City of Minneapolis

Minneapolis Streetcar Feasibility Study

Phase III Report

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Table of Contents

PAGE

Executive Summary **1**

Chapter 1. Introduction **1-1**

Chapter 2. Summary of Phase I and Phase II Evaluations **2-1**

Chapter 3. Shortest Operable Segments **3-1**

Chapter 4. Operating Plans and Operating Costs **4-1**

Chapter 5. Ridership Estimates **5-1**

Chapter 6. Capital Costs **6-1**

Chapter 7. Maintenance and Storage Facilities and Potential Sites **7-1**

Potential Site Locations 7-2

Chapter 8. Summary and Next Steps **8-1**

Appendix

Table of Figures

PAGE

Figure ES-1 Long-Term Streetcar Network Carried Forward from Phase II Analysis (Map)...3
Figure ES-2 Shortest Operable Segments 7
Figure ES-3 Summary of Shortest Operating Segments Characteristics 13
Figure 2-1 Candidate Streetcar Corridors Carried Forward to Phase II Evaluation....2-1
Figure 2-2 Streetcar Corridors Carried Forward from Phase II Evaluation 2-3
Figure 2-3 Long-Term Streetcar Network Carried Forward from Phase II Analysis (Map) 2-5
Figure 3-1 Peer System Streetcar Segment Lengths 3-1
Figure 3-2 Center Lane Streetcar Terminal, Portland, Oregon 3-6
Figure 3-3 Shortest Operable Streetcar Segments....3-7
Figure 4-1 Operating Cost Estimates for Shortest Operable Segments 4-11
Figure 4-2 Operating Cost Estimates for Long-Term Corridors 4-21
Figure 4-3 Estimated Impact on Annual Operating Costs 4-23
Figure 4-4 Hennepin Avenue Typical Cross Section 4-25
Figure 4-5 Typical Community Corridor Cross Section 4-26
Figure 4-6 Typical Community Corridor Cross Section (Neighborhood Commercial Node)4-27
Figure 4-7 Typical Commercial Corridor Cross Section 4-28
Figure 4-8 Typical Downtown One-Way Street Cross Section 4-29
Figure 5-1 Factors Influencing Ridership (Streetcar vs. Bus) 5-2
Figure 5-2 Ridership Estimates – Long-Term Streetcar Network 5-7
Figure 5-3 Peer Streetcar System Ridership....5-9
Figure 5-4 Ridership Estimates – Shortest Operable Segments 5-11
Figure 6-1 Streetcar per Track Mile Construction Costs (Order of Magnitude) $2007....6-3
Figure 6-2 Order of Magnitude Streetcar Capital Costs by Segment – All Corridors, Embedded Track....6-7
Figure 6-3 Order of Magnitude Streetcar Capital Costs by Segment – Midtown Greenway, Ballasted Track 6-9
Figure 8-1 Summary of Shortest Operating Segments Characteristics....8-5

Executive Summary

The Access Minneapolis project recommends a series of Primary Transit Network (PTN) corridors, which can be defined as a network of high-frequency; all-day transit services that are intended to carry the majority of transit ridership in the city. This study evaluates the feasibility of introducing streetcar service in 14 PTN corridors throughout the city. In order to accomplish the goals of this study, the evaluation has been conducted in a series of phases. **Phase I** first developed a set of evaluation criteria and, based on those criteria, "screened" each of the 14 candidate corridors to eliminate those corridors (or segments of corridors) with significant or serious physical flaws. **Phase II** added additional information, including utility impacts, additional land use information and impacts on the bus network. The second Phase concluded by recommending a long-term streetcar network consisting of the following corridors. These corridors are shown in Figure ES-1.

- **W Broadway Avenue/Washington Avenue** – from Robbinsdale Transit Center to downtown via Washington Avenue.
- **Central Avenue NE** – from the Columbia Heights Transit Center to downtown via Central Avenue NE and the 3rd Avenue or Hennepin Avenue bridge.
- **University Avenue SE / 4th Street SE** – from University Village to downtown via University Avenue SE / 4th Street SE and Hennepin Avenue and 1st Avenue NE.
- **Chicago Avenue S** – from 38th and Chicago to downtown, either via 9th/10th to Nicollet or via Park Avenue to 5th Street.
- **Nicollet Avenue S** – from 46th Street to downtown entirely on Nicollet Avenue5.
- **Hennepin Avenue S** – from Uptown to downtown entirely on Hennepin Avenue.
- **Midtown Greenway** – from the future West Lake station on the Southwest LRT line to the Lake Street/Midtown station on the Hiawatha LRT line.

While the long term plan for streetcar service in Minneapolis was established in the previous report, this Phase III analysis recognizes that the system can not be built at once. Experience from other "streetcar cities" suggests that the initial starter line will be only a few miles long. This report focuses on defining "shortest operable segments" that will be the building blocks of the larger network. This phase also refines the impact on the bus network, and estimates both capital and operating costs for the shortest operable segments as well as the long-term network.

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Figure ES-1 Long-Term Streetcar Network Carried Forward from Phase II Analysis

Source: MetroGIS, Met Council, and the City of Minneapolis

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Future transit corridor sources:

1. Central Corridor LRT: Metropolitan Council
2. I-35 BRT: MnDOT
3. Southwest Transitway: Southwest Transitway.org
4. Bottineau BRT: Metro Transit

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Selecting the Shortest Operable Segments

Most modern streetcar implementations in North America have consisted of initial operating segments that are quite short (1-5 track miles in length). Shorter segments are generally selected both because of complex public-private funding arrangements that require benefit districts, or other types of local funding to be developed; and for speed of implementation. Streetcar segments are generally designed with longer lines in mind, allowing for extension or expansion in the future. Guidelines for selecting the shortest operable segment on each potential corridor were developed in order to ensure that even an initial segment would be viewed as a success. Key considerations include serving major concentrations of population and employment that may either be currently underserved or may have additional transit potential that is not being fully realized by current transit services. Physical considerations include the potential to develop a storage and light maintenance facility close to revenue tracks and identifying a location to provide layover and turn streetcars around. Through an iterative process with the consulting team, City staff and the Project Steering Committee, the following corridors were identified as shortest operable segments:

- **Hennepin Avenue** from Groveland to E. Hennepin and University/4th.
- **Washington Avenue** from 10th Ave N to Nicollet Ave/5th Street (LRT station)
- **Washington Avenue** from 10th Ave N to Park Ave/5th Street (LRT Station)
- **Nicollet Avenue** from Grant Avenue (Convention Center) to Washington Avenue
- **9th/10th Streets and Nicollet Avenue** from 14th Street/Chicago Avenue to Nicollet Avenue/Washington Avenue.

In consultation with City staff, the Project Steering Committee, the Mayor and several City Council members and other local stakeholders, slightly longer lines were identified as being more desirable for initial implementation if possible. The shortest operable segments and possible extensions for initial implementation are shown on Figure ES-2. Additional analysis will be completed in the Draft Final Report to determine whether these longer segments are practical as an initial implementation stage. Costing and operating plan information provided throughout this report refer only to the Shortest Operable Segments listed above.

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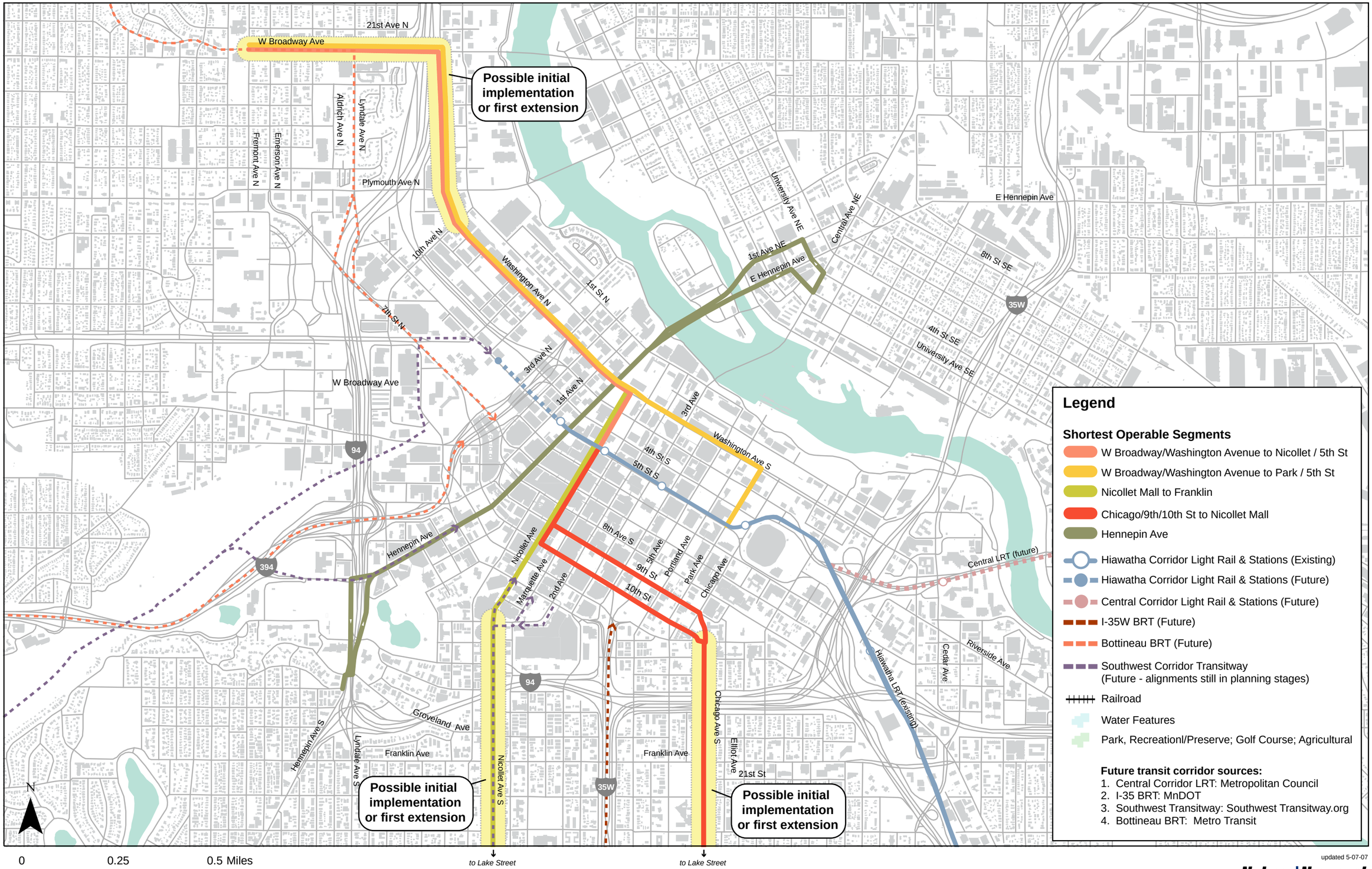
Figure ES-2 Shortest Operable Streetcar Segments



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Operating Plans

Operating plans were developed for the shortest operable segments as well as the long-term network. Because none of the shortest operable segments would have a significant impact on the underlying bus network (until service is implemented in the full corridor), all initial segments are proposed to operate on 15 minute headways, seven days a week. During weekdays and on Saturdays, the service would operate a total of 16 hours. Service span would be reduced to 14 hours on Sundays.

Operating plans for the long-term network assume full build-out for each corridor. In some corridors, the underlying bus network can ultimately be greatly reduced and replaced by a robust streetcar service, while in other corridors, adding streetcar service within the City of Minneapolis would have less of an impact. The following guidelines were used to develop the operating plans for the long-term network:

- Streetcars should only replace bus volumes where significant overlap occurs.
- Forced transfers are undesirable, unless at major turnover locations (such as Uptown, 38th Street/Chicago Ave S, 46th Street / Nicollet Ave S and downtown).
- No major route restructuring of the bus network was proposed.
- To justify the investment, and consistent with the requirements of the PTN, minimum streetcar service frequency is assumed to be 15 minutes, 16-18 hours per day. More frequent streetcar service would be provided if ridership demanded higher service levels.

Based on these guidelines, initial operating plans that include an estimate of annual revenue hours and total annual operating costs were developed. In addition, the number of vehicles required to operate each line was calculated, which are a major capital cost item for streetcar service.

Ridership Estimates

Planning-level estimates of ridership were developed for each of the long-term streetcar corridors as well as the segments identified for initial operations. Different methodologies are used for the long-term network and the shortest operable segments, primarily because the shortest operable segments are not intended to replace existing bus lines. To estimate ridership for any of the shortest operable segments, examples were used from other cities where relatively short streetcar lines are serving similar land uses in their downtown areas. Ridership estimates for the long-term network was "pivoted" off of the performance of the existing bus service in each corridor and then factored up or down based on several factors that impact ridership. Ridership estimates for the Midtown Greenway were developed by the Hennepin County Regional Railroad Authority.

Capital Cost Estimates

Order-of-magnitude capital cost estimates were developed for segments that make up the long-term streetcar network, as well each of the shortest operable segments. The cost estimates were developed based on component costs from other comparable projects in the same region of the country, where appropriate. The capital cost estimates developed for the Southwest Corridor LRT being conducted by Hennepin County provided local unit cost information for many of the materials required to build a streetcar. Because there are only a small number of examples of modern streetcar systems already built in North America, Portland, OR was selected as a good peer to help formulate costs appropriate to a modern streetcar system. Since cost estimates were completed in previous years, costs were inflated and adjusted to more closely match local construction costs in 2007. It should be noted that all estimates presented in this report are order-of-magnitude for planning and feasibility assessment purposes only and do not represent any level of design. A preliminary design and engineering study would need to be completed to increase the accuracy of capital cost estimates.

A standard capital cost per track mile was developed so that the cost of each segment of the streetcar network could be calculated based on mileage. The cost of $9,948,067 per track mile is based on the following major items required for streetcar:

- **Trackwork** – this includes slab type construction and additional costs for switches, crossovers and other special devices/improvements.
- **Platforms** – this includes simple platforms that includes ramps, shelter / bench, trash receptacle, static passenger information and possibly street lighting, drainage modification, or fire hydrant relocation as needed.
- **Catenary system, signals and substations** – this includes costs for the catenary system itself (poles and wires), train control system for single track sections of the alignment and the cost of required power stations.
- **Utilities** – This includes the cost to deal with major public utilities (water, sewer, sanitation).
- **Construction soft-costs and taxes** – includes an allowance to cover unforeseen costs related to the road itself (utilities, traffic systems, street lighting, drainage, etc.) as well as any State of Minnesota taxes that may apply to construction materials.
- **Engineering and project management** – this includes project design and engineering, and the administration of the project startup.
- **General Contingency** – this includes a general contingency fund for all other unforeseen costs to the project as a whole.

Based on the order-of-magnitude estimate of cost per track mile, basic construction costs were developed for each of the shortest operable segments and all long-term corridors. In addition to the basic cost per track mile, major capital improvements, such as incorporating streetcar operation into the Mississippi River bridges (Hennepin and 3rd Avenue), are estimated separately and added to the total segment cost.

It is important to note that in addition to basic construction costs, vehicle and maintenance/storage facility costs add to the total capital cost per corridor. There will be some economies of scale associated with vehicles and a maintenance/storage facility as the streetcar network grows, but costs for these items will represent a significant part of an initial investment.

Figure ES-3 summarizes operating costs, ridership estimates and capital costs for the shortest operable segments.

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Figure ES-3 Summary of Shortest Operating Segments Characteristics

	Hennepin Avenue	Broadway/Washington Avenue to Nicollet Avenue	Broadway/Washington Avenue to Park Avenue	Nicollet Avenue	9th/10th Streets to Nicollet Avenue
From	*Groveland*	*10th Avenue N*	*10th Avenue N*	*Grant Avenue*	*Chicago Avenue / 14th Street*
To	*Central Ave NE/4th StreetSE*	*5th Street / Nicollet Avenue*	*5th Street / Park Avenue*	*Washington Avenue*	*Nicollet Avenue / 5th Street*
Operating Characteristics					
Peak Vehicle Requirement	3	2	2	2	2
Annual Service Hours	17,200	11,450	11,450	11,450	11,450
Estimated Annual Operating Costs (assuming $149.75/hour)	$2,571,507	$1,714,338	$1,714,338	$1,714,338	$1,714,338
Ridership Estimates					
Estimated Weekday Ridership – Low	2,357	1,312	1,226	1,747	1,139
Estimated Weekday Ridership – High	2,885	1,603	1,498	2,138	1,392
Estimated Annual Ridership – Low	831,449	461,916	431,460	616,226	401,004
Estimated Annual Ridership – High	1,016,215	564,564	527,340	753,166	490,116
Capital Cost Estimates ($2007)					
Route Miles	2.6	1.2	1.7	1.0	1.3
Track Miles	4.8	2.2	3.4	1.8	2.6
Estimated Cost per Track Mile	$9,948,067	$9,948,067	$9,948,067	$9,948,067	$9,948,067
Subtotal	$47,750,722	$21,885,747	$33,823,428	$17,906,521	$25,864,974
Additional Capital Costs	1) Lowry Tunnel - $244,000 2) Hennepin Bridge (Miss. River) - $2.08 M 3) Center Stations (Wash – 10th) - $450,000 4) LRT Crossing - $50,000	1) 4th Avenue N Bridge - $70,000 2) LRT Crossing - $50,000 3) Mall Modifications - $300,000	1) 4th Avenue N Bridge - $70,000 2) LRT Crossing - $50,000	1) LRT Crossing - $50,000 2) Mall Modifications - $2,100,000	1) LRT Crossing - $50,000
Vehicle Costs[1]	$12,000,000	$9,000,000	$9,000,000	$9,000,000	$9,000,000
Non-revenue track[2]	$4,459,479	$4,459,479	$4,459,479	$4,459,479	$4,459,479
Maintenance Facility[3]	$4,000,000	$4,000,000	$4,000,000	$4,000,000	$4,000,000
Total Capital Costs ($2007)	$70,790,201	$39,765,226	$51,402,907	$37,516,000	$43,374,453
Cost Effectiveness Measures					
Capital Cost per Passenger – High	$69.66	$70.44	$97.48	$49.81	$88.50
Capital Cost per Passenger - Low	$85.14	$86.09	$119.14	$60.88	$108.16
Operating Cost per Passenger – High	$3.09	$3.71	$3.97	$2.78	$4.28
Operating Cost per Passenger – Low	$2.53	$3.04	$3.25	$2.28	$3.50
Service Efficiency Measure					
Passengers per Service Hour – High	60.1	50.1	46.8	66.8	43.5
Passengers per Service Hour – Low	49.1	41.0	38.3	54.6	35.6

[1] Costs include one spare vehicle per shortest operable segment. If all segments were implemented together, the number of spare vehicles would likely be lower.
[2] For planning purposes, it is assumed that ½ mile of single track would be required to access a maintenance facility.
[3] Maintenance facility costs would only apply to the first shortest operable segment.

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Next Steps

The following items will be included in the Draft Final Report, which will allow the City to make a decision on which segment to implement first.

1. **Identify most feasible maintenance facility and turnaround locations.** As noted earlier, streetcar service requires a maintenance and storage facility be located as close to the initial segment as possible. Unlike bus operations, a streetcar maintenance facility requires non-revenue track, which costs the same per track mile as revenue track. Initial streetcar segments also must consider turnaround locations. These issues will be explored further for each possible shortest operable segment and possible extensions to those initial segments.
2. **Update ridership, operating cost and capital cost estimates.** Once reasonable locations for a maintenance/storage facility and possible extensions outside of downtown are evaluated further, updates to the cost information and ridership estimates will be made.
3. **Identify most likely public and private funding sources.** A list of potential funding sources will be identified in the Draft Final report. The likelihood of utilizing these funding sources to build and operate streetcar will be evaluated and recommendations for the most likely sources will be identified.
4. **Identify potential owner/operator arrangements and detailed implementation plan.** Possible owner/operator arrangements will be identified and a preferred operator will be selected. An implementation plan will outline the steps that need to be take to develop a first streetcar segment, including an estimated timeline for completing all identified tasks.
5. **Gauge community support.** Public open house meeting will be conducted to gauge the level of support among the various neighborhoods potentially served by an initial streetcar line, as well as by city residents in general. The neighborhood that shows the greatest support for an initial streetcar line will help identify initial segments and future extensions.

Once this feasibility study is complete, it will be important for the City to select an initial a streetcar segment to begin with and identify how this initial segment will further the development of the long-term network. The following "next steps" have been identified to help move this process forward.

1. **Continue to gauge political support.** It is important to ensure that elected officials are supportive of an initial investment that will serve downtown only. It must be understood that the streetcar system will eventually serve many corridors throughout the city.

2. **Gauge developers support and economic development potential**. Developers have had strong influence in making streetcar lines happen in Portland, Memphis, Little Rock and Tampa. While the long-term streetcar network proposed for Minneapolis will eventually be an integral component of the PTN, support from local developers and a line that supports economic development can tip the scales to one segment over another.
3. **Develop detailed funding plan.** Discussions regarding potential funding options have already been initiated with various City staff. Utilizing the recommendations made in the Draft Final Report, the most promising sources should be selected and evaluated further. The options should then be presented to other public and private entities and a detailed capital and operating funding plan should be developed. A detailed funding plan can vary by corridor, and help the City identify which shortest operable segment gets built first.
4. **Further evaluate the impact on the local bus network.** Although streetcars and buses generally do not have major conflicts when operating in the same corridor, downtown will be different because of limited right-of-way available for transit through the core. In the Nicollet Mall, for example, it will be especially difficult to integrate streetcars and buses in the short-term because of peak hour bus volumes and the speed at which streetcar may need to operate through the curves. Hennepin Avenue will be somewhat easier because there are no curves (and thus streetcars can operate at a comparable speed to buses), but the additional streetcar vehicles may create additional impacts in terms of total transit volumes in that corridor. Throughout the decision process, Metro Transit should continue to be consulted to identify those segments that have the greatest impact, both positive and negative, on the bus network.
5. **Ensure that streetcar corridors with programmed streetscape improvements consider future streetcar operations.** Some of the corridors included in the long-term streetcar network are slated for major streetscape and reconstruction over the next 5 years. To help make streetcars more cost-effective, some of these streetscape projects could incorporate streetcar treatments prior to laying track (such as station bulbouts, utility relocation, etc.). Even if streetcar service is not implemented in these corridors right away, this may help identify the most logical shortest operable segment.

Chapter 1. Introduction

In March 2006, the City of Minneapolis authorized Meyer-Mohaddes Associates and its subconsultants Nelson\Nygaard Consulting Associates, Short, Elliot, Hendrickson (SEH), and Richardson, Richter & Associates to study the feasibility of implementing a streetcar network in Minneapolis. The study is being conducted in conjunction with the Access Minneapolis Ten-Year Transportation Action Plan, which lays the groundwork for transportation improvements that are designed to meet the long-term objectives of the Minneapolis Plan.

The Access Minneapolis project recommends a series of Primary Transit Network (PTN) corridors, which can be defined as a network of high-frequency; all-day transit services that are intended to carry the majority of transit ridership in the city. The PTN corridors are designed to be "mode neutral" – that is PTN routes can be operated by any appropriate transit technology (bus, streetcar, light rail, etc.) so long as certain performance quality standards are met. This Streetcar Feasibility Study builds on the work of the Access Minneapolis project by evaluating 14 PTN corridors for potential streetcar operations.

The primary goals of the Streetcar Feasibility study are to:

- Evaluate the feasibility and cost of developing streetcar services in these corridors;
- Identify initial operating segments for streetcar operations;
- Prioritize future streetcar investments; and
- Assess potential as catalyst for development.

In order to accomplish the goals of this study, the evaluation has been conducted in a series of phases. Phase I first developed a set of evaluation criteria and, based on those criteria, "screened" each of the 14 candidate corridors to eliminate those corridors (or segments of corridors) with significant or serious physical flaws. The Phase I analysis also screened out corridors where land use and zoning are not expected to be supportive of streetcar investments (during the life of the plan). Based on this screening process, the remaining corridors were put through a more rigorous evaluation. The Phase II analysis added additional information, including utility impacts, additional land use information and impacts on the bus network. The results of these analyses are summarized in Chapter 2 of this report. This third and final major phase of analysis provides detailed operating and capital plans and preliminary costs for each of the corridors, and identifies initial operating segments for each corridor. There are almost no examples of the initial segment of new streetcar lines being built in North America that are as long as existing bus lines in Minneapolis. Therefore, initial operating segments have been identified which may be buildable and would provide a needed service, but could be expanded on in the future to replace significant amounts of bus service.

This report is the final phase of the study, Phase III, which includes a detailed operating and capital plan for the corridors carried forward from Phase II, including more refined operating/capital cost estimates and ridership estimates.

Following this phase of analysis, a final report will be developed which will include a detailed review of potential funding sources, owner/operator arrangements and how the network might be phased in over time.

It should be noted that this feasibility study focuses exclusively on modern streetcar operations. Although similar in many ways to historic or replica streetcar vehicles, modern streetcar vehicles have unique operating characteristics that were considered when evaluating each corridor, such as wider turning radii, overhead clearance and stations that are accessible to people with disabilities.

This Phase III report includes the following chapters:

Chapter 2. Summary of Phase I and Phase II Evaluations. This chapter reviews the results of the Phase I and Phase II evaluations and presents the long-term streetcar network for Minneapolis.

Chapter 3. Shortest Operable Segments. This chapter presents several "shortest operable streetcar segments" that could be implemented in the short-term but build toward the long-term network.

Chapter 4. Operating Plans and Operating Costs. This chapter presents operating scenarios and annual operating costs for the long-term streetcar network as well as the shortest operable segments identified in Chapter 3.

Chapter 5. Ridership Estimates. Based on existing bus ridership, and criteria that make transit attractive, this chapter presents ridership estimates for each of the long-term streetcar corridors and shortest operable segments. Ridership estimates for the Midtown Greenway were prepared by the Hennepin County Regional Railroad Authority.

Chapter 6. Capital Costs. This chapter presents order-of-magnitude capital costs for the long-term streetcar network, which includes the shortest operable segments. In addition to a standard cost per track mile, major capital items are identified and added to the cost of each segment.

Chapter 7. Maintenance and Storage Facilities and Potential Sites. This chapter presents basic requirements for a streetcar maintenance and storage facility, and identifies some general areas where a facility might be appropriate.

Chapter 8. Summary and Next Steps. Because the entire network will not be developed at one time, this chapter presents a preliminary phasing plan. A list of additional steps required to identify an initial segment is included.

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Chapter 2. Summary of Phase I and Phase II Evaluations

The first phase of the study, Phase I, evaluated 14 candidate corridors and "screened" them based on geometric and physical characteristics that are supportive of streetcar operations. Phase I also screened out corridors where planned land use and existing zoning are clearly not supportive of streetcar investments over the next 20 years. The Phase I evaluation eliminated some candidate corridors from further study, as well as portions of several others. The results of that initial evaluation are summarized in Figure 2-1 below.

Figure 2-1 Candidate Streetcar Corridors Carried Forward to Phase II Evaluation

Candidate Corridor	Carried Forward from Phase I Evaluation	Corridor evaluated in Phase II	Reason for Not Carrying Forward to Phase II Evaluation
W Broadway Ave	Yes, entire corridor	Downtown to Robbinsdale Transit Center	–
Central Ave NE	Yes, south of 29th Ave NE	Downtown to 29th Ave NE	Railroad crossing at 36th Ave NE (could be extended to Columbia Heights Transit Center at some future date if this is resolved).
Chicago Ave S	Yes, north of Lake St	Downtown to Lake St	Low transit-supportive land use south of Lake St
15thAve SE / Como Ave	No	–	Low underpass at 8th St SE
Franklin Ave	Yes, between Nicollet Ave S and Chicago Ave S	Nicollet Ave S and Chicago Ave S	Steep grade east and west of Lyndale Ave S; low overpass at Hiawatha Ave
Fremont Ave N / 44thAve N / Osseo Rd	No	–	No strong anchor north of 44thAve N / Penn; Difficult turns at Fremont/Plymouth; Low transit-supportive land use along entire corridor
Hennepin Ave S	Yes, entire corridor	Downtown to Lake St / Lagoon Ave	–
Lake St / Midtown Greenway	Yes, west of Hiawatha Avenue	Southwest LRT to Hiawatha LRT	Low transit-supportive land use east of Hiawatha (could be extended at some future date if density of land use changes).
Nicollet Ave S	Yes, entire corridor	Downtown to 66th St in Richfield	–
University Ave SE / 4th St SE	Yes, entire corridor	Downtown to Washington Ave SE	–
Cedar Ave / Riverside Ave	No	–	Turning movements at Seven Corners; possible duplication with Hiawatha and Central LRT
Washington Ave	Yes, entire corridor	West of I-35W	–
Penn Ave N / Hwy 55	No	–	No strong anchor north of 44thAve N / Penn; Low transit-supportive land use along entire corridor
Lyndale Ave S / Bryant Ave S	Yes, north of Lake	Downtown to Lake St	No strong anchor south of Lake St; Low transit-supportive land use south of Lake St

The corridors carried forward from the Phase I screening evaluation are at least technically feasible for operation as a streetcar corridor. However, not all corridors are equally well suited for streetcar operations in the short-term. The purpose of the Phase II evaluation was to develop a long-term streetcar network, which could be implemented over the next 20 or more years. This potential streetcar network is a long range vision, which can not be implemented in a single phase. Over the next 20 years, many land use changes are predicted for Minneapolis, which may increase or decrease the viability of a particular corridor for streetcar service. New corridors that may not have high potential in this analysis may appear more feasible in the future. The long-term streetcar network proposed in the Phase II report is based on existing and projected information, and may evolve over time.

Figure 2-2 provides a summary of the refined long-term streetcar network that is carried forward to Phase III of the evaluation. Figure 2-3 shows the long-term streetcar network.

Figure 2-2 Streetcar Corridors Carried Forward from Phase II Evaluation

Candidate Corridor	Included in Long-Term Streetcar Network?	Comments / Explanation
W Broadway Avenue (Robbinsdale Transit Center to downtown)	Yes	Lacks high intensity land uses but shows long-term potential, especially east of Penn Avenue N.
Central Avenue NE (Columbia Heights Transit Center to downtown)	Yes, extended to Columbia Heights Transit Center	Lacks high intensity land uses but shows long-term potential, especially near Lowry Avenue NE and in East Hennepin area. Extended to the Columbia Heights TC due to the impact on the underlying bus network (assuming issues related to at-grade rail crossing are resolved).
Chicago Avenue S (38th Street to downtown)	Yes	High intensity land uses along entire corridor with both short- and long-term potential. At least two potential alignments through downtown are included.
Franklin Avenue	No	Does not work well as a stand-alone corridor.
Hennepin Avenue S (Uptown to downtown)	Yes	High intensity land uses in Uptown and in downtown with short-and long-term potential.
Lake Street	No	Good potential to impact local bus network and more traditional streetcar corridor. However, has less potential as a regional connection between LRT lines compared to Midtown Greenway. Lake Street is in process of major reconstruction and streetscaping project.
Midtown Greenway (West Lake Station to Hiawatha/Lake Station)	Yes	Good redevelopment potential and ease of transit operations. Better than Lake Street at providing regional connection between Hiawatha and Southwest Corridor LRT lines. Will function more as a regional service (similar to LRT) than a local streetcar service.
Nicollet Avenue S (46th Street to downtown)	Yes, only as far as 46th Street	High intensity land uses (north of Lake Street) with strong potential to impact local transit services. 46th Street determined to be the best southern terminal location because of the planned I-35 BRT station and bus service drops off south of 46th Street. *Note: would not be included if the Uptown/Nicollet alignment is chosen for the Southwest Corridor LRT line.*
University Avenue SE / 4th Street SE (U of M campus to downtown)	Yes	High intensity land uses in downtown, East Hennepin area and around the University of Minnesota. Both short and long-term potential.
Lyndale Avenue S	No	Less redevelopment potential and minimal impact on transit operations. Higher capital costs than other corridors.

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Figure 2-3 Long-Term Streetcar Network Carried Forward from Phase II Analysis

Source: MetroGIS, Met Council, and the City of Minneapolis

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Future transit corridor sources:

1. Central Corridor LRT: Metropolitan Council
2. I-35 BRT: MnDOT
3. Southwest Transitway: Southwest Transitway.org
4. Bottineau BRT: Metro Transit

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Chapter 3. Shortest Operable Segments

Most modern streetcar implementations in North America have consisted of initial operating segments that are quite short (1-5 track miles in length). Figure 3-1 shows segment lengths from a number of peer properties. Shorter segments are generally selected both because of complex public-private funding arrangements that require benefit districts, or other types of local funding to be developed; and for speed of implementation. Streetcar segments are generally designed with longer lines in mind, allowing for extension or expansion in the future. In Portland, for example, the initial streetcar line, which was 4.8 track miles long (2.4 route miles), has been extended twice and another short extension is underway. By mid-2007, the line will include a total of 7.7 track miles (4.3 route miles), with future extensions to the Central Eastside and Lake Oswego (a nearby suburb) already planned.

Figure 3-1 Peer System Streetcar Segment Lengths

City	Segment	Year Implemented	Route Miles	Track Miles
Portland, OR	(NW 23rd Ave to Portland State University)	2001	2.4	4.8
	(Portland State University to Riverplace)	2005	0.6	1.2
	(Riverplace to SW Gibbs)	2006	0.9	0.9
	(SW Gibbs to SW Lowell)	2007	0.4	0.8
	Total		4.3	7.7
Tacoma, WA	(LINK Light Rail)	2003	1.0	2.4
Little Rock, AK	(Downtown to N. Little Rock)	2004	2.5	2.5
	(Clinton Library Extension)	2007	0.5	1.0
	Total		2.5	3.5
Memphis, TN	(Main Street)	1993	2.5	5.0
	(Riverfront Loop)	1997	2.5	2.5
	(Madison Line)	2004	2.2	4.4
	Total		7.2	11.9
Tampa, FL	(TECO Line)	2003	2.4	3.2

This chapter identifies the "shortest operable segments" that could be implemented in the next 5 years, if funding were available. Shortest operable segments include portions of the long-term network that are generally no more than 1-2 miles in length and also serve an important short-term circulation function. The initial segments are the building blocks of the long-term network.

It should be noted that in consultation with City staff, the Project Steering Committee, the Mayor and several City Council members and other local stakeholders, slightly longer lines were identified as being more desirable for initial implementation if possible. The shortest operable segments and possible extensions for initial implementation are shown on Figure 3-2 later in this chapter. Additional analysis will be completed in the Draft Final Report to determine whether these longer segments are practical as an initial implementation stage. Costing and operating plan information provided throughout this report refer only to the Shortest Operable Segments listed above.

This chapter does not make a final recommendation as to which shortest operable segment should be implemented first. That decision will be driven by the level of community support, private sector interest and ability to generate sufficient capital and operating funding for the segment.

Process for Selecting Shortest Operable Segments

Guidelines for selecting the shortest operable segment on each potential corridor were developed in order to ensure that even an initial segment would be viewed as a success. A well selected initial segment will not only generate further interest in streetcars, but will also build confidence that streetcars can successfully be integrated into the transportation network. An unsuccessful initial segment almost guarantees minimal investment in future extensions and a general lack of support for completing the long-term network.

Several general guidelines used to select the shortest operable segments are discussed below:

1. Avoid segments that may conflict with other decisions.

In general, it is important to avoid major projects that could conflict with (or delay) the development of an initial streetcar line. Several proposed developments and transit projects are well into the planning and/or development stages that could have a major impact on an initial streetcar alignment, including:

- **The Metrodome.** As one of the major landmarks in downtown Minneapolis, plans call for demolition of the Metrodome and construction of a new Vikings stadium on the existing site. The Metrodome sits just east of Chicago Avenue (Kirby Puckett Place) between 4th and 6th Streets, encompassing much of the East Downtown area. The most recent plans include a new retractable stadium surrounded by new development east of the stadium that would include as many as 4,500 new housing units, 1.7 million sq. ft. of office and a new hotel. Chicago Avenue would remain a through street under the new plans, but would be closed regularly for events at the new stadium.

- **Southwest Corridor LRT.** While LRT has been selected as the preferred mode, the preferred alignment of the Southwest Corridor LRT line is still being evaluated. Currently, several possible alignments into downtown Minneapolis are being evaluated, two of which present major conflicts with streetcars – Hennepin Avenue and Nicollet Avenue S – and would likely preclude streetcars from operating in that segment of the corridor.
    - The Hennepin Avenue S alignment would branch off of the Kenilworth alignment at Dunwoody Boulevard and continue into downtown Minneapolis via Hennepin Avenue.
    - The Uptown/Nicollet alignment would travel in the Midtown Greenway to Nicollet Avenue S and continue (underground from the Greenway to Franklin Avenue) into downtown Minneapolis via the Nicollet Mall.

While service connecting to these major land use and transportation hubs will ultimately be very important, selecting segments for short-term implementation that conflict with studies or planned construction activities is not desirable.

2. The initial line needs to be successful from the beginning

Another important feature of an initial streetcar line is that it needs to be successful from the beginning. While this may seem intuitive, the key to achieving early success is to connect major nodes and serve many transit riders. Success should be judged based on the number of streetcar riders, the impact on overall transportation operations as well as the impact on the urban environment and economic development.

Based on this criterion, segments that are downtown or that connect close-in neighborhoods to downtown have high potential to attract riders immediately and to complement development patterns. A line serving downtown would be highly visible, not just to those that use it, but to everyone working, living in and visiting the downtown area. The other major activity centers that may justify an initial streetcar line include the East Hennepin area, Uptown and the Dinkytown/University of Minnesota area.

3. Avoid major capital costs

Some of the streetcar corridors included in the "long-term network" have some segments which will require a special treatment and an unusually high cost. For example, the Hennepin Corridor, connecting Uptown to downtown, requires going through the Hennepin/Lyndale "bottleneck" at I-94. Getting through this area may require special treatments with higher than average construction costs. Similarly, bridge crossings, the availability of a maintenance/storage facility, the complexity of the turnaround location and other physical challenges may result in higher than average capital investment. Burdening a short starter line with a very expensive element could potentially jeopardize funding for

the entire project. Ideally, the initial starter segments would avoid areas which require unusual expense. Once the streetcar has been proven, it is more likely that an extension will be supported, even when higher costs are required to manage a physical limitation.

4. Ensure that the short segment leads to a longer line

In order to build toward the long-term streetcar network, it is important that a starter line leads to a longer corridor. While it is also ideal if the initial streetcar line through downtown Minneapolis follow the PTN network, minor adjustments may be appropriate as long as the line eventually points toward a longer corridor.

Refining the Shortest Operable Segments

Based on the guidelines presented above, and an iterative process with City Staff, project consultants and the Project Steering Committee, the following shortest operable segments were identified:

- **Hennepin Avenue** from Groveland to E. Hennepin and University/4th.
- **Washington Avenue** from 10th Ave N to Nicollet Ave/5th Street (LRT station)
- **Washington Avenue** from 10th Ave N to Park Ave/5th Street (LRT Station)
- **Nicollet Avenue** from Grant Avenue (Convention Center) to Washington Avenue
- **9th/10th Streets and Nicollet Avenue** from 14th Street/Chicago Avenue to Nicollet Avenue/Washington Avenue.

The shortest operable segments listed above represent the minimum length that is recommended as an initial streetcar line. However, based on feedback from City staff, the Project Steering Committee, the Mayor and several City Council members, it was recommended that the project team evaluate short extensions of several shortest operable segments to serve neighborhoods just beyond downtown. Lengthening the initial segments in the Washington Avenue / W Broadway, Chicago and Nicollet corridors was recommended to reach beyond the immediate downtown core area. While a more detailed evaluation of possible extensions in these corridors will be prepared for the Draft Final report, an initial discussion of the major issues involved in extending the initial segments in each corridor is provided below.

- **Chicago Avenue S.** Currently, this shortest operable segment terminates at 14th Street and Chicago Avenue between 9th and 10th Streets. The next major street outside of downtown is Franklin Avenue, where connections to the crosstown Route 2 can be made. While this is the first *reasonable* extension outside of downtown, the most logical location for an extension outside of downtown is Lake Street. An extension only to Franklin would still fall short of the major hospitals along Chicago and Metro Transit would not likely operate short lines from Franklin (once the full

corridor is completed) – thus the underlying bus volumes would need to remain in the corridor even with this short extension. An extension to Lake Street would also make an important connection to Routes 21 and 53.

- **Nicollet Avenue S.** The shortest operable segment along Nicollet terminates at Grant Street on the south end. As with the Chicago corridor, the next *reasonable* extension outside of downtown would be to Franklin, where connections to Route 2 can be made. While Franklin is a reasonable extension, a more logical extension outside of downtown would be to Lake Street for several reasons:
  - A connection can be made to Routes 21 and 53,
  - The intensity of development is uniform between Franklin and Lake Streets, and
  - Short lines from Lake Street are more likely than from Franklin.
- **Washington Avenue / W Broadway.** The shortest operable segment in this corridor currently ends at 10th Street N. While the intensity of development drops off significantly north of 10th Avenue N, it was suggested that this corridor be extended at least to W Broadway. Once an extension has gone that far north, however, it makes sense to at least continue west to at least Lyndale Avenue where connections to Route 22 can be made. Continuing even beyond Lyndale to Fremont Avenue offers additional advantages including
  - Providing a connection to Route 5 (one of Metro Transit's most productive local routes), and
  - Serving the most intensely developed section of the W Broadway corridor.

Turnaround Considerations

With the exception of the Midtown Greenway, streetcars in Minneapolis are assumed to operate in mixed traffic on major thoroughfares. Therefore, turnaround locations for short segments will require a safe location to turn the vehicle around that is off of the main corridor. Unlike buses, streetcars require additional infrastructure (track, overhead power, etc.) to provide a safe place for the vehicle to stop, layover and turn around. Because modern streetcar vehicles can be operated from either end, a common method for turning streetcar vehicles around includes two tracks merging into a single lane in the roadway median, out of traffic (see Figure 3-2). Because of traffic on the main corridor, a short section of track will need to be incorporated into a side street with less traffic. Streetcars can also be turned around by looping around a block or creating a small loop in an exclusive right-of-way. These options are far more expensive because they require either exclusive right-of-way, additional track mileage or both.

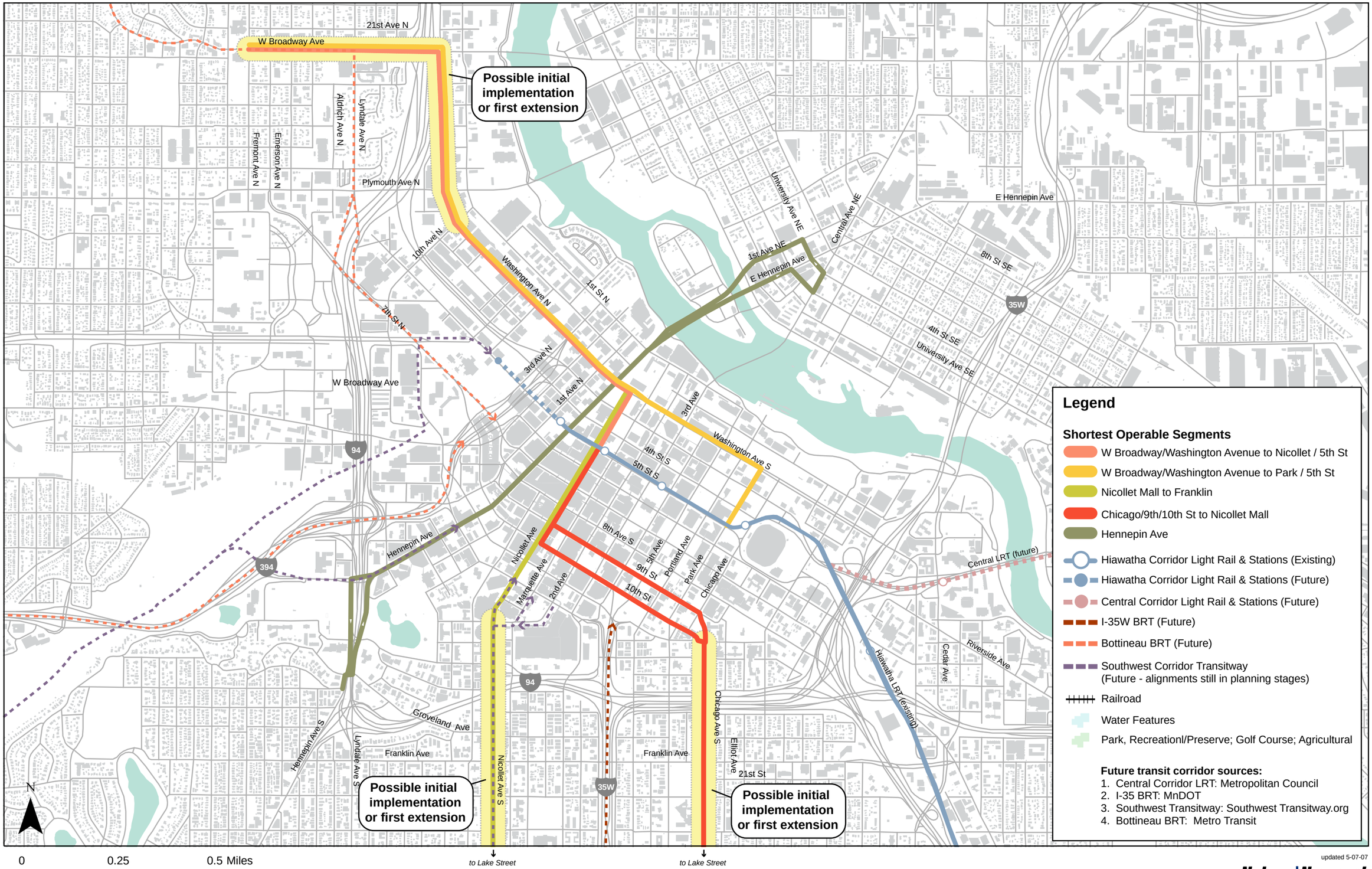
Figure 3-2 Center Lane Streetcar Terminal, Portland, Oregon

From an operational standpoint, there are several important issues that need to be considered when selecting a turnaround location.

- **Short line operation.** Ideally, the location of a turnaround should be useful in the long run by providing a location for "short turns." A short line provides the opportunity to turn some vehicles around and provide more frequent service over the most heavily used part of a line, without bringing every streetcar out to the end of the long line.
- **Abandoned track.** If a turnaround location is not a good location to operate a short line, this will likely become an unused section of track. Because streetcar requires significant capital investment, it is important to avoid unused track if possible.
- **Operating plans.** Assuming streetcar service operates on a regular headway, the location of a turnaround also affects the operating plan, and how much it costs to operate the service. It is important to maximize the time the vehicle is in service versus traveling to a terminal location.

The shortest operable segments and possible extensions are shown in Figure 3-3. It should be noted that for two of the long-term corridors, Central Avenue NE and the Midtown Greenway, no shortest operable segment has been defined. These corridors have good potential as part of a long-term network, but do not have short segments that meet the criteria described above.

Figure 3-3 Shortest Operable Streetcar Segments



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Chapter 4. Operating Plans and Operating Costs

This chapter provides planning level operating plans and estimated costs for the long-term streetcar network developed in Phase II of the report, as well as for the shortest operable segments identified in Chapter 3. Operating plans for the extended initial segments will be developed in the Draft Final Report. The operating plans provide an initial concept for how the proposed streetcar line could integrate with underlying bus service to provide the best possible service to the largest number of riders. Depending on who operates the service and how ridership patterns develop, it may be possible to operate these lines in other ways. However these initial plans are designed to work well with existing services and operations, assuming that the streetcar line and underlying bus service will provide a combined service improvement in the corridor.

Operating plans for the shortest operable segments are presented first as they will be the building blocks of the long-term network. Because of their relatively short length, it is assumed that they will not have an impact on the existing bus network – in other words, for a period of time, existing levels of bus service will operate in the same corridor as the streetcar. Streetcar trips would be primarily local in nature and would generally be very short trips. Longer trips, and trips into the corridor from outlying areas would continue to be made by bus. The service was not designed to "force" transfers between the "long line" bus service and the "short line" streetcars in the short-term, as this would require more streetcar service than would otherwise be justified, and would require large numbers of passengers to make transfers very close to their ultimate destinations.

Operating plans for the long-term network is presented at the end of this chapter. Long-term plans in each corridor assume that the full corridor has been implemented. Because the long-term network includes relatively long corridors, in most cases the underlying bus network would be modified to significantly reduce the number of buses in the corridor in favor of streetcar service. While this does require some transfers from bus to streetcar, this plan avoids requiring passengers to transfer at the very end of their trip, a condition that discourages transit ridership. Where transfers are required, every effort should be made to ensure seamless timed transfers are provided.

The operating plans are based on several key variables:

- **Length of the corridor.** This is the round trip distance of the streetcar line in miles.
- **Travel speed.** Streetcar travel speed will vary by corridor and time of day. Average travel speeds, including stops, were estimated between 8-10 mph during the peak period and between 10-15 mph during other times. Streetcar travel speeds were

adjusted based on the peak and midday travel speeds of the underlying bus network in each corridor. Travel speeds should be at least 30% of the speed limit, as proposed for the PTN network. The Midtown Greenway, with exclusive ROW, was estimated at a consistent 18 mph throughout the day.

- **Layover requirements.** Assuming Metro Transit would be the streetcar operator, layover time for streetcar is the same as for bus, or 15% of the total round-trip running time.
- **Frequency of service**. This parameter varies greatly for each corridor and was based on the impact streetcar would have on the underlying bus network. Frequencies need to mimic the underlying bus network **or** operate every 15 minutes (as proposed for the PTN network), whichever is more frequent. Frequencies can fluctuate depending on the day of the week, but should never be less frequent than every 15 minutes.
- **Hours and days of service.** Total hours of service for the long-term network should mimic that of the underlying bus network, or a minimum of 18 hours per day[4], whichever is greater. This is also the standard established for the PTN network. Streetcar service is assumed to operate 255 weekdays, 52 Saturdays and 58 Sundays and holidays annually. Initial lines would operate 16 hours on weekdays and Saturday and 14 hours on Sunday.

Based on these parameters, it is possible to develop planning level estimates of:

- **Total annual revenue hours**. This is the total number of hours each streetcar line is in revenue service. It does not include "deadhead" time, or non-revenue time at the beginning and ending of each shift. Transit service levels are generally expressed in terms of service hours.
- **Fleet requirement.** This includes the maximum number of vehicles required to operate each line during peak periods *plus* an additional factor for spare vehicles.

Once **total annual revenue hours** and the total **fleet requirement** have been estimated, it is possible to generate estimates of **total annual operating costs** and **capital costs associated with streetcar vehicles**.

Capital costs associated with streetcar service include the peak number of vehicles required to operate the line plus additional spare vehicles. As a general rule of thumb, a 20% spare factor is generally sufficient. However, this factor may be lower depending on the total size of the fleet. For the purposes of this analysis, a spare factor of 20% is used to estimate capital costs for vehicles.

[4] For the shortest operable segments, it is more appropriate to operate the service 16 hours/day during the weekday and Saturdays and 14 hours/day on Sundays.

Total annual operating costs are estimated simply by multiplying the estimated annual revenue hours by a standard operating cost per revenue hour. The standard operating cost per revenue hour is described in more detail below.

Standard Operating Cost per Revenue Hour

The operating cost for streetcar service, as with any type of transit service, is driven by the number of hours and miles operated, and by the cost for a unit (usually a revenue hour) of operation. The number of revenue hours and revenue miles operated by any transit service is a direct result of the parameters outlined above. For example, increased frequency of service usually increases the number of vehicles required and results in a greater number of operators, which results in higher costs. The cost per revenue hour is unique to the operator providing the service and reflects prevailing wage rates, operator-specific overhead costs, costs specific to the vehicles purchased, etc.

Based on experience in other cities that operate bus and streetcar service, streetcar operating costs average 35-50% higher than the hourly cost for bus service.[5] Even at properties that operate modern streetcars, streetcar operation tends to be more costly than bus. Generally, there are more buses in operation than streetcars, resulting in economies of scale for that mode.

In Portland, for example, an hour of streetcar service costs about $130 compared with about $85 for a fully allocated hour of bus service. In this case, the streetcar includes fully allocated administrative, marketing and other ancillary expenses that are unique to the streetcar. This 52 percent "premium" for an hour of service is at the high end of what could be expected in Minneapolis – especially in the long-term. The premium is due to the maintenance of track-way and a unique vehicle which requires separate shop facilities, etc. as well as the lack of economies of scale that accrue to larger fleets.

Based on data from the 2005 National Transit Database, Metro Transit's fully allocated operating cost per revenue hour for buses is approximately $99.83. By comparison, the operating cost per revenue hour for light rail (LRT) is $165.22. Generally, operating costs for streetcar is between bus and light rail operating costs. For planning purposes, and as a conservative estimate, this study assumes a 50% premium over bus operating costs for streetcar, or approximately $149.75 per revenue hour.

Operating Plans for Shortest Operable Segments

As discussed in Chapter 3, and shown in Figure 4-1, operating plans were developed for the following shortest operable segments:

[5] This is based on a review of all currently operating streetcar systems in the United States conducted by Nelson\Nygaard, which compared hourly operating costs to hourly operating costs for local bus service.

- **Hennepin Avenue** from Groveland to E. Hennepin and University/4th.
- **Washington Avenue** from 10th Ave N to Nicollet Ave/5th Street (LRT station)
- **Washington Avenue** from 10th Ave N to Park Ave/5th Street (LRT Station)
- **Nicollet Avenue** from Grant Avenue (Convention Center) to Washington Avenue
- **9th/10th Streets and Nicollet Avenue** from 14th Street/Chicago Avenue to Nicollet Avenue/5th Street.

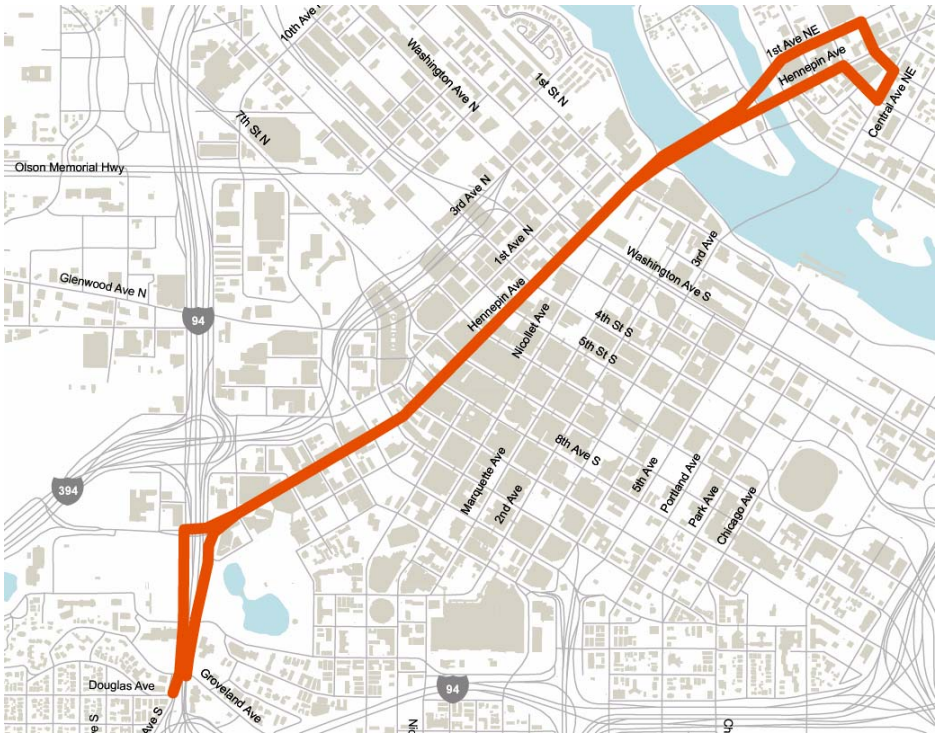
A detailed description of the operating plans for each of the short segments is provided below. Because none of the initial segments would have an impact on the underlying bus network, all are proposed to operate on 15 minute headways, seven days a week. During weekdays and Saturday, the service would operate a total of 16 hours. Service hours would be reduced to 14 hours on Sundays.

It should be noted that operating plans for the possible extensions of the shortest operable segments will be developed and refined in the Draft Final Report. It is also possible to rearrange the shortest operable segments into different alignments than have been identified here. These issues will be explored further in the Draft Final Report.

Hennepin Avenue

The shortest operable Hennepin Avenue segment would travel from just south of the Walker Art Center to the East Hennepin area, mostly via Hennepin Avenue. The streetcar line would be double-track on Hennepin from I-94 to the Mississippi River. On the south end of the line, the terminal station could be integrated into the short segment of Douglas Avenue just south of Groveland Avenue (west of Hennepin). On the north end, the streetcar would use Hennepin Avenue northbound, turn eastbound on University Ave SE and then return via Central Ave NE, 4th Street SE and 1st Ave NE. All portions of this segment would operate in mixed traffic.

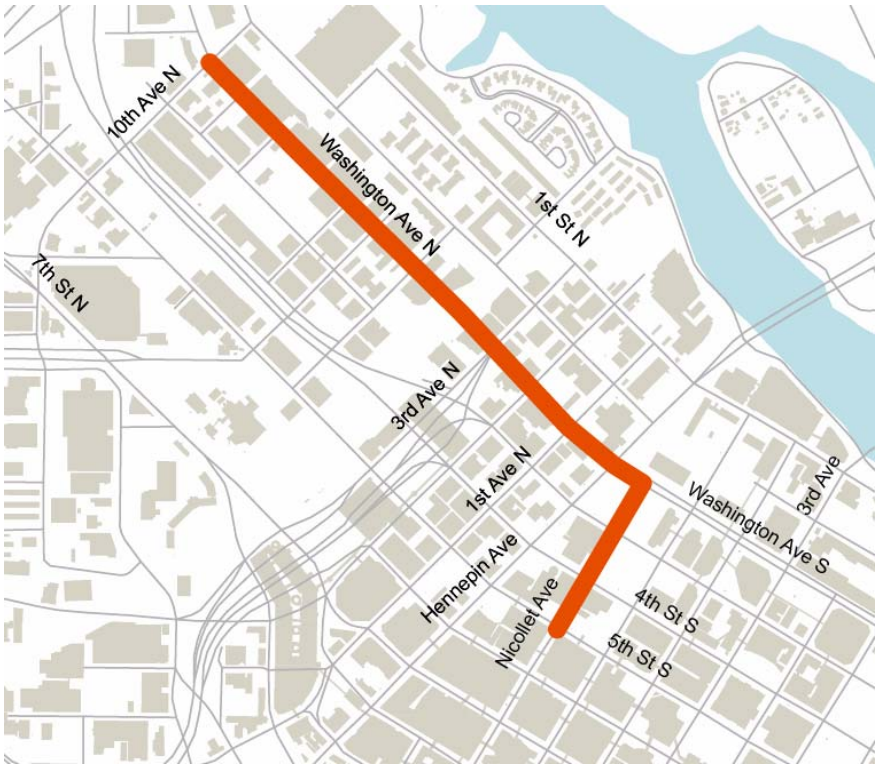
The line is 2.6 route miles (5.1 track miles). A maximum of three in-service vehicles would be required to maintain 15-minute headways.



Washington Avenue to Nicollet

The first shortest operable segment including Washington Avenue would travel from the North Loop area to the inner core of downtown and the Hiawatha LRT station at 5th Street via Nicollet. This segment would be double track on Washington and feed into a short single-track segment between Washington Avenue and the LRT station at 5th Street – ideally in an exclusive right-of-way that would not interfere with the buses operating on Nicollet. On the north end, the line would have a terminal station on 10th Avenue N, likely between Washington Avenue and 2nd Street N.

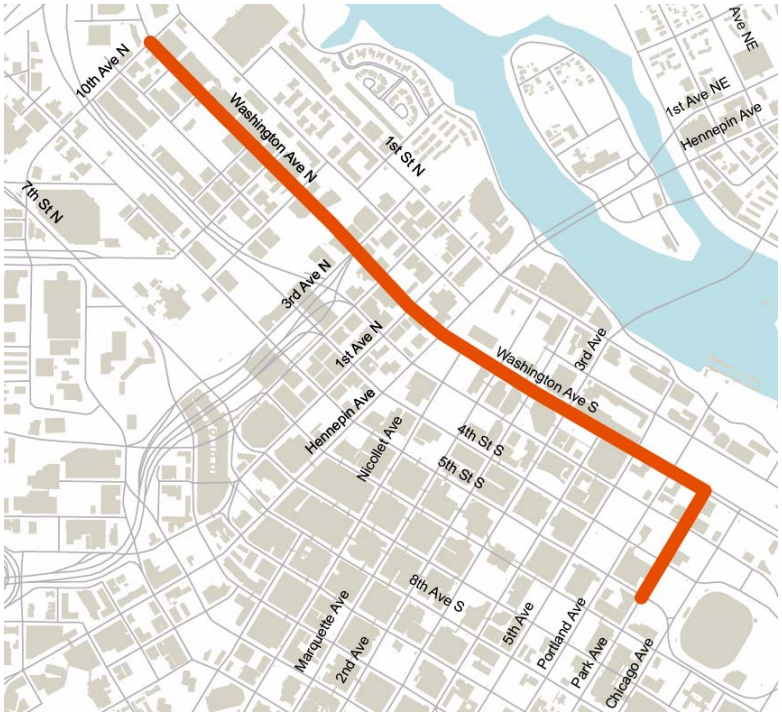
This line is 1.2 route miles (2.1 track miles). A maximum of two in-service vehicles would be required to maintain 15-minute headways.



Washington Avenue to Park

The second shortest operable segment including Washington would have the same alignment on the north end but continue on Washington Avenue and turn south on Park Avenue to the Hiawatha LRT station between 4th and 5th Street. The entire line would be double-track.

This line is 1.7 route miles (3.4 track miles). A maximum of two in-service vehicles would be required to maintain 15-minute headways.



Nicollet Avenue

This line would connect the Convention Center with the inner core of downtown (including the Hiawatha LRT station at 5th Street) and serve Minneapolis' most prominent street. The line would be double-width the entire way from Grant Street to Washington Avenue. Due to the volume of buses that are proposed to operate with streetcar service on Nicollet Avenue, an exclusive section of track is recommended on the north and south ends of the line for layover purposes[6]. On the south end, an initial segment may include a short spur to serve the front door of the convention center and layover on a less congested street than Nicollet.

This line is 1 route mile (2.0 track miles). A maximum of two in-service vehicles would be required to maintain 15-minute headways.

[6] If streetcar service has a regular impact on bus operating speeds on Nicollet, some buses may need to be re-routed to other north-south corridors, such as Hennepin or Marquette/2nd.

9th/10th Streets to Nicollet

This line would connect the Elliot Park neighborhood to the inner core of downtown and the LRT station at 5th Street. Starting from 14th Street and Chicago Avenue, this line would be double track using 9th and 10th Streets and then Nicollet Avenue to the LRT station at 5th Street. Like the other lines using Nicollet, it is recommended that the terminal station on the north end be in an exclusive right-of-way so as not to interfere with the volume of buses required to use Nicollet[7].

The total length of the line (from end to end) is 1.3 miles. A maximum of two in-service vehicles would be required to maintain 15-minute headways.

[7] If streetcar service has a regular impact on bus operating speeds on Nicollet, some buses may need to be re-routed to other north-south corridors, such as Hennepin or Marquette/2nd.

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Figure 4-1 Operating Cost Estimates for Shortest Operable Segments

Shortest Operable Segments	Route Miles	Weekdays			Saturday			Sunday			Annualized				
		Peak Vehicles	Revenue Hours	Operating Cost	Peak Vehicles	Revenue Hours	Operating Cost	Peak Vehicles	Revenue Hours	Operating Cost	Operating Cost			Revenue Hours	Operating Cost
											Weekday	Saturday	Sunday		
Hennepin – from Groveland Avenue to E. Hennepin/Central Avenue NE															
	2.6	3	48	$7,188	3	48	$7,188	**3**	**42**	$6,290	**$1,832,940**	**$373,776**	**$364,791**	**17,172**	**$2,571,507**
Broadway / Washington – from 10th Avenue N to Nicollet / 5th Street															
	1.2	2	32	$4,792	2	32	$4,792	**2**	**28**	$4,193	**$1,221,960**	**$249,184**	**$243,194**	**11,448**	**$1,714,338**
Broadway / Washington – from 10th Avenue N to Park Ave / 5th Street															
	1.7	2	32	$4,792	2	32	$4,792	**2**	**28**	$4,193	**$1,221,960**	**$249,184**	**$243,194**	**11,448**	**$1,714,338**
Nicollet Avenue – from Grant Street to Washington Avenue															
	1.0	2	32	$4,792	2	32	$4,792	**2**	**28**	$4,193	**$1,221,960**	**$249,184**	**$243,194**	**11,448**	**$1,714,338**
9th / 10th Streets / Nicollet – 14th Street / Chicago Avenue to Nicollet / 5th Street															
	1.3	2	32	$4,792	2	32	$4,792	**2**	**28**	$4,193	**$1,221,960**	**$249,184**	**$243,194**	**11,448**	**$1,714,338**

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Operating Plans for the Long-Term Network

The operating plans for the long-term network are based on an assessment of the impact streetcar operations would have on the underlying bus network. Ideally, as streetcar service is expanded in a corridor, underlying bus service can be decreased, as more riders are able to take advantage of streetcar service. Ideally, streetcars would replace buses in a PTN corridor "one-for-one", and still provide enhanced service. While this may be ideal, it is often simply not practical – most of the PTN routes are very long, coming into central Minneapolis from outlying neighborhoods and adjacent suburbs, while the streetcar corridors being studied are either entirely within the City of Minneapolis or continue only to the next adjacent jurisdiction. Corridors can certainly be extended, however implementation timeframes are significantly elongated when multiple jurisdictions are involved. Most modern streetcar implementations in the United States have initially been very short - only a mile or two in length to start - and most cities have planned only one streetcar line at a time. Minneapolis is taking a longer view and is planning a long-term streetcar network that encompasses several highly productive transit routes. This approach is similar to the approach that has been taken by the City of Toronto for many years. The city recognizes that implementation will occur one corridor at a time and recognizes that initial implementation may need to be a very short starter line. It is important, however, that this starter line be one from which the long range system can grow.

Methodology for Developing Operating Plans

The Phase II report developed initial operating plans for each of the candidate corridors carried forward from the Phase I screening report. Based on that evaluation, and through follow-up conversations with City staff, the Project Steering Committee and Metro Transit, several of the candidate corridors were refined for improved operational potential. This chapter provides more refined operating plans for the following corridors that make up the long-term network:

- **W Broadway Avenue/Washington Avenue** – from Robbinsdale Transit Center to downtown via Washington Avenue. Alternative options to serve downtown include via Washington Avenue to Nicollet, or via Washington Avenue to Park Avenue to 5th Street.
- **Central Avenue NE** – from the Columbia Heights Transit Center to downtown via Central Avenue NE and the 3rd Avenue or Hennepin Avenue bridge.
- **University Avenue SE / 4th Street SE** – from University Village to downtown via University Avenue SE / 4th Street SE and Hennepin Avenue and 1st Avenue NE.
- **Chicago Avenue S** – from 38th and Chicago to downtown, either via 9th/10th to Nicollet or via Park Avenue to 5th Street.
- **Nicollet Avenue S** – from 46th Street to downtown entirely on Nicollet Avenue[8].

- **Hennepin Avenue S** – from Uptown to downtown entirely on Hennepin Avenue.
- **Midtown Greenway** – from the West Lake station of the future Southwest Corridor LRT line to the existing Hiawatha LRT station at Lake Street[8].

The following guidelines were used to refine the operating plans and are based on the initial operating plans developed in Phase II:

- Streetcars should only replace bus volumes where significant overlap occurs.
- Forced transfers are undesirable, unless at major turnover locations (such as Uptown, 38th Street/Chicago Ave S, 46th Street / Nicollet Ave S and downtown).
- No major route restructuring was proposed.
- To justify the investment, minimum streetcar service frequency is assumed to be 15 minutes, 16-18 hours per day (PTN levels). More frequent streetcar service would be provided if ridership demanded higher service levels.

Based on these guidelines, bus service was re-evaluated for the corridors that make up the long-term network and an assessment was made as to which, if any, bus routes or trips would be affected if streetcars were present. In the absence of major route restructuring, several strategies were considered for the underlying bus network if streetcar service were introduced:

- **Replacement of bus trips.** If a significant number of buses could be replaced by streetcars, then the base service frequency for streetcars was adjusted accordingly. In other words, if all buses along a particular segment are replaced by streetcars, and the existing service levels are greater than 15 minutes, then streetcar service levels mimic the bus service.
- **Limited stop bus operation.** If it did not make sense to eliminate bus trips with streetcars present, another way to improve the cost effectiveness of operating streetcars is to operate some or all buses along the streetcar corridor on a limited stop basis. This not only speeds up the buses (making the service more attractive to riders beyond the streetcar corridor), but has an impact on bus operating costs.
- **No change to underlying bus network.** In some cases, it was not possible to replace buses, there is no underlying bus service, or there was no significant advantage to limited stop bus operation along the streetcar corridor. In this case, the streetcar was simply another mode and was added to total vehicle volumes and operating costs.

[8] If the preferred Southwest Corridor LRT alignment in Minneapolis is via the Midtown Greenway to Nicollet, the long-term streetcar network would be amended to include a connection only between the 28th Street / Nicollet station and the Hiawatha LRT station at Lake.

Based on this process, revenue service hours and vehicle requirements were developed for streetcar service in each long-term corridor. Likewise, if bus trips were replaced, or buses operated limited stop, an initial estimate of reduced service hours associated with this change was developed.

Possible Connections between Corridors

One of the most important features of any successful transit network is connectivity. Many of the local bus lines in Minneapolis flow into and out of downtown, ultimately forming a radial network where riders can make connections and get to most corners of the city. Route 6, for example, is one of Metro Transit's most productive lines. It serves Uptown via Hennepin Avenue S, traverses the core of downtown and then serves Dinkytown and the University area via University Avenue SE. While this line serves some very dense urban neighborhoods, as well as downtown, one of its strengths is the connection between different parts of the city. This radial network of bus routes is based on the historic streetcar network and is one of the primary features of Minneapolis' transit system.

For the purposes of this study, it is assumed that a long-term streetcar network would function in a similar way, with connections between corridors that feed into and out of downtown. Based on the existing bus network, and travel patterns transit users are accustomed to, the following connections were identified between corridors in the long-term streetcar network:

- **W Broadway Avenue** to **Chicago Avenue S** – via Washington Avenue, Nicollet Mall and 9th/10th Streets
- **W Broadway Avenue** to **Chicago Avenue S** – via Washington Avenue, Park Avenue and 9th/10th Streets
- **Central Avenue NE** to **Nicollet Avenue S** – via 3rd Avenue, Washington Avenue and the Nicollet Mall
- **Central Avenue NE** to **Hennepin Avenue S** – via East Hennepin and 1st Avenue NE
- **Hennepin Avenue S** to **University Avenue SE/4th Street SE** - via East Hennepin and 1st Avenue NE

In addition to connections between the various streetcar corridors, connections to other regional transit services, especially light rail, are also important. All of the corridors in the long-term streetcar network have at least one connection to an LRT station. Depending on the outcome of Southwest Corridor LRT, some of the streetcar corridors could provide connections between two LRT lines (such as the Midtown Greenway, which would connect the Southwest Corridor LRT and the Hiawatha LRT).

Detailed Operating Plans for the Long-term Network

The following section provides a summary of the operating plans for each of the corridors in the long-term streetcar network. Figure 4-2 provides a summary of streetcar service in each corridor along with an estimate of total operating costs. A more detailed description of the operating plans is included in the Appendix.

W Broadway Avenue/Washington Avenue

Long-term streetcar service in this corridor would begin at the Robbinsdale Transit Center (TC), travel south via Broadway Avenue, France Avenue, Oakdale Avenue, and then W Broadway Avenue, Washington Avenue to Hennepin Avenue. The portion of Washington Avenue between W Broadway Avenue and Hennepin Avenue was determined to be the most logical connection to downtown.

While this corridor is served by both Route 14 and Route 32, it was assumed that only Route 14 trips could be affected if streetcars were present in this. Route 32 also serves Lowry Avenue and would continue to be needed. Most Route 14 trips operate from the Robbinsdale Transit Center to south Minneapolis through downtown. Very few existing bus trips on Route 14 end in downtown.

If streetcars were present, it was assumed that all Route 14 trips in this corridor would be replaced. The Route 14 trips that serve other streets in Robbinsdale would be replaced by other routes. All local service on Broadway would be handled by streetcars. It should be noted that Route 14 buses between downtown and south Minneapolis would still continue to operate. Some additional costs would be associated with severing this route in downtown, but at this stage of the analysis that difference was assumed to be negligible.

Because all buses are replaced by streetcars, at least 10 minute frequency is required on weekdays during peak periods, with 15 minute service at all other times. A service span of 18 hours a day was determined to be sufficient for streetcars in this corridor. Streetcar service in this corridor would require approximately 34,000 annual service hours, offset by the reduction of 19,600 in bus hours. Seven streetcar vehicles are required to maintain peak headways in this corridor.

Central Avenue NE

As noted earlier, streetcar service in this corridor was extended from 29th Avenue NE to the Columbia Heights Transit Center, primarily due to the impact this would have on bus volumes. To achieve this, the line will need to resolve an at-grade railroad crossing between 36th and 37th Avenue NE. It is assumed that in the future, the at grade railroad crossing would either be eliminated or a physical alternative will be designed to avoid this crossing.

From the Columbia Heights Transit Center, streetcar service in this corridor would continue via Central Avenue NE into downtown via the 3rd Avenue Bridge. In downtown, this corridor includes a small portion of Washington Avenue between 3rd Avenue and Nicollet.

The only bus route that would be affected by streetcar service in this corridor is Route 10. Because the streetcar corridor was extended to the Columbia Heights Transit Center, all Route 10 trips are replaced by streetcar. Streetcars would provide service at all local stops on Central Avenue NE.

To replace this level of bus service, 10 minute frequency is recommended during peak and midday periods on weekdays with 15 minute frequencies other times of day. To mimic current bus service, it is recommended that the streetcar operate at least 19 hours a day. Streetcars in this corridor would require approximately 40,000 annual service hours, which is offset by approximately 34,100 hours for replaced stop service. Nine streetcar vehicles are required to maintain peak headways in this corridor.

Chicago Avenue S

As discussed in the Phase II report, this corridor is defined as operating from a southern terminus at 38th Avenue to downtown via 9th and 10th Street. The southern terminus was selected to allow for replacement of current short line Route 5 service. The streetcar alignment follows Chicago from 38th Street to 9th/10th Street in downtown. From this point, several alignments are possible: 1) via 9th/10th Street to Nicollet and 2) via Park Avenue to Washington Avenue to Nicollet.

All Route 5 buses that operate from 38th Street to downtown could be replaced by streetcars under this scenario. All other Route 5 buses that operate south of 38th Street would operate very limited stop between downtown and 38th Street (with only one or two stops between 38th Street and downtown). Streetcars would provide all local service on Chicago Avenue. It should be noted that Route 5 buses between downtown and north Minneapolis would still continue to operate, and serve a very important market. Some additional costs would be associated with severing this route in downtown, but at this stage of the analysis that difference was assumed to be negligible.

Although only a portion of buses were replaced in this corridor, it is assumed that streetcar service should mimic bus service in this corridor – especially since streetcar service is serving the local function. Therefore, service frequencies on weekdays would be every 7.5 minutes during peak and midday periods with 10-15 minute frequencies at other times. On weekends, service frequencies would fluctuate from 10-15 minutes. The service span in this corridor should mimic the bus service, or about 23 hours on weekdays and between 20 and 22 hours on weekends.

Streetcar service in this corridor would require approximately 46,000 annual service hours, offset by approximately 16,100 bus hours for some eliminating bus trips and operating limited stop bus service north of 38th Street. Eight streetcar vehicles are required to maintain peak headways in this corridor.

Without extending the streetcar corridor significantly to the south, (to the Mall of America) it is unlikely that streetcars will be able to replace additional buses in this corridor.

Nicollet Avenue S

The Nicollet Avenue S corridor operates from 46th Street on the south into downtown, entirely via Nicollet Avenue S and the Nicollet Mall. Ideally, this will allow Route 18 buses operating north of 46th on Nicollet to be replaced by frequent streetcar service. Passengers on Route 18 traveling north of 46th Street would either transfer to the streetcar line or to the new I-35W BRT line with service directly to downtown Minneapolis.

Based on these assumptions, streetcar service on Nicollet Avenue S would need to operate weekdays every 7.5 minutes, 22 hours a day (to mimic current Route 18 service hours). Service frequency on the weekends would fluctuate from 10-15 minutes, with service between 21-22 hours per day.

Streetcar service in this corridor would require approximately 47,000 annual service hours but could be offset by approximately 43,600 bus hours due to eliminating most Route 18 buses that operate only from 46th Street to downtown. Nine streetcar vehicles are required to maintain peak headways in this corridor.

Hennepin Avenue S / University Avenue SE / 4th Street SE

Streetcar service in the Hennepin Avenue and University Avenue SE / 4th Street corridors have been combined to maximize the impact on the underlying bus network. Streetcar service would operate from Hennepin Avenue and Lake Street to downtown Minneapolis and then to the University of Minnesota via E Hennepin Avenue and University Avenue SE / 4th Street SE. Although a number of bus lines operate on Hennepin Avenue, Route 6 is most directly impacted by streetcar service on Hennepin. Two other significant local routes, Route 17 and Route 12 are assumed to continue via their current alignment even with streetcar service operating in the corridor.

Route 6 provides most of the local service on Hennepin Avenue and provides service to southwest Minneapolis and adjacent suburbs. Although forced transfers are generally undesirable, Uptown is a major destination and transfer location to several cross-town bus routes (Route 21, 23 and 53). Because there is likely significant turnover in Uptown, and because it would be desirable to replace as many bus trips with streetcars as possible, **all** Route 6 buses would terminate at the Uptown Transit Center *except* during peak commute

periods, Monday through Friday. During peak commute periods, all Route 6 buses would continue to downtown Minneapolis or the University of Minnesota as they do currently. The Route 6 buses that operate just from 36th Street and Hennepin and downtown are replaced entirely by streetcar service.

Because Route 17 only serves a portion of Hennepin, and provides a link between Hennepin and Nicollet, it is not recommended to modify this line if streetcars are present. Route 12 operates throughout the day but only serves Hennepin Avenue during peak hours (this route terminates at the Uptown Transit Center at off-peak times). Although Route 12 buses could be terminated at Hennepin all day, this is not recommended because it would be a major inconvenience for passengers, many of whom are likely continuing on to downtown.

Based on these assumptions, streetcar service on Hennepin Avenue would need to be at least as frequent as existing Route 6 service – especially during off-peak periods when all Route 6 buses are proposed to terminate in Uptown. One way to accomplish this is to set up a **short line** and a **long line**. The **long line** would operate from Uptown to the University of Minnesota every 15 minutes during peak periods on weekdays and weekends. Then, a **short line** would operate from Uptown to downtown (terminating near Washington Avenue) every 30 minutes during the midday when higher frequencies are required between Uptown and downtown. During peak periods, when Route 6 buses continue to downtown or the University, service frequencies between bus and streetcar will be slightly higher than existing volumes. During off peak periods, when streetcars are the only continuous local service on Hennepin, frequencies of the short and long line combine to provide 10 minute frequencies between Uptown and downtown. The service span is assumed to operate about 22 hours a day on weekdays and 20 hours per day on Saturdays and Sundays.

Based on these parameters, streetcar service in this corridor would require approximately 46,000 annual service hours, offset by approximately 24,000 hours for eliminating buses that operate only from 36th Street to downtown.

It should be noted that because of the structure of the underlying bus network, the operating plan for this corridor is an integral component of the operating plan for the University Avenue SE / 4th Street SE corridor (see that section below for more detail).

University Avenue SE / 4th Street SE[9]

As noted above in the operating plan for Hennepin Avenue, the **long line** that is required to replace all buses on Hennepin also serves the University Avenue SE / 4th Street corridor. During peak periods (on weekdays only), both buses and streetcar would operate in the

[9] On Figure 4-2, this corridor is analyzed as part of the Hennepin Avenue S/University/4th Street line.

same corridor so that transfers during the peak period are not required in Uptown. Therefore, the combined frequency of streetcar and bus (during peak periods) will provide slightly improved service over current levels. During off peak periods, service frequencies would be every 15 minutes, the minimum requirement to be considered a PTN corridor. This would be an improvement over existing bus headways in this corridor, which range from 20-30 minutes outside of peak periods.

Because the operating costs associated with this plan are included in the Hennepin Avenue corridor, no additional costs are assumed for the University Avenue SE / 4th Street SE corridor. Although the service throughout the day is at least every 15 minutes, at some point in the future additional frequency could be added on the long line to enhance service in this corridor.

Midtown Greenway

Streetcar service in the Midtown Greenway would operate from the West Lake station (along the proposed Southwest Corridor LRT line) to the Hiawatha LRT station at Lake Street. This operating plan assumes a very similar operation to that envisioned by the Midtown Greenway Coalition, which evaluated the potential of a single-track operation with some passing bays.

Streetcar service in this corridor would operate in exclusive right-of-way, more like light rail than traditional streetcar, with stations only at major intersections. For this reason, the Midtown Greenway is very different than other streetcar corridors and serves more as a regional connector than local circulator. Therefore, it was assumed that streetcar in this corridor would not replace any buses along Lake Street and service would be new, additional costs for vehicles and operating costs.

Because streetcar service in the Greenway would be designed around connectivity with light rail, headways should mimic light rail service, or approximately every 7 ½ minutes during peak periods, every 10 minutes during the midday and every 15 minutes in the early morning and evening. Service hours are approximately 21 hours a day. This service would require approximately 28,200 annual service hours and three streetcar vehicles.

Figure 4-2 Operating Cost Estimates for Long-Term Corridors

Long-term Streetcar Network	Weekdays			Saturday			Sunday			Annualized				
	Peak Vehicles	Revenue Hours	Operating Cost	Peak Vehicles	Revenue Hours	Operating Cost	Peak Vehicles	Revenue Hours	Operating Cost	Operating Cost			Revenue Hours	Operating Cost
										Weekday	Saturday	Sunday		
W Broadway Ave/Washington – from Robbinsdale Transit Center to Downtown														
	7	96	$14,376	5	90	$13,478	5	90	$13,478	$3,665,880	$700,830	$781,695	34,380	$5,148,405
Central Ave NE/3rd Ave – from Columbia Heights Transit Center to Downtown														
	9	123	$18,419	6	84	$12,579	5	66	$9,884	$4,696,909	$654,108	$573,243	39,561	$5,924,260
Chicago Ave S/9th/10th - from 38th Street to Downtown														
	8	137	$20,516	7	126	$18,869	5	70	$10,483	$5,231,516	$981,162	$607,985	45,547	$6,820,663
Hennepin Ave S / Univ./ 4th (long line) – from Uptown to the University of Minnesota*														
	7	116	$17,371	6	114	$17,072	6	114	$17,072	$4,429,605	$887,718	$990,147	42,120	$6,307,470
Hennepin Ave S (short line) – from Uptown to Downtown														
	2	12	$1,797	2	12	$1,797	0	0	$0	$458,235	$93,444	$0	3,684	$551,679
Midtown Greenway – from West Lake Station (Southwest Corridor LRT) to Hiawatha/Lake Station (Hiawatha LRT)														
	5	79	$11,830	4	73	$10,930	4	73	$10,930	$3,016,714	$568,451	$634,042	28,175	$4,219,206
Nicollet Ave S – from 46th Street to Downtown														
	9	139	$20,815	7	121	$18,120	6	96	$14,376	$5,307,889	$942,227	$833,808	47,305	$7,083,924

* Includes the University Avenue SE/4th Street SE Corridor.

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Figure 4-3 below provides a summary of the estimated annual operating costs in each corridor, taking into account the reduction in bus service where appropriate.

Figure 4-3 Estimated Impact on Annual Operating Costs

Corridor	Streetcar Service Hours	Annualized Streetcar Operating Cost (1)	Estimated Reduction in Bus Revenue Hours	Annualized Reduction in Bus Operating Cost (2)	Estimated Adjusted Change in Operating Costs
W Broadway Ave/Washington	34,380	$5,148,405	19,600	$1,956,668	$3,191,737
Central Ave NE/ 3rd Ave	39,561	$5,924,260	34,100	$3,404,203	$2,520,057
Chicago Ave S/9th/10th	45,547	$6,820,663	16,100	$1,607,263	$5,213,400
Hennepin Ave S / Univ./ 4th (long and short line)	45,804	$6,859,149	24,000	$2,395,920	$4,463,229
Midtown Greenway	28,175	$4,219,206	0	$0	$4,219,206
Nicollet Ave S	47,305	$7,083,924	43,600	$4,352,588	$2,731,336

(1) Assuming $149.75 per revenue hour
(2) Assumes Metro Transit's fully loaded cost per revenue hour of $99.83 (2005)

Streetcar Cross Sections

Several locations along the long-term network were chosen to illustrate how streetcar tracks could be integrated into the street. Cross sections are illustrated for both double track and single track sections of the corridor. It is important to note that these illustrations are **not to scale** and are only intended to show the location of the streetcar in relation to other uses in the right-of-way (see figures 4-3 to 4-8). Six cross sections are illustrated:

- **Hennepin Avenue between Washington Avenue and 11th Street.** The Hennepin Avenue alignment assumes two-way operation along the entire segment and shared operation in the curb lanes with buses.
- **Typical Community Corridor.** A typical community corridor includes Nicollet Avenue S, which has only one travel lane in each direction and on-street parking.
- **Typical Community Corridor (Neighborhood Commercial Node).** Both Nicollet Avenue S and Chicago Avenue S have neighborhood commercial nodes at various locations along the corridor.
- **Typical Commercial Corridor.** The Washington Avenue, W Broadway Avenue, Central Avenue NE and Hennepin Avenue S corridors typically have two travel lanes in each direction with an on-street parking lane.
- **Typical Downtown One-Way Street.** The one-way streets in downtown typically have three travel lanes and on-street parking on both sides.

Figure 4-4 Hennepin Avenue Typical Cross Section

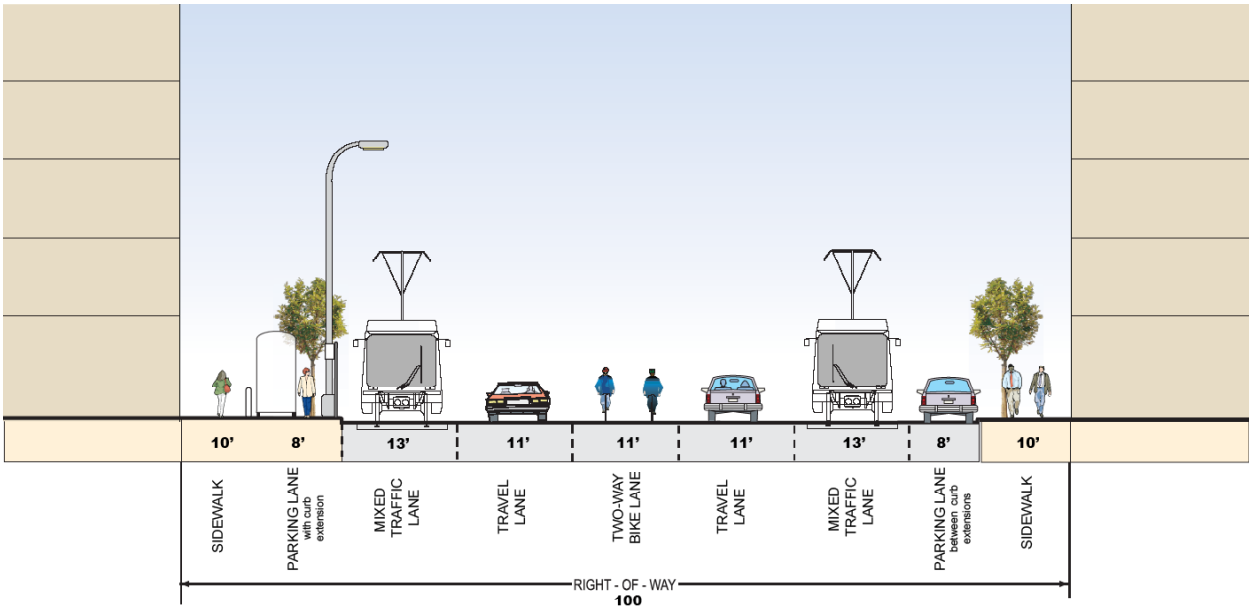


Figure 4-5 Typical Community Corridor Cross Section

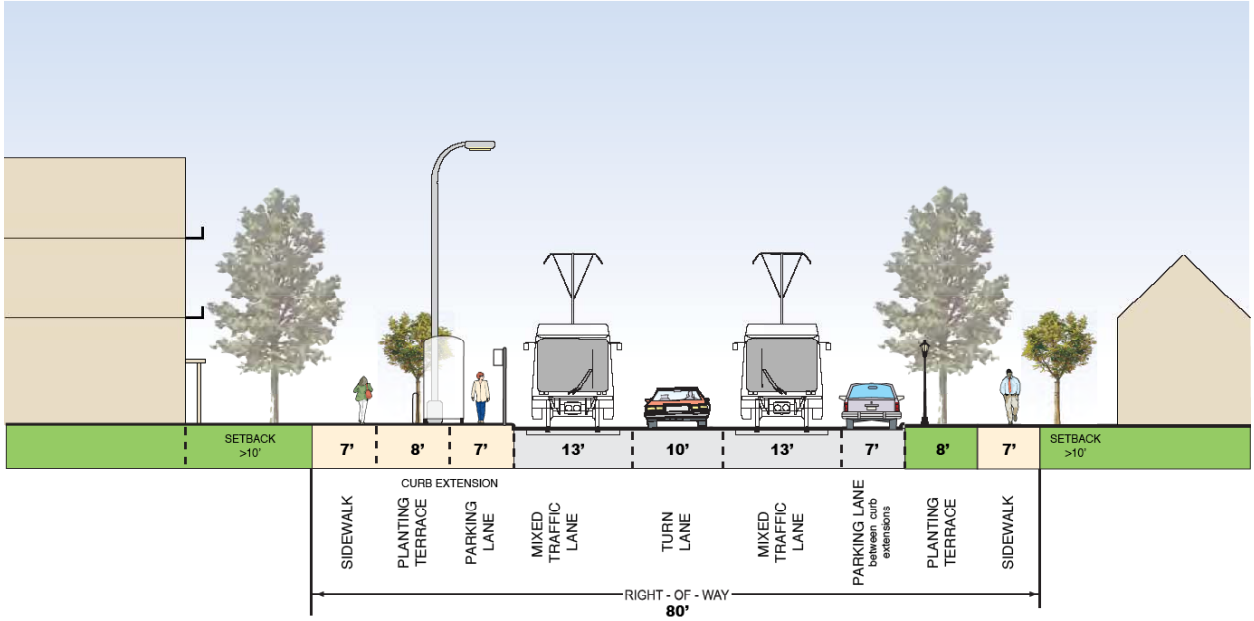


Figure 4-6 Typical Community Corridor Cross Section (Neighborhood Commercial Node)

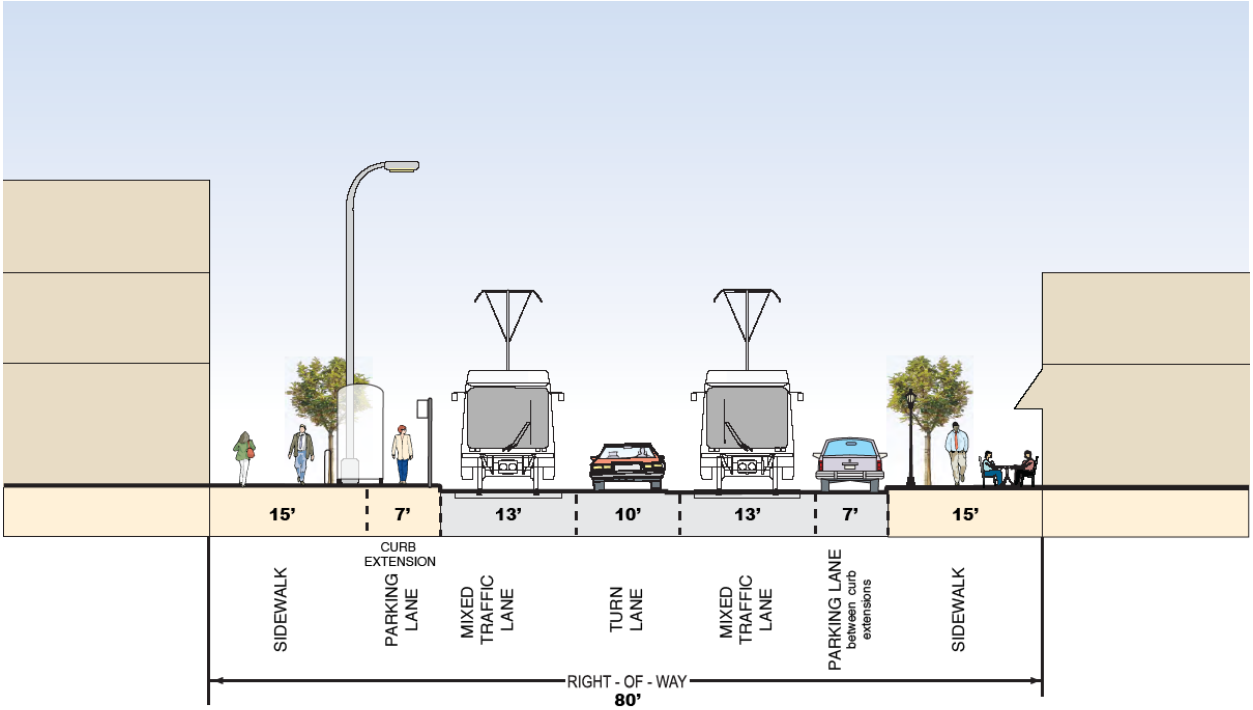


Figure 4-7 Typical Commercial Corridor Cross Section

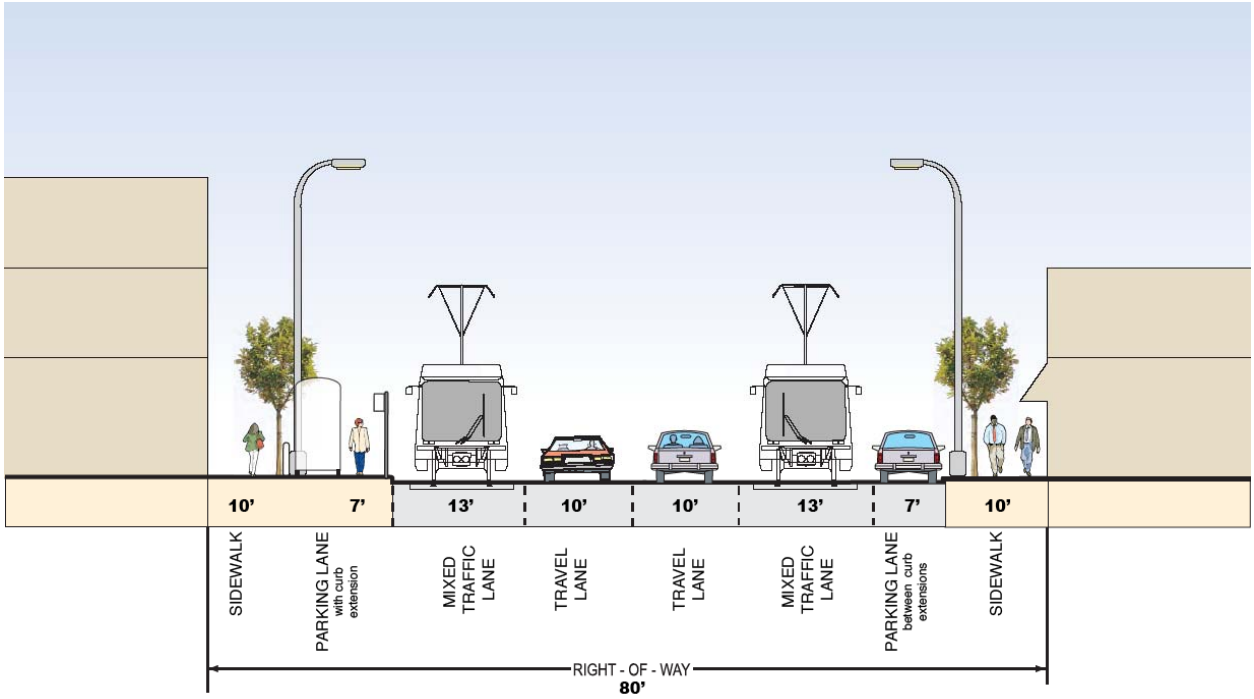
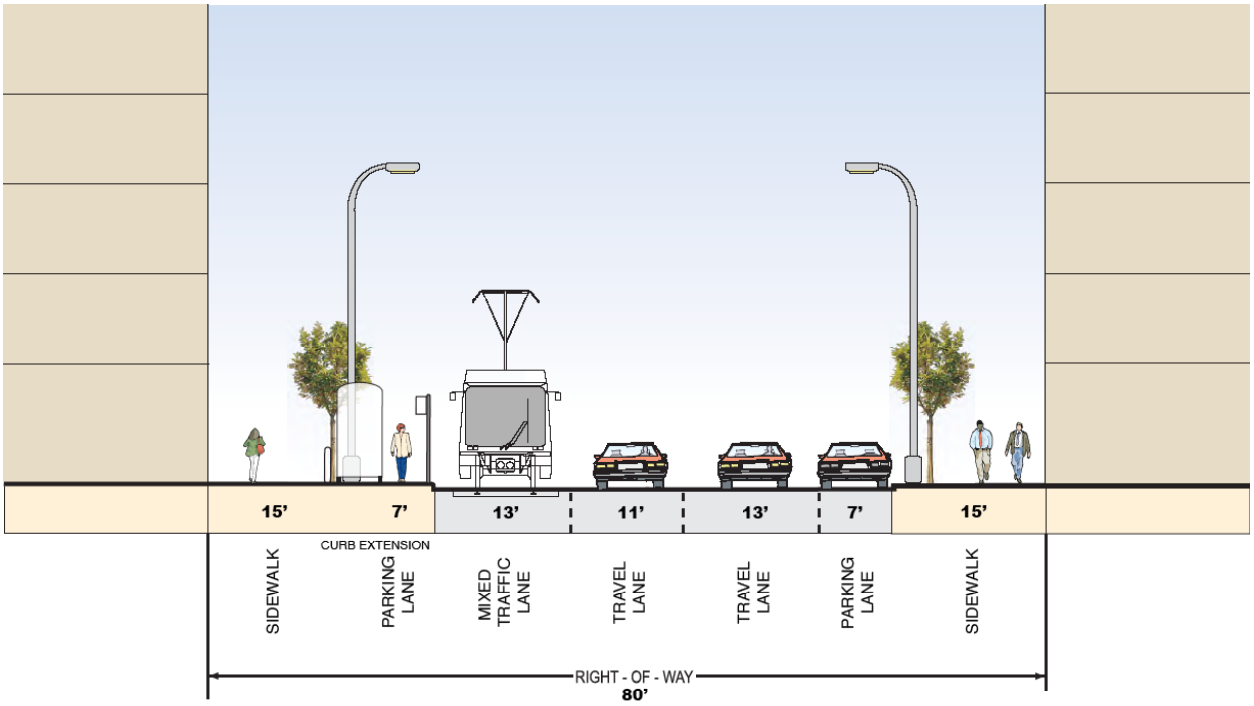


Figure 4-8 Typical Downtown One-Way Street Cross Section



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Chapter 5. Ridership Estimates

This chapter provides planning-level estimates of ridership for each of the long-term streetcar corridors as well as the segments identified for initial operations. Different methodologies are used for the long-term network and the shortest operable segments, primarily because the shortest operable segments are not intended to replace existing bus lines.

Factors Influencing Ridership

There are a number of known factors that contribute to streetcar ridership. These include:

- Intensity of land use within walking distance of the line – including both residential and employment density
- Mix of land use – residential, employment, retail, recreational
- Travel time (speed of service)
- Frequency of service
- Fares
- Connectivity to a broader public transportation network
- Legibility and information
- Comfort and ride quality

Each of these factors, and how it is influenced by streetcar development, is described in the following pages. It is important to note that while there is no direct mathematical relationship between all of these factors and ridership, they have collectively proven to be key factors in attracting ridership to all types of transit routes. Figure 5-1 summarizes these factors and compares the ability of bus routes and streetcar lines to capitalize on each factor. The cumulative advantages of streetcar service explain the ridership increase transit operators have noted when replacing a bus route with an equivalent streetcar line.

Figure 5-1 Factors Influencing Ridership (Streetcar vs. Bus)

Factor	How it Influences Ridership	Ridership Advantage – Streetcar vs. Bus
Intensity of Land Use	Density is the most direct influence on transit ridership – the greater the intensity of land use, the greater the ridership.	Advantage to streetcar, which tends to have higher carrying capacity than bus on a one for one basis.
Mix of land uses	Different land uses have different demand patterns. Mixing land uses ensures steady ridership through the day, rather than directional peaking.	Streetcar has a proven track record of attracting some types of trips that generally do not use bus transit – especially non-work, visitor- and tourist-oriented travel and weekend trips.
Travel Time	Riders are attracted to transit services that more closely match auto travel times.	Both bus and streetcar can be designed for fast service. The flexibility of bus service may give it an advantage as buses can maneuver around obstacles.
Frequency and Span of Service	Frequent service reduces wait times and allows riders to make trips without planning. Services with a longer service span are attractive to more types of trips. Longer evening service ensures riders who work late, or attend events in the evening will be able to get home.	No advantage – both bus and streetcar can be designed to run frequently and over long service spans.
Fares	High fares discourage ridership. Lower fares encourage ridership.	No advantage – fares can be the same for both.
Connectivity to a Broader Network	Connecting to regional services provides greatly enhanced mobility and enhances the ridership of the overall system.	Advantage to streetcar, which provides a highly visible connection to other routes.
Legibility and Information	The easier it is to understand a transit system, the more likely it is that occasional riders will use it. Real time information has been proven to increase ridership by as much as 5%.	Both bus and streetcar can be designed for quality real time information. However, streetcar has an advantage in that the tracks provide instant legibility.
Comfort	Roomier seats, ample room for standees, and a less “rocky ride” contribute to rider comfort and to increased ridership.	Advantage to streetcar, which operates on rails and therefore has less lateral movement than a bus. Riders often report they can read on streetcars but not on buses.

Intensity of land use – There is a direct correlation between the intensity of land use along a transit corridor and the number of transit riders in the corridor. In fact, intensity of land use has proven to be the most important factor in determining transit ridership, and has a far more direct relationship than any demographic factor such as income or age. It should be noted that a mix of uses, including housing and jobs, creates the best opportunity for high transit ridership.

Land use densities for all lines in the long-term network clearly support at least 15-minute streetcar service.

Mix of land use (residential, employment, retail, recreational) – While overall density is the single most important factor in estimating transit ridership, the mix of land uses is also a contributing factor. Areas that are dominated by a single land use type may generate high ridership, but the ridership will be very directional and very peaked. For example, ridership from a residential neighborhood will generate a high number of commute trips leaving the area in the morning and returning at night, but relatively little ridership midday. A mixed-use area will attract commute trips in and out of the neighborhood as well as retail, recreational and other non-work trips within the immediate neighborhood.

Both bus and streetcar lines have been proven able to attract routine trips such as commute travel, both for residents and employees. Where streetcars have an advantage over buses is in attracting occasional trips, especially for recreational purposes.

Travel Time and Operating Speed – Higher operating speeds and shorter travel times make transit more competitive with auto travel and will generate higher transit riders. Travel times and operating speed are typically a function of the following five major components:

- Traffic controls in the corridor (stop signs, stop lights, etc);
- Traffic congestion;
- Vehicle acceleration/maximum speed;
- Distance between stops; and
- Dwell times (for passenger boarding/alighting).

Because streetcars are designed to operate in mixed flow traffic just like buses, the first four components will affect streetcar operating speeds just as much as bus operating speeds. Dwell times for passenger boarding and alighting, however, can be very different between buses and streetcar vehicles, primarily because of fare policy and multiple door boarding. While Metro Transit is experimenting with different fare mechanisms, one of the major sources of slow operating speeds on many of Metro Transit's heavily used transit lines is boarding time. Current fare policy requires all users to insert either a card or cash into the farebox, which results in slower operating speeds where boarding activity is heavy.

Streetcar operating speeds could be significantly faster than bus if a proof-of-payment fare policy is implemented from the beginning. However, for the purposes of this analysis, streetcar operating speeds were more conservatively estimated to be at least 30% of the speed limit in all corridors – ranging from 8 to 15 mph. The only corridor that offers a significant travel time advantage over bus service is the Midtown Greenway, where average streetcar speeds are estimated at 16-18 mph because it can operate in an exclusive right-of-way.

Frequency and Span of Service – The more frequent a transit line operates, the less time spent waiting. In addition, very frequent service (at least every 15 minutes) allows riders to make trips without planning in advance. This is a very important factor in estimating transit ridership, particularly for generating trips that are not routine or made at the same time every day. For shuttle trips, which will make up the bulk of ridership on any proposed streetcar line, the route should be no less frequent than every 15 minutes.

Longer service spans are attractive to more types of trips. Service that operates longer into the evening ensures that riders who work late, or attend events in the evening, will be able to get home.

Both buses and streetcars can be designed to operate frequently and have long service days. Therefore, streetcar service does not really have an advantage over bus service.

As part of the PTN, all streetcar corridors are designed to operate at least every 15 minutes, with a goal of service 18 hours per day.

Fares – Low or no fare systems encourage ridership by eliminating the need to put money in the farebox and by encouraging "short hop" trips that might otherwise be made on foot. In Portland and Tacoma, for example, the streetcar route is within the "free fare zone" for the transit operator, and no fare is charged. Currently, Minneapolis does not have a free fare policy but does offer a reduced $0.50 fare in the downtown zone. For the purposes of estimating ridership, Metro Transit fares were assumed.

Connectivity to a Broader Network – Connectivity to the high capacity regional network (such as the Hiawatha LRT and future Southwest Corridor LRT) is clearly a key factor in influencing transit use. These connections are very important to maintaining ridership especially for "short hop" connections between a commute line and final destination or employment site.

Legibility and Information – Attracting riders is clearly easier when the streetcar route is easy to understand, and when the customer feels comfortable knowing when the next transit vehicle will arrive and where it will be going. Recent studies show as much as a five percent ridership increase based on the availability of real time information alone. Both bus and streetcar systems can be designed with a high degree of real time

information. However, only streetcars can provide the legibility of tracks in the street that defines the line. This is especially true in urban areas where there are many bus routes, but clearly only one streetcar track. Legibility and information have the greatest influence on attracting occasional or visitor trips, where riders do not have the time or experience to become fully familiar with a line route.

Comfort – There are many factors affecting passenger comfort, and they create an intangible factor that influences riders who have other travel mode options for their trip. Comfort may come in the form of more spacious or padded seats, bigger windows, ample standing room, and reduced motion. Any transit vehicle can be designed to maximize comfort, but here the advantage goes to streetcars, which operate on tracks, rather than buses, which experience significantly more lateral motion. Many riders describe the difference of "being able to read on the streetcar but not on the bus."

Ridership Estimates for Long-Term Network Corridors

When looking at a large overall transit network, it is possible to use traditional modeling tools to estimate transit ridership. In general, these citywide or region-wide modeling tools are not sensitive enough to capture ridership changes that result from shifting from one mode to another or from making small changes in a single line.

To develop some sense of ridership potential on the long-term streetcar corridors, ridership estimates are "pivoted" off of productivities (passengers per revenue hour) from existing bus lines. Productivities of bus lines in each corridor are based on three different sector studies completed from 1998 – 2004. It should be noted that the bus productivities used for this analysis are for the entire bus line. Because this analysis uses average productivities for the entire line, it is likely that the ridership estimates are conservative.

The existing bus productivities are then subjectively adjusted based on the eight factors outlined above. Based on these adjustments, an adjusted "streetcar productivity" was calculated. A range of streetcar productivities was then calculated by using plus or minus 10% of the adjusted figure. The range is then multiplied by the total revenue hours[10] for each corridor to arrive at an estimated range of daily and annual ridership figures.

Ridership Estimates – Midtown Greenway

Because it would operate differently from other streetcar corridors, the Southwest Transitway Alternatives Analysis Study prepared a detailed model of ridership for in the Midtown Greenway. The projected ridership is for the year 2030 using the same assumptions described in Chapter 4 (Operating Plan). The model was run assuming the LRT 1A alignment via the Kennilworth alignment to downtown Minneapolis. The

[10] Revenue service hours are from the operating plans presented in Chapter 4.

estimates were made using the Twin Cities Travel Demand Model and assumed streetcar would have the same attributes as light rail transit.

Based on the travel demand model, approximately 3,300 weekday boardings were generated on the Midtown Greenway. The model produced several primary trip types:

- Internal trips on the Midtown Greenway (50%)
- Transfers to the southbound Southwest LRT line (25%)
- Transfers to the northbound Southwest LRT line (2%)
- Transfers to the southbound Hiawatha LRT line (8%)
- Transfers to the northbound Hiawatha LRT line (<1%)

Overall, the model suggests that about half of all boardings on the Midtown Greenway streetcar are internal to the Greenway. That is, approximately 1,650 daily weekday boardings in the Greenway alight in the Greenway. Approximately 25% of all boardings begin in the Greenway and transfer to the southbound Southwest LRT line, and 8% of trips begin in the Greenway and transfer to the southbound Hiawatha LRT line. Trips originating in the Midtown Greenway and transfer to the northbound Hiawatha or northbound Southwest LRT lines is relatively small. The model also predicted a small increase in total light rail boardings as a result of the streetcar in the Midtown Greenway.

Ridership estimates were not developed for the alternate streetcar alignment if the Uptown to Nicollet alignment is chosen for the Southwest LRT line.

Figure 5-2 presents a summary of the ridership estimates for each long-term corridor. A more detailed table showing the productivity estimates is provided in the Appendix.

Figure 5-2 Ridership Estimates – Long-Term Streetcar Network

Corridor	Passengers per Revenue Hour					Streetcar Ridership Estimates				
	Existing Bus	Estimated Adjustment	Estimated Streetcar	Range High	Low	Revenue Hours (1)	Daily Ridership High	Daily Ridership Low	Annual Ridership High	Annual Ridership Low
Chicago Ave S										
Weekday	68	30%	88.4	97.2	79.6	137.0	13,322	10,900	3,397,079	2,779,429
Saturday	62	30%	80.6	88.7	72.5	126.0	11,171	9,140	580,900	475,282
Sunday	67	30%	87.1	95.8	78.4	70.0	6,707	5,487	388,989	318,263
Hennepin Ave S / University Ave SE / 4th St SE										
Weekday	70	20%	84.0	92.4	75.6	128	11,827	9,677	3,015,936	2,467,584
Saturday	52	20%	62.4	68.6	56.2	126	8,649	7,076	449,729	367,960
Sunday	41	20%	49.2	54.1	44.3	114	6,170	5,048	357,841	292,779
Nicollet Ave S										
Weekday	63	25%	78.8	86.6	70.9	139	12,041	9,852	3,070,423	2,512,164
Saturday	56	25%	70.0	77.0	63.0	121	9,317	7,623	484,484	396,396
Sunday	59	25%	73.8	81.1	66.4	96	7,788	6,372	451,704	369,576
W Broadway / Washington Ave										
Weekday	42	20%	50.4	55.4	45.4	96	5,322	4,355	1,357,171	1,110,413
Saturday	35	20%	42.0	46.2	37.8	90	4,158	3,402	216,216	176,904
Sunday	32	20%	38.4	42.2	34.6	90	3,802	3,110	220,493	180,403
Central Ave SE										
Weekday	40	25%	50.0	55.0	45.0	123	6,765	5,535	1,725,075	1,411,425
Saturday	32	25%	40.0	44.0	36.0	84	3,696	3,024	192,192	157,248
Sunday	32	25%	40.0	44.0	36.0	66	2,904	2,376	168,432	137,808
Midtown Greenway										
Weekday (2)						79	3,300	3,300	841,500	841,500
Saturday (3)						73	2,640	2,640	137,280	137,280
Sunday (3)						73	2,640	2,640	153,120	153,120

Notes
(1) Based on Operating Plans
(2) Based on Technical Memorandum on Travel Demand Forecasting for LRT 1A with Midtown Streetcar, Hennepin County Regional Railroad Authority, Draft 2007
(3) Saturday and Sunday assumes 80% of weekday ridership.

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Ridership Estimates – Shortest Operable Segments

Ridership estimation for the long-term corridors can be based on existing bus ridership because they are intended to replace significant portions of those bus routes. The shortest operable segments, however, are too short to attract the same market as the bus service in the longer corridors and are not expected to replace any bus lines. Therefore, a different methodology using experience in other cities was used to develop ridership estimates in Minneapolis.

Ridership Experience in Other Cities

To estimate ridership for any of the shortest operable segments, we have reviewed examples from other cities where relatively short streetcar lines are serving similar land uses in their downtown areas. Figure 5-3 shows the range of ridership and productivity (as measured in passengers per hour) for each of the peer cities included in this analysis. Also included is a brief description of the unique factors that may contribute to each city's ridership compared to the shortest operable segments in downtown Minneapolis.

Figure 5-3 Peer Streetcar System Ridership

City	Annual Ridership	Ridership (Riders/ Rev. Hour)	Factors Contributing to Ridership
Tampa	519,564	29.7	• Less intense land use compared to downtown Minneapolis • Does not directly serve downtown Tampa • Serves major tourist attractions along water • Connects with specialized rubber-tired service, called "In-Town Trolley"
Tacoma	794,582	79.9	• Free service and plentiful parking • Good connections to regional commuter rail system • Similar land use to Minneapolis • Integral to current and future transit network
Little Rock	204,000 (estimated)	25.8	• More intense land uses in downtown Minneapolis • Serves major tourist attractions in Little Rock and North Little Rock
Portland	1.9 M (estimated)	91.0 (estimated)	• Similar land use to downtown Minneapolis • Free fares for the majority of the line • Utilizes real-time information at each stop
Average Riders per Rev. Hour:		60.7	

Based on the productivities in the peer cities listed above, an average productivity figure of 60.7 was calculated. This average figure was then adjusted for each of the shortest operable segments based on the following two factors:

- **Number of activity centers served (land use).** Certain corridors will attract more riders because they serve more activity centers and the land use is more conducive to higher ridership. Hennepin Avenue, for example, is longer and serves more activity centers than any other shortest operable segment, thus the average productivity on this line would likely be somewhat higher than other segments. Conversely, the line via 9th/10th Streets to 5th Street and Nicollet is likely to be somewhat less productive since it serves fewer activity centers (at least until the lower intensity land use between Eliot Park and Nicollet is fully built out). For this reason, the average productivity was subjectively adjusted up or down to account for the variability that is likely between the corridors.
- **Proportion of the line within the Downtown Fare Zone.** Current fares on Metro Transit's local services range from $1.50 (non rush-hours) to $2.00 (rush hours), with reduced $0.50 fares in the Downtown Zone. Because fares can have a huge impact on transit ridership, the expected productivity of each shortest operable segment was adjusted based on how much of the line is within the Downtown Fare Zone. Those segments that extend beyond the Downtown Zone would require the full fare, thus the productivity is expected to be lower.

To estimate ridership on the shortest operable segments, a low and high range was calculated by taking plus or minus 10% of the adjusted average productivity. This range of productivities is then multiplied by the annual revenue hours, which is based on the operating plans developed in Chapter 4, to develop high-level annual ridership figures for the five shortest operable segments (see Figure 5-4).

Based on feedback from Metro Transit and other stakeholders, the Draft Final report will refine the rideship estimates for the shortest operable segments. The same methodology using peer streetcar systems will be used, but include other streetcar peers and be further customized for each shortest operable segment. The possible extensions to the shortest operable segments will also be factored into the new ridership estimates.

Figure 5-4 Ridership Estimates – Shortest Operable Segments

		Shortest Operable Segment				
		Hennepin Avenue	Washington Avenue (via Nicollet)	Washington Avenue (via Park)	Nicollet Avenue	9th/10th to Nicollet
Adjusted Productivity Activity Centers / Land Use Within Downtown Fare Zone		No change -10%	-10% -15%	-15% -15%	No Change No Change	-20% -15%
Adjusted Average Productivity		54.6	45.5	42.5	60.7	39.5
Annual Revenue Hours (based on operating plan)		16,920	11,280	11,280	11,280	11,280
Productivity	Low Estimate	49.1	41.0	38.3	54.6	35.6
	High Estimate	60.1	50.1	46.8	66.8	43.5
Annual Ridership	Low Estimate	831,449	461,916	431,460	616,226	401,004
	High Estimate	1,016,215	564,564	527,340	753,166	490,116

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Chapter 6. Capital Costs

This chapter provides order-of-magnitude capital cost estimates for both the shortest operable segments as well as each "long line" streetcar corridor included in the long-term streetcar network.

Capital Costing Methodology

Initial order-of-magnitude cost estimates were developed based on component costs from other comparable projects in the same region of the country. The capital cost estimates developed for the Southwest Corridor LRT being conducted by Hennepin County provided local unit cost information for many of the materials required to build a streetcar. Because there are only a small number of examples of modern streetcar systems already built in North America, Portland, OR was selected as a good peer to help formulate costs appropriate to a modern streetcar system. Since cost estimates were completed in previous years, costs were inflated and adjusted to more closely match local construction costs in 2007.

All estimates presented in this report are order-of-magnitude for planning and feasibility assessment purposes only and do not represent any level of design. A preliminary design and engineering study would need to be completed to increase the accuracy of capital costs.

A number of key components drive the cost of rail streetcar in an urban environment. These include:

- **Trackwork** – costs for trackwork assume that Minneapolis would use a slab type construction throughout the network (with the exception of the Midtown Greenway). Costs are estimated on a per mile basis and include additional costs for switches, crossovers and other special devices/improvements.
- **Platforms** – this plan assumes the use of simple platforms raised approximately 12 inches above the existing sidewalk. The 10′ x 40′ platform base is located in a "bumpout area" extending from the existing curb ten feet into the street containing the streetcar line. The basic costs contained in each platform include the base, ramps, shelter / bench, trash receptacle, static passenger information and possibly street lighting, drainage modification, or fire hydrant relocation as needed.
- **Catenary system, signals and substations** – this category is also referred to as the Power System. It includes costs for the catenary system itself (poles and wires), train control system for single track sections of the alignment and the cost of required power stations. Power cost estimates were based on the SW Corridor study using a general figure of $2.0 million per route mile.

- **Utilities** – A utility cost estimate was derived from the Southwest Corridor study on a linear foot basis and adjusted for this report. Major public utilities (water, sewer, sanitation) are not expected to be a significant issue due to the City of Minneapolis practice of placing these at a depth that should not conflict with a streetcar line (around 8 feet deep). However, costs were conservatively estimated to be moderate for the purposes of this report to account for unforeseen utility relocation issues.
- **Switch** –a standard amount per switch was used per the Southwest Corridor study. Two switches per mile were assumed.
- **Construction soft-costs and taxes** – this cost estimate includes an allowance to cover unforeseen costs related to the road itself (utilities, traffic systems, street lighting, drainage, etc.) as well as any State of Minnesota taxes that may apply to construction materials.
- **Engineering and project management** – this category assumes a cost estimate of 20% for project design and engineering, and the administration of the project startup.
- **General Contingency**. A 25% general contingency was added for all other unforeseen costs to the project as a whole.

Our cost estimation methodology uses these component costs to develop a generic cost per single-track mile estimate that can be applied to various corridor segments and alignments, as shown in Figure 6-1.

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Figure 6-1 Streetcar per Track Mile Construction Costs (Order of Magnitude) $2007

COST CATEGORY	UNIT COST	QUANTITY	TOTAL PRICE
Trackwork - Track Slab Installation	$420 / LF	5,280	$2,217,600
Catenary System, Signals and Substations	$228 / LF	5,280	$1,203,840
Switch	$18 / LF	5,280	$95,040
Utilities – Moderate Conflicts	$360 / LF	5,280	$1,900,800
Platforms	$60,000 each	avg. 5 per mile	$300,000
Construction Soft Costs and Taxes	20%	of cost	$1,143,456
SUB-TOTAL CONSTRUCTION COST	-	-	$6,860,736
Engineering and Project Management	20%	of sub-total	$1,372,147
General Contingency	25%	of sub-total	$1,715,184
TOTAL ANTICIPATED CONSTRUCTION COST ($2007)	PER MILE		$9,948,067

Assumptions:

- All costs are for single track miles; double track cost is twice the amount per mile
- Cost estimates are based on Southwest Corridor LRT unit costs and adjusted where needed based on the Portland Streetcar project or Midtown Greenway estimates.
- Unit costs are based on 2003 data and inflated 5% per year to 2007 dollars. The inflation rate of 5% was used to account for recent increases in the cost of steel, concrete and other construction materials required for streetcars.

Other Costs

The following costs are not included in the standard cost per track mile calculation shown in Figure 6-1, but do add to the total cost of the project.

- **Vehicles** – a wide range of vehicle types are available for streetcar service. This study does not presuppose a preferred vehicle type, but does assume a cost associated with modern vehicles similar to those used in Portland and Tacoma (between $2.5 and $3.0 million each).
- **Maintenance and storage facility** – see Chapter 7 for a more detailed discussion of maintenance and storage facility requirements.
- **Right-of-way** – One advantage of urban streetcars over heavier gauge rail modes is that they can operate in mixed traffic, allowing them to share existing right-of-way

with private vehicles. This reduces the need for expensive and often difficult right-of-way acquisition. Because all service is either in an existing row, or in the case of the Midtown Greenway, owned by a public entity (Hennepin County), property acquisition costs are not estimated.

- **Other major capital improvements:** Major capital improvements, such as incorporating streetcar operation into the Mississippi River bridges (Hennepin and 3rd Avenue), are estimated separately and added to the total segment cost.

Summary of Capital Costs by Segment

Figure 6-2 provides a summary of the order-of-magnitude capital costs for each segment included in the short-term and long-term streetcar network. The component costs can be used to calculate costs of alternative alignments. A variety of potential alternatives will be included in the Draft Final Report that will make it possible to combine these segment in different ways to estimate capital costs.

For the purposes of this analysis, each segment is provided a unique label, roughly corresponding to the major corridor is represents. For example, the Hennepin Avenue corridor has two segments, labeled 1-A and 1-B. Segment 1-A represents the section from Groveland Avenue to Lake Street and Segment 1-B represents the section from Groveland Avenue to the East Hennepin area across the river.

From a capital costing perspective, it is important to identify costs by segment, allowing lines to be "built" by combining various segments in the most advantageous way. This also avoids "double counting" when more than one line uses the same alignment. Portions of the Nicollet Mall, for instance, would be utilized by several streetcar lines – Nicollet Avenue, Central Avenue NE, W Broadway Avenue/Washington Avenue. Therefore, in order to produce an accurate capital cost for the entire network, it is important to estimate costs by segment and to include each segment only once.

For each segment, the standard cost per track mile shown in Figure 6-1 is multiplied by the track miles required for each segment of the network. In segments where major capital improvements are needed to overcome physical or operating barriers (e.g., trackage on the river bridges, underpasses, LRT rail crossings, etc.) the estimated cost for those components are added to the standard per mile cost. Total capital costs are rounded to the nearest $100,000 to emphasize that these are planning estimates and would require further refinement.

It is important to note that the capital costs noted in Figure 6-2 do not include the cost of two important components: vehicles or a maintenance/storage facility. While these costs are usually included in the total capital cost of a streetcar line, they are not included in this chapter because they are related to the type of service provided in each corridor, as well as the extent of the network that is implemented. Because this plan is developing a ***network***

of streetcar lines, rather than a single line, there will be cost savings associated with multiple lines. An initial line, however, will be burdened with higher costs associated with a maintenance facility, higher vehicle spare ratio and other start-up costs. These issues will be addressed further in Chapter 9, which discusses phasing of the streetcar network.

Because they are required to operate in mixed traffic, all of the streetcar corridors require embedded streetcar track. The exception to this is the Midtown Greenway, which would operate in exclusive right-of-way and *could* be constructed using ballasted track. Ballasted track is less expensive to construct than embedded track because it requires less excavation and foundation work.

Ballasted track is estimated to cost approximately $288/linear foot, or $1,520,000 per track mile. This compares to $420/linear foot for embedded track, or $2,220,000 per track mile. Adjusting all other costs in Figure 6-1 that are calculated as a percentage (i.e., soft costs, engineering, contingency, etc.), the total cost per track mile for ballasted track is estimated to be $8,735,000. Figure 6-3 provides an adjusted cost estimate for streetcar in the Midtown Greenway assuming ballasted track.

More detail regarding the capital cost estimates are included in the Appendix.

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Figure 6-2 Order of Magnitude Streetcar Capital Costs by Segment – All Corridors, Embedded Track

Segment	Corridor	From…	To…	Track Miles	Cost per Track Mile (see Figure 6-1)	Basic Cost	Major Capital Items	Major Capital Costs	Total Capital Cost (excluding vehicles and maintenance facility)3[11]
1-A	Hennepin	Groveland / Hennepin	University / 4th / Central	4.8	$9,948,067	$47,750,722	1) Lowry Tunnel 2) Hennepin Bridge (Miss. River) 3) Center Stations (Wash – 10th) 4) LRT Crossing	$244,000 $2,080,000 $450,000 $50,000	$50,600,000
1-B	Hennepin	Groveland / Hennepin	Lake / Hennepin	3.0	$9,948,067	$29,844,201	1) Greenway Bridge	$120,000	$30,000,000
2-A	University/4th	University / 4th / Central	Washington / University	3.6	$9,948,067	$35,813,041	1) I-35W Bridge 2) Dinkytown Bridge	$400,000 $440,000	$36,700,000
3-A	Broadway/Washington	10th Ave N / Washington	Nicollet / Washington	1.8	$9,948,067	$17,906,521	1) 4th Avenue Railroad Bridge	$70,000	$18,000,000
3-B	Broadway/Washington	Nicollet / Washington	Nicollet / 5th St	0.4	$9,948,067	$3,979,227	1) LRT Crossing 2) Mall Modifications	$50,000 $300,000	$4,300,000
3-C	Broadway/Washington	Nicollet / Washington	Chicago / 5th (1)	1.6	$9,948,067	$15,916,907	1) LRT Crossing	$50,000	$16,000,000
3-D	Broadway/Washington	10th Ave N / Washington	North Memorial Hosp.	6.2	$9,948,067	$61,678,015	1) I-94 Bridge	$660,000	$62,300,000
3-E	Broadway/Washington	North Memorial Hosp.	Robbinsdale TC	3.4	$9,948,067	$33,823,428	-	$0	$33,800,000
4-A	Chicago	Nicollet / 5th	14th St / Chicago	2.2	$9,948,067	$21,885,747	-	$0	$21,900,000
4-B	Chicago	Park / 5th	14th St / Chicago	1.0	$9,948,067	$9,948,067	-	$0	$9,900,000
4-C	Chicago	14th St / Chicago	Chicago / Lake	2.8	$9,948,067	$27,854,588	1) I-94 Bridge 2) Greenway Bridge	$660,000 $180,000	$28,700,000
4-D	Chicago	Chicago / Lake	Chicago / 38th	2.0	$9,948,067	$19,896,134	-	$0	$19,900,000
5-A	Nicollet	Nicollet / 5th St	Nicollet / Grant	1.4	$9,948,067	$13,927,294	1) Mall Modifications	$1,800,000	$15,700,000
5-B	Nicollet	Nicollet / Grant	Nicollet / Lake	2.8	$9,948,067	$27,854,588	1) I-94 Bridge 2) K-Mart Bridge	$400,000 $200,000	$28,500,000
5-C	Nicollet	Nicollet / Lake	Nicollet / 46th	4.0	$9,948,067	$39,792,268			$39,800,000
6-A	Central	Nicollet / Washington	1st Ave NE / University	2.0	$9,948,067	$19,896,134	1) 3rd Ave Bridge (Miss. River)	$3,800,000	$23,700,000
6-B	Central	Central / 4th St SE	Central / 29th Ave NE	4.8	$9,948,067	$47,750,722	1) 9th Street NE RR Bridge 2) Broadway Street NE Bridge	$300,000 $440,000	$48,500,000
6-C	Central	Central / 29th Ave NE	Columbia Heights TC	2.8	$9,948,067	$27,854,588	1) 36th Ave NE RR Crossing	$50,000	$27,900,000
7-A	Midtown Greenway	West Lake Station	Hennepin	1.4	$9,948,067	$13,927,294	1) Side Track – (3) 2) Vertical Circulation – (1)	$1,860,000 $400,000	$16,600,000
7-B	Midtown Greenway	Hiawatha / Lake Station	Chicago	1.3	$9,948,067	$12,932,487	1) Side Track – (3) 2) Vertical Circulation – (2)	$1,860,000 $800,000	$15,200,000
7-C	Midtown Greenway	Chicago	Hennepin	1.7	$9,948,067	$16,911,714	1) Side Track – (4) 2) Elevators – (2)	$2,480,000 $800,000	$20,200,000
7-D	Midtown Greenway	Hiawatha / Lake Station	28th St Station	2.7	$9,948,067	$26,859,781	1) Side Track – (3) 2) Elevators – (2)	$1,860,000 $800,000	$29,500,000

[11] Figures rounded to the nearest $100,000.

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Figure 6-3 Order of Magnitude Streetcar Capital Costs by Segment – Midtown Greenway, Ballasted Track

Segment	Corridor	From…	To…	Track Miles	Cost per Track Mile	Basic Cost	Major Capital Items	Major Capital Costs	Total Capital Cost (excluding vehicles and maintenance facility)
Entire Corridor									
7-A-1	Midtown Greenway	West Lake Station	Hennepin	1.4	$8,735,357	$12,229,500	1) Side Track – (3) 2) Vertical Circulation – (1)	$1,860,000 $400,000	$14,900,000
7-B-1	Midtown Greenway	Hiawatha / Lake Station	Chicago	1.3	$8,735,357	$11,355,964	1) Side Track – (3) 2) Vertical Circulation – (2)	$1,860,000 $800,000	$13,600,000
7-C-1	Midtown Greenway	Chicago	Hennepin	1.7	$8,735,357	$14,850,107	1) Side Track – (4) 2) Elevators – (2)	$2,480,000 $800,000	$18,100,000
Alternate Alignment (if Southwest Corridor LRT via the Midtown Greenway / Nicollet is chosen)									
7-D-1	Midtown Greenway	Hiawatha / Lake Station	5th Ave S	1.5	$8,735,357	$13,103,035	1) Side Track – (3) 2) Elevators – (2)	$1,860,000 $800,000	$15,400,000
7-E-1	Midtown Greenway[12]	5th Ave S	28th Street Station	1.2	$9,948,067	$11,937,681	-	-	$11,900,000

[12] This section shares right-of-way with other uses and therefore must be embedded track.

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Chapter 7. Maintenance and Storage Facilities and Potential Sites

In order for a streetcar network to function, there must be facilities to maintain and store the streetcar vehicles. Since Minneapolis does not currently operate streetcars, an initial streetcar line would require a new facility designed to house and maintain the streetcar vehicles. As new streetcar lines are added, existing facilities would need to be expanded, or new facilities would need to be added if the vehicles could not access the existing facility. It is important to emphasize that one of the most important factors influencing the decision on where to begin building a streetcar network is the ability to find a location to house and maintain the vehicles.

Initial Maintenance and Storage Facility

The maintenance and storage facility for an initial streetcar line would maintain and store the streetcar vehicles on a daily basis. A typical streetcar vehicle is 66 feet long and 8 feet wide, runs on standard gauge tracks, is 11.5 feet high, and is classified as a low-floor vehicle. These vehicles have support equipment (HVAC, air compressor, resistor banks) mounted at roof level. The SKODA vehicle, which is being used in Portland and Tacoma, has two trucks with either a single or double center articulation. Each truck has two AC motors and drive units mounted on a wheel set that may or may not have resilient/bochum wheels. Although modern streetcar vehicles can be stored outside (as long as they are in a secure area), it is assumed that all vehicles in Minneapolis would need to be stored inside to minimize the impacts of extreme weather.

Key functions that will need to be provided for at a maintenance and storage facility include:

- Vehicle Storage
- Equipment and Parts Storage
- Administrative Functions
- Employee Parking
- Vehicle Cleaning (interior and exterior)
- Daily Inspections
- Preventative Maintenance
- Running Repairs

Metro Transit could use their existing LRT maintenance facilities for heavy repairs. Streetcar vehicles can be transported on a tractor-trailer to this facility when major repairs are required. Portland Streetcar uses this method, using trailer trucks to transport streetcar vehicles to the TriMet light rail maintenance facility for major work, overhauls and component change-outs.

Site and Building Size Requirements

Site and building size requirements are dependent on the vehicle fleet size the facility will need to accommodate. A facility should be designed to accommodate peak vehicle requirements of an initial planned segment and any planned expansions.

Assuming a fleet size of 8 to 10 vehicles (which includes fleet expansion) a one- to two-acre site is needed. The site should be flat and generally rectangular in shape. The building footprint would be in the range of 8,000 square feet and would need to accommodate two tracks within the building of 100 feet in length each. One track could be used for inspections, running repair and exterior and roof-mounted work. The other should be over a pit to allow for work on the entire undercarriage of the vehicles.

Prefabricated steel buildings are a low cost alternative for a maintenance facility if area zoning and design standards allow for their use. The facility should be designed and situated on the lot to allow for easy expansion as the system grows and additional bay/storage capacity is required.

Cost

It is estimated that the development of a fully functional storage and maintenance facility would cost in the range of $2-4 million. This cost does not account for property acquisition, so it is preferable if the site is owned by Metro Transit, the City of Minneapolis, Hennepin County or another public entity willing to contribute the land.

Potential Site Locations

Deciding which initial streetcar segment to begin with is dependent on the availability of a site for a maintenance and storage facility. Based on the shortest operable segments identified in Chapter 3, the location will need to be somewhere in the general vicinity of downtown. The maintenance and storage facility should be sited as close as possible to the initial streetcar alignment, as it will require additional track to get vehicles from the line to the facility (thus adding to the total cost of the project). In Portland, for example, the maintenance facility was located between the two directions of revenue track under a freeway overpass that would never have demands for higher and better uses. While this

may be an ideal situation, the location of this facility made the initial streetcar line more cost effective than if non-revenue track was required to access a maintenance facility.

Although specific sites are not identified in this study, the following section identifies some general areas that are appropriate for a maintenance and storage facility. A possible alignment for connecting these areas with an initial segment is also identified.

Dunwoody Boulevard and I-394

The area north of this intersection is primarily zoned Industrial 1 (I-1) or Industrial 2 (I-2), which would be appropriate for a maintenance and storage facility. It may be possible to use the area under I-394 in the vicinity of Dunwoody Boulevard (likely owned by MnDOT), or another parcel north of the Dunwoody Institute. A short section of single track, approximately 2,000 feet, could be used to access a facility in this location. This location would be most appropriate for an initial streetcar line on Hennepin Avenue. Although additional study of the area is necessary, expansion opportunities are likely in this area.

North Loop Area

Much of the North Loop area is currently zoned I-2. Due to the changing character of this area, however, a maintenance facility will only be appropriate in certain locations. The area between 10th Avenue N, 4th Street N, 6th Avenue N and 7th Street N, as well as the industrial park northwest of Washington Avenue / 10th Avenue N, shows the most promise. Although the 3rd/4th access viaduct lanes to and from I-94 may not always define the character of this area, it is likely that this area will remain industrial – at least for the foreseeable future. One major advantage of this area is the proximity to the existing Heywood Bus Garage facility, owned by Metro Transit. It may be possible to integrate a streetcar maintenance facility into this facility, though this has not been confirmed with Metro Transit and other needs at that facility may prevent use for streetcar vehicles.

A section of single-track could be used to access a maintenance facility in this area. From Washington Avenue, a facility in this area could be accessed via 10th Avenue N with less than ½ mile of track. A maintenance facility in this area would be most appropriate for any of the initial streetcar segments on Washington Avenue. Based on existing land use, expansion opportunities appear to be strong in this area, especially closer to the 3rd/4th Street access lanes and I-94.

Downtown East / Metrodome

Most of the area east of the Metrodome (to I-35W) is currently zoned I-1. While there are currently several opportunities for a maintenance/storage facility in this area, the Downtown East / North Loop Master Plan envisions a dramatic change in character for this neighborhood, including medium-density housing. The Downtown East / North Loop

Master Plan also suggests the addition of a new LRT station east of the Metrodome, and a transit-oriented community node.

If the Metrodome remains in its current location, or is rebuilt in this general vicinity, a maintenance/storage facility may be more appropriate in this area – possibly integrated into future parking facilities.

Midtown Greenway

The area with the greatest potential to accommodate a maintenance/storage facility along the Midtown Greenway is in the vicinity of Hiawatha Avenue and 28th Street E. Most of the land in this area is currently zoned industrial (I-1, I-2 or I-3), and it appears that several parcels are either vacant or underutilized. Access to this area would likely be via 28th Street E and require less than 1,300 feet of non-revenue track.

Although there are several other areas along the Greenway that may be conducive to a maintenance/storage facility, accessing those areas will likely be too expensive due to grade issues. There is, however, an at-grade crossing of the Greenway at 5th Avenue S which could provide access to this area (currently zoned I-1). It should be noted, however, that while industrial zoning currently exists along the Greenway, the long-term vision is for more residential and commercial uses, which is not entirely compatible with a maintenance/storage facility.

Another possible location for the maintenance/storage facility is the existing LRT facility located near Hiawatha Avenue and Franklin Avenue. However, it is likely that this facility will be at capacity when vehicles are acquired for the Central LRT and connecting with the LRT tracks to reach the facility could require a bridge to cross Hiawatha Avenue. For these reasons, the existing LRT facility is not a likely candidate for streetcar maintenance and storage.

Chapter 8. Summary and Next Steps

This chapter presents a summary of the Phase III analysis, focusing on the shortest operable segments that will form the foundation of the streetcar network. Following the summary of the shortest operable segments, a series of steps are presented that will help the City make a decision on which initial line to start building the network.

Summary of Shortest Operable Segments

The estimated operating costs, capital costs and ridership figures for the shortest operable segments are summarized in Figure 8-1. As a way to compare the shortest operable segments, two cost effectiveness measures and one service efficiency measure are included:

- operating cost per passenger
- capital cost per passenger
- passengers per service hour

In addition, two key cost elements that were left out of the earlier capital cost estimates are also included:

- **Vehicles.** Modern streetcar vehicles, such as those used in Portland and Tacoma, typically cost $3.0 million each, depending on the vehicle configuration and market conditions when the vehicles are acquired. In addition, spare vehicles will be required for scheduled maintenance and unexpected breakdowns. For all of the shortest operable segments, a single spare vehicle is assumed. However, as the system grows, a standard spare ratio of 15-20% should apply.
- **Maintenance and storage facility.** A maintenance facility for a starter line can range from $2.0 to 4.0 million, depending on the size of the facility. This figure assumes that the land will be owned by the City (or other government entity) and that land acquisition costs are minimal. Also, costs associated with a maintenance facility may be slightly higher in Minneapolis because streetcar vehicles are assumed to be stored inside. Another consideration is the location of the maintenance facility. The further the facility is located from the main line, the longer the track required to reach the facility will be and the higher the costs. For planning purposes, it is assumed that capital costs associated with a maintenance/storage facility would cost approximately $4.0 million and that ½ mile of single track would be required to access the facility.

It is important to note that a maintenance/storage facility will be a one-time cost that would apply only to the first line. As the system evolves, however, it may be necessary to construct an additional maintenance/storage facility.

Next Steps

While the ultimate streetcar system in Minneapolis should include all of the corridors described in the Phase II report, the question is where to start. Based on the information in Figure 8-1, it is possible to start comparing the segments based purely on capital and operating cost measures. The Nicollet Mall, for example, has the lowest capital cost per passenger and operating cost per passenger[13]. On the other hand, the Broadway/Washington to Park Avenue/5th Street segment has the highest capital cost per passenger and is moderately high in terms of operating cost per passenger. And because of its length, the Hennepin corridor had the highest total capital costs, but on a cost per passenger basis was in the middle compared to other segments.

While these measures are important for comparing the corridors, other factors are equally important when making the decision which segment to implement first. These factors include community support, private funding opportunities and economic development potential. Another important consideration when making this decision is that once an initial line is built, it means a commitment must be made to that corridor – at least until it reaches a logical terminal location or anchor. Incremental extensions on streetcar projects around the country typically continue along a single line until it reaches a logical anchor. In Portland, for example, the initial line was clearly pointing to the new South Waterfront district, even though the initial line stopped several miles short. After several small extension projects, the streetcar line recently reached the north end of the South Waterfront and another short extension will serve the south end of the district.

The next phase of this study, the Draft Final Report, will further analyze the possible extensions to the shortest operable segments. While the extensions could increase the utility of the initial segment, this analysis will also require revised ridership, operating cost and capital cost estimates.

The following items will be included in the Draft Final Report, which will allow the City to make a decision on which segment to implement first.

1. **Identify most feasible maintenance facility and turnaround locations.** As noted earlier, streetcar service requires a maintenance and storage facility be located as close to the initial segment as possible. Unlike bus operations, a streetcar maintenance facility requires non-revenue track, which costs the same per track mile as revenue track. Initial streetcar segments also must consider turnaround

[13] Nicollet Mall capital cost estimates assume that no extraordinary modifications are required between Washington and 12th Street. Due to the more dramatic curvature of the street between 13th Street and Grant, however, and to account for modifications related to fire hydrants, street lights, traffic signals, street furniture, etc., moderate additional costs were added to the total capital cost for this segment. This cost would also cover granite sidewalk adjustments due to placement of overhead wire support poles. If any segment of the Nicollet Mall does require straightening, the total capital costs could be significantly higher.

locations. These issues will be explored further for each possible shortest operable segment and possible extensions to those initial segments.

2. **Update ridership, operating cost and capital cost estimates.** Once reasonable locations for a maintenance/storage facility and possible extensions outside of downtown are evaluated further, updates to the cost information and ridership estimates will be made.
3. **Identify most likely public and private funding sources.** A list of potential funding sources will be identified in the Draft Final report. The likelihood of utilizing these funding sources to build and operate streetcar will be evaluated and recommendations for the most likely sources will be identified.
4. **Identify potential owner/operator arrangements and detailed implementation plan.** Possible owner/operator arrangements will be identified and a preferred operator will be selected. An implementation plan will outline the steps that need to be take to develop a first streetcar segment, including an estimated timeline for completing all identified tasks.
5. **Gauge community support.** Public open house meeting will be conducted to gauge the level of support among the various neighborhoods potentially served by an initial streetcar line, as well as by city residents in general. The neighborhood that shows the greatest support for an initial streetcar line will help identify initial segments and future extensions.

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Figure 8-1 Summary of Shortest Operating Segments Characteristics

	Hennepin Avenue	Broadway/Washington Avenue to Nicollet Avenue	Broadway/Washington Avenue to Park Avenue	Nicollet Avenue	9th/10th Streets to Nicollet Avenue
From	*Groveland*	*10th Avenue N*	*10th Avenue N*	*Grant Avenue*	*Chicago Avenue / 14th Street*
To	*Central Ave NE/4th StreetSE*	*5th Street / Nicollet Avenue*	*5th Street / Park Avenue*	*Washington Avenue*	*Nicollet Avenue / 5th Street*
Operating Characteristics					
Peak Vehicle Requirement	3	2	2	2	2
Annual Service Hours	17,200	11,450	11,450	11,450	11,450
Estimated Annual Operating Costs (assuming $149.75/hour)	$2,571,507	$1,714,338	$1,714,338	$1,714,338	$1,714,338
Ridership Estimates					
Estimated Weekday Ridership – Low	2,357	1,312	1,226	1,747	1,139
Estimated Weekday Ridership – High	2,885	1,603	1,498	2,138	1,392
Estimated Annual Ridership – Low	831,449	461,916	431,460	616,226	401,004
Estimated Annual Ridership – High	1,016,215	564,564	527,340	753,166	490,116
Capital Cost Estimates ($2007)					
Route Miles	2.6	1.2	1.7	1.0	1.3
Track Miles	4.8	2.2	3.4	1.8	2.6
Estimated Cost per Track Mile	$9,948,067	$9,948,067	$9,948,067	$9,948,067	$9,948,067
Subtotal	$47,750,722	$21,885,747	$33,823,428	$17,906,521	$25,864,974
Additional Capital Costs	1) Lowry Tunnel - $244,000 2) Hennepin Bridge (Miss. River) - $2.08 M 3) Center Stations (Wash – 10th) - $450,000 4) LRT Crossing - $50,000	1) 4th Avenue N Bridge - $70,000 2) LRT Crossing - $50,000 3) Mall Modifications - $300,000	1) 4th Avenue N Bridge - $70,000 2) LRT Crossing - $50,000	1) LRT Crossing - $50,000 2) Mall Modifications - $2,100,000	1) LRT Crossing - $50,000
Vehicle Costs[14]	$12,000,000	$9,000,000	$9,000,000	$9,000,000	$9,000,000
Non-revenue track[15]	$4,459,479	$4,459,479	$4,459,479	$4,459,479	$4,459,479
Maintenance Facility[16]	$4,000,000	$4,000,000	$4,000,000	$4,000,000	$4,000,000
Total Capital Costs ($2007)	$70,790,201	$39,765,226	$51,402,907	$37,516,000	$43,374,453
Cost Effectiveness Measures					
Capital Cost per Passenger – High	$69.66	$70.44	$97.48	$49.81	$88.50
Capital Cost per Passenger - Low	$85.14	$86.09	$119.14	$60.88	$108.16
Operating Cost per Passenger – High	$3.09	$3.71	$3.97	$2.78	$4.28
Operating Cost per Passenger – Low	$2.53	$3.04	$3.25	$2.28	$3.50
Service Efficiency Measure					
Passengers per Service Hour – High	60.1	50.1	46.8	66.8	43.5
Passengers per Service Hour – Low	49.1	41.0	38.3	54.6	35.6

[14] Costs include one spare vehicle per shortest operable segment. If all segments were implemented together, the number of spare vehicles would likely be lower.
[15] For planning purposes, it is assumed that ½ mile of single track would be required to access a maintenance facility.
[16] Maintenance facility costs would only apply to the first shortest operable segment.

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Once this feasibility study is complete, it will be important for the City to select an initial a streetcar segment to begin with and identify how this initial segment will further the development of the long-term network. The following "next steps" have been identified to help move this process forward.

1. **Continue to gauge political support.** It is important to ensure that elected officials are supportive of an initial investment that will serve downtown only. It must be understood that the streetcar system will eventually serve many corridors throughout the city.
2. **Gauge developers support and economic development potential**. Developers have had strong influence in making streetcar lines happen in Portland, Memphis, Little Rock and Tampa. While the long-term streetcar network proposed for Minneapolis will eventually be an integral component of the PTN, support from local developers and a line that supports economic development can tip the scales to one segment over another.
3. **Develop detailed funding plan.** Discussions regarding potential funding options have already been initiated with various City staff. Utilizing the recommendations made in the Draft Final Report, the most promising sources should be selected and evaluated further. The options should then be presented to other public and private entities and a detailed capital and operating funding plan should be developed. A detailed funding plan can vary by corridor, and help the City identify which shortest operable segment gets built first.
4. **Further evaluate the impact on the local bus network.** Although streetcars and buses generally do not have major conflicts when operating in the same corridor, downtown will be different because of limited right-of-way available for transit through the core. In the Nicollet Mall, for example, it will be especially difficult to integrate streetcars and buses in the short-term because of peak hour bus volumes and the speed at which streetcar may need to operate through the curves. Hennepin Avenue will be somewhat easier because there are no curves (and thus streetcars can operate at a comparable speed to buses), but the additional streetcar vehicles may create additional impacts in terms of total transit volumes in that corridor. Throughout the decision process, Metro Transit should continue to be consulted to identify those segments that have the greatest impact, both positive and negative, on the bus network.
5. **Ensure that streetcar corridors with programmed streetscape improvements consider future streetcar operations.** Some of the corridors included in the long-term streetcar network are slated for major streetscape and reconstruction over the next 5 years. To help make streetcars more cost-effective, some of these streetscape projects could incorporate streetcar treatments prior to laying track (such as station bulbouts, utility relocation, etc.). Even if streetcar service is not implemented in these corridors right away, this may help identify the most logical shortest operable segment.

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APPENDIX

Phase III Streetcar Operating Plans

DRAFT – 5-15-07

Summary

Corridor	Notes	Peak Streetcar Vehicle Requirement	Net Change in Ann Operating Hours (+)	Net Change in Daily Vehicle Volumes – NB/EB (+)	Net Change in Daily Vehicle Volumes – SB/WB (+)
Broadway		**7**	**14,400**	**20**	**21**
Chicago		**8**	**29,900**	**98**	**102**
Central		**9**	**5,900**	**4**	**1**
Midtown Greenway	**1, 2**	**5**	**28,200**	**116 (1)**	**116 (1)**
University/4th	**See Hennepin**				
Nicollet		**9**	**3,400**	**5**	**4**
Hennepin (Short Line)	**3**	**4**	**22,000**	**30**	**32**
Hennepin (Long Line)	**3**	**7**			

Notes:
(1) Operates in exclusive ROW and is not adding or replacing an existing bus line.
(2) No impact on bus routes has been determined yet. This figure will be lower if service on parallel corridors is replaced.
(3) Long line and short line are intended to operate together as part of the long-term network.

Phase III Streetcar Operating Plans

DRAFT – 5-15-07

W. Broadway Ave

Route
(Robbinsdale TC, R Hubbard, L 41st, R Broadway, R France, L Oakdale, R Broadway, R Washington, R Nicollet Mall to 5th Street)
Monday-Friday, 10 min. frequency, 6:00-9:00 am and 3:30 – 6:00 pm; 15 min. frequency other times (total operation 5:00 am – 1:00 am)
Saturday and Sunday, 15 min. frequency, 6:00 AM – 12:00 AM

Southbound Buses:
Route 14E and 14A via Broadway/Oakdale replaced by streetcar
Route 14E and 14A via Regent/39th/Noble/36th replaced by streetcar.

Northbound Buses:
Route 14R via Broadway/Oakdale replaced by streetcar.
Route 14N via 36th/Noble/39th/Regent replaced by streetcar.

Peak Streetcar Vehicle Requirement: 7

Estimated Impact:

Streetcar Operating Hours:	+	34,000 annual revenue hours
Reduction in bus operating hours:	-	19,600 annual revenue hours
Operating cost difference:	+	14,400 annual revenue hours
M-F daily streetcar trips (NB):	+	84
M-F daily bus trips (NB):	-	64
NB trip difference:	+	20
M-F daily streetcar trips (SB):	+	84
M-F daily bus trips (SB):	-	63
SB trip difference:	+	21

Notes:

- Assumes a 12.5 mph streetcar average operating speed peak and base, 15 mph evening.
- May be some additional costs b/c some 14 trips not interlined in downtown (not calculated at this point).
- Some additional operating hours may be required to cover lost service in Robbinsdale (14N Northbound and 14A/E Southbound). These hours are not reflected in the figures shown above.

Phase III Streetcar Operating Plans

DRAFT – 5-15-07

Chicago Ave S

Route
(38th St/Chicago, continue via Chicago, L 9th, R Nicollet Mall to Washington)
Monday-Friday, 7.5 min. frequency, 6:00 am - 6:00 pm; 10-15 min. frequency other times (total operation 4:00 am – 2:00 am)
Saturday, 10-15 min. frequency, 4:00 AM – 2:00 AM
Sunday, 10-15 min. frequency, 4:00 AM – 12:00 AM

Southbound Buses:
Monday-Friday, all Route 5 buses operating only between downtown and 38th St replaced by streetcar.
Monday-Friday, all Route 5 buses operating only south of 38th run very limited stop (only two stops) between Nicollet Mall and 38th St.

Northbound Buses:
Monday – Friday, all Route 5 buses operating only between 38th St and downtown replaced by streetcar.
Monday-Friday, all Route 5 buses operating only south of 38th run very limited stop between 38th St and Nicollet Mall.

Peak Streetcar Vehicle Requirement: 8

Estimated Impact:

Streetcar Operating Hours:	+	46,000 annual revenue hours
Reduction in bus operating hours:	-	16,100 annual revenue hours
Operating cost difference:	+	29,900 annual revenue hours
M-F daily streetcar trips (NB):	+	140
M-F daily bus trips (NB):	-	42
NB trip difference:	+	98
M-F daily streetcar trips (SB):	+	140
M-F daily bus trips (SB):	-	38
SB trip difference:	+	102

Notes:

- Assumes a 1.75 times improvement in travel speed between 38th and 8th St downtown
- Assumes a 8 mph streetcar average operating speed peak, 10 mph base, 12 mph evening.
- Route extended to 38th St E to connect with Route 23 and to replace shortline buses to 38th (39 trips SB and 42 NB).

Phase III Streetcar Operating Plans

DRAFT – 5-15-07

Central Ave NE

Streetcar
(Columbia Heights TC, continue via Central Ave NE to 3rd Ave Bridge, R Washington, L Nicollet Mall to Grant)
Monday-Friday, 4:30 AM – 12:30 AM, 10 min peak and midday frequency, 15-30 min other times.
Saturday, 4:30 AM – 12:30 AM, 15 min peak and midday frequency, 30 min other times
Sunday, 4:30 AM – 12:30 AM, 20 min peak and midday frequency, 30 min other times

Southbound Buses:
All Route 10 trips replaced by streetcar.

Northbound Buses:
All Route 10 trips replaced by streetcar.

Peak Streetcar Vehicle Requirement: 9

Estimated Impact:

Streetcar Operating Hours:	+	40,000 annual revenue hours
Reduction in bus operating hours:	-	34,100 annual revenue hours
Operating cost difference:	+	5,900 annual revenue hours
M-F daily streetcar trips (NB):	+	97
M-F daily bus trips (NB):	-	93
NB trip difference:	+	4
M-F daily streetcar trips (SB):	+	97
M-F daily bus trips (SB):	-	96
SB trip difference:	+	1

Notes:

- Assumes a 10 mph streetcar average operating speed peak, 12 mph base and 15 mph evening.
- Assumes that at-grade RR crossing at 37th Ave NE is no longer operational.

Phase III Streetcar Operating Plans

DRAFT – 5-15-07

Midtown Greenway

Streetcar
(Via Greenway from SW LRT to Hiawatha LRT)
Monday-Friday, 7.5 min frequency during peak hours (6:00 – 9:00 am) and (3:30 – 5:30 pm); 10 min frequency 9:00 am – 3:30 pm; 15 min. frequency all other times. Total hours of operation: 4:30 AM – 1:30 AM

Saturday and Sunday, 15 min frequency during peak hours (6:00 – 9:00 am) and (3:30 – 5:30 pm); 10 min frequency midday (9:00 am – 3:30 pm); 30 min. frequency all other times. Total hours of operation: 4:30 AM – 1:30 AM.

Eastbound Buses:
No bus routes replaced by streetcar.

Westbound Buses:
No bus routes replaced by streetcar.

Peak Streetcar Vehicle Requirement: 3

Estimated Impact:

Streetcar Operating Hours:	+	28,175 annual revenue hours
Reduction in bus operating hours:	-	0 annual revenue hours
Operating cost difference:	+	28,175 annual revenue hours

M-F daily streetcar trips (EB):	+	116
M-F daily bus trips (EB):	-	0
EB trip difference:	+	116

M-F daily streetcar trips (WB):	+	116
M-F daily bus trips (WB):	-	0
WB trip difference:	+	116

Notes:

- Assumes an 18 mph average operating speed throughout the day.
- If SW LRT alignment via Greenway/Nicollet is chosen, streetcar would only be feasible in the Greenway between the Hiawatha LRT line and the Nicollet/28th St Station. This alternative alignment would use 5th Ave S to 28th Street and then travel west to the planned 28th Street Station. It should be noted that 5th Avenue S is the only at-grade crossing of the Midtown Greenway.

Phase III Streetcar Operating Plans

DRAFT – 5-15-07

University / 4th

See Hennepin Avenue

Phase III Streetcar Operating Plans

DRAFT – 5-15-07

Nicollet

Streetcar
(Via Nicollet from 46th Street/Nicollet to downtown):
Monday-Friday, 4:30 am - 2:30 am, 7.5 min. frequency 6:00 am – 8:00 pm, 10-30 min. frequency other times; Saturday, 10-15 min. frequency, 5:00 am - 1:30 am; Sunday 5:00 am – 2:30 am, 10-12 min. frequency 11:00 am-7:00 pm, 15-30 min frequency other times.

Northbound Buses:
Replace all Route 18 buses between downtown and 46th Street, including those operating on Grand Ave S. Connections would be made with buses that continue south of 46th.

Southbound Buses:
Replace all Route 18 buses between 46th Street and downtown, including those operating on Grand Ave S (a neighborhood shuttle would continue to operate between Grand/46th and Lake/Nicollet). Connections would be made with buses that continue south of 46th.

Peak Streetcar Vehicle Requirement: 9

Estimated Impact:

Streetcar Operating Hours:	+	47,000 annual revenue hours
Reduction in bus operating hours:	-	43,600 annual revenue hours
Operating cost difference:	+	3,400 annual revenue hours
M-F daily streetcar trips (NB):	+	146
M-F daily bus trips (NB):	-	141
NB trip difference:	+	5
M-F daily streetcar trips (SB):	+	146
M-F daily bus trips (SB):	-	142
SB trip difference:	+	4

Notes:

- Assumes a 10 mph streetcar average operating speed peak, 12 mph base, 15 mph evening.
- 18G route (via Grand) would be replaced by a neighborhood shuttle between Grand/46th and Lake/Nicollet.

Phase III Streetcar Operating Plans

DRAFT – 5-15-07

Hennepin and University/4th

Route

Long Line *(From Uptown TC via Hennepin to Washington Ave SE via University/4th)*:
Monday-Friday, 15 min. frequency, 5:00 am 1:00 am; 30 min frequency 4:00 am – 5:00 am and 1:00 am – 2:00 am.
Saturday and Sunday, 15 min. frequency, 5:30 am – 12:30 am; 30 min 4:30 am – 5:30 am and 12:30 am – 1:00 am

Short Line *(From Uptown TC via Hennepin to Washington Ave)*
Monday-Saturday, 30 min. frequency 9:30 am – 3:30 pm.

Eastbound/Northbound Buses:
Replace all Route 6 buses between 36th/Hennepin and the University – all day.
Terminate all Route 6 buses between 36th/Hennepin and downtown/University at the Uptown Transit Center – midday, early morning and evening only. Peak buses continue to downtown.

Westbound/Southbound Buses:
Replace all Route 6A buses between the University and 36th/Hennepin.
All Route 6 buses between downtown/University 36th/Hennepin begin trip at the Uptown Transit Center – midday, early morning and evening only. Peak buses continue to downtown.

Peak Streetcar Vehicle Requirement (Long Line): 7
Peak Streetcar Vehicle Requirement (Short Line): 2

Estimated Impact (Long and Short Line):

Streetcar Operating Hours:	+	46,000 annual revenue hours
Reduction in bus operating hours:	-	24,000 annual revenue hours
Operating cost difference:	+	22,000 annual revenue hours
M-F daily streetcar trips (EB/NB):	+	96
M-F daily bus trips (EB/NB):	-	66
EB/NB trip difference:	+	30
M-F daily streetcar trips (WB/SB):	+	96
M-F daily bus trips (WB/SB):	-	64
WB/SB trip difference:	+	32

Notes:

- Assumes a 8 mph streetcar average operating speed peak, 10 mph base, 15 mph evening.
- Route 12 not affected. Might be able to eliminate evening trips on 12 (minimal impact)

Ridership Pivot Model
Minneapolis Streetcar

Bus Route	Corridor	Period	Days per Year	Notes	Productivity	Intensity of Land Use -5% 0% 5%	Mix of Land Use -10% 0% 10%	Travel Time -5% 0% 5%	Frequency Span -5% 0% 5%	Fares -5% 0% 5%	Connectivity -5% 0% 5%	Legibility -10% 0% 10%	Comfort -5% 0% 5%	Total Adjustments	Adjusted Productivity	Streetcar Service Hours Per Day	Adjusted Daily Ridership	Adjusted Annual Ridership	Productivity Range Low	Productivity Range High
5	Chicago	Weekday	255		**68**	5%	5%	0%	5%	0%	0%	10%	5%	30%	88.4	137.0	12,111	3,088,254	79.56	97.24
5	Chicago	Saturday	52		**62**	5%	5%	0%	5%	0%	0%	10%	5%	30%	80.6	126.0	10,156	528,091	72.54	88.66
5	Chicago	Sunday	58		**67**	5%	5%	0%	5%	0%	0%	10%	5%	30%	87.1	70.0	6,097	353,626	78.39	95.81
6	Henn/Univ/4th	Weekday	255		**70**	0%	0%	0%	5%	0%	0%	10%	5%	20%	84.0	128.0	10,752	2,741,760	75.60	92.40
6	Henn/Univ/4th	Saturday	52		**52**	0%	0%	0%	5%	0%	0%	10%	5%	20%	62.4	126.0	7,862	408,845	56.16	68.64
6	Henn/Univ/4th	Sunday	58		**41**	0%	0%	0%	5%	0%	0%	10%	5%	20%	49.2	114.0	5,609	325,310	44.28	54.12
18	Nicollet	Weekday	255		**63**	5%	5%	0%	0%	0%	0%	10%	5%	25%	78.8	139.0	10,946	2,791,294	70.88	86.63
18	Nicollet	Saturday	52		**56**	5%	5%	0%	0%	0%	0%	10%	5%	25%	70.0	121.0	8,470	440,440	63.00	77.00
18	Nicollet	Sunday	58		**59**	5%	5%	0%	0%	0%	0%	10%	5%	25%	73.8	96.0	7,080	410,640	66.38	81.13
14	W Broadway	Weekday	255		**42**	0%	0%	0%	5%	0%	0%	10%	5%	20%	50.4	96.0	4,838	1,233,792	45.36	55.44
14	W Broadway	Saturday	52		**35**	0%	0%	0%	5%	0%	0%	10%	5%	20%	42.0	90.0	3,780	196,560	37.80	46.20
14	W Broadway	Sunday	58		**32**	0%	0%	0%	5%	0%	0%	10%	5%	20%	38.4	90.0	3,456	200,448	34.56	42.24
10	Central	Weekday	255		**40**	5%	5%	0%	0%	0%	0%	10%	5%	25%	50.0	123.0	6,150	1,568,250	45.00	55.00
10	Central	Saturday	52		**32**	5%	5%	0%	0%	0%	0%	10%	5%	25%	40.0	84.0	3,360	174,720	36.00	44.00
10	Central	Sunday	58		**32**	5%	5%	0%	0%	0%	0%	10%	5%	25%	40.0	66.0	2,640	153,120	36.00	44.00

actual
estimated

Notes

Midtown Greenway ridership estimates are based on Hennepin County Regional Railroad Authority

Capital Cost Notes

Background Data (all figures in $2003)

- All calculations were made assuming a single track in each direction
- Single track cost per Greenway (in pavement) is $350/FT
- Single track cost (ballasted track) is $240/FT
- Line Poles - Greenway used 240 poles and system is 4.3 miles therefore
  - 240/4.3 = 56 poles/mile
  - ($2600 per pole x 56 poles/mile) /5280 = $28/FT
- Substations - 2 per mile
  - ($500,000 x 2)/5280 = $189/FT
- Platforms - 5 per mile @ $50,000 ea (Greenway)
  - (5 x 50,000) /5280 = $47/FT Single Track
- Utilities - SW Corridor included general per-route-mile costs. We used a moderate $350 per route-foot to account for unforeseen utility costs.
- Total per mile cost had 20% added for engineering and project management and then an additional 25% for contingencies.
- Power Costs were originally calculated per the Greenway but seemed vague enough that we were more comfortable using the SW Corridor general figure $2,000,000/route mile
  - Double Track = $2,000,000/5280 = $379
  - Single Track = $190/FT

MIDTOWN GREENWAY

Assume:

- Side Tracks (8 total). Three each (segments 7A and 7B), four (segment 7C) and three (alternative segment 7D).

  Approx. 400 FT in length

- **<u>Side Tracks: 1 each, Segment #7 Sections</u>**

Single Track - 400FT each @ $350/FT	$140,000
Switches - $40,000 ea (2)	$80,000
Signal per siding track - $400,000	$400,000
	$620,000

- **<u>Stations</u>**

  Assume - $50,000 ea., 5 per mile each direction

  - $10,000 per bump out plus platform, shelter, bench, ramps, lighting

  - Located every other block

  Downtown - Every block Approx <u>10</u> per mile

  Hennepin - Center Station @ $100,000 each

- **<u>Elevators</u>**

  - $200,000 each

  Assume - 3 per segment

OTHER

- **<u>Lowry Tunnel</u> - Track over Tunnel, Assume $100 per Lineal Foot**

  NB Hennepin = 1320FT

  SB Hennepin = 1120

2440 FT X $100/FT = $244,000

- **LRT Crossings**

  - $50,000 each double track crossing

- **Brick Roadway (Chicago Avenue)**

  - Assume $20/Ft^2

  - 400Ft long block x 20ft cross section = 8,000 Sq Ft

  - 8000 FT^2 x $20/Ft^2 = $160,000

- **Nicollet Mall**

  - Assume $200K per block (5th Street to Grant Street)

  - Assume $100K per block (5th Street to Washington Avenue)

Footnotes

Underpasses - Not considered to be a problem and therefore no extraordinary costs

Skyways - No extraordinary costs but further study needed to determine if streetcar line under hospital (HCMC) has any electrical interference issues

Transit Stations - Standard Station costs were used at the Transit Center end points in Robbinsdale and Columbia Heights as well as the West Lake LRT Stop. Any extraordinary costs for these locations would need to be added.

Streetcar Line Endpoints - No extraordinary costs were applied to these locations, standard station costs were used

Midtown Greenway - A single track design with side tracks in each segment was used. It was assumed that no bridge modifications were needed at any underpass location. Also any bike trail realignment costs due to the streetcar track placement were not included

Chicago Av. S (4th St S-5th St. S) - This segment also known as Kirby Puckett Way is subject to closure for most events held at the Metrodome.

Roadway section over Lowry Tunnel - All extraordinary costs were included in the Hennepin (4th St. SE - Groveland) section although some would undoubtedly fall in the section south of Groveland.

List of Extraordinary Costs By Segment
5/15/07

1A	Hennepin (Groveland - Univ/4)			
		Lowry Tunnel 2440 FT x $100/FT^2		= $ 244,000
		Hennepin Avenue Bridge (Mississippi River) 1040 FT @ $2,000 FT		= $2,080,000
		Center Stations	9 @ $50,000 additional	= $ 450,000
		LRT Crossing	1@ $50,000/crossing	= $ 50,000
1B	Hennepin (Groveland - Lake)			
		Bridge - 29th St Greenway	60FT x $2000/FT	= $ 120,000
2A	Univ. (Central - EWASH)			
		Bridge - I35W	200FT x $2000/FT	= $ 400,000
		Bridge - Dinkytown	220FT x $2000/FT	= $ 440,000
3A	WASH (10th Avenue North - NIC)			
		Bridge - 4th Ave. N.	35FT x $2000/FT	= $ 70,000
3B	NIC (WASH - 5th St)			
		LRT Connection	Assume same as a crossing @ $50,000	= $ 50,000
		Mall Modifications	Assume $100K per block	= $ 300,000
3C	WASH (NIC-Chicago) & Chicago (Wash-5th St)			
		LRT Crossing (angle)	1 @ $50,000	= $ 50,000
3C1	WASH (NIC-Park) & Park (Wash - 5th St)			
		LRT Crossing	1 @ $50,000	= $ 50,000
3D	10th/Wash - N. Mem Hosp (Via W. Broadway			
		I94 Bridge	300FT x $2000/FT	= $ 660,000
3E	Broadway - Wash (N. Mem Hosp - Robbinsdale TC)			
4A	Chicago via NIC (5th - 9/10) - (9/10 - Chicago)			
4B	Chicago - (5-14th)			

4B1	Park (5th St - 9th/10th St) & 9th/10th St (Park - Chicago)			
4C	Chicago (14th St - Lake St)			
	I94 Bridge		330FT @ $2000/FT	= $ 660,000
	Midtown Greenway Bridge		90 FT @ $2000/FT	= $ 180,000
4D	Chicago (Lake- 38th St)			
5A	Nicollet (5th St-Grant)			
	Mall Modifications		Assume $200K per block	= $ 1,800,000
5B	Nicollet (Grant - Lake)			
	I94 Bridge		200 FT @ $2000/FT	= $ 400,000
	K-Mart Bridge?		100 FT @ $2000/FT	= $ 200,000
5C	Nicollet (Lake-46th St)			
6A	Central/Wash (NIC - 3rd Ave S) & 3rd Av. S (WASH - Univ)			
	Miss River Bridge		1900FT x $2000/FT	= $ 3,800,000
6B	Central (Univ - 29th Av NE)			
	9th St NE	RR Bridge	150 FT x $2000/FT	= $ 300,000
	Broadway St NE	Bridge	220 FT x $2000/FT	= $ 440,000
6C	Central (29th Av NE - Columbia HTS TC (40th))			
	36th Av NE	RR Crossing	Use 1 LRT Crossing @ $50,000	= $ 50,000
7A	Greenway (Lake St Station - Hennepin)			
	Side Track	Single Track	400FT @ $350/FT	= $ 140,000
		Switches	2 @ $40,000	= $ 80,000
		Signals	per siding	= $ 400,000
				$ 620,000
	Side Tracks 3 @ $620,000			=$ 1,860,000
	Calhoun/Isles Channel Bridge (RR capable)			NONE
	Vertical Circulation	1 @ $400,000		= $ 400,000

7B	Greenway (Hiawatha/Lake - Chicago)		
	Vertical Circulation	2 @ $400,000	= $ 800,000
	Side Tracks	3 @ $620,000	= $ 1,860,000
7C	Greenway (Chicago - Hennepin)		
	Vertical Circulation	2 @ $400,000	= $ 800,000
	Side Track	4 @ $620,000	= $ 2,480,000
7D	Greenway (Hiawatha/Lake - Nicollet)		
	Vertical Circulation	2 @ $400,000	= $ 800,000
	Sidetracks	3 @ $620,000	= $ 1,860,000

Note

Construction Costs on Bridges

$50/FT^2

20FT width in each direction

(Due to support beams)

$50/FT^2 x 20FT width = $1000 per lineal foot

OR $2000 per lineal foot - both directions