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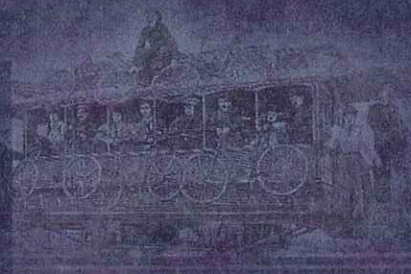

29th STREET and Southwest CORRIDORS

Vintage Rail Trolley Study

SRF
Consulting Group, Inc.

VINTAGE RAIL TROLLEY STUDY

29TH STREET AND SOUTHWEST CORRIDORS

HENNEPIN COUNTY & METROPOLITAN COUNCIL

September 2000

Prepared by:

SRF CONSULTING GROUP, INC.

Study questions may be addressed to:

Katie Walker
Hennepin County
417 North 5th Street
Minneapolis, MN 55401
Tel: (612) 348-2190
Fax: (612) 348-9710
E-mail: katie.walker@co.hennepin.mn.us

A Note to the Reader

This vintage rail trolley study should be read as an addendum to the *29th Street and Southwest Corridors Busway Feasibility Study*. As such, the analysis contained in this study document is based upon and constrained by the assumptions contained in the previous study.

Acknowledgements

A Study Management Team composed of representatives from Hennepin County, Metro Transit, the Metropolitan Council, the cities of Hopkins, St. Louis Park, and Minneapolis, and the Midtown Greenway Coalition guided this study and provided technical support. Participation on the Study Management Team does not necessarily equate to endorsement of the study assumptions and findings.

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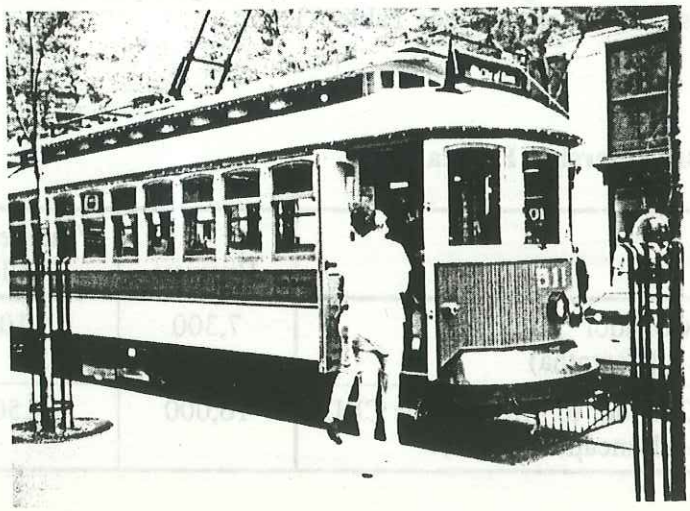
EXECUTIVE SUMMARY

The *29th Street and Southwest Corridors Busway Feasibility Study* was completed in February 2000. The study objective was to determine the feasibility, defined in terms of ridership forecasts and costs, of constructing and operating a busway and to determine if a busway is a practical first step toward future light-rail transit (LRT). This vintage rail trolley study was initiated by Hennepin County and the Metropolitan Council in April 2000 at the request of the Midtown Greenway Coalition. This study is intended to determine the feasibility, defined in terms of ridership forecasts and costs, of constructing and operating a vintage rail trolley and to determine whether a vintage rail trolley is a practical step toward future LRT. This study is intended to be an addendum to the *29th Street and Southwest Corridors Busway Feasibility Study.* For more detailed information regarding a busway the *29th Street and Southwest Corridors Busway Feasibility Study* should be referenced.

VINTAGE RAIL TROLLEY

Vintage rail trolley systems currently operate in a number of U.S. cities including Portland, Dallas, New Orleans, Seattle, and Memphis. Vintage rail trolley systems are generally two to four miles in length, use either refurbished PCC-type cars or newly-constructed replica trolley cars, and operate on rails with an overhead power system similar to that used to operate light rail vehicles. Figure 1 depicts a vintage rail trolley vehicle operating in Portland, Oregon.

FIGURE 1
Vintage Rail Trolley in Portland, Oregon



Study Assumptions

For purposes of this study, vintage rail trolley service is assumed to be a state-of-the-art system operating on dual tracks with service levels and infrastructure equivalent to a busway or LRT (i.e., transit stations, park-and-ride lots, fare collections systems and trackwork). The assumed purpose of the vintage rail trolley is transportation, not tourism. (See Appendix A for a summary of vintage rail trolley characteristics.)

The following two alignments were analyzed in this study:

1. *29th Street Alignment* defined as West Lake Street to Hiawatha Avenue.

2. *Southwest to Minneapolis CBD Alignment* defined as 5th Avenue in Hopkins to downtown Minneapolis via either an exclusive right-of-way or a surface street.

Study Findings

Based solely on ridership forecasts and cost estimates, a vintage rail trolley in the 29th Street and Southwest Corridors is considered technically feasible. Furthermore, based on capital costs, constructing a vintage rail trolley will not preclude conversion to LRT in the future.

2020 Ridership Forecasts

By 2020, a vintage rail trolley system is expected to carry 6,100 passengers per day along the 29th Street alignment and 14,500 passengers per day along the Southwest to Minneapolis CBD alignment (see Table A).

TABLE A
2020 Transit Ridership Forecasts

Alignment	Busway	Vintage Rail Trolley	LRT
29th Street Corridor (West Lake – Hiawatha)	7,300	6,100	7,700
Southwest Corridor to Minneapolis CBD (Hopkins – Minneapolis CBD)	16,000	14,500	16,500

Cost Estimates

For the 29th Street alignment, a vintage rail trolley is expected to cost $84 million to construct and $2.2 million annually to operate and maintain. For the Southwest to Minneapolis CBD alignment, a vintage rail trolley is expected to cost between $144 and $194 million to construct and $11.2 million annually to operate and maintain. The vintage rail trolley construction and operations/maintenance (O&M) cost estimates in 2005 dollars are presented in Tables B and C below.

TABLE B
Capital Costs (2005 Dollars)

Alignment	Busway	Vintage Rail Trolley	LRT
29th Street Corridor (West Lake – Hiawatha)	$59M	$84M	$122M
Southwest Corridor to Minneapolis CBD (Hopkins – Minneapolis CBD)	$84-95M	$144M - $194M	$244-$289M

TABLE C
Annual Operating and Maintenance Costs (2005 Dollars)

Alignment	Busway	Vintage Rail Trolley	LRT
29th Street Corridor (West Lake – Hiawatha)	$2.0M	$2.2M	$2.3M
Southwest Corridor to Minneapolis CBD (Hopkins – Minneapolis CBD)	$9.1M	$11.2M	$8.4M

Issues Identification

A number of issues relating to vintage rail trolley service arose during the study process. These include intermodal connectivity (between trolley cars, LRT, and/or exclusive busway vehicles), compatibility with other transportation modes (freight rail, pedestrian and bicycle), physical design (transit stations, transitway treatments, retaining walls, bridge work, and landscaping), and potential social, economic and environmental impacts. Although outside the scope of this study, these issues will be explored in greater detail if future planning for vintage rail trolley is initiated in either the 29th Street or Southwest Corridors.

I. INTRODUCTION

STUDY PURPOSE AND BACKGROUND

The *29th Street and Southwest Corridors Busway Feasibility Study* was completed in February 2000. The study objective was to determine the feasibility, defined in terms of ridership forecasts and costs, of constructing and operating a busway and to determine if a busway is a practical first step toward future light-rail transit (LRT). This study was initiated by Hennepin County and the Metropolitan Council in April 2000 in response to a request by the Midtown Greenway Coalition. This study is intended to determine the feasibility, defined in terms of ridership forecasts and costs, of constructing and operating a vintage rail trolley and to determine whether a vintage rail trolley is a practical step toward future LRT. This study is intended to be an addendum to the *29th Street and Southwest Corridors Busway Feasibility Study.* For more detailed information regarding a busway the *29th Street and Southwest Corridors Busway Feasibility Study* should be referenced.

CORRIDOR HISTORY

The Hennepin County Regional Railroad Authority (HCRRA) was established in 1980, in part to purchase and preserve railroad rights-of-way for future transit use. In 1988, a Stage I LRT Plan was completed by the HCRRA and the 29th Street and Southwest Corridors were identified as a potential LRT alignment. In the early 1990s, the HCRRA purchased the 29th Street Corridor right-of-way from West Lake Street to Hiawatha Avenue to preserve it for future LRT. At the same time, the HCRRA purchased the northern half of the Southwest Corridor. Canadian Pacific Rail retained ownership of the southern half of the right-of-way and continues to operate freight rail service through Hopkins and St. Louis Park.

Throughout the 1980s, the HCRRA continued to plan for LRT in Hennepin County. However, as LRT seemed less imminent the HCRRA decided to use some of their rights-of-way for bicycle/pedestrian trails on an interim basis. A Land Use Management Plan adopted by the HCRRA in 1995 specified that permits may be granted to public agencies for park or trail use on HCRRA property on an interim use basis until the corridors were needed for LRT or other transit purposes.

In 1999, Suburban Hennepin Parks constructed the Southwest LRT bicycle and pedestrian trail within the HCRRA's right-of-way from 11th Avenue in Hopkins to Beltline Boulevard in St. Louis Park. Negotiations are currently underway to continue this trail east to Minneapolis. In August 2000, the 29th Street Greenway bicycle and pedestrian trail from Chowen to 5th Avenues opened to public use. Subsequent phases of the 29th Street Greenway trail project will provide a connection to the Mississippi River. The vision for the 29th Street and Southwest Corridors is to create user-friendly, multi-modal facilities that serve the needs of transit riders, pedestrians, and bicyclists.

ASSUMPTIONS

The assumptions concerning a vintage rail trolley system are based upon those used for busway and LRT in the *29th Street and Southwest Corridors Busway Feasibility Study* and information provided by the Lomarado Consulting Group. The basic assumption guiding this study is that a vintage rail trolley or a busway would be built and operated as a state-of-the-art system and, as such, would have service levels and infrastructure either equivalent to or easily convertible to LRT.

The vintage rail trolley elements assumed to be equivalent to LRT include all trackwork, the communications system, bridge and trail modifications, utilities, park-and-ride lots, traffic equipment signals, and the fare collection system (i.e., proof-of-payment). The vintage rail trolley elements that are assumed to differ from LRT include the length of the station platforms (vintage rail trolley platforms are shorter due to the shorter length of the vehicles) and the track electrification system (vintage rail trolley vehicles require a less powerful track electrification system than do light rail vehicles). Table 1 summarizes the assumptions for busway, vintage rail trolley, and LRT contained in this study and the *29th Street and Southwest Busway Feasbility Study.*

ALIGNMENT ALTERNATIVES

Due to the limited scope and timeframe for this study, only two alignment alternatives were considered. In addition to the two alignments described below, the *29th Street and Southwest Busway Feasibility Study* included a Southwest to 29th Street alignment which was defined as beginning at 5th Avenue in Hopkins and terminating at Hiawatha Avenue in Minneapolis. Figure 2 depicts the two alignments alternatives as described below:

The ***29th Street Alignment*** defined as extending from West Lake Street to Hiawatha Avenue.

The ***Southwest to Minneapolis CBD Alignment*** defined as extending from 5th Avenue in Hopkins to the Minneapolis CBD via either an exclusive right-of-way or a surface street.

TABLE 1
Study Assumptions

OPERATIONS	BUSWAY	VINTAGE RAIL TROLLEY	LRT
Service Hours			
29th Street Corridor	6 a.m. to 10 p.m.	6 a.m. to 10 p.m.	6 a.m. to 10 p.m.
Southwest Corridor	4 a.m. to 1 a.m.	4 a.m. to 1 a.m.	4 a.m. to 1 a.m.
Frequency			
29th Street Corridor	10-minute peak 15-minute off-peak	10-minute peak 15-minute off-peak	10-minute peak 15-minute off-peak
Southwest Corridor	10-minute peak 15-minute off-peak	10-minute peak 15-minute off-peak	10-minute peak 15-minute off-peak
Vehicle Capacity			
29th Street	80	65	120
Southwest Corridor	80	60	120
Operations and Maintenance (cost per vehicle mile)	$7.62 + $100,000 per year for roadway maintenance	$9.00	$10.28
Minimum Right-of-Way Required	28 feet	30 feet	30 feet
CAPITAL COSTS			
Guideway	NA (roadway costs at 1,447,0o0 per mile)	$936,000 per mile	$936,000 per mile
Utilities	$104,000 per mile	$104,000 per mile	$104,000 per mile
Stations	$1,458,000 per station	$1,358,000 per station	$1,458,000 per station
Park-and-Ride Lot	$1,152,000 per lot	$1,152,000 per lot	$1,152,000 per lot
Track Work	NA	$1,903,000 per mile	$1,903,000 per mile
Signal Equipment and Gates	$160,000 each	$160,000 each	$160,000 each
LRT Signals	NA	NA	$1,877,000 per mile
Traction Electrification	NA	$1,000,000 per mile	$1,472,000 per mile
Communications	$730,000 per mile	$730,000 per mile	$730,000 per mile
Fare Collection	$251,000 each	$251,000 each	$251,000 each
Agency/Engineering Insurance	25 percent of construction cost	25 percent of construction cost	25 percent of construction cost
Right-of-Way	$5,000,000	$5,000,000	$5,000,000
Vehicles	$548,000 each	$700,000 each	$3,600,000 each
Yards-and-Shops	$220,000 per vehicle	$429,000 per vehicle	$1,000,000 per vehicle

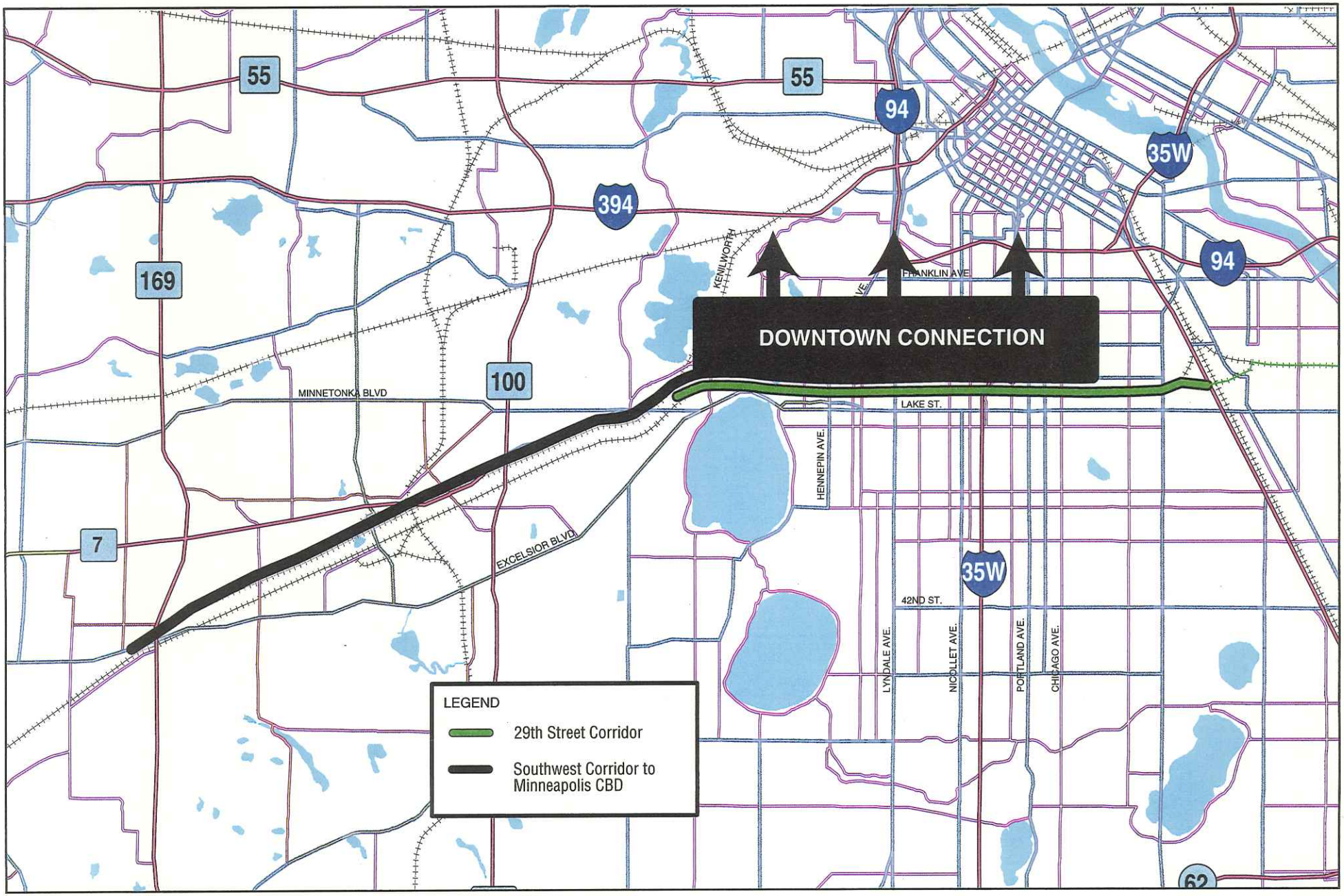


FIGURE 2

ALIGNMENT ALTERNATIVES

29th Street and Southwest Corridors Vintage Rail Trolley Study

II. RIDERSHIP FORECASTS

Ridership forecasts were developed for the *29th Street and Southwest Corridors Busway Feasibility Study* using the Metropolitan Council's regional travel forecasting model. The same forecast methodology was used to develop the vintage rail trolley ridership estimates for year 2020.

TRANSIT SERVICE ASSUMPTIONS

The following transportation assumptions were made for purposes of forecasting vintage rail trolley ridership.

Feeder Routes – Feeder bus routes were assumed to consist of existing north-south bus routes that cross the 29th Street Corridor. In the Southwest Corridor, feeder bus routes were assumed to be existing bus routes reconfigured to connect with the proposed transit stations.

Lake Street Service – Lake Street is currently served by Metro Transit Route 21. It was assumed in the model that this service would remain in place, but that service frequency would drop from its current frequency of 7-1/2 minutes to 10 minutes.

Park-and-Ride Lots – Three new park-and-ride lots were assumed to be located just east of 5th Avenue in Hopkins, at Louisiana Avenue and at Beltline Boulevard.

Hiawatha LRT Connection – Although connections were assumed possible from vintage rail trolley to the Hiawatha LRT for both alignments studied, a "transfer penalty" was assumed for purposes of forecasting ridership. Input received from Metro Transit indicated that vintage rail trolley could not directly access either the Hiawatha – Lake Street Station (29th Street Corridor alignment), nor the 5th Street tracks in downtown Minneapolis (Southwest Corridor to Minneapolis CBD alignment). The additional time necessary for persons riding vintage rail trolley service to transfer to Hiawatha LRT service is reflected in the ridership forecasts as presented in Table 2.

Hours of Service – Service on the 29th Street corridor would begin at 6:00 a.m. and conclude at 10:00 p.m. Service for the Southwest Corridor to Minneapolis CBD was assumed to begin at 4:00 a.m. and end at 1:00 a.m.

Service Frequencies – Identical service frequencies were assumed for both alignments studied, 10-minute peak and 15-minute off-peak. These frequencies were assumed for the purpose of forecasting ridership. Operational frequencies may be different and are established by actual passenger demand.

FORECASTING RESULTS

According to the year 2020 ridership forecasts, a vintage rail trolley is expected to carry 6,100 passengers per day and 14,500 passengers per day along the 29th Street and Southwest to Minneapolis CBD alignments, respectively. Table 2 presents the ridership forecasting results.

TABLE 2
2020 Transit Ridership Forecasts

Alignment	Busway	Vintage Rail Trolley	LRT
29th Street Corridor (West Lake – Hiawatha)	7,300	6,100	7,700
Southwest Corridor to Minneapolis CBD (Hopkins – Minneapolis CBD)	16,000	14,500	16,500

Net new transit riders, defined as someone who did not previously use transit and not as someone diverted from another transit more mode or route, are summarized in Table 3. According to this calculation, a vintage rail trolley will attract 610 new passengers per day while operating along the 29th Street alignment and 3,600 new passengers per day while operating along the Southwest to Minneapolis CBD alignment.

TABLE 3
Net New Transit Riders (2020)

Alignment	Busway	Vintage Rail Trolley	LRT
29th Street Corridor (West Lake – Hiawatha)	730	610	770
Southwest Corridor to Minneapolis CBD (Hopkins – Minneapolis CBD)	4,000	3,600	4,500

III. COST ANALYSIS

Capital and operating/maintenance cost estimates were completed for the two alternative alignments. The cost estimates are based upon those used for the *29th Street and Southwest Busway Feasibility Study* and information provided by the Lomarado Consulting Group. Identical capital costs for vintage rail trolley and LRT were assumed for the guideway, trackwork, communications' system, bridge and trail modifications, utilities work, park-and-ride lots, traffic equipment signals, and fare collection system. Capital cost differences were limited to track electrification and stations. For a detailed discussion of the cost assumptions for LRT or busway, the *29th Street and Southwest Busway Feasibility Study* should be referenced.

FLEET REQUIREMENTS

Fleet requirements were estimated by using vehicle capacity, projected ridership demand and "headway", defined as the frequency of vehicles operated in an hour. Estimations of fleet requirements are presented in Table 4.

TABLE 4
Fleet Requirements (includes assumption of 15 percent spares)

Alignment	Busway	Vintage Rail Trolley	LRT
29th Street Corridor (West Lake – Hiawatha)	5	7	4
Southwest Corridor to Minneapolis CBD (Hopkins to Minneapolis CBD)	28	32	18

For the purposes of this study, a vehicle capacity of 60 passengers and 65 passengers was assumed for service along the 29th Street and Southwest to Minneapolis CBD alignments, respectively. This slight difference in passenger capacity was intended to account for the different type of transit market being served. For the 29th Street Corridor, trips would typically be for shorter distances with more passenger off- and on-loading while, for the Southwest Corridor to Minneapolis CBD, trips would typically be "express" to downtown Minneapolis.

Vintage rail trolley service in the 29th Street Corridor requires six vehicles to operate during the peak hour, thereby maintaining the established, 10-minute policy frequency. Vintage rail trolley service in the Southwest Corridor to Minneapolis CBD requires 28 vehicles and approximately two minute frequencies to accommodate projected peak passenger demand.

Capital Costs

Capital cost estimates, which include construction, vehicles, stations, bridges and retaining walls are presented in Table 5. A range of costs is presented for the Southwest Corridor to Minneapolis CBD. This range reflects the potential alignments for a downtown connection, via either exclusive right-of-way or surface street. Unit cost assumptions are included in Table 1 and detailed cost estimates are included in Appendix C.

Vintage rail trolley capital costs differed from the LRT capital costs used in the *29th Street and Southwest Corridors Busway Feasibility Study* in the size of the station platform, the power system, the signalization system, and the vehicles.

TABLE 5
Capital Costs (2005 Dollars)

Alignment	Busway	Vintage Rail Trolley	LRT
29th Street Corridor (West Lake – Hiawatha)	$59M	$84M	$122M
Southwest Corridor to Minneapolis CBD (Hopkins – Minneapolis CBD)	$84-95M	$144M - $194M	$244-$289M

Annual Operating and Maintenance Costs

Annual operating and maintenance (O&M) costs for busway, vintage rail trolley, and LRT are presented in Table 6. These estimates include costs for administration, labor, route miles traveled and energy. For the purposes of this study, it was assumed that vintage rail trolley service O&M costs would average $9.00 per vehicle mile in 2005 dollars. It was also assumed that vintage rail trolley vehicles were not capable of being "trained" or linked together.

TABLE 6
Annual Operating and Maintenance Costs (2005 Dollars)

Alignment	**Busway**	**Vintage Rail Trolley**	LRT
29th Street Corridor (West Lake – Hiawatha)	$2.0M	$2.2M	$2.3M
Southwest Corridor to Minneapolis CBD (Hopkins – Minneapolis CBD)	$9.1M	$11.2M	$8.4M

COST-EFFECTIVENESS MEASURES

Two measures of cost-effectiveness, passengers-per-revenue hour and cost per new passenger, were calculated and are presented in Tables 7 and 8. Although the Metropolitan Council did not establish a performance threshold for vintage rail trolley in its' 1996 *Transit Redesign*, the performance thresholds for large bus service (15 passengers per revenue hour) and LRT (50 passengers per revenue hour) would be surpassed by a vintage rail trolley.

Cost per new passenger is the measure of cost-effectiveness used by the United States Department of Transportation to rank proposed new transit projects. This cost is arrived at as a calculation of the annual number of new transit riders attracted to a proposed service divided by annualized capital costs.

TABLE 7
Passengers-Per-Revenue Hour

Alignment	Busway	Vintage Rail Trolley	LRT
29th Street Corridor (West Lake – Hiawatha)	99	74	105
Southwest Corridor to Minneapolis CBD (Hopkins – Minneapolis CBD)	64	63	162

TABLE 8
Cost Per New Passenger

Alignment	Busway	Vintage Rail Trolley	LRT
29th Street Corridor (West Lake – Hiawatha)	$29	$40	$44
Southwest Corridor to Minneapolis CBD (Hopkins – Minneapolis CBD)	$15	$21	$23

CONVERSION TO LRT

The conversion cost from vintage rail trolley service to LRT service was estimated to determine if constructing a vintage rail trolley system precludes future conversion to LRT. Conversion costs were estimated using the Southwest to Minneapolis CBD alignment alternative.

It was assumed that capital elements such as stations, the fare-collection system, bridge work, retaining wall construction, and trackwork constructed for vintage rail trolley would remain for LRT. The service conversion was assumed to require an upgraded power system, an LRT signalization system, new light rail vehicles, construction of LRT maintenance facilities (yards and shops), and extending station platforms from 180 to 300 feet.

The incremental cost to convert vintage rail trolley to LRT is approximately 17 percent greater than the cost of constructing LRT with no initial provision of vintage rail trolley service. These costs are presented in Table 9.

TABLE 9
Trolley Conversion to LRT (Southwest Corridor to Minneapolis CBD)

Cost Element	Cost (2005 dollars)
New Power System (8.19 miles)	$8M
LRT Equipment Signals	$16M
Light Rail Vehicles (18)	$71M
Station Modifications	$1M
Yards and Shops	$18M
Agency/Engineering/Insurance (@ 25%)	$29M
Total Conversion Cost	$143M

IV. ISSUES IDENTIFICATION

The issue areas discussed below arose during the course of this study and the *29th Street and Southwest Busway Feasibility Study*. Due to the limited scope of this study, these issues were not analyzed in detail. A more detailed discussion of these issues can be found in the *29th Street and Southwest Busway Feasibility Study.*

DOWNTOWN CONNECTION ISSUES

Given the narrow scope of this study, the Southwest to Minneapolis CBD alignment was not analyzed in detail sufficient to choose a preferred route (exclusive right-of-way, major arterial or local surface street). The issues that must be considered in choosing a route include impacts to residential neighborhoods, businesses, and traffic.

TRANSIT/TRAIL ISSUES

The *29th Street and Southwest Busway Feasibility Study* analysis concluded that transit and a trail can coexist in these corridors with some retaining wall and bridge modifications. Because the vintage rail trolley is assumed to require the same amount of right-of-way as LRT (see Figure 3), identical retaining walls and bridge modifications are assumed necessary. Figures 4 and 5 depict a vintage rail trolley in the Southwest and 29th Street Corridors, respectively.

INTERMODAL ISSUES

Intermodal issues include connections between different types of transit service (e.g., feeder buses, busway, vintage rail trolley, and LRT) at stations, particularly the West Lake Street Station. A means to accommodate transfers and share infrastructure elements must be integrated into the design of the transit system and the stations.

EXISTING RAIL SERVICE

Currently, freight rail service exists in both the 29th Street and Southwest Corridors. To implement transit service in the 29th Street Corridor, the freight rail service must be discontinued. To implement transit service in the Southwest Corridor, either a rail swap with Canadian Pacific Rail or a southern interconnect must occur.

SOCIAL, ENVIRONMENTAL AND ECONOMIC ISSUES

The potential social, environmental and economic impacts of constructing and operating vintage rail trolley service were not addressed in this study. If the region decides to study vintage rail trolley in the future, these impacts will be analyzed.

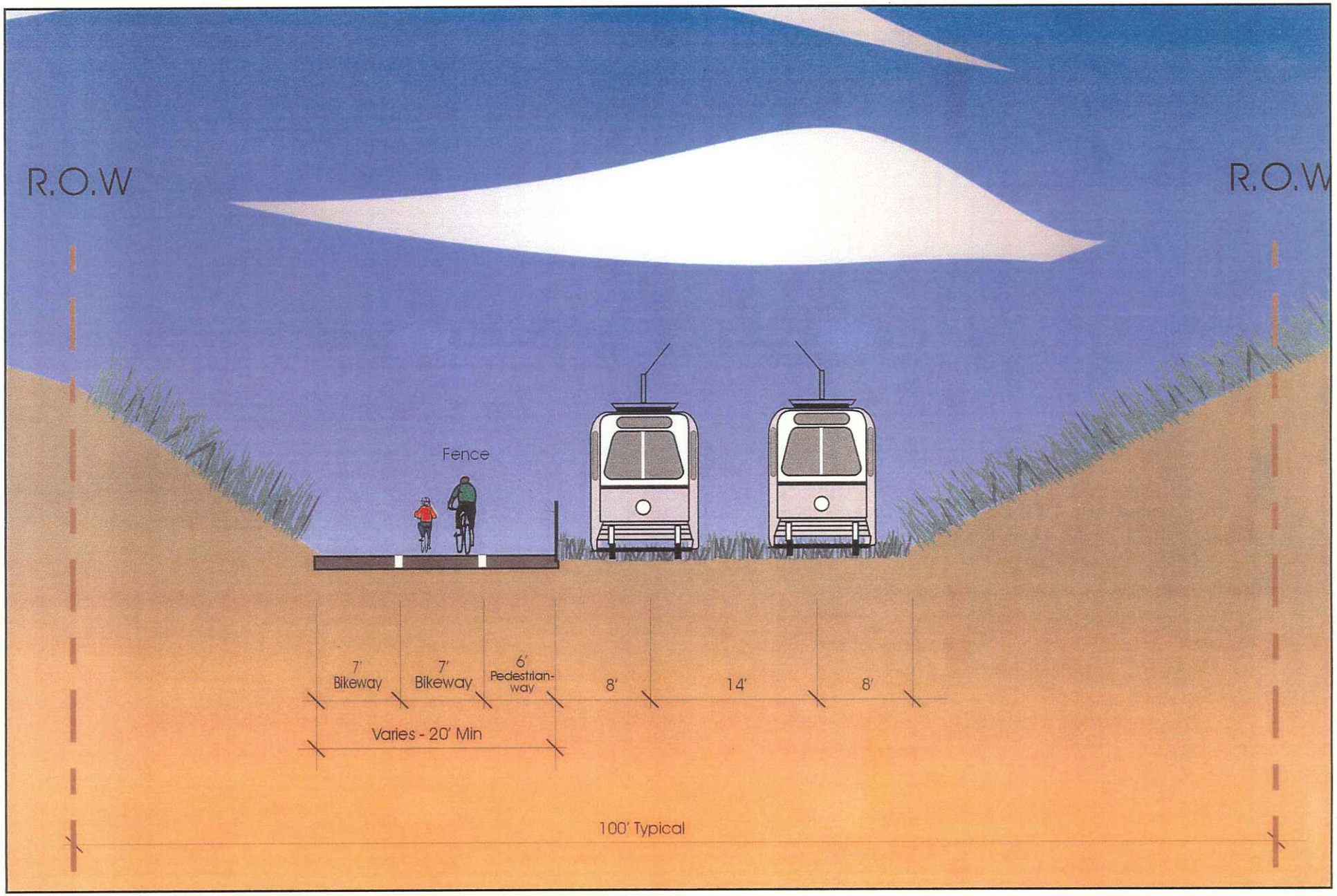


FIGURE 3

VINTAGE RAIL TROLLEY RIGHT OF WAY REQUIREMENTS

29th Street and Southwest Corridors Vintage Rail Trolley Study

FIGURE 4 VINTAGE RAIL TROLLEY WITH EXISTING FREIGHT RAIL - SOUTHWEST CORRIDOR

FIGURE 5 VINTAGE RAIL TROLLEY IN THE 29TH STREET CORRIDOR

APPENDIX A: VINTAGE RAIL TROLLEY CHARACTERISTICS

VINTAGE RAIL TROLLEY CHARACTERISTICS

(The information here is exerpted from a technical memorandum produced by James Graebner from the Lomarado Consulting Group for the Midtown Greenway Coalition)

VEHICLES

Some cities have been able to locate the remains of streetcars, which actually ran in that area. While restoration of an actual old Twin Cities streetcar would add a wonderful exhibit to the line, there are a number of actors which mitigate against a fleet of such vehicle providing the base service. First, the available car bodies re of wood construction and may not meet today's commonly accepted standards for crashworthiness and fire protection. Secondly, the cars are not accessible and missing all of the mechanical and electrical equipment. It is likely that a fleet of restored Twin City Rapid Transit cars would approach the cost of purchasing new replica vehicles.

In recent yeas, several cities around the world have been retired streetcars 30 to 50 years old. Some of these vehicles have been rehabilitated and found new homes on vintage trolley systems. While the initial cost of such cars is generally low, the cost of modification needed to make them suitable for reliable service may be quite high. It is important to remember that such cars are retired by the owner because they are basically obsolete and won out. To rehabilitate them for another two or three decades of service is a major task. There is also the question of the suitability of the available cars for the system on which they are proposed to operate.

A third source of vintage trolley vehicles is that of replica vehicles. At least two manufacturers have produced such cars, which feature a new body and rehabilitated electrical and mechanical components. Galveston, Portland, and Lowell are three systems where such cars are used. Several different designs have been produced, and replica cars have proven to be reliable and attractive performers. Since they are built new, they are available when the customer is ready to order. Similarly, since American manufacturers build them, there are service and warranty provisions in the purchase contracts. They can be customized to suit local requirements, although major modifications may require costly design changes.

SERVICE AREA

Vintage trolley lines, other than those of a purely museum nature, are locate din urban area. The area served is usually commercial, with some mixed use residential and a good deal of retail. Track is mostly in the street, in embedded pavement, which is shared with autos, but there are several examples of median strip operation with turf-embedded track.

ROUTE LENGTHS

Route lengths vary, but typically fall into a range of 2-3 miles one way. Both San Francisco and New Orleans are somewhat longer.

Fare Collection

Where the existing transit authority operates the vintage trolley, the fare system, including collection, is designed to be integrated with the rest of the system. There is no technological problem with fully integrating the vintage trolley into any common fare collection system.

Dwell Times

Typical dwell times at stations fall in the 15-20 second range. At heavily-used stops, this may increase to 30 seconds. A rough rule is 1.3 seconds per passenger per entryway.

Service Frequencies

Service frequency, or headway, varies among systems. The Memphis Main Street Trolley, the New Orleans St. Charles line, and the San Francisco "F" line all operate at mid-day and peak headways of five minutes or less between vehicles. Other systems typically range from 10 to 20 minute headways. These include Galveston and Seattle's Waterfront line. A few systems, such as Fort Smith, Arkansas, Tucson, and Fort Collins, operate only on weekends.

Hours of Service

The hours and days of service operated by vintage trolley systems general fall into two broad categories, largely dependent on the type of ridership generated. Several smaller lines, such as Tucson, Fort Smith, and Fort Collins; whose ridership is almost entirely tourists and visitors, run primarily or exclusively on weekends during daylight hours. Similarly, the lines in San Jose and Portland, which share tracks with light rail lines having frequent all day service, operate as adjuncts to the light rail, mainly during daylight hours.

By contrast, systems such as San Francisco, New Orleans and Memphis, which serve a ridership base with a broad range of tri-making purposes, typically provide service throughout the day and well into the evenings.

Ridership

Among systems for which data is available, as reported by those firms, which are member of the American Public Transit Association, the following data is available for 1998 and 1999.

Table A
Annual Ridership Vintage Rail Trolley Lines APTA Member Systems

System	1998 Riders	1999 Riders
Memphis Area Transit Authority	819,300	922,400
New Orleans Regional Transit Authority	4,879,900	4,942,800
Seattle: King County Department of Transportation	428,000	436,800

There is a fairly consistent relationship between the amount of service provided on vintage trolley lines and the ridership, which can reasonably be expected to be generated. This relationship is the average number of passengers per vehicle mile. Table B shows the number of passengers per vehicle mile experienced on seven vintage trolley systems in operation around the country. The range is between 5.1 and 8.6 with an average of just over six.

System	Passengers Per Vehicle Mile
Dallas	5.1
Memphis	5.4
Galveston	5.6
San Jose	6.4
Seattle	6.4
Fort Collins	6.5
Tucson	8.6

Operating Costs

The annual operating cost can be influenced dramatically by the level of service provided. Based on typical experience reported for the systems listed, and eliminating the extremes reported, a typical cost per mile could be anticipated to lie in the range of $8 to $15, with a reasonable average of $11.50 per mile.

Table 6
Operating and Maintenance Costs from Selected Cities

System	O & M Cost/Mile	Notes
Fort Collins	$2.00	Largely volunteer.
Tucson	$5.00	Largely volunteer.
New Orleans	$5.02	
Dallas	$8.46	Some volunteers.
El Paso	$9.94	Projected costs.
Galveston	$15.28	
Seattle	$18.82	
San Jose	$28.64	

APPENDIX B: RIDERSHIP FORECASTING METHODOLOGY

TECHNICAL MEMORANDUM

RIDERSHIP FORECASTS

29TH STREET AND SOUTHWEST CORRIDORS
VINTAGE RAIL TROLLEY STUDY

PROCESS

Transit ridership forecasts for the year 2020 were prepared using the Metropolitan Council's regional travel forecast models. These models were developed in 1994 using inputs from a Travel Behavior Inventory conducted in 1990. The models are based on the traditional four-step travel forecasting process with some enhancements to provide a more behaviorally responsive forecasting process.

Basic inputs for existing conditions are used to determine how well the model replicates existing conditions. Specific attributes are then changed for the purpose of testing alternatives. The changes involve either different demographic assumptions (for forecast years) or network assumptions (for testing alternatives).

The components of the model are:

Zonal and Network Definition – The region is divided into 1,200 transportation analysis zones (TAZs) for the purpose of preparing forecasts. The regional highway and transit systems are represented in the model as a series of links. In the case of the highway system, the primary attributes of the links are speed and capacity. The transit system is represented by the transit routes and their frequencies, as well as link speeds. The transit network is also distinguished by its separate walk-access and auto access (park and ride) links from the zones to the defined transit routes.

Socioeconomic Data – The regional model uses population, household and employment data developed for the 1,200 TAZs to determine travel characteristics such as trips generated by an area. Automobile ownership is based on these demographic characteristics plus a measure of transit accessibility.

Trip Generation – A total of 15 trip purposes are included in the model to better reflect the different trip types, trip lengths and transit market share associated with land uses and demographic characteristics.

Trip Distribution – The amount of travel between the TAZs is determined by trip type considering travel time between zones and the levels of trip generation by each TAZ. Work trip distribution is affected by transit accessibility and other factors that influence transit ridership, including congestion and cost.

Mode Choice – The mode choice model determines whether the trips would use transit, drive alone or carpool. Transit use includes separate consideration of auto access (park and ride) or pedestrian access. The primary variables of the mode choice model are:

- Highway in-vehicle time (including the effects of congestion)
- Highway out-of-vehicle time (such as walking to destinations in downtown areas)
- Highway operating costs (including typical out of pocket costs and parking costs)
- Transit in-vehicle time (time spent riding on transit vehicles, including consideration of whether service is express or limited-stop)
- Transit out-of-vehicle time (more onerous than in-vehicle time, it includes time spent walking to or waiting for transit, including transfers)
- Transit fares
- Automobile ownership levels

Temporal Distribution – This component of the model separates trips into different time periods by mode. Also included in this process is identification of which trips are going from home-to-work or work-to-home, for example.

Highway Assignment – The auto trips between zones are routed to the highway system. The process uses a multiple-iteration technique that simulates the effects of capacity-related congestion on travel route choices. HOV trips are given the choice of using HOV lanes.

Transit Assignment – Transit trips between zones are allocated to likely transit routes based on proximity (walk or drive distance), service frequency and transit travel time, including transfers. The assignment of trips to vintage rail trolley was done using outputs from the Regional Model with no factoring of subjective customer preference for vintage rail trolley. Differences in estimates of ridership are accounted for by quantitative assumptions of service elements such as dwell time for trolley vehicles loading passengers as well as acceleration/deceleration rates.

Alternatives Considered

Basic ridership forecasts were prepared for vintage rail trolley service for the following alignments:

- **29th Street Corridor** – This alignment assumes service running from West Lake Street to Hiawatha Avenue.

- **Southwest Corridor to Minneapolis CBD** – This alignment assumes service from 5th Avenue and ~~Highway 169~~ in Hopkins to downtown Minneapolis. A downtown connection would be provided on either exclusive right-of-way, a major arterial street or a local street.

The following transportation system changes were assumed:

Feeder Routes – Feeder bus routes for the 29th Street Corridor are assumed to consist of existing north-south bus routes that cross the corridor. Transfers to and from these existing bus routes could be made from the 29th Street Corridor to routes serving downtown Minneapolis, the University of Minnesota and other destinations.

Existing bus routes in the Southwest Corridor were reconfigured to connect with the proposed transit stations. If corridor service were ever in place, the decision would need to be made by Metro Transit on whether to truncate these routes at the stations or to continue them into downtown Minneapolis. The modeling process assumes some of both strategies (truncation or continuation of feeder routes) are in place.

Lake Street Service – Lake Street is currently served by Metro Transit Route 21. It is assumed in the model that this service would remain in place, but that service frequency would drop from its current frequency of 7-1/2 minutes to 10 minutes.

Park and Ride – Three new Park and Ride lots are assumed for the Southwest corridor, east of 5th Avenue in Hopkins, at Louisiana Avenue, and at Beltline Boulevard.

Other Transit Service – Although connections were assumed possible from vintage rail trolley to the Hiawatha LRT for both alignments studied, a "transfer penalty" was assumed for purposes of forecasting ridership. Input received from Metro Transit indicated that vintage rail trolley could not directly access either the Hiawatha – Lake Street Station (29th Street Corridor alignment), nor the 5th Street tracks in downtown Minneapolis (Southwest Corridor to Minneapolis CBD alignment). The additional time necessary for persons riding vintage rail trolley service to transfer to Hiawatha LRT service is reflected in the ridership forecasts as presented in Table 2.

Hours of Service – For the 29th Street Corridor, service would begin at 6:00 a.m. and end at 10:00 p.m. Service on the Southwest Corridor to Minneapolis CBD alignment commences at 4:00 a.m. and concludes at 1:00 a.m.

Service Frequencies – Service frequencies were identical for both alignments studied, 10-miute peak and 15-minute off-peak.

Travel Time – Vintage rail trolley travel time is dependent on four factors:

- Maximum speed (dependent on grade separation and adjacent street speeds)
- Dwell time (station pickup/drop-off time, assumed at 45 seconds)
- Traffic signals (assumed at 85 percent preemption)
- Acceleration/deceleration rates

Terminal to terminal travel times for busway, vintage rail trolley and LRT are shown in Table 1. LRT alternatives are somewhat faster because of shorter dwell times and slightly better acceleration/deceleration.

Table 1
Transitway Travel Times

Alignment	Busway	Vintage Rail Trolley	LRT
29th Street Corridor (West Lake – Hiawatha)	15.1 minutes	14.3 minutes	13.5 minutes
Southwest Corridor to Minneapolis CBD (Hopkins – Minneapolis CBD)	26.1 minutes	26.1 minutes	23.5 minutes

KEY MODEL ASSUMPTIONS

Socioeconomic Data

Existing and forecast (Year 2020) population, household and employment values for each TAZ were obtained from the Metropolitan Council. The 1996 Regional Blueprint forecasts were used.

Highway Improvement

Highway improvements included in the 1996 Metropolitan Council Transportation Development Guide were included in all alternatives as well as improvements included in the region's 1999 Transportation Improvement Program (TIP). A key improvement affecting the 29th Street Corridor was the proposed Hiawatha LRT service to the Mall of America and the associated bus system changes assumed in all alternatives.

Transit and Highway Costs

Transit fares for the year 2020 are assumed to be the same as currently exists:

- $1.00 base fare
- $0.50 express surcharge
- $0.50 peak period surcharge

Service alternatives are treated as limited-stop service, which would be subject to local fares ($1.50 peak, $1.00 off-peak).

Automobile operating costs are assumed to increase at the rate of inflation. The model currently assumes 13.3 cents per mile, which includes fuel costs (about 40 percent of the total) plus other typical out-of-pocket costs such as maintenance. Automobile ownership is not included in this variable, as it is represented elsewhere in the modeling process.

Parking costs are a key factor in work trip transit choice. The regional models include a special parking cost model. This model estimates parking costs based on employment density. The models were initially developed for the Midway Corridor study in 1988, and revised in 1990 as part of the TBI. The calibrated model is based on monthly parking costs (converted to daily costs) for work trips and hourly parking costs for non-work trips.

Minneapolis is expected to experience ongoing tight parking supplies. The effects of reduced parking availability in the two downtowns were represented in the model as reductions in parking convenience. To represent the decreased convenience of downtown parking, the highway terminal (walking) travel times were increased as follows:

- Work trips to TAZs in the core of the downtown area: 5 additional minutes
- Work trips to TAZs at the fringe of the downtown area: 2.5 additional minutes
- Non-work trips to TAZs in the core of the downtown area: 2.5 additional minutes

Forecasting Results

Table 2 summarizes the forecasting results for busway, vintage rail trolley and LRT.

Table 2
Transit Ridership Forecast

Alignment	Busway	Vintage Rail Trolley	LRT
29th Street Corridor (West Lake – Hiawatha)	7,300	6,100	7,700
Southwest Corridor to Minneapolis CBD (Hopkins – Minneapolis CBD)	16,000	14,500	16,500

APPENDIX C: CAPITAL COST ESTIMATES

TECHNICAL MEMORANDUM

CAPITAL AND OPERATING COST ASSUMPTIONS
29TH STREET AND SOUTHWEST CORRIDORS
VINTAGE RAIL TROLLEY STUDY

The purpose of this technical memorandum is to summarize and document the methodology used to estimate capital and operating and maintenance costs for the 29th Street and Southwest Corridors Vintage Rail Trolley Study.

The cost estimates were based on an assumption that vintage rail trolley would be a state-of-the-art system operating on dual tracks with service and infrastructure equivalent to a busway or LRT (i.e., transit stations, park-and-ride lots, fare collections systems and trackwork). The assumed purpose of the vintage rail trolley was transportation, not tourism. This service would operate along two different alignments:

29th Street Corridor: Between West Lake Street and Hiawatha Avenue in Minneapolis.

Southwest Corridor to Minneapolis CBD: Between Hopkins at 5th Avenue continuing into the Minneapolis CBD along either exclusive right-of-way or major arterial or local surface street.

The cost assumptions concerning a vintage rail trolley system are based upon those used for busway and LRT in the previous *29th Street and Southwest Corridors Busway Feasibility Study* and information from the Lomarado Group. The basic assumption guiding this study was that the service levels and infrastructure for a vintage rail trolley, an exclusive busway, and LRT are equivalent. For more detailed information regarding cost methodology, the *Busway Feasibility Study* should be referenced.

All costs are estimated in 2000 dollars and were adjusted from the 1997 dollars used in previous reports prepared for the Hiawatha LRT and Riverview Corridor projects by applying an annual inflation rate of 3.1 percent. These 2000 costs were inflated to year 2005 costs (earliest anticipated build year) by applying an annual inflation rate of 3.5 percent.

Other cost assumptions include the following:

- Unit costs are consistent with unit costs used for the Hiawatha corridor (March 1998, BRW, Inc., Bechtel, Inc. and LTK, Inc.)
- Costs from Hiawatha were used for that segment most similar to the 29th Street and Southwest Corridors, i.e., at-grade with no tunneling.

- Yards and shops were estimated at $429,000 per vintage rail trolley vehicle needed to operate the service.
- Vintage rail trolley vehicle costs were provided by the Lomarado Group, consultant to the Midtown Greenway Coalition.
- Capital costs were broken down into nine construction elements. The construction cost elements and their respective contingencies include:

Cost Element	Contingency (%)
Guideway (Civil)	30
Utilities	30
Stations	20
Park and Ride Lot	20
Track Work	20
Signals	15
Traction/Electrification	10
Communications	10
Fare Collections	10
Vehicles	5

- Agency/Engineering/Insurance costs were assumed to be 25 percent of total segment construction cost.

Operations and Maintenance

Vintage rail trolley O&M costs per vehicle mile were estimated using average costs from other vintage rail trolley systems operating in U.S. cities (see page 9 in Appendix A). Although these costs ranged greatly (from $2.00 in Fort Collins, Colorado to $28.64 in San Jose, California), a cost of $9.00 per vehicle mile was close to the average for these systems and consistent with O&M cost assumptions used in the previous *29th Street and Southwest Corridors Busway Feasibility Study*.

Methodology for Calculating Performance Measures

Passenger/Revenue Hour (Daily passengers divided by the daily revenue hours of service):

The revenue hours of service are derived from the number of revenue miles of service per day divided by the average running speed of the service. The revenue miles of service are based on the number of vehicle trips per day to satisfy the headway and peak load requirements times the length of the individual corridors. The average running speed is derived from the corridor length and the forecast model travel time estimates. The travel time estimate assumes a maximum speed of 43 mph and station dwell times of 45 seconds and assumed 85 percent preemption for traffic signals.

Cost per New Rider: Cost per new rider is derived by calculating the annualized capital costs plus annual operating costs over annual new ridership.

The following annualization factors were used (source: USDOT, Technical Guidance on Section 5309 New Starts Criteria, 1997). Differences in factors are meant to account for the useful life of the cost element with the higher factor having the lesser useful life:

Capital Cost Element	Factor
Right-of-way	0.070
Right-of-way preparation (major grading, etc.)	0.070
Structures	0.081
Trackwork	0.081
Signals, electrification	0.081
Pavement, parking lots, grade crossings	0.094
Rail Vehicles	0.086
Buses	0.126

It was assumed that 10 percent of projected ridership on the 29th Street Corridor alignment were new riders. On the Southwest Corridor to Minneapolis CBD alignment, 25 percent of the projected ridership were assumed to be new riders. Tables 1 and 2 present cost per new passenger and total number of new passengers, respectively.

Table 8
Cost Per New Passenger

Alignment	Busway	Vintage Rail Trolley	LRT
29th Street Corridor (West Lake – Hiawatha)	$29	$40	$44
Southwest Corridor to Minneapolis CBD (Hopkins – Minneapolis CBD)	$15	$21	$23

Table 2
Net New Transit Riders (2020)

Alignment	Busway	Vintage Rail Trolley	LRT
29th Street Corridor (West Lake – Hiawatha)	730	610	770
Southwest Corridor to Minneapolis CBD (Hopkins – Minneapolis CBD)	4,000	3,600	4,500

SUMMARY

29th Street and Southwest Corridors Vintage Rail Trolley Study

Vintage Rail Trolley Cost Estimate (2005 dollars)

Cost Elements			29th STREET CORRIDOR			SOUTHWEST CORRIDOR TO MINNEAPOLIS CBD		
Distance (feet)			23,708			43,231		
Distance (miles)			4.49			8.19		
Stations (ea)			7			11		
	Unit	Unit Cost ($)	Quantity	Total ($)	Annualized ($)	Quantity	Total ($)	Annualized ($)
01 Guideway (Civil)								
.10 Guideway	MILE	935,910	4.49	4,202,236		8.19	7,665,103	
.20 Bridge - New	SF	75	0	0		6,000	450,000	
.30 Bridge - Expansion/Reconstruction	SF	75	14,400	1,080,000		20,400	1,530,000	
.40 Bridge - Slope Work	EA	100,000	12	1,200,000		1	100,000	
.50 Bridge - Open Portal	EA	100,000	3	300,000		0	0	
.60 Retaining Wall	SF	30	74,800	2,244,000		16,000	480,000	
.70 Trail Removal	SF	1	144,000	144,000		280,272	280,272	
.80 Trail Reconstruction	SF	1.25	144,000	180,000		280,272	350,340	
.90 Trail Fencing	LF	20	23,708	474,160		29,910	598,200	
.100 Exit 29th Street Trench	TOTAL	5,000,000	0	0		1	5,000,000	
.110 Downtown Turn-Around	TOTAL	105,000	0	0		1	105,000	
.120 Contingency @ 30%				2,947,319			4,967,674	
Total Guideway ($)				12,771,715	894,020		21,526,589	1,506,861
02 Utilities								
.10 Utilities	MILE	104,331	4.49	468,446		8	854,470	
.30 Contingency @ 30%				140,534			256,341	
Total Utilities ($)				608,979	49,327		1,110,811	89,976
03 Stations								
.10 Station w/ vertical circulation	EA	1,358,002	6	8,148,012		2	2,716,004	
.20 At-Grade Station	EA	669,440	1	669,440		5	3,347,200	
.30 On-Street Station	EA	250,000	0	0		4	1,000,000	
.40 Contigency @ 20%				1,763,490			1,412,641	
Total Stations ($)				10,580,942	857,056	11	8,475,845	686,543
04 Park-and-Ride Lot								
.10 Park and Ride	EA	1,151,147	0	0		3	3,453,440	
.20 Contigency @ 20%							690,688	
Total Park-and-Ride Lots ($)				0	0		4,144,128	389,548

SUMMARY

29th Street and Southwest Corridors Vintage Rail Trolley Study
Vintage Rail Trolley Cost Estimate (2005 dollars)

Cost Elements			29th STREET CORRIDOR			SOUTHWEST CORRIDOR TO MINNEAPOLIS CBD		
Distance (feet)			23,708			43,231		
Distance (miles)			4.49			8.19		
Stations (ea)			7			11		
	Unit	Unit Cost ($)	Quantity	Total ($)	Annualized ($)	Quantity	Total ($)	Annualized ($)
05 Track Work								
.10 Embedded Track	MILE	1,903,381	4	8,546,181		8	15,588,690	
.20 Contingency @ 20%				1,709,236			3,117,738	
Total Track Work ($)				10,255,417	830,689		18,706,428	1,515,221
06 Signals:								
.10 Traffic Equipment Signals	EA	160,222	6	961,335		30	4,806,674	
.20 Contingency @ 15%				144,200			721,001	
Total Signals ($)				1,105,535	89,548		5,527,675	447,742
07 Traction/Electrification								
.10 Traction Electrification	MILE	1,000,000	4	4,490,000		8	8,190,000	
.20 Contingency @ 10%				449,000			819,000	
Total Traction / Electrification ($)				4,939,000	400,059		9,009,000	729,729
08 Communications:								
.10 Communication Systems	MILE	729,878	4	3,277,152		8	5,977,701	
.20 Contingency @ 10%				327,715			597,770	
Total Communications ($)				3,604,867	291,994		6,575,471	532,613
09 Fare Collection:								
.10 Fare Collection System	EA	250,526	7	1,753,680		11	2,755,782	
.20 Contigency @ 10%				175,368			275,578	
Total Fare Collection ($)				1,929,048	156,253		3,031,361	245,540
10 Segment Construction (2000 $)				**45,795,503**	**3,568,947**		**78,107,308**	**6,143,773**
10.1 Segment Construction (2005 $)				**54,496,649**	**4,247,047**		**92,947,697**	

SUMMARY

29th Street and Southwest Corridors Vintage Rail Trolley Study
Vintage Rail Trolley Cost Estimate (2005 dollars)

Cost Elements			29th STREET CORRIDOR			SOUTHWEST CORRIDOR TO MINNEAPOLIS CBD		
Distance (feet)			23,708			43,231		
Distance (miles)			4.49			8.19		
Stations (ea)			7			11		
	Unit	Unit Cost ($)	Quantity	Total ($)	Annualized ($)	Quantity	Total ($)	Annualized ($)
11 Agency/Engineering/Insurance @ 25%				11,448,876			19,526,827	
12 Right of Way								
.10 R/W Acquisition				5,000,000			5,000,000	
.20 Contigency				0		0	0	
Total Right of Way ($)				5,000,000	350,000		5,000,000	350,000
13 Vehicles:								
.10 Vehicles (29th Street)	EA	700,000	7	4,900,000		32	22,400,000	
.30 Spare Parts, Testing, Training @ 10%			0	490,000		0	2,240,000	
.30 Contingency @ 5%				269,500			1,232,000	
Total Vehicles ($)				5,659,500	486,717		25,872,000	2,224,992
14 Yards & Shops								
.10 Yards & Shops	PV	429,000	7	3,003,000		32	13,728,000	
.20 Contingency				0			0	
Total Yard & Shops ($)				3,003,000	243,243		13,728,000	1,111,968
15 Total Project Cost (2000 $)				**70,906,879**	**4,298,907**		**142,234,135**	**9,480,733**
15.1 Total Project Cost (2005 $)				**84,379,186**	**5,115,699**		**169,258,621**	**11,282,072**