



**SEATTLE STREETCAR**  
**Network Development Report**  
**Appendix C**

**Seattle Department of Transportation**  
**May 2008**

# S E A T T L E   S T R E E T C A R

## AN ANALYSIS OF FUTURE MAINTENANCE FACILITY CAPACITY

09, May 08

### Description of Typical Growth Requirements by Comparison to Portland Streetcar

As modern streetcar systems have emerged in the United States over the last decade, significant emphasis has been placed on developing the industrial engineering requirements of the operations and maintenance facilities (usually dubbed: “the car house”). Comparisons to larger light rail facilities that have been in operation for nearly 30 years is futile. Streetcars are similar in basic electrical and mechanical systems, but fleet size is significantly smaller. It is well understood by facility designers that facility space requirements are not proportional to the fleet size in a linear relationship. Comparisons to vintage car operations, and even modernized replica car fleets, has not proven successful for numerous reasons, but primarily due to the non-similarity of the vehicle.

The Portland Streetcar System was the first system using today’s generation of “modern” streetcars. It began operation in 2001 with an initial order of five cars. After nearly seven years of service the fleet size is now at ten cars, and expected to continue to expand.

The original Portland Car House was designed to accommodate the five car fleet; and incorporates the following specifications:

- Two track bays, each with an under car maintenance pit.
- Each track bay can accommodate only one car within the building perimeter.
- Total facility square footage is approximately 12,700 divided between ground floor area of 7,800 sq ft and second floor area of 4,900 sq ft.

[by contrast, the Seattle SLU facility is about 10,000 sq ft]

Both Portland Streetcar and LTK personnel have followed the progression of the fleet and worked toward increasing the efficiency of this facility. A consensus opinion by those individuals is that a facility with only two track bays will become increasingly inefficient once the fleet size grows beyond five to seven cars. Essentially, any long term repair in which a car must occupy a track bay, and can not be moved, takes vital capacity away from the facility.

The most blatant of these operations is wheel truing. A car going through the wheel truing procedure is de-trucked, the tires are removed, and transported to an outside contractor - all in the first day. The car remains on jacks the second and possibly third day depending upon the machine shop’s schedule. The fourth day the car is reassembled and the suspension is re-shimmed. The first and fourth day usually require overtime to maintain schedule. Other examples of long term repair items are HVAC units and propulsion inverters. Each will average two days troubleshooting and replacement time.

At seven cars, certain functions become labor intensive. For example: the Portland facility was built with an area designated for exterior car washing,. It is a single, outdoor, car space for hand washing. At seven cars, the amount of time to move cars in and out of the wash space becomes more significant. At a ten car level, the “quality of service” goal is not being met.

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Although inefficient, Portland is in fact operating with a ten car fleet in their original 2 track facility. The Portland system has significant growth potential. Therefore, a second facility is currently in the latter stages of design, and is planned for the property immediately across the street from the original facility. The combination of the original and the new addition is intended to support an expected doubling of the fleet size over the next 15 years. The new facility will provide:

- Two additional track bays – both with under car service pits
- Total facility square footage is approximately 10,300 divided between ground floor area of 8,300 sq ft and second floor area of 2,000 sq ft.
- A wheel truing machine.
- A gantry style automated vehicle wash.
- Such amenities as a Plan Room for drawings and maintenance documents for both vehicles and maintenance of way.
- A doubling of total storage, component repair, and machine shop area.

Two operational differences between Portland and Seattle should be noted: First, the Portland Streetcar System will most likely retain the single location Operations and Maintenance Center strategy for many years to come (no satellite facilities). This central location suits their current system and future route planning. By contrast, in Seattle, some potential route expansion alternatives would not work well without a satellite facility. Notably the West Seattle route where distance back to the Harrison Street Facility is substantial.

Second, although Portland's growth has substantiated the need for a wheel truing machine, Seattle has not reached that level yet. We do not recommend the purchase of a wheel truing machine for Seattle at this time. We do recommend the purchase of a second spare truck. This will allow a full car set of trucks to be removed, and the spare trucks can put the streetcar back in service quickly. Thus saving valuable time and space in the shop.

## **Seattle Future Streetcar Routes -vs- Variations Facility Size and Location**

There are several future Seattle routes under study at this time. Potential expansion could be one route, or a combination of more than one route. Ultimate future expansion could be all routes under study. Cost, available real estate, and time frame for expansion will certainly be critical factors in any decisions regarding the size and scope of the facilities to be developed to support expanded streetcar operations.

Although each possible route may yield differing fleet size calculations, we are using a “stepped” approach to quantify the capacity of six logical facility scenarios:

- Two possible expansion concepts for the current SLU – Harrison Street facility – both intended to service a fleet of approximately six cars.
- Two low cost alternatives to service a fleet of seven to ten cars. Some efficiency loss occurs in both of these cases.
- A medium cost approach to service 12 cars without efficiency loss.
- A major expansion to service 20 cars without efficiency loss, or 25 cars as a maximum system capacity.

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Cost estimates for each alternative are located in Addendum One. Costs figures contained within this report are based on historical construction costs with estimated sizes and quantities taken into consideration. Cost numbers are “rounded” for simplicity.

Details of each alternative are provided below:

**Alternative A:    Expansion of the South Lake Union - Harrison Street Facility.  
To Accommodate a Fleet of Six Cars.**

Please refer to Figure One for illustrated details. This scenario would accommodate an expansion of the SLU line to the University with five cars in running service and one car in spare or repair. A question comes up as to whether the expansion to the University requires five or more cars to maintain acceptable headways. It is thought that at the start of service, five running cars will suffice for headways matching today’s SLU service level. However, it would be logical that this could become a very popular route and place demands exceeding six cars.

It should be noted that in the original planning of this property it was thought that a third yard track could be added to accommodate storage of five cars outdoors, and two cars indoors, for a total of seven cars at this facility. However, in our analysis we believe that this facility will prove to be short on both parts storage and component repair space as the fleet size grows to that size. Our recommendation is to extend the existing building to shelter more indoor track space and provide additional parts storage.

In addition, the following changes be made to the facility at time of expansion:

- We recommend a second inspection pit be installed on Track 1. In figure One, we show it within the existing facility for work efficiency. But it could be placed in the new portion of the building. Placing it in the new building area avoids some disruption in the facility during construction.
- We recommend a new single bridge crane to replace the existing jib crane and monorail crane. The existing crane hoists would be re-used.

A distinct disadvantage of expansion at this facility is the lack of space to jockey cars between tracks. It places a high level of emphasis on which cars, and when cars, can come out of service.

**Alternative B:    Expansion of the South Lake Union - Harrison Street Facility With  
Addition of a Car Switching Track in a Vacated Portion of Harrison St.,  
And Additional Shop Space Built on the Adjacent Property Bordering  
Fairview Avenue. Will Accommodate a Fleet of up to Fifteen Cars.**

Please refer to Figure Two for illustrated details. This scenario would accommodate an expansion of the SLU line, to the University and other routings and assumes thirteen cars in running service and two cars in spare or repair. This Alternative offers an excellent arrangement for car storage, and car movement and sorting.

This concept includes built in place infrastructure to allow a future addition of a wheel truing machine – see summary comments at the end of this report. The only drawback to operations on this property would be vehicle washing. Washing would remain labor intensive since the property

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constraints will not allow for a pass thru track with either a gantry or fixed automated washing system.

To achieve an efficient sixteen car fleet operation (as illustrated in Figure Two), this plan would include:

- Vacation of Harrison Street, including the northern sidewalk.
- Making provision for local freight access to the business directly across Harrison from the car house.
- Removal of existing tracks in Harrison Street between Minor Avenue and Fairview Avenue; and addition of tracks as shown in Figure Two.
- Construction of a second shop building, identical in structure to the first building, but with internal layout changes.
- Modifications to the both buildings to add storeroom and component repair space.

By vacating Harrison Street, SLU would gain traffic control and could provide security gates at Minor and Fairview Avenues. Although we recommend vacating Harrison Street for the maximum good of the facility, we also recognize that this comes with certain impacts to both city operations and local residents. A decision to simply allow on-street parking of the streetcars during the off-hours could also be considered. Assuming this to be necessary every night from 12:00am to 5:00am; security of the cars would rely on work crews in attendance at the car house during these hours (cleaning crews, repair crews, etc). Note that some on-street parking for streetcars may be required during daytime and evening hours as cars are temporarily shuffled from one track position to another. At minimum, no automobile parking could be allowed on Harrison.

Also noteworthy: by shifting the track to the North side of Harrison, the bus OCS wire crossing at Fairview could be made at an angle (as opposed to the present 90 degree crossing). This would aide in the reliability of this crossing.

**Alternative C:    Expansion of the South Lake Union - Harrison Street Facility  
Development of the Fairview Avenue Adjoining Property.  
To Accommodate a Fleet of Seven to Ten Cars.**

Please refer to Figure Three for illustrated details. This alternative also achieves servicing of a seven to ten car fleet at the Harrison Street Property with eight cars being the optimum. This alternative would entail the development of the adjoining property, immediately to the west of the SLU car house. Although use of this property has been slated for commercial development by SDOT, this property could be ideal for car storage. In Figure Two we indicate the addition of a single track with three additional cars in storage. A second track could be added for two more cars. The track geometry becomes complicated but is technically feasible. Also note that a track turn-out will need to be placed west of Fairview Ave in Harrison Street. TWC and traffic signaling systems will need modification.

This scenario allows for better employee parking and some lay down area for spare OCS poles. It improves car shuffling somewhat. A prime drawback to this alternative is the more complicated OCS crossing for both bus and streetcar. We recommend addition of switching apparatus wherein bus power can be turned off and streetcar power turned on when the crossing is needed by the streetcar.

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**Alternative D:   Expansion of the South Lake Union - Harrison Street Facility and Addition of a Fremont Line Layover Facility To Accommodate a Fleet of Seven to Ten Cars.**

In this scenario a fenced yard and inexpensive storage building would be built on property available at the end of the Fremont Alignment. The building would accommodate up to four cars, and allow a night cleaning crew to clean the cars. However, maintenance related activities would be strictly limited to replacement of running lights or other minor repairs for car safety.

The concept behind this alternative, when taken together with Alternative “A”, “B”, or “C”, was thought to present a low cost alternative to accommodate a fleet size of up to 10 cars. However, the cost was not as inexpensive as originally thought. Further, the inefficiency of maintaining a night crew, the distance involved, and duplication of facility maintenance and other life cycle costs, all tend to discourage this option. We recommend considering this option as a last possibility. No diagram of this facility was produced for this report.

**Alternative E:   Expansion of the South Lake Union - Harrison Street Facility and Addition of a New Medium Cost Facility to Accommodate a Fleet of 12 to 15 Cars.**

Please refer to Figure Four for illustrated details. This scenario envisions a second, two track facility, in conjunction with the expansion of Harrison Street as described in Alternatives “A”, “B”, or “C”. The facility would be slightly larger than Harrison Street and would include a doubling of current office space. A fleet of up to 15 cars could be serviced before inefficiencies would be noticed.

If built with a link to SLU, and with the servicing of up to 15 cars, we recommend the addition of an automated vehicle wash. A small gantry style wash would add approximately \$240,000 to the price of the facility

This facility could also be assumed as a stand alone facility to service a new alignment that is not linked to the existing SLU alignment. As a standalone facility expect a cost of around \$4,000,000. Total fleet served when used as a standalone facility would be ten cars, as Illustrated.

This facility depicted in Figure Four would require property measuring 145 feet x 545 feet. These dimensions can be decreased somewhat, but can be used as a guideline in a hunt for available property.

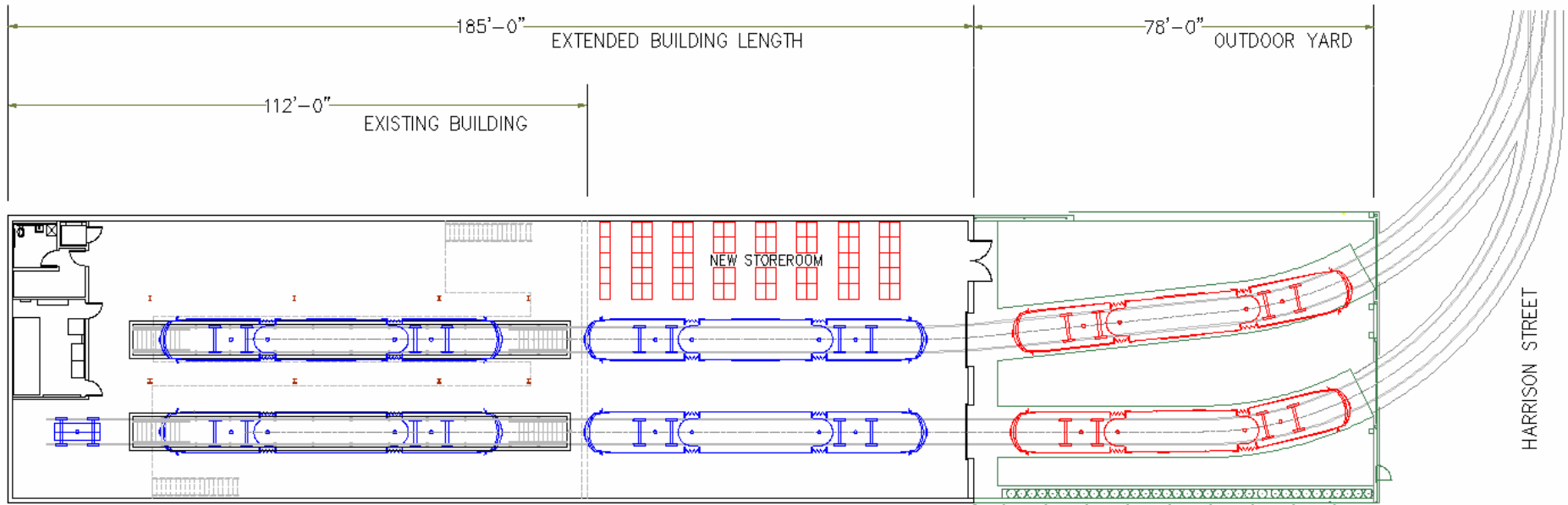
**Alternative F:   Expansion of the Harrison Street Facility and Addition of a New Major Facility to Accommodate a Fleet of 20 to 25 Cars.**

Refer to Figure Four for details of the facility, and Figure Five for a generic property layout.

This scenario envisions a second, three track facility. As a standalone facility this concept would serve the needs of the West Seattle to Ballard Line without requiring a link to the existing SLU line (10 to 15 cars). When combined with the expansion of Alternative “A”, “B” or “C”, a fleet size of 20 to 25 cars could be reached. Costs estimated for this facility do include an automated Vehicle Wash.

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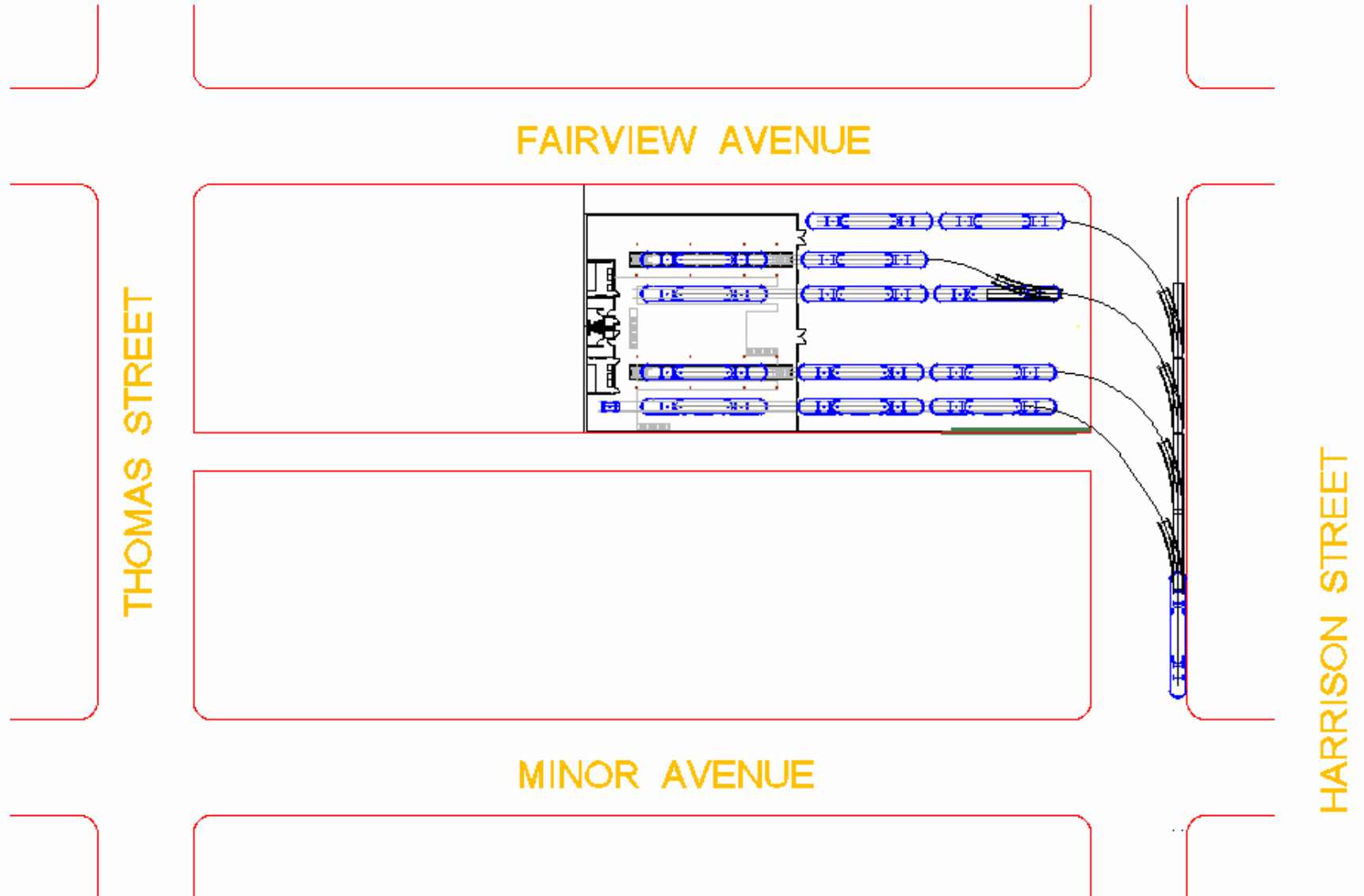
## ALTERNATIVE "A"



**FIGURE ONE: EXPANSION OF HARRISON STREET MAINTENANCE BUILDING**

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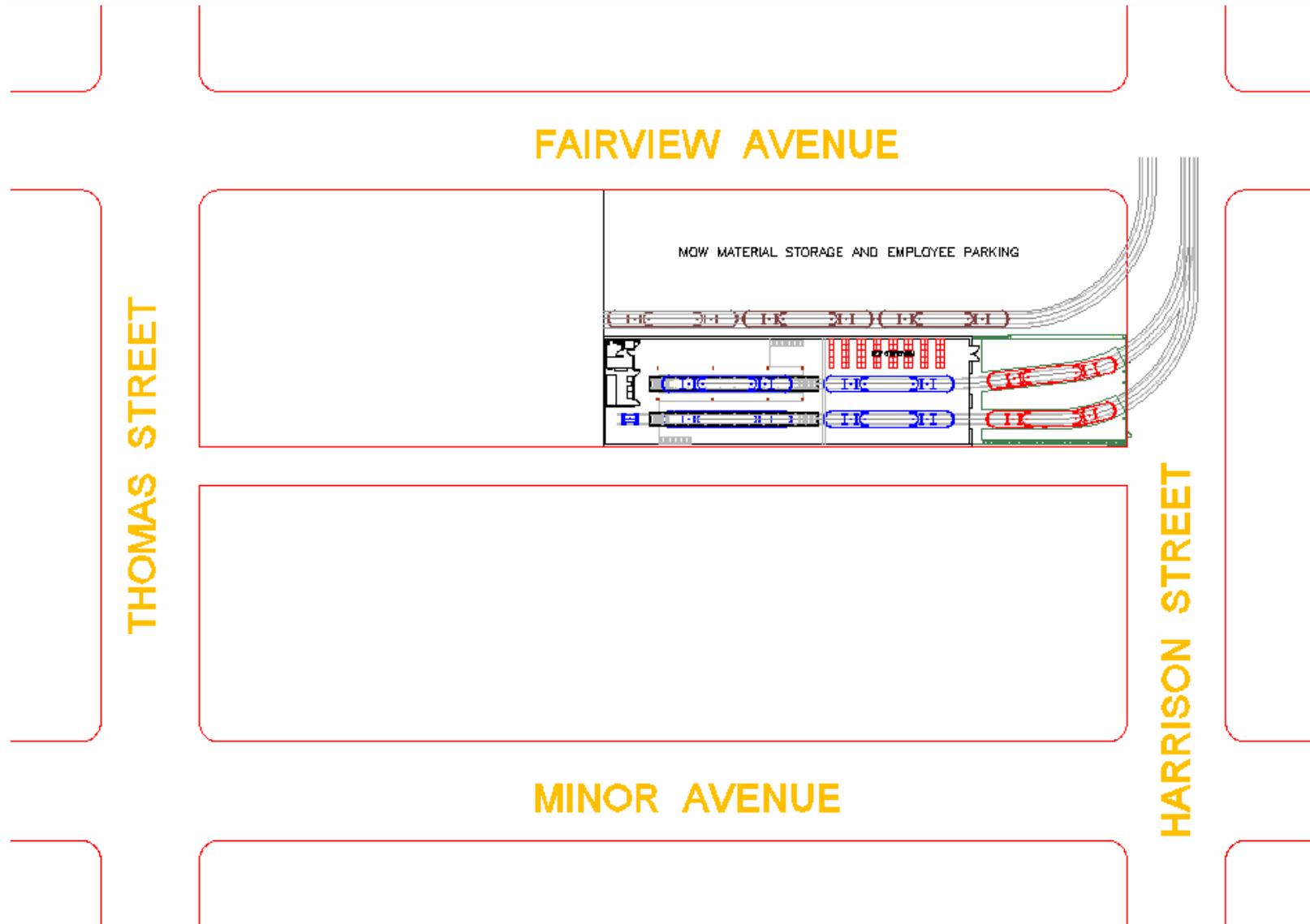
ALTERNATIVE "B"



**FIGURE TWO: VACATE HARRISON ST. & ADD SHOP ADDITION BORDERING FAIRVIEW**

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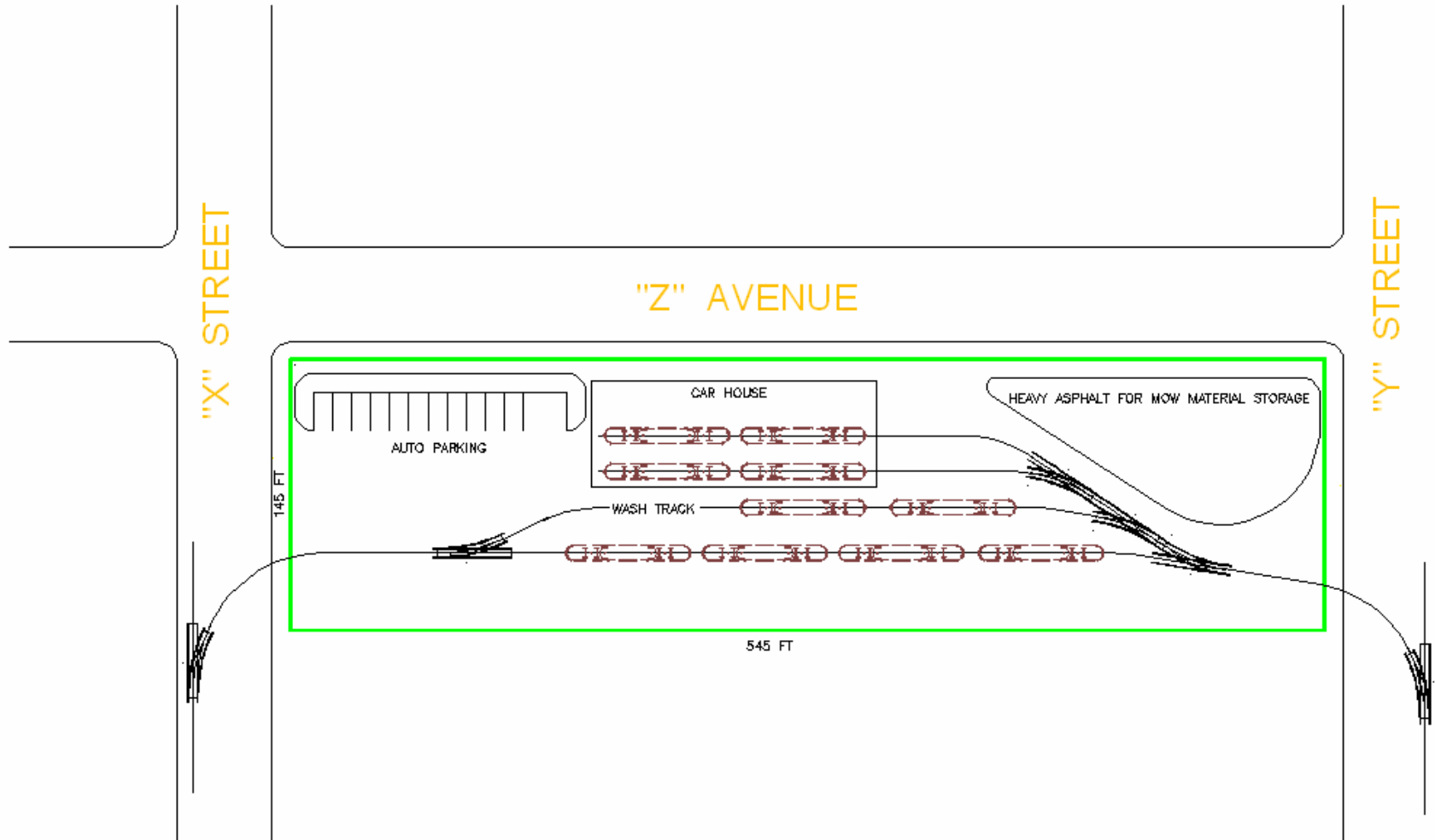
## ALTERNATIVE "C"



**FIGURE THREE: DEVELOPMENT OF HARRISON STREET ADJACENT PROPERTY**

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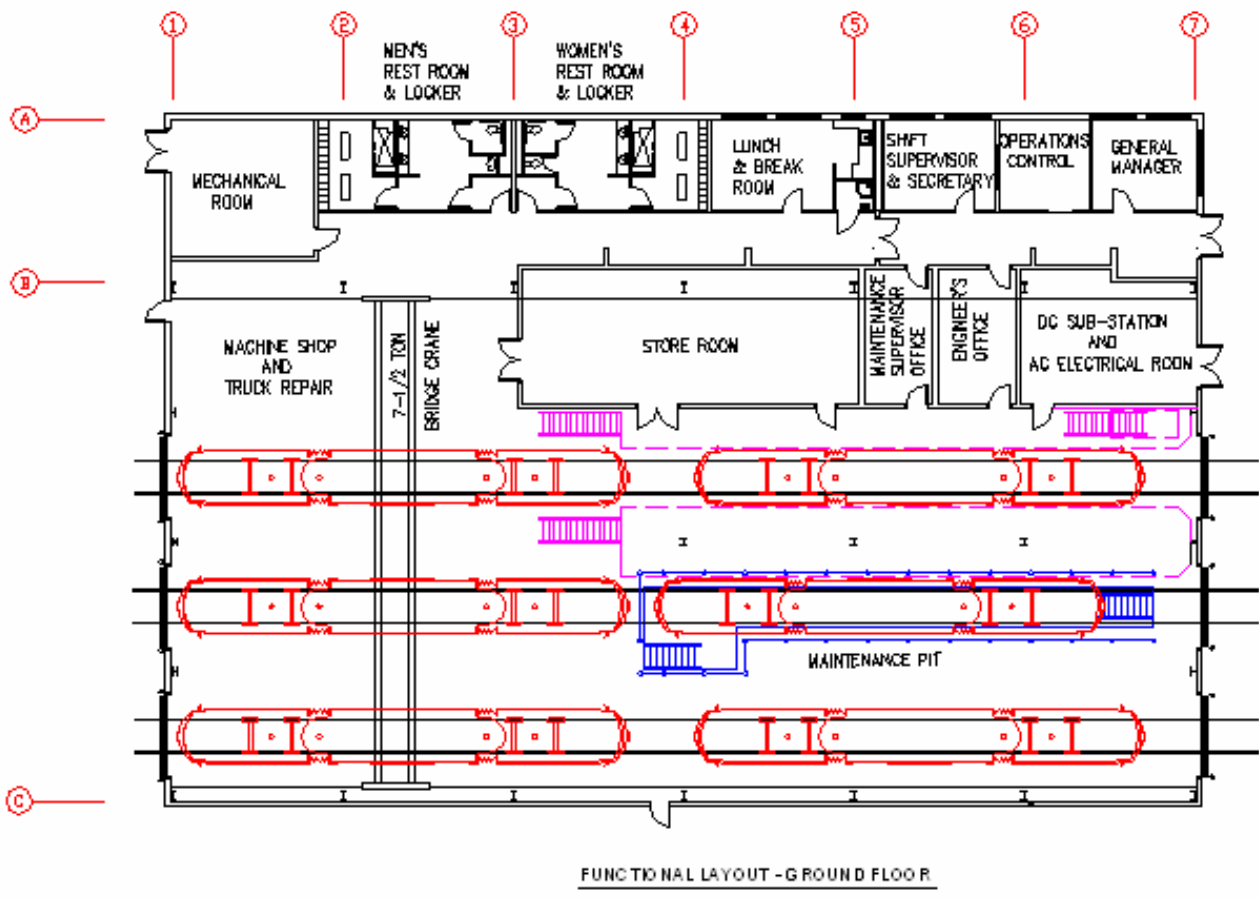
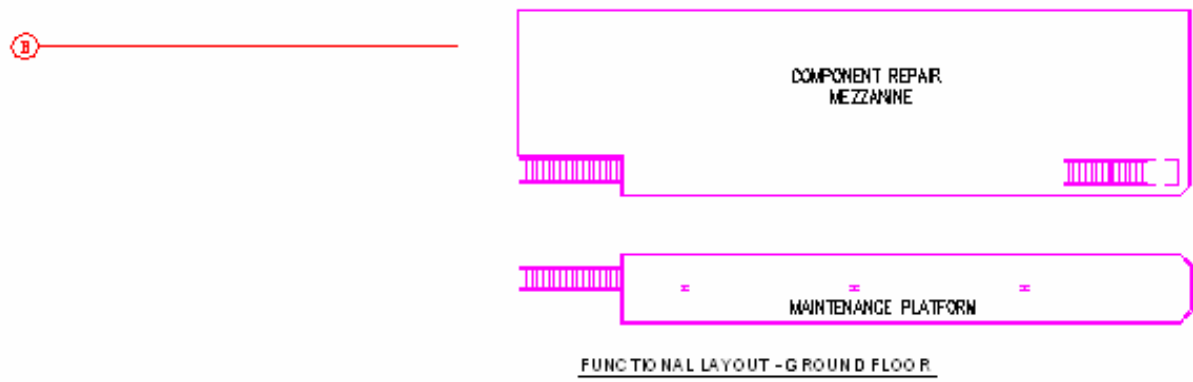
## ALTERNATIVE "E"



**FIGURE FOUR: SITE LAYOUT OF NEW TWO TRACK FACILITY**

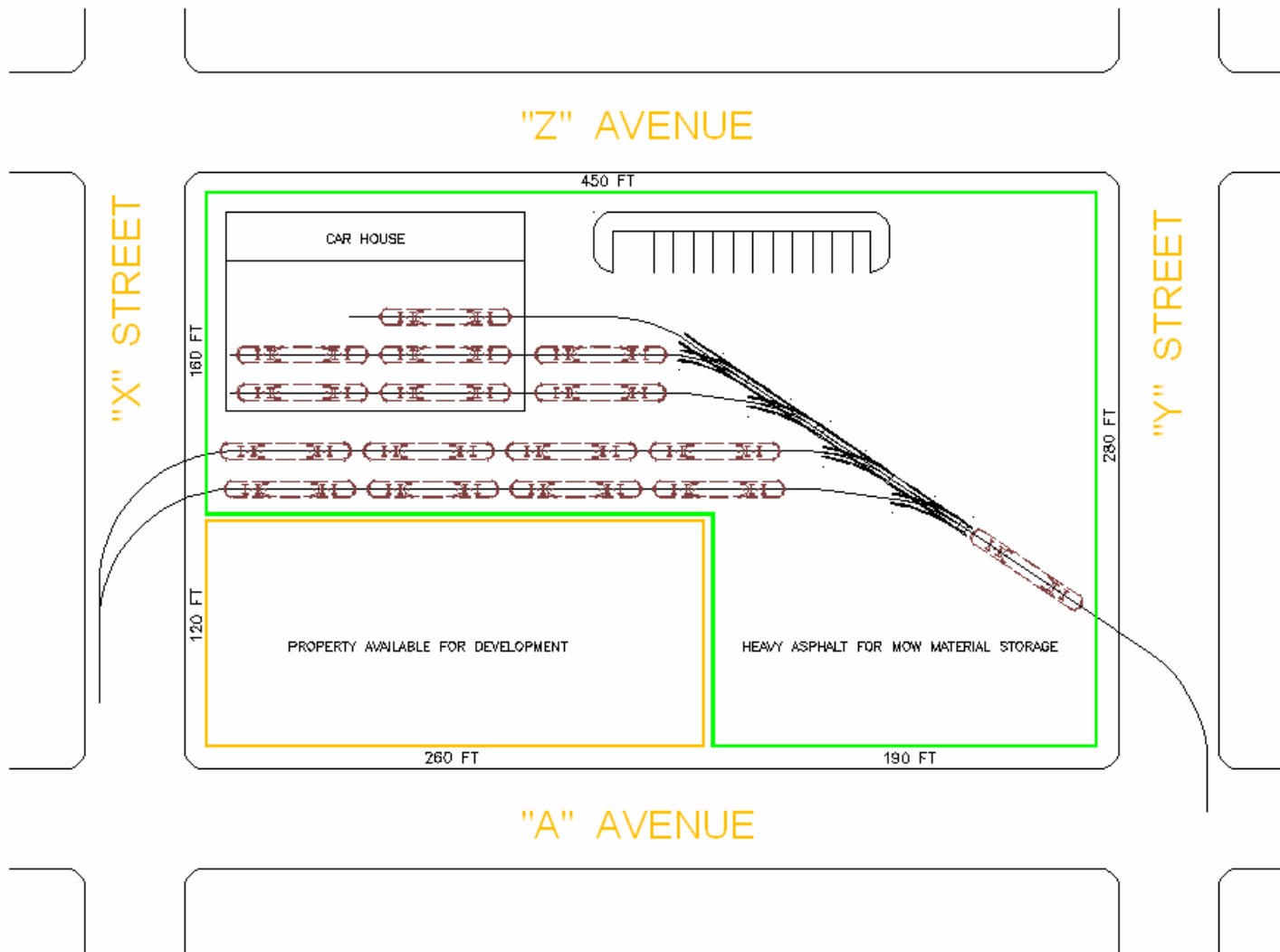
# SEATTLE STREETCAR

## ALTERNATIVE "F"



**FIGURE FIVE: NEW THREE TRACK FACILITY**

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**FIGURE SIX: SITE LAYOUT OF NEW THREE TRACK FACILITY**

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## **CONCLUDING REMARKS:**

A basic break down of the costs to build the facilities required for each alternative are contained in the attached addendum. We caution the reader that while these costs can be used to make comparisons of the relative worth of each option, they can not be used as a basis to set a budget for construction. The costs are based on historical prices from past projects, and are factored to a 2008 approximation for inflation. They are not based on an actual design, nor do they account for all site specific conditions. They do not include the cost of real estate.

From the alternatives presented in this report, we would narrow the choices somewhat, and recommend that SDOT consider these prime options:

### 1. For A Fleet Size of up to fifteen Cars – Best Economic Choice

To achieve servicing of up to a fifteen car fleet the best economic alternative is Alternative “B”: the use of Harrison Street as a new storage and switch yard; and use the adjacent property for additional shop space, at a cost of approximately \$4,250,000. This of course has many extenuating circumstances with a street vacation that can not be assured at this time. However, there is a hidden economic benefit to this alternative in that it uses property already owned by SDOT. In both Alternatives D, E and F, the land must be purchased in addition to the costs tabulated in the cost estimates. We also point out that this alternative may have hidden costs as well. Chiefly, those involved with possible incentives / settlements with local land owners regarding their inconvenience caused by the street vacation.

The technical merit of Alternative “B” is quite high and warrants our endorsement. Although SDOT initially sought to preserve this property for potential commercial development; we point out that this possibility may still be possible. The car house could be built to accommodate floors built above the shop for condominiums, or possible other commercial ventures. This determination goes beyond the scope of this report, but we would recommend that an architect take a look at this possibility. The Seattle Vintage Streetcar Line has looked at such a possibility; and in Portland, TriMet has looked at a similar concept for their 11<sup>th</sup> Street Turn-around.

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Included in the cost estimate is the cost of the dual purpose inspection and wheel truing pit. This would allow a future addition of a wheel truing machine for best facility efficiency. If installed today, an additional outlay of approximately \$1.6mm would be required. However, this addition, coupled with a complete Harrison Street vacation could produce a facility that can efficiently maintain a twenty car fleet size. Note however, above 15 cars and night time storage becomes a limiting factor.

With existing the property ownership and the potential for expansion, Alternative “B” should be considered the prime alternative given what we know today of potential new routing.

## 2. For A Fleet Size Up to 15 Cars – Best Choice for an Independent –or- “Stand Alone” Facility

The prospect of a potential new route with no connection to the SLU line would shift our recommendation to a “do nothing” at the Harrison Street Facility and build the facility discussed in Alternative “F”. We also point out that with wheel truing capacity, and given the proper property choice allowing car storage; this facility would have expansion possibility as well

Expenditure: Approximately \$5,500,000

In summary, the key decision factor affecting the maintenance facility is the new routing and either a connection to SLU –or- no connection to SLU. Both alternatives recommended can be built with no disruption of the existing SLU daily operation along the route. Alternative “B” could have some disruption of maintenance activities; but with good planning, this can be nearly seamless. The primary disruption is the new switch track installation on Harrison St. This may require temporary track panels to be placed at night and mornings to get cars in and out while construction takes place (about a 30 day duration). But this situation is manageable.

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## ADDENDUM ONE -- COST ESTIMATE

**City of Seattle - Department of Transportation  
Seattle Streetcar System  
Cost Estimate & Alternatives Study  
Future Maintenance Facility Capacity**

DATE: 09, May 2008  
REVISION: Rev 2 - 18, April 08

DESCRIPTION	ALTERNATIVE "A" Expand SLU Base Case	ALTERNATIVE "B" Expand SLU Using Harrison St & Adj Prop	ALTERNATIVE "C" Use SLU Adjacent Prop	ALTERNATIVE "D" Freemont Layover w/ SLU Base Case	ALTERNATIVE "E" New Small Facility w/ SLU Base Case	ALTERNATIVE "F" New Major Facility w/ SLU Base Case
Total Number of Cars in System	6	12 to 15	7 to 10	7 to 10	12 to 15	Up to 25
<b>DIRECT COSTS</b>						
1.0 Track Work	\$28,000	\$625,000	\$350,000	\$212,000	\$495,000	\$640,000
2.0 Civil Works	\$185,000	\$410,000	\$390,000	\$198,000	\$350,000	\$520,000
3.0 OCS & Systems	\$75,000	\$175,000	\$185,000	\$212,000	\$248,000	\$285,000
4.0 Shop DC Sub Station	\$0	\$0	\$0	\$0	\$380,000	\$380,000
5.0 Building - Structural Concrete	\$195,000	\$190,000	\$0	\$65,000	\$300,000	\$372,000
6.0 Building & Finishes	\$265,000	\$950,000	\$0	\$180,000	\$850,000	\$1,011,400
7.0 Building Mechanical	\$45,000	\$280,000	\$0	\$92,000	\$260,000	\$372,600
8.0 Building Electrical	\$60,000	\$305,000	\$0	\$165,000	\$298,000	\$338,000
9.0 Machinery & Tools	\$95,000	\$160,000	\$0	\$20,000	\$100,000	\$275,000
10.0 Engineering	\$200,000	\$450,000	\$130,000	\$172,000	\$395,000	\$410,000
11.0 Sub Total	=====	=====	=====	=====	=====	=====
	\$1,148,000	\$3,545,000	\$1,055,000	\$1,316,000	\$3,676,000	\$4,604,000
Contractor GC's @ 12% of Line 10.0	\$137,760	\$425,400	\$126,600	\$157,920	\$441,120	\$552,480
Contractor O&P @ 7.5% of Line 10.0	\$86,100	\$265,875	\$79,125	\$98,700	\$275,700	\$345,300
	=====	=====	=====	=====	=====	=====
	\$1,371,860	\$4,236,275	\$1,260,725	\$1,572,620	\$4,392,820	\$5,501,780
<b>ROUNDED UP VALUE FOR COMPARISON PURPOSES</b>	<b>\$1,400,000</b>	<b>\$4,250,000</b>	<b>\$1,300,000</b>	<b>\$1,600,000</b>	<b>\$4,400,000</b>	<b>\$5,500,000</b>

**POTENTIAL COSTS - NOT INCLUDED ABOVE**

- A. Permits and Fees
- B. Land Acquisition
- C. Environmental Impact Study
- D. Environmental Remediation
- E. Project Management Costs

NOTE: Alternative "C" includes demolition of existing building, Other cases do not include any major demolition.  
Alternative "C" does not include the Main Line Traction Power Sub Station