CHIEF ENGINEER.

MELBOURNE & METROPOLITAN TRAMWAYS BOARD.

PROPOSALS

FOR

GENERAL SCHEME.

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for the future

development of Tramways

for the service of the

Metropolis.

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THE PROPOSALS OF THE MELBOURNE AND METROPOLITAN TRAMWAYS BOARD for a GENERAL SCHEME FOR THE FUTURE DEVELOPMENT OF TRAMWAYS FOR THE SERVICE OF THE METROPOLIS.

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The proposals of the Board are set forth in the map herewith marked "A".

Proposed new tramways are shewn on the plan colored green.

Existing Electric Tramways are shewn in red.

Existing Cable Tramways are shewn in brown.

Accompanying the said map are the plans and graph referred to in the Appendix hereto and a brief report explanatory of the above proposals.

DATED this Thirtieth day of November, 1922.

The COMMON SEAL of the MELBOURNE AND METROPOLITAN TRAMWAYS BOARD was hereto affixed in the presence of) (SEAL)

Alex. Cameron, Chairman

W. W. Cabena)
Colin Templeton)
Thos. O'L. Reynolds) Members.
J. G. Membrey)
Ernest H. Willis)
H. H. Bell)

W. O. Strangward, Secretary.

INTRODUCTORY.

Under the Melbourne Tramways Act 1918, No.2995, Section 34, Subsection (2), the Board is required to submit proposals for a General Scheme for the future development of tramways for the service of the metropolis.

The problem of devising a comprehensive tramway system for Melbourne differs in important respects from that of any other City where a systematic attempt has been made to solve the like problem. In addition to making provision for the future development of tramways, a number of distinct electric systems have to be linked up and co-ordinated. Many of the natural routes, however, which are essential for connecting lines are already occupied by cable tramways. The conversion of the cable system forms an integral part of the problem. This is recognised by the Board's Act which gives the Board power to convert any cable line to electric traction.

As the City is, and always will be, in a state of growth the greatest difficulty is in formulating a plan for its transportation system which in the nature of things can never be complete. If, like the cable system, it is not capable of gradual and easy extension or variation, the system will fail for want of flexibility. It is well known that traffic increases at a faster rate than the population of the area served. The consumption of food and water, for instance, increases directly in proportion to the growth of the population, with some slight allowance for increase in consumption per head, due to the increase in wealth. In the case of transportation, however, if the City's population is doubled there are not only twice as many people to carry, but generally they travel more frequently, each one having potential business or social intercourse with every other person in the community. Moreover, as the City grows the average distance

travelled is increased. A plan that will meet the ultimate demands of the service must be capable of expansion up to the physical limits of the routes available.

It is therefore necessary not only to estimate the growth of population, but also to provide for an increased number of journeys per head of population per annum.

It is more important that the system should be susceptible of extension as the population spreads out rather than that it should be laid out beforehand to follow definite routes within fixed limits, outside the area at present served. The Act properly provides for amendment of the Scheme from time to time, as it is impossible to foresee all the changes which may take place over a lengthy period.

The construction of large works West of Spotswood or the settlement of the Fishermen's Bend area, would render lines necessary where, in the absence of some special inducement, no settlement is likely to take place. In the last-named case a direct tramway connection to Williamstown could be given by a line from Boundary Street, Port Melbourne, along Williamstown Road, and over the Yarra by a car ferry.

The Board's aim is to construct a framework upon which systematic extensions can be made to meet further possible needs, without disturbing the proper functioning of existing and projected tramways, or altering the location of any of the main lines.

One important object of a General Scheme should be to avoid the mere duplication of transport facilities. An instance can be given of tramways running parallel to each other at a distance of less than half-a-mile, with an electric railway between, all serving the same people in a district not sufficiently settled throughout the length of the competing lines to support them all.

A study of the growth of cities shows that they develop both by expansion and aggregation. The tendency is always to spread out from the centre, and at the same time there is a reflex action causing congestion at the heart of the city. Modern transportation methods have so revolutionsed social conditions that both of these conflicting tendencies have become accentuated. The continuous growth of the area of settlement makes the problem of providing public services more and more difficult. The daily movement of a large part of the population to and from the business centre in such circumstances results in congestion in thoroughfares leading to the city. These tendencies have to be taken into consideration in devising a transportation system which is intended to serve for a generation to come. The system must not only be suitable for extension in the suburbs, but also be capable of development at the centre.

In many communities population gathers around separate business centres. This is particularly noticeable in Melbourne. In addition to centres of business and trade, there are places of education and amusement, beaches and football grounds, etc., which cause aggregations of people. For all these provision has to be made. In Melbourne the problem of conveying the population to the beaches or foreshores in summer is second in importance only to that of conveying the people to and from the City.

Traffic develops along natural lines, and due regard has been given to this in the treating of new routes.

The Board has, however, preserved the existence of practically all lines authorised prior to its taking office, although several of these lines are not well located in relation to the system as a whole.

Passengers should be able to reach their destinations without unnecessary changes of car. The Board's aim has been to lay out a system which will, in conjunction with the Railways, enable passengers to travel, with the fewest exceptions possible, from one point in the metropolis to any other point with not more than two changes in the streets.

Consideration has been given to the fact that in the metropolis there is an electrified suburban railway system offering cheap and rapid transport to most suburbs. The relative functions of railways and tramways were kept in mind.

Description of Existing System. Plan "B" shows the tramways existing in Melbourne and the suburbs of which the Board has control. These are as follows :-

	Route Miles.
The Cable System	45.927
The Zoo Horse Tramway	.625
The Prahran & Malvern System ...	35.152
The Hawthorn System	11.174
The Preston System	5.822
The Coburg System	7.0728
The Footscray System	4.725
The North Melbourne & Essendon Tramway System	7.240
	117.7378

Also the following tramways not under the control of the Board :-

		Route Miles.
The St. Kilda/Brighton Tramway	(Government)	5.160
The Sandringham/Black Rock Tramway	(Tramways)	2.410
		7.570

There are in addition a number of tramways (shown on the plan) authorised by the Board's Act but not yet constructed, viz. :-

	Route Miles.
The South Melbourne Electric Tramway ...	3.187
Tramway in Princes Street & Willsmere St., Kew ...	1.48
High Street, Kew, Extension to Bourke Road..	.75
Wattle Park Tramway ...	.725
Toorak Road Extension ...	.1875
Chapel Street, Extension ...	.25
Hyde Street, Footscray ...	1.2
Nicholson Street, Footscray ...	.8875
Barkly Street, St. Kilda ...	1.7875
Gellibrand Street, Kew ...	.350
Essendon, Maribyrnong Rd. to Keilor Rd. ...	1.8125
Total	12.617

As the Board's preliminary investigations showed that there were certain districts quite unserved by tramways, a special Act was passed authorising the Board to submit special construction schemes to the Minister, prior to the preparation of the General Scheme

The following are the lines which have been submitted as Special Construction Schemes, and reported on by the Parliamentary Standing Committee on Railways :-

		Route Miles
Tramway in West Brunswick	...	3.19
Tramway in William St., Peel St., and Flemington Road	...	2.09
Tramway in Church St. Richmond, and Chapel St. Prahran	...	2.01
Tramway in East Northcote	...	2.6
		9.89

The following tramway has been submitted to the Parliamentary Standing Committee on Railways but not yet reported on :-

		Route Miles
Tramway in West Coburg	...	1.47

The following are lines for which Orders-in-Council for authority to construct have been obtained :-

		Route Miles
Tramway in Church Street, Hawthorn	...	.66
Tramway in Brunswick Road Brunswick, and Holden Street, Fitzroy	...	.99
Tramway in Bell Street, Coburg and Preston	...	.61
Cable Tramway in Lonsdale Street	...	.15
		2.41
Grand total excluding Government tramways		141.56

THE CABLE SYSTEM.

The dominating consideration in any transport system is that all cars should be capable of operating over the entire system. It is in this feature that the combination of a cable and an electric system fails.

Amongst the evil consequences of such a combination are the following :-

Passengers have to change wherever the cable tramway meets the electric tramway on a through journey. This involves inconvenience, loss of time, and the payment of a second fare. This deprives the passenger of the advantage of tapering rate on through fare, so that in addition to losing time the passenger loses money. The tramways also lose passengers who, if a through journey were provided, would be picked up or set down within say a quarter-mile of the point of change, but who at present prefer to walk the short distance to or from the junction. Congestion is created in the streets at the points of change, and in places this is very serious, and will be still more serious the nearer such points are to the heart of the city. At such junctions one or more cars can always be seen standing idle or shunting. This results in the loss of the services of a large number of cars and crews. The total loss to the Board in operating expenses at the present time at these transfer points is estimated at £20,000 per annum. In addition there is the capital value of some 20 trams (with their car shed accommodation, etc.) practically earning no revenue. Serious as this loss is, the public inconvenience is of even greater importance. It is estimated as the result of counts made at the more important transfer points, including only those which will be eliminated by complete conversion, that at least 7½ million passengers per annum change twice daily. The value of the time thus lost by passengers is considerable : there is also

the discomfort in wet weather and the risk of accident.

Except where transfers are given, each change involves an extra charge of ½d., equivalent to a total of £15,000 per annum taken from the public as a partial offset against the above cost.

It is well known that traffic increases at a greater rate than the population, to a degree depending upon the facilities provided. The total capacity of a system is limited by the capacity of the routes passing through the heart of the city. In Melbourne most of the city routes are now fully loaded. It is therefore futile to add lines in the suburbs with an increasing population, unless more routes can also be provided in the city or the capacity of existing congested routes be increased. This view is emphasized by Mr. McElroy, the late General Manager of the Manchester Corporation Tramways, in his report on the Passenger Transportation Problem of Manchester, as follows :-

> "The ultimate volume of traffic which a tramway "system can deal with is limited by the capacity of the "arterial lines near the central parts of the city. "When the traffic on these lines approaches the "saturation" "point; then additional main arteries must be opened out "or other transit facilities provided."

Traffic returns show that several routes on the cable system are already overloaded. It is recognised that Electrification will give at least double the capacity. This increased capacity will be required for handling the anticipated future traffic.

In the end a tramway system must be judged by its effectiveness in the performance of its function, which is to transport the largest possible number of passengers over the routes available in a limited time. It is owing to its shortcomings in this respect rather than to its disadvantages in minor points, that the cable system has been abandoned wherever it has been used, except on grades too heavy for self-propelled cars to negotiate.

The inflexibility of the cable system renders it particularly unsuitable for handling special services, whereas by Electrification the Board will be able to deal satisfactorily with crowds from football matches and racecourse and beaches, or on festive or other public occasions which lead to aggregations of people.

The conversion of the cable system is therefore an essential factor in the General Scheme. The retention of any portion of such system in the city, would be directly opposed to the principle above enunciated.

It is well to indicate the important difficulties in the work of converting the cable system, as the considerations involved have a bearing on the question of the selection of any system maintaining a portion of the cable system in use, and also affect the order in which the conversion can be carried out.

The spacing of the tracks is such that they cannot be used safely with the Board's electric rolling stock, even if the tracks could stand the heavier loading ; consequently the rails have to be laid in a new position. This makes it imperative to fill in the slot to form a proper foundation for the inside rail, which will be almost over the conduit. On this account, and since for obvious reasons single line working is impossible, it is necessary to convert both tracks at once. The public convenience makes it desirable to convert only a short length of track at a time. Every section, however, involves the building of a terminal sheave pit which must be drained and fitted with sheaves and pulleys at considerable expense. For this reason the sections should be as long as possible. Alternatively a bus service may be provided.

Conversion must proceed either from the city or from the outer end of a rope towards the engine house, but as the depots are in every instance.(except on Toorak line) placed at the end of the lines, the first portion of track converted, if a start be made at the suburban end, cuts off the cars from their regular depot. Accommodation must therefore be provided for the cars elsewhere. As, however, there is practically no spare accommodation at any of the depots, a new depot must be provided if a considerable proportion of the cars are to be kept in service for the portion of the line not being converted. Conversion from the city end wuld block the through route, forcing through passengers to change twice.

SYSTEMS AVAILABLE.

It has been pointed out above that any combination of an electric system with the existing cable system cannot offer a satisfactory solution of the transportation system of the metropolis in the future.

The electric lines must either pass round, but within walking distance of the centre of the city, or terminate on loops convenient thereto, or pass through the city.

In its simplest form, neglecting natural or artificial barriers, the system of feeding on to a square surrounding the centre of the city, provides four (4) through routes or eight (8) exits, and would have a capacity which would be adequate for some years. If, however, too large a square be taken, many passengers will be landed at some distance from their destinations. If, to overcome this objection the trams are routed along two sides of the square, junctions are introduced at the intersections, and the capacity of the system halved. Taking the Post Office as the centre, the obvious square is formed by Latrobe, Russell, Flinders, and William Streets, to the use of which little exception can be taken.

William Street may be connected through to South Melbourne as already suggested in the West Brunswick-City extension proposal. Russell Street has, however, no outlet across the railway. If, to overcome this difficulty, cars were turned along Flinders Street and across Princes Bridge, the capacity of the Flinders Street-Richmond line would be cut down, and a most inconvenient junction introduced at Princes Bridge. Alternatively, the Russell Street cars could be routed east to Richmond, and cars from St. Kilda Road west along Flinders Street : this would necessitate another awkward junction and loading point at the most congested pedestrian crossing in Australia.

The general use of a looping system in the city is only warranted where through routing is impossible. A large number of loops would be necessary, each surrounding one or more blocks in the city : if certain streets are barred to tramway traffic, these loops could only be connected to the main lines by indirect routes involving a number of curves - the wiring at these curves would be objectionable. The placing of the loops of the southern lines at the south side of the River would be inconvenient and lead to most serious congestion.

The system of through routing along the main arteries of traffic, wherever it can be employed, therefore is by far the best from every point of view. Passengers are enabled to pass through the city without change, they have the advantage of the tramways in the main streets for travelling short distances ; junctions on the main streets are avoided, and there is less congestion of traffic. This system has, therefore, been adopted as far as possible in laying out the General Scheme, and an effort has been made to avoid numerous right-angled junctions in the city where the overhead wiring would be objectionable. Little exception can be taken to the overhead wiring necessary for a through line.

POPULATION.

Whilst the Board's Act indicates that the General Scheme shall meet the future requirements of the metropolis, no future fixed date or specified population has been laid down therein.

The capacity of any complete scheme must necessarily be finite, therefore the Board has had to choose an arbitary future date as the limit up to which the tramway transport requirements of the metropolis should be provided for. The year 1940 has been selected for this purpose.

In order to determine the future traffic requirements, and to set out a programme of construction, it is necessary to estimate the growth of population of the metropolis during the named period.

It is difficult to forecast the growth of any city over a long period of years with any degree of accuracy, as the factors which contribute to the variation of population are so diverse.

A study of the past growth of numerous cities of the world reveals how wide is the variation of their rates growth.

Generally in the case of cities of considerable size the percentage increase of population per decade is lower than that for the preceeding decade, or in other words the population of such cities generally increases at a decreasing rate of increase.

Figure I shows graphically the population of Melbourne for each decennial census period from 1861 to 1921.

From this it will be seen that between 1881 to 1901 there was a period of very rapid growth followed by a period when the population remained almost stationary. This is explained by the conditions existing during the land boom period and the period of reaction which followed, both conditions being abnormal. Except

for this period the growth of Melbourne has followed a fairly regular curve and for the purpose of the General Scheme it has been assumed that the growth of Melbourne will approximate to the continuation of this curve.

On figure 2 is plotted a curve for the past and future growth of population which has been derived from the above assumptions.

The increases per decade for this curve compared to the past increases are set out in the following table :-

	ACTUAL GROWTH		AVERAGE GROWTH ON CURVE	
Year	Population	% Increase	Population	% Increase
1861	139,916	-	134,981	-
1871	206,780	47.78	206,253	52.8
1881	282,947	36.83	291,641	41.34
1891	490,896	73.49	390,876	34.03
1901	496,079	1.09	503,775	28.88
1911	593,237	19.59	630,118	25.07
1921	766,506	29.21	769,771	22.16
1931	-	-	922,588	19.85
1941	-	-	1,088,435	17.97
1951	-	-	1,267,214	16.42

The above forecast is conservative. If the rate of growth for the last 10 years, viz., 29.21 were continued, the population would be 1,279,700 by 1941 instead of 1,088,435 as estimated.

For the purposes of the General Scheme, the Board has adopted the average curve as set out above and shewn on the graph figure 2.

This gives a much smaller increase in population than the figures apparently adopted by the Metropolitan Board of Works. In laying out a water supply scheme, a generous estimate is advisable in order that the supply and the main conduits may be of ample proportions. The capacity of a tramway track is, however, not capable of variation by alteration in its construction. If traffic increases beyond the limits provided for, additional tracks must be laid down.

As indicated above, the population of Melbourne according to the 1921 census is 766,506. The area over which this was taken does not, however, coincide with the Board's area as defined by the Act. The data collected by the Board show that the population of its area is 774,000. For statistical purposes in connection with the General Scheme, this is the figure which has been used.

Allowing for the differences in area as above mentioned, it is estimated that the population of the Board's area will be 1,094,500 by the year 1940, as compared with 1,088,435 estimated for the census in 1941.

Of the present total population (774,000), 717,000 or 92½% are served by either tramways or railways, and of the future population of 1,094,500 a figure of 1,060,800 or nearly 97% has been assumed as the population which will be served by either tramways or railways.

The present area served by either railways or tramways is 61,965 acres, and the average density of population in this area is 11.6 per acre.

The present total mileage of tramways in the metropolis is 125.31. There are, therefore, 16.21 route miles of tramway to every 100,000 people, or a population of 6.180 per route mile.

If, however, the mileage were increased by lines urgently required for areas without any means of transit, such as West Brunswick, the route miles of tramways would be 133.31, and the miles of tramway per 100,000 inhabitants would be 17.2.

If to the above is added the mileage of tramways already authorised, which are admittedly considered necessary, and also of those lines which should be constructed on the fringe of the settled areas for developmental purposes, the route mileage would be 145 and the miles per 100,000 would be 18.8.

Owing to the radial layout of the railway system of Melbourne, the area to be served by tramways lying between the railway lines will increase as the City expands.

In order to serve the metropolitan area satisfactorily for the calculated period, it has been found necessary to provide a route mileage of tramways which works out at a rate per 100,000 inhabitants much greater than exists at present.

The total route mileage of tramways in Melbourne when the new lines are wholly provided as set out in this scheme, will be 266.21 or 24.3 route miles per 100,000 with a population of 4.111 per route mile.

The total area served by both railways and tramways when these lines are provided will be 39,303 acres, and the average density of population in this area will be 11.8 against the present average density of 11.6.

It will be seen that the tramway extensions proposed in the general scheme will amply provide for the requirements of the estimated population by the year 1940, and will suffice up to the period when the population reaches 1,500000. The number per route mile of tramway will then still be under 5,700, and the average density per acre below 17 or for those served areas outside the

four-mile radius only about 13 per acre against the present figure outside 4 miles of 6.4.

In preparing the General Scheme, surplus mileage has been laid out in order to allow as nearly as possible for expansion of the City in any direction. Uniform expansion in every district, however, up to the limits provided for, is unlikely.

Comparing the districts to the North and South of the Yarra, i.e., those from Heidelberg around to Williamstown on the Northern side with those from Nunawading around to Port Melbourne on the Southern side, the facts are as follow :-

		NORTHERN	SOUTHERN	TOTAL
		Miles	Miles	Miles
Present	Route Miles of Tramways	48.7	76.6	125.3
	Per Cent. of Total	39%	61%	
Future	Route Miles of Tramways	117.8	148.4	266.2
	Per Cent. of Total	44%	56%	

		NORTHERN	SOUTHERN	TOTAL
		Acres	Acres	Acres
Present	Area served by Railways & Tramways	25,421	36,544	61,965
	Per Cent. of Total	41%	59%	
Future	Area served by Railways & Tramways	42,649	46,654	89,303
	Per Cent. of Total	48%	52%	

It will be seen that taking into account the existence of a complete electrified suburban railway system, the scheme makes adequate provision as regards the amount of track provided. As pointed out above, traffic increases at a greater rate than the population. The number of tramway journeys per head per annum

in 1920 in the metropolis was 290. It is estimated that a total tramway travel of 390 per head per annum can be reasonably anticipated by the year 1940.

This would give a total of 411 million journeys per annum or an average of 1,540,000 journeys per route mile per annum, as against 1,675,000 at present.

SELECTION OF ROUTES.

The selection of a route where one is not already pre-indicated, is governed by various considerations, sociological, topographical, engineering and traffic.

Under sociological may be classed such matters as density of population and the habits of the people, the class of business along the route, and the direction of travel.

The topographical considerations are the width of the streets, the absence of heavy gradients, railway, river and creek crossings.

A desirable extension, for instance, would be along Toorak Road East of Glenferrie Road, but its adoption is precluded by two severe gradients, one near the railway crossing on the Glen Iris line, and the other immediately West of Tooronga Road. Similarly, an extension from Warragul Road North along Boundary Road and Union Road to Whitehorse Road would involve severe grades. At Punt Road the gradient is so heavy that a tunnel or a deviation as shewn will be necessary.

The traffic considerations are the methods of connecting with existing routes, and how the public can be most convenienced.

In many instances the most suitable route is indicated by existing vehicular and pedestrian traffic, the location of shops, the width of the roads and ease of connection to existing means of transport.

There are three zones to be considered :-

(1) The inside City zone, where the main difficulty is to get a sufficient number of routes to carry the traffic concentrated thereon.

(2) The outside zone, where the difficulty is to decide how many routes, if any, are required.

(3) The intermediate zone, covered by connecting lines.

The most important and difficult problem in preparing the General Scheme is the provision of sufficient routes into the City, and their inter-connection. In order to furnish the means of dealing intelligently with the problem, a large amount of statistical work has been necessary. The total population at the date selected had to be estimated, its distribution had to be gauged by the aid of data on the existing distribution of population. The proportion which will use the railway from each district had then to be estimated, an increase in the general riding habit allowed for, and the number of cars required to carry the resulting traffic then determined.

At the present time 17,300 passengers leave the City by tram during the half-hour of maximum traffic. This represents 2.8% of the average week-day traffic. After allowing that the Railways will in the future carry a larger proportion to the distant suburbs they serve, it is estimated that 36,000 or about 3% of the estimated future week-day traffic will leave the City by tram during the maximum half-hour.

With electric service a headway of twenty seconds is practicable in streets with few intersecting lines, but in designing a system it is not advisable to reckon on such a dense service throughout, as it is not practicable to distribute the loading equally over all the routes leading to the City. An endeavour has been made to avoid extreme congestion as far as possible. Allowance has therefore been made for an average loading of 30 cars outward half-hourly at peak load. As double truck cars will be

used in the City, an allowance of 100 passengers per car is made. The Board's largest standard cars are easily capable of carrying more, but experience shows that equal loading on all cars is not attainable. The minimum number of routes required on this basis is twelve (12).

Excluding Flinders Street Extension (the line to the River, Wharfs and Docks) which does not lead to any suburb, the number provided is fourteen (14). That to Footscray will carry relatively few passengers. As full provision is made in the Board's Act for amendment of the General Scheme as occasion may require, any additional routes that may hereafter be required can be added when occasion arises.

It is estimated that over one-third of the total number of passengers leaving the City during the half-hour of heaviest loading will travel towards the South and South-eastern suburbs. After allowing for those who will reach their destination via the Church Street Bridge, it will be necessary to provide cars for about 10,000 passengers per half-hour on routes crossing Princes Bridge, Queens Bridge, and the new Spencer Street Bridge. The majority of these passengers will desire to travel by Princes Bridge, as this offers the shortest route to the South-eastern suburbs. This line will therefore be loaded up to the limit fixed by the minimum headway. The balance of the passengers will have to be accommodated on the other two routes.

On the lines leaving the City on the North to the West of Nicholson Street, provision is required for about 12,000 passengers in 30 minutes. These should be handled with comfort by electric cars on the five routes shown.

To the East and North-east accommodation will be necessary for about 14,000 passengers, including those travelling to the South-eastern suburbs via Batman Avenue. As provision

must also be made on Victoria Street for cross town traffic not included in the above figure, five routes are indicated, including a new route along Albert Street which will be useful also during conversion.

These routes have been connected through the City in order to gain advantages in operation which are unobtainable with the cable system in which the arrangement of the gear makes it impracticable to connect many lines now terminating at the same point.

In connecting up the various routes in the City consideration has been given to the following points :-

1. The convenience of the travelling public.
2. The balancing of services.
3. The reduction of congestion at necessary crossing points.
4. The provision of services passing along the City boundary. (Cross town traffic).

The convenience of the public will be met as far as possible by routing distinct services from the one district to different lines in the City, so that passengers from a distant suburb by changing cars at an intersecting point, which will, if possible, be made a fare section, will be able to reach any part of the City traversed by electric trams, with the least extra charge and at a minimum of inconvenience.

It is estimated that the traffic to the South and South-east will about balance that of the North-west. Cars will therefore be routed through from the one district to the other. Cars from the East and North-east will have, however. no outlet from the West after passing through the City. Provision is therefore made for shunting at the end of Bourke Street, at a point convenient to Spencer Street Station. Those cars which will traverse Latrobe and Lonsdale Streets can turn South past the Station to a

loop in South Melbourne. Others will shunt in Batman Avenue as at present.

During conversion of the cable trams, and later, owing to unequal growth or difficulty in balancing, it may prove necessary to turn cars back either North or South of the City. In the latter case the loop in South Melbourne will be of service, in the former the loop shewn in Queensberry Street and at the junction of Sydney Road and Flemington Road. These loops will also be of service for storing cars near the City to deal with special traffic. For traffic towards the East the shunt in Little Collins Street and the track in Flinders Street West will be used.

An endeavour has been made to reduce the delay at the crossings in Swanston Street by using Russell Street for routing cars through to the East.

Services will be provided along Victoria Street so that passengers may travel from the West and North-west to the East and South-east suburbs, without passing through the City and adding to the congestion there.

In selecting routes through the City from the North to South, Spencer Street, William Street, and Swanston Street have been chosen because they lead directly to bridges (existing or proposed) across the River. In selecting routes from East to West, as Collins Street is barred, it is necessary to use Bourke Street as otherwise there would be too great a spacing between the routes and an insufficient number available. Bourke Street moreover leads directly to the Spencer Street Station, and is an important shopping street.

Of the passengers travelling via Spencer Street and Queens Bridge from the City, a large proportion will wish to reach districts East of St. Kilda Road. They will, therefore, have to travel via Hanna Street, from which a proportion of the

cars will be routed along Toorak Road. The balance can only be accommodated on St. Kilda Road by the use of a third track which the Board desires to provide from Princes Bridge to St. Kilda Junction. If the necessary authority for laying down this track, when required, cannot be obtained, it will be necessary to use Queens Road. A route along this road as far as High Street has therefore been shewn as an alternative route on the plan.

SUBURBAN EXTENSIONS.

The problem in the suburban area embodies several considerations :-

1. How far to extend.
2. The relative functions of railways and tramways in outer districts.
3. The economic considerations.
4. The spacing to be allowed between lines.

These considerations are all inter-related. Population follows the means of transport and settles first along the railway line. The map giving the distribution of population shews outside the tramway districts an area of settlement around each railway station. As this area becomes congested, home seekers find it more satisfactory to settle near the more distant stations, as by doing so the total travelling time from home to the City and vice versa, including walking time, will be less. Those to whom the fare is a more important consideration than time will, however, choose the nearer suburbs. The breadth of the zone which can be settled by a railway line is therefore a complex of many considerations, such as distance between the stations, amount of fares, and the income of the inhabitants, in addition to many other minor factors, topographical and sociological. Many of these factors have been modified by the electrification of the suburban railways which has brought

distant suburbs so close to the City in point of time that the question of relative fares and convenience is now of greater importance.

The tramway system in Melbourne extends Easterly for a distance of $7\frac{1}{2}$ miles from the City, and many passengers travel the full distance by tramway in preference to walking the distance to and travelling by the railway, although they would save time by doing so, as the time map "C" shows. It is evident then, that the possible limit of through tramway travel has not yet been reached. As, however, both systems belong to the public, it is undesirable that new tramways should be built to traverse districts served by railway unless they serve the Railway Stations, and compete only incidentally by their connection with the lines leading to the City.

The St. Kilda/Brighton tramway, for instance, terminates at the Brighton Station, and is at no point distant more than half-a-mile from the railway. It carries a large through traffic, however, and serves the local traffic much better than a railway system.

The heaviest items in the operating cost of a passenger transport system are the platform costs. These are a function of time and not of distance, of the car hour and not of the car mile. The aim of managers is therefore to run as many car miles or passenger miles per hour as possible. It is by running large units at a high speed that the operating costs per passenger mile on a railway can be kept low enough to leave a margin for paying the high fixed charges on the right-of-way, permanent way, and stations. If, in an effort to secure local traffic, stations are placed much closer together than a mile, the schedule speed is so much reduced that the long distance travellers are seriously penalised in time, or the power costs are greatly increased in an effort to maintain a high schedule speed. Any reduction in schedule speed results in increased platform costs per car mile, as explained above.

Over 50% of tramway passengers travel one section only, but only a small proportion of the journeys begin and end near a railway station. For local and short distance travel, therefore, the tramway is more convenient. The traveller from a distance to the City should therefore be encouraged to take the train, while the short distance trayeller should use the tramway. A tramway will, of course, provide a through journey to the City in the process of catering for the local traffic along the route. It also best serves passengers up to distances of three or four miles from the City, by reason of the fact that it picks them up and sets them down nearer their destinations.

The erection of new railway stations at short intervals within a distance of, say, three miles of the City, is therefore to be deprecated. Conversely, at distances of about eight miles, the trams should, as previously set down, act as feeders to the railways. This has been the object in the extensions proposed in the Brighton and Heidelberg districts where the lines feed railway stations. In the former case, routes leading East and West, rather than North and South, have been selected, in order to reach the foreshores.

A tramway laid down to serve a railway, should of course, deliver the passengers close to the railway station. Unfortunately, however, the stations are not always so placed as to be reached readily by a tram line, and when they are, a level crossing usually exists. A short line of tramway carrying only passengers to and from the railway has no prospect of paying : it must depend to a great extent upon traffic crossing the railway. The operation of a series of isolated tramways economically is impossible. It is considered, therefore, that the obligation on the tramways to serve the railways carries a reciprocal obligation on the part of the Railways Department to locate the stations where they can be reached and the line crossed by the tram line, and that the whole expense of abolishing level crossings should not fall mainly on the Tramways Board.

Tramway extensions seldom pay at the outset either directly or indirectly, unless they reach some definite objective such as a business or pleasure resort or a large centre of population. Consider an extension one mile in length, with its tributary population gradually getting sparser as the terminus is approached. For the first quarter-mile, the majority of the inhabitants will walk to the section, i.e., the old terminus, to save the extra fare, so that less than three-quarters of the population beyond the former terminus will use the new track. As settlement progresses, particularly towards and beyond the new terminus, extra traffic on the whole line helps to fill half-empty cars on the original final section and produces a surplus on the inner sections which pays for the extra fixed and running charges on the new section. It is usually not until a further extension is added that the original section gives a direct return, and most of this is required to balance the charges on the new extension. Speaking broadly, it is the central portion of any system which provides the surplus to cover the cost of extension, but it is the extension which produces the travel on the central portion. It is therefore sound policy, while the population is growing, to carry out a moderate programme of extension, provided that the central system is capable of providing the surplus to cover the initial loss, and that there is a prospect of the extension paying in a few years. In other words, it is necessary that traffic created by the extension will, within a reasonable time, be sufficient to maintain the average of the whole system, assuming that the latter is just paying, which should be the case in a system owned by and operated for the public. To expect more at present costs is useless ; to require less would eventually lead to bankruptcy, for increasing fares beyond the present figure would reduce the traffic and the total revenue

For the whole M. & M. T. B. system to 30th June, 1922, the earnings per mile of route were £16,600 and 1,952,256 passengers per mile of route per annum were carried, giving a return of £2.17.9 per annum per head of population served, which averages 5,820 per route mile. The average of the car miles run per annum per mile of route is 189,200.

To the year ending 30th June, 1922, the capital expenditure on electric tramways only is about £1,750,000 or £27,200 per mile of route.

At present costs the total annual expenditure per mile of route with a service proportioned to the population is shewn in Diagram attached. On the same diagram the straight line gives the total revenue per mile with different populations corresponding to travelling habits of 360 and 396 and for 10 and 11 passengers per car mile respectively. The present figure in Melbourne is over 10, and that in Sydney 12. The diagram shews that with the riding habit expected, and average population of about 5,000 per mile of route will be required to pay the fixed and operating charge on the system, assuming that it is all built with new capital. As a matter of fact the conversion of the cable system will be partly carried out by the renewal fund of that system.

This does not mean that the above density and service is required on the extensions, but that it must be maintained on the whole system as an average for the tramways to pay. In the above capital cost no allowance is made for contributions to the State revenue, but merely for interest rate and renewals.

If capital costs and interest charges continue to fall the average population required per mile of tramways will decrease. There will also be a certain amount of single track on the extensions, but on the other hand there are additional costs due to wood-paving which are not included in the figures on which the diagram is based.

SPACING OF ROUTES.

It is obviously impracticable to provide tramways in every main street in the suburbs, not only because of the excessive cost of track, but because it would be impossible to provide a frequent service on many lines, without running more cars than could be filled, or than can be run on the lines in the City upon which these outside routes converge.

A tramway with a service less frequent than twenty minutes never attracts much travel except during business hours, unless it serves some definite objective such as a beach or park, or some centre of population.

By doubling the distance between parallel lines with the same population served, it is practicable to run twice the number of cars on the smaller number of routes. The effect is that without increasing the operating costs, the total car mileage being the same, the standing charges on tracks are cut in half, no more cars are required, and the district gets the benefit of a service of double the frequency. The question then arises as to what is the proper spacing in such a case.

With tramlines a mile apart the average person from the area between will have to walk approximately a quarter of a mile to reach the tramline, and allowing a rate of walking a little less than four miles an hour, he will reach the tramline in four minutes, and have to wait, on the average, half the interval between trams before he starts his tram journey.

An investigation based on the above assumption shews that where only infrequent services are justified by the traffic, the average time between the home and the tramcar is a minimum for a spacing of about one mile. The Board has, therefore, taken as a basis of its investigation that the served area extends for half-a-mile on each side of a tramway and the same distance

beyond the terminus. This is ccnsistent with experience elsewhere.

SPECIAL SERVICES.

The inflexibility of the Cable system renders it particularly unsuitable for handling special services. The rate at which cars can be shunted is slow, sidings cannot be operated except by auxiliary ropes, and their construction would be very costly. It is impracticable to use loops.

In the scheme as laid out, advantage is taken of the flexibility of the electric system to provide loops or sidings at points where special loading is to be handled. These include:-

The Esplanade Terminus,
Caulfield Racecourse,
Flemington Racecourse,
The Agricultural Show Grounds,
Richmond Racecourse,
Victoria Park,
South Melbourne Cricket Ground,
St. Kilda Cricket Ground,
Essendon Cricket Ground,
North Carlton Ground,
Fitzroy Cricket Ground.

In devising the foregoing Scheme the Board has given particular attention to the following considerations :-

(a) The provision of sufficient transport facilities to serve all settled portions of the Board's area for a generation ahead. These facilities include tramways leading to the City, either direct or indirectly, and to other objectives, such as industrial centres or recreation resorts. Lines are also provided between those suburbs where the interflow of traffic may warrant a cross connecting tramway.

(b) The provision of a sufficient number of routes in the City proper, and inner suburbs, to carry the estimated future peak loads without undue crowding of passengers on the cars or undue congestion of cars along the routes.

GENERAL SCHEME.

STATISTICS (TOTAL).

		Present	Future
POPULATION.	Total Population	774,000	1,094,500
	Served Population (Rail or Tram)	717,000	1,060,800
	Area Served Acres (Rail or Tram)	61,965	89,303
	Area Served Square Miles	97	140
	Density per Acre (Served Area)	11.6	11.8
TRAMWAYS.	Route Miles of Tramways	125.3	266.2
	Miles per 100,000 of Total Population	16.2	24.3
	Route Miles of Tramways per Square Mile	1.29	1.9
	Total Population per Route Mile	6,180	4,111
PASSENGERS.	Total Passengers per annum	210,000,000	411,000,000
	Riding Habit (served Population)	290	390
	Journeys per annum per Route Mile	1,675,000	1,540,000
	Half-hour volume from City at outbound peak	17,300	36,000
	Half-hour volume at outbound peak as percentage of week day passengers	2.8%	3.%

A P P E N D I X.

The following are the plans and graphs referred to in the proposals of the Board.

PLAN A. GENERAL SCHEME -

Shews, new routes proposed in the General Scheme, Cable lines to be converted, existing Electric lines and lines to be abandoned.

PLAN B. PRESENT SYSTEMS -

Shews, existing systems, authorised lines, and lines submitted as special schemes.

PLAN C. PRESENT SYSTEMS TIME MAP -

Shews, Railway time Zones within served areas and Tramway Zones outside Railway served areas.

PLAN D. GENERAL SCHEME SERVED AREAS -

Shews, areas served by electric tramways and railways under the General Scheme.

PLAN E. PRESENT SYSTEMS SERVED AREAS -

Shews, areas served byexisting tramways and railways, also the present distribution of population.

GRAPH FIG. 1.

Shews, the growth of the population of Melbourne for each decennial census period from 1861 to 1921.

GRAPH FIG. 2.

Shews, a curve for the past and future growth of the population of Melbourne.

GRAPH FIG. 3.

Shews, total annual expenditure per mile of route with a service proportioned to the population and the total revenue per mile with different populations corresponding to travelling habits of 360 and 396 and for 10 and 11 passengers per car mile respectively.