

# REPORT

ON

## **Proposed Melbourne to Burwood Electric Tramway**

AND

## **Electrification of Hawthorn Horse Tramway**

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McCARTY, UNDERWOOD & CO.,  
Consulting Electrical Engineers,  
31 QUEEN STREET,  
MELBOURNE.

MAY, 1914.

31 Queen Street,  
Melbourne,

May 11th, 1914.

Gentlemen,—

We have the honour to acknowledge receipt of your letters of the 8th, 16th, and 23rd of April, 1914, in which you ask us to prepare and place before you a Report on the Proposed Electric Tramway from Melbourne to Burwood.

We will deal with all the questions you have placed before us, and will give you the information in the following order:—

- (a) Estimate of cost of Construction.
- (b) Estimate of Revenue.
- (c) Estimate of Expenditure.
- (d) Engineering Difficulties.

Before proceeding with our Report, we may mention that we have been furnished with copies of the estimates that have been placed before you from time to time, and have analysed them thoroughly. You will observe that there are certain items in our Report that have not been embodied in the above-mentioned estimates, and which will add to the capital expenditure, while on certain items which appear in the above estimates we show a substantial saving.

We have taken the line as from Princes Bridge along Yarra Bank Road, Swan Street, Wallan Road, Power Street, Riversdale Road, and Camberwell Road to the intersection of Bowen Street.

The other section which is treated in the Report is that portion of the Horse Tramway to be electrified, from the corner of Wallan Road and Power Street along Power Street to Burwood Road, and along Burwood Road over the River Yarra to the terminus of the present cable Tramway in Bridge Road.

The line from the intersection of Bowen Street and Camberwell Road along Norwood Road to Boundary Road will be a single track, with a passing station.

The route mileage of double track on the main line from Princes Bridge to Bowen Street, Camberwell, will be 5 miles 50 chains 52 feet.

The mileage of Horse Tramway to be electrified in Hawthorn along Power Street from the intersection of Wallan Road, including Burwood Road, over the River Yarra to the present terminus, is 1 mile 5 chains 61 feet of double track.

The mileage of single track, exclusive of passing station, from the intersection of Bowen Street and Camberwell Road along Camberwell and Norwood Roads to Boundary Road will be 2 miles 6 chains 43 feet.

Dealing with the information required by you in the order given above, we beg to report as follows:—

#### **(a) ESTIMATED COST OF CONSTRUCTION.**

We assume that you desire to know what the actual cost would be of a complete modern electric tramway covering the route mileage as given above, double and single track as specified, with special work; complete overhead construction; say, 20 cars, car depot, and converter station with equipment and necessary offices; the whole to be complete in every detail ready to commence operations.

## PERMANENT WAY CONSTRUCTION.

We have assumed that the turnout required at the intersection of Yarra Bank Road with Princes Bridge will be placed close to the footpath on the northern side of Yarra Bank Road, and started from a point so as to allow a car to stand close to the footpath well up towards the boundary at Princes Bridge. This position would not interfere with the present traffic in Yarra Bank Road, and the cars could be seen from Flinders Street, and would be in a convenient position for passengers to enter the cars without crossing to the centre of the road.

The gauge taken is the recognised standard, i.e., 4ft. 8½in., and the distance from centre to centre of the double track 10ft., with side-pole construction. This standard construction would be carried along Yarra Bank Road and Swan Street, with the exception of that portion of Swan Street between Lennox and Church Streets, where a special construction would be carried out in order to comply with the wood blocking which is now in existence in this section of Swan Street.

The present Horse Tram line in Burwood Road, Power Street, and Riversdale Road would be taken up and a new Electric Tramway Track put down in place of the present tramline, but the centre between tracks would be 10ft. in the new line as against 9ft. centres with the present tram line. This Horse Tramline was very well constructed originally, and we anticipate that a considerable quantity of ballast will be recovered when re-laying the track, and in consequence of this we have run out a special estimate for the new line to replace the Horse Tramline, and you will note that, even when taking up and stacking the old rails and sleepers, the recovery of ballast will make this section of the line a little cheaper per mile than the main line standard construction.

It will probably be necessary to acquire a portion of the vacant block of land at the corner of Wallan Road and Power Street in order to bring the double track from Wallan Road into Power Street.

The construction we would recommend for the permanent way would be what is practically called now in Australia "Standard Construction," and consists of 90 lb. girder type tram rails on the straight, and 95lb. rails for all curves. We have estimated on using rails 60ft. in length. All joints to be Thermit welded, with the exception of expansion joints, and these to be as few as possible.

The sleepers to be 7ft. 6in. long, 9in. wide, and 4½in. thick, and for the purpose of this estimate we have obtained prices for ironbark sleepers of the above dimensions, price for same being 6s. 9d. We think that ironbark sleepers are the best to select for this work, but, of course, the price is much dearer than for Tasmanian Blue Gum, etc., the difference in price being about £280 per mile of single track.

The excavation to be taken out to a depth of 17in. in all standard ballast construction. This allows 6in. of ballast under the sleepers, which is ample where good foundations are obtainable.

The excavation will be different for the special construction in the wood blocking area in Swan Street.

The ballast to be of the best 2½in. metal. We have estimated the cost of the metal at the ruling price now being paid for it in the districts to be traversed by the trams. We have also taken into consideration the necessary consolidation that would be obtained after rolling in the ballast with a 12½ ton steam roller.

Surface finish over the tracks to be the best tar macadam. The estimate covers this finish from 18in. outside each outer rail, and includes the roadway between tracks.

The single track from Bowen Street to Boundary Road will be carried along one side of the road, so that, when traffic requires it, a duplication can be made on the other side without interfering with the present line when laid down.

All necessary bonds and expansion joints, rail to rail bonds, track to track bonds.

Special work to be supplied as follows (this work is given separately in the schedule of prices):—

Turnout at Princes Bridge.

„ Bowen Street.

„ Bridge Road, Richmond.

Crossover in Swan Street, near the Melbourne Cricket Ground.

„ „ „ Lennox Street.

„ „ „ Park Grove.

„ Power Street, near Wallan Road.

„ Riversdale Road, at Auburn Road.

Double main line turnout at corner of Wallan Road and Power Street.

Altering special work at corner Glenferrie and Riversdale Roads.

One passing station for single track line to be located approximately near the intersection of Toorak and Camberwell Roads.

Special work at Car Depot.

There is little doubt in our minds but that a standing loop will be required at the Melbourne Cricket Ground entrance in order to store cars to deal with rush traffic, without interfering with the main line traffic. This siding is not included in the estimate. The turnouts are essential, also the crossover located at the Car Depot and at Power Street, together with the double main line turnout and special work for the Car Depot. The crossover at the Melbourne Cricket Ground will be found most convenient in handling traffic at this point; also the crossover on Swan Street, near Lennox Street, will be found very convenient when handling a rush traffic from the Richmond Railway Station to the City. The crossover in Swan Street, near Park Grove, is to enable cars to be run from Princes Bridge to this point only. The crossover at Auburn Road and Riversdale Road is put in in order that cars may be run from Princes Bridge to this point only.

In order to carry out the permanent way work, it is necessary to have certain alterations made to sewers, man-holes, bench marks, and to alter some of the water pipes. An estimate for this work has been prepared and submitted by the Melbourne and Metropolitan Board of Works.

A certain amount of work will have to be undertaken in connection with the gas pipes, and the Metropolitan Gas Company have submitted a price of £3000 for the work as they suggest it should be done. We have placed this whole amount on the estimate, but we do not agree that the total amount should be a charge against the Trust. Before the line is constructed the engineers for the Trust should investigate this proposed charge of £3000, as, no doubt, the amount is high.

The price of £4500 for the strengthening of Wallan Road bridge over the River Yarra is an estimate for the necessary work. We will give you an idea of the work required under the title of Engineering Difficulties.

### **OVERHEAD CONSTRUCTION.**

The Overhead Construction to consist of steel side-poles with double overhead trolley wire, the whole to be put up in conformity with the best modern practice.

We would here suggest that it might be advisable for the Trust to see if it could come to an arrangement with the Postmaster-General, the Melbourne City Council and the Melbourne Electric Supply Company to carry their wires on the Trust side-poles, charging them an annual rental for such service. The poles would need to be obtained a little longer to carry such wires, but the annual rental should pay a good return on the extra capital involved. This would do away with all the unsightly wooden poles now used to carry telephone and electric light wires along the route. The Adelaide Tramway Trust and the Prahran and Malvern Tramway Trust have adopted this practice, and the improvement in the appearance of the streets is very marked.

The trolley wire to be of the best hard-drawn copper of equivalent section to No. 3/0 B. and S. gauge; section to be of the non-fouling or channel type. Span wire to be 7/14 best galvanised steel wire. Trolley ears of approved mechanical type, hangers, ball strain insulators and section insulators to be of the very best construction; all suitable frogs, pull-offs, etc., for crossovers, turnouts and curves.

Special overhead construction for all turnouts and crossovers and all special overhead work at Car Depot.

Trolley feeders required are included and would be carried overhead and equipped with isolating switches where necessary.

Telephone Exchange at Car Depot; telephones at Princes Bridge; Melbourne Cricket Ground crossover; Richmond Railway Station crossover; Park Grove crossover; corner Wallan Road and Power Street; Bridge Road; Auburn Road crossover; Bowen Street; and at the loop on the single track and at Boundary Road.

The number of tram cars that we would recommend at the beginning would be 20, consisting of 10 small single truck cars, seating about 36 passengers, and 10 Bogie cars, seating about 56 passengers.

The 10 small cars would be similar to those used by the Prahran-Malvern Tramway Trust, and the Bogie cars would be similar to the latest design adopted by the above Trust. The Bogie car is very suitable for a crush traffic and would be extremely valuable for such a loading as would probably develop between Princes Bridge and the Melbourne Cricket Ground at certain times. The centre portion of the car being dropped, allows easy entrance to the car. The smoking portion of the Bogie car is in the centre, while in the single truck car both ends are used for smokers.

The Car Depot and Sub-station should be located somewhere near Park Grove and Swan Street. This is the proper position for the Sub-station, and would be a very convenient place indeed for the Car Depot. Of course, we are unable to say whether land could be obtained at this point, but we have assumed that such is the case in making our report. If land, however, is available at the corner of Power Street and Wallan Road this would make a good site for a Car Depot, and would not alter our estimate of cost of construction.

For estimating purposes, we have laid down a rough design of the proposed Depot, equipped with four tracks, and capable of housing, say, 10 Bogie cars and 18 single truck cars, or 28 in all.

The Car Depot would have a total area of 265ft. long x 72ft. wide, and, besides being able to house 28 cars, it would have offices as follows:—

- General Office,
- Receiving Office,
- Manager's Office,
- Board Room,
- Conductors' and Motormen's Rooms,
- Rooms for the Battery and Converting Apparatus, and
- Workshop:

Necessarily the length and width of the building will depend upon the ground available, but if the building is made wider and shorter it should not make very much difference in the total cost of the building. It would only add a little more cost to the special work on the tram tracks at the Depot entrance, but this would not materially affect the price.

We think it is wise to make the capacity of the Car Depot as large as mentioned above, as we have every reason to believe that the storage requirements will be fully occupied in the very near future.

We have obtained an estimate for a Car Depot and Sub-station of the size indicated, built in brick, with steel girders for supporting the roof; the whole to be of the very latest design; the price for such a building is given in the schedule below. However, if you decide to have the building constructed in wood and iron, it would cost about £2,800 less than the prices given for the brick building described above, but we do not think it would be wise to build it in wood and iron for the reason that insurance on the cars would be much greater, and a building of this type should be constructed in a substantial manner in the first place.

The Battery we have estimated on is just large enough to act as a floating battery on the line in conjunction with an automatic reversible Booster, which will keep the load on the supply feeders at the Sub-station steady. The Corporation supplying the power will require these measures to be taken to regulate the load.

The distances or lengths of different road ways as given in your estimate dated March 31st, 1914, do not agree with measurements that we have taken from maps or that have since been given to us. The differences are not great, so we have decided to take an average for each section, and this should make no great difference in the total estimate.

## COST OF CONSTRUCTION.

### Permanent Way Construction

4 miles, 24 chains, 34 feet double track standard construction, at £10,652 per mile . . . . .	£45,873	0	0
2 miles, 10 chains, 13 feet double track standard construction, covering section of present Horse Tramline, at £10,308 per mile . . . . .	21,930	0	0
22 chains double track wood-block construction in Swan Street, between Lennox and Church Streets, at £12,430 per mile . . . . .	3,419	0	0
2 miles, 6 chains, 43 feet single track standard construction, Camberwell and Norwood Roads, between Bowen Street and Boundary Road, at £5,326 per mile . . . . .	11,095	0	0
Altering sewers, manholes, etc., and removing bench marks and boxes, Estimate of Melbourne and Metropolitan Board of Works . . . . .	2,100	0	0
Altering water mains. Estimate of Melbourne and Metropolitan Board of Works . . . . .	4,730	0	0
Re-laying, lowering, and duplicating gas mains, etc. Estimate of Metropolitan Gas Co. . . . .	3,000	0	0
Strengthening Wallan Road bridge over River Yarra . . . . .	4,500	0	0
		£96,647	0 0

### Special Work

Three turnouts . . . . .			
Five crossovers . . . . .			
One double main line turnout . . . . .			
One two-track intersection at corner of Riversdale and Riversdale Roads			
Car Depot special work, including a turnout and all track work . . . . .	3,209	0	0
One passing station for single track . . . . .	367	0	0
		£3,576	0 0

### Overhead Construction

6 miles, 56 chains, 47 feet overhead construction complete for double track, including special overhead construction . . . . .	9,613	0	0
2 miles, 6 chains, 43 feet overhead construction for single track . . . . .	2,506	0	0
Estimated cost of alterations to P.M.G.'s wires, Melbourne C.C.'s electric light wires, and Melbourne Electric Supply Co.'s wires . . . . .	1,338	0	0
		£13,457	0 0

### Cars, Car Depot, Equipment, &c.

10 bogie cars, at £1,650 each . . . . .	£16,500	0	0
10 single truck cars, at £1,150 each . . . . .	11,500	0	0
		£28,000	0 0
Car Depot Offices . . . . .		10,570	0 0
Battery, booster, station wiring and lighting . . . . .		3,795	0 0
Interest during construction . . . . .		2,461	0 0
Engineering fees and unforeseen contingencies . . . . .		9,000	0 0
Total . . . . .		£167,506	0 0

## (b) ESTIMATED REVENUE.

The most difficult portion of a report on a Proposed Tramway Scheme is the estimating of revenue. The cost of construction can be given with accuracy, and the annual expenditure can be calculated on the car mileage basis; but in arriving at the probable income, the conditions that prevail in the locality under review have to be considered. There is no general rule for arriving at the probable returns of any Proposed Tramway, but we are of the opinion that the proper way to arrive at a fair figure is to base the estimate on the annual return per head of population that may reasonably be expected, taking into consideration local conditions.

The population, as given to you in the previous estimates, was as follows:—

Within $\frac{1}{2}$ mile of Proposed line in Camberwell . . . . .	3,371
„ $\frac{1}{4}$ „ „ Hawthorn . . . . .	7,526
„ $\frac{1}{4}$ „ „ Richmond . . . . .	15,450
„ $\frac{1}{4}$ „ „ Power St. and Burwood Road ..	2,373
	Total .. 28,720

To these figures we propose to add the extra population south of the line in Richmond and outside the  $\frac{1}{4}$  mile line allowed in the previous estimates, for the reason that this population has no means of access to the City of Melbourne except by the Proposed Line or the Railway. The population included in this area between the  $\frac{1}{4}$  mile line from the tramway and the River Yarra is 3,000, making a total of 31,720.

The estimate of population along the Proposed Line in this case is not a fair comparison when taken with other lines, for the reason that it does not give the line credit for the very large population that it taps at Princes Bridge. This will be the first through Electric Tramway Line that will come almost to the centre of the City, and we have little doubt that it will show a much higher rate or return per head of population along its route than any other electric line now in existence in or about Melbourne.

Princes Bridge is a good position for the terminus of the proposed line, as it is as near the centre of the City of Melbourne as either of the Flinders Street Railway Stations. In the future, if the cable tramway system is electrified, this line can easily be connected with the completed system and taken to such a point in the City of Melbourne as the operating authorities think fit. This connecting up in the future will add to the earning capacities of the line, but, of course, it is not taken into consideration in this report.

The present terminus at Princes Bridge will give excellent facilities for the patrons of the line to visit the various picture shows and other places of amusement at Princes Bridge, and this traffic should give good results from a revenue point of view.

We suggest that penny fares should be charged on the proposed line as given below. Certain sections taken together, as indicated, will give the through fares, while other sections overlap the ordinary penny sections and are intended to catch certain local traffic. It is essential to assume such a scale of fares, in order to arrive at the proper revenue of the proposed line.

## SUGGESTED PENNY SECTIONS.

	DISTANCE ABOUT.
First Ordinary Penny Section—	
From Princes Bridge to Richmond Railway Station . . . . .	120 chains.
From Melbourne Cricket Ground Entrance on Swan Street to intersection of Burnley and Swan Streets . . . . .	105 chains.
Second Ordinary Penny Section—	
From Richmond Railway Station to corner Wallan Road and Power Street	145 chains.
From Burnley Street to Glenferrie Road (twopence from Glenferrie Road to Melbourne C.G.) . . . . .	125 chains.
Third Ordinary Penny Section—	
From corner Wallan Road and Power Street to Auburn Road . . . . .	85 chains.
From Glenferrie Road to Burke Road . . . . .	104 chains.
Fourth Ordinary Penny Section—	
From Auburn Road to Bowen Street, Camberwell . . . . .	104 chains.
From Burke Road to Hartwell Hill Road . . . . .	85 chains.
Fifth Ordinary Penny Section—	
From Bowen Street to about the intersection of Norwood Road . . . . .	85 chains.
Sixth Ordinary Penny Section—	
From end of last section to Boundary Road . . . . .	80 chains.
Hawthorn Penny Section—	
Corner Power Street and Wallan Road to Bridge Road, Richmond . . . . .	85 chains.

These penny sections would catch a considerable amount of local traffic, and although the sections in a few cases are rather long, it is due in most instances to the Proposed Tram line traversing park lands.

The first section of the line has many attractions which must be taken into consideration in estimating the revenue to be derived from the line. The tramway, passing as it does along the northern bank of the River Yarra for a considerable distance from Princes Bridge, offers passengers an opportunity of viewing the river and the opposite bank from the very best vantage point. This may seem a very small matter, but it is one the public will appreciate.

There is a ferry at present located near the intersection of Yarra Bank Road and Swan Street, which could be improved, and which would allow passengers on this tram line easy access to the Botanical Gardens. These gardens, as is well known, are very beautiful, and there are a great number of citizens that are now deprived of the pleasure of visiting them, due to lack of tramway facilities.

The first section of the Tramway passes through Richmond Park, which is a favourite resort for all kinds of sport. The Scotch College and Friendly Society Sports Grounds are located on either side of the route.

The Melbourne Cricket Ground is situated on the north side of the railway, and made accessible to Swan Street by an overhead footbridge which spans the railway line. The distance from the Melbourne-Burwood line to the Cricket Ground is about equal to that from the Cricket Ground to the cable trams. The majority of the passengers travelling to the Cricket Ground by either tram would be picked up in the vicinity of Princes Bridge, and so in this respect the services would be equal. This Cricket Ground traffic, although what is called a "rush traffic," should be very remunerative.

The Richmond Cricket Ground is located on Punt Road, near the Railway line, and should materially add to the revenue. You will note that the section fares are arranged to meet the requirements of not only Richmond Cricket Ground but also of the Melbourne Ground.

The Richmond Railway Station is the largest suburban railway station in the metropolitan area. The number of passenger journeys to and from Richmond in 1912 was 2,810,091. With the suggested fare of one penny from Richmond to Melbourne, as against two pence single fare second class on the railway, it is evident that the electric service should obtain a very large portion of this traffic.

The City of Richmond will furnish a large portion of the traffic on the line, and you will note, under the cost of construction, that we have arranged under special work for the necessary crossovers.



One of the prettiest portions of the River Yarra is situated near the Wallan Road Bridge, over which the electric trams will run. Tea Gardens are located near the bridge, and with increased travelling facilities, this portion of the river should become very popular.

The revenue in Hawthorn and Camberwell will undoubtedly increase after the line is installed some little time, and a certain amount of local traffic will develop that is not now in evidence.

The continuation of the line from Bowen Street, Camberwell, along Camberwell Road to Boundary Road, will open up new country which it will take some time to develop.

The Adelaide Tramways, during 1912, showed a return of £2 1s. 5d. as the average traffic revenue per head of population served. This figure is very high, but they have no competition with other tramways, and practically no railway competition.

The Prahran and Malvern Tramways Report for 1912 shows, when worked out, that the average total revenue per head of population served per annum is about 15s. 11d. The 1913 Report of the same Trust shows that the return is about 17s. 10 2-5d.

The first year's operation of the Fremantle Tramways showed about 16s. 6d. as the average total revenue per head of population per annum.

We have taken the population of the area to be served at 31,720, being those who reside on the route within the distances given previously. After mature consideration, and taking into account those who are not in the tramway area, and yet will use the line, for reasons given before, we think that a reasonable deduction can be made that the return per head of population in the area under review should be given as 19s. 6d. This gives a return as follows:—31,720 at 19s. 6d.; making a gross annual return of £30,927.

### (c) EXPENDITURE.

We would recommend that a supply of electric energy be obtained from either the Melbourne City Council or the Melbourne Electric Supply Co. It is a matter which affects the cost of operation, and we have assumed, for the purpose of the estimate, that the supply of power will be obtained from either of the above-mentioned supply authorities. They will require the Trust to instal a battery, booster and switchboard, and the cost of this apparatus has been placed in the estimate. We have taken an assumed figure for the cost per unit supplied at the D.C. Switchboard, but will not publish this figure in the report.

The character of the route leads us to believe that the current consumption per car mile will not be as high as on certain Metropolitan electric lines. From Princes Bridge to Punt Road there is an almost level track without any stops for passengers except on special occasions, and the consequence is that a high average speed per car mile will be obtained with low power consumption. There is a clear run from Park Grove, Richmond, to Power Street, Hawthorn, which will mean a saving in current consumption per car mile. From Bowen Street, Camberwell, to Boundary Road, the current consumption will not be exceedingly high, although there are some heavy grades in this section. Assuming that bogie cars are not run on the last two miles from Bowen Street to Boundary Road at the start, and taking the above conditions into account, we do not think the current consumption should exceed 1.7 units per car mile.

When deciding upon the car mileage per annum, we came to the conclusion that early morning trams must be provided; the service to be augmented so that at least three trams arrive at the Melbourne terminus between 7 and 7.30 a.m., and from then on a gradually increasing service to 7½ minutes, and, if traffic warrants it, an intermediate service between Park Grove, Richmond, and Melbourne. The service to be reduced as traffic falls off in the morning. A special service to be given at midday, and from 4.45 p.m. to 8.15 p.m. The evening service to be 7½ min. or 10 min. service, depending on requirements.

The service from Auburn Road along Riversdale Road, Power Street, and Burwood Road to Bridge Road to be a 10 minute service.

The service from Bowen Street, Camberwell, to Boundary Road to be a 20 minute and 30 minute service.

By running out a time-table on these lines we have come to the figure of 590,000 car miles per annum. The service on the section of the line from Power Street and Wallan Road to Auburn Road will have trams running on a five minute headway during the greater part of the day.

With the gross annual income of £30,927, and taking the car mileage as 590,000, this gives the return per car mile at 12.58 pence, against the Prahran and Malvern return in 1913 of 14.422d. per car mile. The Adelaide Tramway Trust's return per car mile in 1912 was 14.275d.

We estimate that the working expenses of the system will be 9.5d. per car mile; therefore the annual working cost on 590,000 car miles will be £23,355. This working cost of £23,355 is equivalent to 75.51 of the gross receipts estimated, i.e., £30,927. Prahran and Malvern's working expenses for 1912 were 63.584 per cent. of the total revenue, and the working expenses for 1913 were 66.309 per cent. of the total revenue. The Adelaide Tramway Trust's working expenses for 1912 were 64.873 per cent. of the total revenue. We can only account for the high working cost as against the total revenue for this line inasmuch as the population per mile of the proposed tram line is now low, and with facilities for travelling this low population will increase and bring the proportion down on the line.

The annual interest on the total capital expenditure of £167,506, at 4½ per cent., would be £7538.

We are of the opinion that a Renewal's Reserve Fund on the following expenditure should be provided:—

Permanent Way . . . . .	£82,317	0	0
Special Work . . . . .	3,576	0	0
Overhead Construction . . . . .	12,119	0	0
Cars . . . . .	28,000	0	0
Car Depot and Offices . . . . .	10,570	0	0
Battery, Automatic Booster and Switchboard . . . . .	3,795	0	0
	<u>£140,377</u>	<u>0</u>	<u>0</u>

If two per cent. (2%) per annum is charged on this sum of £140,377 for the Renewals Reserve Fund, it would amount to £2,808. The financial aspect of the proposed line would then be as follows:—

Revenue per annum . . . . .	£30,927	0	0
Working expenses per annum, including maintenance, power cost, and management, 590,000 car miles, at 9.5d. . . . .	£23,355	0	0
Interest on £167,506, at 4½% . . . . .	7,538	0	0
Renewals Reserve Fund, 2% on £140,377 . . . . .	2,808	0	0
	<u>33,701</u>	<u>0</u>	<u>0</u>
	<u>£2,774</u>	<u>0</u>	<u>0</u>

This leaves a deficiency of £2,774, but we think that the cost of the line and special work that has to be undertaken in the first instance may account for some of the apparent loss, but with the district to be traversed there is little doubt that at an early date the loss will disappear, and a profit be shown, providing the line is built as specified and properly operated to meet the public requirements.

The above-mentioned deficiency of £2,774 divided between the Municipalities on the estimated car mileage basis as run in each Municipality would work out as follows:—

Melbourne City Council . . . . .	£474	16	6
Richmond " " . . . . .	709	18	6
Hawthorn " " . . . . .	1,166	2	0
Camberwell " " . . . . .	423	3	0
	<u>£2,774</u>	<u>0</u>	<u>0</u>

The time of completion of the tramway from the time of actual authorisation of the Trust's Engineers to proceed with the designing has not been given previously in the report, but we should judge that the total time required for the designing, letting of Contracts and completion of construction should not occupy more than twelve months.

#### **(d) ENGINEERING DIFFICULTIES.**

We have examined the route of the proposed tramway very carefully from end to end, and have included a price in our estimate to cover the cost of any work that will be necessary in order to overcome any obstacles in the way of construction.

The terminus at Princes Bridge presents no difficulties. We would recommend that the terminus be made close to the footpath on the north side of Yarra Bank Road, and as close to Princes Bridge as possible.

The altering of Sewers, Manholes, etc., and removing of bench marks and boxes, as well as altering water mains along the route, will have to be entrusted to the Metropolitan Board of Works. The Engineers to the Board have submitted an estimate of the cost of this work. We would recommend that this work be one of the first authorised by the Trust, so that these alterations will not delay construction.

The necessary alterations to gas pipes is a matter that the Trust Engineers in the future will have to go into. The price (£3,000) given by the Metropolitan Gas Co. for altering and duplicating mains and re-connecting service pipes would appear to be very high. We have included this whole amount in the estimate of Permanent Way construction, because we were not in a position to go into this matter with the Gas Co.

The overhead railway bridge crossing Swan Street at Richmond has had our attention. The present head room between the street level and under side of bridge is 12ft. 3in., and we desire 13ft. 6in. head room. By obtaining the above head room, a clearance will be obtained sufficient to allow the largest Electric Tram now in service about Melbourne to pass beneath this bridge. To obtain the additional 1ft. 3in. in height, we propose that the roadway underneath the bridge be lowered to this extent. As far as we could ascertain there are no engineering difficulties in the way of lowering the road as desired.

The roadway in Swan Street East passes over the railway, and presents no difficulties in the way of tramway construction.

The Wallan Road bridge over the River Yarra presents certain engineering difficulties. We had a very great amount of trouble in collecting information about this bridge, which was erected in 1882. The builders of the bridge were unable to give us any information. We therefore had to make a careful examination of the bridge, and engaged an expert to assist us. The bridge is 19ft. 6in. wide, not including the footpath on the north side, which is 4ft. wide. We propose to carry the two lines of trams over the bridge, with 10ft. centres, as per standard construction for the track work. The outside measurement that would be required for the tramway is 18ft. 9½in. We prefer to carry both lines across the bridge, as it keeps all vehicular traffic on its proper side of the road. This treatment of a narrow bridge when traversed by a double tram line has been found in actual practice the most satisfactory solution.

We would only allow one tramcar on the bridge at a time, and to this end would make it compulsory for all trams to stop on either side of the bridge, allowing the down cars to pass over the bridge first, providing two cars coming in opposite directions met at the bridge. A curious fact is, that during the running out of the time table for the line, no two cars pass on the bridge.

We have assumed, however, for the purpose of this estimate, that two cars may be on the bridge at the same time by some unforeseen circumstance, and we have accordingly planned the strengthening of the bridge to stand two Bogie Cars overloaded, plus foot and vehicular traffic.

The bridge consists of five spans, supported by two brick shore piers, and four pair of built-up steel columns, evidently filled up with concrete. The supporting girders consist of two 43in. girders in each span. We propose to put in an extra

built-up steel pier to each pair of steel piers now in, and to run a new main girder from shore to shore under the main cross girders. A footpath 5ft. would be added to the bridge on the south side. The present hand rails would be increased in height. The road approaches to the Wallan Road bridge on either side should be so increased as to give ample room for vehicular traffic approaching the bridge, and we would suggest that the spoil from the trenches should be deposited to so widen the roadway as to meet the above requirements. The proximity of a convenient tip for spoil as mentioned above should balance the extra cost of metaling the increased width of roadway. With these improvements the bridge should meet all requirements of tram and vehicular traffic for many years.

It may be necessary to obtain a portion of the vacant corner block of land at the intersection of Wallan Road and Power Street in order to make an easy curve for the double track around the above-mentioned corner.

The tramway crossing at Glenferrie Road and Riversdale Road will have to be taken up and relaid with 10ft. centres on Riversdale Road. The present crossing will do when relaid as specified.

The trees along Camberwell Road are spaced to a minimum of 33ft. between opposite trees. The tramcars where double track is laid in the street must have a clear 18ft. 9½in., and this would leave 7ft. 1¼in. between a passing tram and a tree. A motor-car requires about 6ft. clearance, which would leave only about 6½in. on either side of a motor-car that attempted to pass between a tramcar and tree. Under these circumstances it appears that the trees would be a source of danger to vehicular traffic.

In conclusion, we desire to state that we think the construction of the Tramway is justified. We have estimated on the most approved construction and equipment, and the cost of the completed line is based on the cost of similar Tramways that have been recently constructed, so our estimate should be absolutely correct for the work specified. The maintenance of the entire roadway from 18in. outside each outer rail, including the centre portion between tracks, will be a charge on the Tramway. This will mean a large reduction on the road maintenance in the streets the Tramway traverses. We would advocate a system of lighting the tram tracks similar to that adopted on some of the latest constructed lines, and this system does not entail extra capital expenditure to the Trust, but would make a decided saving on the street lighting accounts of the Cities and Municipalities traversed.

The estimate of Revenue and Expenditure is conservative, and shows that during the first year of operation a loss of £2,774 will be incurred, providing the Tramway is charged up with the Renewals Reserve Fund of £2,808. We are, however, of the opinion that in the very near future the traffic returns will exceed our estimate to such an extent that a profit will be shown on the undertaking.

In closing, we beg to thank the Officers of the Councils interested, and particularly the Honorary Secretary to the Conference (Mr. C. C. Blazey, Town Clerk of Richmond), for the valuable information placed before us.

We have the honor to be;

Gentlemen,

Your obedient servants,

McCARTY, UNDERWOOD and CO.

The Chairman and Members of the Conference for Proposed Melbourne to Burwood Electric Tramway, and Electrification of Hawthorn Horse Tramway.

## APPENDIX A.

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31 QUEEN STREET,  
MELBOURNE,

16TH MAY, 1914.

GENTLEMEN,

### THE STORAGE BATTERY CAR.

We did not mention in the main portion of our report our opinion of the Storage Battery Car, when applied to traction, under the conditions that will prevail on the Melbourne to Burwood line.

The main line from Princes' Bridge to Burwood should be operated as a through line, but certain cars, as explained in the report, would run from Princes' Bridge to sections of heavy loading, and return to the starting point. Other cars would make the through trip to Burwood. No section of the Tramway should be operated separately from any other section.

The schedule speed of the proposed line is 10 miles per hour, and in parts the gradients are heavy, while stops will be frequent in busy portions of the line. Under these circumstances we do not feel that we could recommend Storage Battery Cars for operation on this line, as Storage Battery Cars are not run on a high schedule speed or on long heavy gradients. Quick acceleration, as would be required on this line, takes too much current out of the battery, which necessitates frequent boosting. The cost of operation, as given by independent engineers, and taking into consideration the cost of current in this case, would make the operating cost of Storage Battery Cars higher than the ordinary trams which we have recommended.

We could not recommend Storage Battery Cars operation on the Melbourne section of the line as this would mean the transferring of passengers at the end of the section. The voltage of the main Tram line would be about 600 volts, while the Storage Battery Cars run up to about 276 volts. The Storage Battery Cars could not run in between the ordinary Tram Cars as they could not keep up to the service.

The field for Storage Battery Cars is more or less restricted, but there is a certain class of service for which such requirements are superior to other types of self-propelled cars, but in this case the conditions are against their selection.

We have the honor to be,

Gentlemen,

Your obedient Servants,

MCCARTY, UNDERWOOD & CO.

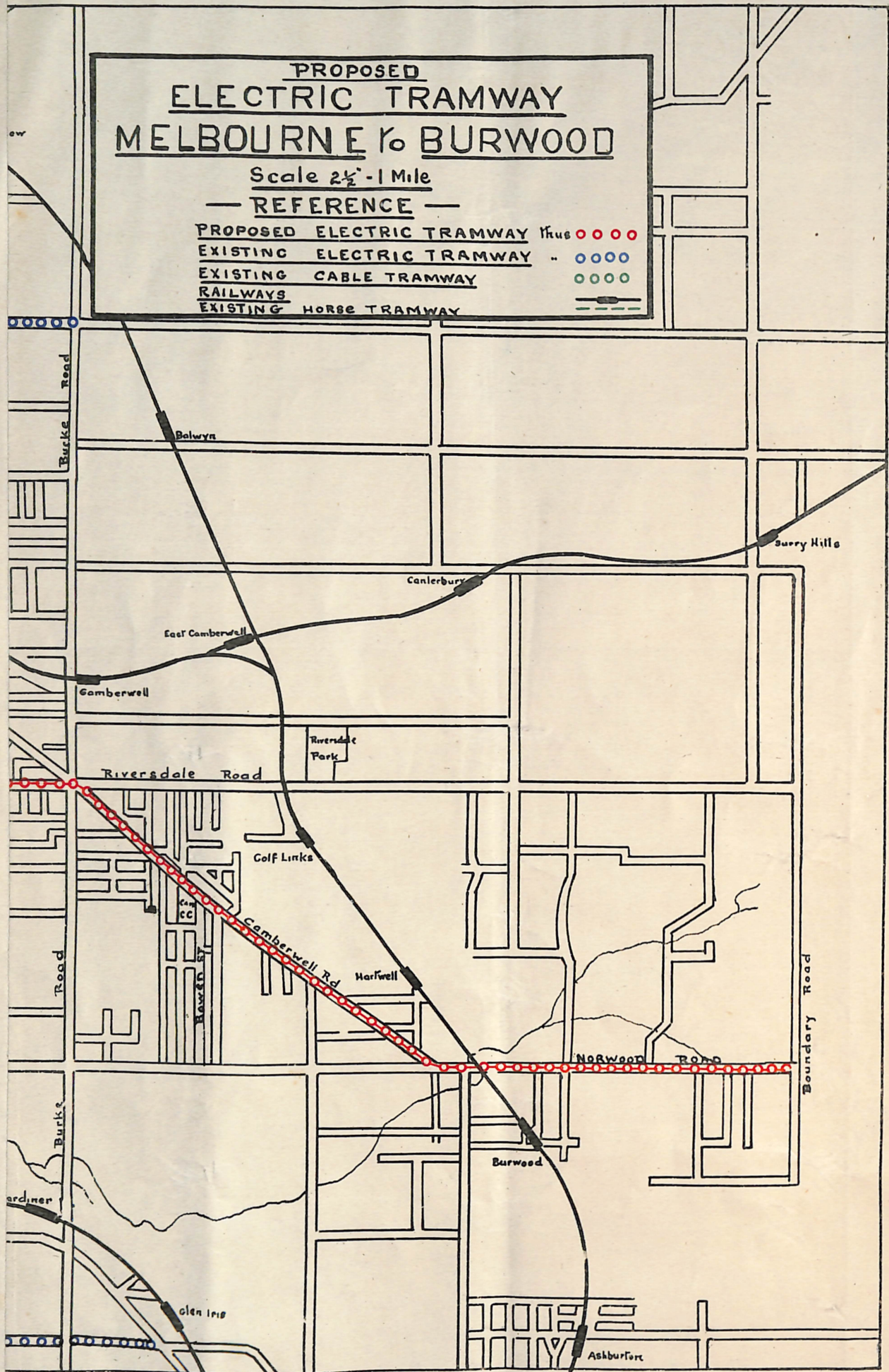
The Chairman and Members of the Conference on Proposed Melbourne to Burwood Electric Tramway and Electrification of Hawthorn Horse Tramway.

# PROPOSED ELECTRIC TRAMWAY MELBOURNE TO BURWOOD

Scale  $2\frac{1}{2}$ " = 1 Mile

## — REFERENCE —

- |                           |      |         |
|---------------------------|------|---------|
| PROPOSED ELECTRIC TRAMWAY | Thru | ● ● ● ● |
| EXISTING ELECTRIC TRAMWAY |      | ○ ○ ○ ○ |
| EXISTING CABLE TRAMWAY    |      | ● ● ● ● |
| RAILWAYS                  |      | — — — — |
| EXISTING HORSE TRAMWAY    |      | — — — — |



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