Honolulu High-Capacity Transit Corridor Project

Memorandum on Forecasts of O&M Costs

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City and County of Honolulu

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Under Subcontract to:
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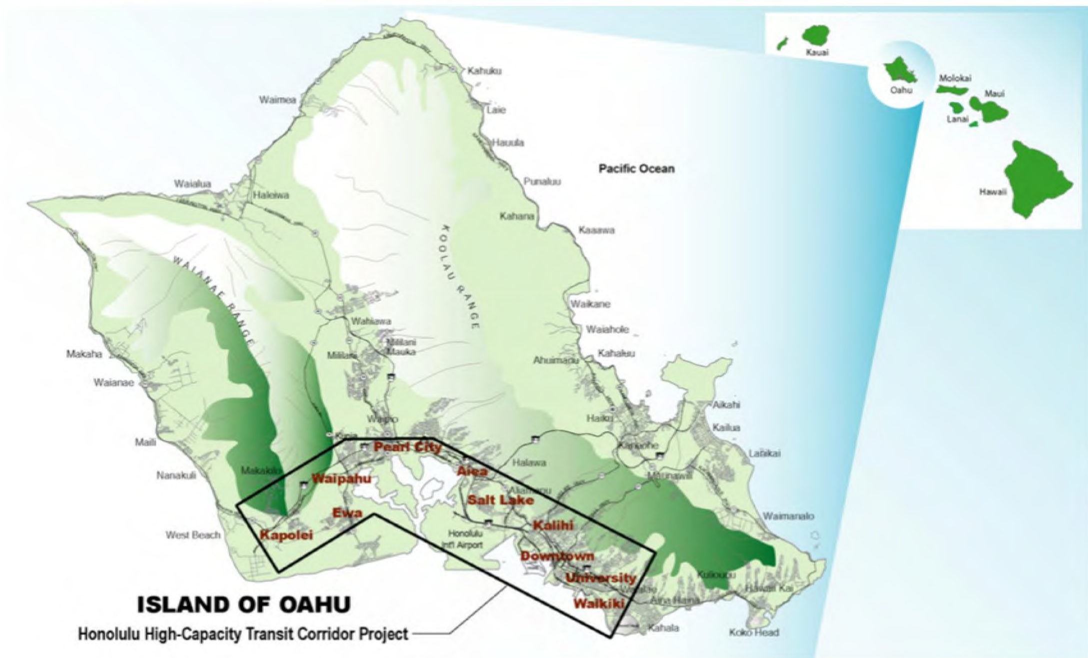
1 Overview of Service Alternative Being Evaluated

The City and County of Honolulu (the Owner), in cooperation with the Federal Transit Administration (FTA), has conducted an Alternatives Analysis (AA) that culminated in the selection of a Locally Preferred Alternative (LPA). The Owner is in the process of developing the Environmental Impact Statement (EIS) in support of implementing the LPA within the Honolulu High Capacity Transit Corridor (HHCTC).

As depicted in Figure 1, the HHCTC extends from Kapolei in the west to UH Mānoa in the east, and is confined by the Wai‘anae and Ko‘olau Mountain Ranges to the north and the Pacific Ocean to the south. Between Pearl City and A'iea the corridor's width is less than one mile between the Pacific Ocean and the base of the Ko'olau Mountains.



SOURCES:
ESRI Atlas GIS v4.0 1998; Information Delivery System (IDS), March 1998; City and County of Honolulu, October 1998.

Figure 1-1: Honolulu High Capacity Transit Corridor

Within the corridor a fixed guideway (rail) system will be implemented, which will be supported and complemented by the Owner's existing bus system, TheBus. This memorandum summarizes the development of the O&M (operations and maintenance) cost allocation models for each transit mode with regard to the fixed guideway alternative selected for the corridor, as well as for the Transportation System Management (TSM) alternative as the baseline alternative.

1.1 TSM Alternative

The TSM alternative is the baseline alternative and would provide an enhanced bus system based on a hub-and-spoke route network, conversion of the present morning peak-hour-only zipper-lane to both a morning and afternoon peak-hour zipper-lane operation, and relatively low-cost capital improvements on selected roadway facilities to give priority to buses. The TSM alternative is not a build alternative and therefore does not include the implementation of a fixed guideway system. O&M costs are reported for the TSM bus system operating at 2018 and 2030 demand levels. All O&M costs are reported in 2007 USD.

1.2 Build Alternative

For the build alternative, three fixed guideway alignment variations were studied throughout the AA and EIS phases of the work. These variations are all described graphically in the fixed guideway plans provided in Appendix A. They included the Salt Lake Boulevard Alignment, the Airport alignment, and the combined Salt Lake Boulevard and Airport Alignments.

The fixed guideway variation selected for implementation in the corridor is the Airport alignment. The initial segment of the Airport alignment to be constructed, the First Project, is a portion of the ultimate project, the Full Build, that can be implemented with available funding. The focus of this memorandum is the First Project Airport alignment.

The fixed guideway plans provided in Appendix A describe the Airport Alignment using the legend references "First Project" and "Airport Alignment". The legend reference "Anticipated Future Extensions" refers to future alignment expansions that, when added to the First Project, comprise the Full Build of the ultimate fixed guideway system. As described in the Appendix A plans, the First Project Airport alignment would be implemented between East Kapolei and Ala Moana Center - a distance of about 20 miles - and would have 21 stations.

The Owner's existing bus system, TheBus, will support and complement the selected fixed guideway alternative described above, although perhaps with different service levels and equipment, depending on the service levels of the fixed guideway system, its operating characteristics, and year. Bus system characteristics are described later in this section.

O&M costs are reported for the bus and fixed guideway systems for the Full Build and First Project operating at 2030 demand levels. Both modes' O&M costs are also reported for the First Project operating at 2018 demand levels. All O&M costs are reported in 2007 USD.

1.3 Bus System

The bus system that will operate with the selected fixed guideway alternative will complement rail service in the corridor. That bus system, or the bus system operating under the TSM alternative, will be similar to the bus system operating in Honolulu today. TheBus currently operates 24 hours/day, seven days per week and is expected to operate similar hours once the selected fixed guideway alternative is implemented. The bus agency operates standard (40-foot) diesel buses, articulated diesel (60-foot) buses, and articulated hybrid (60-foot) buses. Depending on the demand year and alternative, the nature of the bus operation will vary, including the number of each bus type, the specific routes, and overall bus operating data.

A bus O&M cost model, based upon detailed, actual TheBus O&M costs from 2005, was developed as a stand-alone model to estimate bus O&M costs associated with the TSM and selected fixed guideway alternatives described in Sections 1.1 and 1.2. The bus model, forecast of bus O&M costs, and this memorandum were developed consistent with Section 4 of the FTA's *Procedures and Technical Methods for Transit Project Planning*, Draft Version 3 dated August 28, 2008. Recommendations provided by the FTA in its memorandum dated July 29, 2008, have been incorporated in the updated bus O&M cost model and this memorandum. Inherent in the team's modeling approach for the fully-allocated bus O&M cost model is that all costs were assumed to be variable in the long-term, and productivities were assumed to continue in the long term.

1.4 Fixed Guideway System

The fixed guideway system to be implemented under the HHCTC Project (HHCTCP) is a fully-automated, elevated, steel wheel/rail system employing the use of one attendant per train. This primarily dual main track light metro system will operate at headways between three and 10 minutes on the trunk line using minimum train consists of two cars, and up to maximum consists of four cars. A typical weekday will include five operating periods over 20 hours, as follows: an "early" period of two hours, an "A.M. peak" period of four hours, a "base" period of seven hours, a "P.M. peak" period of four hours, and a "late" period of three hours. Weekend days will include three periods over an 18-hour operating day. Service level data were developed based on a vehicle capacity of 162 passengers per car.

The development of the O&M cost model for the HHCTC fixed guideway system presented a unique challenge. The anticipated light metro technology for the Honolulu system currently exists in only two locations in North America (JFK AirTrain and Vancouver SkyTrain), thereby limiting the choices of peer systems from which to obtain detailed cost data for the model. Obtaining detailed, actual cost data from either of those two properties or other rapid transit systems that might be considered peer properties to the proposed Honolulu system also proved challenging.

An extensive effort was made in collecting the detailed, actual O&M cost data from the properties mentioned above, as well as from four (4) others: Los Angeles County Metropolitan Transit Authority (LACMTA), Maryland Transit Administration (MTA), Miami-Dade Transit (MDT), and Washington Metropolitan Area Transit Authority (WMATA).

For half of the properties, the study team was not able to collect any data or was able to collect only gross-level data (at a higher level than that typically reported to the National Transit Database).

The study team was able to collect detailed O&M cost data from two properties, but it was either budgetary rather than actual data, comingled data with other modes, or incomplete.

For the final property, WMATA, the study team was able to obtain detailed, actual O&M cost data for the fixed guideway (rapid transit) mode, which was the system used as the basis for the HHCTCP fixed guideway O&M cost model.

WMATA's metro is a larger fixed guideway system than anticipated for Honolulu, but has a similar operation (automated train operations with one attendant per train), is a steel wheel/rail system, maintains staff in stations, and operates multiple-car consists. The economic profiles of Washington, D.C. and Honolulu, HI are also nearly identical.

The areas where WMATA are dissimilar to the fixed guideway system anticipated for Honolulu include WMATA's line item expenses for interlocking operators, vehicle operator wages related to snow operations, and its lower electricity costs. These dissimilarities were all considered and addressed in the development of the fixed guideway O&M costs.

A fixed guideway O&M cost model was developed as a separate model to estimate fixed guideway O&M costs associated with the selected build alternative described in Section 1.2. The fixed guideway model, forecast of fixed guideway O&M costs, and this memorandum were developed consistent with Section 4 of the FTA's *Procedures and Technical Methods for Transit Project Planning*, Draft Version 3 dated August 28, 2008. Recommendations provided by the FTA in its memorandum dated July 29, 2008, have been incorporated in the new fixed guideway O&M cost model and this memorandum. Specifically, the study team has utilized a more similar peer property and technology (to Honolulu) upon which to base costs, and has developed a fully-allocated O&M cost model based upon <u>detailed</u>, <u>actual</u> cost data from the appropriate peer property. Inherent in the team's modeling approach for the fully-allocated fixed guideway O&M cost model is that all costs were assumed to be variable in the long-term, and productivities were assumed to continue in the long term.

While the O&M cost data obtained from the other properties were not used as the basis for the fixed guideway O&M cost model, values calculated from those properties' data were used to develop productivity ratios in the model, as well as resulting total O&M cost ratios for the selected build alternative discussed above. In that sense development of the fixed guideway model has not been wholly based on one property but adjusted against similar data for a range of peer properties. This process is explained in detail in Sections 3.4 and 3.6 of the Memorandum on O&M Cost Models dated May 2009. Part of this process can also be seen in the tables provided in Section 4.2 of this memorandum.

2 Summary of Projected Bus O&M Costs

The key driving supply variables and estimated bus O&M unit costs for the HHCTCP follow:

Table 2-1: Estimated Bus O&M Unit Costs

HHCTCP Estimated Bus O&M Unit Costs	
Key Driving Supply Variable	**Est. Unit Cost (2007 USD)**
Revenue vehicle mile, SB	$ 2.81
Revenue vehicle mile, AD	$ 3.91
Revenue vehicle mile, AH	$ 3.32
Peak vehicle, SB	$ 26,443
Peak vehicle, AD	$ 31,467
Peak vehicle, AH	$ 26,747
Revenue vehicle hour	$ 56.36
Maintenance facility	$ 843,585
Service center	$ 527,241
Terminal	$ 843,585
Unlinked passenger trip	$ 0.059

SB = Standard Bus
AD = Articulated Diesel Bus
AH = Articulated Hybrid Bus

The estimated total annual bus O&M costs for the alternatives are as follows:

Table 2-2: Estimated Total Annual Bus O&M Costs

HHCTCP Estimated Total Annual Bus O&M Costs (2007 USD)		
	Year 2030	**Year 2018**
TSM Alternative	$ 227,576,478	$ 218,244,051
Build Alternative, First Project, Airport	$ 181,161,316	$ 173,651,194

The estimated bus O&M values for key driving supply variables and estimated total cost by supply variable are provided in the tables on the following pages.

2-3: Estimated Bus O&M Annual Data and Costs, TSM Alternative, Year 2030

HHCTCP ESTIMATED BUS O&M ANNUAL DATA AND COSTS (2007 USD)		
TSM ALTERNATIVE, YEAR 2030		
	Service Level	**Annual Cost**
RVM, SB	11,297,262	$ 31,745,306
RVM, AH	16,330,999	$ 54,218,917
PV, SB	336	$ 8,884,848
PV, AH	250	$ 6,686,750
RVH	2,053,401	$ 115,729,680
MF	3	$ 2,530,755
SC	1	$ 527,241
T	1	$ 843,585
PT	108,633,828	$ 6,409,396
Total Est. Cost		**$ 227,576,478**
Total Cost/RVH		**$ 110.83**

RVM = Revenue Vehicle Miles; SB = Standard Bus
AH = Articulated Hybrid Bus; PV = Peak Vehicles
RVH = Revenue Vehicle Hours;
MF = Maintenance Facilities; SC = Service Centers
T = Terminals; PT = Unlinked Passenger Trips

2-4: Estimated Bus O&M Annual Data and Costs, TSM Alternative, Year 2018

HHCTCP ESTIMATED BUS O&M ANNUAL DATA AND COSTS (2007 USD) TSM ALTERNATIVE, YEAR 2018		
	Service Level	**Annual Cost**
RVM, SB	10,894,692	$ 30,614,085
RVM, AH	16,024,474	$ 53,201,254
PV, SB	311	$ 8,223,773
PV, AH	241	$ 6,446,027
RVH	1,950,208	$ 109,913,723
MF	3	$ 2,530,755
SC	1	$ 527,241
T	1	$ 843,585
PT	100,739,134	$ 5,943,609
Total Est. Cost		**$ 218,244,051**
Total Cost/RVH		**$ 111.91**

RVM = Revenue Vehicle Miles; SB = Standard Bus
AH = Articulated Hybrid Bus; PV = Peak Vehicles
RVH = Revenue Vehicle Hours;
MF = Maintenance Facilities; SC = Service Centers
T = Terminals; PT = Unlinked Passenger Trips

Table 2-5: Estimated Bus O&M Annual Data and Costs, Build Alternative, First Project, Airport, Year 2030

HHCTCP ESTIMATED BUS O&M ANNUAL DATA AND COSTS (2007 USD)		
BUILD ALTERNATIVE, FIRST PROJECT, YEAR 2030		
	Airport	
	Service Level	**Annual Cost**
RVM, SB	12,188,570	$ 34,249,882
RVM, AH	9,362,879	$ 31,084,758
PV, SB	300	$ 7,932,900
PV, AH	190	$ 5,081,930
RVH	1,669,932	$ 94,117,368
MF	2	$ 1,687,170
SC	1	$ 527,241
PT	109,831,653	$ 6,480,068
Total Est. Cost		**$ 181,161,316**
Total Cost/RVH		**$ 108.48**

RVM = Revenue Vehicle Miles; SB = Standard Bus
AH = Articulated Hybrid Bus; PV = Peak Vehicles
RVH = Revenue Vehicle Hours;
MF = Maintenance Facilities; SC = Service Centers
PT = Unlinked Passenger Trips

Table 2-6: Estimated Bus O&M Annual Data and Costs, Build Alternative, First Project, Airport, Year 2018

HHCTCP ESTIMATED BUS O&M ANNUAL DATA AND COSTS (2007 USD)		
BUILD ALTERNATIVE, FIRST PROJECT, YEAR 2018		
	Airport	
	Service Level	**Annual Cost**
RVM, SB	10,605,968	$ 29,802,770
RVM, AH	10,317,042	$ 34,252,579
PV, SB	259	$ 6,848,737
PV, AH	197	$ 5,269,159
RVH	1,587,661	$ 89,480,574
MF	2	$ 1,687,170
SC	1	$ 527,241
PT	98,016,332	$ 5,782,964
Total Est. Cost		**$ 173,651,194**
Total Cost/RVH		**$ 109.38**

RVM = Revenue Vehicle Miles; SB = Standard Bus
AH = Articulated Hybrid Bus; PV = Peak Vehicles
RVH = Revenue Vehicle Hours;
MF = Maintenance Facilities; SC = Service Centers
PT = Unlinked Passenger Trips

3 Summary of Projected Fixed Guideway O&M Costs

The key driving supply variables and estimated fixed guideway O&M unit costs for the HHCTC Project follow:

Table 3-1: Estimated Fixed Guideway O&M Unit Costs

HHCTCP Estimated Fixed Guideway O&M Unit Costs	
Key Driving Supply Variable	**Est. Unit Cost (2007 USD)**
Revenue Train Hour (RTH)	$ 100.60
Revenue Vehicle Mile (RVM)	$ 3.26
Peak Vehicle (PV)	$ 234,687
Directional Route Mile (RM)	$ 35,784
Station (S)	$ 904,484
Maintenance Facility (MF)	$ 319,968
Unlinked Passenger Trip (PT)	$ 0.040

The estimated total annual fixed guideway O&M costs for the build alternative are as follows:

Table 3-2: Estimated Total Annual Fixed Guideway O&M Costs

HHCTCP Estimated Total Annual Fixed Guideway O&M Costs (2007 USD)		
	Year 2030	**Year 2018**
First Project, Airport	$ 79,423,423	$ 69,489,577

The estimated fixed guideway O&M values for key driving supply variables and estimated total cost by supply variable for the build alternative are provided in the tables on the following pages.

Table 3-3: Estimated Fixed Guideway O&M Annual Data and Costs, Build Alternative, First Project, Year 2030

HHCTCP ESTIMATED FIXED GUIDEWAY O&M ANNUAL DATA AND COSTS (2007 USD)		
BUILD ALTERNATIVE, FIRST PROJECT, YEAR 2030		
	Airport	
	Service Level	**Annual Cost**
RTH	113,644	$ 11,432,586
RVM	8,623,989	$ 28,114,204
PV	75	$ 17,601,525
RM	40.37	$ 1,444,600
S	21	$ 18,994,164
MF	1	$ 319,968
PT	37,909,389	$ 1,516,376
Total Est. Cost		**$ 79,423,423**
Total Cost/RVH		**$ 257.75**

RTH = Revenue Train Hour; RVM = Revenue Vehicle Mile
PV = Peak Vehicles; RM = Directional Route Miles
S = Stations; MF = Maintenance Facilities
PT = Unlinked Passenger Trips
RVH = Revenue Vehicle Hour

Table 3-4: Estimated Fixed Guideway O&M Annual Data and Costs, Build Alternative, First Project, Year 2018

HHCTCP ESTIMATED FIXED GUIDEWAY O&M ANNUAL DATA AND COSTS (2007 USD)		
BUILD ALTERNATIVE, FIRST PROJECT, YEAR 2018		
	Airport	
	Service Level	**Annual Cost**
RTH	119,470	$ 12,018,682
RVM	6,839,970	$ 22,298,302
PV	56	$ 13,142,472
RM	40.37	$ 1,444,600
S	21	$ 18,994,164
MF	1	$ 319,968
PT	31,784,712	$ 1,271,388
Total Est. Cost		**$ 69,489,577**
Total Cost/RVH		**$ 290.82**
RTH = Revenue Train Hour; RVM = Revenue Vehicle Mile PV = Peak Vehicles; RM = Directional Route Miles S = Stations; MF = Maintenance Facilities PT = Unlinked Passenger Trips RVH = Revenue Vehicle Hour		

4 Discussion of O&M Costs

4.1 Bus O&M Costs

A recap of the total annual estimated bus O&M costs for the alternatives are provided in the following table.

Table 4-1: Estimated Total Annual Bus O&M Costs

HHCTCP Estimated Total Annual Bus O&M Costs (2007 USD)		
	Year 2030	**Year 2018**
TSM Alternative	$ 227,576,478	$ 218,244,051
Build Alternative, First Project, Airport	$ 181,161,316	$ 173,651,194

As can be seen in Table 4-1, bus costs are higher in 2030, as compared to 2018. The reason for this is due to higher levels of service, caused by higher demand, provided in 2030 vs. 2018. Table 4-2 illustrates that there are more buses operating at a higher overall revenue hours and mileage, and transporting more passengers in 2030. This simply increases the operating costs of the bus operation supporting the particular alternative.

Table 4-2: HHCTCP Estimated Total Annual Bus Service Levels

HHCTCP Estimated Total Annual Bus Service Levels				
	TSM Alternative		Build Alternative, First Project, Airport	
	2030	2018	2030	2018
RVM, SB	11,297,262	10,894,692	12,188,570	10,605,968
RVM, AH	16,330,999	16,024,474	9,362,879	10,317,042
RVM, TTL	27,628,261	26,919,166	21,551,449	20,923,010
PV, SB	336	311	300	259
PV, AH	250	241	190	197
PV, TTL	586	552	490	456
RVH	2,053,401	1,950,208	1,669,932	1,587,661
MF	3	3	2	2
SC	1	1	1	1
T	1	1	-	-
PT	108,633,828	100,739,134	109,831,653	98,016,332

Reasonableness of Costs

The overall reasonableness of the cost forecasts can be examined via comparison of total annual historical operating cost per key driving supply variable for TheBus, versus those of the forecast years for the alternatives. Table 4-3 presents the cost ratios for historical years of TheBus operation in 2007 USD, including an average of the nine historical years presented. Table 4-4 presents the cost ratios of the forecast years for the alternatives in 2007 USD.

Table 4-3: TheBus Total Operating Cost Ratios

TheBus Actual Total Operating Cost Per (2007 USD)			
	RVM	RVH	PV
1999	$ 7.15	$ 98.58	$ 282,317
2000	$ 7.71	$ 105.71	$ 305,356
2001	$ 7.56	$ 104.75	$ 317,476
2002	$ 7.44	$ 102.82	$ 325,234
2003	$ 7.77	$ 105.50	$ 333,434
2004	$ 8.29	$ 112.41	$ 322,281
2005	$ 7.67	$ 103.30	$ 338,962
2006	$ 8.02	$ 107.57	$ 348,428
2007	$ 7.97	$ 105.47	$ 336,951
Avg.	**$ 7.73**	**$ 105.12**	**$ 323,382**

Table 4-4: TheBus Forecast Total Operating Cost Ratios

TheBus Forecast Total Operating Cost Per (2007 USD)			
	RVM	RVH	PV
2030 TSM Alternative	$ 8.24	$ 110.83	$ 388,356
2018 TSM Alternative	$ 8.11	$ 111.91	$ 395,370
2030 Build Alternative, First Project, Airport	$ 8.41	$ 108.48	$ 369,717
2018 Build Alternative, First Project, Airport	$ 8.30	$ 109.38	$ 380,814

As can be seen by a comparison of these tables, the total operating cost ratios for the forecast years are, overall, higher than the historical years' total operating cost ratios for TheBus. RVM cost ratios for the forecast years range from 4.9% to 8.8% higher than historical RVM cost ratios for TheBus; RVH cost ratios for the forecast years range from 3.2% to 6.5% higher than historical RVH cost ratios for TheBus; and PV cost ratios for the forecast years range from 14.3% to 22.3% higher than historical PV cost ratios for TheBus.

Given the forecasted operating characteristics of TheBus, these increases could be expected. The increase in the RVM cost ratios is likely due in part to the use of conservative factors in developing unit costs for articulated hybrid buses in the calibration of the cost model.

The significant increase in PV cost ratios is the result of the operation mix of the more costly articulated buses anticipated for the future than what has been historically operated by TheBus. For example, between the years 1999 and 2007, TheBus operated articulated buses in numbers representing about 10% of its overall fleet. For the forecast years, articulated buses will reach nearly 50% of the fleet. As discussed previously, articulated buses are more costly to operate but give the ability to maintain overall fleet capacity, but with fewer vehicles. Distributing similar (or higher) total operating costs over fewer vehicles will result in higher PV cost ratios.

4.2 Fixed Guideway O&M Costs

A recap of the total annual estimated fixed guideway O&M costs are provided in the following table.

Table 4-5: Estimated Total Annual Fixed Guideway O&M Costs

HHCTCP Estimated Total Annual Fixed Guideway O&M Costs (2007 USD)		
	Year 2030	**Year 2018**
Build Alternative, First Project, Airport	$ 79,423,423	$ 69,489,577

Fixed guideway O&M costs increase from 2018 to 2030. This is the overall result of increasing passenger demand and corresponding increases in service levels.

It should be noted that requirement to operate at three-minute headways during the peak hours increases fixed guideway O&M costs. Demand could still be satisfied by running longer headways with larger train consists, which would likely lower overall operating costs.

Reasonableness of Costs

The overall reasonableness of the fixed guideway cost forecasts can be examined via comparison of total operating cost per key driving supply variable for peer properties, versus those of the forecast years for the selected fixed guideway alternative. Table 4-6 presents the cost ratios for the HR peer properties in 2007 USD, and Table 4-7 presents the cost ratios for the HHCTCP fixed guideway forecast years in 2007 USD.

Table 4-6: HR Peer Properties Total Actual Operating Cost Ratios (2007 USD)

	HR Peer Properties Total Actual Operating Cost Per (2007 USD)					
	RTH	**RVM**	**PV**	**PT**	**S**	**RM**
WMATA HR	$ 1,277	$ 9.45	$ 810,378	$ 2.29	$ 7,368,784	$ 2,992,046
BART HR	$ 1,860	$ 7.13	$ 887,640	$ 4.21	$ 10,672,320	$ 2,195,740
LACMTA HR	$ 1,475	$ 14.59	$ 1,248,117	$ 2.14	$ 5,460,511	$ 2,738,814
Maryland HR	$ 1,287	$ 10.68	$ 936,118	$ 3.84	$ 3,610,740	$ 1,719,400
Miami-Dade HR	$ 1,501	$ 9.65	$ 822,745	$ 4.61	$ 3,664,954	$ 1,791,755
Average	**$ 1,480**	**$ 10.30**	**$ 940,999**	**$ 3.42**	**$ 6,155,462**	**$ 2,287,551**

Table 4-7: Fixed Guideway Total Forecast Operating Cost Ratios (2007 USD)

	HHCTCP Fixed Guideway Total Forecast Operating Cost Per (2007 USD)					
	RTH	**RVM**	**PV**	**PT**	**S**	**RM**
2030 First Project, Airport	$ 699	$ 9.21	$ 1,058,979	$ 2.10	$ 3,782,068	$ 1,967,387
2018 First Project, Airport	$ 582	$ 10.16	$ 1,240,885	$ 2.19	$ 3,309,028	$ 1,721,317

As can be seen by a comparison of these tables, the total operating unit costs for the forecast years are largely consistent with those of the peer properties. The most significant difference exists in the cost per RTH, the values of which are about half for the HHCTCP fixed guideway alternative as compared to the peer properties. The reason for this is due in part to the larger number of RTH operated under the HHCTCP alternative, which is the result of operating smaller consists (approximately half the size of the consists operated at the peer properties) on more frequent headways. This drives up the annual number of RTH, which spreads the total operating cost over a greater number of hours, thereby yielding a lesser cost per RTH than the peer properties. This phenomenon could change as project operating requirements evolve. The difference in total operating cost per RTH could also be explained in part by the productivities estimated in the fixed guideway O&M cost model (based on existing TheBus operator productivities), which are more efficient than those of the peer properties.

Station (S) cost ratios for the forecast years are consistent with the lower end of the S cost ratios for the peer properties. BART is known to have higher than average station costs due to high station staffing levels. WMATA also has higher station costs due to the interlocking operators staffed at those locations (these operator costs were removed during the development of the fixed guideway cost model since those positions will not be used nor needed at the HHCTCP). When removing from consideration the larger peer properties' heavy station costs, the forecast S cost ratios are very much on par with the remaining peer properties' S cost ratios.

Forecast PV cost ratios are higher than the peer properties' PV cost ratios. This can be explained by the assignment of costs to driving supply variables during calibration of the fixed guideway O&M cost model. In a several hundred line item actual cost worksheet, costs without clear descriptions for use in assigning a driving supply variable can be assigned to the PV supply variable since it is often used as a high-level surrogate for system size. For example, a line item cost described as "other miscellaneous expenses", might be assigned to the PV driving supply variable when a better description or knowledge of that cost might otherwise result in its assignment to a different driving variable. The PV driving supply variable can therefore experience higher overall operating costs because of this dynamic, which drives up the forecast PV cost ratios.

The validity of the above reasonableness claims can be substantiated when comparing the HHCTCP total forecast O&M costs and related operating data for the selected alternative with light rail (LR) peer properties around the United States. Tables 4-8 and 4-9 reflect such comparison. While no single LR peer property provides an exact match to all of the forecast data for the selected fixed guideway alternative, each of the LR peer properties have at least one aspect of their operation in common with the selected HHCTCP fixed guideway system. This comparison reinforces the fact that the forecast operating costs for the selected fixed guideway alternative are reasonable, fall within the tolerance of operating costs for similar systems, and therefore limit the risk of underestimating O&M costs on the project.

Table 4-8: LR Peer Properties Total Actual Operating Cost and Related Operating/System Data

LR PEER PROPERTIES TOTAL ACTUAL OPERATING COST AND RELATED OPERATING/SYSTEM DATA (2007 DATA AND USD)								
	TTL O&M COST (000)	RTH (000)	RVM (000)	PV	RM	S	PT (000)	TTL O&M COST PER RVH
Bi-State Development Agency	$51,397	134.50	6,193	56	91.10	37	21,784	$199.06
New Jersey Transit Corporation (River Line)	$89,286	167.80	3,469	58	114.30	43	13,147	$393.33
Port Authority of Allegheny County	$42,666	101.40	1,890	57	47.40	25	7,115	$300.89
Sacramento Regional Transit District	$47,424	81.60	4,128	56	73.80	48	14,490	$226.15
Southeastern Pennsylvania Transportation Authority	$56,414	407.10	3,736	127	82.40	45	27,636	$138.58
Tri-County Metropolitan Transportation District of Oregon	$73,656	261.70	6,564	81	95.10	63	36,124	$171.69
Utah Transit Authority	$26,191	88.90	2,818	46	37.30	25	16,272	$107.65

Table 4-9: HHCTCP Fixed Guideway Total Forecast Operating Costs and Related Operating/System Data

HHCTCP FIXED GUIDEWAY TOTAL FORECAST OPERATING COST AND RELATED OPERATING/SYSTEM DATA (2007 DATA AND 2007 USD)								
	TTL O&M COST (000)	RTH (000)	RVM (000)	PV	RM	S	PT (000)	TTL O&M COST PER RVH
HHCTCP 2030 First Project, Airport	$79,423	113.60	8,624	75	40.37	21	37,909	$257.75
HHCTCP 2018 First Project, Airport	$69,490	119.50	6,840	56	40.37	21	31,785	$290.82

4.3 Combined Build Alternative Bus and Fixed Guideway O&M Costs

The total annual fixed guideway O&M costs provided herein represent the estimated costs to operate and maintain the particular fixed guideway alternative with a stand-alone rail transit agency/authority, i.e., separate from that of TheBus organization. This type of fixed guideway O&M organization incurs typical labor pension costs.

Should operations and maintenance of the fixed guideway system be consolidated under the current bus O&M organization in Honolulu (i.e., a common operating agency for bus and rail), it is reasonable to consider the overall cost savings that could be realized under such a scenario.

The potential overall cost savings can be estimated on an order-of-magnitude level based on general administrative costs that might be saved by consolidating the fixed guideway and bus O&M organizations (i.e., the overall general administrative costs for the fixed guideway alternative could be reduced by utilizing those resources already present in the bus organization). At the same time, it is recognized that there would be an increase, although likely not an overall one-to-one increase, in general administrative costs for the bus organization to assume those general administrative costs for the fixed guideway organization.

General administrative costs, as a percentage of total operating costs for rapid rail metro systems across the United States, were examined for 2007. It was found that general administrative costs range from one-half percent to 30% of total rapid rail operating costs for those properties. The median point of this range, 15%, is used as an order-of-magnitude starting point in estimating the cost savings that might be realized for the fixed guideway organization, and the cost increase that might be incurred by the bus organization in assuming the general administrative costs of the fixed guideway organization. For the purpose of this analysis, it was assumed that the fixed guideway O&M costs would be reduced by 15% to reflect the general administrative costs savings of combining the bus and fixed guideway organizations. It was also assumed that the associated bus O&M costs would be increased by 5% of overall fixed guideway O&M costs to reflect the increase in general administrative costs that might be incurred by the bus organization assuming the general administrative functions of the fixed guideway organization (this effectively reduces the fixed guideway organization by only 10%). This yields an overall cost savings of approximately 2.9% to 3.0% for the selected fixed guideway alternatives provided in the following tables. The total annual estimated HHCTCP O&M costs are provided hereafter both with and without the savings associated with a combined O&M organization.

Table 4-10: Estimated Total Annual O&M Costs, Build Alternative, First Project, Airport, Year 2030

HHCTCP ESTIMATED TOTAL ANNUAL O&M COSTS (2007 USD)	
BUILD ALTERNATIVE, FIRST PROJECT, YEAR 2030	
	Airport
Bus	$ 181,161,316
Fixed Guideway	$ 79,423,423
Total	**$ 260,584,739**
Total w/Savings	*$ 252,642,397*

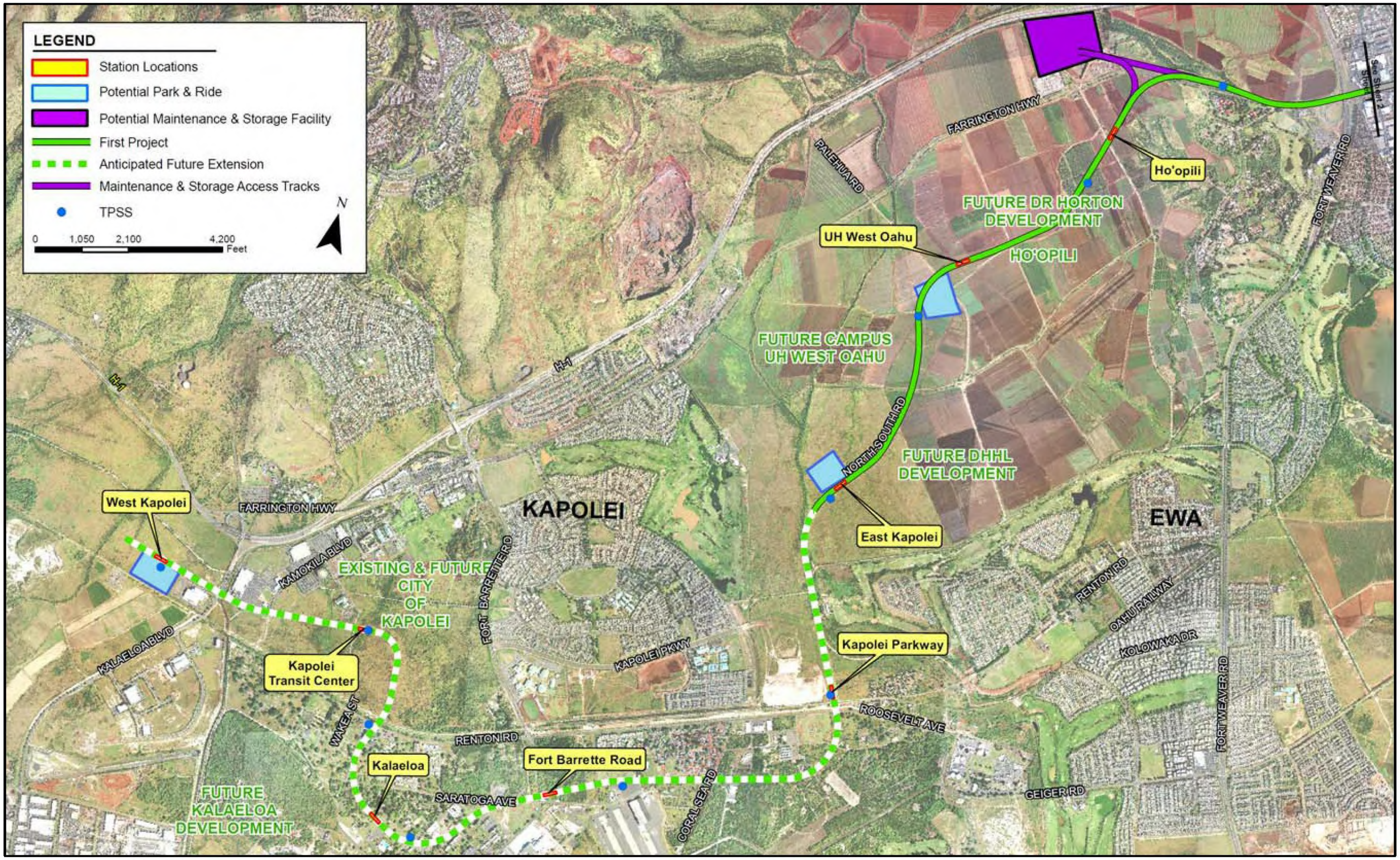
Table 4-11: Estimated Total Annual O&M Costs, Build Alternative, First Project, Airport, Year 2018

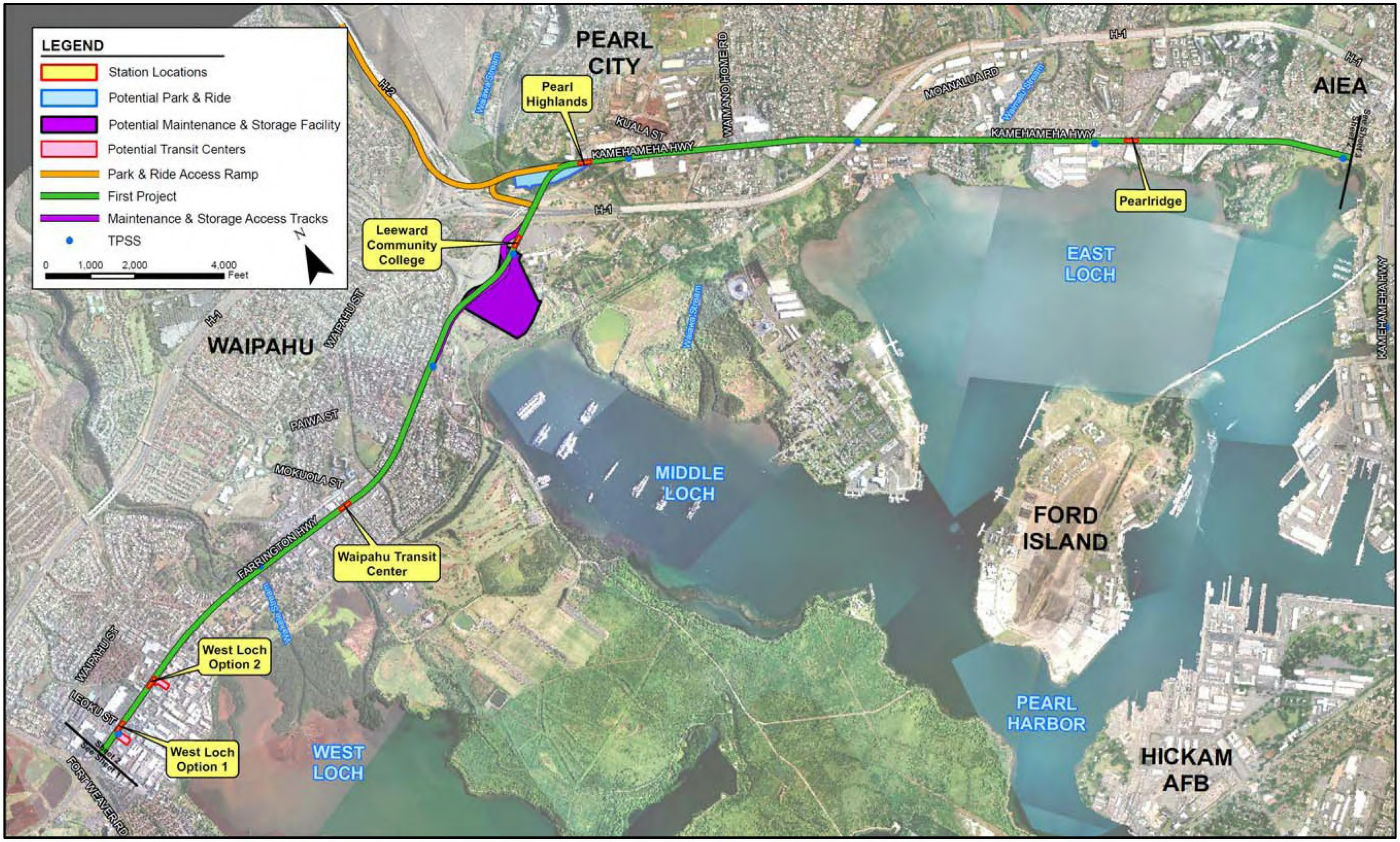
HHCTCP ESTIMATED TOTAL ANNUAL O&M COSTS (2007 USD)	
BUILD ALTERNATIVE, FIRST PROJECT, YEAR 2018	
	Airport
Bus	$ 173,651,194
Fixed Guideway	$ 69,489,577
Total	**$ 243,140,771**
Total w/Savings	*$ 236,191,813*

5 Conclusion

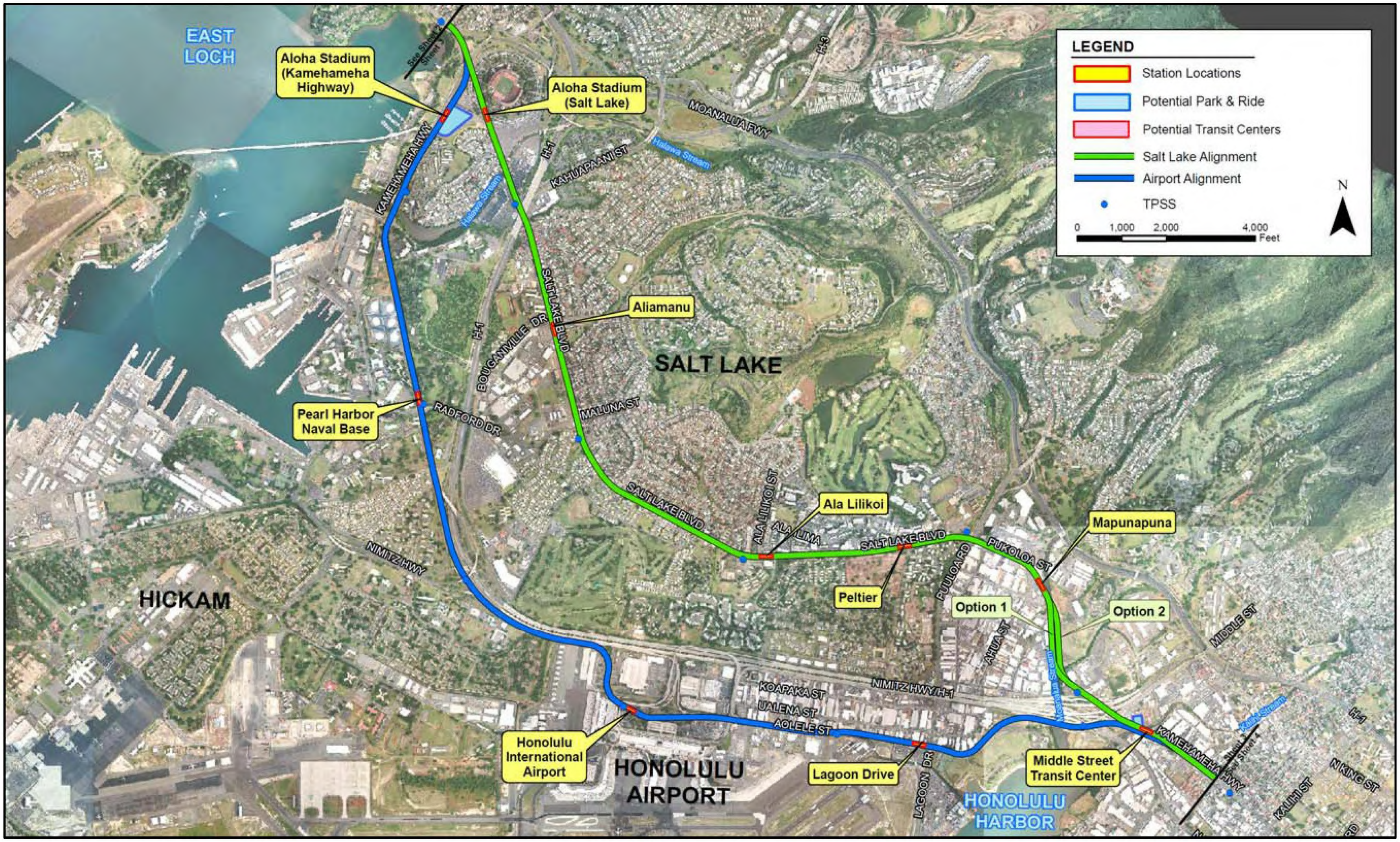
The focus of this memorandum has been on reporting and discussion of the forecast of O&M costs for the HHCTCP. Reporting and discussion of the methodology used in developing the HHCTCP O&M cost models are provided in the HHCTCP Preliminary Memorandum on O&M Cost Models dated May 2009.

Appendix A - Fixed Guideway Alignment Plan

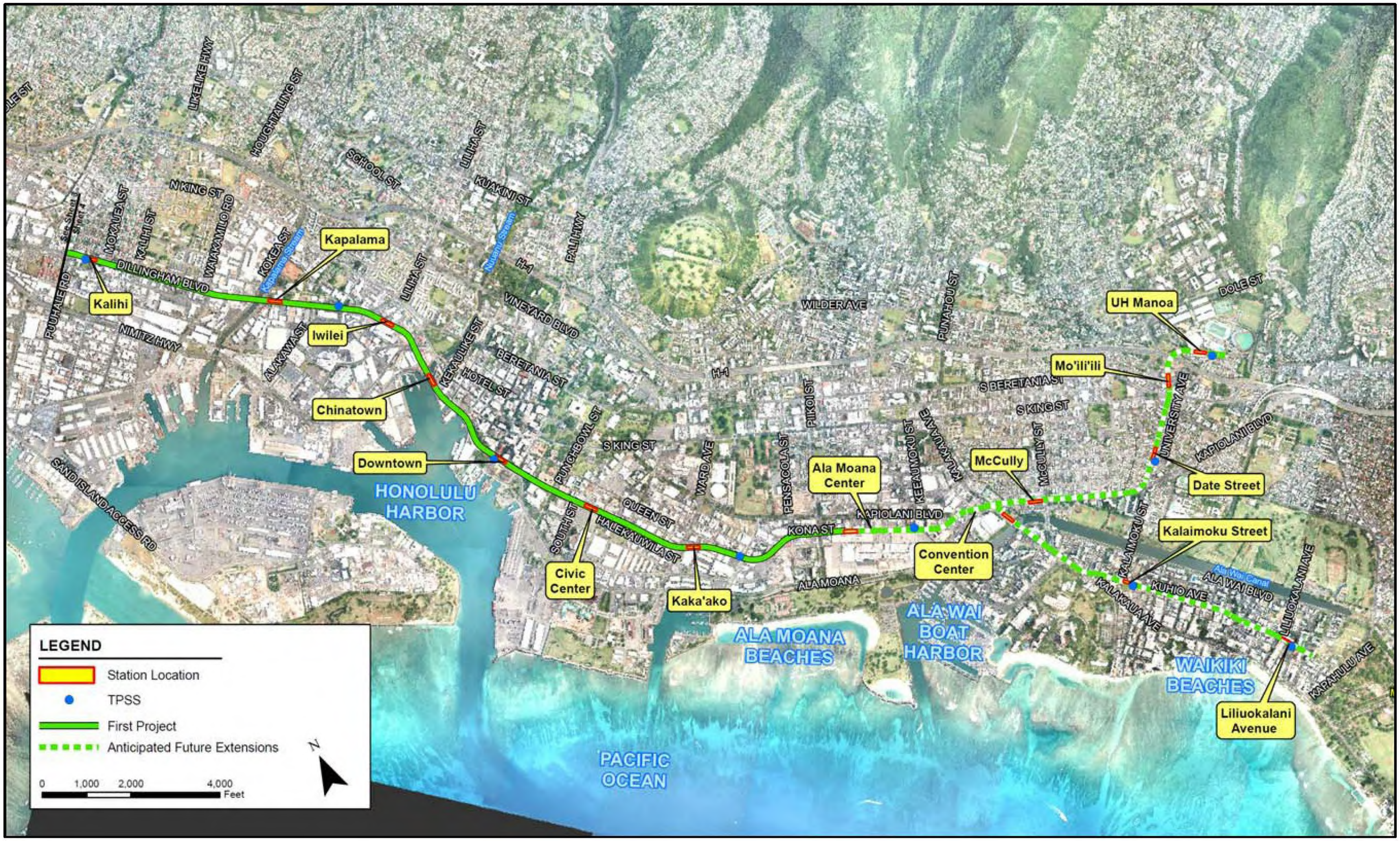

LEGEND
Station Locations
Potential Park & Ride
Potential Maintenance & Storage Facility
First Project
Anticipated Future Extension
Maintenance & Storage Access Tracks
TPSS
0 1,050 2,100 4,200 Feet
N
West Kapolei
Kapolei Transit Center
Kalaeloa
Fort Barrette Road
Kapolei Parkway
East Kapolei
UH West Oahu
Ho'opili
FUTURE DR HORTON DEVELOPMENT
HO'OPILI
FUTURE CAMPUS UH WEST OAHU
FUTURE DHHL DEVELOPMENT
EXISTING & FUTURE CITY OF KAPOLEI
FUTURE KALAELOA DEVELOPMENT
KAPOLEI
EWA
FARRINGTON HWY
H-1
PALEHUA RD
NORTH-SOUTH RD
FORT WEAVER RD
KAMOKILA BLVD
KALAELOA BLVD
FORT BARRETTE RD
KAPOLEI PKWY
WAKEA ST
RENTON RD
SARATOGA AVE
CORAL SEA RD
ROOSEVELT AVE
GEIGER RD
OAHU RAILWAY
KOLOWAKA DR



LEGEND
Station Locations
Potential Park & Ride
Potential Maintenance & Storage Facility
Potential Transit Centers
Park & Ride Access Ramp
First Project
Maintenance & Storage Access Tracks
TPSS
0 1,000 2,000 4,000 Feet
N
PEARL CITY
AIEA
WAIPAHU
Pearl Highlands
Leeward Community College
Pearlridge
Waipahu Transit Center
West Loch Option 2
West Loch Option 1
EAST LOCH
MIDDLE LOCH
WEST LOCH
FORD ISLAND
PEARL HARBOR
HICKAM AFB
KAMEHAMEHA HWY
FARRINGTON HWY
MOANALUA RD
WAIMANO HOME RD
KUALA ST
WAIPAHU ST
PAIWA ST
MOKUOLA ST
LEOKU ST
FORT WEAVER RD
H-1
H-2



LEGEND
Station Locations
Potential Park & Ride
Potential Transit Centers
Salt Lake Alignment
Airport Alignment
TPSS
0 1,000 2,000 4,000 Feet
N
EAST LOCH
Aloha Stadium (Kamehameha Highway)
Aloha Stadium (Salt Lake)
Aliamanu
SALT LAKE
Pearl Harbor Naval Base
Ala Lilikoi
Mapunapuna
Peltier
Option 1
Option 2
HICKAM
Honolulu International Airport
HONOLULU AIRPORT
Lagoon Drive
Middle Street Transit Center
HONOLULU HARBOR
MOANALUA FWY
KAHUAPAANI ST
Halawa Stream
KAMEHAMEHA HWY
SALT LAKE BLVD
BOUGANVILLE DR
H-1
H-3
RADFORD DR
MALUNA ST
NIMITZ HWY
ALA LILIKOI ST
ALA LIMA
PUKOLOA ST
PUULOA RD
AHUA ST
MIDDLE ST
NIMITZ HWY/H-1
KOAPAKA ST
UALENA ST
AOLELE ST
LAGOON DR
KALIHI ST
N KING ST


Kapalama
Kalihi
Iwilei
Chinatown
Downtown
Civic Center
Kaka'ako
Ala Moana Center
Convention Center
McCully
Date Street
Kalaimoku Street
Liliuokalani Avenue
UH Manoa
Mo'ili'ili
HONOLULU HARBOR
ALA MOANA BEACHES
ALA WAI BOAT HARBOR
WAIKIKI BEACHES
PACIFIC OCEAN
DILLINGHAM BLVD
NIMITZ HWY
N KING ST
SCHOOL ST
KUAKINI ST
VINEYARD BLVD
BERETANIA ST
HOTEL ST
S KING ST
QUEEN ST
HALEKAUWILA ST
KONA ST
KAPIOLANI BLVD
ALA MOANA
WILDER AVE
S BERETANIA ST
UNIVERSITY AVE
DOLE ST
KUHIO AVE
ALA WAI BLVD
KALAKAUA AVE
KAPAHULU AVE
LEGEND
Station Location
TPSS
First Project
Anticipated Future Extensions
0 1,000 2,000 4,000 Feet
N