To: Metropolitan Policy Committee
From : Lane Transit District Staff
Date: 1/4/2011
Re: December 7, 2010 MPC Memorandum on Regional Transportation Plan Project List Review

---

In reference to the questions posed in Commissioner Handy's December 7 e-mail to MPC, two in particular had to do with transit. As is discussed below, the answers to these questions come with significant caveats and would require collaboration on the part of the cities of Eugene and Springfield, the County, LCOG, and LTD to address with any measure of completeness. It may be possible to address these questions at least partially through the updates of the Regional Transportation Plan (RTP), Transportation System Plans (TSPs), or the Long Range Transit Plan. Given the time and resources available at this point, the answers provided below should be considered high-level.

What is the potential over the RTP's 20 year planning horizon for electrification of transit vehicles on primary transit corridors in the MPO area? What is the comparative transit carbon footprint with and without electrification?

<u>Summary</u> - *There is potential for significant advances in propulsion technologies over the planning horizon. As in the past, and similar to other public agencies, LTD will evaluate making investments into new technologies based on an evaluation of risks and gains of specific opportunities.*

Recent research into the life-cycle GHG emissions of various transit modes suggests that the ridership productivity being realized by a specific operation is a primary determinant of the carbon footprint of that operation as expressed in terms of GHG emissions per passenger mile. Experience in the San Francisco area has demonstrated that a productive regular diesel bus can achieve a lower carbon footprint per passenger mile than a light-rail vehicle based on the full lifecycle GHG emissions of each vehicle (see Figure 1).

To answer the first question (transitioning to an all-electric system within the RTP time frame), multiple possibilities need to be evaluated. There are two primary methods of electrifying a bus system: batteries, or overhead (catenary) lines, either of which presents obstacles. In the case of batteries, one obstacle is cost. Lithium ion batteries, commonly used to power buses, cost up to $800 per kilowatt-hour, though could be as low as $264 per kilowatt-hour.[1] One cost estimate that was put together a few years

---

[1] Department of Energy. *Energy Storage Research and Development: Annual Progress Report 2009*. January 2010. Retrieved from http://www1.eere.energy.gov/vehiclesandfuels/pdfs/program/2009_energy_storage.pdf.

ago at LTD indicated that electric buses add approximately $180,000 to the capital cost of a new bus. In addition, additional maintenance costs might be incurred, particularly until electric buses would comprise a majority of the fleet, though there would be lower operating costs. A new analysis would need to be undertaken to know what the current cost trade-off might be with current technology.

As a small transit district, we need to balance our investments in new technology with the associated risks. The rapid advance of battery technology makes a focused investment in one technology problematic. For example, General Electric recently announced a new dual-battery system that could lower costs by as much as 20%.[2] Given the pace of technological advancement, even if LTD were to invest heavily in battery-powered vehicles, there is a good chance that a new battery-type or system could render the investment obsolete. Indeed, when the agency invested in all-electric buses years ago, the "cutting edge" quickly became the "bleeding edge" as the vehicles were constantly having maintenance issues and eventually had to be decommissioned.

The second option - overhead, or catenary, lines to power the buses bring other obstacles. The most significant is the capital cost of installing the overhead lines. Seattle's Metro planners estimate that each mile of overhead lines costs around $1 million to construct, which does not include the extra costs associated with maintenance of the lines and bus accessories. Moreover, the same problem exists with overhead lines as with batteries. It is not unreasonable to suggest that cheap, powerful new battery or fuel cell technology could be developed over the next 10 years. This would render a heavy investment in overhead line infrastructure obsolete.

Finally, the second question (relative carbon footprint), would require extensive study to answer fully. This is because a full life-cycle analysis would be needed to understand the tradeoffs between operating an electric system versus traditional diesel-fueled vehicles in the Eugene-Springfield area. For instance, a report recently by the Swiss Federal Laboratories showed batteries to be more environmentally friendly than internal combustion engines, even taking production into account.[3] However, it is unclear what the carbon footprint of catenary infrastructure might be.

Further illustrating the kind of study that would be needed to answer this question, a recent report from the California Transportation Institute investigated energy efficiency and GHG emissions of several modes of travel.[4] Using a full life-cycle analysis, the

---

[2] http://www.green-energy-news.com/nwslnks/clips1210/dec10010.html

[3] Notter et al. *Contribution of Li-Ion Batteries to the Environmental Impact of Electric Vehicles*. Environmental Science Technology. June 2010. Volume 44, 6550-6556.

[4] Chester and Horvath. *Environmental assessment of passenger transportation should include infrastructure and supply chains*. Environmental Research Letters. Doi: 10.1088/1748-9326/4/2/024008. 2009.

authors looked at building materials, power sources, and utilization rates, finding, for example, that diesel-powered buses at peak capacity are the most energy efficient and lowest emitting mode. For other comparative carbon footprints, see Figure 1.

One final example may help to illustrate the difficulty in assessing a carbon footprint. In the Eugene Climate and Energy Action plan, one of the crucial uncertainties was whether to use local utility carbon-intensity or the Northwest Power Pool 's. This is because while the region uses mostly renewable electricity, we also trade electricity with other northwestern producers – which use some coal plants for power generation. This is just one example of an uncertainty that would need to be carefully considered when crafting an answer to the environmental impact of an all-electric system.

Of course, over the 40 years that LTD has been in existence there have been many strides forward in improving emissions and vehicle efficiency. Furthermore, LTD will continue to make advances in its propulsion technology to reduce the environmental impact and improve the efficiency of its service when feasible. It should be noted, however, that transit typically trails the automotive sector in technological innovation for two reasons: first, automobile manufacturers are generally much larger firms with robust R&D budgets; second, transit agencies generally order customized buses, further impeding extensive R&D activities. This means that major innovations typically need to have a "sponsoring" transit agency willing to test new technologies that are not yet industry standards.[5]

What are the long-term operating costs, projected ridership level, and capital costs for a state-of-the-art electric streetcar system, compared with continued BRT buildout over 20 years? What about the magnitude of associated transit-oriented development?

<u>Summary</u> – *While specific aspects of a streetcar system in the region would have to be based on a system that has yet to be identified, comparative costs and ridership experience from other operations are summarized below. There is not definitive research establishing the magnitude of transit-oriented development associated with specific types of transit. Recent research completed on BRT and land development determined that local policy and transit culture may be more important determinants for success in integrating transit and land use than the permanence of the system (often associated with rail-based modes). Research that has identified principles for success in integrating transit and land use are identified below.*

[5] Leslie Eudy and Matthew Gifford. *Challenges and Experiences with Electric Propulsion Transit Buses in the United States*. US Department of Energy, November 2003. Retrieved from http://www.afdc.energy.gov/afdc/pdfs/34323.pdf.

Like the first set of questions, providing definitive answers to these questions would require significantly more evaluation than is readily available. In general, the evidence suggests that capital costs would be much higher for a streetcar system, but the possibility for new development around streetcar lines is greater. However, studies surrounding streetcars are done in much larger metro areas, and so their applicability to the Eugene-Springfield area is unclear.

The consulting firm Railway Preservation Resources showed annual boardings per route mile for a variety of streetcar systems, ranging from 8,120 in Galveston, Texas to 441,444 in Seattle (see Table 1 below). However, it should be noted that all except for two of the comparison cities have populations several times larger than Eugene's. In terms of ridership, EmX compares favorably on a per route mile basis with all but three streetcar systems. Without further analysis, however, it is unclear what expected ridership would be for streetcars versus bus rapid transit.

Compared to bus rapid transit, streetcars are much more expensive to construct. For example, the Portland Streetcar system that has been developing over the last decade had a total construction cost of $12.9 million dollars per track mile, or $25.8 million dollars per system mile. In contrast, EmX has had a construction cost of roughly $6 million dollars per system mile for the first two legs, and a projected $12 - $15 million per system mile for the west Eugene extension.

Two sources provide information on the potential operating cost of a streetcar system. The Eugene/Springfield Urban Rail Feasibility Study from 1995 provides the most recent look at the relative costs of construction and operation of a light rail system. One of the conclusions that was reached was that electric light rail systems, while more expensive to construct, have a 1/3 lower operation cost than diesel or diesel-electric systems. For streetcars, the consulting firm Railway Preservation Resources more recently gave a cost breakdown per boarding, indicating that on a per-boarding basis, streetcars cost on average $4.26, with a high of $8.75 and a low of $1.60 (see table above). EmX compares favorably with a cost per boarding of $0.93.

There is much research yet to be done to establish the definitive relationship between land use development and specific transit modes. However, recent research on BRT and development notes that a particular city's approach to the transit culture has the ability to shape and determine whether or not development occurs and if it will be successful. It makes a conclusion that -"<u>These policies and the local climate may be more of an important factor than the issue of permanence of a transit system."</u>[6] (emphasis added).

[6] "Bus Rapid Transit and Development: Policies and Practices that Affect Development Around Transit" - FTA-FL-26-7109.2009.5 12/1/2009

Emphasizing the importance of local policy and climate, research completed as part of the Transit Cooperative Research Program (TCRP), *TCRP H-1: Public Policy and Transit Oriented Development*, conducted an evaluation of the relationship between land use and transit planning near transit stations (transit-oriented development). The report concluded with a "Summary of Principles" which is to be used for integrating transit and land within the areas of stations. These principles are intended to characterize regions with successful transit-focused development. It was determined that many of these principles, whether used in combination with one another, or simply on their own, can significantly impact development patterns around transit stations.

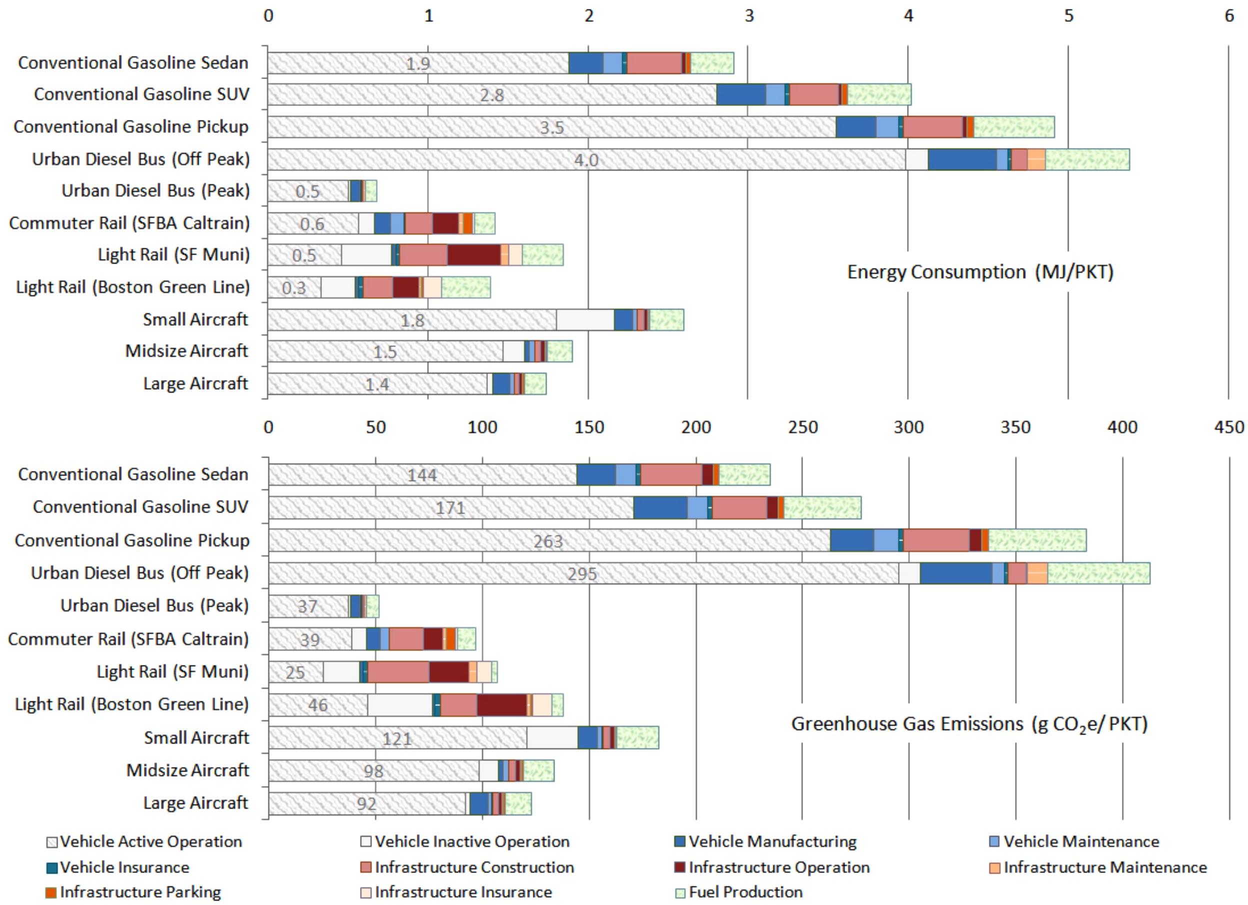
The principles and a summary discussing their meaning, as they appear in TCRP H-1, are listed below.

- "Regional Vision – Regions that have successfully integrated transit and land use planning have developed a vision of the preferred future settlement patterns for their region. Local governments share this vision and develop land use regulations that implement this vision. Transit investments are used to support the land use vision.
- Strong, Respected Institutions – The regions have governmental agencies – transit providers, regional planning bodies, or redevelopment agencies – with the authority (sometimes granted by the state or province, sometimes based on performance) to make transit-oriented development work. There are strong working relationships between local and regional government agencies.
- Leadership – A leader who articulates the regional vision and oversees its implementation is often critical to its success.
- Transit-Supportive Cultures – People in these regions believe that transit is an important component of the urban fabric and an efficient, reliable alternative to the automobile.
- High Quality Transit Service – All the transit agencies provide efficient, clean, and on-time service, have well managed systems, and use transit technology that fits the particular needs of their region. Many are innovators in transit infrastructure and service delivery.
- Regional Growth – In the most successful regions, transit investments were made just prior to or during a period of rapid population growth. Development was occurring that could be channeled to transit corridors and station areas.
- Station Areas with Development Potential – Stations are located in areas with vacant or underutilized land, where both the market and station area policies support development.
- A Variety of Tools to Focus Growth – The region uses a variety of tools to provide the incremental steps to achieving their vision. They include:
    - Regional Tools

        - Limiting the urban area
        - Locating major activity centers
        - Transit-friendly subdivision guidelines
        - Limited freeway construction
    - Station Area Tools
        - Innovative zoning
        - Site design guidelines
        - Parking management
        - Siting public facilities
        - Using redevelopment agencies
        - Building subsidized housing
        - Integrating feeder bus service
- Incremental Steps Towards a Long Term Process – Transit-oriented development takes decades. Small steps with quick results, however, build support for the long-term goal" (TCRP Report 16, Vol. II).

The other question asked here was specific to the Lake Oswego streetcar project. Attached is a memo describing the proposed streetcar line to Lake Oswego relative to the EmX system. In the development of that project, enhanced bus service and BRT were also considered. In brief, the circumstances for this particular transit project are rather unique in that there is existing railroad track right of way owned publically, which lends itself to redevelopment into a streetcar line. Furthermore, the riverfront right of way can be used as match for a federal contribution. The BRT alternative, in contrast, was highly constrained along the corridor by geography (steep slopes on one side and the Willamette River on the other) together with existing development, and a relatively narrow street right-of-way. As a result, there was no feasible way to achieve long enough queue jump lanes required for reliable BRT travel times through congested intersections along the corridor. The Bus Rapid Transit Alternative was removed from further consideration because of relatively high property impacts, high operating costs and poor reliability and, as such, would not meet key elements of the project purpose and need.

Figure 1. Comparative Energy Consumption and Carbon Emissions by Mode[7]



---

[7] Chester and Horvath. *Environmental assessment of passenger transportation should include infrastructure and supply chains.* Environmental Research Letters. Doi: 10.1088/1748-9326/4/2/024008. 2009.

Table 1. Streetcar Comparison[8]

Metropolitan City Area	Population	Annual Boardings (000)	Annual Cost Per Boarding	Annual Boardings per Route Mile
Galveston, TX	60,000	41	$8.75	8,120
Kenosha, WI	90,000	59	$5.12	31,000
LTD (BRT)	**260,000**	**1,439**	**$0.93**	**179,875**
Little Rock, AR	650,000	45	$5.04	17,800
New Orleans, OR	1,000,000	8,920	$1.60	343,065
Memphis, TN	1,300,000	983	$3.64	140,357
Tampa, FL	2,700,000	520	$3.13	162,375
Seattle, WA	3,300,000	795	$3.20	441,444

[8] www.railwaypreservation.com/vintagetrolley/vintagetrolley.htm, Retrieved 31 January 2008.

Memorandum

Date: December 30, 2010

To: Joint Locally Preferred Alternative Committee

From: Tom Schwetz, Lane Transit District

RE: Overview of the Lake Oswego Streetcar Project

Lane Transit District

P.O. Box 7070
Eugene, Oregon 97401-0470

3500 East 17th Avenue

Eugene, Oregon 97403

Phone: 541-682-6100

Fax: 682-6111

TTY: 7-1-1

E-mail: ltd@ltd.org

Web : ltd.org

This memo is in response to a request from the Joint LPA Committee to provide an overview of the Lake Oswego Streetcar Project. This project has been referenced in public comment made as part of the WEEE project development. This reference stems from the Lake Oswego project's consideration of both bus rapid transit (BRT) and streetcar options.

Based on research of the Lake Oswego project development documents (available on Portland Metro's website - http://www.oregonmetro.gov/index.cfm/go/by.web/id=25056) and discussion with project consultants, staff has made the following conclusions:

1. The BRT option considered in the Lake Oswego project is quite different from that being considered for the WEEE project. The buses would be regular 45 foot buses, with about 30% less capacity. Running for the most part in mixed traffic, the minimal travel time savings would be achieved primarily through the use of queue jump lanes with little exclusive right-of-way.

2. The streetcar option considered in the Lake Oswego project is based on the Rapid Streetcar concept. A detailed description of this concept is provided in attachment one. Tri-Met defines the rapid streetcar concept as follows:

   > "The rapid streetcar is a concept for implementing streetcar service that offers higher speeds than buses, and that can attract more riders than comparable bus services. Rapid streetcar combines a variety of technologies and system treatments to create a transit option that would operate more efficiently and provide a higher quality service than bus service, or than conventional streetcar. Rapid streetcar integrates streetcar-type vehicles into a right-of-way that incorporates many of the features of LRT, but at a more economical price than LRT."

3. The value of the existing railroad right-of-way played a primary role in the selection of the streetcar alternative in the Lake Oswego project. In 1988, the Willamette Shore Line Consortium purchased the 6.3-mile long Jefferson Branch line from the Southern Pacific Railroad for $2 million. The Consortium purchased the line for future passenger rail transit use. As noted in the *Lake Oswego to Portland Transit and Trail Alternatives Analysis Evaluation Summary July 12, 2007:*

    > "An important element of the capital cost of the project is the effect of the value of the Willamette Shore Line right-of-way. Current estimates value the right-of-way south of Lowell Street to be $50 million. This right-of-way can be used as local match for a transit project that uses the right-of-way. If a project does not use the right-of-way, the value of the right-of-way is lost. In addition, the amount of federal funds that would match the value of the right-of-way would be lost as well. For example, if the BRT project was chosen and a trail was proposed for the Willamette Shore Line, the value of the trail would be lost ($50 million) in addition to losing the ability to match federal funds for the right-of-way value ($75 million additional). This is a significant opportunity cost that is not captured in the capital cost estimates, but was very real in terms of trade-offs between the various alternatives."

4. The BRT alternative, in contrast, was highly constrained along the corridor by geography (steep slopes on one side and the Willamette River on the other) together with existing development, and a relatively narrow street right-of-way. As a result, there was no feasible way to achieve long enough queue jump lanes required for reliable BRT travel times through congested intersections along the corridor. The Bus Rapid Transit Alternative was removed from further consideration because of relatively high property impacts, high operating costs and poor reliability and, as such, would not meet key elements of the project purpose and need.

5. While there are many differences between the two studies, some valuable symmetries should be noted. First, both the WEEE project and the Lake Oswego project represent extensions of existing lines - BRT in Eugene and streetcar in the Portland area. Second, both modal choices stemmed from decisions made as part of the regional transportation planning process conducted in each region.

Comparison of BRT and Streetcar Alternatives Considered in the Lake Oswego Project

Below is a summary assessment of the BRT and streetcar options considered in the Lake Oswego project development. This summary is drawn from the Lake Oswego to Portland Transit and Trail Alternatives Analysis Evaluation Summary, July 12, 2007.

Corridor Overview

The Highway 43 corridor serves the growing Lake Oswego town center and Portland central business district and provides the primary north/south connection between the two centers. Existing traffic volumes on Highway 43, within the corridor, currently create substantial congestion during the morning and evening commute. Peak period traffic volumes on Highway 43 are forecast to increase by approximately 40 to 99 percent, depending on location, by 2035.

Bus Rapid Transit

The BRT alternative could be advanced into a DEIS along with the required No-Build alternative. Advancing the BRT alternative would not preclude advancing the Streetcar alternative– all three alternatives could advance.

An important finding and caveat of this discussion of trade-off is that the BRT as designed would not provide sufficiently long queue jump lanes to achieve the travel time savings assumed for the ridership forecasts. In order to achieve the forecasted travel time savings over the No-Build, queue jump lane lengths would need to be more than double. This would result in increased capital costs (which could also more than double) and impacts to surrounding properties. This makes the ridership forecasts and capital costs included in the alternatives analysis difficult to achieve. Operating costs may also be underestimated because they were based on a running time that may not be achievable with the capital improvements that are included as part of the alternative.

Relative to the No-Build, the BRT alternative provides faster, more reliable service and results in an increase in ridership. The BRT alternative as developed in this alternatives analysis would cost $50 million to build and $8 million annually to operate. The BRT alternative would result in a net system-wide operating cost increase of $4.61 million compared to the No-Build, and $5.78 million compared to the Streetcar alternative. The BRT alternative is less cost effective in operating cost per boarding ride than Streetcar, but has a reduced annualized capital cost per ride than Streetcar. Because it operates in mixed traffic except at the eight intersections where improvements are planned, the BRT alternative would be less reliable than the Streetcar, which would have a higher percentage of exclusive right-of-way. The BRT alternative would provide operational flexibility and could be extended to the southern reaches of the corridor or to western areas, such as Kruse Way. The transfer assumed to be required at the Lake Oswego Transit Center between the BRT buses and connecting local buses could be eliminated, which would improve ridership.

All transit trips traversing the Corridor between Lake Oswego and Portland would benefit from the BRT improvements, regardless of their point of origin. West Linn and Oregon City riders would see improved travel times relative to the No-Build, however their total travel time would still be longer than with the Streetcar alternative.

BRT would not leverage the same development response as Streetcar, so a level of development adjacent to the BRT line would be more in line with current trends than the Streetcar, which would be expected to accelerate development in Johns Landing and Lake Oswego.

The BRT alternative could provide for a multi-use pedestrian and bicycle trail along the Willamette Shore Line right-of-way, at a cost that is substantially less than the trail option developed with the Streetcar alternative, $7.4 million compared to a range of $58.7 to $61.5 million. Another important finding is that the use of the Willamette Shore Line right-of-way solely for a pedestrian and bicycle trail has yet to be tested legally and may prove to be a hurdle to trail implementation. As mentioned earlier, the opportunity cost of not using the Willamette Shore Line right-of-way for transit purposes ranges from the value of the right-of-way, ($50 million) plus the federal transit funds it could match ($125 million).

Advantages and disadvantages of the BRT alternative are summarized below.

Advantages of the BRT alternative include:
- Higher ridership than No-Build
- Lowest initial capital costs
- Could allow the development of a trail on the Willamette Shore Line
- right-of-way
- Property impacts limited to eight intersections
- Operational flexibility

Disadvantages of the BRT alternative include:
- Longer queue jump lanes would be required than originally anticipated
- Ridership forecasts may be difficult to achieve
- Highest operating costs
- High opportunity cost to use of Willamette Shore Line right-of-way for
- a trail with no transit improvements
- No demonstrated ability to leverage transit supportive economic
- development

Streetcar Alternative
The Streetcar alternative could be advanced into a DEIS along with the required No-Build. Advancing a Streetcar alternative would not preclude the advancement of a BRT alternative into the DEIS; both could be advanced. The discussion of streetcar refers to the representative alignment (Willamette Shore Line with a terminus at Albertsons) unless otherwise noted.

Compared to BRT and the No-Build, the Streetcar alternative has the fastest travel times, highest reliability, highest ridership (10,900), highest capital cost ($138.4 to $157.0 million depending on the trail component) and lowest operating cost ($2.25 million annually), lowest total net system operating cost ($1.53 million less than the No-Build, and $5.78 million less than BRT).

The Streetcar is also the most cost-effective in terms of operating cost per ride and highest in terms of annualized capital cost per ride. Total development potential in the Corridor is approximately 3.3 million square feet by 2025 with the Streetcar alternative.

Operationally, Streetcar would be more reliable than BRT service due to its high percentage of exclusive right-of-way. Transfers would be required at whichever Lake Oswego terminus is chosen. However, even with the required transfer in Lake Oswego, through-passengers from West Linn or points south or west would have an 11-minute faster trip to downtown (PSU) on Streetcar than No-Build and a 9-minute faster trip than BRT.

The Willamette Shore Line right-of-way is adjacent to and also bisects development in Johns Landing and unincorporated sections of Multnomah and Clackamas Counties. If the alternative is advanced into a DEIS, additional analysis would be completed to examine potential impacts and mitigation measures. Property owners closest to the Willamette Shore Line right-of-way have expressed concern about how these issues will be addressed. Concerns have also been raised about the speed of the Streetcar in proximity to residential areas, property access and crossing protection. These concerns would be addressed in DEIS.

One of the project’s biggest challenges has been to fit the trail and Streetcar together in the Willamette Shore Line. Whereas the trail cost for the BRT would be $7.4 million, the cost to add a trail component to the Streetcar alternative would range from $58.7 to $61.50 million. This cost differential occurs for a variety of reasons, including the tight constraints posed by the width of the Willamette Shore Line right-of-way (as narrow as 17 feet in places), the steep topography, minimum design standards for Streetcar and the proximity of the floodplain in several areas.

Summary of advantages and disadvantages of Streetcar are below.

Advantages of Streetcar:

- Exclusive right-of-way yields higher reliability and faster travel times
- Highest ridership of all alternatives
- Lowest ongoing operating and maintenance costs
- Potential 3.3 million square feet of total new development with
- streetcar by 2025 (Macadam and Safeway design options have the
- highest potential)
- Travel times best of any alternative

Disadvantages of Streetcar:

- Highest capital costs
- Proximity to residential areas
- Costly to develop a trail with Streetcar
- No option for through–route to West Linn or other areas