



CITY OF SAINT PAUL

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TRANSPORTATION COMMITTEE OF THE PLANNING COMMISSION

Monday, October 29, 2012, 4:00 p.m. – 5:30 p.m.

All meetings are held in the City Hall Annex 13<sup>th</sup> floor

Conference room at 25 West 4<sup>th</sup> Street in Saint Paul

1. Introduction to the Streetcar Feasibility Study – Christina Morrison, PED, 5 min
2. “Streetcar 101” presentation – Geoff Slater, Nelson Nygaard, 35 min
3. Review and provide feedback on the “Evaluation Process” document – all, 45 min
4. Brief discussion on the general approach to public process – Michelle Beaulieu, PED, 5 min

*Upcoming Transportation Committee Meetings*

- November 5 – Gateway Corridor presentation & action item
- December 3
- December 17

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*Meetings are open to the public. The Chair may allow five minutes for informal public comment (from non-committee members) at the beginning of each agenda as needed. Additional time may be allocated for comments or further discussion at the discretion of the Chair. Meetings will be cancelled if there is not a quorum expected, or if there are no agenda items. For additional information on the Transportation Committee of the Planning Commission, please visit our website at [bit.ly/StPaulTC](http://bit.ly/StPaulTC) or contact Christina Morrison at [christina.morrison@ci.stpaul.mn.us](mailto:christina.morrison@ci.stpaul.mn.us) or 651-266-6546.*

## Transportation Committee Staff Report

Committee date: 10/29/12

<b>Project Name</b>	<b>Saint Paul Streetcar Feasibility Plan</b>
Geographic Scope	Citywide
Ward(s)	All
District Council(s)	All
Project Description	This process will develop of a set of prioritized citywide streetcar corridors that are physically viable, offer the greatest potential for improving local circulation, support economic development, and complement existing and planned regional transportation systems.
Project Contact	Christina Morrison, Senior Planner
Contact email/phone	651-266-6546, <a href="mailto:christina.morrison@ci.stpaul.mn.us">christina.morrison@ci.stpaul.mn.us</a>
Lead Agency/Department	PED
Purpose of Project/Plan	Conducting a feasibility study is an essential first step in determining how best to integrate streetcars into the city's transit system. The study will prepare Saint Paul for long-term success in financing and implementing a comprehensive streetcar network.
Planning References	T 2.1, 2.9, T 2.10
Project stage	System Planning
General Timeline	September 2012- September 2013
District Council position (if applicable)	Na
Level of Committee Involvement	Involvement, development of the plan. The Committee will serve as the community steering committee for the project.
Previous Committee action	None
Level of Public Involvement	Inform, get feedback on specific items
Public Hearing	Unknown
Public Hearing Location	Unknown
Primary Funding Source(s)	Central Corridor Funders Collaborative, McKnight and Saint Paul Foundations, Ramsey County Regional Rail, City
Cost	\$250,000

Staff recommendation	Advise and provide feedback on materials
Action item requested of the Committee	Advise and provide feedback on materials
Committee recommendation	
Committee vote	

## Streetcar 101 Presentation

### **What is Streetcar Service?**

- Rail vehicles (similar to light rail bus smaller)
- Usually operates in mixed traffic
- Typically short length (2-3 miles)
- Close stop spacing (similar to local/standard bus)
- Focus on local trips within corridor
- Much less construction impact than LRT

A photo shows a Portland Streetcar in mixed traffic.

### **What are the Major Benefits of Streetcar Service?**

- Improve local circulation within streetcar corridor
- Provide connections with regional trunk lines
- Stimulate development

A photo shows a Seattle Streetcar stopped next to the sidewalk.

### **In Saint Paul?**

- Same anticipated benefits as elsewhere, plus:
- Streetcar could help fulfill the transit vision outlined in the city's Comprehensive Plan
- Could complement/strengthen other planned improvements:
  - Green Line LRT
  - Arterial BRT
  - Rush Line Corridor
  - Red Rock Corridor
  - Gateway Corridor
  - Robert Street AA

A map shows the Preferred Transit Network from the Saint Paul Comprehensive Plan.

### **Key Streetcar Characteristics**

- Operating environment
- Vehicles
- Stations
- Route length
- Stop spacing
- Ridership
- Economic development
- Integration with other modes (vehicles, bikes, pedestrians)
- Capital costs
- Construction impacts

Photos show mixed-traffic operations in Seattle, Portland, Philadelphia, and Toronto.

### **Operating Environment: Flexibility**

- Very flexible; typically in mixed-traffic

### **Operating Environment: Limitations**

- Some physical features present fatal flaws, such as
  - Steep grades
  - Bridges
    - Vehicle loads similar to highway truck loads
    - But track and relate-infrastructures adds weight
  - Vertical Clearances
  - Roadway Cross Section/Tight turns
- Also need to locate a maintenance/storage facility, preferably close to the line
- Streetcar will be technically feasible in most corridors, but costs will vary significantly
- Electric Codes restrict vehicle power supply wire height over traffic lanes and pedestrian areas for safety
- Vehicle physical characteristics limit wire height
- Typical wire height: 18.5 – 19.0 ft

A photo shows the Union Depot concourse running over Kellogg Boulevard, and the Rivercentre skyway over Kellogg Boulevard.

### **Streetcar Vehicle Types**

#### **Modern Streetcar**

Low floor, higher capacity

Example applications:

- Portland
- Seattle
- Tacoma
- Toronto

#### **Historic Streetcar**

High floor, lower capacity

Example applications:

- Philadelphia
- Memphis
- San Francisco
- Boston

#### **Historic Replica Streetcar**

High floor, Lower capacity

Example applications:

- New Orleans
- Lowell, MA

### Unique Specialty Vehicles

Tourist or Special Event-Related

A photo shows an open-air boat-style streetcar in San Francisco.

### Modern Streetcar – Current Availability

- **Brookville Equipment - Liberty Car** Dallas (in procurement)
- **CAF USA – Urbos** Cincinnati (in procurement)
- **Inekon** Portland and Seattle (in production)
- **Siemens S70 UltraShort** Salt Lake City, Atlanta Streetcar
- **KinkiSharyo AmeriTram** Prototype being offered in US
- **Bombardier Flexity Freedom** Prototype being offered in US
- **United Streetcar** Portland and Tucson (in production)
- Other Foreign Manufacturers May Consider Entering the US Market

Photos show the exterior of each model type.

### Modern Streetcar – Interior and Seating

One photo shows a streetcar interior that is mostly open to maximize standing room, and another photo shows a streetcar with seats, similar to a light rail vehicle. A diagram of a streetcar shows low floor and high floor areas, and ADA seating.

### Streetcar Route Length

- Typically short, but varies:

City	Length (mi)
Boston	2.6
Kansas City (in design)	2.2
Little Rock	3.4
Memphis	2.0 & 2.5
New Orleans	3.6 & 7.5
Philadelphia	10.1-16.2
Portland	3.9
Seattle	1.3
Tacoma	1.6

Tampa	3.0
Tucson (under construction)	3.9

### **Typical Streetcar Stops**

- Streetcar stops are basic, more like a “stop” than a “station”
- Amenities typically include:
  - Shelters, raised platforms, higher-end amenities (benches, signage, lighting, etc.), real-time information, fare payment

Photos show a Planned Cincinnati Streetcar Stop with shelter, and a Seattle Streetcar stop. Both stations are located on the sidewalk.

### **Stop Spacing**

- Typically close—approximately every two blocks

Maps show the Atlanta streetcar route, and the Cincinnati streetcar route. Both streetcars are now under construction.

### **Ridership**

- Strong ability to attract “choice” riders
- Attracts a wider mix of users (students, workers making midday trips, tourists, etc.)
- Fewer commuters; more non-work trips

A photo shows the interior of a crowded Seattle streetcar.

### **Integration with Bus Service**

- Streetcars and buses can operate on the same alignments
- Can also share stops

Photos show a street sharing bus and streetcar in Toronto, and the Northern Terminus of the South Lake Union Streetcar line in Seattle.

### **Integration with Bicycles and Pedestrians**

#### **Photos show:**

- In Portland, an outer bike lane places between the streetcar stop and the sidewalk
- In Portland, a protected left turn for bicycles
- In Toronto, a streetcar line acting as a pedestrian refuge
- In Portland, a streetcar operating through a pedestrian plaza

### **Economic Development**

- Streetcar best at concentrating investment and accelerating development
- Streetcar can strengthen or reinforce other goals (walkability, vibrant street life, etc.)
- Streetcar is a unique mode that attracts attention and development
  - As much about development as moving people
- Streetcar can be good way to revitalize inner-city, low-income neighborhoods

A photo shows building construction in the Pearl District in Portland.

### **Vehicle Maintenance Facility**

- Can fit in small space

A photo shows a two-car streetcar maintenance facility under bridge piers.

### **Capital Costs**

- **Typical Per Mile Costs**
  - Single Track - \$25 - \$30m
  - Double Track - \$50 - \$60m
- **Capital costs include:**
  - Guideway/Trackwork
  - Stations/Stops
  - Maintenance/storage facility
  - Civil/Utilities
  - Systems (Power Supply)
  - ROW
  - Vehicles
  - Professional Services

### **Typical Capital Costs**

A chart shows typical costs in 2012 dollars the following items:

- Guideway & track elements - \$6 Million per mile for double track
- Station and stops - \$2 Million per mile for double track
- Vehicle maintenance and storage facilities - \$4 Million per mile for double track
- Civil work & Utilities - \$8 Million per mile for double track
- Systems power supply - \$8 Million per mile for double track
- Right of way, land and existing improvements - \$2 Million per mile for double track
- Vehicles - \$10 Million per mile for double track
- Professional Services - \$8 Million per mile for double track
- Unallocated contingency - \$6 Million per mile for double track

- Total construction costs subtotal - \$28 Million per mile for double track
- Total costs - \$54 Million per mile for double track

### **Construction Impacts**

- Streetcar is less intrusive in terms of construction impacts than light rail
  - Less impact on underground utilities
  - Faster major construction phase

A photos shows relatively low-impact construction in First Hill, Seattle. Another photos shows streetcar track laid in Charlotte.

### **Summary**

- Vehicles/stop/stop spacing
  - Many different vehicle options available
  - Streetcar typically for local circulation, like local bus
- Operating constraints
  - Grade, vertical clearance, bridges
  - Also need a maintenance/storage facility
- Integration with other modes
  - Generally the greatest issue is integration with bikes
  - Difficult to replace parallel bus service until the line gets very long
- Development impacts
  - Streetcar good at organizing and catalyzing development
  - Also good at attracting private investment, revitalizing neighborhoods
- Capital costs
  - Less than LRT, but more than Arterial BRT
- Impact of construction phase
  - Still a major impact on the street, but less intrusive than light rail

### **How does Streetcar Compare to Other Modes?**

- Many similarities:
  - Light rail: Vehicle type and ride quality
  - BRT/Rapid Bus: Station facilities
  - Local bus: Stop spacings
- Many differences; key differences include:
  - Compared to light rail:
    - Streetcar in mixed-traffic rather than exclusive ROW
    - Focus on shorter, more local trips
    - Much less construction impact
  - Compared to BRT/Rapid Bus/Local Bus:
    - Greater sense of “permanence”
    - Much greater ability to spur development
    - Better ride quality

## **Streetcar Other Modes: Vehicles**

Drawings of various vehicles and measurements are shown:

- Standard bus: 40 feet by 8.5 feet
- Vintage restored streetcar: 50 feet by 8.5 feet
- Vintage replica streetcar: 46.1 feet by 8.6 feet
- Modern Streetcar: 66 feet by 8.1 feet
- Standard bus: 95 feet by 8.5 feet

## **Streetcar versus Other Modes: Right-of-Way**

Streetcar/Bus

- Usually in mixed-traffic

Light Rail/BRT

- LRT usually exclusive right-of-way
- BRT in either exclusive or shared ROW

Photos show:

- A Portland Streetcar in mixed traffic
- Hiawatha LRT line on 5th Street in Minneapolis
- A MAX BRT vehicle in Kansas City

## **Streetcar versus Other Modes: Overlap**

There are also hybrids:

- Light rail and BRT can run in mixed traffic
- Streetcar can run in exclusive right-of-way
- Streetcar and light rail have the same gauge track

Photos show:

- MBTA Green Line Light Rail in Mixed-Traffic in Boston
- Green Line Construction in Saint Paul

## **Streetcar versus Other Modes: Route Length**

Streetcar/Local Bus

- Focus on shorter local trips

Light Rail/BRT

- Focus on longer and regional trips

Maps show:

- A 2.8 mile streetcar route in Portland
- A 9.6 mile route along the Green Line LRT in the Twin Cities
- A 6.6 mile BRT Health Line route in Cleveland

### **Streetcar versus Other Modes: Stop Spacing**

Streetcar/local bus

- Usually closely spaced stops

Photo shows the South Lake Union area in Seattle.

Light Rail/BRT

- Usually 1/2 to 1 mile stop spacing
- Serves longer trips

Photo shows the Hiawatha Line in Minneapolis

### **Streetcar versus Other Modes: Stations**

Streetcar/local bus

- Usually less elaborate
- Streetcar has shorter platform than light rail

Photo shows a sidewalk adjacent station in Portland.

Light Rail/BRT

- Usually more elaborate, longer platform
- Stations vary greatly for BRT

Photos show the Future Westgate Station in Saint Paul, and the Healthline BRT station in Cleveland.

### **Streetcar versus Other Modes: Development**

Streetcar

- Linear, local economic development – 2 to 3 blocks along the corridors

Light Rail

- Nodal economic development – 0.3 to 0.5 miles around the station

### **Streetcar versus Other Modes: Development**

Bus Rapid Transit

- Depends largely on physical improvements
- Nearly always less than streetcar, but...
- There are exceptions:
  - Cleveland's Healthline spurred \$4-5B in development
  - However, infrastructure much more similar to LRT than typical BRT

Two photos show Healthline BRT stations and exclusive running way in Cleveland.

### **Streetcar versus Other Modes: Construction**

Streetcar/BRT

- Lower impact; faster construction

Light Rail

- Often much greater impact

Photos compare the First Hill streetcar construction in Seattle to the Green Line construction in Saint Paul.

### **Summary**

- Usually operates in mixed traffic
- Focuses on shorter, local trips
- Closer stop spacing, like local/standard bus
- Similar but smaller vehicles than LRT
- Less costly than light rail, more costly than BRT
  - Infrastructure between LRT and BRT
  - Capacity similar to BRT
- Strong ability to catalyze and organize development
  - Light rail and BRT can do this as well, but more nodal than linear
- Slower speeds, more like local bus
- Much less construction impact than LRT

## 1. INTRODUCTION/OVERVIEW

The primary goals of the City of Saint Paul Streetcar Feasibility study are to:

- Evaluate the feasibility of developing streetcar services in Saint Paul
- Identify corridors that best meet the goals identified in the City’s Comprehensive Plan
- Prioritize potential initial segments for streetcar investment
- In order to accomplish these goals, the evaluation will be conducted in a series of “iterations” or phases.
- Phase 1 Corridor Screening: The Phase 1 Corridor Screening will screen the universe of candidate corridors to eliminate those corridors (or segments of corridors) with significant physical flaws. Phase 1 will also screen out corridors where planned land uses and existing and planned zoning are clearly not supportive of streetcar investments.
- Phase 2 Detailed Evaluation: Following the completion of the Phase Corridor Screening, the study team will develop potential streetcar lines that could operate in the individual corridors or combinations of corridors. These potential lines and their associated corridors will then be put through a more rigorous evaluation, focusing on conceptual transit operations and system integration, high-level capital and operating costs, preliminary evaluation of economic development potential, initial transit demand, and maintenance/storage facility location and cost.
- Phase 3 Determine Initial Operating Segments: Following the development of the long-term streetcar network, Phase 3 will be to identify the most effective lines/segments to be pursued as the first new streetcar lines.
- Potential Corridors

A “long list” of potential streetcar corridors will be developed based on the Preferred Transit Network and 2030 Land Use from the City’s Comprehensive Plan. This long list of potential corridors will be assessed in Phase 1 and narrowed through the three-phase process to a short list of highest priority corridors and one to two minimum operating segments with the highest potential for a starter line.

The Phase 2 process will also include a separate but parallel screening process to review downtown streetcar operations and to select streets with the highest potential to carry streetcars through downtown.

Our evaluation methodology, summarized in Figure 1, is based on a process that we have used successfully in other similar citywide streetcar or transit studies, including those in Minneapolis and Seattle. These criteria and processes are being developed with input from an interagency staff working group, as well as the Transportation Committee of the Planning Commission.

Figure 1:

#### Phase 1 Corridor Screening

- Grade
- Street Geometry
- Other Physical Barriers
- Terminal Location
- Utilities
- Transit Speed and Reliability
- Conflict with other Transit investments
- Transit Supportive Land Use

Result: Corridors for further consideration

#### Phase 2: Detailed Evaluation

- Special Use Generators and Corridor Anchors
- Transit Supportive Land Use
- Area Targeted for Redevelopment
- Transit Speed and Reliability
- Streetcar operating costs
- Replacement of existing bus service
- Relationship to current/future high capacity transit investments
- Ridership potential/transit supportive land use
- On-street parking impacts
- Conceptual Capital Costs

Result: Long-term streetcar network

#### Phase 3: Determine Initial Lines

- Economic Development Potential
- Transit Operations
- Streetcar Operating costs
- Estimated ridership
- Refined Capital costs

Result: Starter line recommendation

## 2. PHASE 1 CORRIDOR SCREENING

Phase 1 is designed to screen out the “long list” of potential corridors where streetcar operation is either not feasible due to technical issues, or would be inappropriate based on planned land use and/or the ability to accommodate maintenance/storage facility. In some cases, “significant impacts” will be identified that do not necessarily eliminate

candidate corridors from consideration but that require special attention before a corridor may be determined to be feasible. Screening criteria may be used to eliminate entire corridors, or to reduce the viable length of a potential streetcar corridor, limiting future evaluation of streetcar construction and service to the parts of the corridor where streetcar operations would be feasible.

Phase 1 of the evaluation is broken into Primary and Secondary screening criteria. Primary Screening Criteria are intended to screen corridors based on physical and geometric constraints while Secondary Screening Criteria screen the candidate corridors based on planned land use and/or zoning that can accommodate a maintenance/storage facility. If a corridor does not pass all Primary Screening Criteria, it will not be evaluated using the Secondary Screening Criteria. A description of the Primary and Secondary Screening Criteria is provided below and summarized in Table 1.

#### PHASE 1 PRIMARY SCREENING CRITERIA

- **Grade.** Saint Paul has a number of steep grades that could inhibit streetcar operations, or make streetcar operation too expensive. While modern streetcar can climb grades as much as 9%, sustained grades over 7% are generally discouraged, particularly in climates where snow and ice are regular occurrences. Thus, corridors with grades between 7 and 9% will be carried forward to Phase 2 only if they pass all other screening criteria.
- **Street Geometry.** Especially between downtown and the neighborhoods, there are a number of streets in Saint Paul where streetcar operation may be difficult to operate due to street geometry. This criterion identifies whether street geometry would inhibit streetcar operation, or require significant capital investments that make operation infeasible. These include major modifications to interchanges, exclusive right-of-way needs or other types of transit priority that would be required (such as bridges, underpasses, etc.). Potential for wheel noise will be also identified.
- **Other Physical Barriers.** Other physical barriers besides grade and street geometry may inhibit streetcar operations without significant capital expenses and will be identified. Examples include low bridges or skyways, streets that are too narrow and at-grade freight railroad crossings. As noted above, some bridges may exhibit steep grades, but will also be identified here if these bridges could make inhibit streetcar operation.
- **Terminal Location.** As with any transit service, a strong destination—or terminal—helps improve the attractiveness of service. Thus, this criterion evaluates whether there is a reasonable location for a streetcar line to terminate where connections to other transit service can be made, such as a university/college, transit center, Green Line LRT station or other major activity center.
- **Utilities.** One of the highest potential barriers to streetcar operation is the cost associated with utility replacement. Corridors that would require relocation of major utilities (such as water, storm and sanitary) could make streetcar operation too costly to be provided cost effectively. In Phase 1 of the evaluation, a high-level assessment of utility conflicts will be conducted. A more detailed assessment of potential utility conflicts will be conducted in Phase 2.

- Transit Speed and Reliability. As with any transit service, but especially for a transit investment like streetcar that will operate entirely or largely in mixed flow traffic, it is important to maintain adequate speed and operate reliability. Thus, corridors with substantial traffic congestion, and where exclusive ROW is not possible, may be unable to meet minimum service standards. Severe traffic congestion, for the purposes of this study, is defined as a street segment where the volume of traffic is greater than the capacity of that roadway operating at Level-of-Service (LOS) E. Average Annual Daily Traffic (AADT) counts from 2 to 3 recent years will be reviewed.
- Conflict with Other Transit Investments. There are a number of new or potential transit investments currently being considered in Saint Paul, some of which could compete with a potential streetcar alignment. As such, streetcar service should not be designed to duplicate other major transit investments, such as the Green Line or Red Rock Corridor.

Table 1 Phase 1 Screening Criteria and Measures

Criteria	Screening Measure
<b>Primary Screening Criteria and Measures</b>	
Grade	<ul style="list-style-type: none"> <li>▪ Grades greater than 9%. <i>Tentative pass</i>: Grades between 7-9% over sustained lengths (only if corridor passes all other screening criteria)</li> </ul>
Street Geometry	<ul style="list-style-type: none"> <li>▪ Required turns less than 90 degrees, or segments with required weaving or curvature that cannot be negotiated by a modern streetcar (to be evaluated on a case-by-case basis)</li> </ul>
Other Physical Barriers	<ul style="list-style-type: none"> <li>▪ Bridges or skyways less than 14'2" of overhead clearance for combined streetcar and general purpose traffic operation. <i>Tentative pass</i>: Clearances between 14'2" and 14'8"</li> <li>▪ Lane widths cannot be striped to less than 10 feet</li> <li>▪ At-grade freight railroad crossing. At grade crossing of two tracks requires difficult FRA approval and would likely not be allowed without expensive additional signalization or grade separation</li> </ul>
Terminal Location	<ul style="list-style-type: none"> <li>▪ Corridor segments do not logically connect to a strong terminal location, or are too far away to be reasonable</li> </ul>
Utilities	<ul style="list-style-type: none"> <li>▪ Presence of major water, storm and sanitary utilities within 3 feet below proposed streetcar alignment. <i>Tentative pass</i>: presence of major utilities between 3 – 6 feet of proposed streetcar alignment</li> </ul>
Transit Speed and Reliability	<ul style="list-style-type: none"> <li>▪ Assessment of AADT/lane ratios that could impact reliability and travel speed of streetcar in mixed flow corridors. <i>Tentative pass</i>: if right of way exists for dedicated streetcar operation</li> </ul>
Other Transit Investments	<ul style="list-style-type: none"> <li>▪ Corridors that directly compete for riders with existing or programmed transit investments. Service would be seen as competitive if it serves the same market as the BRT or LRT service, and would detract from ridership on those services</li> </ul>
<b>Secondary Screening Criteria and Measures</b>	
Land Use Types	<ul style="list-style-type: none"> <li>▪ Significant areas of "low" transit-supportive land uses – including residential densities below 10 units per acre, industrial land uses, low-scale commercial development and/or no significant area of mixed use development supporting bi-directional service</li> </ul>

**PHASE 1 SECONDARY SCREENING CRITERIA**

- **Transit Supportive Land Use.** As a major transit investment, it is important to ensure that any new streetcar investment serve areas that are as “transit supportive” as possible. Transit supportive land uses are generally medium or high intensity development, but could also be a major activity center such as a college or university. This criterion will evaluate planned land use types (by square footage or units per acre) within ½ mile of each potential streetcar corridor. A more detailed evaluation of development potential will be completed during the Phase 2 evaluation. This evaluation is based on 2010 land use and planned 2030 land use data. A summary of the different levels of transit supportive land use is proposed in Table 2.

**Table 2 Transit-Supportive Land Uses**

• Low	• Medium	• High
<ul style="list-style-type: none"> <li>• Established Neighborhood Residential Corridors</li> <li>• Single Family Residential</li> <li>• Industrial</li> <li>• Parks &amp; Open Space</li> <li>• Golf Course</li> <li>• Airport</li> <li>• Transportation Infrastructure</li> <li>• Water</li> <li>• Undeveloped (no potential redevelopment)</li> </ul>	<ul style="list-style-type: none"> <li>• Residential Corridors</li> <li>• Mixed Use Corridors</li> <li>• Neighborhood Centers</li> <li>• Multi-Family Residential (i.e., under 18 units/acre)</li> <li>• Major Institutional</li> <li>• Retail and other commercial</li> <li>• Office (i.e., under 20 jobs/acre)</li> <li>• Undeveloped (zoned medium intensity)</li> </ul>	<ul style="list-style-type: none"> <li>• Mixed Use Corridors</li> <li>• Neighborhood Centers</li> <li>• Multi-family residential (i.e., over 18 units/acre)</li> <li>• Downtown</li> <li>• Major Institutional</li> <li>• Retail and Other Commercial</li> <li>• Office ( i.e., over 20 jobs per acre)</li> <li>• Undeveloped (zoned high-intensity)</li> </ul>

**DOWNTOWN STREETCAR CORRIDORS**

Due to the complexities involved with potential streetcar operation in downtown Saint Paul, corridor alignment options in the downtown area will be given special attention. Streetcar operation will be considered only on downtown corridors that directly connect with neighborhood corridors.

Downtown alignment opportunities will be considered in conjunction with Phase 1 analysis so that preferred downtown corridors can be considered as part of Phase 2 and 3 alignments. While it is not certain, it is likely that preferred minimum operating segments will include downtown operations, since the downtown area represents the densest, highest demand land use patterns in the City.

To complete this portion of the analysis, a list of potential downtown operating streets or street pairs will be developed. Phase 1 screening criteria will then be used to screen out streets or street pairs with fatal flaws, such as overly steep grades. Phase 2 criteria (described below) will be used to narrow options for downtown operations and all

corridors entering Phase 2, to ensure logical connections between downtown segments and neighborhood corridors.

Because the Central LRT line is aligned through downtown on Cedar and 4th Streets, streetcar service has the potential to be duplicative of LRT rail service, especially on the east side of downtown. However, the LRT alignment could also provide opportunities for joint operation and enhancement of rail service levels at a much lower cost than if streetcar were operating on a completely different alignment. While streetcar might be able to utilize LRT tracks physically through downtown Saint Paul, the study of downtown operations will assess any potential issues associated with joint use to ensure that there is no fatal flaw design or operational issues. For this option to be considered seriously, the City will need to hold detailed discussions with Metro Transit.

There are a number of unique issues in downtown Saint Paul that will be considered when evaluating potential streetcar corridors:

- Need to serve the core of downtown. As with any type of transit service, it is important that any future streetcar line operate as close to the “core of activity” as possible. While downtown Saint Paul is relatively compact and walkable, providing service as close to the middle of the downtown as possible is desirable. In the east-west direction, this includes E. 5th, 6th or 7th Streets, and in the north-south direction, the primary streets include Robert, Minnesota, Jackson, and Wabasha/St. Peter. It may also be possible to utilize the Green Line LRT tracks, which will be on Cedar Street and 4th Street.
- Skyway Clearance. Downtown Saint Paul has a fairly extensive skyway network, which could create issues in terms of overhead clearance. Although clearance is generally not a problem, streetcars, like light rail, require overhead power lines. Because streetcars typically share a lane with other vehicles (i.e., does not have an exclusive right-of-way), a height greater than 14 feet 8 inches is necessary for safety purposes. Although many of the skyways are at least 16 feet high, at least one skyway is below 14 feet 8 inches and many are less than 16 feet high.
- Traffic Congestion and Ingress/Egress. Streetcars typically share lanes with other vehicles, similar to a bus. Unlike buses, streetcars cannot go around obstructions (such as delivery vehicles, double-parked cars) that are typical in highly congested urban environments. Because streetcars are exposed to the same level of delay as other vehicles, and cannot pass obstructions, it is important from a reliability standpoint to operate in streets without severe congestion. Likewise, the high number of entry and exit lanes to parking ramps and the freeway system could create unique issues if a streetcar line were to be introduced.
- Current and Future Bus Volumes. Any future streetcar line will need to consider projected volumes so as not to compromise the speed and reliability of transit operations through downtown. Primary bus-carrying streets in downtown include 5th and 6th Streets, Robert, Jackson, and Minnesota Streets, and Wabasha and St. Peter Streets. The highest bus volumes are on the 5th and 6th couplet, which also likely represents one of the best operating environments for streetcar given penetration of the downtown core, lack of grade and street connectivity on either

- end of downtown. Current and future Metro Transit operations will be evaluated to determine interoperability of streetcar on high-volume bus streets. Potential for bus service reductions will also be evaluated. Streetcars can feasibly replace buses because of their local-stop nature, compared to light rail service, which generally has long stop spacing and does not fully eliminate the need for parallel local bus service.
- Operation on One-Way Streets. Saint Paul has a number of one-way streets in the downtown. Streetcars can operate in parallel directions on one-way streets, however, good design puts opposing directional stops as proximate to one another as possible to improve transparency of operations.

### 3. PHASE 2 DETAILED EVALUATION

We expect that approximately 8 to 10 corridors will emerge from the Phase 1 screening for more detailed evaluation in Phase 2. The goals of the Phase 2 evaluation are to first develop a set of long-term (30-50 years) streetcar corridors, and then identify how streetcar lines could actually operate in these corridors (as individual lines as well as a system).

Expanding on the Phase 1 evaluation, this phase of the evaluation will include new or more detailed analysis of:

- Potential for future transit supportive land use and corridor anchors
- High-level assessment of economic development potential and areas targeted for redevelopment
- Conceptual streetcar operating plans and operating costs
- Conceptual integration with the existing transit system
- Conceptual ridership demand in each corridor
- Cost and other impacts related to on-street parking and utilities
- Conceptual capital costs

Corridors that advance from the Phase 1 screening analysis will have been deemed technically feasible and to have potential to become high priorities for implementation.

However, the goal of Phase 2 is to reduce the number of corridors to those that should become Saint Paul's Long-Term Streetcar Network.

It is assumed that a first round of public outreach will be conducted after the completion of the draft Phase 2 corridor evaluation. This would allow stakeholders and the public to review the results of the evaluation and comment on the corridors most likely to advance to Phase 3 evaluation.

A summary of the Phase 2 evaluation criteria is presented in Table 3.

Table 3 Phase 2 Evaluation Criteria and Measures

Criteria	Description	Measure
Special Use Generators and Corridor Anchors	<ul style="list-style-type: none"> <li>Evaluates number and relative intensity of high-generation uses along the corridor</li> <li>Evaluates scale and strength of anchors for each corridor to generate all day transit demand</li> </ul>	<ul style="list-style-type: none"> <li>Number of "special transit generators" served within ½ mile of each corridor</li> <li>Relative strength of anchor uses (size and distribution of demand)</li> </ul>
Transit Supportive Land Use	<ul style="list-style-type: none"> <li>Measures transit supportive <i>planned</i> land use types (by land area or units per acre) within ½ mile) from the streetcar corridor</li> </ul>	<ul style="list-style-type: none"> <li>Maximum development potential under existing zoning</li> </ul>

Table 3 (Continued) Phase 2 Evaluation Criteria and Measures

Criteria	Description	Measure
Area Targeted for Redevelopment	<ul style="list-style-type: none"> <li>Evaluates redevelopment and community planning initiatives in the corridor and assesses the intensity of development potential in each corridor</li> </ul>	<ul style="list-style-type: none"> <li>Presence of/potential for redevelopment projects or large area master plans with ability to generate significant redevelopment</li> <li>Capacity to generate development beyond adopted comprehensive land use plan estimates</li> </ul>
Transit Speed and Reliability	<ul style="list-style-type: none"> <li>Evaluates existing conditions in the corridor to determine whether or not streetcar operations would be able to maintain adequate speed and reliability</li> </ul>	<ul style="list-style-type: none"> <li>Transit speed as percent of speed limit (Peak and Middy) based on projected intersection/segment LOS (delay or V/S)</li> <li>Need for transit priority investments (either ROW, signalization, etc.) to maintain competitive levels of speed and reliability</li> <li>Ability to increase passenger throughput<sup>1</sup></li> </ul>
Streetcar Operating Costs	<ul style="list-style-type: none"> <li>Based on initial operating plans, evaluates the operating costs of streetcar</li> </ul>	<ul style="list-style-type: none"> <li>Preliminary estimate of operating costs of streetcar assuming a cost per hour similar to comparable streetcar operations</li> </ul>
Replacement of Existing Bus Service	<ul style="list-style-type: none"> <li>Evaluates how well streetcar would fit in the corridor and what impact streetcars would have on existing bus operations</li> </ul>	<ul style="list-style-type: none"> <li>Evaluation based on initial operating plans and potential impact on underlying bus network (see Streetcar Operating Plans section below for more detail)</li> </ul>
Relationship to Current/Future High Capacity Transit Investments	<ul style="list-style-type: none"> <li>Evaluates how well the streetcar corridor connects with future high-capacity transit investments</li> <li>Assesses how potential streetcar lines may enhance or duplicate proposed high capacity service</li> </ul>	<ul style="list-style-type: none"> <li>Qualitative evaluation of corridor relative to current/planned system operations</li> </ul>

<sup>1</sup> The Saint Paul Comprehensive Plan notes that "Person Throughput is a measurement of street capacity and effectiveness that takes into account the total number of people using the road, rather than just the number of vehicles. This measure more accurately reflect the potential of transit improvements and ridesharing to expand system capacity " (Policy T2.4)

Criteria	Description	Measure
Ridership Potential/Transit Supportive Land Use	<ul style="list-style-type: none"> <li>Examines supportiveness of projected land use/demographics in the corridor relative to industry best practice estimates required to support a streetcar mode</li> </ul>	<ul style="list-style-type: none"> <li>Total population and population density within corridor – 2030 forecasted data</li> <li>Total employment and employment density within corridor – 2030 forecasted data</li> <li>Total and density of low income households (i.e. under \$25,000 annual household income) – 2010 data (if available)</li> <li>Total and density of zero-car households – 2010 data (if available)</li> </ul>
Utilities	<ul style="list-style-type: none"> <li>Evaluates in more detail potential utility conflicts in the corridor (compared to high-level screen in Phase 1)</li> </ul>	<ul style="list-style-type: none"> <li>GIS evaluation of presence and diameter of water, storm and sanitary utilities along the corridor</li> <li>Evaluation of potential for conflict given ROW conditions</li> </ul>

Table 3 (Continued) Phase 2 Evaluation Criteria and Measures

Criteria	Description	Measure
On-Street Parking Impact	<ul style="list-style-type: none"> <li>Analyzes impact to on-street parking based on initial operating plans</li> </ul>	<ul style="list-style-type: none"> <li>Count of potential impacted on-street parking spaces</li> <li>Qualitative assessment of impacted on-street parking to neighborhood business uses</li> </ul>
Conceptual Capital Costs	<ul style="list-style-type: none"> <li>Makes a high-level assessment of overall capital cost</li> </ul>	<ul style="list-style-type: none"> <li>Conceptual cost based on standard cost/mile and high-level assessment of major capital costs</li> </ul>

#### 4. PHASE 3 DETERMINE INITIAL LINES

Following the Phase 1 and 2 evaluations, it is anticipated that all remaining corridors are technically feasible and should be considered as part of Saint Paul’s long-term vision for streetcar development. However, there also must be a starting point. To determine what this should be, the Phase 3 evaluation will identify two to three priority corridors and streetcar alignments that could be implemented first. Another outcome of this phase will be a prioritized list of corridors for potential implementation. Based on this evaluation, shorter “starter segments” for the highest priority corridors will also be identified. As with Phase 2, it is assumed that a second round of public outreach will be conducted in conjunction with Phase 3 to ensure that the highest priority corridors selected reflect local support.

A summary of the Phase 3 evaluation criteria is presented in Table 4.

Table 4 Phase 3 Evaluation Criteria and Measures

Criteria	Description	Measure
Economic Development Potential	<ul style="list-style-type: none"> <li>Evaluates the ability of the corridor to generate significant economic development</li> </ul>	<ul style="list-style-type: none"> <li>Assessment of building/structure value (assessed) against underlying land value (assessed)</li> <li>Comparison of existing land use and market value with zoned potential and expected market value increase</li> </ul>
Transit Operations	<ul style="list-style-type: none"> <li>Further refines initial operating plans developed in Phase 2 and evaluates the impact on the underlying bus network and connections to other transit services</li> </ul>	<ul style="list-style-type: none"> <li>Further evaluation of streetcar operating characteristics, including potential impact on underlying bus network</li> <li>Likely replacement/duplication of bus system service</li> <li>Transfer requirements for current Metro Transit passengers</li> </ul>
Operating Costs	<ul style="list-style-type: none"> <li>Based on the initial operating plans, further refines the operating plan for streetcar and estimates the operating costs associated with new service and reduction in costs assuming changes to the underlying bus network</li> </ul>	<ul style="list-style-type: none"> <li>Estimated operating costs of streetcar assuming a cost per hour similar to comparable streetcar operations</li> <li>Estimated reduction in bus operating costs based on Metro Transit's cost per in-service hour</li> </ul>
Ridership	<ul style="list-style-type: none"> <li>Evaluates ridership potential along potential corridors with and without streetcar</li> </ul>	<ul style="list-style-type: none"> <li>Estimated daily ridership based on existing bus ridership and expected ridership increases with streetcar from other services</li> </ul>

Table 4 (Continued) Phase 3 Evaluation Criteria and Measures

Criteria	Description	Measure
Capital Costs	<ul style="list-style-type: none"> <li>Completes a more refined assessment of total capital costs and need for major capital cost items above standard cost/mile</li> </ul>	<ul style="list-style-type: none"> <li>Refined per mile and corridor capital cost including: vehicles, maintenance facility, and any required major capital cost items (e.g., bridges, major utilities conflicts, major road reconstruction, etc.)</li> </ul>

Following the completion of Phase 2, the study effort will have developed a long-term vision for Saint Paul streetcar service. Following the completion of this phase, the starting point for the development of this network and an implementation plan, will be developed.

### STREETCAR OPERATING PLANS

Conceptual operating plans will be developed during Phase 2 of the evaluation and then refined during the Phase 3 evaluation for the highest priority corridors. The operating plans will be developed assuming 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, will initially be estimated (for the Minneapolis Streetcar Feasibility Study we estimated streetcar operations at 8-10 mph during the peak period and 10-18 mph during other times). Streetcar travel speeds will then be adjusted based on a review of the peak and midday travel speeds of the underlying bus network in each corridor. The goal for travel speeds will be at least the same as for bus, and estimated speeds will be checked against any available traffic delay/operating speed data available for each corridor.
- Layover requirements. Layover time for streetcar should mimic the underlying bus network, or about 15-18% of the total round-trip running time.
- Frequency of service. This parameter will vary greatly for each corridor, but will be based on the impact streetcar would have on the underlying bus network in each corridor. Combined streetcar and bus frequencies need to mimic the underlying bus network or operate at least every 15 minutes, whichever is more frequent.
- Hours and days of service. Total hours of service for the streetcar should mimic that of the underlying bus network, or a minimum of 18 hours per day, whichever is greater. Streetcar service is assumed to operate 255 weekdays, 52 Saturdays, and 58 Sundays and holidays annually.
- Based on these parameters, it will be possible to develop planning-level estimates of:
  - Total annual in-service 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.
  - Vehicle requirements. This includes the maximum number of vehicles required to operate each streetcar line during peak periods plus an additional factor for spare vehicles.

Once total annual in-service hours and the total vehicle requirement have been estimated, it is possible to generate estimates of total annual operating costs assuming a standard operating cost per in-service hour .

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 will be estimated based on industry norm adjustments from the Metro Transit bus operating cost per revenue hour. Most agencies that operate bus and streetcar experience approximately 40% premiums in per hour costs for streetcar operations compared with bus.

## CAPITAL COSTS

Capital costs will be estimated for the streetcar corridors using three main elements: vehicles, infrastructure, and a maintenance and storage facility. Further, any major projects specific to the alignment will be included and a high-level capital cost will be estimated.

## Vehicles

The cost of the vehicles will be estimated based on the peak number of vehicles required to operate service, 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.

## Streetcar Infrastructure

There are a number of elements associated with streetcar infrastructure:

- 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 – This 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.

## Maintenance / Storage Facility

Regardless of the length of the streetcar corridor, a maintenance and storage facility is required for streetcar projects. While the size of the facility can vary depending on the vehicle requirements, a basic cost for a facility will be assumed. This can vary greatly depending on the cost of the land, so it is assumed that publicly owned land is preferable to privately owned land. In addition, it is assumed that a maintenance and storage facility will be located in an area that is suitable to an industrial use. Some maintenance and storage facilities have been located in otherwise unusable areas, such as under a bridge or highway overpass. It is also important to note that the cost of non-revenue track to access a maintenance and storage facility site is the exact same as revenue track, though a single track (rather than double track that is usually required for revenue service) could be built to minimize costs.

## Major Projects

In some cases, proposed alignments may require one or more major capital projects. These could include new bridges or grade crossings, tunnels, or retrofits of existing infrastructure such as aging bridges that are not able to accommodate streetcar weights or trackwork under current structural conditions. For such projects, a high-level cost estimate will be developed based on comparable projects and added to the overall and per mile capital cost for the alignment.

## 1. INTRODUCTION

This document describes the current “state of the practice” for streetcar vehicles offered in the US market and the various types of streetcar vehicle technologies that could be considered for a future streetcar line in Saint Paul. It describes:

- Vehicle Types
- Propulsion (Power Supply)
- Boarding
- Vehicle Width
- Vehicle Length
- Passenger Capacity
- Vertical Grades
- Compatibility with Light Rail
- Representative Vehicles

For more detailed information about vehicles, the APTA (American Public Transportation Association) Streetcar Subcommittee is currently in the process of developing “standardized” Modern Streetcar Guidelines that offer significant technical detail regarding Modern Streetcar vehicles and is a good source of current information. Draft technical documents and presentations from committee meetings can be found on their website ([www.modernstreetcar.org](http://www.modernstreetcar.org)).

## 2. VEHICLE CHARACTERISTICS VEHICLE TYPES

Streetcar vehicles come in all different shapes, sizes and configurations. They include modern, historic and replica (made to look historic) vehicles. Irrespective of type, all must meet all current standards for access, accessibility, and crash worthiness. Some more mature streetcar systems, particularly overseas, operate a variety of vehicle types on the same line (a mix of historic and modern). However, this is most often found on legacy systems that were built prior to accessibility laws that require equal access to users with disabilities. Because of accessibility laws, mixing vehicle types such as modern and historic is much more challenging because accessible boarding methods differ greatly between the different types of vehicles (see section on boarding).

Figures 1 through 3 show photos of a Modern Streetcar, Historic Streetcar, and Replica Streetcar

### PROPULSION (POWER SUPPLY)

Figure 4: Pantograph

## Figure 5: Trolley Pole

Streetcars are typically electrically powered, with power supplied from an overhead “trolley wire” using either a trolley pole or pantograph (see Figures 4 and 5). The power supply is typically around 750 volts DC and supplied from substations that are spaced every ½ to one mile along the alignment.

There are emerging technologies being introduced to the US that eliminate the need for overhead power for some sections of the alignment. This is accomplished by the use of on board energy storage (typically a combination of batteries and super-capacitors) that charge while on a “wired” section of the alignment and then use their stored power to propel the vehicle in the “off-wire” segments. Seattle’s First Hill Streetcar will have a short section, mostly downhill, that will be off-wire and Dallas is in the process of procuring a vehicle that will operate off-wire for a one mile segment (about 60% of the alignment).

## BOARDING

Figure 6: Level Boarding on an LRT platform

Figure 7: Wheelchair Lift on a Historic Replica Streetcar

Figure 8: Mini-High Ramp/Platform adjacent to the sidewalk to meet the height of the historic streetcar

Figure 9: Modern Streetcar Vehicle with Bridge Plate that helps create a small ramp to help in boarding

All streetcar systems built today must comply with all current regulations including the Americans with Disabilities Act (ADA). This requires either level boarding, near level boarding with an automatic bridge plate, a lift, or mini-high platforms with a manually deployed bridge plate by the vehicle operator (see Figures 6, 7, 8 and 9).

The industry is moving in the direction of fully level boarding where platform and vehicle floor heights are the same, which allows wheelchair users to board and alight vehicles in the same manner as everyone else with no bridge plates or ramps. This requires a 14” +/- high platform at streetcar stops and that vehicles have automatic leveling capabilities that adjust the floor height depending upon vehicle load. This approach is only available with Modern low-floor streetcar vehicles, and not with historic or replica vehicles. Low-floor vehicles come in 50%, 70% and 100% versions as illustrated in figure 10.

Historic and Replica cars use wheel chair lifts or mini-high platforms that are level with the vehicle floor height and that require the operator to manually place a bridge plate between the platform and the vehicle. Both of these operations require additional infrastructure and space on either the vehicle or at the streetcar stop and increase dwell times.

## VEHICLE WIDTH

In general, modern streetcar vehicles come in two different widths. The “wider” width is 2.65m, or about 8’8.” This width is typical of most light rail vehicles in the US and is also a common width for many overseas tram/streetcar systems. The narrower versions of modern streetcars available in the United States are either 2.4 or 2.46 meters, or about 8’0”. Regardless of the vehicle width, all modern streetcar vehicles operate on standard rail gauge of 4’ 8 ½“ which is the same gauge as Light Rail Vehicles (LRVs).

Since streetcars typically operate in mixed traffic with cars, vehicle widths can be an important factor. As shown in Figure 11, a typical bus is about 8’6” wide, which is similar to the width of the streetcars (in addition, there is very little difference in the amount of clearance that is provided for each vehicle type). As a result, in constrained rights of way, width can become a factor as eight-foot wide narrow streetcars could safely operate in 10 foot travel lanes whereas the wider vehicles require 10.5 to 11 foot travel lanes.

Figure 11: Vehicle Widths

## VEHICLE LENGTHS

In general, streetcar vehicles are 20 to 25 meters (66 to 82 feet), and shorter than light rail vehicles, which are typically 30 meters (98 feet). However, in Europe there are segmented vehicles used for streetcar operations that are up to 45 meters in length. A handful of vehicles currently offered in the US market have the capability of adding “segments” to lengthen the vehicle as the ridership and need for additional capacity grows. This increases capacity of the system without measurably increasing the operating costs since additional vehicles and operators are not needed.

## DOOR LOCATIONS AND SPACING

Door locations and spacing vary considerably among streetcar vehicles, even among vehicles of the same length (see Figure 10). In addition, depending on the vehicle, not all doors may be accessible as some doors may be on high floor sections. This effects requirements for stations stop lengths and station configuration.

## PASSENGER CAPACITY

Vehicle capacity varies greatly depending on the type, length and seating arrangements, and can range from 70 to 200 passengers per car (based on four people per square meter). However, most modern vehicles carry 110 to 150 passengers. Though seats are provided on the vehicles, the majority of the passenger capacity for streetcars is standees due to the shorter trips typical of a streetcar passenger (see Figures 12, 13, 14 and 15). In contrast, a standard bus has a capacity of approximately 55-70 passengers and a typical light rail vehicle can carry approximately 150-180 passengers per car.

Figure 13: Interior Vehicle Configuration

Figure 14: Typical Vehicle Interior showing more a open, passenger standing layout

Figure 15: Typical Vehicle Seating

## VERTICAL GRADES

Most modern streetcars can operate on grades up to 9% (see Figure 16). However, it is generally desirable to avoid sustained grades over 7% which is typically the limit of modern light rail vehicles.

Figure 16: 8.75% grades in Portland

## COMPATIBILITY WITH LIGHT RAIL

Modern streetcar and light rail vehicles are very similar, and in some cases are the same. For example, in Salt Lake City, UTA is planning on using the same vehicle for both types of service. In Portland, a new bridge over the Willamette River will serve four different types of light rail vehicles and two different types of streetcar vehicles on the same tracks. This is possible because the basic parameters of both light rail and streetcar vehicles are based on standard dimensions for wheel spacing, track gage, vehicle axel loads, floor heights, clearances, and turning radii.

In addition, both types of vehicles can be equipped with all modern safety measures such as ATS (Automatic Train Stop). This allows streetcar vehicles and light rail vehicles to share portions of track and operate safely. However, as described above, streetcar vehicles can vary considerably, and the same is true of light rail vehicles. Thus, for joint operations or shared use of tracks, it is necessary to use compatible vehicles. In St. Paul, it would be physically feasible for streetcar and light rail to share tracks and stations. For this to occur, new streetcar vehicles would need to be compatible with Green Line light rail vehicles (2.65 m width, low-floor with level-boarding and include all the systems components needed to communicate with the light rail operating and safety systems).

## 3. REPRESENTATIVE VEHICLES

As described above, streetcars are available in many configurations.

The following pages provide a brief overview and technical specifications for the majority of the model vehicles that are currently being marketed in the US. Some of these cars are in operation while others are prototypes that are in various stages of development. All of these vehicles have been proposed by their manufacturer on recent vehicle procurements in the US. The information given is approximate and may vary slightly from what is shown as each vehicle is customized for the city for which it is manufactured.

All the vehicles shown below would be physically compatible operating on the Green Line light rail lane (same gauge and power supply), however only vehicles that are 2.65 meters in width and capable of providing auto-leveling (all modern vehicles can provide this capability) would be able to share a platform with the light rail vehicles.

## BROOKVILLE EQUIPMENT – LIBERTY CAR

The Brookville Modern Streetcar is new to the Market and currently a prototype. This car builder has made various rail vehicles, refurbished historic cars and is in the process

of securing their first order to build two modern vehicles for Dallas to begin operations in late 2014. The Dallas vehicle will operate “off – wire” for a 1 mile segment.

Length: 20.2 m  
Width: 2.45 – 2.65m  
# Passengers: 126  
Number of Seats: 41  
Percent Low Floor: 71%  
Maximum Speed: 44mph (70km/h)  
Minimum Turning Radius: 18M (59ft)

#### CAF USA – URBOS

CAF has been selected by the City of Cincinnati for its modern streetcar system due to open in 2015. CAF is a proven US car builder for light rail vehicles but new to the market for streetcars and will be the first 100% low floor streetcar in the US. This vehicle also has the capabilities to expand by adding sections.

Length: 21.0 – 44.5 m  
Width: 2.65 m  
# Passengers: 160  
Number of Seats: 36  
Percent Low Floor: 100%  
Maximum Speed: ~45mph  
Minimum Turning Radius: 20m (66ft)

#### INEKON

Inekon has supplied vehicles for both Seattle and Portland from the Czech Republic. Recently, Inekon has partnered with a U.S. manufacturer to produce streetcar vehicles compliant with Buy America and are proposing on streetcar orders from around the country.

Length: 20 m  
Width: 2.46 m  
# Passengers: 115  
Number of Seats: 38  
Percent Low Floor: 50%  
Maximum Speed: 70mph  
Minimum Turning Radius: 18m (59ft)

#### SIEMENS S70 ULTRASHORT

The S70 Ultrashort is one of the longer and full width (2.65m) vehicles being offered as a streetcar. It is being used as both a light rail and streetcar in Salt Lake City and will be Atlanta's first streetcar vehicle.

Length: 24 m

Width: 2.65 m

# Passengers: 149

Number of Seats: 60

Percent Low Floor: 70%

Maximum Speed: 45 – 60mph

Minimum Turning Radius: 20 m (66ft)

### KINKISHARYO AMERITRAM

The AmeriTram, like the CAF vehicle, is 100% low floor. It is a Prototype that was developed and tested but not yet sold. Like some of the other vehicles, it has off-wire capabilities and has been tested in both Charlotte and Dallas where it operated for approximately 5 miles off wire.

Length: 20 m

Width: 2.65 m

# Passengers: ~110

Number of Seats: ~29

Percent Low Floor: 100%

Maximum Speed: 44mph

Minimum Turning Radius: 18m (59ft)

### UNITED STREETCAR

United Streetcar's vehicle, similar to the Inekon Vehicle, is made by a US company (Oregon Iron Works) that entered the streetcar business under a technology share agreement with Skoda. They have a prototype vehicle that began operation in Portland in September of 2012 and have additional orders for vehicles in Portland, Tucson and D.C. that are expected to be in service within the next year.

Length: 20 m

Width: 2.46 m

# Passengers: 115

Number of Seats: 29

Percent Low Floor: 50%

Maximum Speed: 44mph

Minimum Turning Radius: 18m (59ft)

## BOMBARDIER FLEXITY FREEDOM

The Bombardier Flexity is not in service in the US but is the streetcar vehicle for Vancouver and is also being produced for Toronto. It is a 100% low floor vehicle and one of the longer streetcars being offered. It has the flexibility to add or remove sections in the middle to make the vehicle longer or shorter.

Length: 20 – 30.8 m

Width: 2.65 m

# Passengers: 186

Number of Seats: 56

Percent Low Floor: 100%

Maximum Speed: 50 mph

Minimum Turning Radius: 25m (82ft)

## HISTORIC REPLICA STREETCAR

Replicas; like those used for Tampa, Little Rock, Charlotte and Memphis; are new vehicles with modern components made to look old. They are generally lower in cost, shorter and have less capacity than modern vehicles. These vehicles only come with high floors so level boarding would only be an option if stops were equipped with mini-high platforms. Alternatively, these vehicles can be equipped with ADA lifts.

Length: 14.6 m

Width: 3.05 m

# Passengers: 73+

Number of Seats: 40+

Percent Low Floor: 0%

Maximum Speed: 30 mph

Minimum Turning Radius: ~50 ft

## HISTORIC PCC STREETCAR

Historic Streetcars like the PCC are still being maintained and used in many cities across the US and world. Because of their arrangement they usually require mini-high ramps (as seen in the photo) for ADA boarding. Often times these vehicles are refurbished with modern components with similar capabilities as modern vehicles.

Length: 14.1 m

Width: 2.44 m

# Passengers: 85

Number of Seats: 46

Percent Low Floor: 0%

Maximum Speed: **50 mph**

Minimum Turning Radius: **50 ft**