5.0 COST ANALYSIS

This chapter answers the questions of what it will cost to build and operate and maintain the proposed transit system alternatives in the PEROW/WSAB Corridor. Conceptual level cost estimates have been identified based on engineering and system design plans developed at a five percent level of information for the Final Alternatives presented in Chapters 2.0 and 3.0.

5.1 Capital Cost Analytical Overview

Capital costs are the expenses associated with the design and construction of the proposed transit system alternatives, with the system costs falling into one of two areas:

1. **Construction Costs** – This category includes the costs that go into building the transit system, such as roadway, track, and guideway elements; stations and parking structures; maintenance and storage facilities; site work (demolition and utility work); and vehicle control and power system equipment.
2. **Total Project Costs** – The second category includes the non-system costs, such as land acquisition; provision of engineering, project, and construction management services; permits; surveying and testing; insurance; and finance charges.

Conceptual order-of-magnitude capital costs were developed by estimating the quantities on a per mile basis for the individual line items required to build and operate each alternative, and then by applying standardized unit costs. The unit costs used in preparing the capital cost estimates were derived from similar Metro and other transit projects with recent construction bid information, and/or detailed preliminary engineering-related cost estimates. The capital costs were identified by multiplying the unit costs by the quantities, such as length of the roadway or track. The resulting capital costs were compiled in Standardized Cost Categories developed by the FTA for comparing project costs on a national basis.

When developing a capital cost estimate at this conceptual level of design, future costs arising from unforeseen project circumstances need to be accounted for. Contingencies provide a way to address evolving project costs due to issues such as unknown site conditions and city requirements. Based on recent Metro projects, an allocated contingency of 30 percent was applied to each cost category, with a five percent contingency applied to the vehicles, and an unallocated contingency of 10 percent applied to the overall project cost. An additional contingency factor was identified and applied to the Low Speed Maglev Alternatives reflecting unknown costs as this technology is not yet in revenue service in the U.S. While a majority of this option's grade-separated construction elements would be similar to other above-grade U.S. transit systems, the future costs of migrating the Japanese maglev guideway, and integrated operating and power systems, along with the system-specific vehicles are unknown. An additional allocated contingency of 20 percent was applied to these unique system elements to reflect unforeseen costs, especially those related to meeting U.S. transit requirements.

5.2 Capital Costs

Order-of-magnitude capital cost estimates were developed for the TSM Alternative and the four build options based on the previously discussed methodology. The No Build Alternative was not included in this effort, as all No Build costs are considered to be within the financial capability of Metro and OCTA as reflected in their adopted LRTPs. The transit service projects included in the TSM Alternative were identified with Metro, OCTA, and Long Beach Transit staff, and project costs were based on cost projections developed by each agency or identified in cooperation with the transit agencies. The conceptual estimated costs were reviewed with Metro and OCTA staff and compared to historical pricing data received from Metro and the Exposition Authority and the costs were increased by 27.8 percent reflecting the analytical results.

5.2.1 Vehicle Requirements

Alternative-specific vehicle requirements were identified based on each option's run time, or the time it would take to travel from one end of the alignment to the other. Run times vary based on factors such as the alignment length and configuration, and the number of stations proposed for each option. Service frequency and fleet requirements were based on approved Metro and OCTA bus service plans, and Metro's adopted rail operational policies.

The vehicle assumptions for the BRT Alternatives were as follows; The decision on whether to use 60-foot articulated buses, similar to those used on the Metro Orange Line, was deferred to the future when more detailed operating plans may be developed if a BRT Alternative moves forward.

- **HOV Lane-Running Option** – 45-foot NABI vehicles similar to those used for Metro Silver Line service, and
- **Street-Running Option** – 40-foot NABI vehicles similar to those used for Metro Rapid service.

The vehicle assumptions for the Guideway Alternatives were:

- **Street Car** – The Siemens S70 Street Car low-floor vehicle reflecting the anticipated Orange County Street Car system decision;
- **LRT Option** – Breda 2550 LRV vehicles similar to those currently used by Metro; and
- **Low Speed Maglev Option** – Nippon Sharyo HSST-100L vehicles similar to those utilized by the Linimo system in Nagoya, Japan.

Table 5.1 – Fleet Requirements for TSM and BRT Alternatives

Alternative	Peak Vehicles	Maintenance Spares[1]	Total Fleet Size
TSM Alternative	98	20	118
BRT Alternative: HOV Lane-Running	32	6	38
BRT Alternative: Street-Running	16	3	19

[1] Maintenance spares are vehicles available to be put into service in case of operational problems.

As presented in Table 5.1, bus requirements for the TSM and BRT alternatives were developed based on the number of peak revenue vehicles required by the identified service headway frequency and resulting run times presented in Chapter 3.0. Maintenance spares, required in case of operational problems, were defined as equal to 20 percent of the peak revenue vehicles based on Metro's adopted *2011 Transit Policy*. The resulting number of vehicles required by the BRT alternatives varies from a total of 19 daily vehicles for the Street-Running Alternative to 38 for the HOV Lane-Running Option. The fleet difference reflects the more frequent service headway proposed for the HOV Lane-Running Alternative – five minutes compared to ten minutes. The Street-Running Alternative was proposed to have less frequent service due to the significant number of buses already operating in the Northern and Southern Connection areas of the Corridor.

The vehicle requirements for the guideway modal and alignment alternatives presented in Table 5.2 were calculated based on the proposed service headway frequency and resulting run times discussed in Chapter 3.0. The total fleet size reflects Metro rail operational requirements for maintenance spares and "ready cars". Maintenance vehicles are calculated as 20 percent of the total peak revenue vehicles. Ready cars are three-car gap trains ready to pull into service in case of a late train or other operational problems, and are typically available at each end and sometimes in the center of the alignment.

Table 5.2 – Fleet Requirements for Guideway Alternatives

Modal/Alignment Alternative	Peak Revenue Vehicles	Ready Cars[1]	Total Revenue Vehicles	Maintenance Spares[2]	Total Fleet Size
Street Car					
‣ East Bank 1	84	9	93	19	112
‣ West Bank 1	81	9	90	18	108
‣ West Bank 2	84	9	93	19	112
‣ West Bank 3	81	9	90	18	108
Light Rail Transit					
‣ East Bank 1	75	9	84	17	101
‣ West Bank 1	72	9	81	16	97
‣ West Bank 2	78	9	87	17	104
‣ West Bank 3	72	9	81	16	97
Low Speed Maglev					
‣ East Bank 1	51	9	60	12	72
‣ West Bank 1	51	9	60	12	72
‣ West Bank 2	54	9	63	12	75
‣ West Bank 3	51	9	60	12	72

[1] Ready Cars are vehicles available at each end and in the center of the alignment in case of operational problems.
[2] Maintenance spares equal 20 percent of peak revenue vehicles based on the Metro *2011 Transit Policy*.

The resulting fleet requirements for the three guideway alternatives vary from 72 to 112 vehicles. While all of the guideway options are proposed to operate with the same service frequency, the alignment lengths, number of stations, vehicle operational speeds, and resulting run times vary. The Low Speed Maglev Alternative requires the lowest number of vehicles due to the fastest average operational speed and the shortest alignment length of the modal options, with its proposed terminus at the future Harbor Boulevard Street Car Station. The Street Car Alternative has the largest fleet requirement reflecting the longest run times among the alternatives due to having the lowest maximum and average speeds along with more stations than the other two guideway alternatives. The resulting average operational speeds are 31.0 mph for Street Car service and 35.3 mph for LRT service. The slower Street Car average speed results in longer run times than the LRT alternatives – approximately seven minutes longer for the end-to-end trip from Union Station to the SARTC.

Among the alignment alternatives, the East Bank and West Bank 2 options require more vehicles due to longer alignments, more stations, and resulting longer run times required in the Northern Connection Area. While the West Bank 3 alignment alternative has the highest number of stations in this section, serving more cities and longest alignment length, more than 25 percent of this option's alignment operates in a grade-separated configuration compared to eight percent for the other alignment options. For the Low Speed Maglev Alternative, the West Bank 2 alignment option requires slightly more vehicles due to the longest run time among the Low Speed Maglev alignment options.

5.2.2 Storage and Maintenance Facilities

All of the proposed alternatives will require:

- **Overnight vehicle storage** – Vehicle storage is typically provided at either one end, or both ends (depending on the length of the alignment), to provide overnight storage to reduce "deadhead" or non-revenue service, time required to put the vehicles into position for morning service. Overnight storage space may incorporate daily cleaning and light maintenance capabilities; and
- **Storage/Heavy Maintenance Yard** – A majority of the service fleet is typically stored overnight in a larger location incorporating facilities for vehicle washing and heavy maintenance and repair.

The capital cost estimates presented below in Table 5.3 include a placeholder cost of $184 million for construction of a storage and heavy maintenance facility to support system operations for each of the alternatives except the TSM option, which would accommodate the proposed vehicle increase in existing facilities. This cost represents the purchase of 25 acres to house approximately 80 vehicles along with construction of a related maintenance and repair facility.

Storage and maintenance of the bus fleets required for the BRT Alternatives was assumed to require a new facility to accommodate busses that may be different than the existing fleet. Some overnight storage for early morning peak period services was assumed to be accommodated at the northern end of the alignment at a Metro-owned site adjacent to Union Station, at the southern end at the SARTC along with other transit facilities proposed as part of this transit center's master plan, and along the

PEROW/WSAB ROW, where BRT operations would require only 30 to 60 feet (approximately at stations) of the available 75 to 195 feet ROW width.

Storage and maintenance of the guideway vehicle fleets required for the Street Car, LRT, and Low Speed Maglev alternatives was assumed to require a new facility, either to accommodate the new Street Car and Low Speed Maglev technologies, or due to constrained storage available at existing Metro LRT facilities. Some overnight storage for morning peak period services was assumed to be accommodated at the southern end of the alignment at the SARTC within the future Santa Ana Street Car storage and maintenance site. At the northern end of the Corridor, there is no storage capability at Union Station or at nearby existing LRT facilities, and a new site would have to be identified.

A maintenance and storage site possibility exists just to the south of Union Station where Metro owns property along the Harbor Subdivision known as the Malabar Street Yard in Vernon. This linear 4.9-acre site is owned in part with the BNSF, which currently uses a majority of the property (4.3 acres) for freight rail storage. Site improvements would be required to make this site viable for the proposed guideway vehicles. Co-use of the site by freight and passenger rail vehicles would require construction of new track, operational control system, and fencing. This site would only be viable for the West Bank alignment alternatives; the East Bank vehicles may be stored at the Mission Junction property or other sites being evaluated by Metro for Eastside LRT vehicle storage. Future guideway storage facility sites in Orange County are limited due to the built-out residential and commercial nature of this portion of the Corridor; industrial sites east of the SARTC appear to offer the only possible opportunities. If the future transit system were implemented in Minimum Operable Segments (MOSs), the first construction phase was assumed to be along the PEROW/WSAB Corridor ROW, currently owned by Metro and OCTA, with the existing ROW providing ample room for pavement, tail tracks, or guideway structure to accommodate overnight vehicle storage.

Possible maintenance yard site options were identified in the northern portion of the Corridor along or adjacent to the guideway alignment options, including the PEROW/WSAB ROW, the Harbor Subdivision ROW, and the San Pedro Subdivision ROW. Several sites of publicly- and/or privately-owned land were identified ranging in size from 18 to 32 acres, which could accommodate 57 to 102 vehicles. Possible sites were identified primarily in this area due to the number of larger sites that are either vacant or appear to be underutilized. The final decision on where to locate the project's support facilities, and how to allocate the cost, would be based on further policy and cost analysis work performed during possible future engineering and environmental assessment efforts, and within the larger framework of transit agency or private-operator system decisions.

5.2.3 Capital Costs

Capital cost estimates were identified and presented in a variety of ways to help elected officials, stakeholders, and the public to understand the differences among the alternatives: by segment, with and without vehicle costs; per mile; per county; and per possible MOS. In addition, cost estimates were prepared for building totally grade-separated systems, similar to the Low Speed Maglev Option, for the Street Car and LRT alternatives.

Capital Costs by Corridor Study Area

Table 5.3 presents order of magnitude project capital cost estimates for the modal and alignment alternatives divided into each of the three Corridor areas. This information allows for consideration of the varied alignment sections and their costs, and provides a basis for the consideration of possible MOSs in the identification of a preferred transit strategy or phasing of strategies that is discussed below.

Table 5.3 – Order of Magnitude Capital Costs (FY 2010 dollars)

Modal/Alignment Alternative	Northern Connection Area Cost (Millions)	PEROW/ WSAB Area Cost (Millions)	Southern Connection Area Cost (Millions)	Total Project Capital Cost (Millions)	Incremental Increase over TSM[1] (Millions)
TSM Alternatives					
Core Service Project	NA	NA	NA	$9.9	--
Corridor System	NA	NA	NA	$249.0	--
BRT Alternatives					
Street-Running	$275.9	$583.3	$216.0	$1,075.2	$826.2
HOV Lane-Running	$282.3	$583.3	$216.0	$1,081.6	$832.6
Street Car Alternatives					
East Bank 1	$1,397.6	$873.0	$304.2	$2,574.7	$2,325.7
West Bank 1	$1,433.9	$873.0	$304.2	$2,611.0	$2,362.0
West Bank 2	$1,407.2	$873.0	$304.2	$2,584.3	$2,335.3
West Bank 3	$1,741.0	$873.0	$304.2	$2,918.1	$2,669.1
LRT Alternatives					
East Bank 1	$1,552.4	$1,039.1	$377.6	$2,969.2	$2,720.2
West Bank 1	$1,493.1	$1,039.1	$377.6	$2,909.9	$2,660.9
West Bank 2	$1,481.6	$1,039.1	$377.6	$2,898.3	$2,649.3
West Bank 3	$1,799.3	$1,039.1	$377.6	$3,216.5	$2,967.5
Low Speed Maglev Alternatives					
East Bank 1	$2,847.8	$3,772.9	NA	$6,620.7	$6,371.7
West Bank 1	$2,841.4	$3,772.9	NA	$6,614.3	$6,365.3
West Bank 2	$3,404.4	$3,772.9	NA	$7,177.4	$6,928.4
West Bank 3	$3,703.8	$3,772.9	NA	$7,476.7	$7,227.7

[1] Compared to the TSM Corridor System Alternative.

The capital cost for all of the build alternatives includes the cost for the TSM Alternative as required by the FTA for AA studies. It should be noted that two TSM costs were identified: 1) the TSM Corridor System option representing all of the proposed bus services, including the two bus lines serving the same alignment as the build alternatives (the Union Station-Los Cerritos Center and the Katella Avenue BRT lines); and 2) the TSM Core Service Project representing only the two bus lines replicating the service provided by the build alternatives. The TSM cost included in the build alternative capital cost estimates is for the TSM cost without the two lines ($239.2 million), rather than the TSM Corridor System cost of $249.0 million.

While all of the modal alternatives have the single alignment in the PEROW/WSAB Area in common, there are four different alignment options in the Northern Connection Area, and two alignments for the Street Car and LRT alternatives in the Southern Connection Area. The construction costs vary due to different alignment lengths and number of stations reflecting the cities and destinations being served, and the engineering requirements to fit the proposed transit system within the built-out Corridor. The length and number of stations for the four alignments in Northern Connection Area vary, while there is only one alignment in the PEROW/WSAB Area for all of the modal alternatives, and the Harbor Boulevard/1st Street/SARTC alignment in the Southern Connection Area was used for the Street Car and LRT options. There are no Southern Connection Area costs for the Low Speed Maglev alternatives due to the proposed terminus at the future Santa Ana-Garden Grove Fixed Guideway Harbor Station.

As may be expected, the at-grade alternatives have the lowest total project capital costs, with the TSM and BRT alternatives identified as costing the least. The TSM Alternatives were estimated to cost $9.9 million for the Core Service Project and $249.0 million for the TSM Corridor System. The BRT options were projected to cost $1.1 billion for both the Street-Running and the HOV Lane-Running Options. The Street-Running Alternative was estimated to cost slightly less due to fewer vehicles being required to provide the proposed limited stop bus service. The cost of the Street-Running Alternatives includes implementation of signal priority system improvements to support operations beyond the PEROW/WSAB ROW in both the Northern and Southern Connection areas, while the HOV Lane-Running Alternative would only require signal priority improvements in the Southern Connection Area as it would use freeway HOV and Harbor Transitway lanes in the Northern Connection Area. It should be noted that buses typically have a 10 to 15 year lifecycle, and that the initial capital investment in the bus fleet would have to be repeated in the future, and is not included in the identified capital costs for the BRT Alternatives.

The Low Speed Maglev alternatives, designed as entirely grade-separated, would have the highest estimated capital costs – ranging from approximately $6.6 to $7.2 billion for an approximately 30-mile system running from Union Station to Harbor Boulevard. The capital costs for the Street Car and LRT alternatives would range from $2.6 to $2.9 billion and $2.9 to $3.2 billion respectively, for an approximately 35-mile system operating from Union Station to the SARTC.

For both the Street Car and LRT alternatives, the West Bank 3 would have the highest cost primarily due to 27 percent of the Northern Connection Area alignment being grade-separated compared to the other alternatives, along with having the highest number of stations. Costing approximately $300 million more among the Street Car options and $250 to $320 million more for the LRT alternatives than the other alignment options, the West Bank 3 Alternative provides the highest average speed and fastest travel time. This alignment option also was the highest among the Low Speed Maglev Alternatives, costing $300 to $860 million more than the other options, primarily due to a higher number of stations.

The Northern Connection Area capital costs were the highest among the three Corridor sections primarily due to the cost methodology that placed the cost for all of the vehicle requirements and the maintenance yard in this first system section, adding $184 million to this area's capital costs, while the TSM Alternative costs were included in the PEROW/WSAB Area costs. Table 5.4 presents a capital cost breakdown presenting the system component costs and how they contribute to the overall project cost.

Table 5.4 – Capital Cost Breakdown (FY 2010 dollars)

Modal/Alignment Alternative	TSM Cost (Millions)	Main. Yard Cost (Millions)	Vehicle Cost (Millions)	Construction Cost (Millions)	Total Project Cost (Millions)
BRT Alternatives					
‣ Street-Running	$239.2	$184.0	$9.0	$643.0	$1,075.2
‣ HOV Lane-Running	$239.2	$184.0	$18.0	$640.4	$1,081.6
Street Car Alternatives					
‣ East Bank 1	$239.2	$184.0	$411.6	$1,739.9	$2,574.7
‣ West Bank 1	$239.2	$184.0	$396.9	$1,790.9	$2,611.0
‣ West Bank 2	$239.2	$184.0	$411.6	$1,749.5	$2,584.3
‣ West Bank 3	$239.2	$184.0	$396.9	$2,098.0	$2,918.1
LRT Alternatives					
‣ East Bank 1	$239.2	$184.0	$371.1	$2,174.9	$2,969.2
‣ West Bank 1	$239.2	$184.0	$356.5	$2,130.2	$2,909.9
‣ West Bank 2	$239.2	$184.0	$382.2	$2,092.9	$2,898.3
‣ West Bank 3	$239.2	$184.0	$356.5	$2,436.8	$3,216.5
Low Speed Maglev Alternatives					
‣ East Bank 1	$239.2	$184.0	$540.0	$5,657.5	$6,620.7
‣ West Bank 1	$239.2	$184.0	$540.0	$5,651.1	$6,614.3
‣ West Bank 2	$239.2	$184.0	$562.5	$6,191.7	$7,177.4
‣ West Bank 3	$239.2	$184.0	$540.0	$6,513.5	$7,476.7

Capital Cost Per Mile

An evaluation of the conceptual capital costs on a per mile basis is presented in Table 5.5. Implementation of the BRT Alternatives would cost the least at approximately $34.0 million per mile, while the entirely grade-separated Low Speed Maglev Alternatives would have the highest cost at $222.9 to $256.0 million per mile for the East Bank and West Bank 3 alignment options respectively.

Table 5.5 – Estimated Capital Cost Per Mile (FY 2010 dollars)

Modal/Alignment Alternative	Alignment Length (Miles)	Total Project Cost (Millions)	Total Project Cost Per Mile (Millions)
BRT Alternatives			
‣ Street-Running	38.2	$1,075.2	$34.5
‣ HOV Lane-Running	39.0	$1,081.6	$34.0
Street Car Alternatives			
‣ East Bank	35.2	$2,574.7	$73.1
‣ West Bank 1	35.2	$2,611.0	$74.2
‣ West Bank 2	35.6	$2,584.3	$72.6
‣ West Bank 3	34.5	$2,918.1	$84.6
LRT Alternatives			
‣ East Bank	35.2	$3,213.0	$84.4
‣ West Bank 1	35.2	$3,153.7	$82.7
‣ West Bank 2	35.6	$3,142.2	$81.4
‣ West Bank 3	34.5	$3,459.9	$93.2
Low Speed Maglev Alternatives			
‣ East Bank	29.7	$6,620.7	$222.9
‣ West Bank 1	29.6	$6,614.3	$223.5
‣ West Bank 2	29.9	$7,177.4	$240.0
‣ West Bank 3	29.2	$7,476.7	$256.1

The Street Car Alternative ranges from $72.6 to $84.6 million per mile for the West Bank 2 and West Bank 3 alignment, while the LRT Alternative ranges from $81.4 to $93.2 million per mile for the West Bank 2 and 3 respectively. While Street Car systems typically have a lower capital cost due to a range of factors including lighter vehicles requiring less structure and less expensive power systems due to fewer Operating Control System (OCS) poles and traction power substations, two of the LRT options are less expensive than the most costly Street Car option. The West Bank 3 Alternative would have the highest cost per mile, while having the shortest alignment, it has more stations, a higher percentage of grade-separation, and the most complex system needs as it weaves through multiple freeways and bridges in Vernon and downtown Los Angeles.

Capital Cost Per County

The conceptual capital costs per county were identified, as presented in Table 5.6, to allow for a comparison to available funding and to support consideration of MOSs, as the decision may be made to implement the proposed system in segments.

Table 5.6 – Estimated Capital Cost Per County (FY 2010 dollars)

Modal/Alignment Alternative	Los Angeles County Cost (Millions)	Los Angeles County Portion (Percent)	Orange County Project Cost (Billions)	Orange County Portion (Percent)	Total Project Capital Cost (Millions)
TSM					
‣ Core Service Project	$5.2	53%	$4.7	47%	$9.9
‣ Corridor System	$26.9	11%	$222.1	89%	$249.0
BRT Alternatives					
‣ Street-Running	$466.8	43%	$608.4	57%	$1,075.2
‣ HOV Lane-Running	$473.2	44%	$608.4	56%	$1,081.6
Street Car Alternatives					
‣ East Bank 1	$1,757.3	68%	$817.4	32%	$2,574.7
‣ West Bank 1	$1,793.6	69%	$817.4	31%	$2,611.0
‣ West Bank 2	$1,766.9	68%	$817.4	32%	$2,584.3
‣ West Bank 3	$2,100.7	72%	$817.4	28%	$2,918.1
LRT Alternatives					
‣ East Bank 1	$1,984.3	67%	$984.9	33%	$2,969.2
‣ West Bank 1	$1,925.0	66%	$984.9	34%	$2,909.9
‣ West Bank 2	$1,913.4	66%	$984.9	33%	$2,898.3
‣ West Bank 3	$2,231.6	69%	$984.9	31%	$3,216.5
Low Speed Maglev Alternatives					
‣ East Bank 1	$4,662.2	70%	$1,958.5	30%	$6,620.7
‣ West Bank 1	$4,655.8	70%	$1,958.5	30%	$6,614.3
‣ West Bank 2	$5,218.9	73%	$1,958.5	27%	$7,177.4
‣ West Bank 3	$5,518.2	74%	$1,958.5	26%	$7,476.7

While approximately 60 percent of the project length would be located in Los Angeles County compared to Orange County, the actual percentage of capital costs varies per alternative. The TSM Alternative is more costly for Orange County based on the more extensive range of enhanced and new bus services and the provision of arterial system improvements at 21 intersections along six major streets identified for this section of the Corridor. For the BRT Alternatives, a majority of the project capital cost is related to reuse of the PEROW/WSAB ROW with provision of a paved ROW, stations, and signal system at roadway crossings. The Orange County portion is higher due to more of the PEROW/WSAB ROW – approximately 12 of the 20 total miles – being located in this county.

The percentage of capital costs for the guideway alternatives would be higher for Los Angeles County (66 to 74 percent) reflecting the alignments traveling through the challenging combination of former railroad ROWs and city street systems coupled with freeway and river crossings in the Northern Connection Area to connect with Union Station. For the Low Speed Maglev Alternatives, 70 to 74 percent of the alignment cost would occur in Los Angeles County reflecting a longer alignment length compared to the Orange County portion of the system as this alternative does not continue through the City of Santa Ana to the SARTC.

Possible MOS Costs

With a transit project of this length and complexity, it would most likely be constructed in MOSs, or system segments that could stand alone as operable systems providing needed connections between key locations. The definition of MOSs would also be county-based reflecting public agency system priorities and funding constraints. Four proposed MOSs, with the first two segments located in Los Angeles County reflecting the Measure R funding commitment to this project, have been defined and an order of magnitude of cost identified below in Table 5.7:

- **MOS 1** – In Los Angeles County, the first segment would run from the Metro Green Line Lakewood Boulevard Station along the Metro-owned WSAB ROW to the Bloomfield Avenue Station which would serve as an interim terminus at the county line. This section is similar to the Los Angeles County portion of the PEROW/WSAB Area cost, but is 0.56 of a mile shorter as the MOS alignment turns up Lakewood Boulevard to connect with the existing Metro Green Line Lakewood Boulevard Station.
- **MOS 2** – The second segment would operate north from the end of the PEROW/WSAB ROW in Paramount from a new Metro Green Line station along the Ports-owned ROW, various active and inactive railroad ROWs, and city streets to a northern terminus at Union Station. The cost for this section is the Northern Connection Area cost for each of the alternatives.
- **MOS 3** – The first segment in Orange County would continue south from the county line along the OCTA-owned PEROW to an interim terminus at the future Santa Ana-Garden Grove Fixed Guideway Harbor Boulevard Station. This section's cost is the Orange County portion of the PEROW/WSAB Area capital cost as identified previously.
- **MOS 4** – The final segment of the system would be constructed south through the City of Santa Ana along the Harbor Boulevard/1st Street/SARTC alignment, and the cost is the Southern Connection Area capital cost.

Table 5.7 – Capital Cost for Possible Minimum Operable Segments (FY 2010 dollars)

Modal/Alignment Alternative	MOS 1 Metro Green Line to County Line (Millions)	MOS 2 Metro Green Line to Union Station (Millions)	MOS 3 County Line to Harbor Boulevard (Millions)	MOS 4 Harbor Boulevard to SARTC (Millions)
BRT Alternatives				
‣ Street-Running	$183.3	$275.9	$392. 3	$216.0
‣ HOV Lane-Running	$183.3	$282.3	$392. 3	$216.0
Street Car Alternatives				
‣ East Bank	$345.3	$1,397.6	$513.3	$304.2
‣ West Bank 3	$345.3	$1,741.0	$513.3	$304.2
LRT Alternatives				
‣ East Bank	$414.6	$1,552.4	$607.2	$377.6
‣ West Bank 3	$414.6	$1,799.7	$607.2	$377.6
Low Speed Maglev Alternatives				
‣ East Bank	$1,741.9	$2,847.8	$1,958.5	NA
‣ West Bank 3	$1,741.9	$3,703.8	$1,958.5	NA

Street Car and LRT Capital Costs with Grade-Separated System

The Street Car and LRT alternative capital costs presented above were based on a proposed combination of at-grade and grade-separated operations. Grade-separated operations are considered to be primarily above-grade and not in a subway configuration. During Initial Screening, subway construction was removed from further consideration due to the PEROW/WSAB ROW's high water table which ranges from approximately two to 20 feet below the surface, resulting in higher construction costs, as well as the costly need to address the possibly contaminated ground water from years of railroad operations. The West Bank 3 Alternative does include a subway segment as the proposed alignment transitions from the Metro-owned Harbor Subdivision to travel through the densely-developed Central City East and Little Tokyo areas of downtown Los Angeles to Union Station.

Conceptual vertical alignment decisions were made based on engineering best practices and Metro's nationally-recognized *Grade Crossing Policy for Light Rail Transit*, which was used for the entire corridor to provide a consistent cost methodology. Table 5.8 presents a summary of the percentage of each alignment segment that was designed at-grade or grade-separated at this point in the system planning process. As previously stated, the West Bank 3 alignment alternative is the only option designed with a percentage of grade-separated operations in the City of Vernon and Central City East area of Los Angeles.

Table 5.8 – Street Car and LRT Alignments: Definition of Vertical Configuration

Alignment Alternative	Northern Connection Area (Percent)		PEROW/ WSAB Area (Percent)		Southern Connection Area (Percent)		Total (Percent)	
	At-Grade	Aerial/ Subway	At-Grade	Aerial	At-Grade	Aerial	At-Grade	Aerial/ Subway
East Bank 1	76%	24%	92%	8%	92%	8%	87%	13%
West Bank 1	78%	22%	92%	8%	92%	8%	87%	13%
West Bank 2	85%	15%	92%	8%	92%	8%	90%	10%
West Bank 3	73%	27%	92%	8%	92%	8%	86%	14%

If the decision were made to construct the Street Car and LRT options in an entirely grade-separated configuration, similar to the Low Speed Maglev alternatives, the resulting increase in estimated capital costs for each Corridor area is presented in Table 5.9. The increase in cost to grade-separate the Street Car and LRT alternatives is approximately two times (1.8) the cost estimates presented in Table 5.3.

Table 5.9 – Estimated Capital Cost For 100% Grade-Separated Systems (FY 2010 dollars)

Alignment Alternative	Alignment Section	Street Car Cost (Millions)	Street Car Cost Per Mile (Millions)	LRT Cost (Millions)	LRT Cost Per Mile (Millions)
East Bank	Northern Connection Area	$2,473.0		$2,542.0	
	PEROW/WSAB Area	2,580.7		2,850.8	
	Southern Connection Area	722.1		843.1	
35.2 Miles	**Total**	**$5,775.8**	**$164.1**	**$6,235.9**	**$177.2**
West Bank 1	Northern Connection Area	$2,447.8		$2,526.5	
	PEROW/WSAB Area	2,580.7		2,850.8	
	Southern Connection Area	722.1		843.1	
35.2 Miles	**Total**	**$5,750.6**	**$163.4**	**$6,220.4**	**$176.7**
West Bank 2	Northern Connection Area	$2,534.8		$2,644.1	
	PEROW/WSAB Area	2,580.7		2,850.8	
	Southern Connection Area	722.1		843.1	
35.6 Miles	**Total**	**$5,837.5**	**$164.0**	**$6,338.0**	**$178.0**
West Bank 3	Northern Connection Area	$2,535.0		$2,685.7	
	PEROW/WSAB Area	2,580.7		2,850.8	
	Southern Connection Area	722.1		843.1	
34.5 Miles	**Total**	**$5,837.8**	**$169.2**	**$6,379.6**	**$184.9**

5.3 Operating and Maintenance Costs

Operating and maintenance (O&M) costs are those related to the day-to-day operations of the proposed transit service including labor, vehicle maintenance, and overall transit system maintenance. O&M costs were projected based on the level of service and unit costs for each alternative as described in detail in *Appendix E: PEROW/WSAB Corridor AA Operating and Cost Estimate & Financial Analysis Report.*

Project level of service was estimated based on operating plans prepared for each alternative incorporating information including vehicle revenue miles, vehicle revenue hours, and peak vehicles. The O&M unit cost estimates were based on existing bus and rail service unit costs from Metro and OCTA, as well as from other peer transit operators after adjustment to reflect the operating conditions (i.e., labor costs) in Los Angeles and Orange counties. For each alternative, four sets of O&M unit costs were estimated, as it was not known who the operator would be for two of the proposed transit services. While there is extensive BRT and LRT experience in the Corridor, there is no local operating information available for Street Car and Low Speed Maglev. In addition, the four sets of O&M unit costs reflect the conceptual level of planning and provide a common level of comparison among alternatives. The first two sets of O&M unit costs reflect operation by either Metro or OCTA and are based on the labor costs for these two agencies. The second set of numbers represented the costs reflecting the low and high costs of peer agencies for each mode (e.g., the Vancouver TransLink and Miami Metromover systems for Low Speed Maglev). For the O&M information presented below, the costs are based on assuming all Metro operations. To derive unit costs, the total expenses assigned to each supply variable were divided by the annual service quantities; and the unit cost for each supply variable was multiplied by the projected annual units of service to identify the annual O&M costs presented in Table 5.10.

Table 5.10 – Estimated Annual O&M Costs (FY 2011 dollars)

Alternative	Total Annual O&M Cost (Millions)	Incremental Cost over TSM (Millions)
TSM Alternative		
‣ Corridor System	$56.9	--
BRT Alternatives		
‣ Street-Running	$41.6	($15.3)
‣ HOV Lane-Running	$53.1	($3.8)
Street Car Alternatives		
‣ East Bank 1	$217.9	$161.0
‣ West Bank 1	$216.8	$159.9
‣ West Bank 2	$219.4	$162.5
‣ West Bank 3	$217.5	$160.6

Table 5.10 – Estimated Annual O&M Costs (FY 2011 dollars)

Alternative	Total Annual O&M Cost (Millions)	Incremental Cost over TSM (Millions)
LRT Alternatives		
East Bank 1	$216.0	$159.1
West Bank 1	$210.0	$153.1
West Bank 2	$214.1	$157.2
West Bank 3	$204.0	$147.1
Low Speed Maglev Alternatives		
East Bank 1	$152.3	$95.4
West Bank 1	$155.1	$98.2
West Bank 2	$153.2	$96.3
West Bank 3	$151.9	$95.0

During any subsequent engineering and environmental review efforts, system components and requirements would become more detailed and updated operator-specific O&M cost assessments would be prepared.

5.4 Financial Feasibility Analysis

This section begins with a discussion of the sources and uses of available funds, which addresses both capital and operating revenues and expenses. A second discussion presents funding requirements, including the revenue required to fund the gap between projected sources and uses of funds for project capital and O&M costs. The concluding section presents an overview of the cash flow analysis for selected project alternatives. More detailed information presented in the *Appendix E: PEROW/WSAB Corridor AA Operating and Cost Estimate and Financial Analysis Report.*

5.4.1 Sources and Uses of Funds Analysis

This section presents an overview of the funding required to construct and operate the alternatives studied in the PEROW/WSAB Corridor AA. All references to fiscal year in this analysis refer to the Metro and OCTA fiscal year, which begins on July 1 and ends on June 30.

Capital Uses of Funds

The construction period of the recommended project resulting from this study is assumed to be between FY 2015 and FY 2026, with the exception of the TSM Alternative which is assumed to be completed within five years from FY 2022 to FY 2026. For AA evaluation purposes, the implementation schedule was assumed to be as follows reflecting Measure R funding availability in Los Angeles County:

- **MOS 1** consisting of the segment along the portion of the PEROW/WSAB ROW owned by Metro from the Metro Green Line to the county Line.
  - PE/DEIS/DEIR initiated in 2013 and completed in 2015.
  - Construction initiated in Winter 2015, and assuming six years of construction based on the Exposition Phase 1 Project, completed in early 2021.
  - Initiate operations in early-2021
- **MOS 2** consisting of the segment north from the Metro Green Line to Union Station.
  - Construction initiated in mid-2021 and completed in early 2027.
  - Initiate operations in early 2027.

Capital cost estimates were first developed in FY 2010 dollars and then escalated to FY 2011 dollars. The resulting capital costs were escalated at 3.33 percent based on the R.S. Means Construction Cost Index for San Jose, California, prepared in June 2010. This projection was prepared for the Santa Clara Valley Transportation Authority by Moody's Economy, and was the most detailed and recent projection available. It should be noted that this inflation rate differs from the 3.0 percent inflation rate used in the preparation of Metro's *2009 Long Range Transportation Plan (LRTP)*. The 3.33 percent rate was used instead of the LRTP rate since it is a more recent estimate. The inflation forecast is summarized in the financial analysis section of the *Appendix* E: *PEROW/WSAB Corridor AA Operating and Cost Estimate & Financial Analysis Report*. The financial analysis also projected the costs to rehabilitate, replace, and maintain capital assets in a state of good repair. Rehabilitation and replacement costs typically are incurred beginning 12 years after the initial construction costs, and are based on the useful life of capital assets as identified by FTA.

Capital Sources of Funds

The following Los Angeles County and federal funding sources were assumed to be available to support construction of the PEROW/WSAB Corridor project. Federal New Starts funding was assumed not to be available given other funding priorities by Metro and OCTA.

Measure R

Measure R is a sales tax initiative approved by Los Angeles County voters in 2008. A half-cent sales tax effective July 1, 2010, ending in 2039, is to be used for public transportation purposes. Approximately $240 million from Measure R bond proceeds is allocated to West Santa Ana Branch (WSAB) portion of the PEROW/WSAB Corridor project from FY 2020 to FY 2025 in Metro's *2009 LRTP*.

Prop A 35% Bond

Proposition A is a half-cent sales tax, passed by Los Angeles County voters in 1980, to be used to improve public transit with 35% of the revenue dedicated to rail development and operations. $124.4 million from Prop A 35% bond proceeds are allocated to the WSAB portion from FY 2025 to FY 2028 in the Metro *2009 LRTP*.

Prop C 25%

Proposition C is a half-cent sales tax, passed by Los Angeles County voters in 1990, to be used for public transit purposes with 25% of the revenues dedicated to transit-related highway funds. $500,000 from the Prop C 25% program is allocated to WSAB portion of the PEROW/WSAB Corridor project in FY 2011 and FY 2012 in the Metro *2009 LRTP*.

Local Agency Contribution

Metro's *2009 LRTP* also identified a total of $19.5 million funding as local agency contribution available to the WSAB portion of the PEROW/WSAB Corridor project in FY 2022 and FY 2025.

Section 5309 Fixed Guideway Modernization Grants

These are discretionary federal funds derived by formula as specified in The Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU) and published in the *Federal Register*. The formula is a function of transit vehicle-revenue miles and route-miles, and funds are available seven years after each segment of a new fixed guideway transit project enters revenue service.

Operating Sources of Funds

The following discussion summarizes funding sources that were assumed to be available to support operations of the PEROW/WSAB Corridor project.

Passenger Revenues

Passenger revenues were based on a projection of the average fare paid per rider and the projected riders for each alternative. The average fare paid per rider was sized to cover the unmet requirements of the operating fund. Ridership projections were based on the average weekday travel demand forecast prepared for each alternative; an annualization factor of 319.5 average weekdays per year was applied, based on recent Metro and OCTA experience. Growth in ridership from the opening year to the design year takes into consideration the following factors:

- **Demographic growth –** Ridership was projected to increase between the opening year and the design year based on projected population growth in the PEROW/WSAB study area.
- **Fare increases** – The average fare per rider was projected to grow with inflation adjusted every other year. The impacts of these fare increases on projected ridership were taken into account by assuming a fare elasticity of -0.3 percent; that is, for each real fare increase (net of CPI inflation) one percent ridership would be expected to fall by 0.3 percent. In years that fares do not change, ridership increases marginally because fares are declining in real terms.

Advertising Revenues

Advertising revenues were projected based on recent Metro and OCTA revenue per rider and projected ridership based on Metro and OCTA information derived from the *2009 National Transportation Database Report*. The ridership projection was based on the travel demand forecast for each alternative. Advertising revenue per rider was projected to grow by the projected rate of California San Jose CPI identified by Moody's Economy.com in June 2010.

Section 5307 Urbanized Area Formula

These discretionary funds were derived by a formula specified in SAFETEA-LU and published annually in the *Federal Register*. The apportionment of these funds is based primarily on service level and ridership variables. The annual allocation of funds to Urbanized Areas is based on the level of service operated in the previous two years. SAFETEA-LU limits the application of these funds to capital expenditures for areas with a population greater than 200,000, but preventative maintenance expenses in the operating budget may be considered as "capital." One percent of these funds must be applied to "enhancements" which include the new initiative capital projects. Incentive tier funding in this grant program were not assumed to be available to the PEROW/WSAB Corridor project, but would be available to the existing bus operators in the urbanized area. The estimated funding applied in the financial analysis was based on level of service projection of each alternative.

5.4.2 Additional Capital and Operating Funding Requirements

The financial analysis identified that the projected capital revenue sources described above would not be sufficient to cover the estimated PEROW/WSAB Corridor project capital costs. Funding requirements on a cash basis were identified by subtracting the capital expenditures from the projected funding revenues in year-of-expenditure dollars. The resulting unmet capital funding requirements are presented below in Table 5.11, and the larger numbers than the original cost reflect financing funding requirements. TSM capital expenditures were assumed to be shared by the Los Angeles County and the Orange County, therefore no unmet funding requirement of TSM was projected.

Table 5.11 – Capital Funding Requirements: FY2011 to FY2040 (Year-of-Expenditure)

Alternative	Funding Shortfall (Millions)
BRT Alternatives	
Street-Running	$1,120
HOV Lane-Running	$1,135
Street Car Alternatives	
East Bank	$2,855
West Bank 3	$3,285
LRT Alternatives	
East Bank	$3,015
West Bank 3	$3,470
Low Speed Maglev Alternatives	
East Bank	$8.210
West Bank 3	$9,325

At this point in the planning process, the unmet capital funding requirements were assumed to be addressed through the assumption of a future incremental sales tax in Los Angeles and Orange Counties.

Additional sales tax was assumed in the cash flow analysis to close the gap in capital funding identified in Table 5.11. The additional sales tax revenues were sized proportionally to the capital costs breakdown between the two counties for each alternative. The sales tax base amount in each county was provided by SCAG in October 2011.

An overview of the resulting conceptual cash flow analysis is presented in Table 5.12. Bridge financing was applied to address the working capital needs during peak years of construction. The short-term debt was assumed to be retired after five years, and the interest and debt management expenses repaid by sales tax revenue streams. The interest rate applied in this analysis was based on a June 2010 projection of tax-exempt commercial paper interest rates developed by Moody's Economy.com, which is summarized in *Appendix E: Operating and Cost Estimate & Financial Analysis Report.* The bonds were assumed to incorporate the costs of the first year's debt service payment, the debt issuance expense (equal to 0.6 percent of the gross amount of debt issued). The coverage ratio of the short-term debt was maintained above 2.0 during the entire analysis period. The average fare paid per rider was adjusted to size the passenger revenue to close the operating funding gap except for the TSM component. The Metro high O&M unit cost was applied in calculating the O&M costs of the PEROW/WSAB Corridor alternatives.

Table 5.12 – Summary of Cash Flow Analysis

Alternative	Average Fare Per Unlinked Trip	Incremental Sales Tax			
		Tax Rate		Implementation Period	
		Los Angeles	Orange	Los Angeles	Orange
BRT Alternatives					
‣ Street-Running	$2.42	0.0006%	0.032%	2015	2029
‣ HOV Lane-Running	$2.64	0.0006%	0.032%	2015	2029
Street Car Alternative					
‣ West Bank 3	$9.60	0.038%	0.036%	2015	2040
LRT Alternative					
‣ West Bank 3	$8.23	0.033%	0.041%	2015	2040
Low Speed Maglev Alternative					
‣ West Bank 3	$7.12	0.101%	0.110%	2015	2040

The cash flow analysis derived the incremental sales tax rate in each county necessary to generate sufficient sales tax revenues to close the estimated capital funding gap of each alternative and maintain sufficiently high debt service coverage. The incremental sales tax was assumed to be implemented in 2015 and continue through 2029 for the BRT alternative and through the end of the 30-year analysis period for the Street Car, LRT, and Low Speed Maglev alternatives. It should be noted that for the Street Car, LRT, and Low Speed Maglev alternatives, further refinement of the cash flow analyses could include lowering the incremental tax rate in the last 5 to 10 years of the 30-year analysis period, thereby avoiding large 2040 year-end cash balances.

Other Financing Sources

A *PEROW/WSAB Corridor AA Value Capture Memo* was prepared to evaluate the derivation of transit project financing from enhanced land value attributable to the transit investment. Three areas of value capture solutions were assessed: joint development, special assessments, and tax increment financing. A Corridor-level transit improvement undertaken by Metro or OCTA could benefit from local value capture, as long as a mechanism existed to accommodate the transfer of funds from individual municipalities to the entity funding the project. Under California's uniquely flexible Joint Powers process, such an entity could easily be created. The following summarizes the findings:

- **Joint development** – There is virtually no surplus Metro or OCTA-owned land along the PEROW/WSAB Corridor alignment, but the joint development concept may also be applied to land which is owned now, or might be assembled in the future, by the cities or their former redevelopment agencies. Each city would have the option of tying the redevelopment of parcels in their ownership to the transit investment, by dedicating the sale or ground lease proceeds of the transactions in question to the project. For the LRT or Low Speed Maglev Alternatives, it is also conceivable that developers of adjacent properties could be induced to participate in station construction as demonstrated elsewhere.
- **Special Assessments –** The creation of betterment assessment districts is available to Metro or OCTA and to each municipality. Enacted in 1996, Proposition 218 requires that any new assessment district be approved in a weighted-vote election among affected property owners.[1] The willingness of any of the affected jurisdictions to pursue a betterment assessment district and see it through to electoral approval is speculative.
- **Tax Increment Financing** – California's version of TIF was reflected in its community redevelopment law first enacted in 1945. It allowed any city or county to create a redevelopment agency, which oversaw one or more redevelopment project areas. The creation of such areas requires a "finding of blight", which triggered the availability of the law's broad redevelopment powers. Among these is the capture, for a maximum of 50 years, of the tax increment derived from all taxable parcels within the project areas. In response to budget challenges, the California State Legislature passed a law in the summer of the 2011 that abolished redevelopment agencies. The law was appealed and on December 28, 2011 the California Supreme Court ruled in favor of the state law and more than 400 redevelopment agencies ceased to exist as of February 11, 2012. Redevelopment advocates are expected to return to the Legislature to ask lawmakers to restore the ability of local governments to reestablish redevelopment project areas.

Many cities in the PEROW/WSAB Corridor had redevelopment project areas that included lands within a half-mile of the proposed stations with the potential for transit-oriented development (TOD). The TOD

[1] Legislative Analyst's Office; http://www.lao.ca.gov/1996/120196_prop_218/understanding_prop218_1296.html.

potential is greatest at those stations in recognizable downtown and community areas, such as downtown Los Angeles and Pacific Boulevard in Huntington Park, and where mixed-use development is already present or anticipated in local planning and zoning. The introduction of a high-capacity transit service with direct connections to and from Corridor activity centers and destinations could be expected to induce a more intensified, transit-oriented development pattern over time. While not contributing to the construction of the project, future TOD development will support the success of the transit system alternatives by attracting higher levels of system ridership.