crossing.

Distribution of Street Railway Travel

Charts 14 and 15 show respectively inbound and outbound travel by twenty minute periods from 6 A.M. to 12 P.M. on all Los Angeles Railway lines which reach the central

business area, including lines "C", "I" and "T" but not including "K" nor "V" nor any of the shuttle lines. These charts are the results of summarizing traffic checks taken at points just outside the congested area and show quite clearly how the street railway passenger travel is distributed throughout the day.

They show, for example, that during the maximum hour of the morning travel from 7:20 A.M. to 8:20 A.M. approximately 44,300 passengers are brought into the business area. Between 6 A.M. and 9 A.M. the Los Angeles Railway carries into this area about 97,000 passengers. During the 5 P.M. to 6 P.M. hour of maximum travel the company carries 55,600 people away from the congested area and during the 3 hours from 3:40 to 6:40 P. M., a total of almost 120,000 passengers are transported homeward from this section. Truly they form an army of riders to be considered in working out a solution for the traffic problem.

A further analysis of the time distribution of street railway travel is shown in Chart 16, and is based on data from Charts 14 and 15. Thirty-two percent of all inbound travel occurs by 9 A.M., 50 percent by 12:10 P.M., 75 percent by 4:40 P.M., and 95 percent by 8:20 P.M. Outbound travel lags behind in percentage, the difference being business people and shoppers who spend the day in the business section. Only 14 percent of the total outbound travel occurs

by 9 A.M., 23 percent by 12 Noon, 50 percent by 4:40 P.M., 75 percent by 6:10 P.M. and 90 percent by 9 P.M.

The distribution of the 55,600 outbound passengers between 5 P.M. and 6 P.M., is shown on Chart 13. The width of the bands radiating from the congested area is proportional to the number of passengers carried according to the scale indicated. The Pacific Electric local city passengers are also shown on this chart but are in addition to the 55,600 Los Angeles Railway Passengers. Details as to routes of Los Angeles Railway lines may be found in Chart 11 if it is desired.

It will be noted that the width of the bands of Chart 13 diminishes with distance from the congested area, not in direct ratio but according to local conditions along each line. This shows roughly the justification for not sending 100% of the service through to the outer terminals when usually only about 30% of the passengers are beyond a point where turnback service reasonably may be established.

Staggered Hours

During the war a great deal of prominence was given to the question of "staggered hours" for opening and closing of stores, offices and factories for the purpose of spreading out the rush hour travel peaks. This matter has also been discussed in Los Angeles as a possible aid

in the relief of traffic congestion.

By referring to Charts 14 and 15 showing the total passengers carried by all lines of the Los Angeles Railway into and out of the business area it will be noted that while the rush hour peaks are very pronounced they are fairly well spread.

There are over 13,000 passengers per 20 minute period for four consecutive twenty minute periods in the morning rush inbound and in the next period there are approximately 12,000 passengers. Any successful effort to have any group of downtown employees shift their hours would merely pull the 20 minute maximum of 16,000 from one period to another and nothing in particular would be gained.

It might appear at first that some of the travel could be shifted a little later to come inbound nearer 9 o'clock. This would mean shifting a corresponding amount of traffic into a later period on the outbound afternoon peak. To be of any material benefit in spreading out the evening peak this travel would have to be thrown back to the period from 6:20 P.M. to 6:40 P.M. It is very unlikely that any group of employees which can arrange to start work at 9:00 A.M. can be held after 6:00 P.M.

To smooth out the morning inbound peak by shifting part of the travel to later periods and to smooth out the afternoon outbound peak by shifting

part of the travel to earlier periods would mean shorter hours for the groups affected. This is a question into which the company, being an outside party, would scarcely assume to enter.

The "staggered hour" plan is of greatest value, practically, when applied to large industrial concerns employing thousands at concentrated points and served by a limited number of street railway lines. The disadvantage of having all employees start work and leave work at the same hour is very easily demonstrated to the plant manager, who, in the last analysis, is the one upon whom the consent for changing of hours depends.

Too much should not be expected from the "staggered hour"plan, particularly where its application would change the hours of a large number of employees in the offices and stores in the central business section. It is a matter of co-operation and not compulsion, and therefore trying to deal with hundreds of store managers or office managers to secure changes in their hours is very likely to lead to an expenditure of unproductive effort.

Through Lines vs Loop Lines

The suggestion has been offered by some that the present system of through routes from one side of the city through the business area to another residential section

beyond be abandoned in favor of individual lines which would loop back "some place downtown". This would almost double the mileage operated in the congested area and would multiply the delays and interferences. It would add greatly to traffic congestion and, in our opinion, would create an impossible condition for operation.

It would vastly increase the number of turning movements by street cars in the congested area and is not feasible. The rerouting program of the joint report of the California Railroad Commission and the Board of Public Utilities in 1919 followed a correct principle in reducing the curve movements to a minimum and in arranging for those really necessary to be outside points of heaviest congestion whenever possible.

Others have suggested that the present through routes be cut apart and the separate lines be turned back at the edge of the congested area, the service in the business section to be supplied by a "central loop". This, no doubt, would make it easier to maintain regular headways on the separate outlying lines and might be more satisfactory to a very few who would be able to reach their destination without a transfer, but such a plan has so many objections it is not feasible.

Practically every passenger would have at least one transfer to get anywhere in the congested area and those

who desired to go to the opposite side of the city would have to make at least two transfers. The enormous increase in the volume of transferring could not be handled by the present methods. It would be necessary to use enclosed prepayment areas and the so-called "bodily transfer" as used in subway and elevated systems. Several stations with prepayment areas would be required and these would be costly.

Such a plan would not substantially decrease the actual number of cars in the congested area because in order to handle 60,000 passengers per hour at 75 passengers per car 800 car units are required, regardless of how many times an individual car may come around the loop within the hour. If the cars made a round trip in an hour it would take 800 cars, and if it took only half an hour for a round trip it would take 400 cars but there would be the same 800 car units to handle the 60,000 passengers. Therefore congestion would not be decreased and passengers would not be served in as satisfactory a manner.

Any compromise of turning most of the lines back at the edge of congestion and leaving a few of the old through routes as at present is open to much objection. The lines that did run through would become increasingly heavier requiring more and more cars due to their loads downtown and such a situation might lead to the point where more cars would be required than under present operation and the service would not be as satisfactory.

There is now a concrete example of how this plan works out. The Temple Street line terminates at Temple and Spring. Practically all these passengers transfer to through line cars toward the central business section, adding to their inbound loads. If there were ten lines like the Temple Street line dumping passengers at the edge of the congested area it would be necessary to put enough additional cars on the through routes to handle these transfers and it would actually take more cars than if the ten lines went into the congested area. Limitations of equipment justify individual cases like the West First Street line and the Temple Street line but a general application of such an arrangement is not feasible.

In our opinion the principle of through routes is sound where the service requirements on the two parts are approximately in balance. In Los Angeles through routes are essential in order to eliminate as many curve movements as possible and in order that the service may be rendered without the duplication of mileage in the congested area as would be the case with individual lines having overlapping loops.

It is also our opinion that some rerouting is necessary, possibly including different line combinations, but since these matters are essentially a part of the unification study no details are included in this report.

One Way Traffic

The one way traffic plan has been suggested from time to time by some who are interested in the traffic problem. Such a plan as applied to downtown Los Angeles fails to take into account the topography, the irregular streets and the consequent limitations at the "bottle necks". It also fails to take into account the physical impossibility of moving all south bound street car traffic on two streets and all north bound street car traffic on two other streets using only one track in each street. Chart 12, Car Flow Diagram, shows the scheduled distribution of street cars in the congested area on normal week days as at June 15, 1923.

The intersections of 7th and Broadway and 7th and Spring are now almost taxed to the limit in moving cars both north and south at the same time on one signal and moving cars east and west at the same time on the other signal. There are now 151 east and west movements and 170 north and south movements (total 321 movements) scheduled at 7th and Broadway between 5 P.M. and 6 P.M. on weekdays. At 7th and Spring the total movements scheduled for the same hour is 339.

Actual observations taken in July 1923 showed 347 street car movements over the 7th and Broadway intersection, and 357 over 7th and Spring in the 5 P.M. to 6 P.M. rush

hour. The 7th and Hill and 7th and Main crossings are not as heavy as 7th and Broadway and 7th and Spring but it would be absolutely out of the question to operate all cars north on Main, south on Spring, north on Broadway and south on Hill. It would be beyond the limit of track capacity.

Any plan which fails to take into account the movement of street cars which handle approximately ten times as many people as automobiles in the hour of peak travel, cannot be considered a feasible plan to apply to the Los Angeles traffic congestion problem.

Tandem Movement of Street Cars

Early in January we recommended that street cars be moved over intersections two at a time to save delay caused by each car making a service stop at the property line. Under such a plan the loading zone or safety isle would extend for two car lengths, and two cars pulling up together would take on and discharge passengers simultaneously, the leading car standing in the "first position" and the following car in the "second position". A car that had stopped in the "second position" would not make another stop in the "first position" but would follow the car ahead over the intersection.

Such a plan had been used during the Christmas Holidays but it had not been continued. In our opinion the double berthing or tandem movement was desirable as a permanent operating feature to expedite traffic movement, so that when

the police department also suggested it in May we again recommended that it be adopted.

The group movement was modified to include three cars instead of two, the safety zones were extended to three car lengths and the new plan of operation put into effect June 12th, 1923. A very material improvement in traffic movement was immediately apparent. Three and four cars are able to get over the crossing on one "GO" signal. The time required for cars to run through the congested area one way, has been reduced an average of from five to eight minutes.

Restriction of Vehicular Traffic

When the volume of vehicular traffic attempting to move on the streets of the central business area exceeds the amount that can move with reasonable dispatch, causing material delay and inconvenience to car riders who comprise from 80% to 90% of the mass of people using means of transportation on these streets, then the volume of vehicular traffic must be restricted. This is not a capitalistic proposal for the benefit of a corporation. It is simple justice to the most efficient users of the roadway space- the street car rider.

The time may come when the streets within a limited zone may be reserved for street car patrons and pedestrians only, in certain hours, but at least one other regulatory step

should be first applied in Los Angeles. The restriction in the volume of vehicular traffic should first be accomplished by an ordinance requiring automobiles, trucks and other vehicles to stay off the street car track zone except at street intersections.

This would eliminate the delays now caused by the automobile road hog who cuts out of line, races down the car tracks to the end of the safety zone, and sticks the nose of his machine into the line waiting for the line to move on the next traffic signal but meanwhile blocking street cars in the middle of the block. If automobiles are forced to keep off the car tracks then the delays caused by too many automobiles trying to use the same street will affect only automobiles and in self interest they will detour around the congestion.

The street railway therefore has a vital interest in the development of traffic arteries outside the congested area. One of the very important contributing causes of congestion in the central business area is the fact that travel from one part of the city to the other is almost compelled to come through this central area because of the lack of direct, well paved traffic routes outside of it.

Interferences by Parades

A very aggravating situation arises whenever there is a street parade in the central business area- and scarcely

ever is a parade staged that does not take in the principal streets in that area. Parades apparently have right of way over all forms of street traffic, pedestrian, vehicular and street railway, regardless of the inconvenience that may result to thousands of people.

When streets are closed to traffic for the benefit of a parade, vehicles can usually detour but street cars get little consideration. The possibility of rerouting street cars is necessarily restricted by track facilities so that when the line of march includes Broadway and either Spring or Main confusion and interruption to service is bound to result.

Under the existing circumstances the company owes it to its patrons to give the best possible service by rerouting cars and turning cars back outside the blockaded zone in order to keep cars running on the outer sections of the lines. Turnback points should be selected as close as possible to the blockaded area.

The company lays itself open to just and severe criticism if it deliberately fails to co-operate in expediting the movement of the parade when the authorities have granted the permit for a particular line of march. A much better plan is to give the best possible service under the circumstances as an evidence of good faith and to give all

available advance information to the public concerning the changes that will be necessary in the routing of cars during the interruption.

Parades, like traffic congestion, are beyond the company's individual control. Permanent relief should be sought through the creation of public sentiment by education and publicity demanding municipal regulation of parades, restricting them to streets which will cause a minimum of delay to the city's transportation system.

Responsibility of Utilities

The street railways and other public utilities are not without responsibility for some of the conditions causing serious traffic congestion. There have been some very glaring examples in recent months which should serve to show the railways the necessity of eliminating causes for congestion which are within their control.

In tearing up the streets for the repairing or relaying of tracks, conduits, manholes, etc., on streets where traffic is heavy, the work should be carried on diligently night and day if traffic conditions permit work during the day. If not, then openings should be temporarily covered at the street intersections whenever possible during heavy traffic periods and the work pushed with all possible speed during the night. There needs to be a better under-

standing on the part of construction superintendents and foremen of the importance of keeping traffic ways unobstructed.

The public is not concerned with what department of the railway company's organization is doing the work or whether it is being done under contract by outside parties. Their thought is that somebody connected with the railway is responsible for having the street torn up and that causes the congestion. To merit public co-operation the company must play fair on its own work.

The street railways should also make it a point to secure the co-operation of the electric, water, gas and telephone utilities, whether privately or municipally owned, so that whenever it becomes necessary to open up manholes or conduits or to obstruct the streets in any manner it may be done with the least possible interference to street traffic.

In support of the [illegible] of [illegible] [illegible] number of [illegible] and proved that autos and other vehicles driving upon st car tracks, the [illegible] [illegible] the special [illegible] on traffic had one day [illegible] from the [illegible] that the [illegible] [illegible] only, for their safety, [illegible] [illegible] ~~[illegible]~~ during the period from the [illegible] to the close of the holiday season.

The [illegible] dept of St Ry Co believes that if [illegible] are not taken there will be [illegible] the [illegible] of traffic during this due to [illegible] of city shoppers.

~~[illegible] that~~ The [illegible] is [illegible] is at work upon a plan for [illegible] relief - physical condition the number of riders

DETAILS OF OPERATION

More Cars in Service.

Excessive Layover.

Time Points Extended.

Adjusted Running Time.

Supervision.

New Train Number Plates.

Route and Destination Signs.

Cars and Equipment.

Use of Safety Cars.

Two-Car Train Operation.

Reassignment of Routes to Divisions.

Need for Additional Special Work.

Elimination of Stops.

Co-operation with Pacific Electric.

Handling Complaints.

More Cars in Service

Early in January 1923, the number of cars in service during the P.M. rush hour on weekdays averaged from 840 to 845. (Chart 19) Increased service was desired. It was reported that no more cars were available for service unless cars were withheld from the shops when due in for general overhaul or painting.

Investigation disclosed that approximately 40 O.K. cars were being held in reserve for replacements at the division car houses by the mechanical department during rush hours. We recommended that all O.K. cars available at car houses at 4:30 P.M., be put into service and that any replacements necessary during the rush hour be made by the supervisory force of the operating department using tripper cars scheduled to pull in.

The recommendation was immediately adopted and the number of cars in service was increased as fast as crews were available. The adoption of this recommendation represents a saving of approximately $600,000.00 which would have been required in capital expenditure for new cars to give the same service under the method of operation formerly used.

Excessive Layover

Our observations indicated that on many lines there was an excessive amount of layover time at terminals.

Two reasons were found for this condition,-

(a) Motormen were not being required to observe time points on trips outbound from the center of the city, resulting in fast motormen speeding to the end of the line in order to get additional layover whenever possible.

(b) There was an insufficient running time differential in schedules to meet changing conditions throughout the day- the necessity for more running time being covered by additional layover or protective time, producing the same result as above.

Time Points Extended

We recommended that the first step for improvement in the regularity of the service be to require motormen to observe additional time points on outbound trips. Our recommendation was adopted resulting in better spacing of cars along the line and less bunching of cars at the terminals in layover. In our opinion there is still too much layover time allowed and as schedules are rebuilt this should be carefully analyzed and the excess eliminated.

Adjusted Running Time

It has been the practice for sometime on the Los Angeles Railway lines to have only two running times- "short" time and"long" time. Short time has been used from 6:15 P.M. to 7:00 A.M., and long time from 7:00 A.M. to 6:15 P.M. The change in running time took effect at the first time point passed after 7:00 A.M. or after 6:15 P.M.

It is obvious that conditions of street traffic, number of passengers carried and number of stops made must vary during the different periods of the day for the different sections of the line. Under the old plan of long and short time it was common knowledge that cars could not get through on schedule at certain periods. Trainmen, supervisors and others expected cars to be several minutes late. The psychological effect was bad.

Extended observations were taken for a five day period of all cars entering and leaving the congested area and from these observations it was disclosed that the periods during which cars were running very late were well defined and regular. It was also found from the observations that at certain times cars were going into the congested area practically on time but coming out of the congested area several minutes late. This was regularly recurring on successive days at the same time of day showing conclusively the necessity of an adjustment in running time.

Similarly, a time study along the lines beyond the congested area showed the need of a differential in running time. Adopting our recommendations in this matter all new schedules are now being prepared embodying this feature, which will make it normally possible to secure "on time" operation.

The exact running times from time point to time point as chosen for the first revision of schedules on this plan should not be considered something fixed and never to be changed. The principle of a differential in running time to meet the changing conditions of travel is the idea to keep securely in mind, but the details of running time should be adjusted as often as necessary. Frequent observation and checking will be found desirable.

Supervision

Adequate supervision is an essential feature of satisfactory service. Supervisors are the company's official representatives in directing the operation of cars on the streets. They should be able to grasp a situation and act quickly, at the same time displaying good judgment in their decisions.

Quite naturally supervisors are recruited from the list of motormen and conductors because such a background of experience is necessary. In order that a supervisor's posi-

tion may appeal to the trainmen best suited for it, it should be attractive not only because of its increased responsibility and authority, but also because of its financial advancement.

Unfortunately, the financial inducement is lacking. A motorman or conductor holding a ten and a half hour run daily, Saturday and Sunday would earn $166.95 in a thirty day month at the top wage of 53 cents an hour. For the trial period of 90 days as supervisor pro tem he would receive only $150.00 per month and if finally appointed to the supervisory staff would receive only $165.00 per month. As a trainman he might hold a day run but if he took a supervisor's position he would be assigned to a night shift for several years, under the system of promotion that has been in force.

In our opinion supervisor's salaries should be materially increased above the present scale so that it will be possible to attract the best men in the train service. The hours should be arranged to alternate the day and night work for all supervisors, the changes being made at intervals of two weeks or four weeks. It is to be expected that some of the older supervisors will object to this plan just as they object to anything new, but if all supervisors are put on the same basis there will be more general satisfaction eventually and both the company and the service will benefit.

The low salaries and night work assignments for

all new men may partly explain some of the deficiencies of the supervision now obtained. Present methods of supervision are inadequate both as to quantity and quality. Lack of ability or inclination on the part of supervisors to jump into a blockade and clear it up by rerouting, diversion or switchbacks has been so plainly evident that it raises the question of whether or not they have been properly trained and instructed.

A supervisor's chief duties are to keep cars on time under normal conditions of operation and to see that patrons of the line get the best possible service under any unusual conditions that may arise. Normally, therefore, the supervisor should be watching his cars and checking their actual time against their scheduled time and ascertaining the cause for any deviations. Chronic cases of irregular operation should be checked in particular and fully reported so that appropriate measures for correction may be taken.

Obviously a supervisor cannot check his cars from memory unless he has very few cars on a regular but infrequent headway. It, therefore, has been the practice to supply the supervisors with schedule data showing the time cars are due to leave the terminals arranged in the order in which they are due to leave. Many supervisors carried only the terminal times in their books and had no time shown at the

point where they were stationed for a period of several hours daily.

The result was that an individual mental calculation of time had to be made in order to check each inbound car by adding to the terminal time, the running time to the point of observation, and to ascertain if that total corresponded to the observed time. Outbound cars, if checked accurately, required the same calculation figuring from the other terminal. But actually very little real checking of outbound cars was done. Instead, the supervisor merely figured to see if the car had time to make the scheduled terminal in time to start on the next trip.

The books were so arranged that a supervisor checking cars on two lines in each direction had to look four places in his book, and to check three lines he had to look in six places. Such an arrangement was both clumsy and slow with the result that the lines were not carefully supervised. Many of the supervisors carried their books in their pockets a large part of the time apparently with the attitude of letting things go unless some crew asked what to do. Under these general conditions let due credit be given to those supervisors who are putting into their work that interest and attention which the position calls for.

Upon our recommendation there has been adopted an improved type of supervisor's book which greatly facilitates

his work. Time by half minute intervals is printed in a column in the center of the page. The left half of the page is used for inbound cars and the right half of the page is used for outbound cars, one column being reserved for each route passing the checking point for which the book is made up.

The new book is made up to show the time that each car on the schedule is due to pass the supervisor's station by having its train number in the proper route column on the proper horizontal time line. This enables the supervisor to tell quickly whether the car is on time, late or ahead of time. The clearly detailed yet compact arrangement of the schedule data enables him to tell quickly the relative position of the cars from different routes on common track and if at a junction he can readily direct which car should have the preference when two arrive at the same time.

The new book also shows the layover at the next terminal for each train so that the supervisor has right before him the number of minutes leeway he has on the outbound car before it will be necessary to consider turning it short of destination. For example, if an outbound car has 7½ minutes layover and passes the supervisor 6 minutes late it should leave the terminal on time. If the car had been 20 minutes late outbound with only 7½ minutes layover it lacked 12½ minutes of having time to make the terminal to leave on

time. The supervisor then may put this car on time by turning it back at a crossover from which the running time to the terminal and return is not less than 12½ or 13 minutes.

The advisability of turning cars short of scheduled destination is a matter that must be considered in the light of circumstances and conditions at the time. The supervisor must exercise judgment.. It would depend upon how many passengers the car had on board, upon whether the prevailing direction of travel was outbound or inbound, upon whether other cars were immediately ahead of or behind the car to be turned short and perhaps on some other conditions.

The elimination of, or a reduction in the number of, turnbacks may be a general indication of improved operating conditions but the fact must not be overlooked that there are times and conditions when the service would be benefited if there were more turnbacks. There are usually more people desiring transportation at other points along the line than at the terminals and they are to be considered. Day cars which are late in the morning rush and night cars which are late in the afternoon rush often can be advantageously put on time by a turnback, filling in the service to the terminal by using a tripper which is due to pull in.

It is our opinion that on a system the size of the Los Angeles Railway there should be direct supervision on the street for approximately 18 hours per day according to

the following plan. Supervisors should be located at strategic points for control of the various lines. On through routes there should be a supervisor located on each half of a line at a point beyond the congested area, each supervisor looking after one of more lines at his station.

One supervisor should be held primarily responsible for each line to avoid confusion over orders but the supervisor stationed on the other half of the line should assist in carrying out the plan of control determined upon by the supervisor in charge. In fact each supervisor should have in his book the times of cars on all lines past his station, not that he will have to work all of them but that he should be in a position to step in and take action in an emergency.

For example suppose that a southbound line "W" car has been delayed at a railroad crossing on San Fernando Road after passing the supervisor at 25th and Dayton and the line is blocked until the next two "W" cars are also held up. When the crossing is cleared three "W" cars will be running southbound together. The supervisors at Bridge Junction and Plaza should have the "W" line times in their books so that either of them can act in the emergency.

In the case cited above of three cars bunched coming inbound all carrying signs "Washington to Rimpau", the first car would be at least 12 minutes possibly 14 minutes late on a 6 minute headway. If all three cars were

permitted to run through to the end of the line at Washington and Rimpau there would be a "space" or "gap" in the line not only on the outbound trip but also on the next inbound trip.

If the three cars go through the congested area with"Rimpau" destination signs the first car is sure to be heavily overloaded because it is the first car through after the delay. By the time the three cars get to the supervisor of the Washington Street half of the line there is no opportunity for him to turn the first car back and put it on time.

The proper way to handle such a situation would be for the supervisor at Bridge Junction or Plaza, seeing two or three "W" cars coming down together, to look at his book and note that the first "W" car was perhaps 14 minutes late, the second 8 minutes late and the third one 2 minutes late, all having perhaps 4 or 5 minutes layover at Rimpau. The supervisor should give the crew on the first car orders to turn back at 8th Avenue and carry a sign "8th Avenue Only" so that in coming down through the central business area where the outbound load is picked up, only those passengers desiring to go to some point between the Plaza and 8th Avenue would board the car. Passengers desiring to go beyond would be able to take either of the two cars following closely behind the first one.

In this way the first car after the space would not

get such a heavy load, it would not be necessary to put off a lot of passengers at 8th Avenue and the car would come inbound on Washington Street practically on time. The essential features of such a plan are dependent upon having a supervisor at a point where the orders could be given before the car started to pick up its West Washington load, and dependent upon having the information regarding the scheduled time of these cars readily accessible. The new supervisor's book provides the second essential and a correctly planned system of point supervision would provide the first.

Under such a plan it is not contemplated that a point supervisor can never be taken off the point. He should leave his station to go to an accident, derailment or blockade if he can do more good there, but except in emergencies he should stay at his point, which, if properly selected, is the strategic point for the control of the lines under his direction.

The objection is sometimes raised to point supervision on the grounds that the crews always know where the supervisors are located and may be leaving terminals late, running by passengers or running ahead of time because they think it will not be discovered. If the point supervisors are giving careful attention to the cars passing their stations they will usually be able to detect any serious irregularities. A limited number of travelling supervisors should be assigned to travel on several lines to correct such matters as mentioned

in the preceding paragraph and to follow up cases of recurring irregular operation that the point supervisor may report.

On many street railways the division superintendents have the responsibility for the operation of cars on the street but this function is delegated to "District Chiefs" under the Director of Traffic on the Los Angeles Railway. The district chiefs should be assigned to a certain territory and have general direction of all lines and all supervisors within that territory. Territorial division for the district chiefs is to be preferred over a group of through lines because it enables them to cover the lines with less lost motion or duplication of supervision on trunk lines. It gives a better distribution of their services.

New Train Number Plates

The distinguishing mark for each car to designate its place on the schedule is its train number. It is essential that supervisors be able to distinguish train numbers quickly and as easily as possible. Formerly a 2½ inch disc was hung inside the window on the front end of the car only. At the end of the line the motorman removed the disc and placed it on the hanger at the other end of the car. Frequently he forgot to hang it up but instead left it in his pocket.

It was difficult to see the old train number discs when not standing directly in front of the car because they

were small and because of the light reflection on the window. This was particularly true under conditions of low visibility. The new numbers are much clearer and more easily read than the old ones and it is a great convenience to the supervisors and to the motormen to have the numbers displayed both on the front and the rear of the car.

The new train number plates are of sheet metal 5½" x 6" and have aluminum leaf figures on a black background. Two are used for each train, one placed on the front and the other on the rear above the window to the right of the center line of the car. The train numbers stay in place from the time the car leaves the car house until it returns to the car house, while it is on the same train run.

Route and Destination Signs

It apparently has been the policy of the Los Angeles Railway to discontinue the use of illuminated roller route and destination signs, substituting therefor an illuminated line letter in a box on the front right hand corner of the roof and a non-illuminated metal sign on the front right hand dash.

This appears to be a backward step rather than a forward step in car signs, because it is impossible to read the metal dash sign at night except by reflected light from sources outside the car. A good sign is an essential

part of the car equipment. It is one of the selling points for service, the only commodity the company has for sale. Signs cost money. So do seats, straps, lights, windows, doors and other car parts. Poor signs not only exasperate intending passengers but delay cars unnecessarily because when the signs are not clear patrons signal cars they do not care to board.

It had been the practice in Los Angeles to show on the dash signs local points of interest along the route- in addition to the destination. Further- these intermediate points were given as much prominence on the signs as the destinations so that in addition to the fact that it was difficult to determine just where the car was scheduled to go, the display of many points along the line was entirely misleading to those not thoroughly acquainted with the city- because during the most of the run some of the points shown on the front of the car had already been passed. Hence the purpose of the showing of extra points of interest on the dash sign was defeated- as these were displayed chiefly for the benefit of persons not familar with the city.

If the metal dash signs are to be used, they should be as plain and as clear as it is possible to make them. New dash signs now being placed in service are the result of our recommendations to eliminate everything from the sign except route and destination. The signs are 20" x 23" and the letters are 3 inches and 5 inches in yellow on a black background. The

size of the sign affords a border or background in black of sufficient width to set out the sign itself from the yellow car body.

There is no objection to the line letter or route letter sign per se, but the objection to the Los Angeles roof type line letter sign is that it is not easily changed. The letter is displayed to the front and side by holes in a metal plate punched to form the letter outline. To change the letter someone must climb upon the roof of the car, pull out one set of letter plates and insert another set.

If the illuminated route letter sign is to be used with a metal dash sign then the two color illumination for different terminals is almost essential for night indication to supplement the inadequate non-illuminated dash sign. The present scheme of changing the color in this sign is for the motorman or the conductor to climb on top of the car and exchange the green lamp for a red one, or vice versa. To do this while the car is in motion is dangerous and to hold the car while it is done causes delay.

It had been suggested some time ago that the sign boxes be wired for two lamps, one red and one green, to be controlled by a switch inside the car. This plan was turned down because it was thought impossible unless larger sign boxes were used to replace the ones now in use. Our inves-

tigation disclosed that a feasible plan could be worked out for the use of the present sign boxes, and by the use of two switches instead of one a material reduction in the cost could be effected. We recommend further that all cars be so equipped, using green and red or green and white lights.

// It ought to be possible for a supervisor to take a car from one line and divert it to another to fill a "space" or "gap" in the service. With the present style of signs such a procedure has little value because the car will not be properly signed on its special trip. Without proper signs how can the public be expected to know where a car is going?

It is manifestly impossible to carry a full set of dash or route letter plates on the car. On account of the space required to house them it is doubtful if it would be practicable for the supervisor to have a set at his station. In our opinion the route letter sign should be an illuminated roller sign adjustable from within the car. Instead of the metal dash sign another illuminated roller sign should be used for destinations. Cars could be regularly scheduled for shop trips and school trips to much better advantage and supervisors could give better service in emergencies if illuminated roller signs were used.

Cars and Equipment

All the cars of the Los Angeles Railway (excepting

only No. 1101, and the safety cars) have three compartments, a closed center section and open end sections. This, no doubt, has many advantages and is probably well suited to this climate.

It is very noticeable that the open sections of the cars are often crowded when there may be vacant seats in the closed center section. This condition is due to poor ventilation in the closed section. In warm weather this is especially noticeable. We recommend that as cars come to the shop for heavy repairs, overhaul or paint, provision be made for two windows which can be opened on each side of the closed section.

In rebuilding the old standard 44 seat cars two additional cross seats were being added to increase the seating capacity to 48. Our observations disclosed that these additional seats were obstructing the right hand front exit and the capacity of the loading space at the rear. We recommended that these extra seats be left out of the rebuilt cars for further observation. This has been done and the objectionable features mentioned are thereby corrected. We further recommend that the seating capacity of the rebuilt standard cars be held at 44 and that the seating capacity of the new 1200 class cars be reduced from 52 to 48 for the same reasons.

All cars on the Los Angeles Railway lines are equipped with protruding type fenders which, in our opinion, cause much unnecessary interference in the congested streets. The non-protruding fender or life guard provides the essential safety features and takes up no street space beyond the car body. It has been accepted and approved by State Commissions and other public bodies after exhaustive tests, and we recommend that further efforts be made to secure approval for its use in Los Angeles.

While it is not the intention to go into the details of car design it is within the scope of this report to point out that from the standpoint of an operating unit to handle mass transportation and from the standpoint of safety features for preventing boarding and alighting accidents to passengers, the new standard 1200 class car leaves much to be desired. We recommend that more serious consideration be given to a low floor car that will provide an easier entrance and exit; a car having doors at entrances and exits, for safety; having illuminated roller route and destination signs, for the guidance of the prospective passengers; having non-protruding fenders or life guards to reduce street obstruction without the loss of the safety feature; and having four motor multiple unit equipment to provide rapid service in one- or two-car trains.

Use of Safety Cars

The safety car is serving a very useful purpose on many electric railway properties. It is being used advantageously on several lines of the Los Angeles Railway but in our opinion there are limitations to its use. The problem of traffic congestion has been discussed elsewhere in this report but comment on the bearing of the safety car on that question has been reserved for this section.

The successful application of the safety car contemplates a service of such frequency that none of the cars will be overloaded. Traffic congestion in Los Angeles is such that the cars are frequently delayed and the regular headway disturbed. Under such circumstances the safety cars operating on lines running through the central business area become heavily overloaded, delaying other lines at the loading zones.

For mass transportation in heavy traffic congestion the safety car is too slow in loading and is too small a unit to handle efficiently a great volume of traffic when the number of cars is almost at the limit of track capacity. At 7th and Spring, 357 cars passed over the intersection in one hour, some of them being safety cars. The other cars each carry perhaps twice the number of passengers a safety car carries, certainly twice the number of passengers the safety car should carry.

It would be a physical impossibility to operate safety cars for the others on a 2 for 1 basis and get them all over an intersection such as 7th and Spring in one hour. What is needed is a large unit that loads quickly and moves over the intersection without the loss of time.

It is, therefore, our recommendation that safety cars be withdrawn from lines passing through the congested area as soon as other equipment is available. In this connection we think consideration should be given to the use of a one man- two man car which can be operated by one man during light traffic periods and by two men during heavy traffic periods to increase its effectiveness as a unit for mass transport.

Two-Car Train Operation

The last seventy five cars placed in service by the Los Angeles Railway and all those now on order are designed for train operation. It has been pointed out in preceding paragraphs that large quick loading units are the most suitable for mass transportation in congested areas. The two car train supplies the large unit but the quick loading feature is not attained because of the high platform and the seat arrangement.

The full value of the car equipment designed for train operation is not being realized because of the way

in which it is being operated. Most of the cars have been running as single units and those made up as trains were rarely uncoupled except to shop one of the cars. On the Grand-Moneta Line the trains were operated about 18 hours; later they were cut off after the P.M. rush period, and operated only about 14 hours. On the San Pedro-Western Avenue Line the two car units were put out as trippers, or single cars changed off on the road for a two car train just before the rush period and the train changed off for a single unit just after the rush period.

Substituting trains for single units and vice versa involving transferring of passengers on the street should not be made a regular practice. Such a procedure ought not be necessary with car equipment designed for train operation. It should be possible to augment the rush hour service by making up two car trains by coupling a car from the car house to one running on the street. After the rush hour the second car can be cut off again and sent in leaving a single car in service.

Two car train operation is not recommended for all day service on city lines unless the travel is so heavy that the time spacing of cars with trains in service will still provide a reasonable frequency to attract short haul traffic. If applied to a split terminal line it results in infrequent service on each branch. It makes a particularly

bad combination if single and double units are intermingled in branch line service in off peak operation.

The service on the Grand-Moneta Line under this plan may be taken as an example. Using single car units the base trunk line headway mid-day was 4 minutes making 8 minutes on each branch, with alternate cars going to Manchester and to 54th and Mesa. Using two-car trains the main line headway was 8 minutes and the branch line headways were each 16 minutes, which is not reasonably frequent city service. When single units and two-car trains are intermingled, the single cars follow 4 minute spaces on the main line and the trains follow 8 minute spaces on the main line. The single car that follows 4 minutes behind a train on the main line will have a 12 minute (8 plus 4) space on the branch line because the train ahead of it went to the other terminal. If the branch line requires an 8 minute service with single cars, the single car following the 12 minute space on that branch will be overloaded. Our recommendation that two-car trains be taken off mid-day service on the Grand-Moneta Line was adopted, effective July 18, 1923.

We do not maintain that two-car trains should never be used in mid-day service on city lines but their use generally should be restricted to lines without split terminals and to lines having a very frequent service. The Pico-East First Street Line would have been a much better

application of 14 hour train operation than the Grand-Moneta Line for the reasons stated although it is doubtful if an 8 minute headway would be satisfactory on the Pico Line as a substitute for the present 4 minute headway.

Reassignment of Routes to Divisions

Prior to April 1, 1923, it was the practice, with few exceptions, to operate the cars on through routes from two divisions. This assignment was not arranged in order to classify cars or equipment nor for the convenience of getting cars on their respective routes. It is recognized that there are conditions under which it is advantageous to operate a route from two car houses but there are more advantages in having all the cars from one division provided no material increase in mileage is entailed.

One distinct advantage of having all cars of one route from one division is that the crews work together better. There is not the petty friction that arises between crews from two divisions working on the same line. In investigating matters involving several crews one division Superintendent would handle all the cases. Since run assignments are made up by routes there is an opportunity to arrange better work-runs for the trainmen if all of the cars are in one division. The new arrangement also simplifies work in the auditing department.

For one or two early morning inbound trips on

lines having terminals remote from the car house from which the line is operated, one or two cars from another car house may be used in order to keep down the spread time in the runs and to save a very early pull out. The analysis of the local situation showed the assignment of routes to a single division to be desirable and our recommendation for this change was adopted and put into effect April 1, 1923.

Need For Additional Special Work

There is a very serious lack of special work on the lines of the Los Angeles Railway. It is our opinion that a more liberal policy should be pursued in designing special work layouts. It is a mistake to design a layout only for the existing regular routing. Provision should be made for alternate routing in emergencies. The reverse policy seems to be followed, for many pieces of special work that would be useful in emergencies are not replaced when rebuilding the track. A few examples will suffice.

For many months there was much unnecessary delay to cars going into Division One because a crossover had been removed near 6th and Central making it necessary to switch every car individually over the crossover one car length from the busy intersection of 7th and Central. The patrons of the "U" Line were subjected to inexcusable delay. The crossover has been restored and conditions very greatly improved.

There is still unnecessary delay at 7th and Central due to cars switching against traffic in pulling out and in from East 7th Street to the car house. Double track curves are needed in the north east angle.

The track arrangements leading from Division Three car house are entirely inadequate. Every car out and in has to pass over a single track and a derailment or an accident on this track might paralyze the service on half a dozen lines. Such a track arrangement to serve a car house with a capacity of over 250 cars is ridiculous. Additional curves are needed at 28th and Dayton for line "W" cars out and in, to and from the Garvanza end of the line so that they will not delay cars on other lines.

In the event of a serious blockade due to fire, derailment, accident or other causes in the central business area it is extremely difficult to find a diverging route so that cars may be kept moving. At such times it is almost impossible to use crossovers because of other traffic. Cars north bound on Broadway cannot be diverted off Broadway after they pass 11th Street until they reach 4th Street even though there are crossings at 10th, 9th, 7th and 5th. At one o'clock in the morning it might be possible to back a car around a curve against traffic at 7th and Broadway but not when there is any traffic on the street.

There is not a single place where a car southbound at the Plaza can make a loop and go back north. Cars can be diverted from the Plaza or Temple Block via either Main, Spring, Broadway or Hill, but when once started down one of these streets there is no chance to make a loop and get back on any one of the other three streets. It is not even possible by going via Hill and 5th to Figueroa or via Broadway and 7th to Grand. There is not a curve permitting a car from the north to turn east anywhere on Figueroa, Flower, Grand, Hill or Broadway. This is possible only at 7th on Spring Street but then there is no curve at 7th and Main to permit the car to turn back north. Similarly there are no loops possible by turning to the west off of Main, Spring, Broadway or Hill.

With three lines coming from the west on 7th Street it is impossible to divert an eastbound car either north or south at 7th and Figueroa, 7th and Grand, 7th and Hill or 7th and Main. A car could be turned north at Broadway or Spring but could not find a continuous route to get back west on 7th Street unless it was sent to the First-Main-Spring loop at the Temple Block.

In the not very distant future it will be necessary to turn back some of the rush hour tripper service at the edge of what is now the congested area. Not all cars on the lines will be turned back but enough of them to provide service for those who are accustomed to board cars

near the edge of the congested area. Such a plan is now being used successfully in Chicago but there is not a single place on the edge of the congested area in Los Angeles where this plan could even be given a trial because of the almost unbelievable lack of special work.

The location of the industrial area seems to be fairly well defined in the suburb of Vernon approximately four miles south east of the central business area of Los Angeles. Lack of special work at many intersections prevents an efficient handling of traffic to and from this area and practically all passengers are now required to transfer.

Extra cars from other lines are used to augment the service on the "J" and "V" Lines that serve the industrial districts but they cannot be routed through to districts where the workers live because the special work is lacking. It should be possible to turn cars north off Vernon Avenue to the intersecting lines and it should be possible to route cars from Vernon Avenue south on Moneta, and vice versa. Cars from the industrial area north on Santa Fe Avenue dump off many passengers who transfer east on 7th Street and north on the Mateo Shuttle. Special work is needed for through service at this point.

It is recognized that special work is expensive and should not be wastefully located but the fullest con-

sideration should be given to the need for additional curves to permit a more flexible service in emergencies and to permit special through routing from the industrial district, and to permit turnbacks at the edge of the congested area. We have made no attempt to go into the subject exhaustively but some of the definite points cited in the preceding paragraphs may serve to show the seriousness of the situation from a service standpoint. There should be the fullest co-operation between the engineering department and the operating department in a further study of this problem and we recommend that a liberal policy be adopted in the matter of special work.

Elimination of Stops

On some lines the stops are too close together resulting in an average schedule speed that is too low, and in an unnecessary waste of energy. The car rider is not particularly interested in the second item but he is interested in the time required to carry him to his destination. Too many stops result in an uncomfortable ride for the passenger. On many lines the skip stop or alternate stop plan is in force and it is recommended that the same plan be carried to all lines.

Co-operation with Pacific Electric

Since there are streets on which the Los Angeles Railway and the Pacific Electric Railway operate jointly it

is essential that there be the fullest co-operation in clearing up blockades due to defective equipment, derailments or accidents. It was found some months ago that there was some disposition on the part of each company to let the other look after its own troubles exclusively, regardless of how many cars of both systems might be tied up in the blockade.

In fact, there was an order in force forbidding the use of the Los Angeles Railway emergency truck in clearing up any Pacific Electric troubles. The public is not concerned with petty jealousies and the company certainly laid itself open to just criticism for refusing to act while Los Angeles Railway patrons were being delayed and inconvenienced. Upon our recommendation this order was cancelled and full assistance is now given whenever the Los Angeles Railway's emergency crew gets on the scene.

There was one other matter of co-operation of particular importance. In making observations of traffic conditions on the streets it was disclosed that cars were being unnecessarily delayed on Main Street due to some delay in giving signals and throwing switches by the towerman in the Pacific Electric Station at 6th and Main. Our recommendations for improving this situation were adopted and operating conditions were improved both for the Pacific Electric Railway and the Los Angeles Railway.

Handling Complaints

Presumably there will be complaints filed with public service companies as long as they are in business but it seems that there is a growing understanding of utility problems on the part of the public at large and a willingness to have the problems explained.

Complainants usually seek the highest official they have any hope of being able to reach, tell him their story and bring to bear all the influence possible for a favorable decision. The higher the official the less time he has for details of operation and it might prove to be for the good of the service to withhold a decision until the department subhead has been given an opportunity to investigate and report.

Complainants do not always have ALL the facts bearing on the matter in hand and if the executive or department head will give the man in his own organization most familiar with the matter an opportunity to be heard it may materially affect the decision reached.

It may be a safe rule in mercantile business to settle complaints on the basis that "the customer is always right", because the settlement involves only the individual. In the street railway business conditions are considerably altered. Suppose a passenger complains that he boarded a car to go to the end of the line but the car was turned

back somewhere and the passenger had to transfer to reach his destination. He demands that all cars run through to the end of the line.

Settlement of this complaint on the basis of "the customer is always right" would be to ignore the claims of hundreds of other patrons who are benefited by having the car turned back so that service may be maintained in both directions along the line. It would therefore appear obvious that great care needs to be exercised in issuing orders affecting operating matters until all the facts have been presented.

Complaints of trainmen regarding schedules, work assignments and discipline should be handled in the same manner, always giving the department subhead an opportunity to present all the facts he has bearing on the matter. If such a plan were followed there would be less misunderstanding and a better spirit in the organization.

TRAFFIC ANALYSES AND SCHEDULES

Features of Adequate Service.

Importance of Traffic Analyses.

Profitable and Unprofitable Lines.

Traffic Checking Methods.

Graphic Representation of Traffic Data.

Special Charts.

Preparation of Schedules.

Schedule Forms.

Work Assignments for Trainmen.

The Public, The Employees, and The Company.

Features of Adequate Service

Too much stress cannot be laid upon the absolute necessity for a systematic and continuous traffic survey by the schedule department. The only commodity the Los Angeles Railway Company has to sell is service. The service ought to be adequate - commensurate with the fare.

Adequate service has four outstanding features:-

(1) Sufficient cars to handle the traffic.

(2) Cars operated frequently enough to serve a reasonable convenience.

(3) Cars that run with regularity.

(4) Cars that run with speed, not recklessly but fast enough to satisfy the passenger that he is getting somewhere.

Commenting briefly on these four points it may be said:-

(1) "Sufficient cars to handle the traffic" does not mean a seat for every passenger at all times. The American people do not expect it nor want it, though they sometimes think they do. During off peak periods there should be approximately a seat per passenger after making allowance for those who prefer to stand. Standing by preference is still

a real factor on the California type car with its closed center section and open end sections, smoking being permitted in the front open section. During rush hours adequate service contemplates cars loaded to comfortable carrying capacity. The number of standing passengers that may be carried on a car and be within the limits of comfortable carrying capacity is determined by the width of aisles, arrangement of seats, amount of unobstructed floor space and the arrangements of entrances and exits.

(2) "Cars operated frequently enough to serve a reasonable convenience". During the off peak hours the travel on many lines is so light that it becomes a question not of how many cars must run to handle the passengers but how infrequently can they be scheduled and still serve a reasonable convenience. The distance of the territory from the business section of the city, or from some other traffic center, the proximity of other lines and perhaps the density of population in the territory served are some of the factors having a bearing on the required frequency of cars to serve a reasonable convenience.

(3) "Cars that run with regularity", not that the time interval between cars should be the same at all periods, but that cars should be on time at the intervals prescribed in the schedules. In other words, cars must be on time, neither late nor ahead of time. Even a minute makes a difference. If the first car is one minute ahead of time, and the second car is one minute late, and the prospective passenger has just missed the first car, it means that he must wait two minutes longer than the schedule maker intended for him to wait. Not only that, but the second car has a larger load than its share because it followed a time interval two minutes longer than the schedule maker intended. It seems particularly hard to convince old motormen of the disastrous effects on the service of running a minute or two ahead of time.

(4) The fourth element mentioned as being a factor in adequate service was speed - "Cars that run with speed, not recklessly, but fast enough to satisfy the passenger that he is getting somewhere". Safety first, of course, but up to a certain reasonable limit it cannot be said that accidents increase with speed;

speed is not the controlling element in accidents. Slack time in schedules should be taken out. People living in an automobile age demand speedy transportation.

Importance of Traffic Analyses

It is at once apparent that the character of the schedules has a vital bearing on items 1, 2 and 4 referred to above as factors in adequate service. Item 3 is largely a matter of supervision and discipline discussed elsewhere in the report.

Obviously the schedule department must have accurate traffic data upon which to build schedules if the right number of cars are to be provided, if they are to be properly distributed as to time and spacing, and if they are to be scheduled at the proper speed.

The importance of the schedule department of the electric railway is too often overlooked. It is one of the very vital spots of the railway. Correct schedules can show profitable operation on a given fare and satisfy the traveling public with adequate service. Incorrect schedules on the same fare might show too much service and too little return, or too much return and too little service. A large amount can be wasted very quickly by improper schedules.

Profitable and Unprofitable Lines

The auditing department prepares daily a statement by lines showing the revenue, number of passengers carried, revenue per passenger, expense per passenger, net profit per passenger, car seat miles per passenger, percentage of transfer passengers and other data. This report makes it possible to compare the performance of any line from day to day or to compare one line with another provided the different conditions obtaining on the various lines are not overlooked.

It is not possible to put all lines on the same earning basis because of the variable factors such as the length of the line, the speed at which it can be operated, the number of passengers carried, their distribution along the line and their distribution by time periods throughout the day. On a flat fare and a universal transfer basis some lines will never show a profit. If an attempt were made to reduce the service on these lines to a point that would materially pull down the expense per passenger it would cause such an overcrowding of cars that the traffic offering itself could not be handled, causing a reduction in revenue as well as a reduction in expense so that the net per passenger would still not show a profit.

Such a situation would prevail on the Eagle Rock Line, the Washington-Garvanza Line, or the East 4th-Hoover

Line due to long haul and the character of the travel. These lines are consistent losers according to the auditor's report. On lines which have a high percentage of transfers such as the Vernon-Vermont Line, or the East Jefferson Line or the Gage Street shuttle a similar situation would prevail.

The good lines that show a profit must help carry the poor lines that show a loss. If service were added on such lines as the Pico-East First, the Stephenson-West 7th, or the University-Central until their average earning per passenger was reduced to the system average there would be an insufficient surplus to carry the weak lines.

It must therefore appear evident that an adjustment of service to make all lines show approximately the same profit per passenger or to provide the same number of car seat miles per passenger is not the goal to be attained. The auditor's daily analysis cannot be used as the measuring stick of the adequacy of the service unless it has been calibrated by actual traffic observations on each line.

Traffic Checking Methods

It is therefore essential that the schedule department should include a permanent traffic checking staff in order that continuous systematic checking be carried on, and in order that the service may be adjusted to the traffic demands. A tentative program has been outlined for checking all lines not less frequently than every thirty days and

particular lines as much oftener as conditions may require. The staff should include at least eight regular checkers. Owing to the limited opportunity to get observations on Saturday and Sunday travel, the checking program should include observations every Saturday and Sunday, allowing checkers a day off in the middle of the week.

The traffic checkers must be accurate in their observations and records and men with proper qualifications should be selected and trained for this work. Traffic checking is not to be looked upon as a place to use disabled or convalescent trainmen. The records of the traffic checkers form the basis for making schedules and the need for reliability is beyond argument.

New forms have been recommended for use in recording and summarizing the traffic data. These have been adopted and are in use. We have also recommended methods of showing the traffic data graphically and these have been adopted. The following paragraphs set forth some of the details and characteristics of travel that show clearly from the charts.

Graphic Representation of Traffic Data

Chart 21, for example, shows the fluctuations of traffic and variations in headway on the East First Street Line when checked at 1st and Santa Fe on Thursday, February 8th, 1923. Each vertical line represents a car, the length of the line being in proportion to the number of passengers

carried according to the vertical scale, one millimeter representing one passenger. The time the car passed the checking point is shown on the horizontal time scale, - one millimeter representing one minute.

From this chart it is possible to get an idea of the passenger loading of cars and the time spacing between cars very quickly. The following points may be noted from this chart:-

(1) There is frequent service and cars are well loaded inbound (toward congested business section) in the morning rush period, 6 A.M. to 8 A.M., thinning out from 8 A.M. to 9 A.M.

(2) Cars checked at 6 A.M. are well loaded indicating that checking should start earlier as there is early riding on this line. (Workers to industrial plants, etc.) Checking at this point now starts at 5:20 A.M. or 5:30 A.M.

(3) Outbound travel in A.M. rush period is very light showing one way rush hour travel.

(4) Inbound service in the middle of the day is on a very regular headway with an average of a seat for every passenger. The infrequent heavy loads are probably due to

pickup of passengers at steam railroad stations.

(5) Outbound service in the middle of the day is not as regular as inbound due to the delays encountered in coming through the congested business area.

(6) An example of the usual unequal distribution of passengers on the cars when three cars are bunched after a delay is shown on the outbound chart at 2:47 P.M. The first car at 2:47 carried 104 passengers, the second car at 2:47½ carried 55 passengers and the third at 2:48 had only 35 passengers. A similiar condition prevails on a group of three cars inbound just after 3:20 P.M.

(7) The example cited under (6) above serves to show another thing. The three cars that followed a "space" or "gap" outbound at 2:47 P.M. are the same three cars that follow a "space" inbound 30 minutes later. This shows how a "space" circulates back and forth unless a car is turned back to fill the space. (In this case the third car with the lightest load would have had very few passengers by the time it reached the last crossover. Passen-

gers could have been transferred to the car ahead, and the third car in the bunch turned back ahead of its scheduled time to take the place of the car that was late. This is where proper supervision comes into play as a factor in adequate service.)

(8) Frequent service and heavily loaded cars are shown on the outbound chart during the evening rush period from 4:00 P.M. to 6:30 P.M. Even during rush hours when cars get through in bunches the last car in the group may have empty seats. This shows the importance of regular spacing of cars. On account of delays and interruptions in the congested area, most of which are beyond the company's control, it is often impossible to prevent the bunching of cars.

(9) Inbound night travel is very light. The outbound travel is largely from moving picture houses and is somewhat irregular. Some cars are heavily loaded and others have empty seats.

In order to get a better quantative idea of the traffic handled than can be secured from Chart 21, the data from traffic checks is summarized by 20 minute periods and

plotted in the form shown in Charts 22, 23 and 24. From these 20 minute charts the required headway for schedules to give adequate service can be readily determined.

The traffic data on Line "P" taken at 1st and Santa Fe on Thursday, February 8th, 1923, plotted on Chart 21, has been summarized by twenty minute periods and plotted on Chart 22. The solid line shows total passengers carried in the twenty minute period and the dotted line shows the average number of passengers per car in the same period. For convenience in analyzing the data the inbound and outbound curves are put on the same sheet with the inbound at the top on an inverted scale.

The morning peak inbound and the afternoon peak outbound (Chart 22) are characteristic of the travel on normal weekdays, Monday to Friday. The morning peak is about 1000 passengers in a twenty minute period while the travel in the middle of the day drops to an average of about 240 passengers per twenty minute period.

The outbound peak in the afternoon reaches a maximum of 1440 in the twenty minute period 5:00 P.M. to 5:20 P.M. but the preceding twenty minute period totaled only 610 passengers. By reference to Chart 21 on which the time and load of each car is shown, it is clear that some of the cars in the period from 5:00 P.M. to 5:20 P.M. were delayed and normally should have filled in the gap

between 4:45 P.M. and 4:55 P.M. Making this correction the normal 20 minute peak 5:00 P.M. to 5:20 P.M. is approximately 1200 passengers.

The travel characteristic is entirely different on Saturdays (Chart 23). The morning peak inbound is not greatly different from that on weekdays. The inbound travel mid-day from 9:00 A.M. to 4:00 P.M. and outbound after 7:00 P.M. is heavier Saturdays than other weekdays. The most striking difference, however, is that the outbound travel is not concentrated into the 4:00 P.M. to 6:30 P.M. peak but on Saturday is spread out from noon until 7:00 P.M.

The Sunday travel has a characteristic that is entirely different from that on either weekdays or Saturdays, as shown on Chart 24. The morning travel is light, and for the balance of the day the travel is just about the same as that of mid-day on weekdays. The absence of any peaks on Sunday is the important difference.

The number of cars scheduled for operation by hourly periods during the day on weekdays, Saturdays and Sundays is set forth graphically in Chart 20. The cars on weekday schedules are shown by the solid line. The morning and afternoon peaks are very pronounced, the ratio of cars scheduled in the afternoon peak being two and three tenths times the number in service at mid-day, and three and two tenths times the number in service at 9:00 P.M. It may be

noted that the curve of cars in service (Chart 20) has the same characteristic peaks as the total passengers handled inbound and outbound from the congested area (Charts 14 and 15).

The Saturday curve has an entirely different characteristic. The cars in service during the morning peak outnumber those used at any other period. The afternoon 5:00 P.M. to 6:00 P.M. peak is much lower than that on weekdays but it will be noted that the number of cars in service at noon is substantially greater than for the corresponding period weekdays showing how Saturday schedules are varied from weekday schedules to care for the increased travel due to business half-holiday.

On Sundays the curve of cars in service has an entirely different characteristic from that for Saturdays or weekdays. There are no peaks, approximately the same number of cars being in service from 10:00 A.M. to 9:00 P.M. and thus the Sunday schedule is built to fit the Sunday traffic.

It will be noted from Chart 19 that the number of cars in service during the afternoon peak has reached a maximum of 923 on June 5th, 1923, the average daily maximum being about 915. On Saturdays and Sundays the maxima are much lower due to the different distribution of the travel. The Saturday maximum was increased approximately 50 cars in March and now ranges from 725 to 735 during the morning rush which

is the heaviest period on Saturdays. The Sunday and holiday average maximum number of cars in service is 350.

Special Charts

In analyzing traffic data and other statistics relative to schedules, earnings, need for rerouting, reasons for not running all service to the ends of the line, time actually used by cars through congested district, etc., the value of a graphic representation of facts should not be overlooked. There have been included in this report a few examples and others have been filed with the Superintendent of Schedules who should direct the preparation of this information.

Chart 25 has been prepared to show the effect of a new schedule on the Washington-Garvanza Line. On April 1st, 1923, the mid-day service on that line was increased from a 6 minute headway to a 5 minute headway requiring the operation of approximately 700 additional car miles daily. The additional car miles failed to produce any appreciable increase in revenue. The more frequent service failed to attract any new business. Adequacy of service on this line as between a 6 minute headway and a 5 minute headway should therefore be determined by traffic checks. As pointed out in another paragraph this is one of the lines that would show a loss from operation due to the long haul traffic.

Chart 26 shows graphically the distribution of travel

on the Eagle Rock Line from 7th and Broadway to the Eagle Rock terminal on eighteen individual trips. The purpose was to show that all the service should not be operated to the Townsend terminal but a part of it should be scheduled to turn back at West View. The traffic checks for determining adequacy of service on the line are regularly made at 28th and Dayton so that in tabulating each of the eighteen "riding checks" from 7th and Broadway to Townsend, the number of passengers on the car at 28th and Dayton was taken as 100%.

The number of passengers on the car at each of the points shown was calculated in percentage of the number on the car at 28th and Dayton and the results plotted as one curve. This was done for each of the eighteen trips. While there are some trips on which the number of passengers on the car at Plaza or Bridge Junction exceeds the number at 28th and Dayton, the latter is shown to be the proper checking point for the line, all trips considered. The one trip showing 130% as many passengers at Plaza and Bridge Junction as at 28th and Dayton had only a maximum of 24 passengers and was just enough out of the ordinary to prove the rule by the exception.

Practically all of the eighteen trips plotted on Chart 26 show clearly the same general characteristic, namely that the number of passengers on the car decreases approximately in proportion to the distance from 28th and

Dayton. At West View there is on the average only about 30% of the total maximum load still on the car and only about 6% of it is carried to the end of the line.

Provided there are cars enough to handle the traffic and provided they are operated frequently enough to serve a reasonable convenience (the distance of the territory from the city, considered) then it may be concluded that adequate service does not require 100% of the cars beyond West View for the benefit of only 30% of the traffic. Upon our recommendation based on this and other similar data new schedules have been put in effect on this line which embody the principle of turning back a part of the service at a point short of the end of the line. This applies only during the time when the main line headway passing 28th and Dayton is 8 minutes or less.

It may be noted in passing that the new schedule increases the off-peak service both mid-day and at night although the line shows a net profit in red figures. The cars have been badly crowded both in rush hours and in non-rush hours fully justifying an increase in service from that standpoint, even though the auditor's report shows it to be a consistent loser. Based on the figures in that report this is a line on which, at the present rate of fare, the company cannot hope to show a profit. The Eagle Rock end of the line is 9½ miles from 7th and Broadway indicating a high figure in car seat miles per passenger especially when

all cars run through to the end of the line.

Chart 27 showing certain conditions on Line "J", is another one that serves a special purpose, the data being represented in the same manner as explained for Chart 21. The solid lines on the chart show passengers on cars to or from Huntington Park while the dotted lines show passengers on cars to or from Slauson and Santa Fe, as observed at Vernon and Santa Fe. Workmen in the industrial plants along Santa Fe Avenue south of Vernon cause the Slauson cars to show moderate loads outbound between 6:30 A.M. and 7:45 A.M. and inbound between 4:00 P.M. and 5:45 P.M.

At no other time throughout the whole day do the Slauson cars show anything approaching a seated load, while the Huntington Park cars show loads in excess of seating capacity even in the off-peak hours 3½ miles out from 7th and Broadway. The Huntington Park cars are carrying heavier loads than the Slauson cars in the ratio of 4 to 1 or 5 to 1.

Based on such a showing we have recommended that all "J" cars be routed to Huntington Park, except for special shop cars, and that the normal service on Santa Fe Avenue south of Vernon be supplied by line "V" cars. This plan has been adopted and the special work required for this rerouting has been ordered. (Not data on chart 27)

Preparation of Schedules

In the preparation of schedules our recommendations for using the traffic graphs have been adopted and are now in effect. The 20 minute charts (similar to Chart 22) for several different days are taken and analyzed, comparing one day with another, correcting for distortions, and a representative one is selected. From it the headways are determined based on the number of passengers carried. For example, take Chart 22 which shows approximately 250 passengers as the average sustained maximum per 20 minute period during the middle of the day in the controlling direction of travel, which is inbound. If it is desired to schedule service on the basis of 50 passengers per car, then five cars will be required in each 20 minute period, resulting in a 4 minute headway. It may be noted that after 11:40 A.M. the inbound travel falls off so that a 4 minute headway throughout the middle of the day would show an average of less than 50 passengers per car.

In a similar manner the headways required for other periods are calculated except that in the rush hours the average number of passengers per car must be increased to perhaps 80 or 88. To carry 1300 passengers per 20 minute period on the basis of 80 per car would require a 1¼ minute headway. And in this manner the required headways past the point of maximum load are selected. In translating the 20 minute chart into headways a convenient table has been

devised which shows the passenger carrying capacity on different headways at different densities of loading per car.

In addition to the traffic charts from which the headways are determined, the schedule maker must also have riding checks to show the time required between time points all along the line at the different periods of the day. Reference has been made to this feature in the section of the report entitled "Adjusted Running Time", page 38. The schedule maker himself should make several trips over the line to refresh his knowledge of conditions.

We have recommended a different plan of laying out schedules than has been used heretofore. While the schedule maker is laying out his schedule the new plan gives him a better idea of the relative position of the cars, not only at terminals but at intermediate points and gives him a chance to show actual layovers on each trip. If any subsequent changes or adjustments are to be made he can see at once what leeway he has for shifting the time of each car. After trying out the new method it has been adopted because of time saving and other advantageous features.

In laying out schedules providing for turnback service, that is, where all cars do not go through to the end of the line, the principle of having short line cars follow longer headways than through cars has been adopted in order to balance the loads on the long and short line

cars. The headway differential on turnback service may not be the same in all instances depending on the travel characteristic. An average main line headway of 5 minutes might be split as a 6 minute interval before the short line car and a 4 minute interval before the long line car, or the differential cut to one minute by using 5½ and 4½ minute spacing.

Schedule Forms

A change has been made in the form of the schedule and crew assignment sheets. Formerly the schedule sheet showed the leaving times of each train number from one terminal on the left half of the sheet and from the other terminal on the right half of the sheet, all on one horizontal line. To follow a train number through its operation from the time it left the car house until it pulled into the car house it was necessary to look back and forth from one side of the sheet to the other. This schedule sheet was never posted for the trainmen but was used for office reference. Copies were secured by the ditto-graph.

For the trainmen's use there was a large sheet that showed the days work for a crew arranged in a horizontal section of the sheet giving the various times at which they were due to leave the terminals and the times when reliefs were made. On this sheet the various pieces of work by each crew were grouped together but in order to

follow one car or train on its schedule throughout the day it was necessary to look all over the sheet for the particular train number. For the division clerks, the timekeepers and the auditor's office a condensed work run sheet was supplied showing "time on" and "time off" for each piece of work for each crew and the total time of the run. Thus on the old plan the information was grouped three ways on three forms.

On the new form of schedule sheet the information that was formerly in three places has been combined on one form and additional information shown. The run guide as arranged in the form previously sent to the timekeeper is retained in the new schedule sheet. The times that cars are due to leave terminals and one intermediate point on each half trip are shown in the body of the schedule. The intermediate time shown is usually for the time point just at the edge of the congested area inbound.

The details of runs are read horizontally, and each section of the details of runs represents the movements of an individual car or train during the day. The movements of each individual crew are indicated by run numbers written in bold figures, so that the various pieces of work of each individual crew may readily be picked from the schedule. By using this method, the schedule permits one to follow all movements of cars as well as crews, a

feature which is not easily possible when each horizontal section of the details of runs refers to the day's movements of an individual crew rather than of an individual car.

The new schedule sheets are prepared on the typewriter and are arranged for blue printing so that as many copies as desired may be had at any time. All working copies should be blue prints. The master copy should be kept corrected to date so that any copies taken at any time may be correct. An office copy, a carbon copy of the original, should be kept to show the successive changes and alterations without obliterating the original figures so that ready reference may be had at any time to the exact times on the schedule on any particular date.

It has been the practice for some time on the lines of the Los Angeles Railway to make out separate schedules for week days, Saturdays and Sundays (indicated by the cars in service on Chart 20) because of the different characteristics of travel on these three days, which was clearly shown in Charts 22, 23 and 24. It was thought by some that there should be further differentials in the schedules as between the five week days, but it has been demonstrated to their satisfaction that the differences between the other days are so slight when spread out over the whole day that it would be impossible to change the schedules to meet the minor fluctuations at any one time,

although the total for the day might appear to be sufficient to warrant it.

Work Assignments for Trainmen

It is also a part of the work of the schedule department to make up the work runs for motormen and conductors after the schedules have been prepared. Inasmuch as schedules are based on the demands of traffic they should be laid out to meet that demand as near as is reasonably possible and not with the idea of providing work runs for any individual trainman or group of trainmen. Conditions controlling the number of cars operated are something which the Company cannot change and therefore it is not to be expected that work runs for the motormen and conductors can be laid out exactly the same from one schedule to another. The cars cannot leave and return to the car house at the same times on all schedules.

Those not familiar with the street railway business sometimes find it difficult to understand why the working conditions for motormen and conductors cannot be made the same as working conditions for employees in other lines of business. As, for example, why it is necessary for street car men to have such a long spread of time in which to complete a day's work. It might help some in the understanding of this question if reference were made to Chart 20, which shows the number of cars in service by one-hour periods throughout the day. Cars must be on the street in time to take other

employees to their places of business in the morning, and cars must be on the street to take other employees home and return to the car houses in the evening, so that street car men are required to extend their day's labor over a long period of time.

Many references have been made to the morning and afternoon rush periods when great masses of people demand transportation within limited periods of time. This uneven demand for service is one of the fundamental characteristics of the business which every street railway would gladly change if it could, because it affects not only the working conditions for the train men, but also involves a heavy expense on the part of the company for cars, car houses, power, substations and equipment in use for only a limited period.

One of the fundamental difficulties in connection with the operation of cars on the Los Angeles Railway is that too many of the cars are operated as trippers by extra crews and not enough of the cars are made a part of regular runs. This means an unusually large extra list and it means that men have to "fight the extra board" for perhaps several years. This is not a satisfactory condition of affairs and could be improved by allowing a slightly greater spread in the runs so that the day crews coming out of the car house not too early in the morning could be used again in the afternoon rush. It is apparent from Chart 20 that a great many

crews must be used both morning and afternoon if the total number of cars operated are to be handled efficiently. The spread in the runs on the lines of the Los Angeles Railway is not excessive and in fact is much lower than the spread in runs on most other large city properties. We believe it is a distinct detriment to the service without being an advantage to any particular number of men, to maintain the present system of making up runs. We recommend that more of the trippers be worked into parts of regular runs and that the allowable spread in the time to complete the day's work be sufficiently extended to permit this.

The Public, The Employees, and The Company

By reason of the inherent characteristics of the movements of thousands of people, caused by their habits or the requirements of business, which force great mass transports within concentrated periods widely separated from each other, the three parties involved in the transportation problem - the public, the employees, and the company - must each give up something.

The Automobile Driving Public must give up something in the way of parking and driving privileges in the congested areas.

The Street Car Riding Public must give up something in the way of convenience because it would be impos-

sible to provide seats for everyone during the periods of peak travel.

The Street Railway Employees must give up something in the way of convenience in hours of work because the peak demands for cars are widely separated.

The Company must give up something because cars and much other equipment must be provided for use during a very limited period each day.

APPENDIX

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CHARTS AND DIAGRAMS

to accompany

REPORT

on some of the

PROBLEMS OF OPERATION

of the

LOS ANGELES RAILWAY

by

JOE R. ONG

Consulting Transportation Engineer.

INDEX TO CHARTS

Index to Charts cont.

Chart 1

Los Angeles
P O P U L A T I O N
1850---1923
SCHOOL ENROLLMENT
1884---1923

SCHEDULE #A 256 LINE "T" RUNNING TIME
IN EFFECT JUNE-1-1924 SUNDAYS ONLY
RUNNING TIME CHANGES AT TERMINALS ONLY UNLESS OTHERWISE STATED

BELMONT FROM

5:33 AM	TO 8:27½	AM	USE	#1
8:28	" 9:57½	PM	"	2
9:58 PM	" 1:00	AM	"	1

SPRING ST. FROM

5:21 AM	TO 8:17½	AM	USE	#3
8:18	" 9:51	PM	"	4
9:51½ PM	"12:40	AM	"	3

BELMONT TO	#1	#2
BEAUDRY	5	5
SPRING	5	6

SPRING TO	#3	#4
BEAUDRY	5	6
BELMONT	5	5

All Cars West Bound from Temple & Broadway use 1min. less than Running Time from SPRING to BEAUDRY.

CARS West Bound TEMPLE &BROADWAY FROM

5:37 AM	TO 8:18½	AM	USE	#3
8:19	" 9:07		"	4

Chart 1

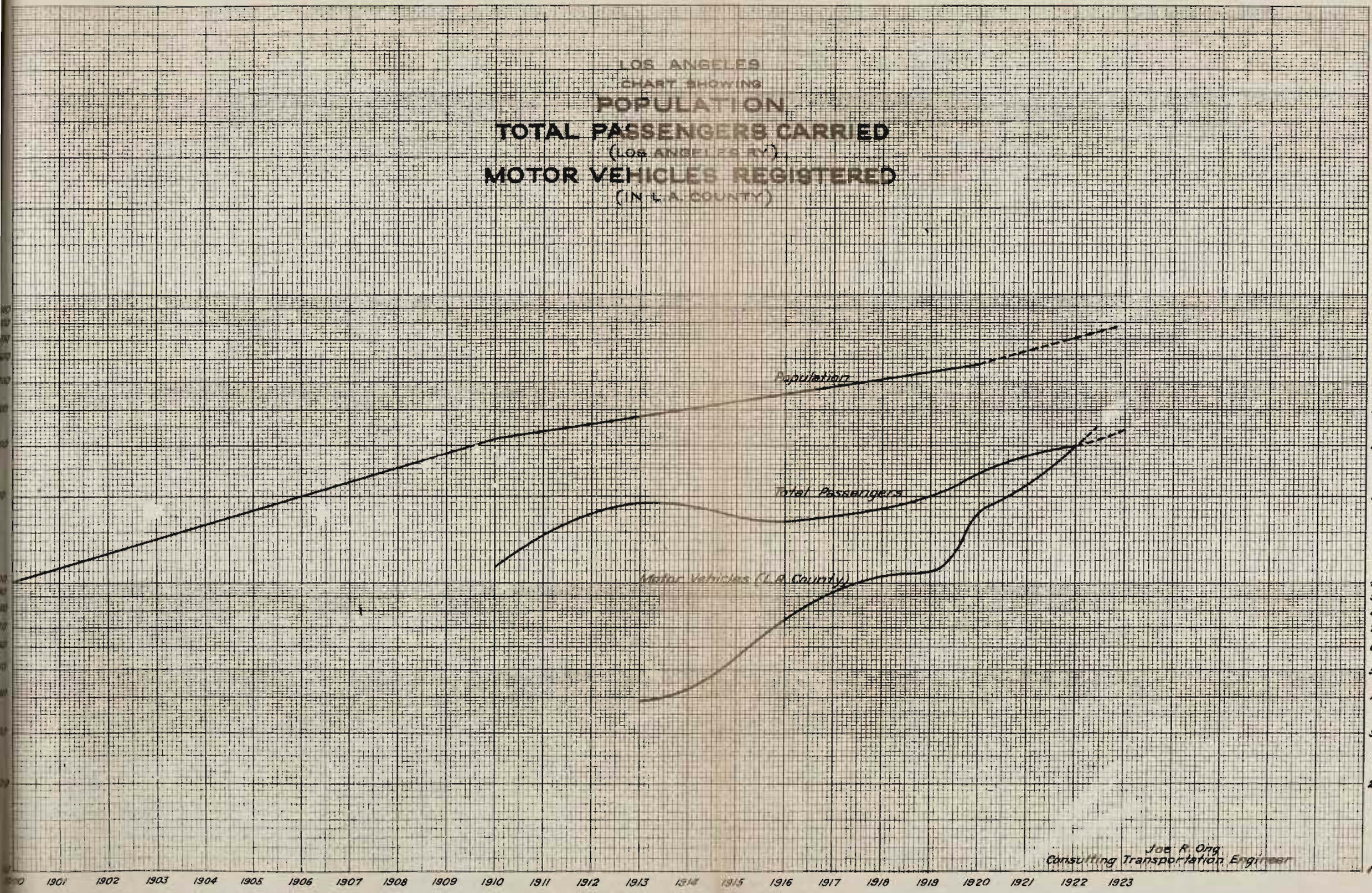
Los Angeles
P O P U L A T I O N
1850---1923
SCHOOL ENROLLMENT
1884---1923

CHART 3

LOS ANGELES

CHART SHOWING

POPULATION
TOTAL PASSENGERS CARRIED
(Los Angeles Ry.)
MOTOR VEHICLES REGISTERED
(In L.A. County)



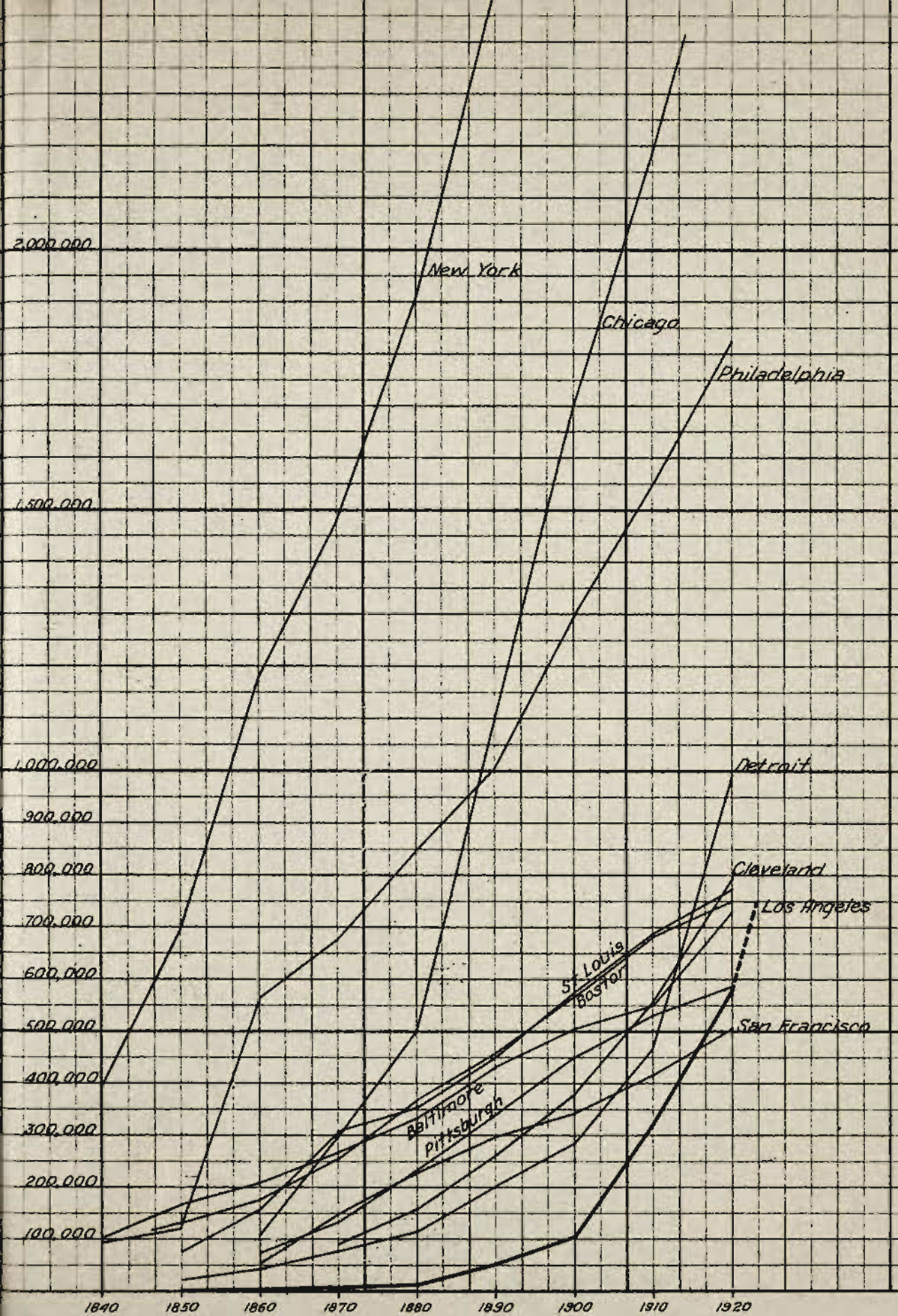
Joe R. Ong
Consulting Transportation Engineer

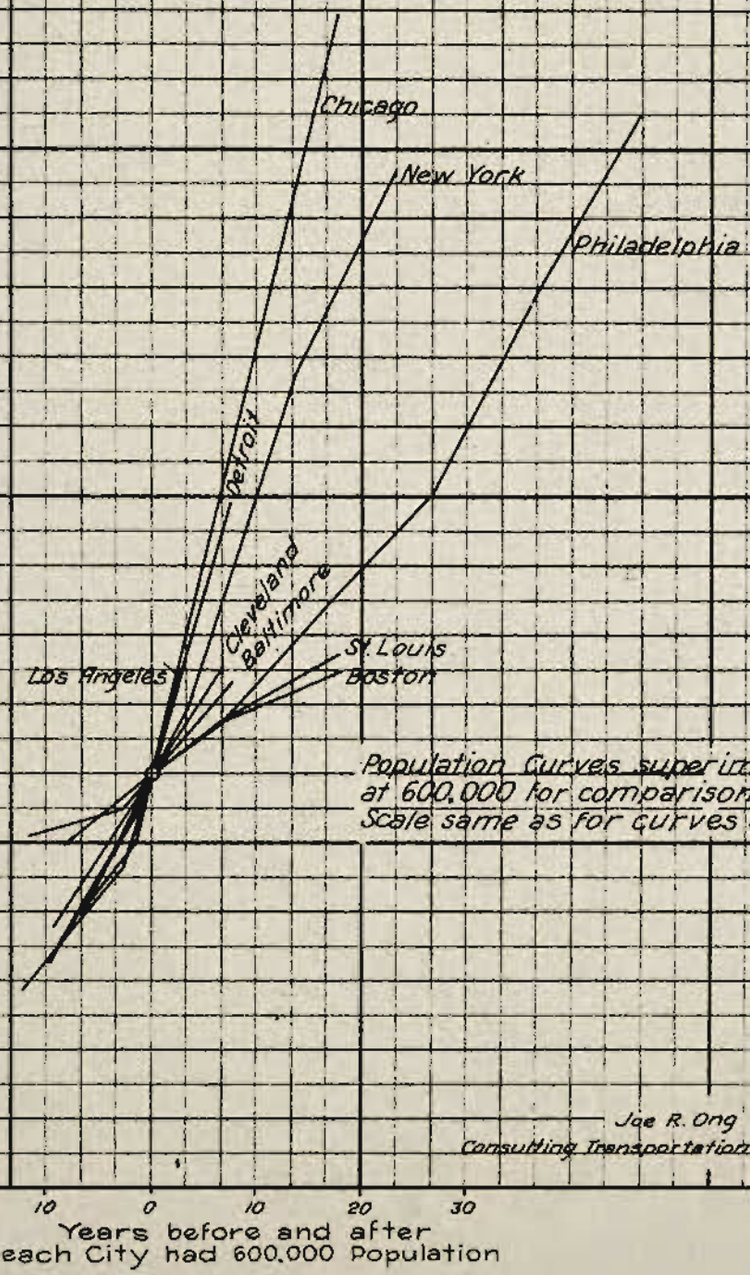
Chart 2

POPULATION and COMPARATIVE GROWTH of LARGE U.S. CITIES

POPULATION AND COMPARATIVE GROWTH OF LARGE U.S. CITIES

CHART 2





Population Curves superimposed at 600,000 for comparison. Scale same as for curves at left.

Years before and after each City had 600,000 Population

Joe R. Ong
Consulting Transportation Engineer

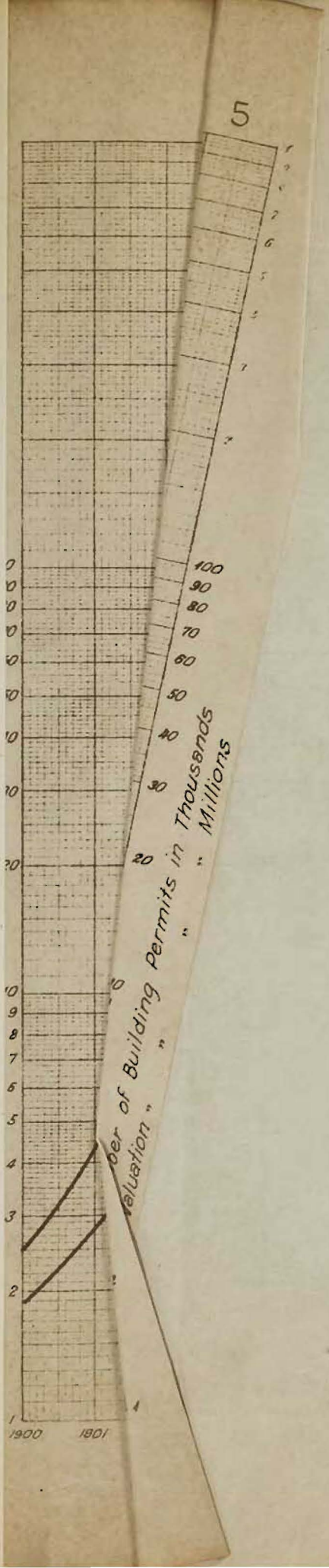
Chart 3

P O P U L A T I O N
Los Angeles
TOTAL PASSENGERS CARRIED
(Los Angeles Ry)
MOTOR VEHICLES REGISTERED
(L.A.County)

Chart 4

POST OFFICE RECEIPTS
and
BANK CLEARINGS
for
Los Angeles
By Years 1900-1922

Chart 5



NUMBER AND VALUATION
of
BUILDING PERMITS
Issued In
City of Los Angeles.
By Years 1900-1922

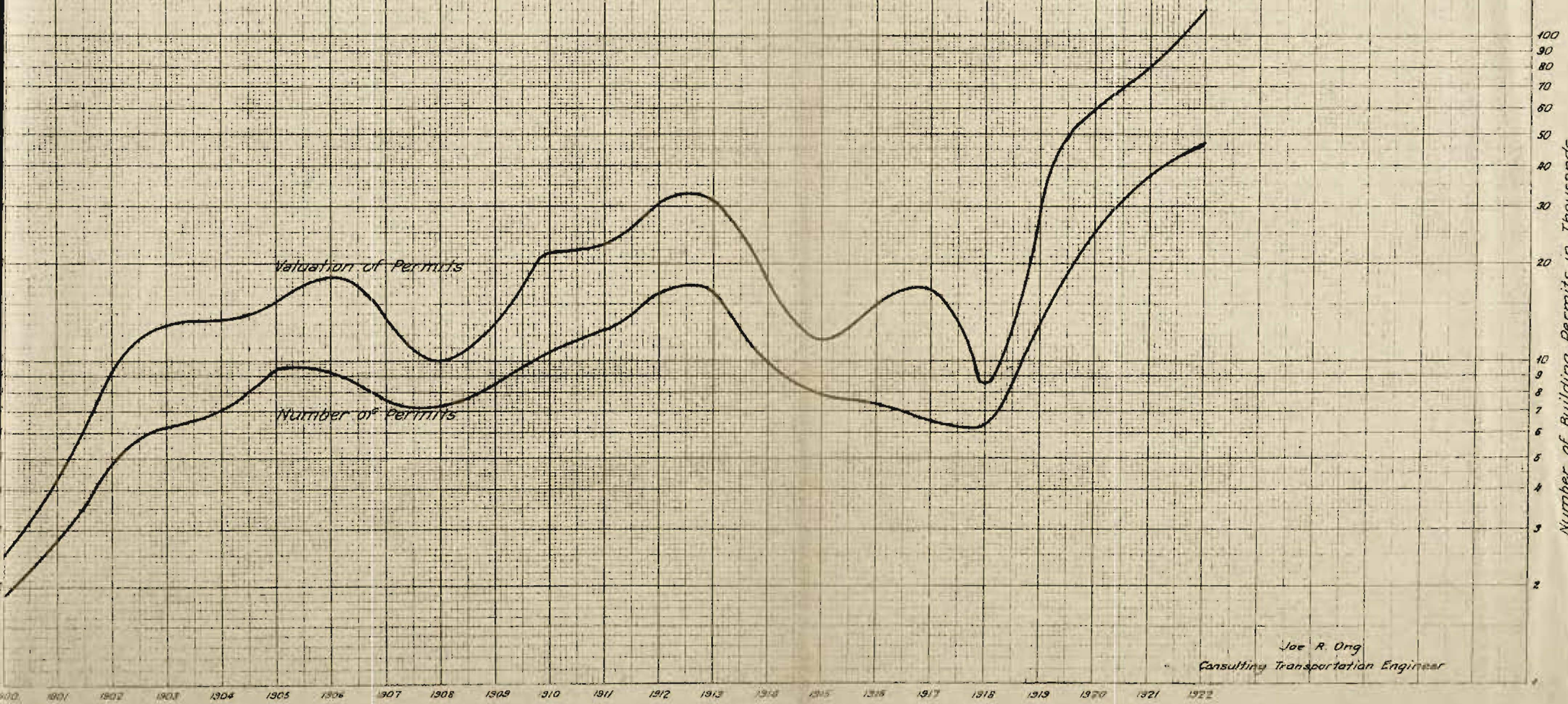
CHART SHOWING

NUMBER & VALUATION OF BUILDING PERMITS

ISSUED IN

CITY OF LOS ANGELES

BY YEARS 1900-1922



Joe R. Ong
Consulting Transportation Engineer

Chart 6

INCREASED USE OF PUBLIC UTILITIES
Electric-Gas-Water
In
Los Angeles
1910---1922

Chart 7

PASSENGERS CARRIED
On
Los Angeles Railway
1910---1922

CHART 7

LOS ANGELES RAILWAY

CHART SHOWING

PASSENGERS CARRIED

1910 - 1922

Joe R. Ong
Consulting Transportation Engineer

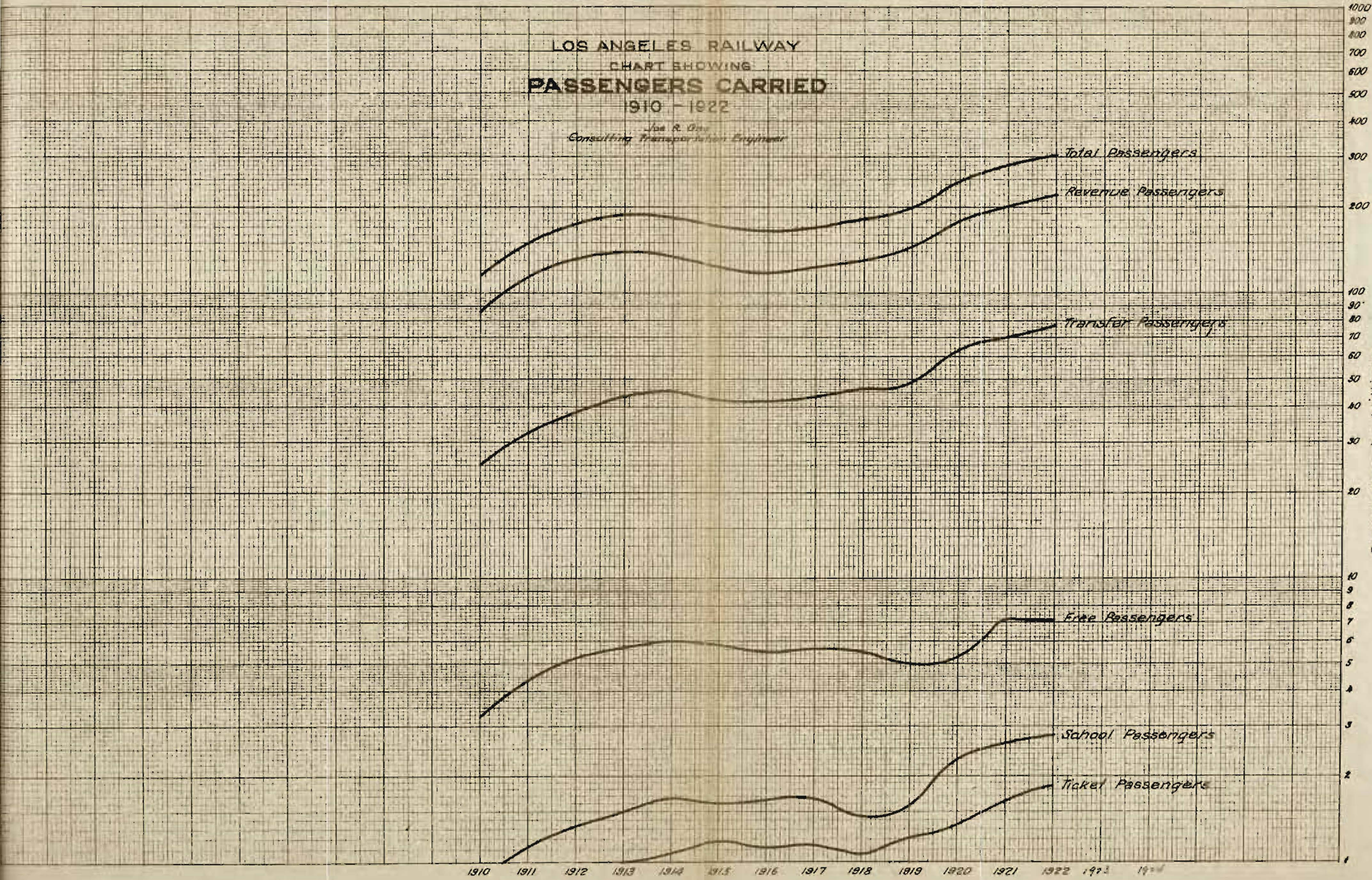


Chart 8

TOTAL PASSENGERS CARRIED
on
Los Angeles Railway
By Months
1917-1923

CHART 8

LOS ANGELES RAILWAY

CHART SHOWING

TOTAL PASSENGERS CARRIED

BY MONTHS

1917 - 1923

Joe R. Ong
Consulting Transportation Engineer

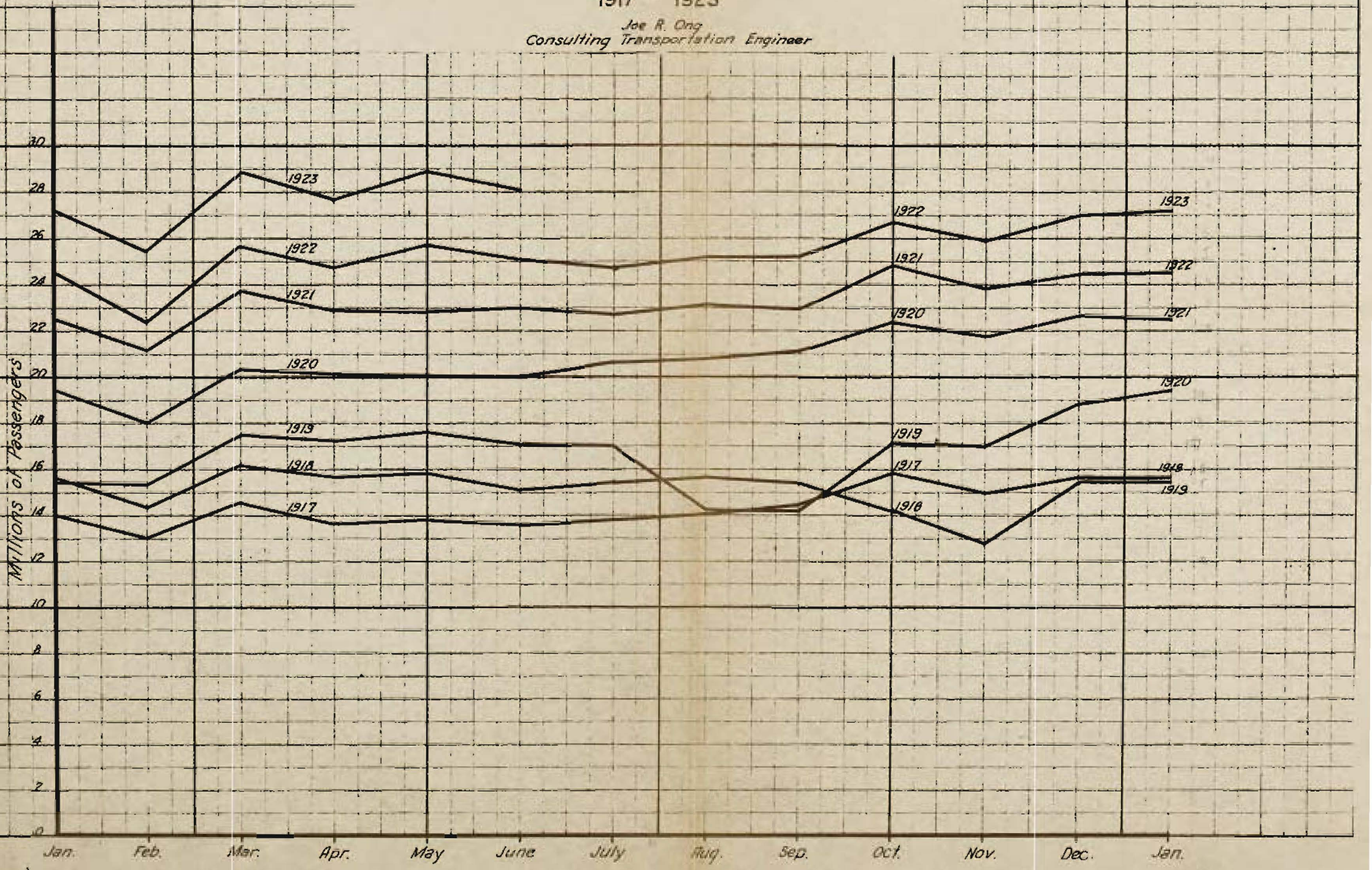


Chart 9

REVENUE PASSENGERS CARRIED
On
Los Angeles Railway
By Months
1917-1923

CHART 9

LOS ANGELES RAILWAY

CHART SHOWING

REVENUE PASSENGERS CARRIED

BY MONTHS

1917 - 1923

Joe R. Ong
Consulting Transportation Engineer

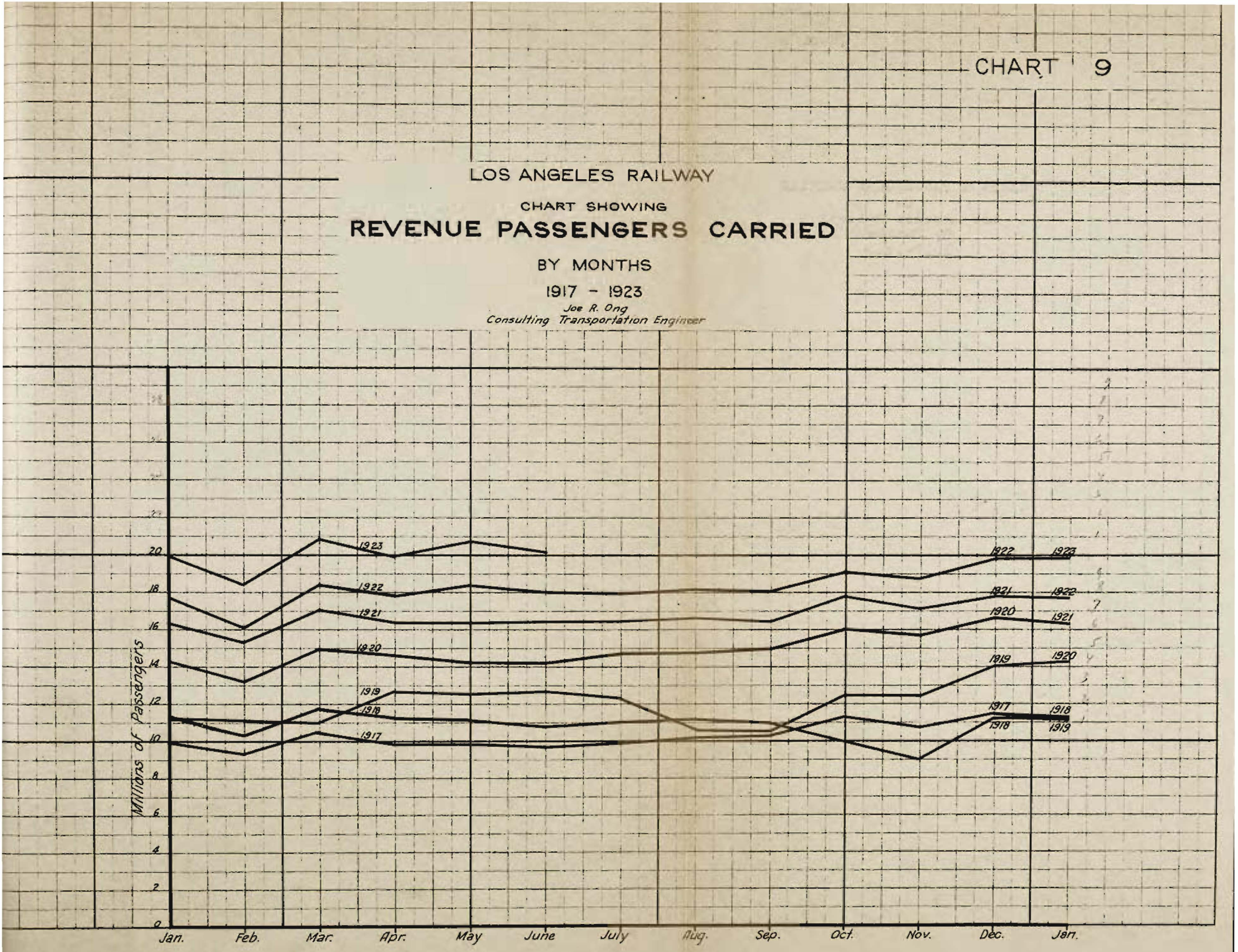


Chart 10

PASSENGERS CARRIED
and
REVENUE CAR MILES
on
Los Angeles Railway
By Months
Jan.1917-June 1923

CHART 10

LOS ANGELES RAILWAY

CHART SHOWING

PASSENGERS CARRIED

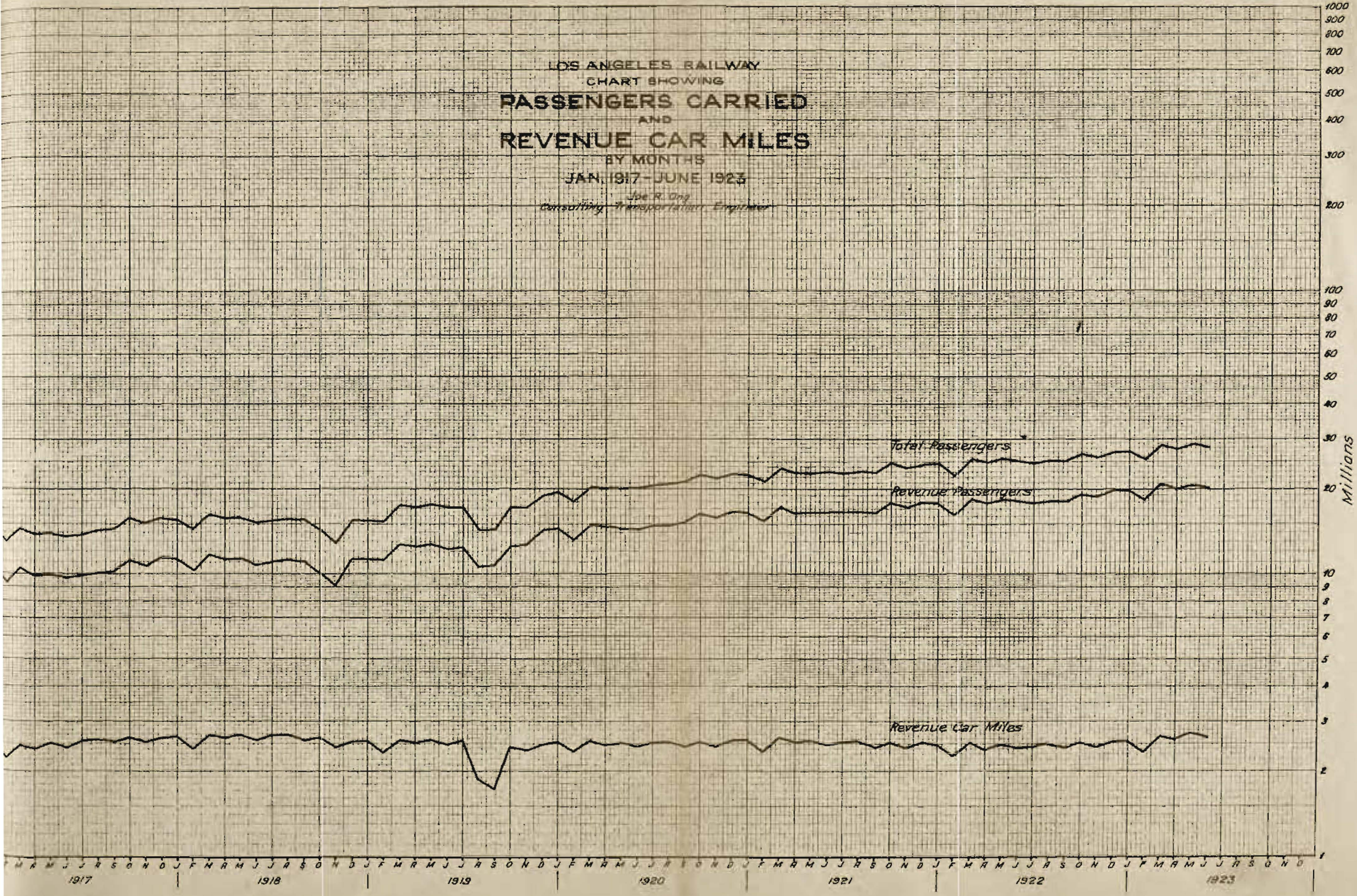
AND

REVENUE CAR MILES

BY MONTHS

JAN. 1917 - JUNE 1923

Joe R. Ong
Consulting Transportation Engineer

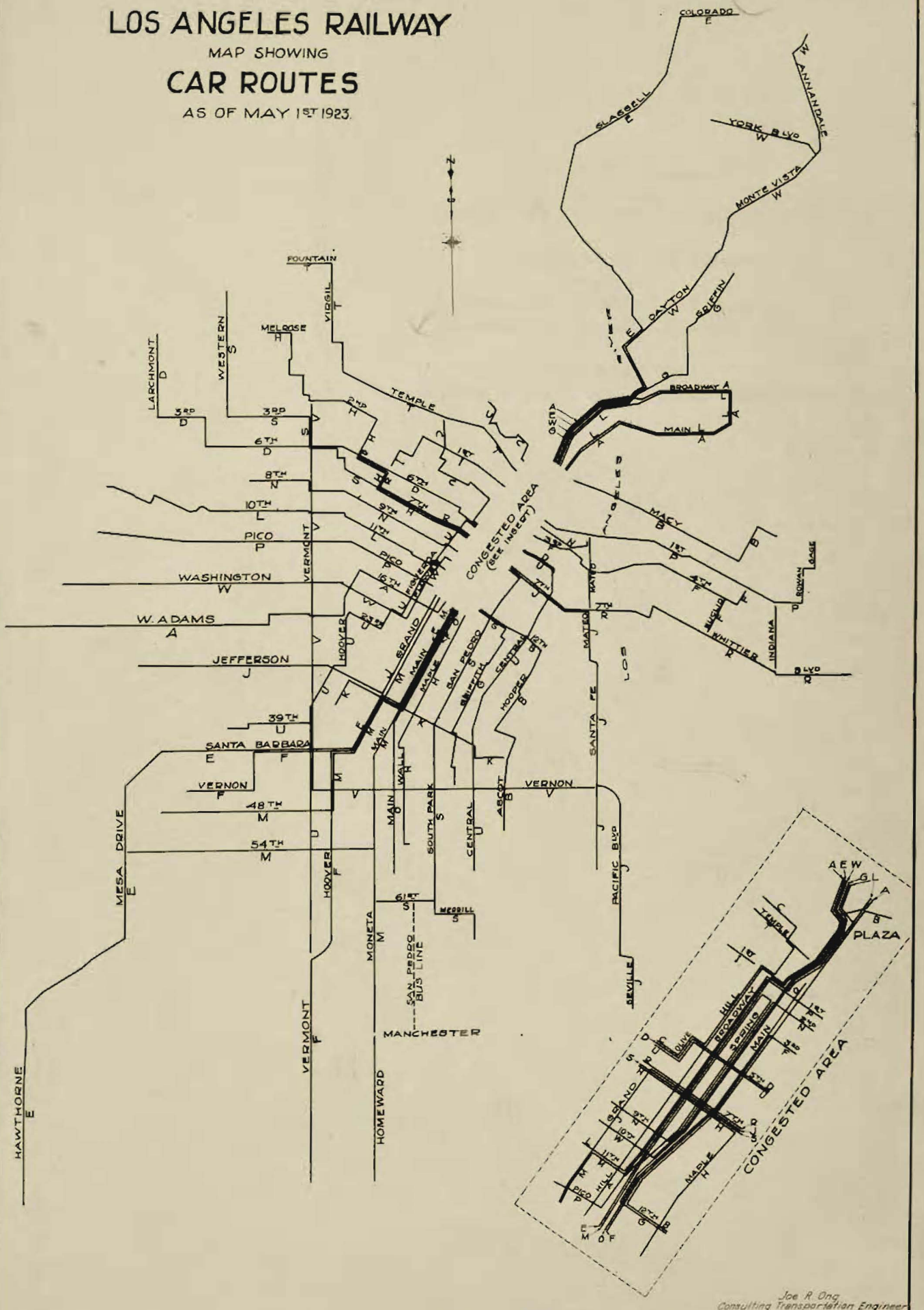


LOS ANGELES RAILWAY

MAP SHOWING

CAR ROUTES

AS OF MAY 1ST 1923.



Joe R. Ong
Consulting Transportation Engineer

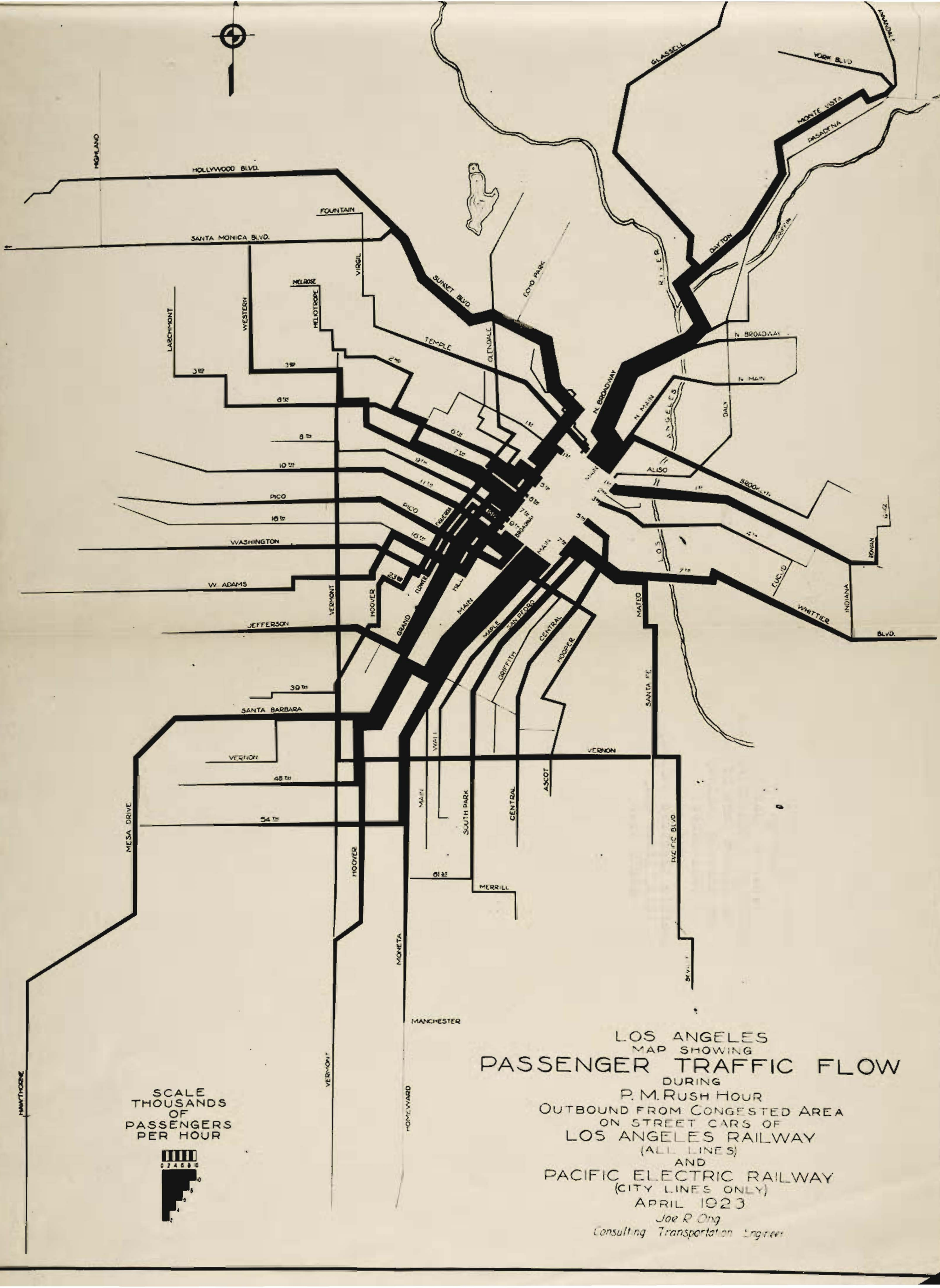
Chart 12

CAR FLOW DIAGRAM
Showing
VOLUME OF STREET CAR MOVEMENTS
By
Los Angeles Railway
And
Pacific Electric Railway
THROUGHOUT THE BUSINESS AREA
Of
Los Angeles
During 5 P.M. to 6 P.M. Rush Hour

Re charted
as of April 1st, 1924

Chart 13

PASSENGER TRAFFIC FLOW
During
P.M. Rush Hour
OUTBOUND FROM CONGESTED AREA
On Street Cars Of
Los Angeles Railway
(All Lines)
and
Pacific Electric Railway
(City Lines Only)
April 1923



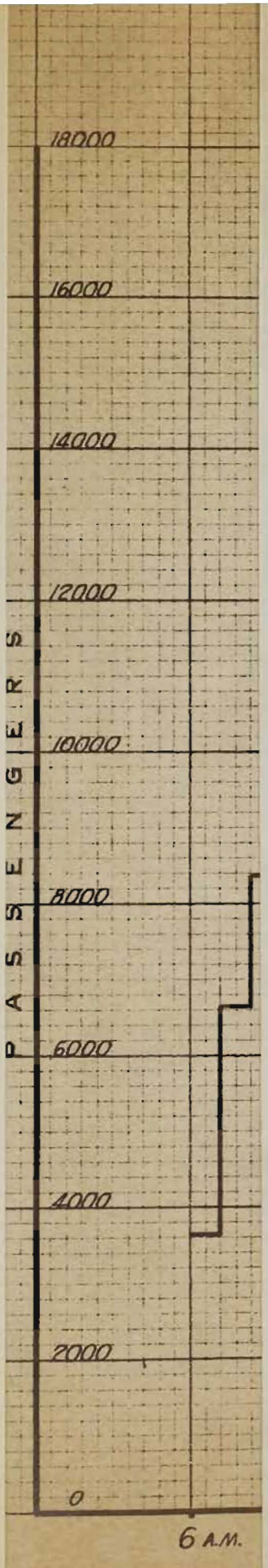
SCALE
THOUSANDS
OF
PASSENGERS
PER HOUR

LOS ANGELES
MAP SHOWING
PASSENGER TRAFFIC FLOW
DURING
P. M. RUSH HOUR
OUTBOUND FROM CONGESTED AREA
ON STREET CARS OF
LOS ANGELES RAILWAY
(ALL LINES)
AND
PACIFIC ELECTRIC RAILWAY
(CITY LINES ONLY)
APRIL 1923

Joe R Ong
Consulting Transportation Engineer

CHART 13

Chart 14



TOTAL PASSENGERS CARRIED
On
Los Angeles Railway
By
20 Minute Periods
Past Points of Maximum Load
INBOUND
In To Business Area On All Lines
On
Normal Weekdays Feb-May 1923

Page 20

CHART 14

LOS ANGELES RAILWAY

CHART SHOWING

TOTAL PASSENGERS CARRIED

BY 20-MINUTE PERIODS

PAST POINTS OF MAXIMUM LOAD

INBOUND

IN TO BUSINESS AREA ON ALL LINES

ON

NORMAL WEEKDAYS FEB.-MAY 1923

Joe R. Ong
Consulting Transportation Engineer

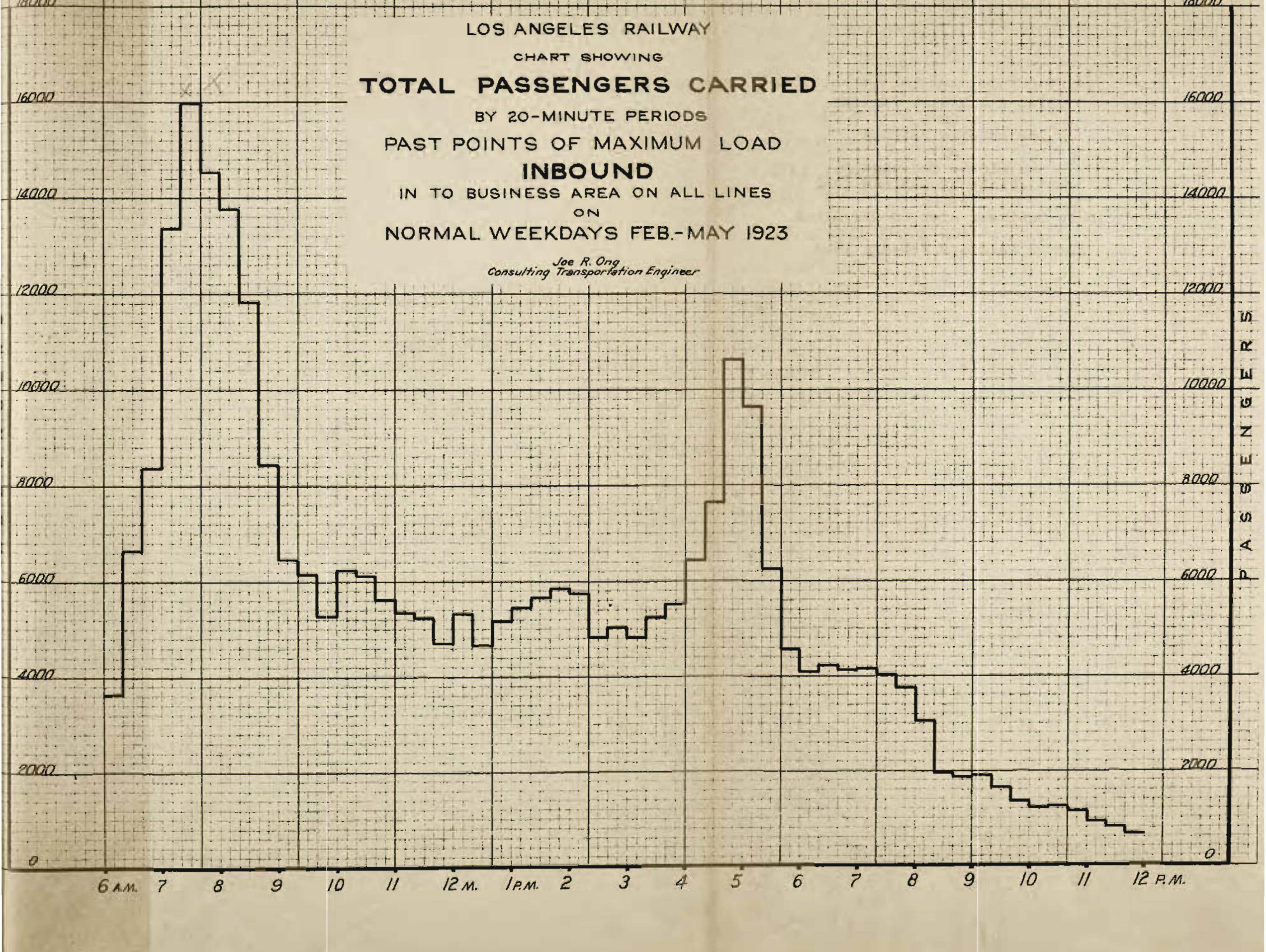


Chart 15

TOTAL PASSENGERS CARRIED
On
Los Angeles Railway
By
20 Minute Periods
Past Points of Maximum Load
OUTBOUND
Out From Business Area On All Lines
On
Normal Weekdays Feb-May 1923

Page 20

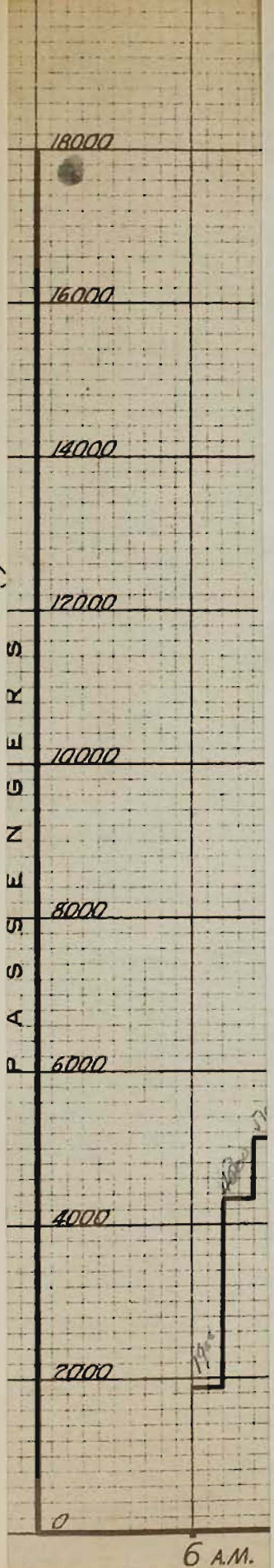


CHART 15

LOS ANGELES RAILWAY

CHART SHOWING

TOTAL PASSENGERS CARRIED

BY 20-MINUTE PERIODS

PAST POINTS OF MAXIMUM LOAD

OUTBOUND

OUT FROM BUSINESS AREA ON ALL LINES

ON

NORMAL WEEKDAYS FEB.-MAY 1923

Joe R. Ong
Consulting Transportation Engineer

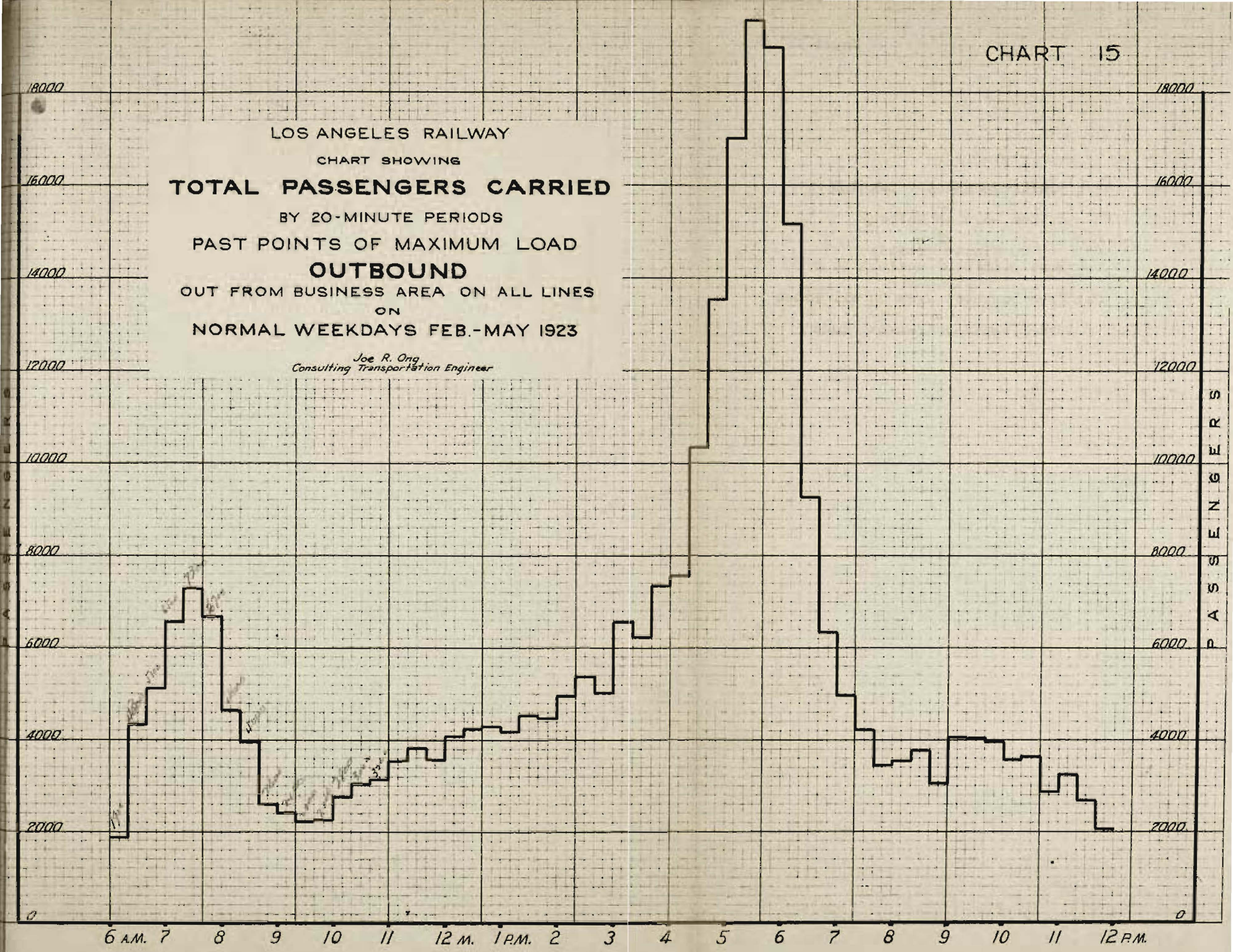


Chart 16

TIME DISTRIBUTION OF TRAVEL
On
Los Angeles Railway
Expressed In
CUMULATIVE PERCENTAGES
By
20 Minute Periods
From 6:00 A.M. to 12:00 P.M.

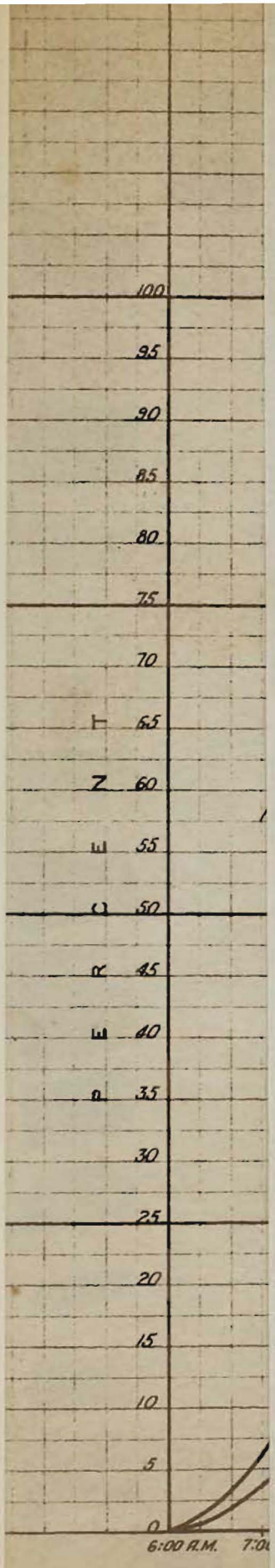


CHART 16

LOS ANGELES RAILWAY

CHART SHOWING

TIME DISTRIBUTION OF TRAVEL

EXPRESSED IN

CUMULATIVE PERCENTAGES

BY 20 MINUTE PERIODS

FROM 6°° A.M. TO 12°° P.M.

Joe R. Ong
Consulting Transportation Engineer

Note:- 6:00 a.m. taken as 0%
12:00 p.m. " " 100%

Inbound

Outbound

PERCENTAGE OF TOTAL TRAVEL

100 95 90 85 80 75 70 65 60 55 50 45 40 35 30 25 20 15 10 5 0

6:00 A.M. 7:00 8:00 9:00 10:00 11:00 A.M. 12:00 M. 1:00 P.M. 2:00 3:00 4:00 5:00 6:00 7:00 8:00 9:00 10:00 11:00 12:00 P.M.

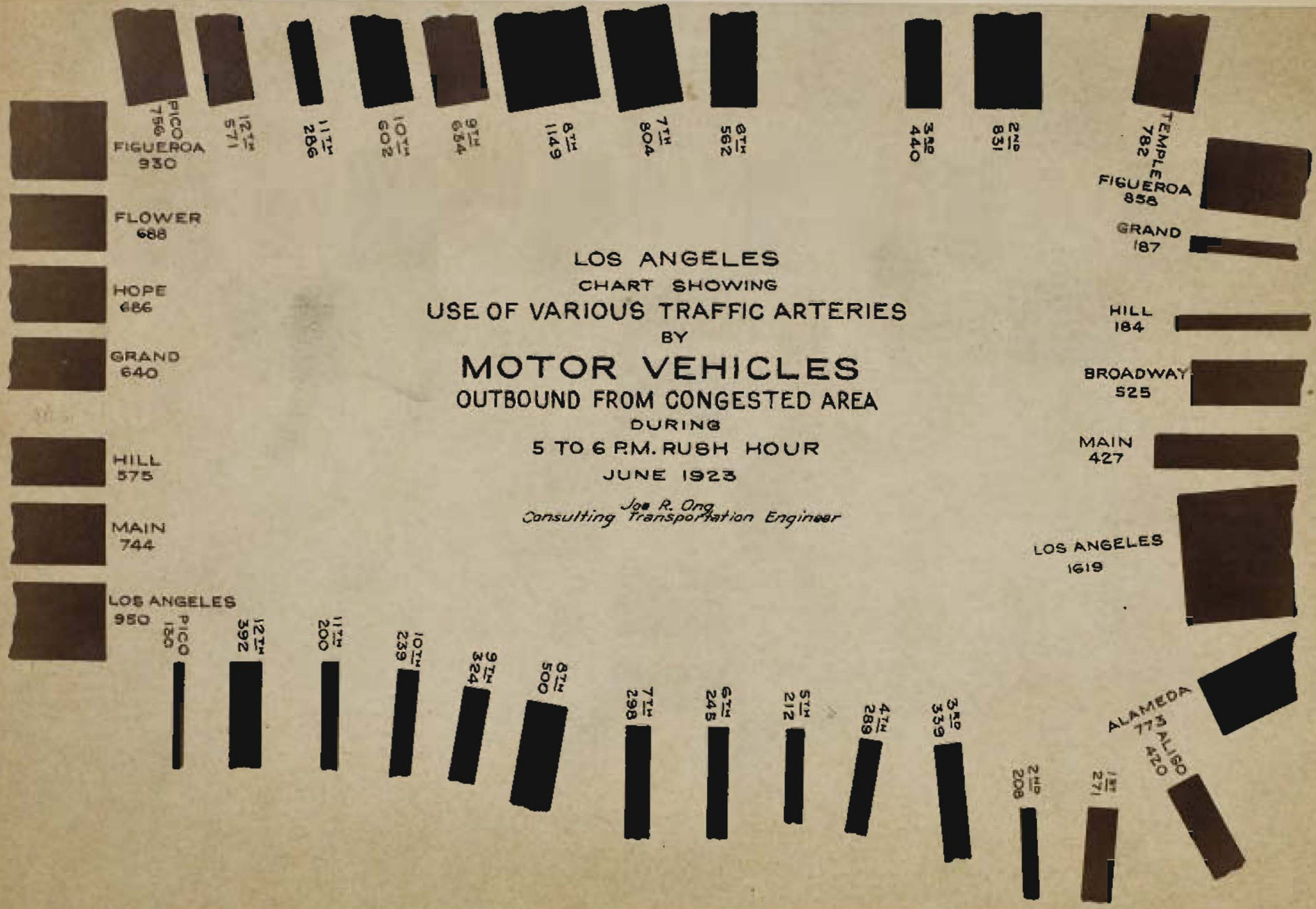
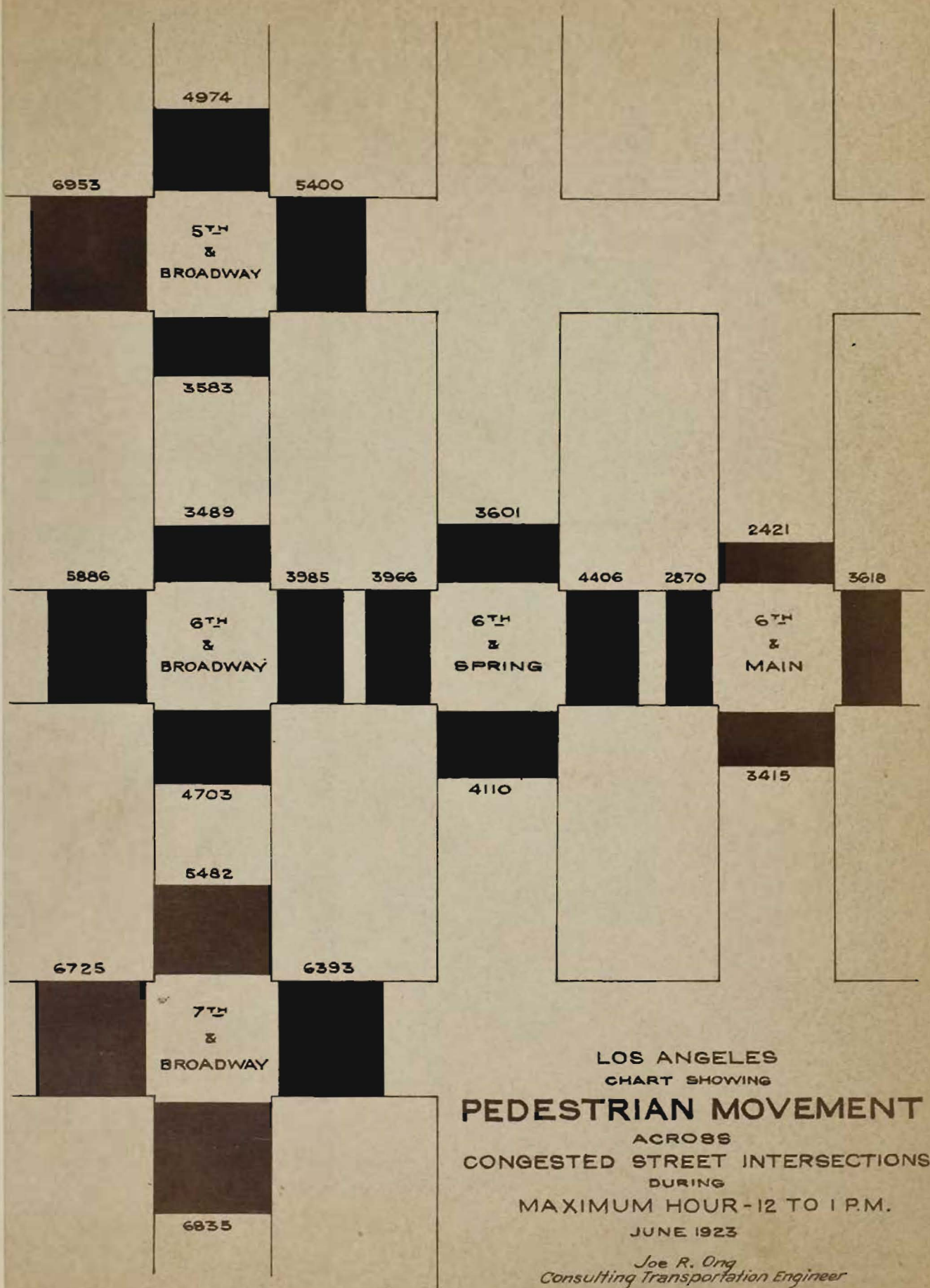

LOS ANGELES
CHART SHOWING
USE OF VARIOUS TRAFFIC ARTERIES
BY
MOTOR VEHICLES
OUTBOUND FROM CONGESTED AREA
DURING
5 TO 6 P.M. RUSH HOUR
JUNE 1923
Joe R. Ong
Consulting Transportation Engineer
PICO 756
FIGUEROA 930
12TH 571
11TH 286
10TH 602
9TH 654
8TH 1149
7TH 804
6TH 562
3RD 440
2ND 831
TEMPLE 782
FIGUEROA 856
GRAND 187
HILL 184
BROADWAY 525
MAIN 427
LOS ANGELES 1619
ALAMEDA 773
ALISO 420
1ST 271
2ND 208
3RD 339
4TH 289
5TH 212
6TH 245
7TH 298
8TH 500
9TH 324
10TH 239
11TH 200
12TH 392
PICO 180
LOS ANGELES 950
MAIN 744
HILL 575
GRAND 640
HOPE 686
FLOWER 688

CHART 17



LOS ANGELES

CHART SHOWING

PEDESTRIAN MOVEMENT

ACROSS

CONGESTED STREET INTERSECTIONS

DURING

MAXIMUM HOUR - 12 TO 1 P.M.

JUNE 1923

Joe R. Ong
Consulting Transportation Engineer

Chart 19

MAXIMUM CARS OPERATED
On
Los Angeles Railway
WEEKDAYS EXCEPT SATURDAY
Jan.-June 1923

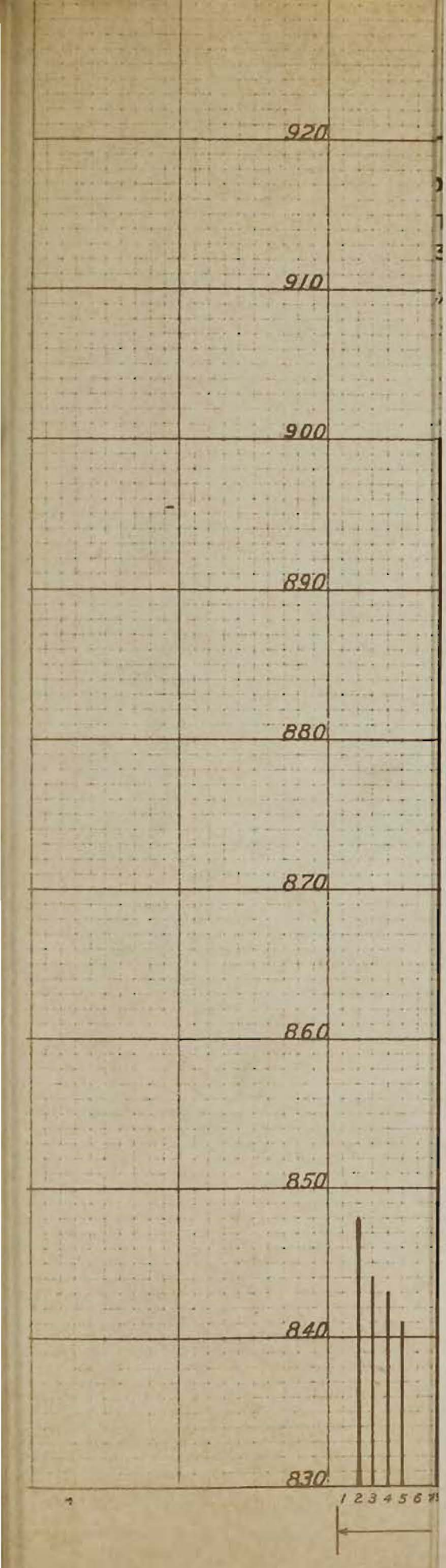


CHART 19

LOS ANGELES RAILWAY

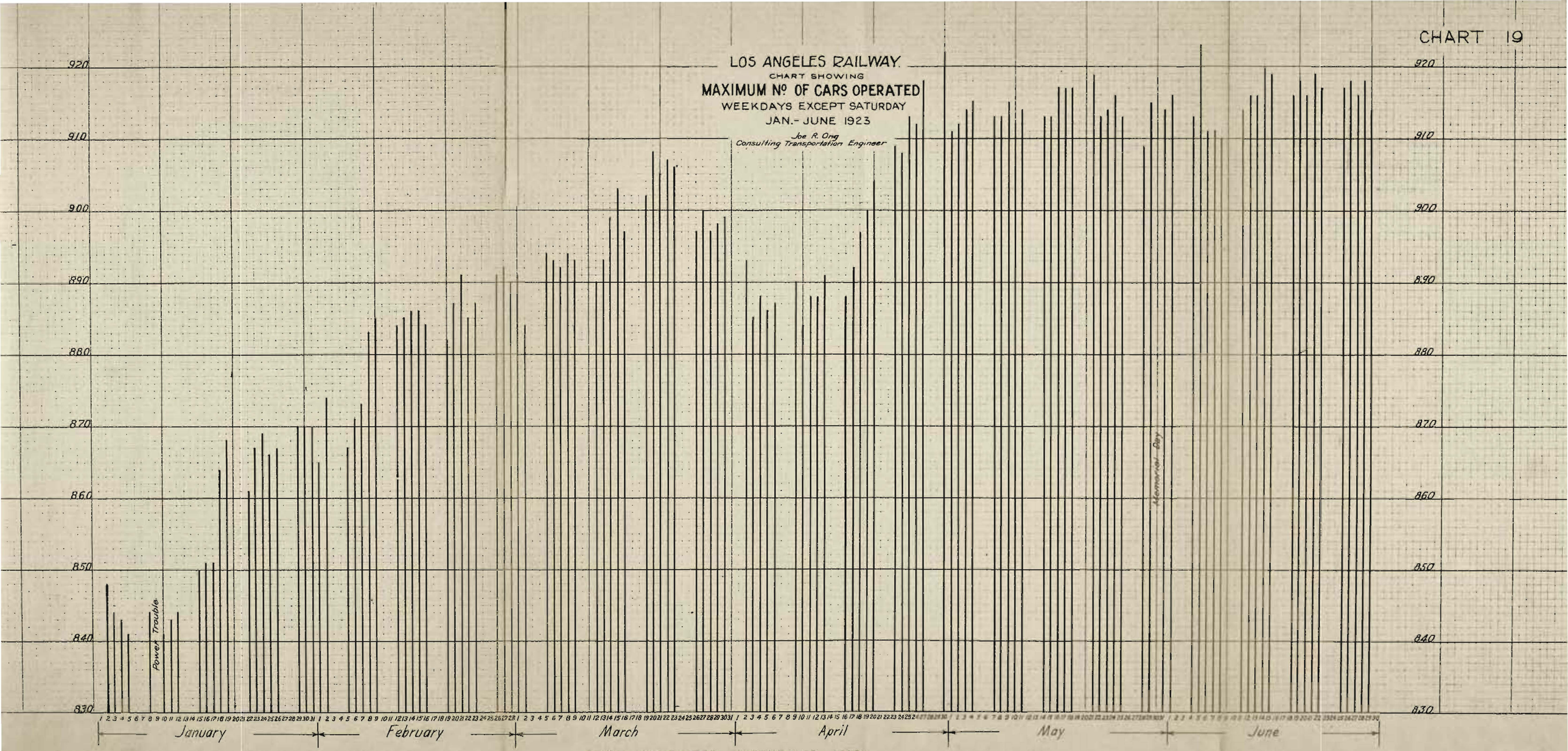
CHART SHOWING

MAXIMUM Nº OF CARS OPERATED

WEEKDAYS EXCEPT SATURDAY

JAN.- JUNE 1923

Joe R. Ong
Consulting Transportation Engineer



CARS OPERATED WEEKDAYS 1923

Chart 20

CARS SCHEDULED FOR OPERATION
On
Los Angeles Railway
April 2,1923
By
ONE HOUR PERIODS THROUGHOUT THE DAY

Rescheduled as of March 15-24

NUMBER OF CARS IN SERVICE

CHART 20

LOS ANGELES RAILWAY CO.

CHART SHOWING

NUMBER OF CARS SCHEDULED FOR OPERATION

APRIL 2, 1923

BY ONE HOUR PERIODS THROUGHOUT THE DAY

Joe R. Ong
Consulting Transportation Engineer

LEGEND

——— Weekday

------- Saturday

— — — Sunday

NUMBER OF CARS IN SERVICE

900
850
800
750
700
650
600
550
500
450
400
350
300
250
200
150
100
50
0

4 A.M. 5 6 7 8 9 10 11 A.M. 12 M. 1 P.M. 2 3 4 5 6 7 8 9 10 11 12 P.M. 1 A.M. 2 3 4 A.M.

CHART 21

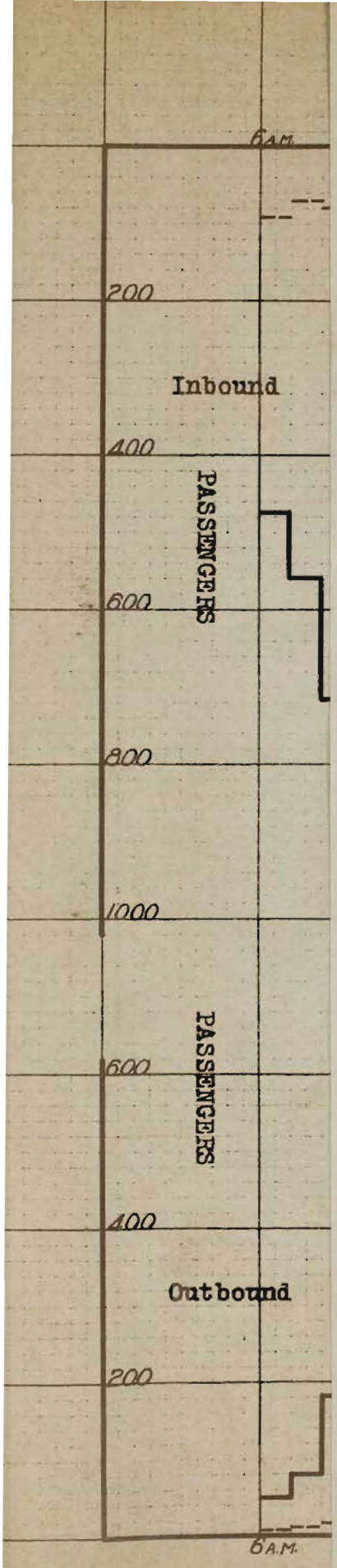
Los Angeles Railway
Chart Showing
Fluctuations in Traffic
and
Variations in Headway
on
EAST 1st ST.LINE
(West Pico-East 1st Line)
LINE P
at
1st & SANTA FE
Thursday Feb.8,1923
Weather-Clear

Legend

To or From Brooklyn Ave


CHART 21
Los Angeles Railway
Chart Showing
Fluctuations in Traffic
and
Variations in Headway
on
EAST 1st ST. LINE
(West Pico-East 1st Line)
LINE P
at
1st & SANTA FE
Thursday Feb.8,1923
Weather-Clear
Legend
To or From Brooklyn Ave
INBOUND
OUTBOUND
PASSENGERS
44 Seat Cars.
0
10
20
30
40
50
60
70
80
90
100
6:00 AM
7:00
8:00
9:00
10:00
11:00 AM
12:00 M
1:00 PM
2:00
3:00
4:00
5:00
6:00
7:00
8:00
9:00
10:00
11:00
12:00 PM

Chart 22



PASSENGER TRAFFIC CONDITIONS
Los Angeles Railway
On
EAST 1ST ST.LINE
LINE P
at
1ST & SANTA FE
Thursday Feb.8,1923

CHART 22

Inbound

PASSENGERS

Outbound

PASSENGERS

Los Angeles Railway
Chart Showing
Passenger Traffic Conditions
on
EAST 1st ST.LINE
(West Pico-East 1st Line)
LINE P
at
1st & SANTA FE
Thursday Feb.8,1923
Weather- Cloudy

Legend

———— Total Passengers carried per 20 Minute period.

---------- Average Passengers per Car 20 Minute period.

6AM 7 8 9 10 11 12M 1PM 2 3 4 5 6 7 8 9 10 11 12P

200 400 600 800 1000 1200 1400

Chart 23

PASSENGER TRAFFIC CONDITIONS
Los Angeles Railway
On
EAST 1ST ST. LINE
LINE P
at
1ST & SANTA FE
Saturday Feb. 10, 1923

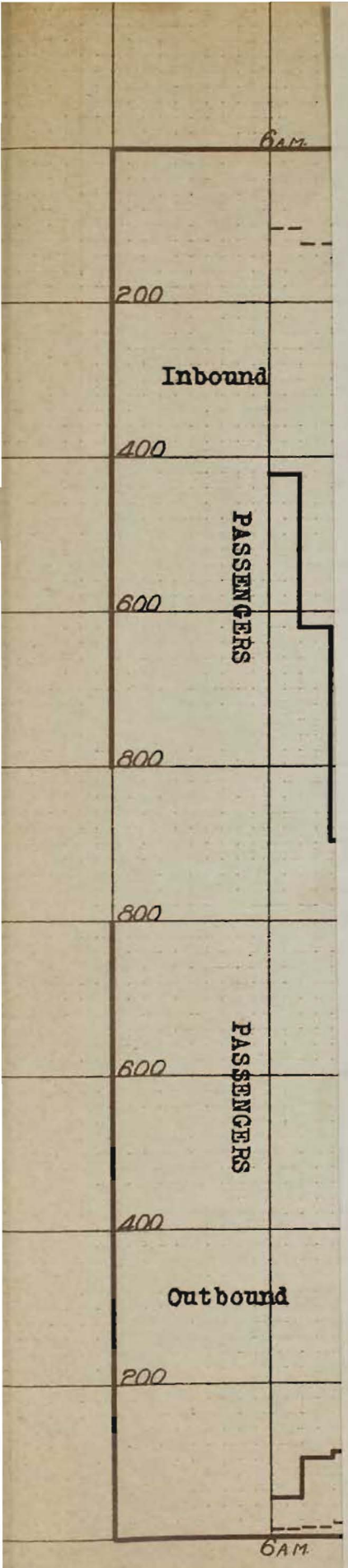


CHART 23

Los Angeles Railway
Chart Showing
Passenger Traffic Conditions
on
EAST 1st ST.LINE
(West Pico-East 1st Line)
LINE P
at
1st & SANTA FE
Saturday Feb.10,1923
Weather- Clear

Legend
———— Total Passengers Carried per 20 Minute period
---------- Average Passengers per Car 20 Minute period.

Inbound

PASSENGERS

200
400
600
800

6AM 7 8 9 10 11 12M 1PM 2 3 4 5 6 7 8 9 10 11 12P

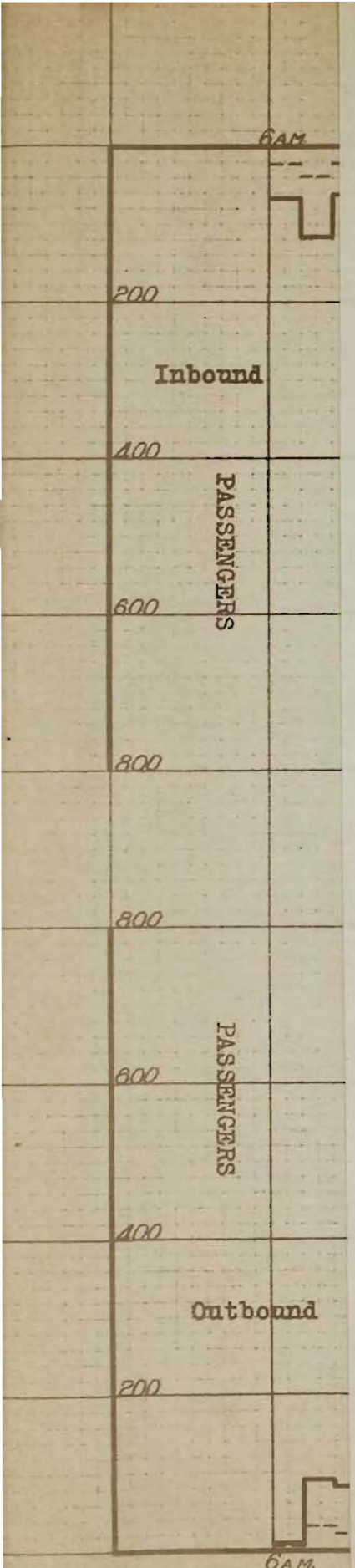
Outbound

PASSENGERS

800
600
400
200

6AM 7 8 9 10 11 12M 1PM 2 3 4 5 6 7 8 9 10 11 12P

Chart 24



PASSENGER TRAFFIC CONDITIONS
Los Angeles Railway
On
EAST 1ST ST. LINE
LINE P
at
1ST & SANTA FE
Sunday Feb.11,1923

CHART 24

6AM 7 8 9 10 11 12M 1PM 2 3 4 5 6 7 8 9 10 11 12P

200 400 600 800

Inbound

PASSENGERS

Inbound

PASSENGERS

Los Angeles Railway
Chart Showing
Passenger Traffic Conditions
on
EAST 1st ST. LINE
(West Pico-East 1st Line)
LINE P
at
1st & SANTA FE
Sunday Feb. 11, 1923
Weather-Rain

Legend

———— Total Passengers Carried per 20 Minute period

- - - - - - - - - - Average Passengers per Car 20 Minute period.

800 600 400 200

PASSENGERS

Outbound

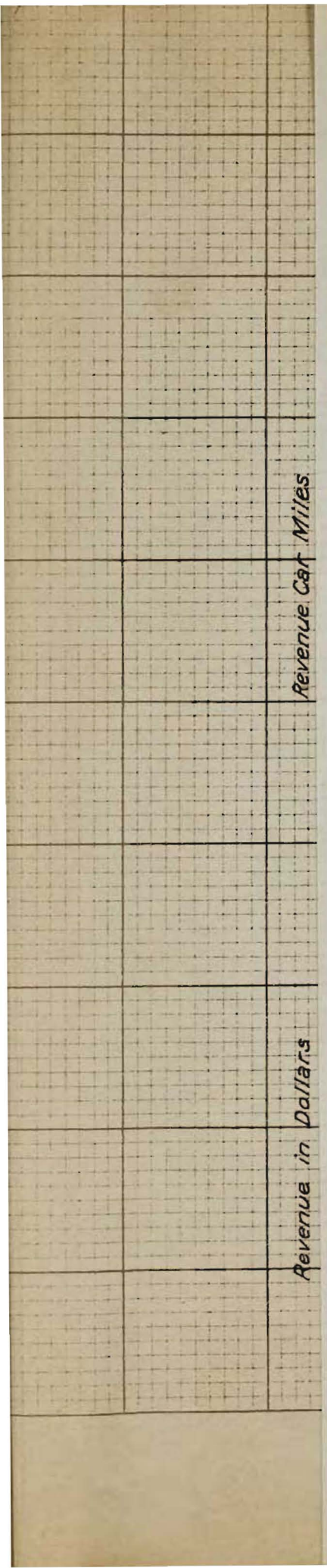
PASSENGERS

Outbound

6AM 7 8 9 10 11 12M 1PM 2 3 4 5 6 7 8 9 10 11 12P

Chart 25

REVENUE AND REVENUE CAR MILES
On
WASHINGTON-GARVANZA LINE
Los Angeles Railway
By Days
From
March 1 1923-May 31 1923



LOS ANGELES RAILWAY

CHART SHOWING

REVENUE AND REVENUE CAR MILES

ON

WASHINGTON-GARVANZA LINE

BY DAYS

FROM

MARCH 1 1923 - MAY 31 1923

Joe R. Ong

Consulting Transportation Engineer

CHART 25

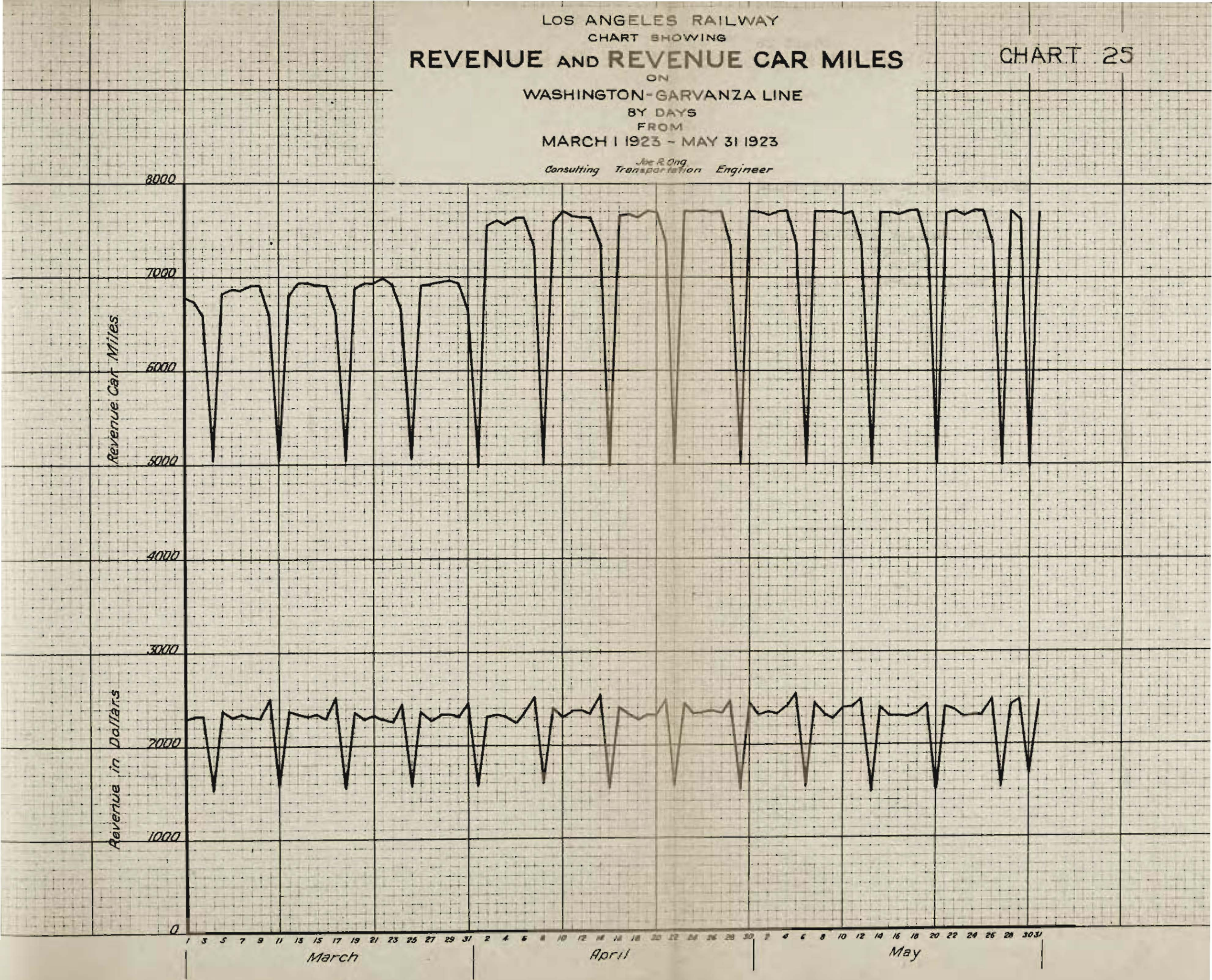


Chart 26

DISTRIBUTION OF TRAFFIC
NORTH BOUND
Along
EAGLE ROCK LINE
LINE E
Los Angeles Railway

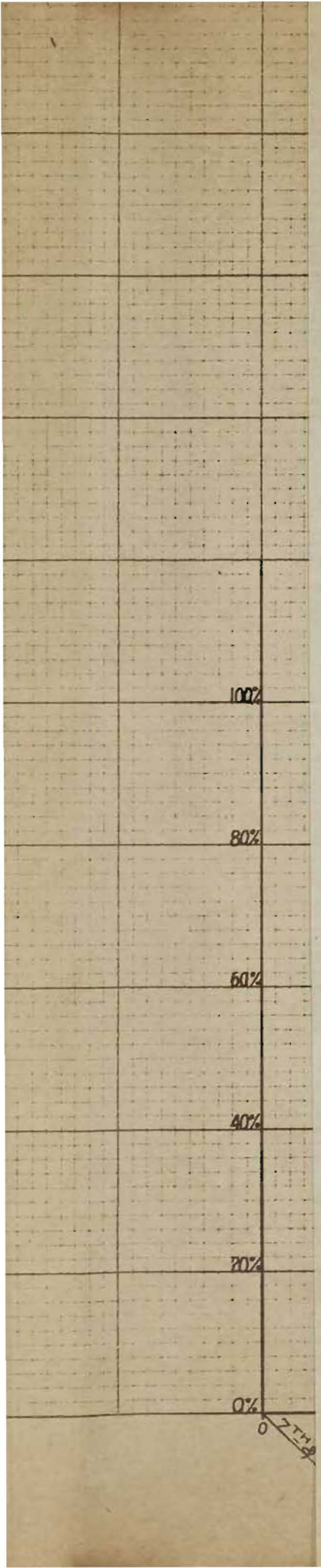


CHART 26

Los Angeles Railway
Chart Showing
DISTRIBUTION OF TRAFFIC
along
EAGLE ROCK LINE
LINE E
Sat., Sun., Mon., March 24, 25, 26, 1923
NORTH BOUND
(Each curve represents conditions on an individual Car)

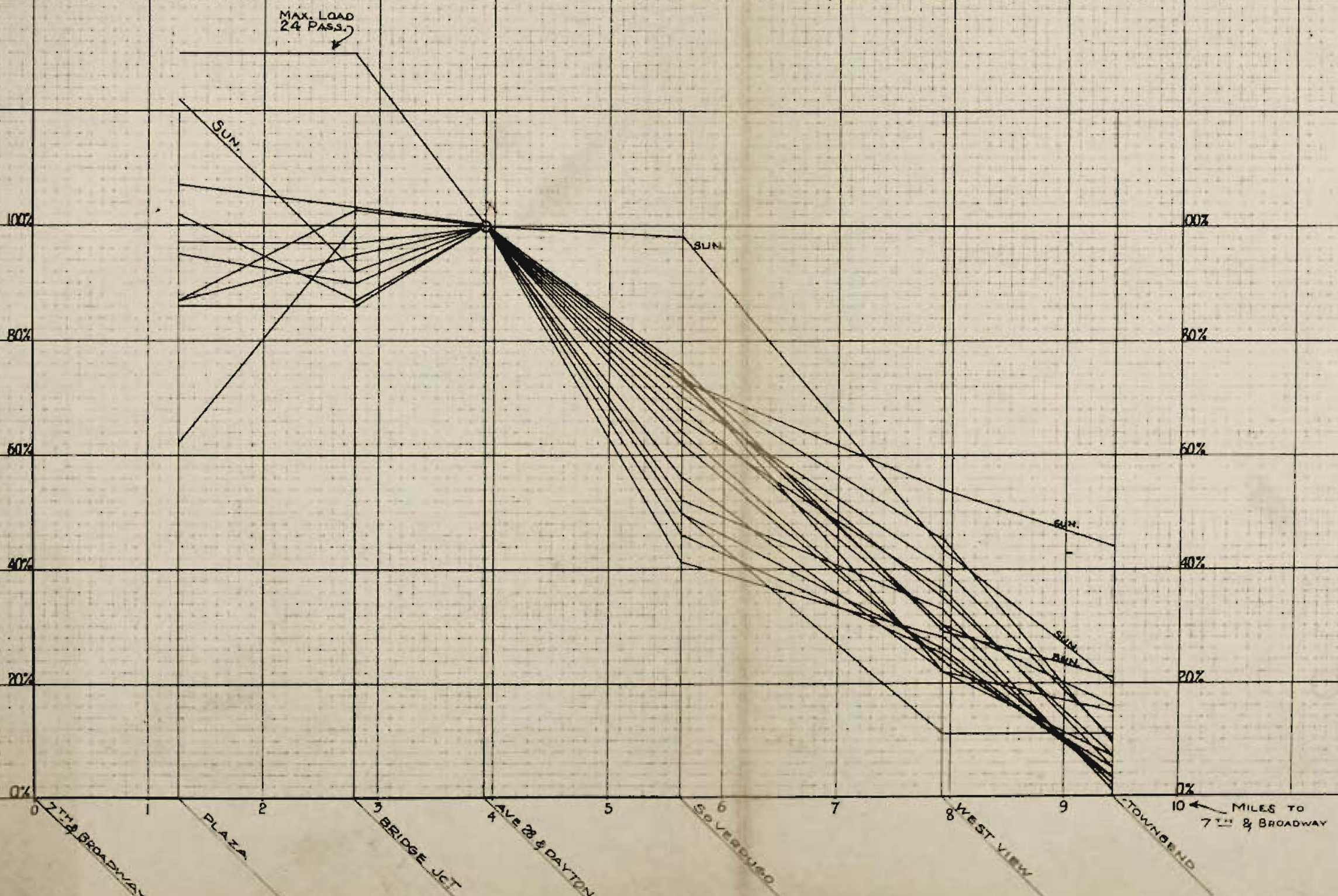


CHART 27

Los Angeles Railway
Chart Showing
Fluctuations in Traffic
and
Variations in Headway
on
HUNTINGTON PARK LINE
LINE-J
at
VERNON & SANTA FE AVES
Tuesday Nov.28,1922

Legend

B — To Barn

To or From Huntington Park

To or From Slauson & Santa Fe

Note:- Special check to show unbalance of traffic on the two branches of the line.

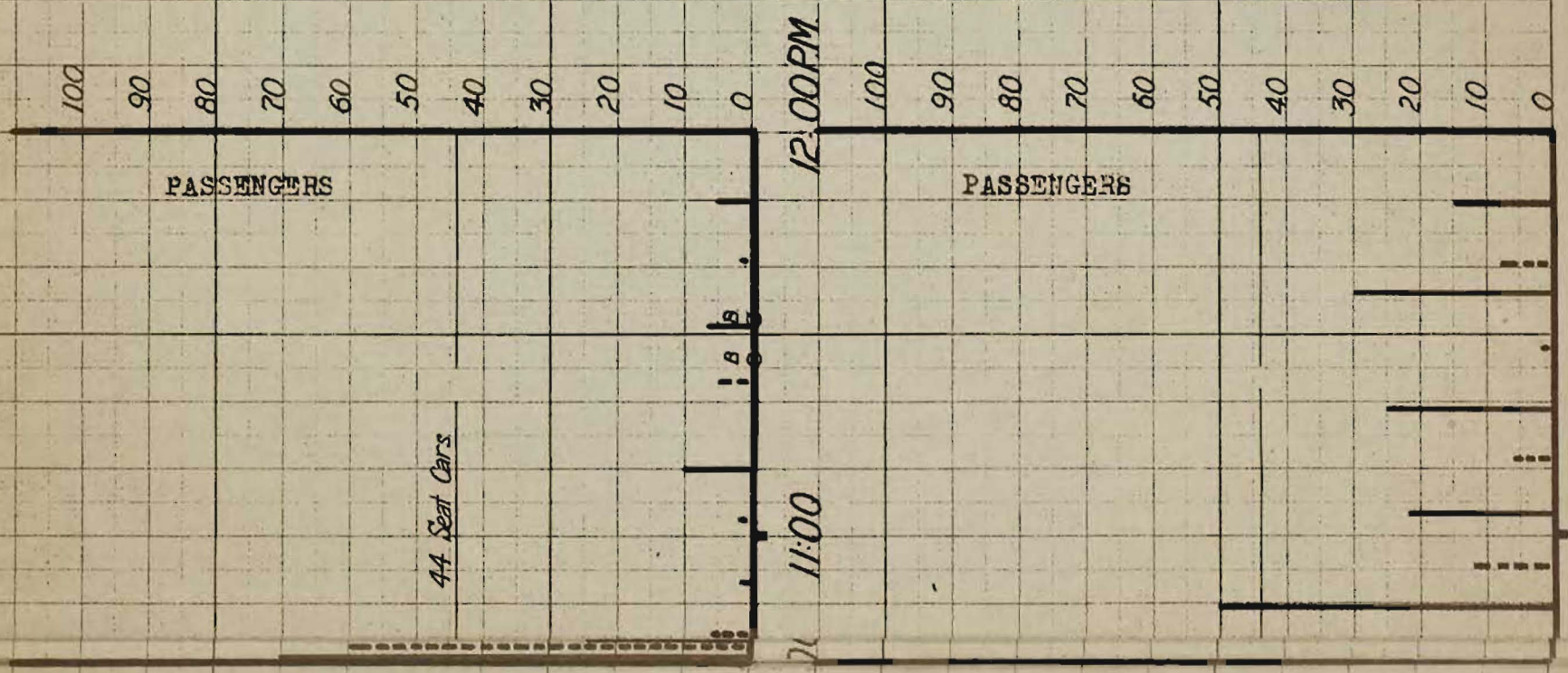
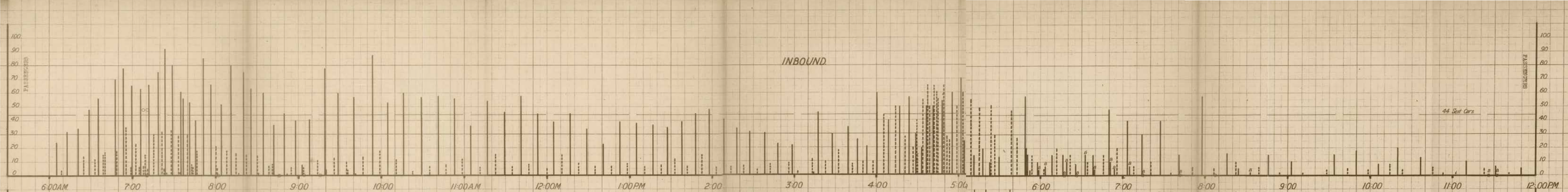


CHART 27

Los Angeles Railway
Chart Showing
Fluctuations in Traffic
and
Variations in Headway
on
HUNTINGTON PARK LINE
VERNON & SANTA FE AVES
Tuesday Nov. 15, 1928



Legend

2½ Cars

2½ or Free Huntington Park

To or From Slauson & Santa Fe

Note:- Special check to show unbalance of traffic on the two branches of the line.