FEDERAL TRANSIT ADMINISTRATION

PROJECT MANAGEMENT OVERSIGHT PROGRAM

Contract No. DTFT60-04-D-00015
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FTA Task Order 12 – Programmatic Services
Work Order 5G

CLIN 0005: Spot Report

Subtask 32A: Project Capacity Review
Subtask 32E: Project Delivery Method Review
Subtask 33A: Parametric Project Cost Estimate Reviews
Subtask 34A: Project Schedule Review
Subtask 35A: Project Cost Contingency Baseline Review
Subtask 35C: Project Schedule Contingency Review
Subtask 40A: Assessment of Project Cost Risk
Subtask 40B: Assessment of Project Schedule Risk

Grantee: City and County of Honolulu

HONOLULU HIGH-CAPACITY TRANSIT CORRIDOR PROJECT
(Airport Alternative)
Date Issued: July 2009 (FINAL)

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AA	▪	Alternatives Analysis
AACE	▪	Association for the Advancement of Cost Engineering
AC	▪	Alternating Current
ACT ID	▪	Activity Identification
AGT	▪	Automated Guideway Technologies
BAH	▪	Booz Allen Hamilton
BCE	▪	Base Cost Estimate
BEA	▪	Bureau of Economic Analysis
BFMP	▪	Bus Fleet Management Plan
BLS	▪	Bureau of Labor Statistics
BRF	▪	Beta Risk Factor
CAGR	▪	Compounded Annual Growth Rate
CC	▪	Community College
CER	▪	Cost Estimating Relationship
CPI	▪	Consumer Price Index
CPM	▪	Critical Path Method
DB	▪	Design-Build
DBB	▪	Design-Bid-Build
DC	▪	Direct Current
DEIS	▪	Draft Environmental Impact Statement
DTS	▪	Department of Transportation Services
EDC	▪	Engineering Design Consultant
EIS	▪	Environmental Impact Statement
ENR	▪	Engineering News Record
FAQ	▪	Frequently Asked Questions
FD	▪	Final Design
FEIS	▪	Final Environmental Impact Statement
FFGA	▪	Full Funding Grant Agreement
ft	▪	Foot
FTA	▪	Federal Transit Administration
GCM	▪	General Construction Manager
GDP	▪	Gross Domestic Product
GEC	▪	General Engineering Consultant
GET	▪	General Excise Tax
HDOT	▪	State of Hawaii Department of Transportation
HHCTC	▪	Honolulu High-Capacity Transit Corridor
LONP	▪	Letter of No Prejudice
LPA	▪	Locally Preferred Alternative
MOS	▪	Minimum Operating Segment
MOT	▪	Maintenance of Traffic
MOU	▪	Memorandum of Understanding
mph	▪	Miles Per Hour
mphps	▪	Miles Per Hour Per Second
MPS	▪	Master Project Schedule
MS	▪	Microsoft
MSF	▪	Maintenance and Storage Facility
MW	▪	Megawatt

NBER	▪	National Bureau of Economic Research
NEPA	▪	National Environmental Policy Act
NTP	▪	Notice to Proceed
OCC	▪	Operations Control Center
OD	▪	Original Duration
O&M	▪	Operations and Maintenance
PB	▪	Parsons Brinckerhoff
PE	▪	Preliminary Engineering
PG	▪	Program Guidance
PHF	▪	Peak Hour Factor
PMC	▪	Project Management Support Consultant
PMO	▪	Project Management Oversight
PMOC	▪	Project Management Oversight Contractor
PMP	▪	Project Management Plan
PPI	▪	Producer Price Index
RAMP	▪	Real Estate and Acquisition Management Plan
RFMP	▪	Rail Fleet Management Plan
RFP	▪	Request For Proposals
ROD	▪	Record of Decision
ROD	▪	Revenue Operations Date
ROW	▪	Right-of-Way
RTD	▪	Rapid Transit Division
SCC	▪	Standard Cost Category
SSMP	▪	Safety and Security Management Plan
SSOA	▪	State Safety Oversight Agency
TCRP	▪	Transit Cooperative Research Program
TPM	▪	Office of Program Management
TSR	▪	Technical Schedule Review
UH	▪	University of Hawaii
UHERO	▪	University of Hawaii Economic Research Organization
WBS	▪	Work Breakdown Structure
YOE	▪	Year of Expenditure

1.0 EXECUTIVE SUMMARY

1.1 Introduction

The City and County of Honolulu ("City" or "Grantee") is requesting to enter into Preliminary Engineering (PE) for the Honolulu High-Capacity Transit Corridor (HHCTC) Project ("Project") in accordance with the Federal Transit Administration (FTA) New Starts requirements. The Project is intended to provide improved mobility in the highly-congested east-west corridor along Oahu's south shore between Kapolei and the University of Hawaii at Manoa (UH Manoa). The Project would provide faster, more reliable public transportation services than those currently operating in mixed-flow traffic. The project also would provide an alternative to private automobile travel and improve linkages between Kapolei, Honolulu's urban center, UH Manoa, Waikiki, and the surrounding urban area.

In March 2007, the Federal Transit Administration (FTA) assigned Booz Allen Hamilton (BAH) to serve as the "resident" Project Management Oversight Contractor (PMOC) for the Honolulu Project. On August 11, 2008, the FTA assigned a second PMOC (Jacobs) to provide concentrated oversight efforts in order to inform FTA's decision regarding the Salt Lake Alternative of the project approval for potential entry to preliminary engineering. On January 28, 2009, the City Council voted to revise the Minimum Operable Segment (MOS) alignment to the Airport Alternative. Jacobs is to provide FTA with "information and well-grounded professional opinions regarding the reliability of the project scope, cost, and schedule of the Locally Preferred Alternative." ***This Spot Report represents the PMOC's (Jacobs) assessment of the Airport Alternative of the Project based on the information provided by the City during the period of August 2008 to June 2009.***

1.2 Project Description

The proposed Project, which includes the Airport Alternative, is an approximately 20-mile alignment extending from East Kapolei to Ala Moana Center. The majority of the Project is to be built on aerial structure but the Project also includes a short at-grade section (0.7 miles). The proposed investment also includes 21 stations (20 aerial and 1 at-grade), 76 transit vehicles, administrative/operations facilities, and maintenance facilities. The specific modal technology for this project is steel wheel on steel rail. The City has referred to the mode as a "Light Metro" vehicle. However, the vehicles can be described as automated short heavy rail vehicles with a tight turning radius. For the purposes of this Spot Report, including the transit capacity analyses, the vehicles are identified as a "heavy rail" vehicle, which corresponds with the modal technology identified in the Standard Cost Category (SCC) workbook estimate provided by the City.

The First Project is planned to be delivered in four design and construction segments.

- Segment I – West Oahu/Farrington Highway
  - East Kapolei to Pearl Highlands
- Segment II – Kamehameha Highway
  - Pearl Highlands to Aloha Stadium (Airport)
- Segment III – Airport Stations
  - Aloha Stadium to Lagoon Station

- Segment IV – City Center
  - Lagoon Station to Ala Moana Center

The City's Base Cost Estimate (BCE) estimate for the Airport Alternative is approximately $5.171 billion in Year-of-Expenditure (YOE) dollars. The City's target Revenue Operations Date (ROD) for the First Project is March 2019.

1.3 Jacobs Scope of Work

Under this Work Order, Jacobs is to provide the following deliverables:

- Subtask 32A: Project Capacity Review
- Subtask 32E: Project Delivery Method Review
- Subtask 33A: Parametric Project Cost Estimate Reviews
- Subtask 34A: Project Schedule Review
- Subtask 35A: Project Cost Contingency Baseline Review
- Subtask 35C: Project Schedule Contingency Review (combined with Subtask 40B)
- Subtask 40A: Assessment of Project Cost Risk
- Subtask 40B: Assessment of Project Schedule Risk (combined with Subtask 35C)

Each of these deliverables comprises individual sections of this Spot Report and is summarized below.

1.3.1 Subtask 32A: Project Capacity Review

Methodology

The Project Management Oversight Contractor (PMOC) followed the requirements outlined in the *FTA Project Management Oversight Operating Guidance (PG) #32: Project Scope, Definition and Capacity Review Procedures,* dated March 29, 2007 to assess and evaluate operational capacity of the Honolulu High-Capacity Transit Corridor Project. This analysis employs practices recommended in the Transportation Research Board's *TCRP 100* to evaluate proposed operations and the capacity of the planned rail transit system. This analysis was based on all information made available to the PMOC by the City of Honolulu (the City). The effective date for the completion of this analysis by the PMOC is June 2009.

At the most basic level, rail transit capacity is a seemingly simple concept that addresses the question of how many persons can be moved within a period of time. The actual calculation of that capacity, however, is somewhat more complex involving considerations relating to car capacity, train length, maximum train speeds, train acceleration and braking characteristics, station dwell times, operating margin, track configuration, traction power system capacity, and safe following distances between trains. For rail transit, *TCRP 100* defines capacity in two ways:

- ***Line capacity***: the maximum number of trains (made up of some number of vehicles forming a "consist") that can pass a point during an interval of time (i.e., cars per hour). Line capacity is a function of train (or consist) length, maximum train speeds, train acceleration and braking characteristics, station dwell times, operating margin, track configuration and associated speed restrictions, terminal station configuration, and safe following distances between trains.

- ***Person capacity***: The maximum number of persons that can be carried in one direction past a point during an interval of time under specified operating conditions without unreasonable delay, hazard, restriction or uncertainty (i.e. passengers per hour). Person capacity is a function of line capacity and rail car capacity. *Rail car capacity* is a function of the number of seats on each rail car, the amount of usable standing space on each rail car and the acceptable level of crowding among standing passengers. *TCRP 100* specifies that 3.2 ft^2 of space per standing passenger is "reasonable service load with occasional body contact. Moving to and from doorways requires some effort."[1]

This document evaluates the proposed Project infrastructure and operation:
- to determine if it provides sufficient ***person capacity*** to carry the forecast volumes of design year peak period passengers and,
- to determine the theoretical ***line capacity*** (provided a sufficient pool of vehicles were available).

<u>Summary of Findings/Conclusion</u>

(1) The PMOC notes that the recent City documentation, analysis and operating philosophy has substantially evolved and has introduced a number of creative elements that address the realities and uncertainties of designing and operating a heavily patronized transit corridor.

(2) The general system capacity assumptions, conclusions and plan are reasonable and within a normal range of precision at this pre-Preliminary Engineering (PE) stage.

(3) The planned peak headway of 3:00 minutes with a mix of two and three car consists can provide a sufficient amount of capacity to serve the 2030 peak-of-the-peak passenger demand.

(4) The minimum dwell time assumption of 20 seconds per station may be too short. Based on the strict application of *TCRP 13* and *TCRP 100* dwell time methodologies, the City dwell assumptions are 4% lower than modeled levels. This was largely due to the minimum 28 second station dwell times assigned to lightly used trains in the reverse direction. However, the PMOC notes that the strict application of dwell times may not be prudent as *TCRP 13* and *TCRP 100* themselves note the methodological uncertainties and wide range of experiences among different transit operators. Evolving Automated Guideway Technologies (AGT) further obscure the precision of a strict dwell time model.

(5) The 2030 project scope has a vehicle fleet size of 85 vehicles The PMOC concurs that this is an appropriate fleet size for this project at this early pre-PE

[1] Kittleson and Associates et al, Transit Capacity and Quality of Service Manual: 2nd Edition (TCRP Report 100) Transportation Research Board, Washington DC, 2003. pp. 5-5.

stage of design. Indeed, the City has done a commendable job at articulating some of the issues that will ultimately impact fleet size. With the 85 car fleet, the City can now work to conserve or mitigate any erosion of corridor velocity or capacity that may occur during the next stages of design.

(6) While full 2019 ridership projections were not available to the PMOC at the time this Spot Report was prepared, the City did provide a total corridor peak hour forecast of 6,977 in the first year of operation (2019) with a corresponding fleet requirement of 76 cars. This peak hour forecast in 2030 is 10,583 with a fleet requirement of 85 cars. The peak hour forecast in 2019 is 66% of that in 2030, whereas the fleet requirement in 2019 is 89% of that in 2030. Based on its fleet plan of 76 cars for the initial service launch operating on the three-minute headway and the operational flexibility that the City will implement through track configuration, the PMOC is confident that there is sufficient capacity to adequately handle the 2019 passenger demand assuming that the boarding and alighting patterns are similar to the 2030 projections. Due to the lesser ridership, the City should be able to have two-car consists for all trains in 2019.

(7) With either a cab-control or moving-block signaling type, service operating at 3:00-minute headways is well within the capability of the planned corridor. A minimum 2:00-minute headway could be operated on this corridor if future demand requires.

(8) The current morning peak direction ridership projection for the project is 10,583 passengers per hour. Depending on the signaling type, the maximum person directional capacity is either 14,129 or 15,753 passengers per hour, which is sufficient to accommodate the anticipated ridership.

Recommendations

(1) The City should perform research and documentation on the actual Honolulu time-of-day and day-of-week travel patterns to substantiate the important peak hour factor. A review of weekend service requirements would also be helpful to ensure that adequate capacity is incorporated into the service design.

(2) Additional review of the benefits, impacts and issues with short-turning some service at Leeward C.C. Station could be beneficial for both vehicle requirements and operations and maintenance (O&M) cost.

(3) During FD, the City should review and detail a service recovery plan that addresses those likely cases when the headway cannot be maintained and what happens due to dropped or late trips. Additionally, the City should consider the interval maintenance issues of operating differing train lengths in a very frequent corridor.

(4) The City should review and consider the minimum dwell time it uses to support its 20 second minimum dwell time assumptions. A review or update on the issues

would be helpful, especially as Vancouver's Canada Line (a peer system) enters initial service.

(5) The City should review its minimum vehicle turnaround requirements. Four minutes may be excessive for an AGT system, based on existing services currently in operation.

(6) The City should ensure that the service velocity does not erode over the next course of design changes. Continually modeling a new or changed alignment or design assumptions is vital to a reliable system that delivers effective mobility.

1.3.2 Subtask 32E: Project Delivery Method Review

Methodology

The PMOC followed the requirements outlined in the *FTA Project Management Oversight Operating Guidance (PG) #32: Project Scope, Definition and Capacity Review Procedures,* dated March 29, 2007 to assess and evaluate the grantee's technical approach for delivering the proposed Project within the constraints of their existing or proposed statutory or organizational procurement authority and in the context of their project strategies, risk analysis, and procurement planning. The PMOC also assessed and evaluated whether the grantee's project delivery method and contracting packaging strategy as defined and implemented in the Project Management Plan (PMP) minimizes project risks and provides the greatest likelihood of implementation success. Specifically, this section of the Spot Report provides an overview of the contracting methodology to be employed during the design, construction, and procurement phases of the project. Full details of this review may be found in Section 4.0 of this Spot Report.

Summary of Findings

The contract delivery methodology proposed by the City could be successfully executed. The City does have the statutory authority to award the contract types currently under consideration.

The PMOC cannot provide a detailed opinion on the constructability of the project since the plans are at a conceptual level of detail as would be expected for a project at this stage (per-PE). However, the PMOC does believe that the conceptual plans have been advanced sufficiently for this phase (pre-PE). The PMOC does have some concerns as they relate to design and construction of key elements that should be further investigated should the Project advance to PE. These concerns are outlined in detail with Section 4.0 and any risks associated with those concerns have been addressed within the Cost Risk Model.

Conclusion

At this juncture of the development of the Project, and as relates to the Project Delivery Method (PG-32E) assessment, the PMOC concludes that the Project ready to enter the PE Phase of work.

Recommendations

Many of the issues identified in Section 4.0 of this Spot Report would typically be addressed during the PE Phase. The PMOC recommends that the City develop a list of action items using the Risk Register (Appendix D) as the basis. These action items should be prioritized and addressed early in PE. The PMOC believes this approach will protect the Federal interests should PE Phase funding be approved and enable the City to embark on PE efforts with a far more definitive scope of work and overall budget and schedule.

1.3.3 Subtask 33A: Parametric Project Cost Estimate Review

Methodology

The PMOC followed the requirements outlined in the *FTA PG #33: Characterization of Grantee Project Cost Estimate and Escalation,* dated March 29, 2007 to assess and evaluate the grantee's cost estimate. Full details of this review may be found in Section 5.0 of this Spot Report.

Summary of Findings

The PMOC reviewed the City's *2009 SCC Estimate* that correlates to the scope and values included in the Draft Environmental Impact Statement (DEIS). The PMOC Cost Estimate Review consists of two primary functions. The first is a review and evaluation of project scope inclusively, as identified in the DEIS. The second is a characterization of the mechanical and fundamental soundness of the cost estimate. The PMOC review also includes an evaluation of the cost estimate source data and its use in the *2009 SCC Estimate*. The cost elements were also reviewed for accuracy and applicability to the project. An assessment of the cost estimate was based on the following specific reviews:

(1) Review of Construction Costs
(2) Review of General Condition Costs
(3) Review of Quantities
(4) Review of Cost Estimate Escalation
(5) Review of Standard Cost Categories

Based on a review of the above items, the PMOC made adjustments to the Project's direct costs due to omissions in scope or to undervaluation of certain cost items. The PMOC has identified adjustments to the Base Cost Estimate (BCE) that can be categorized as Line Item Adjustments or Escalation Adjustments.

The City's BCE of $5.172 billion (YOE) includes $989.30 million in allocated contingency, $281.97 million in unallocated contingency, and $230.87 million in finance charges. The BCE appears to also have some latent contingency, but the amount cannot be easily quantified at this stage of the project because the SCC line items are based primarily on CERs. To condition the BCE, the PMOC identified the following adjustments:

- Line Item Adjustment – $36.57 million (YOE)
- Escalation Adjustment – $132.46 million (YOE)

The input for the Cost Risk Model and basis for the evaluation of project cost contingency is the Adjusted BCE, which is the BCE net of contingencies and finance costs and includes the PMOC adjustments discussed below. To develop the Adjusted BCE, the following steps were taken:

- Start with City's BCE (YOE) – $5,171,503,897
- Strip YOE allocated and unallocated contingency – $1,271,272,632
- Deduct YOE financing costs – $230,873,271
- Apply PMOC YOE adjustments as outlined above – $169,029,334

- Result is an Adjusted BCE (YOE) of $3,838,387,328

Conclusion

In general, the PMOC has found that the current cost estimate is reasonable and acceptable for a project in the pre-PE Phase with the exception of the Line Item and Escalation adjustments that are recommended. Several specific observations are provided in Section 5.0 of this Spot Report, and they should be addressed by the City.

The PMOC recommendations for budget and contingency are discussed in Sections 1.3.6 and 8.0 of this Spot Report.

Recommendations

The PMOC recommends that the City prepare a detailed bottoms-up estimate during early PE. In addition, they should perform quality assurance checks to verify scope inclusivity and that SCC categories are escalated in accordance with the Master Project Schedule. The cost estimate and Basis of Estimate should provide more justification and backup documentation supporting the quantification and assumptions for the "soft costs" and related General Conditions for the Project.

1.3.4 Subtask 34A: Project Schedule Review

Methodology

The PMOC followed the requirements outlined in the *FTA PG #34: Project Schedule Review procedures,* dated March 29, 2007 to assess and evaluate the City's project schedule. The schedule review evaluates the efficiency and effectiveness of the project sponsor's project implementation during any phase of the project life cycle. The schedule review also validates the inclusivity of the Project scope and characterizes individual project elements within the current Project phase. It also validates the program management's readiness to enter and implement the next major program phase, the PE phase. The review of the Project schedule addresses seven subcategories as identified in the PG-34A:

- Schedule
- Technical Review
- Resource Loading
- Project Calendars
- Interfaces
- Project Critical Path
- Critical Areas of Concern

Full details of this review may be found in Section 6.0 of this Spot Report.

Summary of Findings

The City submitted a Master Project Schedule (MPS) titled "HHCTP As of August 25.xer" in early August 2008. The PMOC conducted a preliminary schedule review and produced a list of comments to the City during the Risk Assessment workshop site visit on September 11, 2008. The City incorporated the PMOC comments in a revised schedule, titled "*CITY.prx*", on September 20, 2008. In May 2009, the City submitted a revised and progressed MPS

"MA5A.prx" to the PMOC. The PMOC provided preliminary schedule review comments to the City in late May 2009. As a result the City addressed most of the PMOC's comments and submitted a revised MPS *"MA5E.xer"* on May 29, 2009. The PMOC used this MPS to conclude the PG-34A Project Schedule Review, PG-35C Schedule Contingency Review, and the PG-40B Assessment of Project Schedule Risk.

The MPS contains updated work progress, deletion of the Salt Lake Alternative, and inclusion of the new Airport Alternative. The technical schedule data is included in Table 1-1.

Table 1-1. Schedule Summary

Schedule Item	MPS
Number of activities	368
Number of activities in longest path	25
Started activities	85
Completed activities	51
Number of relationships	615
Percent complete	3.6 %
Number of hammocks	1
Number of early constraints	4
Number of late constraints	7
Number of mandatory constraints	0
Data date	10MAY09
Start date	15SEP08
Imposed finish date	N/A
Latest calculated early finish	04MAR19

Section 6.0 of this Spot Report provides a detailed discussion of the 18 schedule review categories that were addressed per the requirements of PG-34. However, some specific findings are as follows:

- The MPS does not contain an excessive amount of float and the critical path is discernible.
- The MPS was developed with some consideration of physical construction constraints such as construction of the aerial guideway structure, and the relocation, adjustment and installation of utilities in the narrow street limits of the alignment.
- The MPS and the Basis of Schedule address the proposed design and construction packaging strategy adequately.
- The Basis of Schedule includes logical assumptions for crew sizing and optimization related to pier, bent and aerial structure installation.
- The MPS does not include enough detail for utility related activities such as utility agreements, utility coordination and planning, underground utility exploration, relocation, abandonment and installation. A significant amount of expanded detail is needed to address the congested utility corridors requiring adjustment prior to construction. It is expected that this will be addressed during PE.

Table 1-2. Summary Schedule Dates

Description	Start Date	Finish Date
Preliminary Engineering		
PE Request thru FTA Approval	04MAY09A	07JUL09
PE thru ROD	07JUL09	01OCT09
Design Build Procurement		
MSF (thru issuance of NTP)	29MAY09A	30MAR10
West Oahu/Farrington Guideway (thru issuance of NTP)	04FEB09A	13MAR10
Systems (thru issuance of NTP)	09APR09A	25MAY10
Final Design		
Final Design (FD) Request thru FTA Approval	29DEC09	28APR10
Full Funding Grant Agreement (FFGA)		
Application thru Approval	26AUG10	28JUN11
Construction		
Start	13DEC09	
Open Waipahu / Leeward Section		24DEC12
MSF Contract Complete		07MAY14
Open East Kapolei to Pearl Highlands Section		21JUL14
Open Kamehameha Section		21JAN17
Open to Airport Section		22OCT17
Open to Ala Moana Center		04MAR19

Conclusion

The City's Master Project Schedule, "*MA5E.xer*" adequately addresses the PG-34A requirements and the City has demonstrated sufficient schedule management responsibility to support entry into the PE phase.

Recommendations

The PMOC has identified several specific comments that should be addressed and incorporated into the MPS prior to any LONP requests, issuance of the ROD and/or entry into the Final Design phase. These comments are discussed in detail within Section 6.0 of this Spot Report.

1.3.5 Subtask 40A: Assessment of Project Cost Risk

Methodology

The PMOC followed the requirements outlined in the *FTA PG #40: Risk Management Products and Procedures,* dated March 29, 2007 to complete a cost risk analysis of the Project. Full details of this review may be found in Section 7.0 of this Spot Report.

Summary of Findings

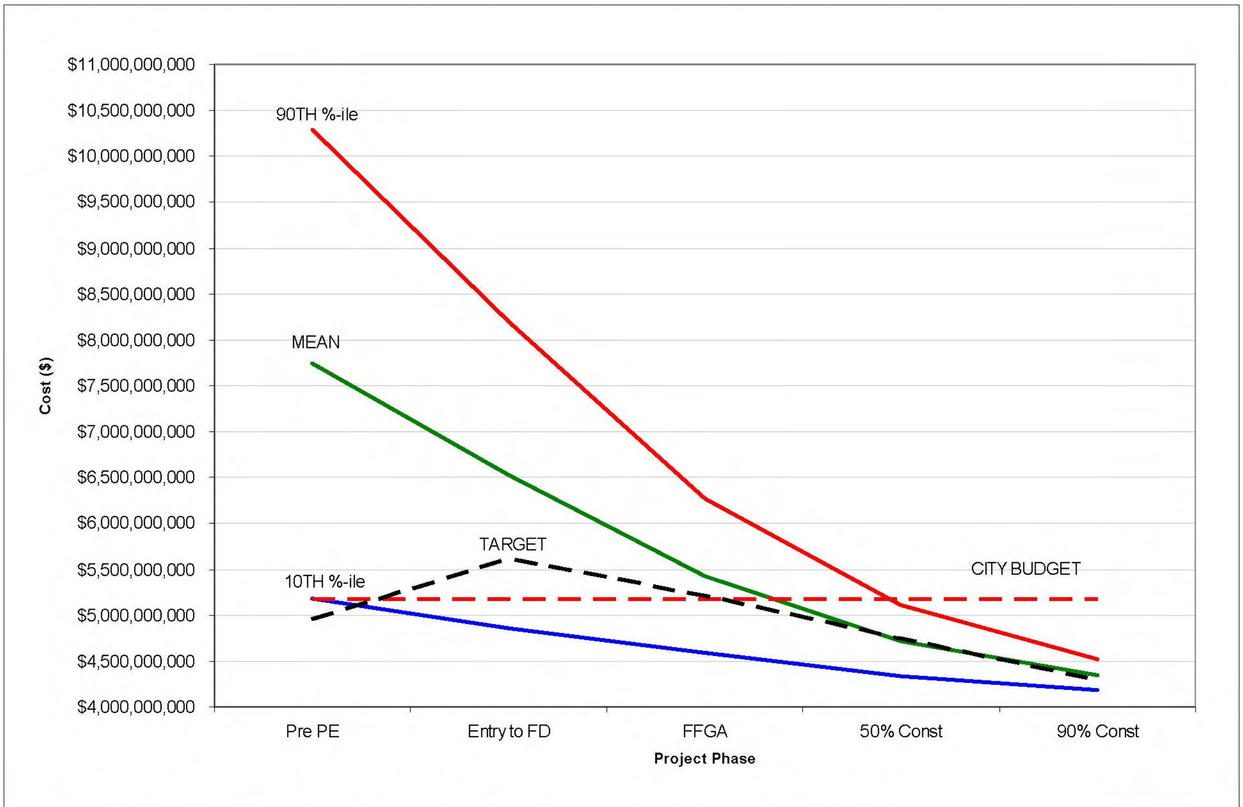
The Level 1 statistical risk analysis was used to forecast the total project cost at the following Project phases:

- Baseline – Entry into PE (Q2/2009)
- Entry into Final Design (Q2/2010)
- FFGA Award (Q3/2011)
- 50% Construction (Q4/2013)

- 90% Construction (Q4/2016)

In this risk-informed dynamic analysis, the BRF values for the different project phases were applied in accordance with PG-40 and in part through FTA program experience with other projects identifying risks that could cause cost escalation. Figure 1-1 depicts how the values of the 10th, 50th (mean), and 90th percentiles of the total project cost change during the life of the project. These values (i.e., projected costs) drop as the requirements, design, and market risks are eliminated from the project through the advancement of the design analysis, engineering applications and the availability of firm bids. The City budget is shown as $5.171 billion.

Figure 1-1. Plot of Cost Risk Model Project Forecasts and Target Values



Note: The target values are associated with the analysis completed per PG-35A.

Conclusion

Based solely on the Cost Risk Model analysis, the Project should include $1.112 billion in total contingency, or 29.0% of the Adjusted BCE, at the pre-PE Phase (or the baseline phase of the project). When considering all adjustments, escalation, contingency, and financing costs, the statistical result is an estimated Total Project Cost of $5.181 billion. It should be noted that the Cost Risk Model indicates that the required contingency may increase during the FD but eventually could decrease. This is the result of the remaining risks and their impacts on the overall budget at the various stages of the project. This analysis must be supported by an assessment of the contingency per PG-35 to confirm the adequacy of the total Project budget, as is done in Section 8.0.

1.3.6 Subtask 35A: Project Cost Contingency Baseline Review

Methodology
The PMOC followed the requirements outlined in the *FTA PG #35: Project Contingency and Third Party Profit Review Procedures,* dated March 29, 2007 to assess and evaluate the City's cost contingency. Per PG-35, the PMOC shall fully identify, describe, and analyze the adequacy of the City's cost contingency. Full details of this review may be found in Section 8.0 of this Spot Report.

Summary of Findings
An analysis of the contingency was completed using three methods:

(1) Forward Pass
(2) Backward Pass
(3) Cost Risk Model

The estimation of the required cost contingency must recognize the mitigation capacity available at each phase of project development throughout the life of project. The recommended contingency in the BCE must be adequate to support the project through project close-out. In this Spot Report, a contingency amount is recommended for inclusion in the BCE at the current phase of the project.

Conclusion
Table 1-3 summarizes the results of the contingency analyses performed for this Project.

Table 1-3. Contingency Analysis Summary

Analysis Method	Resulting Percentage of Adjusted BCE	Calculated Contingency (YOE)	Calculated Total Project Cost (YOE)
Forward Pass	30.0%	$1,151,516,199	$5,220,776,798
Backward Pass	31.8%	$1,219,000,000	$5,288,349,368
Cost Risk Model	29.0%	$1,112,474,678	$5,181,735,277

Recommendations
Based on these analyses, the PMOC recommends a minimum contingency of $1.219 billion (YOE), which is 31.8% of the Adjusted BCE amount of $3.838 billion (YOE). This results in a Total Project Budget of $5.288 billion (YOE), which is an increase of $116.76 million (YOE) or 2.3% of the City's current budget.

1.3.7 Subtask 35C: Project Schedule Contingency Review & Subtask 40B: Assessment of Project Schedule Risk

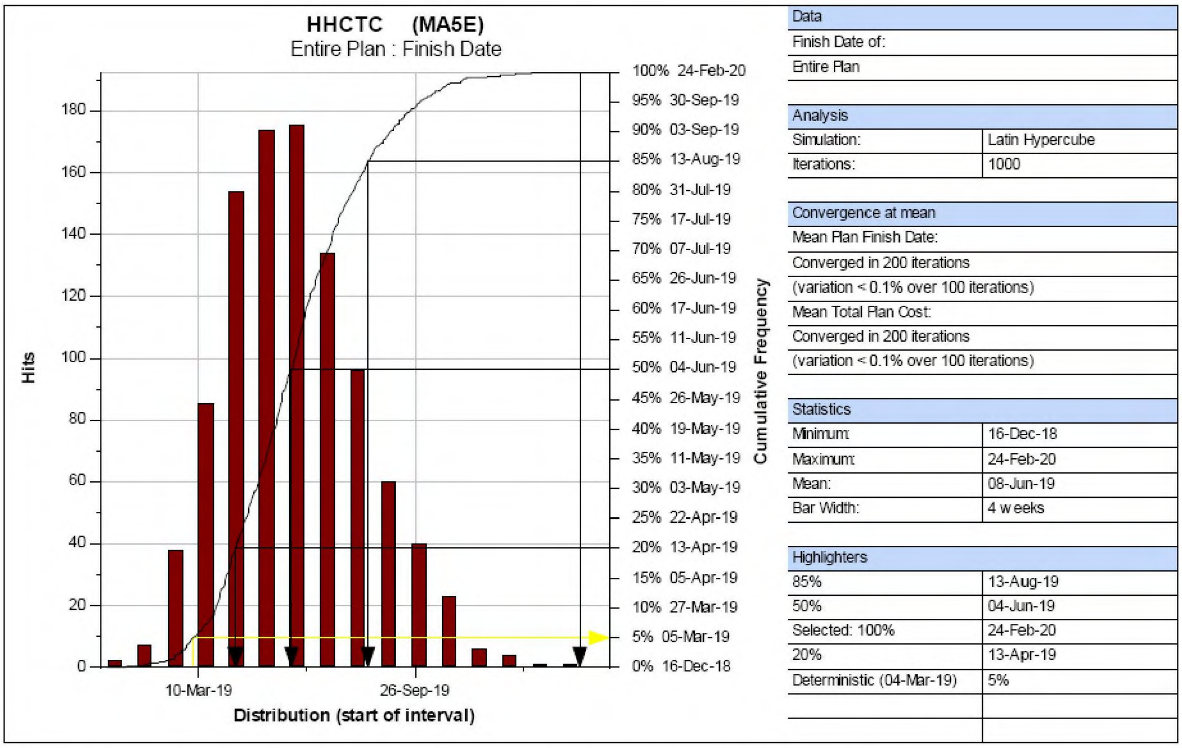
Methodology
The PMOC followed the requirements outlined in the *FTA PG #35: Project Contingency and Third Party Profit Review Procedures,* dated March 29, 2007 to assess and evaluate the City's schedule contingency. The PMOC followed the requirements outlined in the *FTA PG #40: Risk*

Management Products and Procedures, dated March 29, 2007 to complete a schedule risk analysis of the Project. Full details of this review may be found in Section 9.0 of this Spot Report.

Summary of Findings

A quantified schedule risk analysis was performed on the *"MA5A.xer"* schedule. This technique provides a means to determine schedule risk as a function of risk associated with the activities that make up the schedule. The CPM schedule is comprised of a network of activities logically sequenced to identify the longest critical path, start to completion. The schedule risk assessment techniques takes the planning process another step further accounting for uncertainty by using a range of durations to complete each activity instead of a single point duration. It calculates the overall schedule duration by developing a probabilistic distribution for each activity's duration, then totals the durations on the longest critical path. These ranges are then combined to determine the overall schedule duration. The activity duration probability distributions were aggregated using PertMaster, a simulation program that uses a Monte Carlo type probability algorithm. The results of the analysis are shown in Figure 1-2.

Figure 1-2. Finish Date Distribution



In addition to calculation of the ROD date, to assess the schedule mitigation capacity of the project, the schedule distribution was calculated for each of the schedule milestones described in Table 1-4. The distribution for these milestones was calculated in the same manner as for the ROD date. An optimistic date for achieving the milestone is the 20th percentile; high confidence of achievement is at the 85th percentile. Data are also shown for the median date (50th percentile) and the maximum date from the calculation.

Table 1-4. Probability of Achievement Date of Schedule Milestones

Project Timeframe	Activity ID	Schedule Finish Date	Milestone Achievement Date – Percentile Rank			
			20th	50th	85th	Maximum
Entry into PE	N270	01JUL09	30JUN09	30JUN09	17JUL09	14AUG09
Entry into Final Design	D250	22APR10	02MAY10	17MAY10	05JUN10	05AUG10
FFGA Award	F270	16JUN11	09JUL11	05AUG11	01SEP11	17NOV11

Conclusion

The PMOC's schedule risk analysis, generated by the aggregation of activity duration probability distributions determined there is less than a 5% chance of achieving Revenue Operation Date (ROD) by the project completion date/ROD of March 4, 2019. The analysis indicates there is an 85% probability of achieving ROD by August 13, 2019. The earliest calculated date for achieving ROD is December 16, 2018. The latest calculated date for achieving ROD is February 24, 2020. Based on the current MPS and the results of the schedule risk analysis and contingency analysis, the PMOC recommends a project completion date (ROD) no earlier than August 2019.

Recommendations

The PMOC has identified several specific comments that should be addressed and incorporated into the MPS. These comments are discussed in detail within Section 9.0 of this Spot Report.

1.4 Salt Lake Alternative vs. Airport Alternative Cost Assessment

The following table provides a comparison of the cost estimates and PMOC assessment results for the Salt Lake Alternative and Airport Alternative.

Table 1-5. Comparison of Cost Assessment for Salt Lake and Airport Alternatives

Description	Salt Lake Alternative (YOE)	Airport Alternative (YOE)
City Cost Estimate	$5,258,434,182	$5,171,503,897
Contingency	($1,161,213,774)	($1,271,272,632)
Finance Charges	($484,070,860)	($230,873,271)
BCE	**$3,613,149,548**	**$3,669,357,994**
Line Item Adjustments	$193,579,830	$36,569,304
General Excise Tax Adjustment	$49,091,399	$0
Escalation Adjustment	$197,102,727	$132,460,030
Adjusted BCE	**$4,052,923,504**	**$3,838,387,328**
Recommended Contingency	$1,216,000,000	$1,219,000,000
Percentage of Adjusted BCE	30.0%	31.8%
PMOC Recommended Project Budget	**$5,752,994,364**	**$5,288,260,599**

The difference between the recommended budgets for the two alternatives was the result of the following factors:

- Line Item Adjustments – During the review of the Salt Lake Alternative, the PMOC identified Line Adjustments for Utility Relocation (SCC 40.02) and Professional Services (SCC 80). Since that initial review of the Project, the GEC has developed more detailed estimates for the Utility Relocations that have eliminated the need for an adjustment. Professional Services were estimated as a percentage of the costs under SCC 10 through 70. Once the other line item adjustments were eliminated, there was no longer a need to adjust SCC 80. Any adjustment to SCC 80 as a result of the adjustments identified for the Airport Alternative would be minimal.

- General Excise Tax Adjustment (GET) – During the review of the Salt Lake Alternative, the PMOC identified a need to include an adjustment for the GET, including an amount associated with real estate acquisition. However, since the initial review, the City has provided information clarifying that real estate acquisition was not subject to the GET. The GEC then provided the PMOC with a memorandum that detailed its inclusion of a GET component to the cost estimate. Finally, a substantial portion of the GET adjustment was the result of the Line Item Adjustments that had been previously identified. With the overall reduction in the Line Item Adjustments, there was no longer a need to include a GET Adjustment.

- Escalation – A detailed assessment of the escalation factors used by the GEC for development of the Airport Alternative cost estimate was completed by the PMOC. Recommended escalation factors are discussed in Section 5.0.

- Finance Costs – There has been a $253.2 million reduction in the Finance Costs. The PMOC recommends that the Financial Management Oversight Contractor review the Financial Plan and substantiate the current projected finance costs.

1.5 Conclusion

The PMOC recognizes that components of this Project are further advanced than for a typical project in the pre-PE Phase. The PMOC is of the opinion that the Project scope, schedule, and budget are sufficiently developed to allow the Project to advance into the PE phase. ***However, based on the cost risk and contingency analyses completed and presented within this Spot Report, the PMOC concludes that the Total Project Budget at this phase should be $5.288 billion (YOE). This total includes $1.219 billion (YOE) total contingency or 31.8% of the Adjusted BCE. The net increase of $116.76 million over the City's current budget is the primarily the result of line item adjustments to the Base Cost Estimate for vehicle quantity and escalation rates used to estimate Year of Expenditure costs.***

It is recognized that the estimate will undergo significant refinement once the project advances into the PE phase. Over the course of the Project, the Cost Risk Model indicates that it is possible for the Project to be implemented within the current budget with totally effective mitigation. Design development is the primary mitigation method and the preferred method to achieve project cost targets. Secondary mitigation is the amount of additional contingency that must be funded based on the expected risks.

The Schedule Risk Assessment indicates that there is an 85% probability of achieving ROD by August 13, 2019, which is a delay of approximately five (5) months from the City's plan. At this phase of the Project (per-PE), 85% probability is a reasonable basis for determination of the ROD. ***Therefore, based on the current MPS and the results of the schedule risk analysis and contingency analysis, the PMOC recommends a project completion date (ROD) no earlier than August 2019.***

2.0 INTRODUCTION

Report Date	July 16, 2009 (FINAL)
Project Name / Location	Honolulu High-Capacity Transit Corridor Project (Airport Alternative) Honolulu, Hawaii
Project Sponsor	City and County of Honolulu
Project Management Oversight Contractor (PMOC) firm	Jacobs Engineering Group Inc.
Person providing this report	Tim Mantych, PE (MO, IL)
Length of time PMOC has been assigned to this project:	Since August 11, 2008

The Federal Transit Administration (FTA) has contracted Jacobs to provide Project Management Oversight Contractor (PMOC) services on FTA's New Starts and major capital projects. This Task Order provides FTA's Office of Program Management (TPM) in Washington, DC with Project Management Oversight services for programmatic services and products for contract level plans, quality management systems and reporting, white papers, ancillary support, information technology services and status reporting. Subject to the issuance of individual Work Orders by the Contracting Officer's Technical Representative, the Contractor shall also provide PMO services for FTA's Regional Offices' grantees and their major capital projects to the extent that the PMOC has no conflicts of interest. Task Order No. 12 was executed by FTA on July 10, 2007 for the performance of on-going PMOC oversight services. Work Order 5G was issued to Jacobs August 11, 2008 to provide the deliverables contained within this Spot Report. A second Work Order was issued in May 2009 to extend the period of performance for this effort.

This Spot Report represents the PMOC's (Jacobs) assessment of the Airport Alternative of the Project based on the information provided by the City during the period of August 2008 to June 2009.

2.1 Project Background

The City and County of Honolulu ("City" or "Grantee") has requested approval to enter into Preliminary Engineering (PE) for the Honolulu High-Capacity Transit Corridor (HHCTC) Project ("Project") in accordance with the Federal Transit Administration (FTA) New Starts requirements. The Project is intended to provide improved mobility in the highly-congested east-west corridor along Oahu's south shore between Kapolei and the University of Hawaii at Manoa (UH Manoa). The Project would provide faster, more reliable public transportation services than those currently operating in mixed-flow traffic. The project also would provide an alternative to private automobile travel and improve linkages between Kapolei, Honolulu's urban center, UH Manoa, Waikiki, and the surrounding urban area. Drivers and bus riders in the corridor currently experience 42,000 daily hours of delay.

The Alternatives Analysis (AA) for the Project was initiated in August 2005 and the Honolulu High-Capacity Transit Corridor Project Alternatives Analysis Report was presented to the Honolulu City Council in October 2006. The purpose of the report was to provide the City Council with the information necessary to select a mode and general alignment for high-capacity transit service on Oahu. The report summarized the results of the AA that was conducted following the FTA's planning guidance. The report provided information on the costs, benefits, and impacts of four alternatives:

- No Build Alternative
- Transportation Systems Management Alternative
- Managed Lane Alternative
- Fixed Guideway Alternative

During November and December 2006, public meetings were held on the AA. On December 22, 2006, the Honolulu City Council enacted Ordinance No. 07-001, which approved a fixed guideway alternative from Kapolei to the UH Manoa and Waikiki as the Locally Preferred Alternative (LPA) for the Project. Ordinance 07-001 identified a specific alignment for the majority of the corridor but left options open in two locations. At the western end of the corridor, the LPA selection identified two alignments (described in the AA Report as Section I – Saratoga Avenue/North-South Road and Kamokila Boulevard), with the notation "as determined by the city administration before or during preliminary engineering." In the center of the corridor, the LPA selection also identified two alignments (described in the AA Report as Section III – Salt Lake Boulevard and Aolele Street), also with the notation "as determined by the city administration before or during preliminary engineering."

The LPA selection was made recognizing that currently-identified revenue sources, including revenues from the 0.5 percent General Excise Tax surcharge in place from January 1, 2007 through December 31, 2022, and a reasonable expectation of FTA New Starts funds, would not be sufficient to fund the capital cost of the LPA. Thus a financially feasible Minimum Operable Segment (MOS) needed to be chosen. On February 27, 2007, the Honolulu City Council approved as the MOS, East Kapolei to Ala Moana Center, via Salt Lake Boulevard (Resolution 07-039, FD1(c)). On January 28, 2009, the Honolulu City Council voted to revise the MOS to include the Airport Alternative in lieu of the Salt Lake Alternative. The revised MOS is referred to as the "First Project".

2.2 Project History

Following is a history of the Project:

- 2000 – An AA report was developed for a bus rapid transit system for the Honolulu Primary Corridor Project.
- January 1, 2007 – A 0.5% surcharge on the Hawaii General Excise Tax went into effect.
- July 1, 2007 – The City created the Rapid Transit Division (RTD) within the Department of Transportation Services (DTS) through enactment of the City's Fiscal Year 2008 Executive Operating Budget and Program.
- August 24, 2007 – The City executed a GEC contract for $85 million to perform National Environmental Policy Act (NEPA) documentation, AA and PE activities.
- February 22, 2008 – The City's Technology Selection Panel recommended the use of steel-wheel on steel-rail technology based on request for information industry responses submitted in January. Subsequently, Mayor Hannemann directed DTS to base the DEIS on steel-wheel on steel-rail technology.

- September 2008 – Pre-Preliminary Engineering (PE) Risk Assessment performed for Salt Lake Alternative.
- November 2008 – A ballot measure was passed that, in part, approved the development of a "steel wheel on steel rail" transit system for the City of Honolulu.
- January 2009 – City Council voted to revise the Minimum Operable Segment (MOS) alignment to the Airport Alternative.
- May 2009 – Request to Enter PE submitted.
- June 2009 – Pre-Preliminary Engineering (PE) Risk Assessment performed for Airport Alternative.

2.3 Project Description

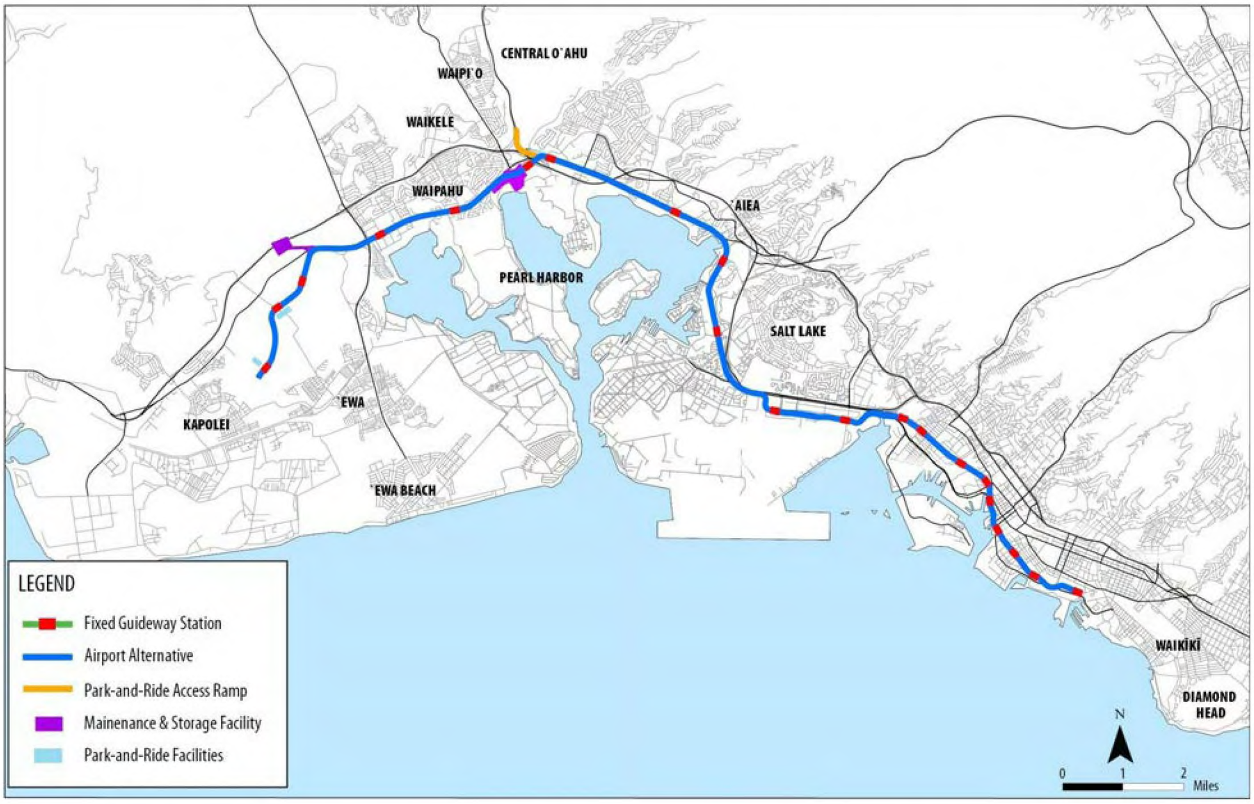
The proposed Project, which includes the Airport Alternative, is an approximately 20-mile alignment extending from East Kapolei to Ala Moana Center. The majority of the Project consists of aerial structure but also includes a short at-grade section (0.7 miles). The proposed investment also includes 21 stations (20 aerial and 1 at-grade), 76 transit vehicles, administrative/operations facilities, and maintenance facilities. The specific modal technology for this project is steel wheel on steel rail. The City has referred to the mode as a "Light Metro" vehicle. However, the vehicles can be described as automated short heavy rail vehicles with a tight turning radius. For the purposes of this Spot Report, including the transit capacity analyses, the vehicles are identified as a "heavy rail" vehicle, which corresponds with the modal technology identified in the Standard Cost Category (SCC) workbook estimate provided by the City.

The First Project is planned to be delivered in four design and construction segments.

- Segment I – West Oahu/Farrington Highway
  - East Kapolei to Pearl Highlands
- Segment II – Kamehameha Highway
  - Pearl Highlands to Aloha Stadium (Airport)
- Segment III – Airport Stations
  - Aloha Stadium to Lagoon Station
- Segment IV – City Center
  - Lagoon Station to Ala Moana Center

The City's Base Cost Estimate (BCE) estimate for the Airport Alternative is approximately $5.171 billion in Year-of-Expenditure (YOE) dollars. The City's target Revenue Operations Date (ROD) for the First Project is March 2019.

Figure 2-1. First Project as Identified in DEIS



Following is a summary of the proposed Project component characteristics at the time this Spot Report was prepared:

<u>Guideway</u>

- Exclusive guideway:
  - Majority of guideway will be elevated structure consisting of concrete box sections
  - 0.70-mile at-grade section in location of Maintenance and Storage Facility will include no grade crossings
- Double-track mainline
- Maximum speed: 55 miles per hour (mph)
- Crossovers spaced at approximately 2 miles
- Pocket Track at Aloha Stadium Station
- Third Track at Ala Moana Station
- At-grade Junction for Merging and Diverging Routes
- Seamless Merging of Parallel Main Lines and Branch Lines

<u>Stations</u>

- 20 aerial stations (13 with concourses)
- One at-grade station (access from below platform circulation space)
- Station length: 240 feet

- Barrier-free

Maintenance and Storage Facility

- Initial construction will accommodate 80 revenue vehicles
- Maximum capacity of site is 150 revenue vehicles
- Yard movements will be manually controlled, except for departure/receiving tracks
- Shop Facility will include administrative and operational offices for the agency, including Operations Control Center (OCC)
- Facility will be designed and commissioned to achieve Leadership in Energy and Environmental Design Green Building Rating System Silver Certification, and will be operated in accordance with FTA Sustainable Maintenance and Operational Standards

Revenue Vehicles

- Heavy rail
- Approximate number of vehicles: 76 (SCC Worksheet incorrectly identifies a quantity of 67 vehicles. The PMOC included a Line Item Adjustment to the Base Cost Estimate as discussed in Section 5.0 of this Spot Report.)
- Standard gauge, steel wheel on steel rail
- Fully automated, manual operation possible (hostler panel)
- Nominal vehicle dimensions:
  - Length: 60 feet
  - Width: 10 feet
  - Height: Up to 13.3 feet
  - Floor Height: 3.77 feet above top of rail (at entry)
- Nominal Passenger Capacity: 190 per vehicle (AW2 load)
- Electric traction via third rail, nominal 750V direct current (DC) supply, all axles powered
- Semi-permanently coupled, bi-directional trainsets
- Wide gangways between end and middle cars
- 2 to 3 double passenger plug doors per side (per car)
- Manual crew doors with steps
- Dynamic / regenerative braking
- Alternating current (AC) propulsion
- 30+ year design life

Systems

- Traction power
  - Distribution system will consist of substations and main line track power distribution facilities
  - Approximately 20 Traction Power Substations will be spaced at approximately one mile intervals along the alignment with ratings in the range of 2 megawatt (MW) to 5 MW
  - Power distribution system will be based on a 750-volt direct current (DC) third rail system

- Train control
  - Automatic train control technology
  - Driverless train operation
  - Two-minute Design Headway
  - Bi-directional operation
  - Fall-back manual train operation
  - Parallel and branch main lines
  - Mid-line Maintenance and Storage Facilities
  - Accurate station stopping
  - Operations Control Center
- Communications
  - Supervisory Control and Data Acquisition System
  - Optical Fiber Transmission System
  - Radio System
  - Telephone System
  - Public Address System
  - Variable Message Sign System
  - Closed Circuit Television System
  - Fire and Intrusion Alarm Systems
  - Maintenance Management Information System
- Fare Collection
  - Fare system will be integrated with the fare structure on the City's existing bus system
  - Proof of payment system

2.4 Project Management Oversight Contractors (PMOC)

In March 2007, the Federal Transit Administration (FTA) assigned Booz Allen Hamilton (BAH) to serve as the "resident" Project Management Oversight Contractor (PMOC) for the Honolulu Project. On August 11, 2008 the FTA assigned a second PMOC (Jacobs) to provide concentrated oversight efforts in order to inform FTA's decision regarding the Salt Lake Alternative of the project approval for potential entry to preliminary engineering. On January 28, 2009, the City Council voted to revise the Minimum Operable Segment (MOS) alignment to the Airport Alternative in lieu of the Salt Lake Alternative. Jacobs is to provide FTA with "information and well-grounded professional opinions regarding the reliability of the project scope, cost, and schedule of the Locally Preferred Alternative."

Unless otherwise stated in this Spot Report, any references to "PMOC" are specific to Jacobs.

2.4.1 PMOC Deliverables

Table 2-1 provides a summary of the deliverables, as governed by the applicable FTA Program Guidance (PG), to be provided under this Work Order by Jacobs.

Table 2-1. Jacobs Deliverables

Subtask	Description
10C	Individual Work Order Level Implementation Plan
32A	Project Capacity Review
32E	Project Delivery Method Review
33A	Parametric Project Cost Estimate Reviews
34A	Project Schedule Review
35A	Project Cost Contingency Baseline Review
35C	Project Schedule Contingency Review
40A	Assessment of Project Cost Risk
40B	Assessment of Project Schedule Risk (combined with PG-35C)

This Spot Report is organized such that each deliverable comprises a separate chapter.

2.4.2 PMOC Activities

Following is a summary of Jacobs' activities associated with this Work Order:

- August 11-13, 2008 – Attended Kick-off Meeting in San Francisco, California. Attendees included representatives from FTA Region IX, the City, Project Management Support Consultant (PMC), General Engineering Consultant (GEC), and BAH.
- August 27, 2008 – Participated in conference call with the City to discuss the Project cost estimate.
- September 8-12, 2008 – During a trip to Honolulu, Hawaii, Jacobs completed the following activities:
  - Participated in a project tour
  - Met with key staff to discuss scope, schedule, and cost aspects of the Project
  - Participated in a Risk Assessment Workshop
- June 2-4, 2009 – During a trip to Honolulu, Hawaii, Jacobs completed the following activities:
  - Participated in a project tour specific to the Airport Alternative
  - Met with key staff to discuss scope, schedule, and cost aspects of the Project
  - Participated in a Follow-up Risk Assessment Workshop

2.5 Evaluation Team

The main agencies involved in the Project are FTA, the City and County of Honolulu (City), Booz Allen Hamilton (resident PMOC), and Jacobs (PMOC for this Work Order). Appendix A presents the Evaluation Team (e.g., participants of the two Risk Assessment Workshops).

2.6 Documents Reviewed

Appendix B provides a listing of the project-related documents that were utilized during development of this Spot Report.

3.0 SUBTASK 32A: PROJECT CAPACITY REVIEW

3.1 Purpose and Objective

The purposes of this Project Capacity Review is to ensure that sufficient service capacity is being designed, programmed and planned to provide safe and reliable transit service to the Honolulu community. Determining the person capacity (Can the system carry the maximum number of people?) and vehicle capacity (Can the system handle the maximum number of vehicles?) are the primary objectives of this review.

There are many analytical approaches available to assess service capacity, often tailored to the unique operating and regional characteristics of a given project. At each design stage of a major transit program, various capacity assessment methodologies are applied to updated plans and system designs that produce more resolution and serve to update the service plan. It is an on-going, evolving process that improves project accountability and ensures that the investment in major infrastructure systems are adequately scaled for "real world" operating conditions.

The industry best practice for assessing transit capacity has become *TCRP 100, Transit Capacity and Quality of Service Manual, Report 100 (TCRP100).*[2] This compendium provides a broad toolbox of transit capacity assessment methodologies and has established a common FTA and industry-accepted approach to review both current and proposed transit services across a wide range of critical system elements, including corridor throughput, passenger crowding, dwell time, running time and track capacity at terminals. It is important to note that *TCRP 100* is a survey of different methodologies and presents them not as standards, but as general approaches that require careful application within a local project context.

3.2 Methodology

The PMOC followed the requirements outlined in the *PG #32: Project Scope, Definition and Capacity Review Procedures,* dated March 29, 2007 to assess and evaluate operational capacity of the Project. This analysis employs practices recommended in the *TCRP 100* to evaluate proposed operations and the capacity of the planned rail transit system. ***This analysis was based on all information made available to the PMOC by the City. The effective date for the completion of the initial analysis by the PMOC is October 2008, with a major update in June 2009.***

At the most basic level, rail transit capacity is a seemingly simple concept that addresses the question of how many persons can be moved across a linear corridor within a period of time. The actual calculation of that capacity, however, is somewhat more complex involving considerations relating to car capacity, train length, maximum train speeds, train acceleration and braking characteristics, station dwell times, operating margin, track configuration, traction power system capacity, and safe following distances between trains. *TCRP 100* defines capacity in two ways for rail transit:

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[2] Kittleson and Associates et al, Transit Capacity and Quality of Service Manual: 2nd Edition (TCRP Report 100) Transportation Research Board, Washington DC. 2003

- ***Line capacity***: the maximum number of trains (made up of some number of vehicles forming a "consist") that can pass a point during an interval of time[3] (i.e., cars per hour). Line capacity is a function of train (or consist) length, maximum train speeds, train acceleration and braking characteristics, station dwell times, operating margin, track configuration and associated speed restrictions, terminal station configuration, and safe following distances between trains.

- ***Person capacity***: the maximum number of persons that can be carried in one direction past a point during an interval of time under specified operating conditions without unreasonable delay, hazard, restriction or uncertainty[4] (i.e. passengers per hour). Person capacity is a function of line capacity and rail car capacity. *Rail car capacity* is a function of the number of seats on each rail car, the amount of usable standing space on each rail car and the acceptable level of crowding among standing passengers. *TCRP 100* presents 3.2 ft^2 of space per standing passenger as a "reasonable service load with occasional body contact. Moving to and from doorways requires some effort"[5]

This document evaluates the proposed Project infrastructure and operation:

- to determine if it provides sufficient ***person capacity*** to carry the forecast volumes of design year peak period passengers and,
- to determine the theoretical ***line capacity*** (provided a sufficient pool of vehicles were available).

3.2.1 Document Review

The PMOC relied on the documents supplied by the City to prepare this analysis as identified in Appendix B.

3.2.2 Project Specifications

The City forecasts that the Project will attract approximately 116,000 daily weekday passengers by year 2030.[6] The design criteria and planned service levels for 2030 are listed below for a system described as having rail cars that are of the "high-floor light metro transit vehicle type" and "vehicle trainsets…bi-directional and fully automated".[7] With its exclusive right of way, high level platforms, frequent service and third rail power distribution system, heavy rail system attributes were applied to this capacity analysis. However, it is noted that the City has classified this as a "light metro" system with its vehicles and short consist length more consistent in operating characteristics with light rail modes. TCRP may wish to expand and establish its modal definitions as automated light rail type systems and automated train control system applications mature in North America. Specifications for the proposed system vehicle characteristics are show below:

- **Car Specifications**

[3] Ibid. pp. 5-2
[4] Ibid. pp. 5-5
[5] Ibid. pp. 5-27
[6] HHCTCP/PMOC Meetings, June 2, 2009.
[7] HHCTCP Draft Section 12, Revenue Vehicle Design Criteria, March 2009 pp. 12 to 26

Table 3-1. Proposed Car Specifications[8]

Length	60	Feet
Width	10	Feet
Seating Capacity	50	Passengers
Standing Space	378	Square Feet
Acceleration	3.00	Miles per hour per second (mphps)
Deceleration	2.2	mphps - (from 55 to 45 mph)
	3.0	mphps - (from 45mph to stop)
Maximum Speed	55	mph
Door Width	48-66	inches
Door notes: Bi-parting doors; configured "two to three per side directly opposite the doors on the other side"		

Table 3-2. Proposed Service Plan Specifications[9]

Layover Time	03:02	4% of run time
Peak Vehicle Capacity Load	3.4	Square feet per standee
Peak Seating Capacity	50	Passengers per car
Peak Standing Capacity	112	Passengers per car
Total Peak Capacity	162	Passengers per car
Eastbound Running Time	42:42	
Westbound Running Time	41:16	
Dwell Time	20-45	Seconds per station
Total Running time	83:58	
Planned Cycle Time	1:27:00	
Planned Peak headway	3	Minutes
Planned Off-Peak Headway	6	Minutes
2030 Peak Trains	29	
2030 Peak Cars	46	

- **Train Control**
  - The Project signaling system has not yet been specified, but the City states its design parameters in the Operations Design Criteria:

    "A Train Control System sufficient to ensure safe train movement while maximizing line capacity shall be provided on all main tracks and yard

[8] Ibid pp. 12 to 26
[9] HHCTCP Fixed Guideway Fleet Sizing Report, June 2009 pp. 6 to 9

selected tracks as determined in final design. Train operations shall normally be completely automatic, allowing for safe operations without requiring onboard manual operation or supervision. The TCS shall consist of ATO, ATP and ATS."[10]

This automated operational objective would translate into a "cab-control" or "moving-block" signal train control system.

- o Given the early stages of this project, revenue vehicle and complementary train control equipment specifications are not detailed. Therefore, since the PMOC could not perform an independent train control requirements analysis, it used moving block signal system performance defaults as provided in *TCRP 100*.

- **Traction Power**
  - o Given the early stage of this project and the design status of the revenue vehicle and auxiliary equipment power consumption specifications, the PMOC has not performed an independent analysis on the traction power requirements.
  - o While the City has yet to develop specific requirements, it has provided general design guidelines requiring sufficient traction power to operate the maximum number of trains at designated speeds and projected load requirements.[11]
  - o Initial review of the preliminary plans shows electrical sub-stations at approximately one mile intervals along the corridor. While a full determination cannot be made from these drawings, this spacing is generally sufficient to support a reliable third rail power system with adequate redundancy.
  - o The specific data may not be present or simulations run with emphasis on traction power compatibility with revenue operations (normal service through emergency situations) intent for the desired type of vehicle, but that is not entirely unexpected at the pre-PE Phase level of planning and design. The City has indicated, and the criteria documentation has shown, that the intent is "to provide sufficient interface information to allow revenue vehicle and other Project systems design development during the PE phase, and to develop estimates of capital, operating, and maintenance costs."[12]

3.3 Capacity Analysis

TCRP 100 outlines procedures for transit capacity and levels of service analysis that typically use project-specific data sets as input variables. In this case, that project specific information is not available. However, *TCRP 100* provides general default values that are derived from modal data of other representative systems.

Key to this capacity analysis is the determination of the peak system demand, as this drives the maximum amount of capacity that will need to be provided. For many urban transit systems, there is an established 15-minute period during the morning weekday period, or the "peak-of-the-peak", when maximum regular utilization can be projected. However, recent demographic and employment trends have challenged the classic "9 to 5" commutation model, causing this 15

[10] HHCTCP Design Criteria – Operations, Revision July 1, 2008 Section 2.2 1.5 pp. 2-3
[11] HHCTCP Design Criteria – Traction Power, June 26, 2008
[12] Ibid. pp. 4

minute peak period to become more dispersed and distributed across the peak hour, and thus lessening peak system demand.

This section summarizes the transit demand forecasts, evaluates the planned peak service capacity, tests the City's dwell time and running time estimates and generates analysis of cycle time and vehicle requirements. Finally, the peak line and person capacity of the Project are calculated following *TCRP 100* methodologies.

The Forecast Design Year ridership projections have increased significantly since the last PMOC capacity review was undertaken. The ridership levels have increased 28% from 88,000 to 116,000 total weekday unlinked trips. While the fleet levels and service plans have been augmented and improved by the City, this substantial increase in demand will challenge even the improved system design and require additional investment in rolling stock.

3.3.1 Forecast Design Year Peak Period Passengers

The 2030 forecast ridership for the Project is 116,000 daily weekday passengers, an estimate whose increase is largely attributable to the addition of service to Honolulu International Airport and Pearl Harbor. The updated ridership forecast also estimates the number of passengers boarding and alighting for each station and direction during the morning peak hour. Although the data was modeled for the evening peak period, the morning peak hour period is considered the maximum utilization period due to the significant home-based work trip patterned corridors that this Project corridor represents.

Typically, passenger loadings are not uniformly distributed throughout the peak period. An adjustment called the 'peak hour factor' (PHF) is routinely used to estimate passenger volumes during the "peak-of-the-peak" 15-minute time period. In its calculations, the City has provided the PHF for the Project of 0.90, which is more moderate and less intensive that the *TCRP 100* recommended PHF of 0.80 for a heavy rail system.[13] The City based its PHF on the 0.84 PHF for the Vancouver SkyTrain, considered a modal peer system, and the Honolulu local bus service PHF of 0.97.[14] The PMOC considers this PHF reasonable given local demographic and employment patterns, as substantiated by the December 1996 TheBus Systemwide *On-Board Bus Survey Results Report* that provides substantial background on the local transit use. The PMOC requested and received system a list of weekday boardings by 15 minute increments from the City. While rail transit corridor utilization may often differ from local bus networks, it is clear that the Honolulu transit market is markedly different from mainland peer systems. The PMOC recommends further refinement and calibration of ridership utilization to fully substantiate its current and future PHF.

The derivation of the peak-of-the-peak 15-minute ridership estimate from the morning peak hour forecasts is arrived at by dividing the peak hour interval into four typical 15-minute slots, then dividing the average 15-minute load by the 0.90 PHF, to estimate the average 15-minute peak boardings. The net effect of this adjustment is to add 15% more riders to the peak-of-the-peak above the average 15-minute peak ridership, in order to reflect the non-uniformity of passenger

[13] TCRP Report 100. pp. 5-68
[14] HHCTCP Fixed Guideway Fleet Sizing Report, June 2009 pp 9

arrivals at the stations. This factoring does not change the overall ridership forecast but reasonably predicts how the overall ridership will use the corridor. Table 3-3 shows the forecast morning peak hour and then calculates 15-minute peak-of-the-peak passenger activity.

Table 3-3. 2030 Station Passenger Morning Peak Hour

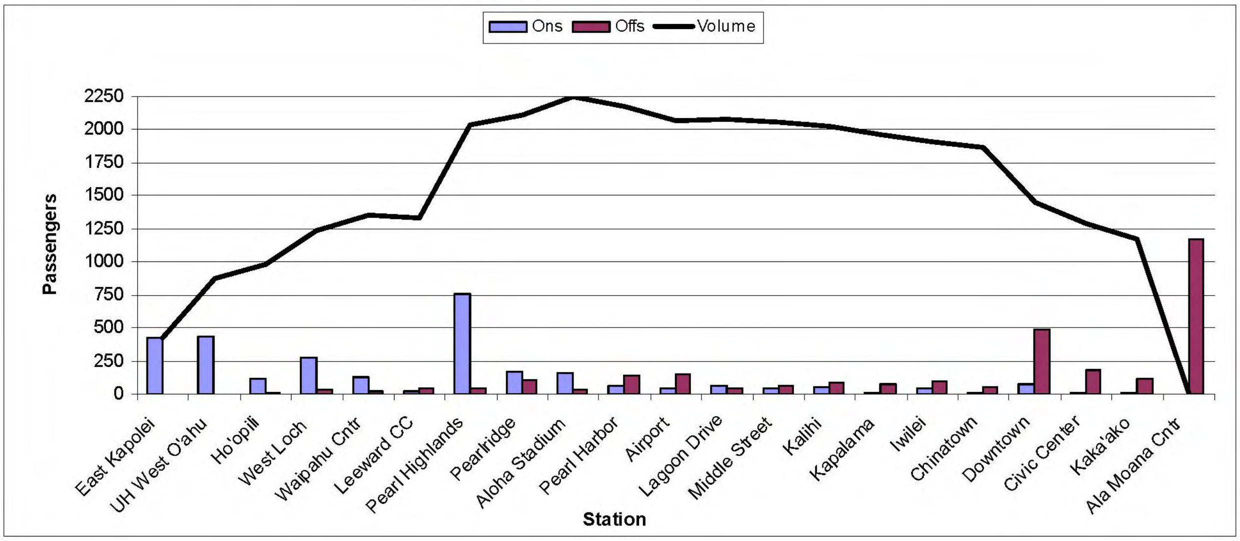
Eastbound	1 Hour peak		15 minute peak		
Station	Ons	Offs	Ons	Offs	Line Volume
East Kapolei	1,546	0	430	0	430
UH West Oahu	1,588	4	442	2	870
Hoopili	439	20	122	6	986
West Loch	1,004	104	279	29	1,236
Waipahu Cntr	466	61	130	17	1,349
Leeward CC	83	156	24	44	1,329
Pearl Highlands	2,712	148	754	42	2,041
Pearlridge	630	368	175	103	2,113
Aloha Stadium	591	114	165	32	2,246
Pearl Harbor	241	488	67	136	2,177
Airport	146	539	41	150	2,068
Lagoon Drive	211	156	59	44	2,083
Middle Street	154	232	43	65	2,061
Kalihi	174	311	49	87	2,023
Kapalama	45	277	13	77	1,959
Iwilei	162	331	45	92	1,912
Chinatown	43	202	12	57	1,867
Downtown	272	1,778	76	494	1,449
Civic Center	48	633	14	176	1,287
Kakaako	28	422	8	118	1,177
Ala Moana Cntr	0	4239	0	1178	0

Westbound	1 Hour Peak		15 minute peak		
Station	Ons	Offs	Ons	Offs	Line Volume
Ala Moana Cntr	1,004	0	314	0	314
Kakaako	83	41	26	13	327
Civic Center	101	97	32	31	328
Downtown	278	253	87	80	335
Chinatown	48	41	15	13	337
Iwilei	240	66	75	21	391
Kapalama	34	81	11	26	376
Kalihi	86	140	27	44	359
Middle Street	172	75	54	24	389
Lagoon Drive	47	177	15	56	348
Airport	62	193	20	61	307
Pearl Harbor	63	284	20	89	238
Aloha Stadium	145	100	46	32	252
Pearlridge	123	256	39	80	211
Pearl Highlands	443	119	139	38	312
Leeward CC	22	232	7	73	246
Waipahu Cntr	108	133	34	42	238
West Loch	40	290	13	91	160
Hoopili	61	34	20	11	169
UH West Oahu	1	225	1	71	99
East Kapolei	0	321	0	101	0

The morning peak direction is eastward, or towards Koko Head. The ons and offs and the line volume for the 15-minute peak-of-the-peak at each station in the peak direction is shown in Figure 3-1.

Aloha Stadium is the eastward peak load point of the line. The peak line segment will be between Aloha Stadium and Pearl Harbor with 2,246 passengers forecast to be traveling east on the line during the morning 15-minute peak-of-the-peak. Large work-based ridership will exit the line at both Pearl Harbor and the Airport. More than 52% of the eastbound peak period passengers are projected to alight at the eastern terminal of Ala Moana.

Figure 3-1. Eastbound/Koko Head Peak 15 Minute Period



3.3.2 Forecast Year Peak System Capacity

The PMOC has confirmed that the City has developed a service plan that will provide sufficient person capacity, with only minor exceptions to its loading standard that are well within the allowable TCRP 100 crowding limits.

The Planned Peak Person Capacity is the total capacity planned to be provided during the peak-of-the-peak period. Once this is established, the planned capacity will be compared against the Forecast Year Peak Period Passengers (see Section 3.3.1), which determines the overall theoretical adequacy of the transit capacity in its 2030 forecast year.

The City is proposing to alternate two and three-car trains every three minutes during peak periods. The City has established a desired loading standard of 3.4 ft^2 of space per standing passenger, which results in an average peak train capacity of 405 passengers. With planned peak service operating two- and three-car trains every 3 minutes, the total capacity in the peak 15-minute period is equal to 2,025 standing and seated passengers.

A slightly tighter 3.2 ft^2 level of crowding is characterized as "reasonable" by *TCRP 100*, or 423 passengers per average train, providing a maximum 2,113 person capacity in the peak 15-minute period. Additionally, a "crush load" of 2.15 ft^2, considered allowable for short segments for limited periods of time during the peak-of-the-peak, has been accepted as an absolute upper bound.[15] Table 3-4 summarizes these differing capacity levels, while Equations 1-3 provide the arithmetic calculations for the train capacity.

Table 3-4. Total Capacity by Loading Density Level[16]

Loading Density Level	Desired	Optimal	Maximum
Space per Standing Passengers (sq/ft per standee)	3.4	3.2	2.15
Seats	50	50	50
Standees Per Car	112	119	177
Total capacity per car	162	169	227
Total capacity per train	**405**	**423**	**568**
Total capacity, 15 minute peak	**2025**	**2113**	**2839**

Equation 1: Desired 15-Minute Total Person Capacity at 3.4 sq/ft per Person

$$15 MinutePersonCapacity = \frac{15 Minutes}{3.0 Minutes / Train} \times 405 Pass / AvgTrain = 2025$$

Equation 2: Optimal 15-Minute Total Seated Capacity at 3.2 sq/ft per Person

$$15 MinuteSeatedPersonCapacity = \frac{15 Minutes}{3.0 Minutes / Train} \times 423 Pass / AvgTrain = 2113$$

Equation 3: Maximum 15-Minute Total Seated Capacity at 2.15 sq/ft per Person

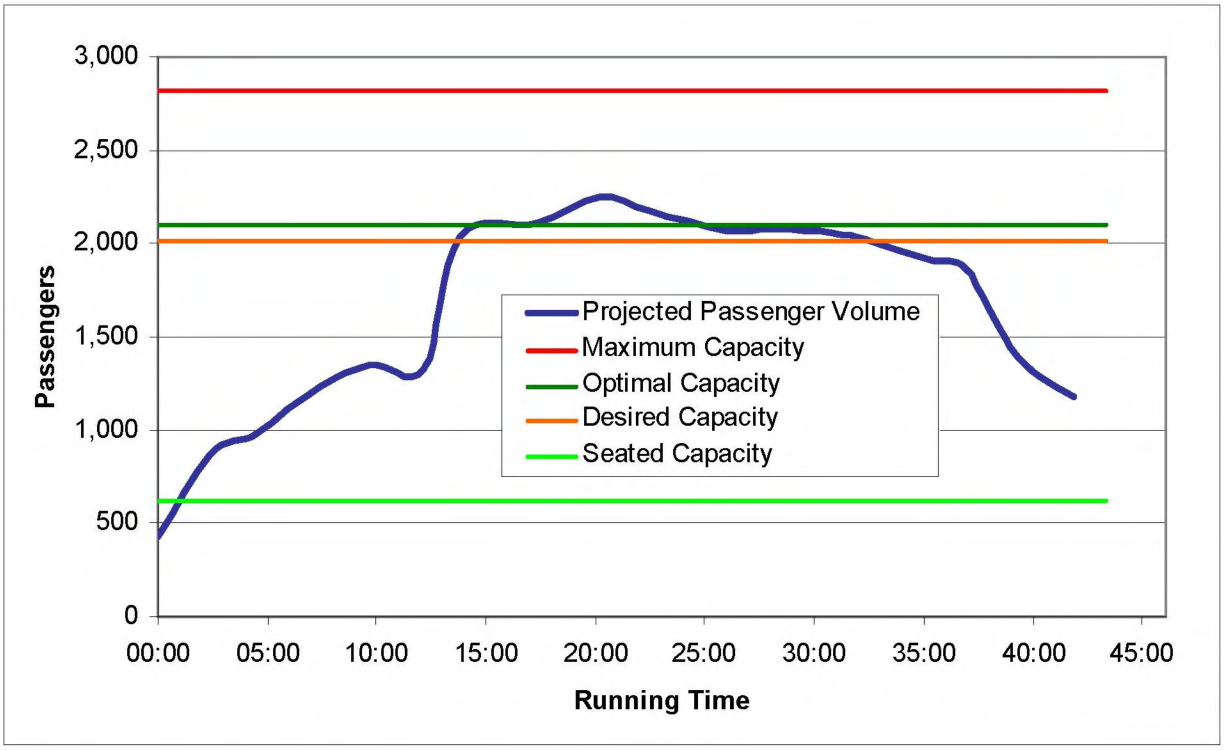
$$15 MinuteSeatedPersonCapacity = \frac{15 Minutes}{3.0 Minutes / Train} \times 568 Pass / AvgTrain = 2839$$

Figure 3-2 illustrates the relationships between the forecast peak 15-minute passenger volume and the planned seated, 3.4 ft^2/standee (City Desired), 3.2 ft^2/standee (TCRP Optimal), 2.15 ft^2/standee (TCRP Maximum) capacities. As shown in Figure 3-2, there will be standees after the departure from the second station at University of Hawaii West Oahu. The chart illustrates the planned service capacity exceeds both the City Desired and TCRP Optimal loading standards, while well within the TCRP maximum "crush" standard that can be accepted during the peak 15 minute period. There is only one single station segment between Aloha Stadium and Pearl Harbor that will marginally exceed the TCRP Optimal loading standard, a segment of less than two minutes in duration.

[15] TCRP 100, (pp 5-27)

[16] Assumes 380.8 sq/ft of floor space in each car

Figure 3-2. East/Koko Head-bound AM Peak-of-the-Peak 15-Minute Passenger Volume



3.3.3 Running, Station Dwell, and Cycle Time Assessment

The running, dwell, and resultant cycle times determine the minimum system train requirements. This section reviews each input independently to develop a cycle time for the proposed system. The City has made a number of refinements in running and dwell time assumptions, and has added to its rolling stock requirements. Reviewing these new running times is essential, especially with the recent 28% increase in forecast ridership made by the City.

3.3.4 Running Time

The City modeled the station-to-station running times with an acceleration assumption of 3.00 mphps and average of 2.2 mphps. The City deceleration assumption is 2.0 mphps. Maximum speed of the vehicle is 55 mph. Without tools needed to replicate the City's calculations, the PMOC will accept the City's simulation was conducted with appropriate speed limitations caused by known curvature, grade, and track quality constraints. Table 2-5 provides a summary of the inter-station running times as provided by the City, and excludes station dwell and terminal recovery time.

Table 3-5. Running Time Projections Station to Station Running Time – Excluding Station Dwell & Recovery

East/Koko Head-bound	
Station	**Time**
East Kapolei	-
UH West Oahu	113
Hoopili	103
West Loch	137
Waipahu Cntr	111
Leeward CC	120
Pearl Highlands	60
Pearlridge	183
Aloha Stadium	140
Pearl Harbor	109
Airport	182
Lagoon Dr	103
Middle Street	129
Kalihi	62
Kapalama	73
Iwilei	64
Chinatown	62
Downtown	84
Civic Center	53
Kakaako	68
Ala Moana Cntr	86
Seconds	**2042**
Total time	**0:34:02**

West/Ewa-bound	
Station	**Time**
Ala Moana Cntr	-
Kakaako	123
Civic Center	69
Downtown	52
Chinatown	80
Iwilei	63
Kapalama	65
Kalihi	74
Middle Street	67
Pearl Harbor	124
Airport	102
Lagoon Dr	186
Aloha Stadium	108
Pearlridge	140
Pearl Highlands	183
Leeward CC	65
Waipahu Cntr	121
West Loch	109
Hoopili	142
UH West Oahu	103
East Kapolei	75
Seconds	**2051**
Total time	**0:34:11**

3.3.5 Station Dwell Time

Dwell time, or the time a train spends while stopped at a station, has been an ever-evolving methodological discussion for the industry. It is expected that the HHCTPC will benefit from new generation train control systems, which are expected to reduce the lagging dwell time performance on first generation AGT systems, including the Vancouver SkyTrain.

TCRP 100 presents three methods to estimate station dwell times. The most developed and tested is based on its predecessor, *TCRP 13,* which models dwell times as a function of passenger activity, an overhead value related to door operation and signal system, and a loading diversity factor, which compensates for unevenly dispersed passenger boarding.[17] It is worth noting that *TCRP 13* notes the ongoing analytical dilemma by stating, "None of these methods are entirely satisfactory. It is regrettable that the study failed to find a better method of estimating dwell or controlling dwell times and explains why other practitioners over a period of three decades have resorted to simply assigning a reasonable value to dwell."[18] The second methodology presented

[17] Parkinson, Tom and Fisher, Ian. Rail Transit Capacity (TCRP Report 13). Transportation Research Board, Washington DC. 1996. pp. 48

[18] TCRP Report 13. pp 81

in *TCRP 100* uses a traditional "mean plus two standard deviations, while the third method utilizes professional peer system performance and experience.

The City utilizes the third methodological approach, using the peer system methodology since it is the most widely used for transit systems in the pre-PE stage of development. There are many unknown and untested elements that may or may not improve dwell time performance, including expected improvements in automated train control systems.

City Proposed Station Dwell Time
The City has presented newly updated variable dwell assumptions, ranging from 20 seconds for stations with fewer than 500 boardings and alightings in the peak hour to 45 seconds for the most heavily used stations that have over 3000 passengers boarding and alighting.[19] Overall, the City has projected that dwell time will be 23.2% of total running time in the peak period and direction. The east/Koko Head-bound intermediate station dwell times are estimated to total 475 seconds, or an average 25 seconds for all intermediate stations. Based on the morning peak station boarding forecasts, the Project corridor has nine of its intermediate stations with fewer than 500 peak hour passenger boardings and alightings - a very low volume of activity considering the frequency of service and the total number of passengers projected to utilize the line. Based on a three-minute planned headway, there would only be an average of 25 boardings and alightings per train, or 5 persons per door in the peak direction at these nine lesser stations, making the 20 second dwell assumption a seemingly reasonable operating assumption at these stations.

Reasonableness of the Proposed Station Dwell Times
Strictly speaking, the PMOC has found the variable dwell times used by the City to be outside current TCRP performance envelopes. However, at this stage of pre-PE, it is clear that the City is considering these relevant dwell issues in its service planning and system design. Furthermore, advances in AGT train control systems can be expected to substantially improve the precision docking and door safety systems, which may allow the City to operate at or near these early design assumptions. There will also be a vital passenger familiarization period when the City will have an opportunity to condition their new system riders with rapid and abrupt door closing sequences in order to minimize dwell times as some North American properties have been able to do (notably Toronto).

The PMOC has tested these City station dwell assumptions against both *TCRP 13* and *TCRP 100* methodologies. In general, the PMOC has found that the City dwell assumptions continue to be optimistic by more than 4% above the *TCRP 13/100* technical outputs. However, the system performance may be feasible based on the final car design, "passenger training," and next generation train control systems. Critical to this effort is the development of a service recovery plan for those instances where dwell exceeds terminal turn back time (which may include dropping back trips and shortening trips with mid-route turnbacks).

The PMOC notes a new challenge to dwell time maintenance that the City has introduced with its recent revisions to its service plan: the operation of alternating two and three car trains. Passengers arriving randomly for peak service will find either a car with less space or more

[19] HHCTCP Fixed Guideway Fleet Sizing Report, June 2009 pp 8

space. The two car trains will have more dwell as the cars gets more crowded, which causes the following three-car set with service capacity to "run up" behind the short set. The train control management system and its ability to maintain even spacing will be critical to best utilizing capacity and overcoming these known performance issues. Additionally, passenger door interference could be expected as passengers positioned for a three car train now must reposition with other passengers when a two car train arrives, even if station platform information systems alert passengers otherwise.

The PMOC was unable to definitively address or isolate this mixed car length dwell time challenge from its assessment of the City's service plan and capacity and has assumed even spacing based on a simple average train length of 2.5 with 4 doors per car side and 10 passenger flow channels.

PMOC TCRP 13 Dwell Assessment
TCRP 13 estimates a nested pair of linear regression equations to model dwell time. First, the passenger activity time is modeled as a function of passengers boarding and alighting. Next, the total time a vehicle will spend standing at a station is modeled as a function of the passenger activity time and a constant term. Using natural logarithms, the functional form of this model is shown in Equation 4 and Equation 5. The estimators for the model are shown in Table 2-6. This regression model was calibrated using data from North American level boarding heavy-rail systems, including systems using automatically controlled doors.[20] Values for each variable are defined in Table 3-6.

Equation 4: TCRP Passenger Activity Time Regression Model

$$Ln(\text{passenger activity time}) = activityConstant + B*boarding + A*Alighting + B2*(Boarding)^2 + A2*(Alighting)^2$$

Equation 5: TCRP Dwell Time Regression Model

$$Ln(\text{dwell time}) = dwell\ Constant + T * (\text{activity time from above equation})$$

Table 3-6. TCRP Dwell Time Regression Model Estimators[21]

Passenger Activity Time Estimators	
activityConstant	1.514
B	0.0987
A	0.0776
B2	-0.00159
A2	-0.000985
Dwell Time Estimators	
dwellConstant	3.168
T	0.0254

[20] TCRP 13. (pp. 45)
[21] TCRP 13, pp 48

Ridership forecasts for the peak-of-the-peak 15-minute time period are then used to estimate the maximum dwell time. Table 3-7 presents the resulting station 15-minute level passenger activity (ons and offs). The passenger activity by station for each train through the peak-of-the-peak is calculated by dividing the passenger activity for the 15-minute peak-of-the-peak by the number of trains scheduled for the peak 15-minute period.

Noted here are the station design criteria for passenger stations, which includes these objectives:

- "Station platforms shall be sized to accommodate site specific patronage projections. The minimum area (excluding elevator, escalator, stair queuing space, and the 24-inch platform safety edge strip) should accommodate the peak 15-minute entraining load at 10sq.ft/person or the peak 15-minute de-training and entraining loads at 7sq.ft/person.
- The minimum width of a center platform is 30'-0".
- The minimum width of a side platform is 12'-0" where the vertical circulation elements (stairways, escalators and elevators) are located outside the limits of the platform.
- In no case shall the clear distance between the edge of the platform and any obstruction be less than 8'-0".
- The length of the boarding platforms shall be 300 feet."[22]

Passengers may board or alight the train at each station in parallel across all the available doors. The vehicle specification calls for two or three double-stream doors on each side of the car.[23] To generate the most constrained dwell time estimates, two double-stream doors per side are assumed for this analysis: Passenger activity per two car train would be distributed across four doors, or eight passenger streams. Since the City has introduced the service concept of operating alternating two and three car trains, an average of 2.5 cars with an average of ten passenger streams is assumed.

Unless a station platform is especially crowded, waiting passengers do not tend to disperse themselves evenly across the platform. When the train arrives, the activity at each door is not identical. To account for the uneven distribution of passenger activity, a door ratio multiplier is used to predict the passenger activity at the peak door. A door ratio value of 1.2, or an increase of 20% over the average door, is recommended for evenly loaded heavy rail systems, with a higher 1.5 door ratio value to reflect the "unevenness" for light rail services.[24]

As Table 3-7 illustrates, the minimum dwell time possible under this TCRP 13 forecast is 28 seconds, regardless of passenger activity. This becomes a critical difference between PMOC and City dwell time assumptions, and will require further discussion as train control performance systems become better defined and the introduction of the Vancouver Canada Line takes place.

[22] HHCTCP Design Criteria – Architectural, Draft June 30, 2008 pp. 30 to 31
[23] HHCTCP Design Criteria – Revenue Vehicle. August 1, 2008. Draft pp. 5
[24] TCRP Report 13 pp. 82

Table 3-7. TCRP 13 Peak Direction Dwell Time Estimates

East/Koko Head-bound	Total Train		Peak Door			Forecast Dwell Time (Seconds)
Station	Ons	Offs	Ons	Offs	Onboard	
East Kapolei	1,546	0	430	0	86	-
UH West Oahu	1,588	4	442	2	174	32
Hoopili	439	20	122	6	197	28
West Loch	1,004	104	279	29	247	30
Waipahu Transit Cntr	466	61	130	17	270	28
Leeward CC	83	156	24	44	266	28
Pearl Highlands	2,712	148	754	42	408	39
Pearlridge	630	368	175	103	423	30
Aloha Stadium	591	114	165	32	449	28
Pearl Harbor	241	488	67	136	435	29
Airport	146	539	41	150	414	28
Lagoon Dr	211	156	59	44	417	28
Middle Street	154	232	43	65	412	28
Kalihi	174	311	49	87	405	28
Kapalama	45	277	13	77	392	28
Iwilei	162	331	45	92	382	28
Chinatown	43	202	12	57	373	28
Downtown	272	1,778	76	494	290	32
Civic Center	48	633	14	176	257	29
Kakaako	28	422	8	118	235	28
Ala Moana Cntr	0	4,237	0	1,177	0	-
Total Dwell (excluding first and last stations)						09:17

<u>Comparison of PMOC and City Running and Dwell Times</u>
Table 3-8 and Table 3-9 provide a comparison between the dwell time assumptions. Overall, the TCRP dwell analysis results in 4.31% additional running time (3:34 additional minutes) for each round trip, due to differing dwell assumptions. As summarized in Table 3-8 below, the primary issue driving this variance between the City and TCRP is due to the large number of lightly used stations where a minimum of 28 seconds is required by TCRP, regardless of passenger activity. This differs from the City's assignment of 20 seconds for each light duty station. This is especially pronounced in the off-peak direction, where minimum travel time varies by over 5% from the City's estimates.

Table 3-8. Summary of Minimum Run Time Estimates

Direction	Running time	Dwell		Minimum Trip Time			
		City	TCRP	City	TCRP	Difference	Percent
Eastbound	34:02	07:55	09:17	41:57	43:19	01:22	3.24%
Westbound	34:11	06:30	08:42	40:41	42:53	02:12	5.41%
Round trip	08:13	14:25	17:59	1:22:38	1:26:12	03:34	4.31%

Table 3-9. Comparison of Direction Dwell Time Estimates

Eastbound	Running Time	Dwell Time (seconds) City	TCRP 13	Difference
East Kapolei	-	-	-	
UH West Oahu	01:53	35	32	2.8
Hoopili	01:43	20	28	-8.0
West Loch	02:17	30	30	0.1
Waipahu	01:51	25	28	-3.5
Leeward CC	02:00	20	28	-7.5
Pearl Highlands	01:00	40	39	1.1
Pearlridge	03:03	25	30	-4.8
Aloha Stadium	02:20	25	28	-3.5
Pearl Harbor	01:49	25	29	-3.7
Airport	03:02	25	28	-3.2
Lagoon Dr	01:43	20	28	-8.0
Middle Street	02:09	20	28	-8.0
Kalihini	01:02	20	28	-8.3
Kapalama	01:13	20	28	-7.5
Iwilei	01:04	20	28	-8.3
Chinatown	01:02	20	28	-7.5
Downtown	01:24	40	32	7.7
Civic Center	00:53	25	29	-3.5
Kakaako	01:08	20	28	-7.9
Ala Moana Cntr	01:26	-	-	
Dwell time		07:55	09:17	
Total Running Time	**34:02**	**41:57**	**43:19**	**01:22**

Westbound	Running Time	Dwell Time (seconds) City	TCRP 13	Difference
Ala Moana Cntr	-	-	-	
Kakaako	02:03	20	27	-7.3
Civic Center	01:09	20	27	-7.3
Downtown	00:52	25	28	-3.0
Chinatown	01:20	20	27	-7.3
Iwilei	01:03	20	28	-7.6
Kapalama	01:05	20	27	-7.3
Kalihini	01:14	20	27	-7.3
Middle Street	01:07	20	28	-7.6
Lagoon Dr.	02:04	20	28	-7.5
Airport	01:42	20	28	-7.5
Pearl Harbor	03:06	20	28	-7.5
Aloha Stadium	01:48	20	27	-7.3
Pearlridge	02:20	20	28	-7.5
Pearl Highlands	03:03	25	28	-3.0
Leeward CC	01:05	20	28	-7.5
Waipahu	02:01	20	27	-7.3
West Loch	01:49	20	28	-7.5
Hoopili	02:22	20	27	-7.3
UH West Oahu	01:43	20	28	-7.5
East Kapolei	01:15	-	-	
Dwell time	-	06:30	08:42	
Total Running Time	**34:11**	**40:41**	**42:53**	**02:12**

3.3.6 Cycle Time & Vehicle Requirements

Cycle time is the sum of the round trip running time and layover time, as a multiple of the headway. The City's planned round trip cycle time for the 3-minute peak headway is 1:27:00, of which is 1:22:38 is inter-station running and station dwell and 4:22 for layover time.[25] The vehicle design criteria report[26] specifies a minimum layover time of two minutes at each terminal, or a total of 4 minutes built into the cycle time. The PMOC has adjusted this recovery time to 06:48 to account for the additional 3:00 minutes of total cycle time necessary when increasing the dwell time. The 06:48 Recovery time represents the total cycle time of 1:33:00, less the station-to-station running time, and adjusted dwell time.

[25] HHCTCP Fixed Guideway Fleet Sizing Report, June 2009 Page 8; The forecast provided in the document counts 80 seconds of dwell time at the last stations as running time, not recovery time. For the purposes of this capacity review, this 80 seconds dwell is included as part of the recovery time, not the gross running time. This allows the HHCTCP to have recovery times that are consistent with its minimum vehicle specifications.

[26] HHCTCP Design Criteria – Revenue Vehicle, March 2009. Draft pp. 12-17

Table 3-10. Cycle Time & Vehicle Requirements Comparison

Item	City	TCRP
Interstation	1:08:13	1:08:13
Dwell	0:14:25	0:17:59
Subtotal	1:22:38	1:26:12
Recovery	0:04:22	0:06:48
Run Time	1:27:00	1:33:00
Cycle	87	93
Trains	29	31
Cars	**73**	**78**
Spare (15%)	11	12
Total cars	**83**	**89**

The PMOC notes that the recent City documentation, analysis and operating philosophy has substantially evolved and has introduced a number of creative elements that address the realities and uncertainties of designing and operating a heavily patronized transit corridor. The City has applied an artificial loading cap of 90% to provide sufficient capacity for the service to grow into.[27] With this self-imposed cap, the City has stated that it needs 85 cars, two above the calculated minimum of 83 cars.

Based on a strict interpretation of the TCRP dwell time analysis, the PMOC estimates that a theoretical minimum standard running time is 93 minutes. However, a 90 minute cycle could be achieved if 12 fewer seconds of dwell time were allowed. The constraining factor is a minimum 4 minute round trip terminal turn stated by the vehicle specifications which require the four minute threshold to be met. A three minute reduction in cycle time is equivalent to one entire train set being removed from the service plan.

With a very conservative 93 minute cycle and assuming the 2.5 cars per train, the project will require 89 cars, or four cars above the City's 85 car fleet projection for 2030.

Given the substantial changes, improvements and creative thinking that have occurred over the last six months, the PMOC does not recommend a strict and overly conservative interpretation of *TCRP 13/100* be applied to this project. The PMOC is confident that the 85 vehicle fleet size will be sufficient to meet the service needs for the City and its customers, especially when short-turning service at Leeward is incorporated into the operating plan.

3.3.7 Terminal Turnback Capacity

The City supplied documentation does not detail the turnback operation (or looping at the ends of the line) so PMOC has no documentation to review and assess. *TCRP 100* provides a methodology to undertake such an analysis, including a formula to calculate the maximum time available per track for terminal layover.[28] However, preliminary plan drawings for the East Kapolei and Ala Moana terminals can be presumed to be optimally designed with double

[27] HHCTCP Fixed Guideway Fleet Sizing Report, June 2009 pp. 11
[28] TCRP Report 100 (pp. 5-15 pp. 5-17)

crossovers in front of both locations, so as to ensure a platform is accessible for an inbound train within the 3:00 minute window to maintain headways and avoid limiting the line capacity. Nonetheless, during peak periods such limited layover times can be difficult to maintain.

Recent discussions with the City on June 3, 2009 indicated that mid-corridor turnbacks of some trains at Leeward were being considered to optimize capacity and minimize car requirements. Review of preliminary plan drawings does not suggest that a clear and reliable turnback operation has been included at this early design stage. The PMOC recommends this design review take place in order to ensure proper integration of the originating trains from the maintenance facility, the short-turning, and that through trains are properly considered.

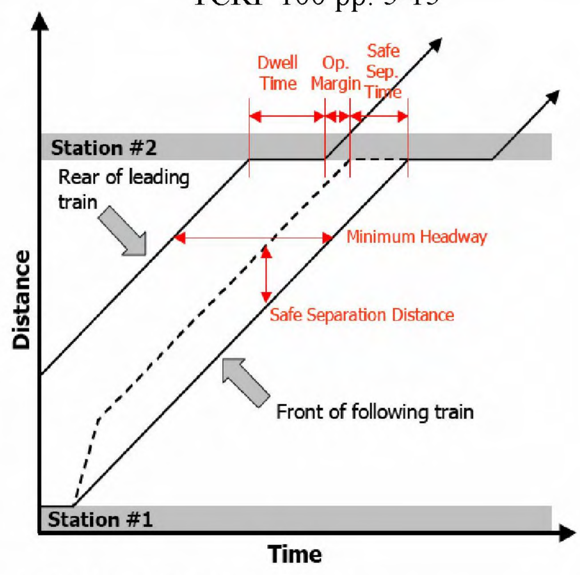
In *TCRP 100*, several strategies are outlined which other peer systems utilize to improve the terminal time turnback. Given the proposed speed restrictions for approaching stations, including terminal stations and the planned operating characteristics of the mini metro transit vehicle, the PMOC encourages the City review and address this critical operating issue early and be prepared to be realistic in finalizing operating schemes and designs so as to effect accurate and reliable terminal operations.

The PMOC recommends that The City review its minimum vehicle turnaround requirements. Four minutes may be excessive for an AGT system, based on existing services currently in operation.

3.4 Maximum Line Capacity

Figure 3-3. Distance-Time Plot of Two

TCRP 100 pp. 5-15



NOTE: Acceleration and braking curves omitted for clarity.

Line capacity is a function of track configuration, passenger activity, station characteristics, vehicle characteristics (performance and length), and the minimum following distance between trains. The Project consists of entirely double-tracked exclusive right of way. In the absence of detailed design and because this corridor is all new construction, the turnbacks at either terminal end are presumed to be optimally designed with double crossovers in front of the configured terminals so as to ensure a platform is accessible within the 2:48 or 3:30 minutes of window to maintain headways and to avoid limiting the line capacity. Consequently, the line capacity is presumed here to be limited solely by the passenger activity, station characteristics, vehicle characteristics, and the minimum following distance between trains. This presumption is not to imply that any of the other points raised are to be overlooked during additional planning and design by the City, but rather that the presumption is made that, given the exclusive guideway and track configuration, the design can be made to meet the cycle times required with the correct train availability and functioning automatic train control and supervision.

Figure 3-3 illustrates how dwell time, operating margin, and safe separation time combine to define the minimum headway.

- Dwell time, as modeled in Section 3.3.1, is influenced by the number of passengers boarding, alighting, and onboard as well as the train and platform configuration.
- Operating margin is literally a margin for random events which introduce service perturbations in daily operations (e.g. a briefcase caught in a door or a glitch in train performance). The estimate of operating margin represents the time for the train to clear the station and depends on platform and train length. *TCRP 100* recommends a default value of 20 seconds for operating margin.[29]
- Safe separation time is a function of the minimum following distance, train length, and vehicle speed.

The minimum sustainable headway is equal to the sum of these three components.

The minimum achievable headway on any double track line is established at the station with the longest dwell time or the station with the most severe speed restriction below the optimal station approach speed. This is called the "critical station." The longest dwell time during the peak-of-the-peak (39 seconds) is forecast to occur at Pearl Highlands in the eastbound direction. The City documentation on civil elements and the data utilized in the train modeling identifies the lowest speed restriction across the entire corridor as 25 mph which, therefore, would not reduce the optimal approach speed to stations and terminals. Since the Project signaling system has not yet been specified, it is expected that the automated operation would rely on a "cab-control" or "moving-block" signal train control methodology.

TCRP provides a safe separation distance calculator to estimate minimum train separation time as a function of: station length; train approach speed to the station; maximum line speed; train's mechanical characteristics; type of signal control; and the grades at the critical station.[30] The formula to calculate the minimum headway is shown in Equation 6: Minimum Train Separation Formula. Variable descriptions and values are shown in Table 3-11.

Equation 6: Minimum Train Separation Formula
(Variables are defined in Table 2-11)

$$H(s)=\sqrt{\frac{2(L+D)}{a_s(1-0.1G_x)}}+\frac{L}{v_a}+\left(\frac{100}{K}+B\right)\left(\frac{v_a}{2d_s(1+0.1G)}\right)+\frac{a_s(1-0.1G)t_{os}^2}{2v_a}\left(1-\frac{v_a}{v_{\max}}\right)+t_{os}+t_{jl}+t_{br}$$

[29] TCRP Report 100. (pp. 5-67)

[30] TCRP A-8 Rail Transit Capacity, Transport Consulting Limited, 111-1141 West 7th Avenue, Vancouver BC Canada.1996.

Table 3-11. Minimum Train Separation Calculation Input Variables

Term	Units	Description	Source	Value
L	meters	length of the longest train	City	54.9
D	meters	distance—front of train to exit block	TCRP Default	10
K	constant	% service braking rate	TCRP Default	75
B *cab control signaling*		train detection uncertainty constant	TCRP Default	1.2
B *moving block signaling*		train detection uncertainty constant	TCRP Default	1
t_{os}	seconds	overspeed governor operating time	TCRP Default	3
t_{jl}	seconds	time lost to braking jerk limitation	TCRP Default	0.5
a_s	m/s^2	service acceleration rate	City	1.34
d_s	m/s^2	service deceleration rate	City	0.89
t_{br}	seconds	brake system reaction time	TCRP Default	1.5
v_{max}	km/h	maximum line velocity	City	88
P_e	meters	Positioning error (moving block only)	TCRP Default	6.25
v_l	%	% of normal line voltage	TCRP Default	90
G	%	Grade into headway critical station	City	-3.12

The minimum train separation is calculated for both cab-control and moving-block signaling in Table 3-12. The optimum approach speed with either signal control type is lower than all speed restrictions on the corridor. Consequently, the approach speed limits do not restrict the minimum achievable headway on the proposed Project. Pearl Highlands would be the critical station because the 39-second dwell time forecast at this station is the longest on the network. The minimum train separation at Pearl Highlands would be 38 seconds for cab-control and 28 seconds for moving-block.

Table 3-12. Signal Type Capacity Constraints

	Cab-control	Moving-block
Minimum train separation (sec)	38	28
Optimal approach speed (mph)	10.5	12

The minimum sustainable headway is equal to the sum of the dwell time, operating margin, and the minimum train separation at the critical station. Dwell time and operating margin are independent of the signaling system. The PMOC estimates the minimum sustainable headway with a cab-control signaling system would be 97 seconds and 87 seconds with a moving-block signaling system heading eastbound at Pearl Highlands Station.

Table 3-13. Minimum Sustainable Headway (seconds)

Item	Cab Control	Moving Block
Dwell Time	39	
Operating Margin	20	
Safe Separation	38	28
Total	**97**	**87**

Therefore, with either signaling type (cab-control or moving-block) a 3:00 minute headway is well within the capability of the planned corridor. In fact, the peak headway could be reduced by almost 50% in response to increased ridership, if sufficient cars were available for operation.

3.5 Maximum Person Capacity

Person capacity is calculated from the line capacity and the car capacity. Section 3.4 found that the Project's minimum sustainable headway for two car trains is 97 or 87 seconds with cab-control or moving-block signaling, respectively. Each average train could carry up to 423 passengers with a loading standard of 3.2 ft^2 of standing space. Following the TCRP guidelines, the person capacity calculation is adjusted downward by a peak hour factor to accommodate realistic variability in passenger loadings (i.e., patrons will generally adjust the arrivals to better ensure either a seat (optimal for many) or a less crowded car, thus the partial mitigation in the consistency of the peak-within-the-peak demand). Depending on the signaling type, the maximum person capacity would be either 14,129 or 15,753 passengers per hour.

Table 3-14. Maximum Person Capacity

	Cab Control	Moving Block
Minimum Headway (sec)	97	87
Trains per Hour	37.1	41.4
Passengers per Train	423	
Peak Hour Factor	0.9	
Maximum Passengers per Hour	**14,129**	**15,753**

3.6 Conclusions

(1) The PMOC notes that the recent City documentation, analysis and operating philosophy has substantially evolved and has introduced a number of creative elements that address the realities and uncertainties of designing and operating a heavily patronized transit corridor.

(2) The general system capacity assumptions, conclusions and plan are reasonable and within a normal range of precision at this Pre-Preliminary Engineering (PE) stage.

(3) The planned peak headway of 3:00 minutes with a mix of two and three car consists can provide a sufficient amount of capacity to serve the 2030 peak-of-the-peak passenger demand.

(4) The minimum dwell time assumption of 20 seconds per station may be too short. Based on the strict application of *TCRP 13* and *TCRP 100* dwell time methodologies, the City dwell assumptions are 4% lower than modeled levels. This was largely due to the minimum 28 second station dwell times assigned to lightly used trains in the reverse direction. However, the PMOC notes that the strict application of dwell times using *TCRP 13* and *TCRP 100* may not be prudent as those manuals themselves note the methodological uncertainties and

wide range of experiences among different transit operators. Evolving automated guideway technologies (AGT) further obscure the precision of a strict dwell time model.

(5) The 2030 project scope has a vehicle fleet size of 85 vehicles The PMOC concurs that this is an appropriate fleet size for this project at this early pre-PE stage of design. Indeed, the City has done a commendable job at articulating some of the issues that will ultimately impact fleet size. With the 85 car fleet, the City can now work to conserve or mitigate any erosion of corridor velocity or capacity that may occur during the next stages of design.

(6) While full 2019 ridership projections were not available to the PMOC at the time this Spot Report was prepared, the City did provide a total corridor peak hour forecast of 6,977 in the first year of operation (2019) with a corresponding fleet requirement of 76 cars. This peak hour forecast in 2030 is 10,583 with a fleet requirement of 85 cars. The peak hour forecast in 2019 is 66% of that in 2030, whereas the fleet requirement in 2019 is 89% of that in 2030. Based on its fleet plan of 76 cars for the initial service launch operating on the three-minute headway and the operational flexibility that the City will implement through track configuration, the PMOC is confident that there is sufficient capacity to adequately handle the 2019 passenger demand assuming that the boarding and alighting patterns are similar to the 2030 projections. Due to the lesser ridership, the City should be able to have two-car consists for all trains in 2019.

(7) With either a cab-control or moving-block signaling type, service operating at 3:00-minute headways is well within the capability of the planned corridor. A minimum 2:00-minute headway could be operated on this corridor if future demand requires.

(8) The current morning peak direction ridership projections for the project are 10,583 passengers per hour. Depending on the signaling type, the maximum person directional capacity is either 14,129 or 15,753 passengers per hour, and thus would support the anticipated ridership projection.

3.7 Recommendations

(1) The City should perform research and documentation on the actual Honolulu time-of-day and day-of-week travel patterns to substantiate the important peak hour factor. A review of weekend service requirements would also be helpful to ensure that adequate capacity is incorporated into the service design.

(2) Additional review of the benefits, impacts and issues with short-turning some service at Leeward C.C. Station could be beneficial for both vehicle requirements and operations and maintenance (O&M) cost.

(3) During FD, the City should review and detail a service recovery plan that addresses those likely cases when the headway cannot be maintained and what

happens to dropped or late trips. Additionally, the City should consider the interval maintenance issues of operating differing train lengths in a very frequent corridor.

(4) The City should review and consider the minimum dwell time it uses to support its 20 second minimum dwell time assumptions. A review or update on the issues would be helpful, especially as Vancouver's Canada Line (a peer system) enters initial service.

(5) The City should review its vehicle turnaround requirements. Four minutes may be excessive for an AGT system, based on existing services currently in operation.

(6) The City should ensure that the service velocity does not erode over the next course of design changes. Continually modeling a new or changed alignment or design assumptions is vital to a robust and reliable system that delivers effective mobility.

4.0 SUBTASK 32E: PROJECT DELIVERY METHOD REVIEW

4.1 Methodology

The PMOC followed the requirements outlined in the *FTA PG #32: Project Scope, Definition and Capacity Review Procedures,* dated March 29, 2007 to assess and evaluate the grantee's technical approach for delivering the proposed Project within the constraints of their existing or proposed statutory or organizational procurement authority and in the context of their project strategies, risk analysis, and procurement planning. The PMOC also assessed and evaluated whether the grantee's project delivery method and contracting packaging strategy as defined and implemented in the Project Management Plan (PMP) minimizes project risks and provides the greatest likelihood of implementation success. Specifically, this section of the Spot Report provides an overview of the contracting methodology to be employed during the design, construction, and procurement phases of the project.

To support the Project Delivery Method Review, the PMOC reviewed the files, reports and documents identified in Appendix B.

4.2 Review

This section refers only to the First Project as described in Section 2.0 of this Spot Report. The First Project has been divided into four (4) segments as shown in Figure 4-1. The City intends to implement the First Project in two phases. Phase I consists of the West Oahu/Farrington segment and is scheduled to begin incrementally staged operations by the end of 2012. Phase II includes the Kamehameha, Airport, and City Center segments and is scheduled to begin incrementally staged operation in late 2017. Full revenue service along the entire corridor is anticipated to occur in March 2019. The City intends to utilize a combination of traditional and alternative contract delivery methods to implement the First Project as described herein.

Table 4-1 presents the City's target dates for key milestones of this New Starts Project as identified in their Master Project Schedule.

During the June 2009 workshop, the potential for packaging several of the Letters of No Prejudice (LONP) requests was discussed. The City will consider this option as they continue to develop their project documents. It should be noted that all milestones associated with LONP must be compliant with the requirements of federally sponsored projects. An LONP cannot be considered until a Record of Decision has been issued. If there is a delay in the issuance of an ROD, there would be a delay in the consideration of any LONPs.

The scope of each Standard Cost Category (SCC) element pertinent to the Project is discussed in the following sections.

Figure 5-1. Construction Segments

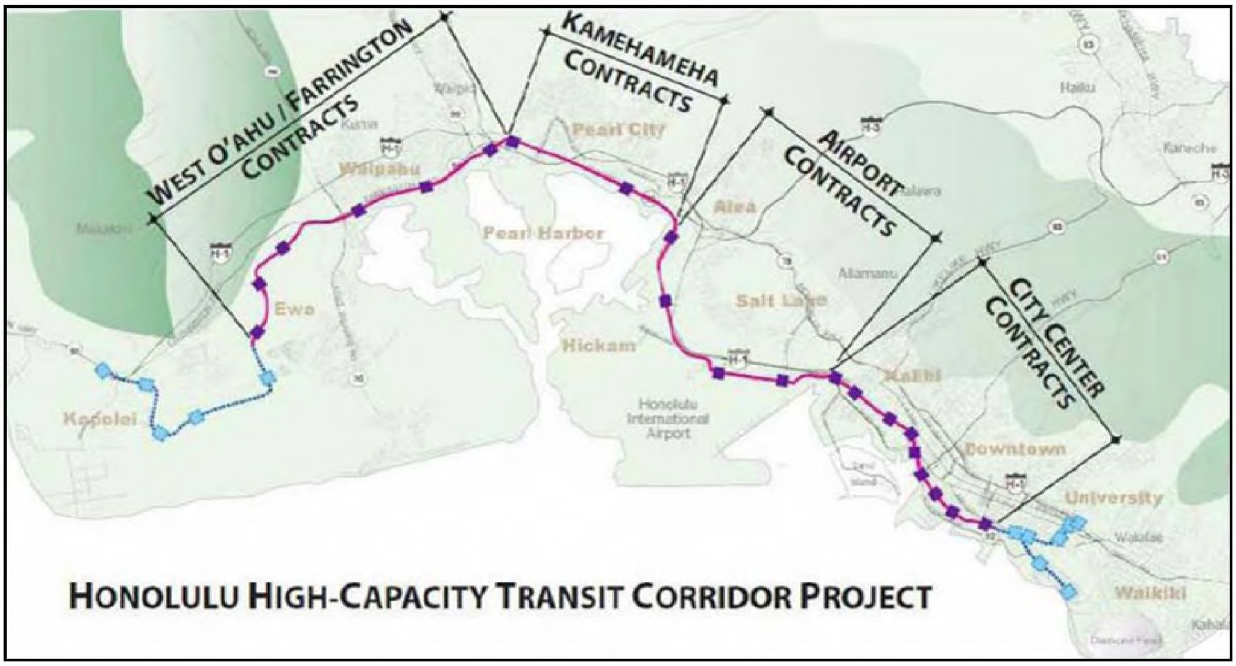


Table 4-1. Target Dates for Key Milestones per Master Project Schedule (MPS)

Milestone	Target Date
Approval to Enter PE	01-Jul-09
Record of Decision	01-Oct-09
Issue LONP for Pearl Highlands Station and Garage FD	02-Oct-09
Issue LONP for Farrington Stations Group FD	02-Oct-09
Issue LONP for West Oahu/Farrington Guideway and Utilities FD	02-Oct-09
Issue LONP for West Oahu/Farrington Guideway and Utilities Construction	02-Oct-09
Issue LONP for Kamehameha Guideway and Utility FD	02-Oct-09
Issue LONP for Airport Guideway and Utility FD	02-Oct-09
Issue LONP for MSF DB	06-Oct-09
Issue LONP for Core Systems DB	13-Oct-09
Request FFGA	19-Oct-09
Issue LONP for Farrington Stations Group Construction	15-Apr-10
Approval to Enter Final Design	22-Apr-10
Execute FFGA	16-Jun-11
Revenue Operations Date (all segments)	04-Mar-19

Note: The dates identified above are targets as identified in the City' MPS and not necessarily dates that have been agreed to by the FTA.

4.2.1 Consultant Services

SCC 80.01 – Preliminary Engineering

The City has contracted with Parsons Brinckerhoff (PB) to serve as the General Engineering Consultant (GEC) in completing PE/EIS efforts for the Project. The period of performance of the contract is August 2007 to March 2010. The scope of work for this contract includes PE for all Project components of Phases I and II. For those items that will be constructed utilizing

Design-Build (DB) methodology, the GEC is required to prepare contract documents that would be included in a two-step Best Value procurement package.

SCC 80.02 – Final Design
The City intends to award approximately 12 EDC contracts to complete Final Design of those components that are to be constructed utilizing Design-Bid-Build (DBB) methodology as identified in Table 4-2, although this strategy may be refined during PE. Management of these contracts would be performed by the City with support from the Project Management Support Consultant (PMC) and the General Construction Management consultant (GCM).

Final Design of Phase I line segment, the Maintenance and Storage Facility (MSF), and Core Systems will be completed by the selected DB contractor.

It should be noted that the City anticipates issuing the first Notice to Proceed (NTP) in October 2009 immediately following receipt of the Record of Decision and receipt of a LONP for the FD specific activities. This rapid sequence is aggressive and possibly not tenable.

SCC 80.03 – Project Management for Design and Construction
A contract was awarded to InfraConsult LLC in April 2007 to serve as the City's PMC. The scope of work includes providing in-house project management services and functions as an extension of the City's staff. In this role InfraConsult provides professional, technical, and managerial support services to initiate and complete the PE and the Environmental Impact Statement (EIS) phase of the Project. The period of performance of the contract is April 2007 to October 2009. During the June 2009 workshop, the City reported that they are working toward issuance of a Request for Proposals (RFP) to contract for PMC services through revenue operations. However, the City did note that they have a provision in the current contract to issue an extension if it is determined that the RFP and selection process cannot be completed prior to end of the current PMC contract.

The scope of the second PMC contract will include: assisting the City with specialized support during design and construction; assisting the City with oversight of design, construction, manufacturing, precasting, installation, testing, and commissioning; and assisting the City with high-level management support including financial and political issues. In general, the PMC contract will serve as a staff augmentation contract for the City. The City's proposed staffing plan should be sufficient to manage the multiple design and construction contracts while maintaining the overall project schedule. However, this aspect will need to be reviewed once the Project is in PE and the delivery methodology is refined.

SCC 80.04 – Construction Administration & Management
The overall responsibility for construction management will be assigned to the GCM, with oversight by the RTD Chief of Construction. The GCM will be procured during the PE phase. The GCM will provide services during Final Design and the numerous construction phases, including oversight of the EDC efforts, resident engineering, office engineering, and construction inspection. The GCM will be responsible for performing Quality Assurance inspections of all EDC and Contractor activities, reviewing all contract document submittals including shop drawings and specifications, reviewing contractor invoices, reviewing requests for information,

reviewing requests for change, conducting inspections, value engineering, and reviewing change order estimates.

Table 4-2. Consultant Contract Packaging

SCC	Description	Contract Package	NTP	Contract End	Notes
80.01	PE/EIS	Project-wide	Aug-07	Mar-10	NTP given to PB in August 2007 for EIS
80.02	Final Design	West Oahu/ Farrington Guideway/Utilities Contract (Phase I) [1]	Dec-09	Jul-13	Final Design to be completed by DB contract team
		Maintenance and Storage Facility[1]	Mar-10	May-14	Final Design to be completed by DB contract team
		Core Systems[1]	Jul-10	Mar-19	Final Design to be completed by DB contract team
		West Oahu Station Group	Nov-10	Dec-11	3 stations
		H2 Ramps and Utility Relocations	Aug-10	Aug-11	
		Farrington Station Group	Jan-10	Jan-11	3 stations
		Pearl Highlands Station/ Multi-Level Parking Facility	Jan-10	Jun-11	1 station
		Kamehameha Utility & Guideway Design	Jan-10	Jun-11	
		Kamehameha Station Group	Apr-12	Jul-13	2 stations
		Airport Utility & Guideway Design	Feb-10	Dec-11	
		Airport Station Group	Aug-12	Nov-13	3 stations
		City Center Utility & Guideway Design	Aug-10	Aug-12	
		Dillingham Station Group	Feb-13	May-14	3 stations
		City Center Station Group	May-13	Aug-14	3 stations
		Kakaako Station Group	Mar-13	Jul-14	3 stations
80.03	Project Management for Design and Construction (1st Contract)	Project-wide	Apr-07	Oct-09	Contract awarded to InfraConsult in April 2007; can be extended if deemed necessary
	Project Management for Design and Construction (2nd Contract)		Jan-10	Mar-19	Second PMC contract to be awarded
80.04	Construction Administration & Management	Project-wide	Oct-09	Mar-19	

[1]Contract will be Design-Build. All others will be Qualifications Based Selection (QBS).

4.2.2 Construction and Major Material and Equipment Procurement

A Design/Build (DB) contract delivery method is planned for the Phase I guideway (West Oahu/ Farrington segment). Design-Bid-Build (DBB) is planned for the Phase II guideway (Kamehameha, Airport, and City Center segments). Vehicles and systems elements are to be included in one separate Core Systems Design-Build-Operate-Maintain contract package.

Following integrated testing, limited operations along a portion of the West Oahu/Farrington segment are scheduled to begin at the end of 2012. Full revenue service is scheduled to begin in March 2019.

<u>SCC 10 – Guideway and Track Elements</u>
The Project is divided into four (4) line segments: West Oahu/Farrington, Kamehameha, Airport, and City Center. The West Oahu/ Farrington segment will be completed under a DB contract. The City will utilize a two-step Request for Proposals (RFP), or Best Value, contract procurement process. Under this single DB contract, the City intends to complete all utility relocations, guideway construction, and trackwork for these two line segments. Station and systems work will be completed under separate contracts as discussed below. Part 1 of the RFP was issued February 4, 2009. Part 2 of the RFP was issued March 3, 2009. Issuance of a notice of intent to award is scheduled for September 25, 2009. Issuance of NTP 1 is scheduled for November 2009, pending receipt of the Record of Decision and LONP.

The three remaining line segments (Kamehameha, Airport, and City Center) will be constructed using the DBB delivery method. The three line segment contracts will each include guideway construction and trackwork. The City anticipates awarding the first of these DBB line segment construction contracts in late 2011. Utility relocations for these segments will be completed under separate DBB construction contracts.

It should be noted that the City indicated during the June 2009 workshop that they may consider utilizing DB for the Kamehameha, Airport, or City Center line segments if the DB approach for the West Oahu/Farrington line segments yields favorable results.

As expected at this development point of the Project, elevated guideway substructure and superstructure details have not been finalized. However, it is anticipated that the foundations generally will consist of drilled piers and pier caps. The elevated guideway will consist of a viaduct supported by columns and bent caps. The current configuration of the viaduct superstructure is a precast segmental trapezoidal box girder proportioned to support two trackways and sound barriers. Erection of the approximately 10-foot long precast concrete segments would occur with the assistance of a long steel truss called an erection gantry. The gantry would travel along the guideway alignment suspending and post-tensioning all the 10-foot segments needed for a 150-foot span in a single stage process. The girder section will be designed to span 150 feet and would be simply supported. For spans longer than 150 feet, particularly where the highway crosses over highway interchanges, other construction methods are being considered including balanced cantilever or possibly cast-in-place viaducts.

SCC 20 – Stations, Stops, Terminals, Intermodal

The City intends to utilize the DBB delivery method for all Phase I and II stations, resulting in a total of eight (8) contract packages. Three (3) of those packages would be prepared to support Phase I. The remaining five (5) station construction packages would be awarded in Phase II beginning in late 2014.

The City intends to issue a separate DB contract to furnish / install / test / commission all elevator and escalator equipment.

SCC 30 – Support Facilities: Yards, Shops, Administration Buildings

The Maintenance and Storage Facility (MSF) contract delivery method will be DB. The City is considering two locations for the MSF: the Navy Drum Site and a site near the University of Hawaii West Oahu Campus. The City's preference is the Navy Drum Site from an operational standpoint as it is located near the midpoint of the alignment. The current issue is timing for acquiring access to the Navy Drum Site to complete the geotechnical exploration program. The site will be environmentally clean when it is turned over to the City.

The Navy Drum Site topography is very steep and will require an extensive amount of cut and fill. Until detailed geotechnical and survey data can be collected and analyzed, the extent of this earthwork cannot be accurately quantified. If access is not granted to the Navy Drum Site in sufficient time to complete the preliminary geotechnical exploration efforts, the City will proceed with locating the MSF on the West Oahu site.

The MSF contract will include design and construction of the maintenance shop, the storage yard, all trackwork, the Operations Control Center, and the administration facilities. The current cost estimate is based on a Cost Estimating Relationship (CER) and is not specific to either proposed location. The City issued Part 1 of the RFP on May 29, 2009. Issuance of a notice of intent to award is scheduled for January 2010. Issuance of NTP 1 is scheduled for March 2010, pending receipt of a LONP.

The City intends to include procurement of all running and third rail materials within the MSF Contract. The MSF contractor would thereby be responsible for procurement, shipping, and storage of the rail until the respective line segment contractors can begin installation. It is anticipated that the line segment contractors would be responsible for transportation of the rail to the specific line segments from the storage point at the MSF.

SCC 40 – Sitework & Special Conditions

The Phase I DB line segment contractor will be responsible for relocation of all utilities within the contract limits. Under Phase II, the City anticipates awarding three separate Advanced Utility Relocation contracts using the DBB project delivery method starting in late 2011.

Execution of utility relocation agreements between the City and the respective utility owners is scheduled to begin by the end of 2009.

SCC 50 – Systems and SCC 70 – Vehicles

The City has indicated that the technology for the revenue vehicles will consist of a heavy rail vehicle with steel wheels running on steel rail at standard gauge. The vehicles will be electrically powered by means of a third rail. As expected for a project in pre-PE, specific details on the vehicle design criteria have not fully developed at this time.

The City is utilizing a Best Value approach for selection of a Core Systems Design-Build-Operate-Maintain (DBOM) contractor. The two-part RFP is being used includes: design / manufacture / testing of approximately 76 revenue vehicles; design / supply / installation / testing of the traction power, signal system, train control, and communications systems; operation of the system; and maintenance of the entire system. The City believes that this would reduce their risk in integrating new revenue vehicle technology with third-party systems components. The City held a workshop on August 22, 2008 to solicit input and feedback from the contracting and manufacturing community on this approach.

The City issued Part 1 of the RFP on April 9, 2009. Part 2 of the RFP is to be issued July 31, 2009. Notice of intent to award a contract is scheduled for May 2010. NTP 1 is scheduled for July 2010.

Delivery of revenue vehicles would be scheduled to support the start of revenue service along a portion of the Phase I segment in late 2012. It is uncertain at this time how many vehicles would be procured to support Phase I. However, during the Risk Assessment Workshops, the City indicated that initial limited operations could begin with the first two (2) vehicles, once accepted. Service would possibly increase as additional vehicles are delivered and accepted.

Manufacture and delivery of vehicles for Phase II would begin in 2013. Phase II systems design / supply / installation / testing would begin in 2013 under the same DB contract for Phase I.

The City intends to award a separate DBB contract the installation of all owner furnished fare collection equipment. A potential NTP for this contract has not yet been developed but will be done during PE without impacting the Project schedule.

SCC 60 – Right-of-Way

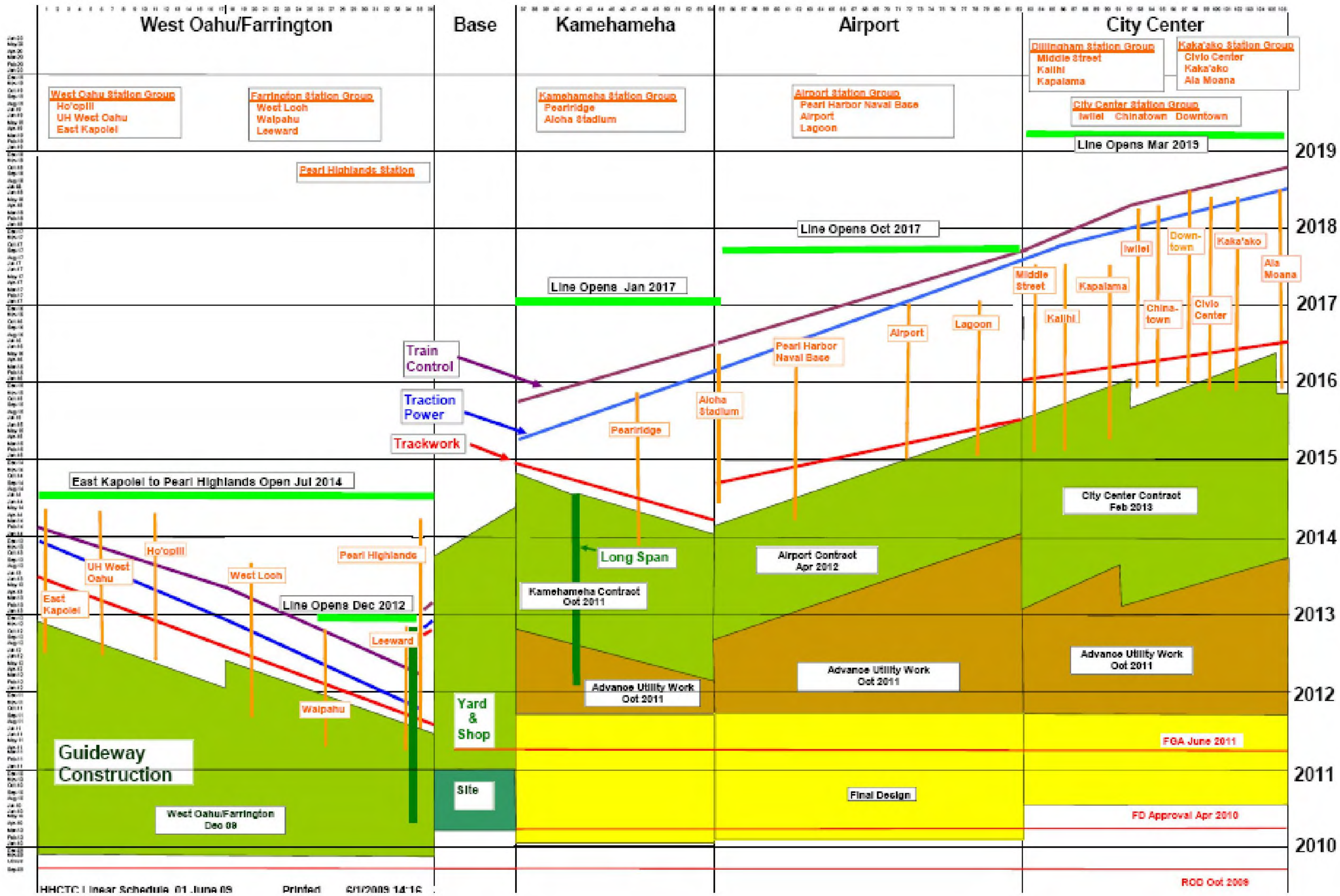
Acquisition of right-of-way (ROW) is anticipated to begin in December 2009 and to be complete by the end of 2011.

Table 4-3 summarizes the preliminary methodology that the City is considering for each Standard Cost Category (SCC) construction element. Figure 4-1 presents the Linear (or “Horseblanket”) Schedule for the Project dated June 2009. It should be noted that this is only a graphic representation of the project delivery methodology, proposed timing, and coordination for the discrete contract packages that the City is considering. The primary tool being used to manage the Project is the Master Project Schedule.

Table 4-3. Construction and Equipment Contract Packaging

SCC	Description	Contract Package	Contract Type	NTP	Contract End	Notes
10	Guideway and Track Elements	West Oahu and Farrington Guideway and Utilities Contract	DB	Nov-09	Jul-13	Includes installation of running/third rail
		Kamehameha Contract	DBB	Oct-11	Dec-14	Includes installation of running/third rail
		Airport Contract	DBB	Mar-12	Jun-15	
		City Center Contract	DBB	Jan-13	Jun-16	
20	Stations	West Oahu Station Group	DBB	Jun-12	May-14	3 stations
		Pearle Highlands Station and Garage	DBB	Sep-11	Apr-14	1 station
		Farrington Station Group	DBB	May-11	Sep-13	3 stations
		Kamehameha Station Group	DBB	Oct-13	Jun-16	2 stations
		Airport Station Group	DBB	Feb-14	Jan-17	3 stations
		Dillingham Station Group	DBB	Aug-14	Jul-17	3 stations
		City Center Station Group	DBB	Nov-14	Jun-18	3 stations
		Kakaako Station Group	DBB	Aug-14	Jun-18	3 stations
		H2 Ramps	DBB	Nov-11	May-14	
		Elevators and Escalators (SCC 20.07)	DB	Sep-11	Jan-18	Procure, install, test, and commission
30	Support Facilities	Maintenance Facility and Storage Yard (SCC 30.01 and 30.03)	DB	May-10	Jun-14	Includes procurement of rail for full alignment; two sites under consideration
40	Sitework and Special Conditions	Kamehameha Utility Relocation (SCC 40.02)	DBB	Sep-11	Nov-12	
		Airport Utility Relocation (SCC 40.02)	DBB	Sep-11	Jan-14	
		City Center Utility Relocation (SCC 40.02)	DBB	Sep-11	Sep-13	
50	Systems	Train Control and Signaling (SCC 50.01)	DB	Jul-10	Mar-19	To be packaged revenue vehicles procurement
		Traction Power Supply (SCC 50.03)				
		Traction Power Distribution (SCC 50.04)				
		Communications (SCC 50.05)				
		Central Control (SCC 50.07)				
		Fare Equipment (SCC 50.06)	DBB	Not yet defined	Not yet defined	Install owner furnished equipment
70.02	Vehicles	Heavy Rail Vehicles	DB	Jul-10	Mar-19	To be packaged with systems components

Figure 4-1 .   Linear Schedule ("Horse Blanket" Diagram)



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4.3 Findings

The following sections provide the PMOC findings for each SCC. These findings were utilized in development of the PG-40A and B products, as included within this Spot Report.

General

The contract delivery methodology proposed by the City could be successfully executed. The City does have the statutory authority to award the contract types currently under consideration. However, the PMOC does have some general concerns as they relate to the overall Project implementation:

- The PMOC is concerned that the multiple delivery methods being considered for guideway construction may not be the most cost-effective means to deliver the Project. The PMOC recognizes that this risk can be mitigated with proper coordination of contracts and sufficient contract language. However, until there is progress with regard to these items, the risk remains.

  The City must not presume that the unit costs associated with work for the DB segments under Phase I will equate to the unit costs for the DBB segments under Phase II. Further, given that the spread of bidding for Phase I and II will occur over a period of several years, the City must ensure they have adequate contingency to account for construction market changes relative to labor, material, and equipment.

  The PMOC understands that the City may consider utilizing a DB contracting approach for Phase II line segments if they realize favorable results with DB for the Phase I line segment. However, this decision should be made as soon as possible to maximize any cost and schedule opportunities for Phase II.

- According to the State of Hawaii's Department of Business, Economic Development & Tourism "E. Construction" Newsletter for the 3rd Quarter of 2008,

  > *"The dollar value of private building authorizations and government contracts awarded both decreased in the second quarter of 2008 compared with the same quarter last year".*

  However, this is in contrast to another statement in the newsletter that stated:

  > "*…construction jobs continued to grow, although the pace of growth has slowed from the previous two years".*

  The PMOC shares the City's concern that there may not be sufficient labor to support the Project without significant increases in unit costs to offset travel, subsistence and relocation costs of imported labor to the island. It must be noted that the Project staff has meet with labor unions in Hawaii to discuss future labor requirements. The unions committed to working with the City and the successful bidders to help provide sufficient labor capacity throughout the duration of the construction. However, the estimated construction value of this project is over $3 billion in year of expenditure dollars. This work is to be completed over nine years, resulting in an average value of $300 million per year, with a peak estimated at approximately $700 million in 2013. This construction period has been targeted by the City to coincide with its cash flow projections. The estimated value of construction for the State of Hawaii for the past three years has averaged $7.1 billion according to the Department of Business, Economic Development & Tourism website. This peak year for the Project would thus represent 10% of the entire construction value for the State of Hawaii.

- The PMOC shares the City's concern that the availability of major materials (fuel, cement, steel, copper, lumber, etc.) will be an issue for the Project and the bids will reflect such uncertainty. The concern is two-fold. First, there is uncertainty in the global construction market that is impacting material costs. Since this is a multi-year award and build-out, conditions are subject to change and can vary greatly as they have in the past year. Second, the limitation of available materials for an island market may impact cost and schedule. There is a significant cost and time component associated with shipping materials to Hawaii.

- The PMOC shares the City's concern regarding the availability of construction equipment available to support the Project schedule. There will be numerous contracts being simultaneously executed over the course of the Project. The increase in equipment needs, particularly during the peak years, may result in higher than anticipated unit costs and schedule issues.

  Additionally, installation of the approximately 10-foot long precast concrete segments would likely occur with the assistance of an erection gantry. With this assumed construction technique, it is a real possibility that the DB contractor will appear to prospective Phase II DBB contractors to have a significant competitive advantage during the Phase II bidding since the Phase I DB contractor will have already made an investment in necessary equipment. Such an assessment by prospective DBB bidders could result in a decision not to submit bids for Phase II, thereby adversely impacting the competitive bid environment.

The PMOC cannot provide a detailed opinion on the constructability of the project since the plans are at a conceptual level of detail as would be expected for a project at this stage (per-PE). However, the PMOC does believe that the conceptual plans have been advanced sufficiently for this phase (pre-PE). The PMOC does have some concerns as they relate to design and construction of key elements that should be further investigated should the Project advance to PE.

<u>SCC 10 – Guideway and Track Elements</u>

- The City has access to an extensive amount of geotechnical data from previous investigation programs. The GEC has effectively compiled and utilized this information to establish geotechnical criteria. From a review of the geotechnical data provided by the City, it is clear that the subsurface conditions are highly variable along the 20-mile corridor. Specific concerns include undulating stratigraphy, high water tables, and numerous environmental surface restrictions. Production rates for foundation installation should be conservative given the variability of the subsurface conditions and the access restrictions, particularly within the Phase II segments. The PMOC is concerned that the cost estimate may not adequately reflect fluctuations in production rates and the probability of encountering unforeseen underground conditions.

The City has indicated that a Geotechnical Baseline Report will be used for this Project. Although Geotechnical Baseline Reports are typically utilized for underground construction (i.e., tunnels), the PMOC concurs with this approach given the extensive number of deep foundations that will be required for this Project.

- Site access will be of particular concern for both guideway and station construction. The amount of traffic and pedestrian congestion and close proximity of business and residential properties, particularly along Phase II, will severely restrict the contractors' access, material delivery, and installation. This could result in schedule pressure and increased costs due to loss of contractor productivity. In addition, the City will require the contractors to identify the laydown, or staging, areas for each individual contract. The PMOC recommends the City identify and secure as much land as reasonably possible to support contractor staging/storage areas.

- The PMOC was provided a copy of the boilerplate "General Conditions of Construction Contract" dated July 1999. The PMOC was also provided a copy of Part I of the RFP for the West Oahu/Farrington Highway Guideway DB Contract, Part I of the RFP for the MSF DB Contract, and Part I of the Core Systems DBOM Contract. However, due to confidentiality requirements, the PMOC was not provided access to Part II of the RFP for the West Oahu/Farrington Guideway DB Contract. Without access to the full contract documentation for the DB or DBB contracts, the PMOC cannot determine the adequacy of General Conditions or Special Provisions at this time.

- Final Design of the Phase I line segments and systems components will be performed concurrently by two separate DB contractors. The City must ensure that the necessary coordination between the DB contractor for the Phase I line segment and the DB system contract can be achieved adequately to minimize schedule delays or cost impacts.

- The typical viaduct superstructure sections of the line segments will be generally uniform throughout the full corridor. However, by having the DB contractor develop the line segment design for Phase I and an EDC complete the line segment design for Phase II, the City may not realize any potential cost savings from a more efficient Phase II design. The PMOC understands there is no requirement that the viaduct be uniform. However, the PMOC suggests that utilizing a uniform section, where possible, may reduce costs, provide efficiencies in construction, and minimize long-term maintenance costs.

- The schedule for contracting the DBB work is very tight due to contractor workload. Although some float has been included for certain critical activities, the PMOC believes the schedule could use more built-in time contingency (Latent Float Contingency) as a means to recover from contract document amendments during the bidding process, poor bids, protested bids, real estate acquisition delays, and delays associated with access or permits.

SCC 20 – Stations, Stops, Terminals, Intermodal

- Site access will be of particular concern as discussed above.
- Material and equipment staging/storage areas have not been identified. The PMOC recognizes more definitive information will evolve during the PE phase.
- Station security measures have not been clearly defined, and therefore are not detailed in present criteria or design progress at this phase of the Project. The PMOC recognizes more definitive information will evolve during the PE phase.

SCC 30 – Support Facilities: Yards, Shops, Administration Buildings

- The PMOC shares the City's concern that the uncertainty with the MSF location has not been adequately captured in the cost estimate. There will be numerous impacts if the Navy Drum Site cannot be acquired including rail alignment, construction staging (i.e. rail storage), and operational constraints. These issues should be addressed early in PE.
- The scope for the Administration Building and Operations Control Center has not been defined. The PMOC recognizes that this can be more definitively addressed during PE. However, it is typical in pre-PE for a grantee to provide a conceptual design for such a critical facility and its functions. This also provides a "Basis for Design" document for the estimators and subsequent scopes of work for PE phase.

SCC 40 – Sitework and Special Conditions

- The City has not finalized any utility agreements for construction due to the current stage of project development (pre-PE). There is a significant number of underground and above ground utilities requiring adjustment or relocation that have considerable associated costs and schedule risks that the City plans to manage. The PMOC recognizes that more definitive information will evolve during the PE phase.
- The City has not incorporated detailed utility adjustment and relocation activities in the Master Project Schedule. The PMOC recognizes that more definitive information will evolve during the PE phase. This effort should be a primary focus early in PE.

SCC 50 – Systems and SCC 70 – Revenue Vehicles

- Understandably, the scope and criteria for the systems components and revenue vehicles have not been fully defined as the Project remains in the pre-PE Phase. These SCC categories should be addressed immediately in PE given the accelerated nature of Phase I and the critical impact any decisions on vehicle and systems technology will have on the overall Project configuration.

- It appears there will be a de-mobilization required by the systems DB contractor between Phase I (line segment and MSF) and the subsequent Phase II line segments. However, it is unclear what amount of lag time will be required before the systems contractor can re-mobilize to complete the remaining Phase II segments. It is expected that the bids will reflect this uncertainty.

SCC 60 – Right-of-Way

- The ROW schedule, as defined in the PMP, has not been sufficiently developed. The PMOC recognizes more definitive information will evolve during the PE phase.

- The City ROW department and PMC staff are developing a detailed ROW Schedule. The PMOC reviewed the latest ROW schedule draft, which concentrates on the takes associated with the first operable segment. The current MPS includes summary level activities for ROW but requires more detail to better identify critical path and near critical path activities related to early phased ROW acquisitions.

- The PMOC has concerns with the technical capacity (resource availability) of the City's ROW Department to maintain schedule. Staffing with expertise in acquiring property and improvements under various strategies based on project requirements will require expertise and capacity for easements, partial takes, full takes, eminent domain, relocation and relocation assistance, etc. Care must be taken in assuring the City staff can meet the project schedule as well as handle their core departmental needs as well.

- The PMOC has concerns with several significant areas including temporary construction easements, any "economic remainders", and visual/aesthetic impacts of the guideway and stations to adjacent property owners. The City may discover the necessity to acquire more partial or full takes and/or temporary or permanent construction easements than initially planned, thus impacting the project budget and schedule. It should be noted that the City has reviewed access to the properties adjacent to the corridor to mitigate any issues with access during construction and following the start of revenue operations.

4.4 Conclusion

Each of the concerns above has been taken into consideration in development of the PG-40A and B sections of this Spot Report.

The PMOC concludes that the Project is ready to enter the PE Phase with regard to the Project Delivery Method (PG-32E) assessment.

4.5 Recommendations

Many of the issue identified within this section of the Spot Report would typically be addressed during the PE Phase. The PMOC recommends that the City develop a list of action items using the Risk Register (Appendix D) as the basis. These action items should be prioritized and addressed early in PE. The PMOC believes this approach will protect the Federal interests should PE Phase funding be approved and enable the City to embark on PE efforts with a far more definitive scope of work and overall budget and schedule.

5.0 SUBTASK 33A: PARAMETRIC PROJECT COST ESTIMATE REVIEW

5.1 Methodology

The PMOC followed the requirements outlined in the *FTA PG #33: Characterization of Grantee Project Cost Estimate and Escalation,* dated March 29, 2007 to assess and evaluate the grantee's cost estimate. Specifically, the PMOC completed a review of the project cost estimate to ensure it was:

- Mechanically correct and complete
- Free of any material inaccuracies or incomplete data
- Consistent with relevant, identifiable industry or engineering practices
- Uniformly applied by the grantee's cost estimators and consistent in its method of calculation
- Consistent with the project scope outlined in the appropriate NEPA documents

The PMOC then assessed the integration and traceability of the estimate into the defined scope of the project for the purposes of "baselining" the project estimate as the costs, scope issues and project become more fully defined and developed through progression of project definition. Using the data developed from this analysis, the PMOC made adjustments to the grantee cost estimate for use in the PG-40 Risk Assessment.

The PMOC also reviewed and evaluated the general uniformity in the grantee's escalation of costs from the base year, to the YOE dollars, the escalation factors used to estimate YOE dollars and the soundness of the economic forecasts and escalation factors.

The focus of this evaluation is the City's 2009 Standard Cost Category (SCC) Estimate, referred to within this Spot Report as the *2009 SCC Estimate*. The City's *Main Worksheet – Build Alternative* from the *SCC Worksheet* is included as Appendix C. This estimate was prepared by their General Engineering Consultant (GEC) and their subconsultants. However, much of the information used to evaluate this estimate is contained in other supporting project documentation made available to the PMOC including those items identified in Appendix B.

5.2 Review

The PMOC reviewed the City's *2009 SCC Estimate* that correlates to the scope and values included in the Draft Environmental Impact Statement (DEIS). The PMOC Cost Estimate Review consists of two primary functions. The first is a review and evaluation of project scope inclusively, as identified in the DEIS. The second is a characterization of the mechanical and fundamental soundness of the cost estimate. The PMOC review also includes an evaluation of the cost estimate source data and its use in the *2009 SCC Estimate*, particularly with regard to Public Utility Relocation Units previously developed from the *1992 Original Estimate*. The City has prepared a new detailed estimate for the Public Utilities and is no longer utilizing the *1992 Original Estimate*. The cost elements were also reviewed for accuracy and applicability to the project.

The Association for the Advancement of Cost Engineering (AACE) published a recommended practice titled *Cost Estimate Classification System*. Along with the Level of Project Definition, the recommended practice establishes the expected Accuracy Range for five estimate classifications (Table 5-1). An estimate's quality can be measured by its overall accuracy range.

Table 5-1. Cost Estimate Classification System

	Primary Characteristic	Secondary Characteristic			
Cost Estimate Class	**Level of Project Definition (%of Completion)**	**Purpose of Estimate**	**Estimating Methodology**	**Expected Accuracy Range***	**Expected Accuracy Range in Percent**
Class 5	0% to 2%	Screening or Feasibility	Stochastic or Judgment	40 to 20	+400% to –100%
Class 4	1% to 15%	Concept Study or Feasibility	Primarily Stochastic	3 to 12	+160% to –60%
Class 3	10% to 40%	Budget Authorization, or Control	Mixed, but Primarily Stochastic	2 to 6	+60% to –30%
Class 2	30% to 70%	Control or Bid/Tender	Primarily Deterministic	1 to 3	+30% to –15%
Class 1	50% to 100%	Check Estimate or Bid/Tender	Deterministic	1	+10% to –5%

*Note: If the range index value of "1" represents +10/-5%, then an index of value of 10 represents +100/-50%.

The PMOC believes the City's *2009 SCC Estimate* and supporting documentation is an AACE "Class 4" estimate due to its mostly parametric nature. It is understood that the project documents (drawings) may be more advanced than this classification would normally indicate. However, the estimate is based on earlier "adjusted/escalated" information, and thus from an overall viewpoint, it is still a study or feasibility type of estimate. Certain portions of the estimate may exceed this "Class 4" classification but will not significantly change the percentages of an expected accuracy range as noted in the above table.

The City has not yet developed a detailed bottoms-up cost estimate as the project remains in the pre-PE Phase and has formally requested to be allowed to advance to PE during which, according to the staff estimators, a more detailed estimate will be prepared by the end of CY2009. The PMOC did not use a Microsoft (MS) Excel spreadsheet Data Reduction Table to distribute the project costs because the City's estimate was developed using Timberline cost estimating software. Thus, nearly all of the estimate line items are based on Cost Estimating Relationships (CER). Those that are not are included as Lump Sum allowances. The estimate also includes Lump Sum allowance line items for Allocated and Unallocated Contingencies. Understandably, as the project progresses and scope refines with greater detail, a Data Reduction Table can be prepared for more intensive Risk Assessment analysis purposes.

5.2.1 Review of Construction Costs

The PMOC team reviewed the *2009 SCC Estimate* and supporting data provided by the City, which included information regarding civil, architectural, track work, utilities, vehicles, and systems components. The estimate is well organized and appears to support the scope described in the DEIS. The level of development of the estimate is very limited and depends heavily on Allowances, Lump Sums, and CERs. The cost estimate quantity unit measures are predominately Rail-Feet, Track-Feet, or Square Feet. The cost estimate quantities were parametrically derived within the Timberline cost estimating software. The cost estimate contains a significant amount of unit pricing from similar transit projects across the US mainland. These prices were adjusted to reflect the Hawaii market and applied to the respective quantity unit measure.

Previously, the GEC transferred and incorporated cost from the *2007 MK Utility Estimate* for Private Utility Relocations/Removals. A 15.0% reduction was taken for an "assumed" franchise sharing with the utility and a 10.0% reduction was included for utility relocation design as this was stated to have been included in the units in the methodology. However, the City has now prepared a more detailed Public Utility Estimate and incorporated the values in the current budget.

Unit costs are standard throughout the estimate and did not take into consideration varying conditions along the alignment. The cost estimate does not account for unforeseen ground conditions or related unusual geotechnical conditions. Some consideration was given structurally to account for variability in grades, structure heights, span lengths and known geological conditions.

This review discovered some quantity and mechanical errors that were discovered in this review. These are reported in each of the SCC section of this report. Additional cost related issues or risks that were identified as concerns in other sections of this Spot Report are noted below.

5.2.2 Review of General Condition Costs

The GEC generated detailed assemblies for the *2006 Parametric Estimate*. This estimate included the contractor's overhead and profit (General Conditions) in the unit costs as variable percentages dependent upon the individual assembly and estimator's judgment as follows:

- 0.5% to 6.0% for Maintenance of Traffic
- 6.0% to 10.0% for Mobilization/Demobilization
- 0.5% to 4.0% for Minor Utilities

All CER items in the *2009 SCC Estimate* include contractor indirect costs, overhead & profit, and allocated design & construction contingencies, although no specific breakdown of these components is available. However, these General Conditions components from the *2006 Parametric Estimate* are not fully traceable to the *2009 SCC Estimate*. The *2009 SCC Estimate* does not include a separate category or line item(s) for indirect cost and likewise does not contain supporting documentation explaining the inclusion of indirect costs within the direct cost line items. Some of the information typically contained in a General Conditions estimate includes:

- Detailed Construction Schedule
- Contracting and delivery strategy (i.e. Design/Build, CM-at-Risk, Multiple Prime, Fast-track, etc.)

- Necessary equipment lists and durations
- Contract requirements for Quality Control/Assurance, Scheduling, Traffic Control, Liquated Damages, Assignment of Risks.
- More detailed information on actual construction required

The PMOC recognizes that a detailed line item estimate for General Conditions is not feasible this early in the project. However, it is recommended that the City conduct a review and evaluation of all elements typically associated with General Conditions so these items can further developed in PE and adequately incorporated into the cost estimate.

5.2.3 Review of Quantities

The *2009 SCC Cost Estimate* appears to support the scope described in the DEIS. This cost estimate included both summary sheets and detailed backup in MS Excel for each SCC. The cost estimate criteria document describing the methodology used in developing the estimate was provided and is incorporated into the project estimates. The methodology does not, in any detail, address other assumptions made in developing the estimate, the schedule, and documentation of productivity or unit costs, indirect costs or overhead and profit.

The detailed estimate sheets were reviewed for the individual line items of each SCC. Quantity spot checks were not performed on line items or quantities in the *2006 Parametric Estimate* as these are not directly traceable back to the conceptual drawings but were generated by GECs Timberline software in their parametric estimating approach.

The PMOC observed determined that the estimated length of the Airport Alternative alignment of 108,154 Route Feet matches the stationing indicated on the preliminary drawings. This value is critical as the developed parametric units utilize this quantity (divided into segments) for many calculations.

Since this is a parametric style of estimate, an in-depth review and analysis or correlation of project quantities was not performed by the PMOC, as it would normally do for projects in later stages of development and as required by PG-33B. The drawings are considered planning documents as they were developed to support the DEIS. Quantities are basically alignment lengths, structure counts, major utilities identified and other similar broad-style or all-encompassing quantities.

5.2.4 Review of Cost Estimate Escalation

(1) Review of Sources and Methodology Used in the City of Honolulu's Forecasts

The cost escalation forecasts listed in the "Financial Plan For Entry Into Preliminary Engineering Submittal" prepared by the City and County of Honolulu on May 1, 2009 are based on a number of generally accepted sources of data. These sources include Bureau of Labor Statistics (BLS), Engineering News Record (ENR), Global Insight Inc., and the Hawaii Department of Labor. However, the methodology used to develop forecasted cost escalation rates has not been adequately documented. Table 5-2 summarizes the sources and methodology used by the City in determining its cost escalation factors. In the review of the City's report, the following methodological issues have surfaced:

- The final conclusions have been not fully developed and the methodology employed in developing most of the final numbers is somewhat vague and difficult to replicate.
- Data sources have not been clearly labeled and/or defined.
- Discussion of how calendar year data was converted to fiscal year data is insufficient.
- For some of the factors, the report shows forecast escalation rates changing over time without providing a rationale for annual fluctuations.
- Inappropriate benchmarks were used to develop forecasted escalation factors for concrete and professional services.
- Although briefly mentioned in the report, the impact of fuel and shipping costs do not appear to have been factored into the forecasts.

Table 5-2. Sources and Methodology

Factor	Sources	Methodology
Labor	State of Hawaii Department of Labor	Prevailing wage rates published by the State of Hawaii Department of Labor. Forecasts adjusted based on information gathered in industry interviews and contracts.
Steel	N/A	Steel prices are anticipated to continue to fall through Q1 2009, and then recover in Q2 2009, resulting in negative growth from FY09 to FY10. Higher rates are anticipated in FY11 in response to increased demand. Major increases not anticipated until FY 2012
Concrete	BLS, Freedonia Group	N/A
Other Materials	N/A	Cost escalation is based on a general outlook for construction in Hawaii. Cost escalation in FY10 and FY11 is anticipated to fall to 1.9 percent and 1.8 percent, respectively.
ROW	National Association of Realtors., Honolulu Board of Realtors, and Global Insight, Inc.	Right of way cost escalation is based on 3rd party forecasts of real estate prices in Hawaii. After FY14 a consistent rate of 4 percent per year is forecast
Construction Equipment	Moody's Economy.com	Producer Price Index (PPI) for construction equipment. Escalation is forecast to peak at 3.5 percent in FY13. From FY 2014 onward the forecast is around 3 percent per annum.
Vehicles	Moody's Economy.com	The forecast PPI for construction equipment was used as a proxy.
Professional Services	BLS	Consumer Price Index (CPI) w/o energy

Source: Financial Plan For Entry Into Preliminary Engineering Submittal, prepared by the City and County of Honolulu, May 1, 2009

In subsequent discussions with the City of Honolulu and its consultants, a number of clarifications were provided with regard to the sources, methodology, and cost escalation factors used for the Project. These clarifications include the following:

- The annual average increase in PPI for Steel Mill Products from 1970 to 2008 has been adopted as the benchmark for steel cost escalation. This revised forecast is based on an average growth rate of 5.15 percent.

- The cost escalation rates for Right-of-Way (ROW) are based on data tracked by the University of Hawaii Economic Research Organization (UHERO). Specifically, the compounded annual growth rate (CAGR) in median single family and condo prices in Honolulu County has been adopted as the benchmark for right-of-way escalation. This revised forecast provided a recommended annual average growth rate of 5.10 percent.

- The forecast of Professional Services has been revised upward to include 1 percent real growth above CPI from FY 2011 onward.

It should be noted, however, that these revised escalation rates have not been formally incorporated into a revised financial plan.

(2) ***Assessment of the City of Honolulu's Cost Escalation Factors***

In the cost estimates prepared by the City, annual escalation rates have been adjusted to reflect the current downturn in local and national economic conditions. These cost estimates anticipate deflationary cost pressures in the short-term, which has resulted in negative growth rates for steel and right-of-way costs as well as below average increases (or decreases) in concrete, labor, vehicles, and professional services in FY 2010 and FY 2011. In the City's forecasts, additional adjustments were made to the escalation rates for labor to account for new five-year union contracts, which are scheduled to be executed in 2013 and 2018. In anticipation of improved economic conditions, additional adjustments were made in the escalation rates for steel and concrete for 2012 and 2013. Table 5-3 summarizes the cost escalation factors used by the City to develop the *2009 SCC Estimate*.

Table 5-3. City Cost Escalation Summary

Cost Factor	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Concrete	3.0%	4.5%	6.0%	5.0%	4.0%	4.0%	4.0%	4.0%	4.0%	4.0%
Labor	3.7%	4.1%	4.6%	5.0%	4.0%	4.0%	4.0%	4.0%	5.0%	4.0%
Other Materials	1.9%	1.8%	3.5%	4.5%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%
Steel	-8.5%	3.9%	6.0%	6.0%	4.0%	4.0%	4.0%	4.0%	4.0%	4.0%
ROW	-6.8%	-2.8%	1.2%	3.7%	4.2%	4.0%	4.0%	4.0%	4.0%	4.0%
Construction Equipment	4.2%	1.8%	2.2%	3.5%	3.5%	2.9%	3.1%	3.2%	3.2%	3.1%
Vehicles	1.8%	2.2%	3.0%	3.0%	2.9%	3.1%	3.2%	3.2%	3.1%	3.1%
Professional Services	1.5%	2.0%	2.3%	2.5%	2.5%	2.5%	2.5%	2.5%	2.5%	2.5%

Source: Financial Plan For Entry Into Preliminary Engineering Submittal, prepared by the City and County of Honolulu, May 1, 2009

In order to review and assess the viability of the escalation rates provided by the City, the PMOC evaluated historical data and trends as well as possible future trends, which were used to develop a forecast for each cost escalation factor. Moreover, the development of the PMOC's recommended forecasts factored in the recent downturn in global and national output, the timing and magnitude of an economic recovery in the U.S., and local economic conditions in Hawaii. Table 5-4 summarizes data compiled from BLS, the U.S. Bureau of Economic Analysis (BEA) and other sources of the cost escalation rates under review. This table includes long-term, medium-term, and more recent historical trends.

Table 5-4. Summary of Average GDP, CPI and Escalation Rates

Metric	**1970 - 2008 average rate** Very Long Term	**1983 - 2008 average rate** Post high inflation	**2000 - 2008 average rate** China "boom" and forward
U.S. GDP (current dollars, "nominal")	7.13%	5.86%	4.92%
U.S. GDP (chained, 2000 dollars, "real")	2.96%	3.17%	2.33%
U.S. CPI (full, with energy)	4.68%	3.14%	2.90%
Nelson No. American Construction Labor Cost Index	5.10%	3.27%	3.80%
U.S. BLS PPI for Iron and Steel	5.72%	3.84%	9.43%
U.S. BLS PPI for All Metals Products	4.85%	3.07%	6.25%
Average of Iron and Steel & All Metals PPI	5.29%	3.46%	7.84%
U.S. BLS PPI for U.S. Concrete Ingredients and Related Products	5.05%	3.28%	4.71%
U.S. BLS PPI for All Railroad Equipment	4.71%	2.23%	3.30%
U.S. BLS PPI for Construction Machinery & Equipment	4.69%	2.41%	2.60%
Standard & Poors'/Case Shiller Average for 10 U.S. Metropolitan Area (beg. in 1987)	N/A	5.10%	6.00%
U.S. BEA Wages and Income, Hawaii	8.31%	6.84%	4.67%
U.S. BLS PPI for Motor Vehicles	3.10%	1.14%	0.20%
U.S. BLS Professional and Business Services	4.43%	3.94%	4.17%

Sources: BLS, BEA, Standard & Poors', Jacobs Consultancy

Based on the PMOC's analysis, the forecasted cost escalation factors for labor, other materials and construction equipment appear to be consistent with the PMOC's view of likely future trends. These factors could be adjusted in the early years to account for possible cost pressures related to improved economic conditions. However, the cost escalation factors for concrete, steel, right of-way, professional services, and vehicles appear to be relatively low in comparison to historical trends drawn from other generally accepted industry sources.

As part of this review, a sensitivity analysis was conducted to examine the impact on total costs as a result of a 0.1 percent increase in each cost escalation factor. In conducting this analysis, the other cost factors were maintained at the escalation rates delineated in Table 5-3 while each factor was tested. The results from this sensitivity analyses indicated that estimated costs for the project were sensitive to small increases in professional services, labor, concrete, and vehicles. Table 5-5 summarizes the results of the sensitivity analysis.

It should be noted that construction equipment was not tested separately since this cost factor is being used as a proxy for vehicles in the City's forecasts.

Table 5-5. Cost Escalation Sensitivity Analysis

Cost Factor	Cost Increase per 0.1% Increase in Cost Escalation Factor ($ Millions)
Concrete	$3.18
Labor	$4.40
Other Materials	$2.73
Steel	$1.68
ROW	$1.68
Construction Equipment	N/A
Vehicles	$2.99
Professional Services	$4.47

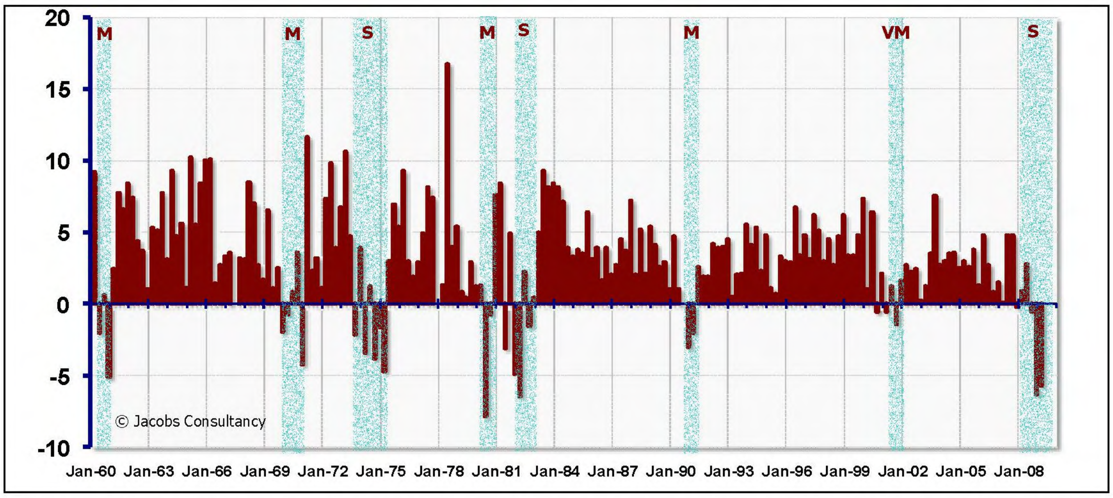
Source: Jacobs Consultancy

(3) Recommendations

The forecasts in this section are based on benchmark historical data drawn from widely accepted industry sources which were used to compare the cost escalation factors developed by the City of Honolulu. These forecasts have attempted to be representative of local and national economic conditions as well as to factor in the impact of an improvement in economic conditions. Estimating the timing of a recovery to within a few quarters is critical to the development of a realistic escalation rate forecast, especially if it made while a recession is underway. This is obvious because recessions and the subsequent recovery periods will profoundly affect construction materials prices and labor wage escalation.

Figure 5-1 shows the position and duration of the current U.S. recession in relation to the previous seven recessions. Recessions are noted by blue-colored bars and the severity of each recession is evaluated using the National Bureau of Economic Research (NBER) definitions; Sharp ("S"), Mild ("M") or Very Mild ("VM"). The current recession, which began in late 2007, has already lasted as long as the recession that occurred in the mid-1970s. In fact, many economists are comparing the current recession to the mid-'70s recession, in terms of depth and duration.

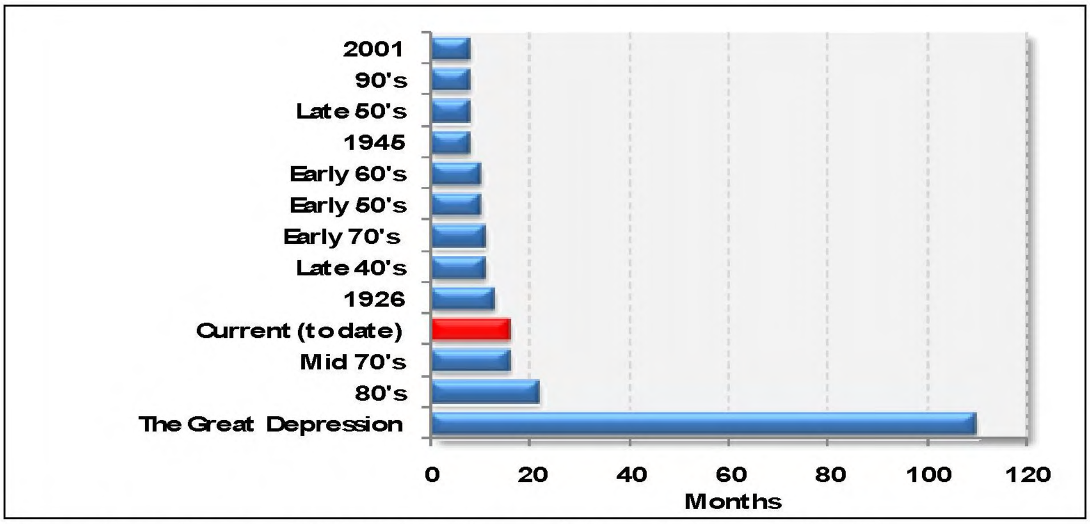
Figure 5-1. Percentage Change Quarterly US. GDP, 1960 through Q1 2009



Source: Jacobs Consultancy

Based on more rigorous forecasts of the current state of the U.S. and world economy and prospects for economic recovery, it is anticipated that the U.S. economy will begin to recover in late 2009 with an annual increase of 2% in real GDP in 2010. The effect of the various economic stimulus plans in the U.S. and Europe as well as continued economic growth in China and India are expected to result in renewed cost pressures for materials. Figure 5-2 provides a comparison in the duration of recent recessions.

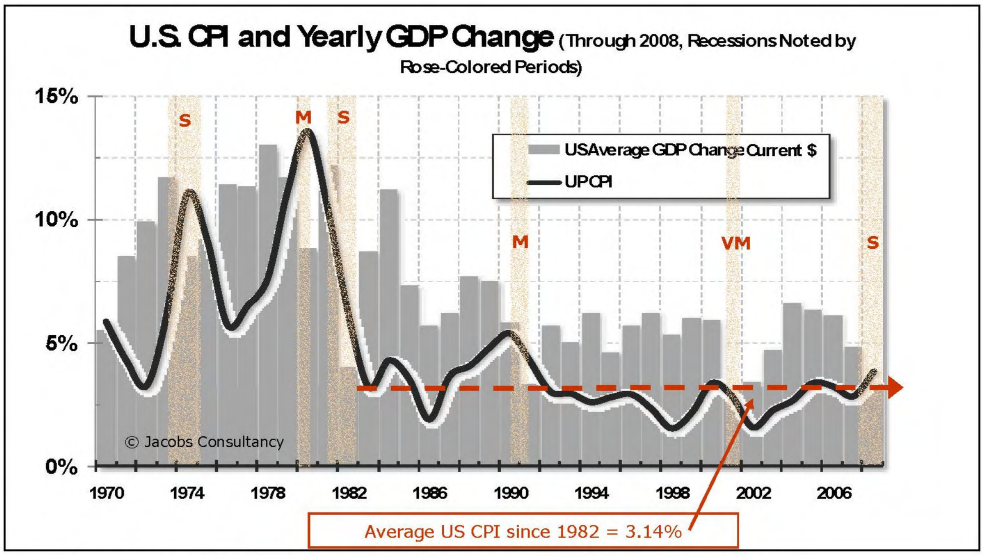
Figure 5-2. Comparison of Major U.S. Recession Durations



Source: Recession.org and U.S. National Bureau of Economic Research (NBER)

In addition, there is no obvious reason to expect that the 25 year average CPI and the PPI will change significantly over time. Figure 5-3 illustrates the recent historical trends for annual changes in CPI compared to GDP for the U.S.

Figure 5-3. U.S. CPI and Yearly GDP Change



Sources: Jacobs Consultancy and U.S. Bureau of Economic Analysis

As a result of the potential improvement in economic conditions, higher or more "conservative" cost escalation estimates have been proposed in order to reduce the risk of potential cost overruns and financing gaps. Table 5-6 summarizes the recommended base cost escalation factors for the Project. For the most part, the PMOC recommends that these rates be applied consistently throughout the forecast period. However, adjustments may be necessary, especially in the short-term, to account for annual fluctuations due to national and/or regional economic conditions.

Table 5-6. Recommended Base Escalation Factors

Cost Escalation Factor	Base Escalation Rate FY 2009 to FY 2019
Concrete	4.71%
Labor	4.67%
Other Materials	3.30%
Steel	5.29%
ROW	5.30%
Construction Equipment	3.60%
Vehicles (rail)	3.30%
Professional Services	4.86%

Source: Jacobs Consultancy

In particular, the PMOC recommends minor adjustments in concrete, labor, professional services, and ROW. For concrete, the PMOC recommends increasing the escalation rates in 2012 and 2013 to reflect possible cost pressures as the economic recovery accelerates in the U.S.

and other developed countries. It should be noted that growth in China and India has slowed only moderately. In a recently updated forecast provided by the World Bank, it was estimated that for 2010, GDP in China and India will increase by 7.7% and 8.0%, respectively. As a result of these national and global trends, there could be increased pressure on concrete costs related to the development of buildings, housing, and infrastructure in the short-term.

Adjustments have also been made for labor in 2013 and 2018 to account for the front-loading of labor costs in the years in which new union contracts go into effect. To account for the current slowdown in the real estate in Honolulu, the PMOC recommends using a 0.0% escalation factor for 2010. Due to the difficulty in providing accurate forecasts for the final five years (FY15 to FY19), consistent factors have been proposed for the entire forecast period, albeit with some adjustments. Table 5-7 provides a summary of the year by year escalation factors.

Table 5-7. Recommended Escalation Factors

Cost Factor	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Concrete	4.71%	4.71%	6.00%	6.00%	4.71%	4.71%	4.71%	4.71%	4.71%	4.71%
Labor	4.67%	4.67%	4.67%	5.00%	4.67%	4.67%	4.67%	4.67%	5.00%	4.67%
Other Materials	3.30%	3.30%	3.30%	3.30%	3.30%	3.30%	3.30%	3.30%	3.30%	3.30%
Steel	5.29%	5.29%	5.29%	5.29%	5.29%	5.29%	5.29%	5.29%	5.29%	5.29%
ROW	0.00%	5.10%	5.10%	5.10%	5.10%	5.10%	5.10%	5.10%	5.10%	5.10%
Construction Equipment	3.60%	3.60%	3.60%	3.60%	3.60%	3.60%	3.60%	3.60%	3.60%	3.60%
Vehicles	3.30%	3.30%	3.30%	3.30%	3.30%	3.30%	3.30%	3.30%	3.30%	3.30%
Professional Services	4.86%	4.86%	4.86%	4.86%	4.86%	4.86%	4.86%	4.86%	4.86%	4.86%

Source: Jacobs Consultancy

- **Concrete**. The PPI published by the U.S. BLS for all concrete products indicates that from 2000 through 2008, the average annual increase was 4.71%. The PMOC recommends that this benchmark be used as the cost escalation factor for concrete. This rate should be applied on a consistent basis for each year of the forecast period except for 2012 and 2013. Because of the potential for higher growth during an economic recovery, the PMOC concurs with the proposed forecasts developed by the City for 2012 and 2013.

- **Labor**. The U.S. BEA reported that wages and income in the state of Hawaii increased by 8.31% from 1970 through the first quarter of 2009. These growth rates are indicative of rapid economic growth in Hawaii, particularly in the tourism and housing industries. In recent years, Hawaii's economy has matured and wages and income growth have increased at an average annual rate of 4.67% from 2000 to 2008. This period captures both the economic downturn at the start of the decade as well as the increase in economic activity during the middle part of this decade. For this reason, the PMOC proposes using this benchmark as the base cost escalation factor for labor, since it is representative of local conditions and recent economic trends. However, a 5% cost escalation factor has been forecasted for 2013 and 2018 to account for the potential impact associated with the union contracts.

- **Other Materials**. The PPI published by the U.S. BLS for all Railroad Equipment indicates that from 2000 through 2008, the average annual increase was 3.30%. The PMOC recommends using this benchmark for escalating other materials costs. This escalation rate should be applied on a consistent basis for each year of the forecast period.

- **Steel**. In the developing a cost escalation rate for steel, the PMOC recommends using a blended rate that encompasses the PPI for iron and steel and the PPI all metals from 1970 to 2008. This rate more fully captures the periods of rapid growth and contraction in the economy. From the PMOC's analysis, this is estimated to be 5.29% per annum, which is comparable to the revised forecast of 5.15% suggested by the City of Honolulu. To account for the possibility of an economic recovery in 2010, the PMOC recommends using this rate throughout the entire forecast period.

- **Right-of-Way (ROW)**. The escalation rates forecasted for ROW that were included in the May 1, 2009 submittal seems somewhat low compared to historical forecasts. The revised data using UHERO data indicates a CAGR of 5.1%. Similarly, the Standard & Poors'/Case-Shiller index for a composite of 10 major U.S. cities also increased by 5.1% from January 1987 to January 2009. As a result, the PMOC recommends using a 5.1% cost escalation factor for each year of the analysis except for 2010. For 2010, the PMOC recommends using a 0% increase to account for continued sluggishness in the local real estate market.

- **Construction Equipment**. The PPI for construction equipment was 4.6% from 1970 to 2008 and 2.6% from 1998 to 2008. The PMOC recommends using the midpoint of these benchmark rates or 3.6%.

- **Vehicles**. Nearly 90%of the estimated costs in the City's forecast are related to the purchase of heavy rail vehicles. Consequently, the Producer Price Index (PPI) for railroad equipment appears to be the appropriate benchmark for this cost escalation factor. From 2000 to 2008, the PPI for Railroad Equipment increased by 3.3% per annum. Although the forecasted rates suggested by the City of Honolulu are in line with this benchmark, the PMOC recommends that this escalation rate be applied consistently throughout the entire forecast period

- **Professional Services**. This cost factor appears to have the greatest impact on the total project costs. In a report published in October 2008 by the Hawaii Department of Labor and Industrial Relations and other statewide agencies, the average annual increase in the professional and technical services sector from 2001 to 2007 was 4.86%. To account for local economic conditions, the PMOC recommends using this benchmark for escalating professional services. This escalation rate could be applied on a consistent basis for each year of the forecast period.

5.2.5 Review of Standard Cost Categories

Table 5-8 provides a summary of the *2009 SCC Estimate* in both base year and year-of-expenditure (YOE) dollars including allocated and unallocated contingency amounts.

Table 5-8. 2009 SCC Estimate

SCC	Description	Project Estimate			
		Base Year		YOE	
		Total	Contingency	Total	Contingency
10	**Guideway & Track Elements (Route Miles)**	**1,408,727,847**	**281,745,569**	**1,651,635,322**	**330,327,064**
10.01	Guideway: At-grade exclusive right-of-way	0	0	0	0
10.02	Guideway: At-grade semi-exclusive (allows cross-traffic)	0	0	0	0
10.03	Guideway: At-grade in mixed traffic	0	0	0	0
10.04	Guideway: Aerial structure	1,235,582,219	247,116,444	1,448,634,128	289,726,826
10.05	Guideway: Built-up fill	0	0	0	0
10.06	Guideway: Underground cut & cover	0	0	0	0
10.07	Guideway: Underground tunnel	0	0	0	0
10.08	Guideway: Retained cut or fill	6,908,743	1,381,749	8,100,020	1,620,004
10.09	Track: Direct fixation	154,161,530	30,832,306	180,743,661	36,148,732
10.10	Track: Embedded	0	0	0	0
10.11	Track: Ballasted	0	0	0	0
10.12	Track: Special (switches, turnouts)	12,075,355	2,415,071	14,157,513	2,831,503
10.13	Track: Vibration and noise dampening	0	0	0	0
20	**Stations, Stops, Terminals, Intermodals**	**305,630,343**	**61,126,069**	**383,399,114**	**76,679,823**
20.01	At-grade station, stop, shelter, mall, terminal, platform	0	0	0	0
20.02	Aerial station, stop, shelter, mall, terminal, platform	232,835,722	46,567,144	292,081,632	58,416,326
20.03	Underground station, stop, shelter, mall, terminal, platform	0	0	0	0
20.04	Other stations, landings, terminals: Intermodal, ferry, trolley, etc.	0	0	0	0
20.05	Joint development	0	0	0	0
20.06	Automobile parking multi-story structure	0	0	0	0
20.07	Elevators, escalators	72,794,621	14,558,924	91,317,481	18,263,496
30	**Support Facilities: Yards, Shops, Admin. Bldgs.**	**121,599,744**	**24,319,949**	**137,262,909**	**27,452,582**
30.01	Administration Building: Office, sales, storage, revenue counting	20,830,953	4,166,191	23,514,171	4,702,834
30.02	Light Maintenance Facility	0	0	0	0
30.03	Heavy Maintenance Facility	100,768,791	20,153,758	113,748,738	22,749,748
30.04	Storage or Maintenance of Way Building	0	0	0	0
30.05	Yard and Yard Track	0	0	0	0
40	**Sitework & Special Conditions**	**757,256,434**	**181,639,115**	**884,830,409**	**212,239,613**
40.01	Demolition, Clearing, Earthwork	34,600,201	8,970,448	40,429,250	10,481,687
40.02	Site Utilities, Utility Relocation	447,848,113	116,109,102	523,296,484	135,669,846
40.03	Haz. mat'l, contam'd soil removal/mitigation, ground water treatments	13,687,321	3,548,575	15,993,206	4,146,398
40.04	Environmental mitigation, e.g. wetlands, historic/archeologic, parks	13,277,602	3,442,351	15,514,462	4,022,279
40.05	Site structures including retaining walls, sound walls	0	0	0	0
40.06	Pedestrian / bike access and accommodation, landscaping	0	0	0	0
40.07	Automobile, bus, van accessways including roads, parking lots	247,843,197	49,568,639	289,597,008	57,919,402
40.08	Temporary Facilities and other indirect costs during construction	0	0	0	0
50	**Systems**	**254,163,056**	**50,832,611**	**310,833,817**	**62,166,763**
50.01	Train control and signals	43,262,482	8,652,496	52,908,722	10,581,744
50.02	Traffic signals and crossing protection	30,281,406	6,056,281	37,033,254	7,406,651
50.03	Traction power supply: substations	52,487,423	10,497,485	64,190,549	12,838,110
50.04	Traction power distribution: catenary and third rail	85,597,152	17,119,430	104,682,757	20,936,551
50.05	Communications	26,013,172	5,202,634	31,813,332	6,362,666
50.06	Fare collection system and equipment	5,451,779	1,090,356	6,667,363	1,333,473
50.07	Central Control	11,069,642	2,213,928	13,537,841	2,707,568
CONSTRUCTION SUBTOTAL (10 - 50)		**2,847,377,424**	**599,663,313**	**3,367,961,572**	**708,865,846**
60	**ROW, Land, Existing Improvements**	**128,451,539**	**42,817,265**	**118,043,921**	**39,348,052**
60.01	Purchase or lease of real estate	124,896,807	41,632,352	114,777,206	38,259,145
60.02	Relocation of existing households and businesses	3,554,732	1,184,913	3,266,714	1,088,907
70	**Vehicles**	**301,613,767**	**58,377,301**	**344,655,026**	**66,707,931**
70.01	Light Rail	0	0	0	0
70.02	Heavy Rail	268,562,519	51,980,276	306,887,258	59,398,029
70.03	Commuter Rail	0	0	0	0
70.04	Bus	0	0	0	0
70.05	Other	0	0	0	0
70.06	Non-revenue vehicles	6,195,050	1,199,052	7,079,104	1,370,161
70.07	Spare parts	26,856,198	5,197,974	30,688,664	5,939,742
80	**Professaonal Services**	**747,370,066**	**157,397,613**	**827,997,138**	**174,377,834**
80.01	Preliminary Engineering	22,487,619	4,735,937	24,913,607	5,246,855
80.02	Final Design	125,835,644	26,501,235	139,410,926	29,360,217
80.03	Project Management for Design and Construction	123,667,704	26,044,663	137,009,107	28,854,389
80.04	Construction Administration & Management	279,634,764	58,891,634	309,802,058	65,244,926
80.05	Professional Liability and other Non-Construction Insurance	41,945,215	8,833,745	46,470,309	9,786,739
80.06	Legal; Permits; Review Fees by other agencies, cities, etc.	41,945,215	8,833,745	46,470,309	9,786,739
80.07	Surveys, Testing, Investigation, Inspection	13,981,738	2,944,582	15,490,103	3,262,246
80.08	Start up	97,872,167	20,612,072	108,430,720	22,835,724
SUBTOTAL (10 - 80)		**4,024,812,796**	**858,255,493**	**4,658,657,657**	**989,299,663**
90	**Unallocated Contingency**	**241,488,771**	**241,488,771**	**281,972,969**	**281,972,969**
SUBTOTAL (10 - 90)		**4,266,301,567**	**1,099,744,264**	**4,940,630,626**	**1,271,272,632**
100	**Finance Charges**	**194,326,562**	**0**	**230,873,271**	**0**
TOTAL PROJECT COST (10 - 100)		**4,460,628,129**	**1,099,744,264**	**5,171,503,897**	**1,271,272,632**

(1) SCC 10 – Guideway and Track Elements

Table 5-9. SCC 10 YOE Estimate

SCC	Description	Cost Estimate Classification				Total
		Plan Quantity	Estimate Quantity	CER	LS	
10.04	Guideway: Aerial Structure			1,448,634		1,448,634
10.08	Guideway: Retained Cut or Fill			8,100		8,100
10.09	Track: Direct Fixation			180,744		180,744
10.12	Track: Special			14,158		14,158
	Total			**1,651,635**		**1,651,635**

Note: All values are in YOE $ x1000.

<u>Quantity Review</u>
Since this is a parametric style estimate, the only quantity checked was overall length for the guideways, and it is accurate.

<u>Unit Measure Pricing Review</u>
The PMOC review of unit prices contained in the assemblies finds that many of the unit prices are in the high range for these SCC 10 elements, but the generated quantities appear reasonable. The material prices for various types of track work, although given as a lump sum unit price, are trending high as compared to industry standard pricing but this may be a result of the entire alignment essentially being elevated and located in roadway ROW. Since the track work length is known and the design is standard (but expensive), the costs for materials and labor are expected to be well understood by the project staff. Overall the trackwork portion of the estimate is reasonable.

In the current estimate for this SCC, the costs are distributed with the CER items representing 100% of the estimate. A review of SCC line items resulted in the following observations:

- *SCC 10.04 Guideway: Aerial Structure ($1,448,634,128 in YOE)*
- *SCC 10.08 Guideway: Retained Cut or Fill ($8,100,020 in YOE)*
- *SCC 10.09 Track: Direct Fixation ($180,743,661 in YOE)*
- *SCC 10.12 Track: Special (Switches and Turnouts) ($14,157,513 in YOE)*
  No discrepancies were identified.

<u>Contingency Review (Allocated and Latent)</u>
Table 5-9 includes only Allocated Contingency and no Latent Contingency was identified for this work element. The value for Allocated Contingency for SCC 10 is $330.327 million (YOE), which represents 25.00% contingency.

(2) SCC 20 – Stations, Stops, Terminals, Intermodal Facilities

Table 5-10. SCC 20 YOE Estimate

SCC	Description	Cost Estimate Classification				Total
		Plan Quantity	Estimate Quantity	CER	LS	
20.02	Aerial Stations			292,082		292,082
20.03	Underground Stations					0
20.07	Elevators/Escalators			91,317		91,317
	Total			**383,399**		**383,399**

Note: All values are in YOE $ x1000.

Quantity Review

Since this is a parametric style estimate, the only quantity checked was the overall count of the stations, which is accurate. It was noted during the September 2008 Risk Assessment Workshop that the count of elevators and escalators is likely conservative but is being reviewed by the GEC. Changes will be reflected in the plans and estimate once the study is completed.

Unit Measure Pricing Review

As expected, the DEIS documents are not developed well enough for a bottoms-up estimate to be generated for the stations other than to generate broad generic line items thru the parametric process. The PMOC noted that these station assembly costs are higher than average for most typical elevated stations; however, the scope is not clearly defined and the prices are not that unreasonable given the geographic location of the project.

In the current estimate for this SCC, the costs are distributed with the CER representing 100% of the estimate. A review of line items resulted in the following observations:

- *SCC 20.01 Aerial Stations ($292,081,632 in YOE)*
  No discrepancies were identified.

- *SCC 20.03 Underground Stations ($0 in YOE)*
  Leeward Community College Station is the only proposed at-grade or slightly depressed station. However, the *2009 SCC Estimate* utilized the aerial stations' CER for this station.

- *SCC 20.07 Escalators/Elevators ($91,317,481 in YOE)*
  No discrepancies were identified.

Contingency Review (Allocated and Latent)

Table 5-10 includes only Allocated Contingency and no Latent Contingency was identified for this work element. The value for Allocated Contingency for SCC 20 is $76.680 million (YOE), which represents 25.00% contingency.

(3) SCC 30 – Support Facilities: Yards, Shops & Admin. Building

Table 5-11. SCC 30 YOE Estimate

SCC	Description	Cost Estimate Classification				Total
		Plan Quantity	Estimate Quantity	CER	LS	
30.01	Administration Building			23,514		23,514
30.04	Heavy Maintenance Facility			113,749		113,749
30.05	Yard and Yard Track					0
	Total			**137,263**		**137,263**

Note: All values are in YOE $ x1000.

<u>Quantity Review</u>
The project scope for support facilities is based upon a square foot requirement for the buildings and a parametric estimate to generate quantities.

<u>Unit Measure Pricing Review</u>
In the current City's estimate for this SCC, the costs are distributed with the CER items representing 100%. A review of line items resulted in the following observations:

- *SCC 30.01 Administration Building ($23,514,171 in YOE)*
  No discrepancies were identified.

- *SCC 30.04 Heavy Maintenance Facility ($113,748,738 in YOE)*
  No discrepancies were identified.

- *SCC 30.05 Yard and Yard Track ($0 in YOE)*
  No cost was contained within this SCC as it was included in SCC 30.04.

<u>Contingency Review (Allocated and Latent)</u>
Table 5-11 includes only Allocated Contingency and no Latent Contingency was identified for this work element. The value for Allocated Contingency for SCC 30 in YOE is $27.453 million, which represents 25.00% contingency.

(4) SCC 40 – Sitework & Special Conditions

Table 5-12. SCC 40 YOE Estimate

SCC	Description	Cost Estimate Classification				Total
		Plan Quantity	Estimate Quantity	CER	LS	
40.01	Demolition, Clearing, Earthwork			40,429		40,429
40.02	Site Utilities, Utility Relocation			523,296		523,296
40.03	Haz Matl ,Contamination				15,993	15,993
40.04	Environmental Mitigation				15,514	15,514
40.05	Site Structures, including retaining walls					0
40.06	Pedestrian/ bike access					0
40.07	Automobile, bus, van access ways			289,597		289,597
40.08	Temporary Facilities and other indirect costs during construction					0
	Total			**853,323**	**31,507**	**884,830**

Note: All values are in YOE $ x1000.

<u>Quantity Review</u>
Since this is a parametric style estimate, the only quantity checked for this SCC was the overall length, which is accurate.

<u>Unit Measure Pricing Review</u>
In the current City estimate for this SCC, the costs are distributed with the CER items ($853.0 million) representing 96.4% of the estimate and Lump Sum or Allowance items ($29.5 million) representing 3.6% of the estimate. A review of line items resulted in the following observations:

- *SCC 40.01 Demolition ($40,429,250 in YOE)*
  No discrepancies were identified.

- *SCC 40.02 Site Utilities, Utility Relocation ($523,296,484 in YOE)*
  No discrepancies were identified.

- *SCC 40.03 Hazardous Materials ($15,993,206 in YOE)*
  No discrepancies were identified.

- *SCC 40.04 Environmental Mitigations ($15,514,462 in YOE)*
  No discrepancies were identified.

- *SCC 40.05 Site Structures including retaining walls, sound walls ($0 in YOE)*
  No cost included in the budget for this SCC.

- *SCC 40.06 Pedestrian/bike access, accommodation, landscape ($0 in YOE)*

No cost included in the budget for this SCC.

- *SCC 40.07 Automobile, bus, van access ways, including roads, parking lots ($289,597,008 in YOE)*
  No discrepancies were identified.

Contingency Review (Allocated and Latent)
Table 5-12 includes only Allocated Contingency and no Latent Contingency was identified for this work element. The value for Allocated Contingency for SCC 40 is $212.240 million (YOE), which represents 31.56% contingency.

(5) SCC 50 – Systems

Table 5-13. SCC 50 YOE Estimate

SCC	Description	Cost Estimate Classification				Total
		Plan Quantity	Estimate Quantity	CER	LS	
50.01	Train Control and Signals			52,909		52,909
50.02	Traffic Signals and Crossing Protection			37,033		37,033
50.03	Traction Power Supply – Substations			64,191		64,191
50.04	Traction Power Distribution – Catenary			104,683		104,683
50.05	Communications			31,813		31,813
50.06	Fare Collection System & Equip.			6,667		6,667
50.07	Central Control			13,538		13,538
	Total			**310,834**		**310,834**

Note: All values are in YOE $ x1000.

Quantity Review
For the Systems, since this is a parametric style estimate, the only quantity checked was overall length, which is accurate. It was noted that the final line segment quantity did not match the stationing, but it was assumed this was due to a longer length being necessary to account for tail tracks or other elements that were not specifically identified.

It was also noted that some of the parametric quantities for the systems elements contained in the CERs had less than whole numbers. In some cases, the aggregate sum of the various line sections did not equal whole numbers. This possible discrepancy was brought to the Project staff's attention at the September 2008 Risk Assessment Workshop. They indicated that it was likely an anomaly of the software used to develop the CERs and would be reviewed to ensure consistency in the estimate preparation. It should be noted that these discrepancies were minor and would not significantly affect the cost estimate at this stage.

Unit Measure Pricing Review

In the current City estimate for this SCC, the costs are distributed with the CER items ($310.8 million) representing 100% of the estimate. A review of line items resulted in the following observations:

- *SCC 50.01 Train Control and Signals ($52,908,722 YOE)*
- *SCC 50.02 Traffic Signals and Crossing Protection ($37,033,254 YOE)*
- *SCC 50.03 Systems: Traction Power: Substations ($64,190,549 in YOE)*
- *SCC 50.04 Traction Power: Third Rail ($104,682,757 in YOE)*
- *SCC 50.05 Communications ($31,813,332 in YOE)*
- *SCC 50.06 Fare Collection ($6,667,363 in YOE)*
- *SCC 50.07 Systems: Central Control ($13,537,841 in YOE)*

  The estimate provides no extensive detail for each of these line items due to the parametric style of estimate. While the PMOC cannot determine whether each of these SCC line items is complete or consistent with future requirements, the PMOC has determined the amount of detail provided sufficiently describes the scope of work for a rough order of magnitude cost estimate developed in the planning phase. The PMOC recognizes a significant number of cost and schedule risks exist for each portion of the work as the scope definition is limited and still evolving.

Contingency Review (Allocated and Latent)

Table 5-13 includes only Allocated Contingency and no Latent Contingency was identified for this work element. The value for Allocated Contingency for SCC 50 is $62.167 million (YOE), which represents 25.00% contingency.

(6) SCC 60 – Right-of-Way

Table 5-14. SCC 60 YOE Estimate

SCC	Description	Cost Estimate Classification				Total
		Plan Quantity	Estimate Quantity	CER	LS	
60.01	Purchase or lease of real estate			114,777		114,777
60.02	Relocation of existing households & businesses			3,267		3,267
	Total			**118,044**		**118,044**

Note: All values are in YOE $ x1000.

Quantity Review

Since this is a parametric style estimate, the real estate quantity was not checked as the design is not advanced sufficiently and is subject to vary greatly as the project advances forward.

Unit Measure Pricing Review

The costs are distributed with the CER items ($118.0 million) representing 100% of the estimate. A review of line items resulted in the following observations:

- *SCC 60.01 Purchase or lease of real estate ($114,777,206 in YOE)*

The City has indicated that the basis of cost for real estate is the City or County tax assessment value. These are updated bi-annually, and a large risk likely exists for acquiring the parcels. The City also stated the cost estimate does not include costs for temporary or permanent easements.

- *SCC 60.02 Relocation of existing households and businesses ($3,266,714 in YOE)*
  No discrepancies were identified.

Contingency Review (Allocated and Latent)
Table 5-14 includes only Allocated Contingency and no Latent Contingency was identified for this work element. The value for Allocated Contingency for SCC 60 is $39.348 million (YOE), which represents 50.00% contingency.

(7) SCC 70 – Vehicles

Table 5-15. SCC 70 YOE Estimate

SCC	Description	Cost Estimate Classification				Total
		Plan Quantity	Estimate Quantity	CER	LS	
70.02	Heavy Rail				306,887	306,887
70.05	Other				0	0
70.06	Non-revenue Vehicles				7,079	7,079
70.07	Spare Parts				30,689	30,689
	Total				**344,655**	**344,655**

Note: All values are in YOE $ x1000.

Quantity Review
The *2009 SCC Estimate* includes the procurement of 67 heavy rail vehicles. However, the GEC has developed a "Fixed Guideway Fleet Sizing Report" dated June 2009 that identified a need for 76 heavy rail vehicles to support full revenue service in 2019. Therefore, the PMOC has included an adjustment to account for this discrepancy as shown in Table 5-19.

Unit Measure Pricing Review
In the current City estimate for this SCC, the costs are distributed with the Lump Sum or Allowance items ($344.7 million) representing 100% of the estimate for this portion of the work. A review of line items resulted in the following observations:

- *SCC 70.02 Heavy Rail ($306,887,258 in YOE)*
  No discrepancies were identified.

- *SCC 70.06 Non-revenue vehicles ($7,079,104 in YOE)*
  No discrepancies were identified.

- *SCC 70.07 Spare Parts ($30,668,664 in YOE)*
  No discrepancies were identified.

Contingency Review (Allocated and Latent)
Table 5-15 includes only Allocated Contingency and no Latent Contingency was identified for this work element. The value for Allocated Contingency for SCC 70 in YOE is $66.708 million, which represents 24.00% contingency.

(8) SCC 80 – Professional Services

Table 5-16. SCC 80 YOE Estimate

SCC	Description	Cost Estimate Classification				Total
		Plan Quantity	Estimate Quantity	CER	LS	
80.01	Preliminary Engineering			24,914		24,914
80.02	Final Design			139,411		139,411
80.03	Project Management for Design & construction			137,009		137,009
80.04	Construction Administration & Management			309,802		309,802
80.05	Insurance			46,470		46,470
80.06	Legal, Permits, review Fees			46,470		46,470
80.07	Surveys, Testing, Investigation, Inspection			15,490		15,490
80.08	Agency Force Account Work			108,431		108,431
	Total			**827,997**		**827,997**

Note: All values are in YOE $ x1000.

Quantity Review
Since this is a parametric style estimate, the quantity was not checked as these professional and administrative type costs are based on a percentage and not on the basis of a staffing or work plan. It is anticipated that once the project is advanced to PE that staffing plans will be developed to improve the accuracy of these estimates.

Unit Measure Pricing Review
Professional Services is one of the largest cost categories in the *2009 SCC Estimate*. The values are calculated on a percentage basis of the construction values. If the base cost increases or decreases, then so do the soft costs, as these are a function of the total project cost in the parametric style of estimating.

In the current Project estimate for this SCC, the costs are distributed with the CER items ($828.0 million) representing 100% of the estimate. A review of line items resulted in the following observations:

- *SCC 80.01 Preliminary Engineering ($24,913,607 in YOE)*
- *SCC 80.02 Final Design – 4.5% of SCC 10-50 ($139,410,926 in YOE)*
- *SCC 80.03 Project Management for Design and Construction –4.3% of SCC 10-50 ($137,009,107 in YOE)*
- *SCC 80.04 Construction Administration and Management – 10.0% of SCC 10-50 ($309,802,058 in YOE)*
- *SCC 80.05 Insurance – 1.5% of SCC 10-50 ($46,470,309 in YOE)*

- *SCC 80.06 Legal Permits: Review fees by other agencies, cities etc – 1.5% of SCC 10-50 ($46,470,309 in YOE)*
- *SCC 80.07 Surveys, Testing, Investigation, Inspection – 0.5% of SCC 10-50 ($15,490,103 in YOE)*
- *SCC 80.08 Start-up – 3.5% of SCC 10-50 ($108,430,720 in YOE)*
  No discrepancies were identified.

Contingency Review (Allocated and Latent)
Table 5-16 includes only Allocated Contingency, and no Latent Contingency was identified for this work element. The value for Allocated Contingency for SCC 80 is $174.378 million (YOE), which represents 26.68% contingency.

(9) SCC 90 – Contingency

Table 5-17. SCC 90 YOE Estimate

SCC	Description	Cost Estimate Classification				Total
		Plan Quantity	Estimate Quantity	CER	LS	
90	Unallocated Contingency				281,973	281,973
	Total				**281,973**	**281,973**

Note: All values are in YOE $ x1000.

Quantity Review
A quantity review was not applicable for this SCC.

Unit Measure Pricing Review
In the current Project estimate, the costs for SCC 90 are distributed with the Lump Sum or Allowance items ($282.0 million) representing 100% of the estimate for this portion of the work. A review of line items resulted in the following observations:

- *SCC 90.00 Contingency ($281,972,969 in YOE)*
  No discrepancies were identified.

Contingency Review (Allocated and Latent)
This section addresses contingencies included in the direct cost line items and all Unallocated Contingency.

- *Design and Construction Contingency Factors*
  A review of the *2009 SCC Estimate* reveals an unallocated contingency level of 7.63% ($281,972,969 YOE) and an allocated contingency level of 27.10% ($989,299,663 in YOE) of the subtotal cost of SCC 10 to 80. Each of the individual SCC elements as shown in the various tables above (SCC 10 to 80) includes the corresponding allocated contingency values. It is shown here to identify the aggregate value in one convenient spot but is not included in the SCC 90 table above.

- *Latent Contingency*
  The PMOC could not identify any Latent Contingency in the *2009 SCC Estimate*, and this issue was discussed at the Risk Assessment Workshops. The Project staff stated

that the estimate did not contain any latent contingency. With that being said, the parametric style of estimating does not lend itself to finding latent contingency in a review analysis due to the lack of detail and the use of software to develop quantities. Additionally since the current drawings and the estimate are not coordinated, and effectively there is not a set of documents identified as the basis of estimate, then a check cannot be made to see if latent contingency exists from a quantity standpoint either.

(10) SCC 100 Finance Charges

Table 5-18. SCC 100 YOE Estimate

SCC	Description	Cost Estimate Classification				Total
		Plan Quantity	Estimate Quantity	CER	LS	
100	Finance Cost				230,873	230,873
	Total				**230,873**	**230,873**

Note: All values are in YOE $ x1000.

<u>Quantity Review</u>
Not Applicable for Finance Costs

<u>Unit Measure Pricing Review</u>
In the current City estimate for this SCC, the costs are distributed with the Lump Sum or Allowance items ($230.873 million) representing 100% of the estimate for this portion of the work.

The allowance for Finance Charges is to reflect the cost of borrowing to match the cash flow requirements for construction progress payments versus the anticipated flow of funding from the contributing agencies.

<u>Contingency Review (Allocated and Latent)</u>
No Allocated Contingency is included for this work element and no Latent Contingency was identified during either the Risk Assessment Workshops or the subsequent review of the furnished project documents.

5.3 PMOC Adjustments to Base Cost Estimate

The PMOC made adjustments to the project's direct costs due to omissions in scope or to under valuation of certain cost items. The PMOC has identified adjustments to the Base Cost Estimate (BCE) that can be categorized as Line Item Adjustments or Escalation Adjustments. The input for the Cost Risk Model (Section 8.0) and basis for the evaluation of project cost contingency (Section 9.0) is the Adjusted BCE, which is the BCE net of contingencies and finance costs and includes the PMOC adjustments discussed below. Table 5-19 provides a summary of the Cost Risk Model Input including PMOC Adjustments.

5.3.1 Line Item Adjustment

The PMOC has identified Line Item Adjustments for the following SCCs:

<u>SCC 70 – Vehicles</u>
The *2009 SCC Estimate* includes the procurement of 67 heavy rail vehicles. However, the GEC prepared a document titled "Fixed Guideway Fleet Sizing Report" dated June 2009 that identified a need for 76 vehicles at the start of full revenue service in 2019. Therefore, the PMOC included an adjustment to SCC 70.02 to account for an increase of nine (9) rail vehicles. The result of this adjustment is shown in Table 5-19.

5.3.2 Escalation Adjustment

As noted in Section 5.2.4, the PMOC developed recommended cost escalation factors for the Project, as summarized in Table 5-7. The PMOC utilized these recommended escalation factors to develop adjustments to the affected SCC line items, as detailed in Table 5-19.

5.3.3 Adjustment Summary

The City's BCE of $5.172 billion (YOE) includes $989.30 million in allocated contingency, $281.97 million in unallocated contingency, and $230.87 million in finance charges. The BCE appears to also have some latent contingency, but the amount cannot be easily quantified at this stage of the project because the SCC line items are based primarily on CERs. To condition the BCE, the PMOC identified the following adjustments:

- Line Item Adjustment – $36.57 million (YOE)
- Escalation Adjustment – $132.46 million (YOE)

The input for the Cost Risk Model and basis for the evaluation of project cost contingency is the Adjusted BCE, which is the BCE net of contingencies and finance costs and includes the PMOC adjustments discussed below. To develop the Adjusted BCE (Table 5-19), the following steps were taken:

- Start with City's BCE (YOE) – $5,171,503,897
- Strip YOE allocated and unallocated contingency – $1,271,272,632
- Deduct YOE financing costs – $230,873,271
- Apply PMOC YOE adjustments as outlined above – $169,029,334
- Result is an Adjusted BCE (YOE) of $3,838,387,328

Table 5-19. PMOC Adjustments and Cost Risk Model Input

SCC	Description	Risk Assessment Model Input: YOE Total w/o Contingency	PMOC Adjustments (YOE): Line Item	PMOC Adjustments (YOE): Escalation	PMOC Adjustments (YOE): Total	Adjusted BCE
10	**Guideway & Track Elements (Route Miles)**	**1,321,308,258**	**0**	**20,945,057**	**20,945,057**	**1,342,253,314**
10.01	Guideway: At-grade exclusive right-of-way	0	0	0	0	0
10.02	Guideway: At-grade semi-exclusive (allows cross-traffic)	0	0	0	0	0
10.03	Guideway: At-grade in mixed traffic	0	0	0	0	0
10.04	Guideway: Aerial structure	1,158,907,302	0	18,370,716	18,370,716	1,177,278,019
10.05	Guideway: Built-up fill	0	0	0	0	0
10.06	Guideway: Underground cut & cover	0	0	0	0	0
10.07	Guideway: Underground tunnel	0	0	0	0	0
10.08	Guideway: Retained cut or fill	6,480,016	0	102,720	102,720	6,582,736
10.09	Track: Direct fixation	144,594,929	0	2,292,084	2,292,084	146,887,012
10.10	Track: Embedded	0	0	0	0	0
10.11	Track: Ballasted	0	0	0	0	0
10.12	Track: Special (switches, turnouts)	11,326,010	0	179,537	179,537	11,505,548
10.13	Track: Vibration and noise dampening	0	0	0	0	0
20	**Stations, Stops, Terminals, Intermodals**	**306,719,291**	**0**	**4,602,236**	**4,602,236**	**311,321,527**
20.01	At-grade station, stop, shelter, mall, terminal, platform	0	0	0	0	0
20.02	Aerial station, stop, shelter, mall, terminal, platform	233,665,306	0	3,506,082	3,506,082	237,171,388
20.03	Underground station, stop, shelter, mall, terminal, platform	0	0	0	0	0
20.04	Other stations, landings, terminals: Intermodal, ferry, trolley, etc.	0	0	0	0	0
20.05	Joint development	0	0	0	0	0
20.06	Automobile parking multi-story structure	0	0	0	0	0
20.07	Elevators, escalators	73,053,985	0	1,096,154	1,096,154	74,150,140
30	**Support Facilities: Yards, Shops, Admin. Bldgs.**	**109,810,327**	**0**	**989,100**	**989,100**	**110,799,427**
30.01	Administration Building: Office, sales, storage, revenue counting	18,811,337	0	169,440	169,440	18,980,777
30.02	Light Maintenance Facility	0	0	0	0	0
30.03	Heavy Maintenance Facility	90,998,990	0	819,660	819,660	91,818,650
30.04	Storage or Maintenance of Way Building	0	0	0	0	0
30.05	Yard and Yard Track	0	0	0	0	0
40	**Sitework & Special Conditions**	**672,590,796**	**0**	**8,087,315**	**8,087,315**	**680,678,111**
40.01	Demolition, Clearing, Earthwork	29,947,563	0	360,093	360,093	30,307,656
40.02	Site Utilities, Utility Relocation	387,626,637	0	4,660,871	4,660,871	392,287,508
40.03	Haz. mat'l, contam'd soil removal/mitigation, ground water treatments	11,846,807	0	142,447	142,447	11,989,255
40.04	Environmental mitigation, e.g. wetlands, historic/archeologic, parks	11,492,182	0	138,183	138,183	11,630,366
40.05	Site structures including retaining walls, sound walls	0	0	0	0	0
40.06	Pedestrian / bike access and accommodation, landscaping	0	0	0	0	0
40.07	Automobile, bus, van accessways including roads, parking lots	231,677,606	0	2,785,720	2,785,720	234,463,326
40.08	Temporary Facilities and other indirect costs during construction	0	0	0	0	0
50	**Systems**	**248,667,054**	**0**	**304,960**	**304,960**	**248,972,014**
50.01	Train control and signals	42,326,977	0	51,909	51,909	42,378,886
50.02	Traffic signals and crossing protection	29,626,603	0	36,333	36,333	29,662,937
50.03	Traction power supply: substations	51,352,439	0	62,977	62,977	51,415,417
50.04	Traction power distribution: catenary and third rail	83,746,206	0	102,704	102,704	83,848,910
50.05	Communications	25,450,665	0	31,212	31,212	25,481,877
50.06	Fare collection system and equipment	5,333,890	0	6,541	6,541	5,340,432
50.07	Central Control	10,830,273	0	13,282	13,282	10,843,555
CONSTRUCTION SUBTOTAL (10 - 50)		**2,659,095,726**	**0**	**34,928,667**	**34,928,667**	**2,694,024,393**
60	**ROW, Land, Existing Improvements**	**78,695,868**	**0**	**7,060,770**	**7,060,770**	**85,756,638**
60.01	Purchase or lease of real estate	76,518,061	0	6,865,372	6,865,372	83,383,433
60.02	Relocation of existing households and businesses	2,177,807	0	195,398	195,398	2,373,205
70	**Vehicles**	**277,947,095**	**36,569,304**	**7,116,716**	**43,686,020**	**321,633,115**
70.01	Light Rail	0	0	0	0	0
70.02	Heavy Rail	247,489,229	33,244,822	6,336,855	39,581,677	287,070,906
70.03	Commuter Rail	0	0	0	0	0
70.04	Bus	0	0	0	0	0
70.05	Other	0	0	0	0	0
70.06	Non-revenue vehicles	5,708,943	0	146,175	146,175	5,855,118
70.07	Spare parts	24,748,923	3,324,482	633,686	3,958,168	28,707,091
80	**Professaonal Services**	**653,619,304**	**0**	**83,353,878**	**83,353,878**	**736,973,182**
80.01	Preliminary Engineering	19,666,752	0	2,508,035	2,508,035	22,174,787
80.02	Final Design	110,050,710	0	14,034,398	14,034,398	124,085,107
80.03	Project Management for Design and Construction	108,154,718	0	13,792,608	13,792,608	121,947,326
80.04	Construction Administration & Management	244,557,132	0	31,187,551	31,187,551	275,744,683
80.05	Professional Liability and other Non-Construction Insurance	36,683,570	0	4,678,133	4,678,133	41,361,703
80.06	Legal; Permits; Review Fees by other agencies, cities, etc.	36,683,570	0	4,678,133	4,678,133	41,361,703
80.07	Surveys, Testing, Investigation, Inspection	12,227,856	0	1,559,378	1,559,378	13,787,234
80.08	Start up	85,594,996	0	10,915,643	10,915,643	96,510,639
SUBTOTAL (10 - 80)		**3,669,357,994**	**36,569,304**	**132,460,030**	**169,029,334**	**3,838,387,328**
90	**Unallocated Contingency**		**0**	**0**	**0**	**0**
SUBTOTAL (10 - 90)		**3,669,357,994**	**36,569,304**	**132,460,030**	**169,029,334**	**3,838,387,328**
100	**Finance Charges**	**230,873,271**	**0**	**0**	**0**	**230,873,271**
TOTAL PROJECT COST (10 - 100)		**3,900,231,265**	**36,569,304**	**132,460,030**	**169,029,334**	**4,069,260,599**

5.4 Conclusion

In general, the PMOC has found that the current cost estimate is reasonable and acceptable for a project in the pre-PE Phase with the exception of the Line Item and Escalation adjustments that are recommended. The PMOC recommendations for budget and contingency are discussed in Section 8.0 of this Spot Report. The following specific observations are provided and should be addressed once the Project is advanced to PE.

(1) The PMOC's review of the City's project cost estimate concludes the estimate is not mechanically correct in some instances but is essentially consistent with the project scope identified in the DEIS.

(2) The PMOC has characterized the project cost data as an AACE "Class 4" estimate due to its mostly parametric nature. The PMOC derived the data elements based on a professional judgment from other projects.

(3) The PMOC found the percentages used by the City for escalation in their *2009 SCC Estimate* are inadequate.

5.5 Recommendations

(1) The PMOC recommends that the City prepare a detailed bottoms-up estimate during early PE. In addition, it should perform quality assurance checks to verify scope inclusivity and that SCC categories are escalated in accordance with the Master Project Schedule. The cost estimate and Basis of Estimate should provide more justification and backup documentation supporting the quantification and assumptions for the "soft costs" and related General Conditions for the project.

(2) The PMOC recommends the City investigate the suspect parametric quantities in the Systems Estimate (SCC 50) that do not sum to a whole number.

(3) The PMOC recommends the City recalculate the values for soft costs once the above adjustments are made to its estimate.

(4) The PMOC recommends the City reconsider the values utilized for escalation to develop the YOE costs for its *2009 SCC Estimate*.

6.0 SUBTASK 34A: PROJECT SCHEDULE REVIEW

6.1 Methodology

The PMOC followed the requirements outlined in the *FTA PG #34: Project Schedule Review procedures,* dated March 29, 2007 to assess and evaluate the City's project schedule.

Jacobs has developed and refined a standard Technical Schedule Review (TSR) report format based on senior program management experience, the evolution of scheduling software packages, and program experience on other federal programs. The TSR provides a standard reporting format for various types of schedules such as design schedules, construction schedules and Master Integrated Program Schedules. In addition, the TSR reviews the contractual requirements set by the project sponsor and evaluates the overall program user(s) conformance of schedule management execution.

The review of the Project schedule addresses seven subcategories as identified in the PG-34A:

- Schedule
- Technical Review
- Resource Loading
- Project Calendars
- Interfaces
- Project Critical Path
- Critical Areas of Concern

The TSR categories characterize each element in the project/program schedule, from schedule development, performance measurement, through post project archive record documentation. Jacobs tailored the TSR format to better synchronize with the PG-34A. The result is a combination of the PG-34 plus additional review categories contained in the "Technical Review" subcategory, listed above. The schedule review will evaluate the efficiency and effectiveness of the project sponsor's project implementation during any phase of the project life cycle. According to the PG-34, the schedule review will also:

> *"...evaluate the completeness, consistency, and adequacy of the project sponsor schedule and make recommendations to the project sponsor on redirecting or reprioritizing its efforts to correct the inadequately defined areas."*

The schedule review also validates the inclusivity of the Project scope and characterizes individual project elements within the current Project phase. It also validates the program management's readiness to enter and implement the next major program phase, the PE phase. The report findings result in a compilation of tabular and graphical reports and conclude with a list of PMOC recommendations for Project sponsor action.

The PMOC used the meeting notes, files, reports and documents identified in Appendix B to support the Schedule Review.

6.2 Review and Analysis of Project Schedule

The City submitted a Master Project Schedule (MPS) titled "HHCTP As of August 25.xer" in early August 2008. The PMOC conducted a preliminary schedule review and produced a list of comments to the City during the Risk Assessment workshop site visit on September 11, 2008. The City incorporated the PMOC comments in a revised schedule, titled "*CITY.prx*", on September 20, 2008. The City submitted a revised and progressed MPS *"MA5A.prx"* to the PMOC in May 2009. The PMOC provided preliminary schedule review comments to the City in late May 2009. As a result the City addressed most of the PMOC's comments and submitted a revised MPS *"MA5E.xer"* on May 29, 2009. The PMOC used this MPS to conclude the PG-34A Project Schedule Review, PG-35C Schedule Contingency Review, and the PG-40B Assessment of Project Schedule Risk Report(s).

The MPS contains updated work progress, deletion of the Salt Lake Alternative, and inclusion of the new airport corridor alignment. The technical schedule data are included in Table 6-1.

Table 6-1. Technical Schedule Data

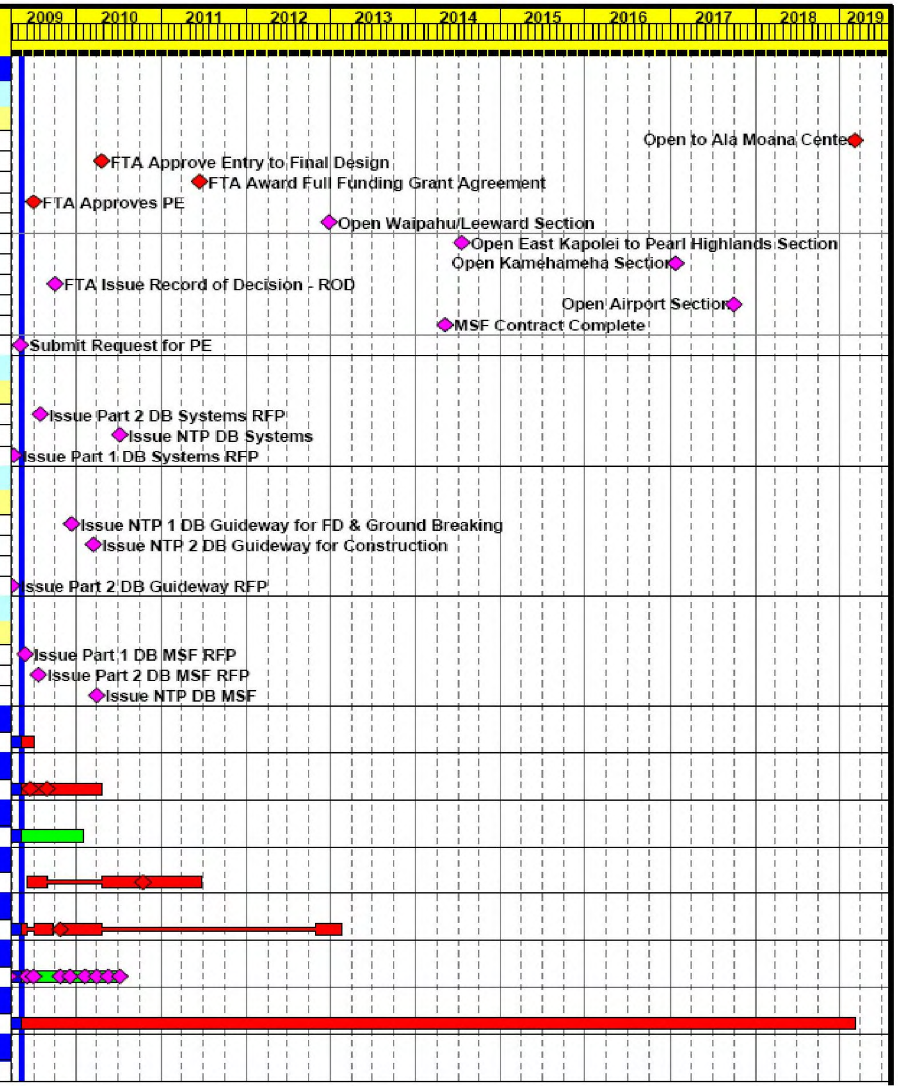
Schedule Item	MPS
Number of activities	368
Number of activities in longest path	25
Started activities	85
Completed activities	51
Number of relationships	615
Percent complete	3.6 %
Number of hammocks	1
Number of early constraints	4
Number of late constraints	7
Number of mandatory constraints	0
Data date	10MAY09
Start date	15SEP08
Imposed finish date	N/A
Latest calculated early finish	04MAR19

Table 6-2. Summary Schedule Dates

Description	Start Date	Finish Date
Preliminary Engineering		
PE Request thru FTA Approval	04MAY09A	07JUL09
PE thru ROD	07JUL09	01OCT09
Design Build Procurement		
MSF (thru issuance of NTP)	29MAY09A	30MAR10
West Oahu/Farrington Guideway (thru issuance of NTP)	04FEB09A	13MAR10
Systems (thru issuance of NTP)	09APR09A	25MAY10
Final Design		
Final Design (FD) Request thru FTA Approval	29DEC09	28APR10
Full Funding Grant Agreement (FFGA)		
Application thru Approval	26AUG10	28JUN11
Construction		
Start	13DEC09	
Open Waipahu / Leeward Section		24DEC12
MSF Contract Complete		07MAY14
Open East Kapolei to Pearl Highlands Section		21JUL14
Open Kamehameha Section		21JAN17
Open to Airport Section		22OCT17
Open to Ala Moana Center		04MAR19

Figure 6-1. Summary Schedule

Activity ID	Activity Description	Orig Dur	Early Start	Early Finish
MILESTONE				
General				
Milestone				
9999	Open to Ala Moana Center	0		04MAR19
D250	FTA Approve Entry to Final Design	0	22APR10	
F270	FTA Award Full Funding Grant Agreement	0	16JUN11	
N270	FTA Approves PE	0	01JUL09*	
I998	Open Waipahu/Leeward Section	0		24DEC12
I999	Open East Kapolei to Pearl Highlands Section	0		21JUL14
J999	Open Kamehameha Section	0		21JAN17
E300	FTA Issue Record of Decision - ROD	0		01OCT09
Z999	Open Airport Section	0		28SEP17
M999	MSF Contract Complete	0		07MAY14
N250	Submit Request for PE	0	04MAY09A	
Core Systems DBOM				
MI920 Core Systems & Vehicles				
P720	Issue Part 2 DB Systems RFP	0	31JUL09	
P990	Issue NTP DB Systems	0	09JUL10	
P312	Issue Part 1 DB Systems RFP	0	09APR09A	
West Oahu/Farrington Guideway				
DB1200 West Oahu/Farrington Guideway & Utilities				
P380	Issue NTP 1 DB Guideway for FD & Ground Breaking	0	13DEC09	
P390	Issue NTP 2 DB Guideway for Construction	0	13MAR10	
P120	Issue Part 1 DB Guideway RFP	0	04FEB09A	
P180	Issue Part 2 DB Guideway RFP	0	03APR09A	
Maintenance Storage Facility				
DB200 Maint. & Storage Facility				
P620	Issue Part 1 DB MSF RFP	0	29MAY09	
P680	Issue Part 2 DB MSF RFP	0	24JUL09	
P685	Issue NTP DB MSF	0	30MAR10	
+ READINESS FOR PELIMINARY ENGINEERING				
		289	15SEP08A	30JUN09
+ EIS & PRELIMINARY ENGINEERING				
		584	15SEP08A	21APR10
+ ADVANCED CONCEPTUAL ENGINEERING				
		505	15SEP08A	01FEB10
+ FULL FUNDING GRANT AGREEMENT				
		751	02JUN09	22JUN11
+ READINESS FOR FINAL DESIGN				
		1,621	15SEP08A	21FEB13
+ DB PROCUREMENT				
		662	15SEP08A	08JUL10
+ CONSTRUCTION & RELATED ACTIVITIES				
		3,823	15SEP08A	04MAR19
+				
		9	15SEP08A	15SEP08A



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The following section includes schedule review categories as listed in the PG-34. In accordance to the PG-34A, the following eighteen (18) categories address the PMOC's opinions noting exceptions and recommendations. Categories 12 thru 18 relate to the schedule review of "sound engineering practices".

(1) The structure of the schedule and its soundness in terms of identified activities, durations, sequencing, and float.

The schedule structure refers to the integrity of the elemental components that make-up a schedule: Work Breakdown Structure (WBS), activities, activity elements, activity relationships, activity float and criticality.

<u>Work Breakdown Structure</u>
Work Breakdown Structure (WBS) is a sorting and organization of project-specific information (budget, cost and schedule) usually determined by the owner. A WBS is defined by activity code or WBS fields in the scheduling software. An MPS that is comprised of multiple subprojects must contain a standardized WBS or activity code structure. Many times WBS or activity code fields are established by the owner and supplied to the schedule users, especially if multiple consultants or contractors are sharing the same program wide WBS. Summary activity grouping such as "hammocking" is frequently used for upwards Level-1 reporting and provides an easy way to sort large groupings of activities in schedules containing hundreds or thousands of activities.

The primary function of the WBS is to clearly identify and illustrate the major areas of work for the Project. It also distinguishes multiple projects (contracts) within a MPS. Such areas of work include but are not limited to:

- Environmental Mitigation
- Right of Way Acquisition and Relocation
- Utility Relocations
- Planning / PE / Final Design / Construction / Startup & Testing / Closeout
- Individual Contract or Project Packaging
- Geographical Areas or Areas by Responsibility
- Procurement for Professional Services
- Material and Equipment Procurement

Each of these categories will be addressed and refined as the Project continues into the PE and Final Design phases.

The following verifications were used to review and evaluate the WBS:

- Verification that the project scope is adequately represented by a sufficient amount of detailed tasks (schedule activities). Major activities and summary level items include rights-of-way; third party coordination (utilities, businesses, communities, related agencies, and related stakeholders), contract packaging strategies, work in place, material procurements, materials in and out of the project (debris and soil hauling, muck, etc.).

- Verification of contract packaging strategies, traceability of schedule organization and structure utilizing activity coding and filtering capability for reporting.

The MPS can be summarized by the activity code structure. The activity code structure contains the following categories for sorting purposes:

- **RESPONSIBILITY**
  - PB EIS /PE Schedule
  - City Right-of-Way Schedule
  - City Rapid Transit Division

- **AREA**
  - General
  - West Oahu Station Group
  - Core Systems DBOM
  - Dillingham Station Group
  - City Center Station Group
  - Kakaako Station Group
  - Airport Station Group
  - Pearl Highlands Station & Garage Group
  - H2 Ramps Group
  - Right-of-Way Acquisition
  - Permits
  - Farrington Station Groups
  - EIS
  - Preliminary Engineering
  - West Oahu/Farrington Guideway
  - Maintenance Storage Facility
  - Kamehameha Guideway
  - Airport Guideway
  - City Center Guideway
  - Kamehameha Station Group

- **STEP**
  - Milestone
  - Readiness for Preliminary Engineering
  - EIS & Preliminary Engineering
  - Advanced Conceptual Engineering
  - DB Procurement
  - Readiness for Final Design
  - Full Funding Grant Agreement
  - Construction & Related Activities

- **CONTRACT NUMBER**
  - DB1200 West Oahu/Farrington Guideway & Utilities

- DB200 Maint. & Storage Facility
- DBB170 West Oahu Stations (3) Construction
- DBB260 H2 Ramps Construction
- DBB270 Farrington Stations (3) Construction
- DBB275 Pearl Highlands Sta. & Garage Construction
- DBB350 Kamehameha Utility Relocations
- DBB360 Kamehameha Guideway Construction
- DBB370 Kamehameha Stations (2) Construction
- DBB450 Airport Utility Relocations
- DBB460 Airport Guideway Construction
- DBB470 Airport Stations (3) Construction
- DBB550 City Center Utility Relocations
- DBB560 City Center Guideway Construction
- DBB570 Dillingham Stations (3) Const.
- DBB572 City Center Stations (3) Construction
- DBB575 Kakaako Stations (3) Construction
- MI920 Core Systems & Vehicles
- MI930 Elevators & Escalators P/I/T/C
- Milestone
- OF940 Ticket Vending Machines
- OF950 Plants & Shrubs
- Preliminary DB1200
- Preliminary DB200
- Preliminary MI920
- SV140 West Oahu Stations (3) Design
- SV230 H2 Ramps Design
- SV240 Farrington Stations (3) Design
- SV245 Pearl Highlands Sta. and Garage Design
- SV330 Kamehameha Guideway & Utilities Design
- SV340 Kamehameha Stations (2) Design
- SV430 Airport Guideway & Utility Design
- SV440 Airport Stations (3) Design
- SV530 City Center Guideway & Utility Design
- SV540 Dillingham Stations (3) Design
- SV542 City Center Stations (3) Design
- SV545 Kakaako Stations (3) Design
- SV900 Program Management Support
- SV910 General Construction Management

- **WORK**
  - Bid-Award Cycle
  - Construction Work
  - Design Work
  - Procurement

- **PHASE**

- Phase 1
- Phase 2
- Phase 3
- Phase 4
- Phase 5
- Phase 6
- Phase 7
- Phase 8
- Phase 9

The activity code library in the scheduling software has been expanded since the last PMOC schedule review. The current MPS can be summarized by major work element or contract as illustrated in Figure 6-2 though more sorting and summary capability remains to be completed.

The MPS activity detail is sufficient to determine the type of work that is being performed.

Figure 6-2. WBS

Activity Description	Orig Dur	Early Start	Early Finish
READINESS FOR PELIMINARY ENGINEERING			
+			
	295	15SEP08A	06JUL09
ADVANCED CONCEPTUAL ENGINEERING			
+			
	202	15SEP08A	04APR09
EIS & PRELIMINARY ENGINEERING			
+			
	590	15SEP08A	27APR10
DB PROCUREMENT			
+ *West Oahu/Farrington Guideway*			
	454	15SEP08A	12DEC09
+ *Maintenance Storage Facility*			
	561	15SEP08A	29MAR10
+ *Systems/Vehicles*			
	617	15SEP08A	24MAY10
READINESS FOR FINAL DESIGN			
+			
	590	15SEP08A	27APR10
FULL FUNDING GRANT AGREEMENT			
+			
	823	28MAR09	28JUN11
CONSTRUCTION & RELATED ACTIVITIES			
+ *General*			
	3,718	15SEP08A	19NOV18
+ *Right-of-Way Acqusition*			
	846	10NOV08A	05MAR11
+ *West Oahu/Farrington Guideway*			
	1,557	03APR09	07JUL13
+ *Farrington Station Groups*			
	1,533	07JUL09	16SEP13
+ *West Oahu Station Group*			
	1,402	27JUL10	28MAY14
+ *Pearl Highlands Station & Garage Group*			
	1,777	07JUL09	18MAY14
+ *H2 Ramps Group*			
	1,505	28APR10	10JUN14
+ *Maintenance Storage Facility*			
	1,749	24JUL09	07MAY14
+ *Systems/Vehicles*			
	3,510	31JUL09	10MAR19
+ *Kamehameha Guideway*			
	2,017	07JUL09	13JAN15
+ *Kamehameha Station Group*			
	1,637	19DEC11	11JUN16
+ *Airport Guideway*			
	2,022	07JUL09	18JAN15
+ *Airport Station Group*			
	1,771	17APR12	20FEB17
+ *City Center Guideway*			
	2,289	28APR10	02AUG16
+ *Dillingham Station Group*			
	1,771	14OCT12	19AUG17
+ *City Center Station Group*			
	1,969	22JAN13	13JUN18
+ *Kaka'ako Station Group*			
	2,019	03DEC12	13JUN18

Activities

Each schedule activity, at a minimum consists of the following elements:

- Activity Identification (ACT ID) Number
- Activity Description
- Activity Type – Explains what kind of activity it is (work task, milestone, hammock, etc.)
- Activity Duration
- Activity Predecessor and Successor
- Some activities contain constraint dates (see Schedule Run Report)

The MPS contains 368 activities, 36 of which are milestones. The MPS contains one hammock activity. The activity descriptions are clear and adequately describe the work task. The small number of activities addresses scope inclusivity on a summary level for a project of such large scope and magnitude.

Durations

During the fall of 2008, the City provided a Basis of Schedule at the request of the PMOC in order to support the general schedule assumptions. The Basis of Schedule explains the schedule structure, WBS and activity categories, and addresses major assumptions for the aerial bridge structures noting the optimization of two gantry equipment systems. It also explains assumptions for guideway aerial structure activity durations. The major assumptions contained in the Basis of Schedule are listed below:

- 1 crew will install 2 (bent) piers / week,
- Install 2 spans (300 linear foot) / 2 Gantry / week
- Install 1 span (150 linear feet) / 1 Gantry / week
- Installation of 400 Route Feet/ week (Area specific)
- Installation of 300 Route Feet / week (Area specific)

The latest Basis of Schedule, dated June 5, 2009, contains more assumptions and supporting data that quantifies or otherwise substantiates schedule durations, production factors, crewing efficiencies, economies of scale, etc.

The MPS activities are very summary in nature and therefore generally contain large durations. Of the 368 schedule activities, 151 (41%) contain a duration greater than 100 days.

Table 6-3. Activity Duration Count

Milestone (0)	1 to 50	51 to 100	101 to 500	501 to 1000	1000 +	Total
37	143	37				217
			119	23	9	151
						368

Includes one (1) hammock activity

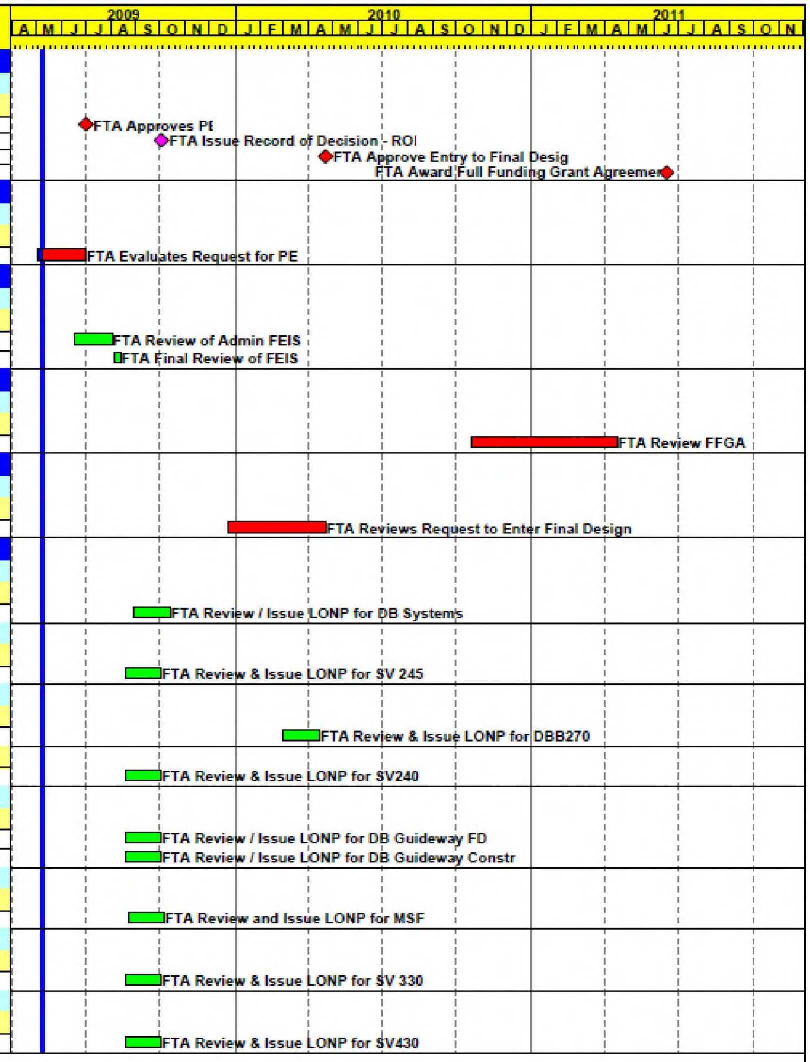
The MPS contains one activity with a duration of 3,420 days for Program Management Support Contract and one activity with a duration of 3,430 days for General Construction Manager Contract; both general description activities and not placement related.

Figure 6-3 presents those activities associated with FTA review periods. The durations for each activity were estimated by the City. The PMOC and the FTA reviewed these activities and provided a suggested duration range for each activity.

The PMOC has determined that some activity durations are still insufficient and some activity durations are excessive. In some cases, the activities are too summary in nature and their durations cannot be adequately evaluated. For instance, the vehicles and system integration technology scopes are not definitive. The PG-40B section addresses each activity duration and criticality index through a Monte Carlo simulation. This simulation accounts for the most probable critical path and generates a probability curve for different project completion scenarios accounting for the variances in activity durations.

Figure 6-3. FTA Participation Activities

Activity ID	Activity Description	Orig Dur	Early Start	Early Finish
MILESTONE				
General				
Milestone				
N270	FTA Approves PE	0	01JUL09*	
E300	FTA Issue Record of Decision - ROD	0		01OCT09
D250	FTA Approve Entry to Final Design	0	22APR10	
F270	FTA Award Full Funding Grant Agreement	0	16JUN11	
READINESS FOR PELIMINARY ENGINEERING				
N260	FTA Evaluates Request for PE	30	04MAY09A	30JUN09
EIS & PRELIMINARY ENGINEERING				
EIS				
E230	FTA Review of Admin FEIS	46	18JUN09	02AUG09
E250	FTA Final Review of FEIS	7	07AUG09	13AUG09
FULL FUNDING GRANT AGREEMENT				
F250	FTA Review FFGA	180	19OCT10	16APR11
READINESS FOR FINAL DESIGN				
D240	FTA Reviews Request to Enter Final Design	120	23DEC09	21APR10
CONSTRUCTION & RELATED ACTIVITIES				
Core Systems DBOM				
MI920 Core Systems & Vehicles				
P970	FTA Review / Issue LONP for DB Systems	45	30AUG09	13OCT09
Pearl Highlands Station & Garage Group				
SV245 Pearl Highlands Sta. and Garage Design				
R310	FTA Review & Issue LONP for SV 245	45	19AUG09	02OCT09
Farrington Station Groups				
DBB270 Farrington Stations (3) Construction				
R202	FTA Review & Issue LONP for DBB270	45	02MAR10	15APR10
SV240 Farrington Stations (3) Design				
R110	FTA Review & Issue LONP for SV240	45	19AUG09	02OCT09
West Oahu/Farrington Guideway				
DB1200 West Oahu/Farrington Guideway & Utilities				
P260	FTA Review / Issue LONP for DB Guideway FD	45	19AUG09	02OCT09
P280	FTA Review / Issue LONP for DB Guideway Constr	45	19AUG09	02OCT09
Maintenance Storage Facility				
DB200 Maint. & Storage Facility				
P675	FTA Review and Issue LONP for MSF	45	23AUG09	06OCT09
Kamehameha Guideway				
SV330 Kamehameha Guideway & Utility Design				
K107	FTA Review & Issue LONP for SV 330	45	19AUG09	02OCT09
Airport Guideway				
SV430 Airport Guideway & Utility Design				
G110	FTA Review & Issue LONP for SV430	45	19AUG09	02OCT09



Sequencing
The PMOC generated a Schedule Run Report (see schedule review category (18) "Mechanical correctness and completeness" for discussion). The Schedule Run Report verifies the absence of "open-ended" activities (missing relationship links), which is a fundamental soundness check. A critical path is partially discernible and the schedule activities flow in a logical and time-scaled descending manner.

Float
The CPM network contains 368 task activities and 1 hammock activity. Many activities and logic paths exhibit positive float. Of the 367 task/milestone activities, 52 activities are 100% complete. The Table 6-4 below indicates the total float spread across the un-progressed schedule activities.

Table 6-4. Activity Total Float Count

< than 1	1 to 19	20 to 49	50 to 99	100 to 500	500 to 1000	1000 +	Total
24	65	50	96				235
				68	7	6	81
							346

Does not include completed activities and hammock activities

The MPS does not contain an excessive amount of float and the critical path is discernible. The MPS also includes a reasonable amount of "near critical paths" for activities containing float less than 20 days.

PMOC Finding
The MPS and Basis of Schedule adequately address the requirements of this review category to support entry into the PE phase. MPS revisions will continue during the PE phase and will understandably better address the construction phase requirements of this PG-34A review category as the project development continues.

(2) The reasonability of logic with respect to physical construction constraints.

The MPS was developed with some consideration of physical construction constraints such as construction of the aerial guideway structure, and the relocation, adjustment and installation of utilities in the narrow street limits of the alignment. More detail related to traffic control, material storage and handling, working adjacent to waterways, and operational adjacencies to third party businesses is needed and will understandably evolve as more project scope and definition is refined during the PE and Final Design phases.

The Risk Mitigation and Monitoring Plan is a good management technique and tool to support the schedule work plan related to physical construction constraints. A greater level of activity detail and activity duration calculations will be necessary to account for "constraining elements" that inherently adversely impact construction staging and material installation.

PMOC Finding

The MPS and Basis of Schedule adequately address the requirements of this review category to support entry into the PE phase. MPS revisions will continue during the PE phase and will understandably better address the construction phase requirements of this PG-34A review category as the project development continues.

(3) The sequencing is consistent with expected contractor crewing requirements and adequate for efficient or expected contracting methods or packaging strategies.

The MPS and the Basis of Schedule address the proposed design and construction packaging strategy. The MPS work breakdown structure clearly distinguishes the contract packaging delivery methods and strategies. Construction sequencing will generally proceed in an easterly direction starting at the Farrington/West Oahu segment. The MPS includes five operation dates related to the incremental construction and operational turnover of the project alignment segments. A design-build contracting delivery method will be used for the first contract segment and the remaining contract segments are planned to be a design-bid-build. The City will evaluate the efficiencies and lessons learned from design and construction of the first segment and may decide to continue the design-build delivery method for the remaining contract segments.

Regardless of the contracting delivery method, the general assumptions stated in the basis of schedule pertain to the optimization of guideway superstructure equipment and placement efficiencies. Most of the 20+ mile aerial guideway substructure and superstructure will be repetitive as the span lengths and structure profiles remains constant. The City expects high efficiency and production factors related to cast-in-place techniques and the use of pre-cast concrete components for the aerial guideway structure.

The MPS adequately address the City’s contract packaging strategies. The City has identified preliminary assumptions in the MPS Basis of Schedule which relate to expected contractor crewing and material/equipment optimizations.

PMOC Finding

The MPS and Basis of Schedule adequately address the requirements of this review category to support entry into the PE phase. MPS revisions will continue during the PE phase and will understandably better address the construction phase requirements of this PG-34A review category as the project development continues.

(4) The work area segmentation connected with the planned right-of-way acquisition provides sufficient work area(s) for efficient use of limited resources.

Since the PMOC initial MPS review in the fall of 2008, the City has developed a preliminary ROW schedule, separate from the MPS. As stated in the City’s PMP, the ROW schedule is a more detailed plan listing all acquisition tasks for each property take. The City’s preliminary ROW schedule concentrates on the takes within the Project’s first operable segment. The MPS contains more activity detail for ROW acquisitions and has established a good starting point (Plan) for optimizing the City's ROW resources. Ultimately the detailed ROW schedule will be "rolled-up" into the MPS as both schedules share the same WBS coding structure.

In May 2009, the City stated it has identified 193 properties, 29 of which are associated with the project's first segment. The MPS does contain summary ROW activities separated by project segment, though a significant amount of detail will be needed to better represent the interface of ROW parcels and the sequencing of acquiring temporary and permanent access prior to respective construction work on each parcel.

Since ROW acquisition is critical to the start of a significant portion of work along the alignment, there may be a considerable amount of schedule risk if real estate acquisition activities are delayed.

PMOC Finding
The MPS and Basis of Schedule adequately address the requirements of this review category to support entry into the PE phase. MPS revisions will continue during the PE phase and will understandably better address the construction phase requirements of this PG-34A review category as the project development continues.

(5) Work efforts of similar nature that occur concurrently are identified and reasonably sequenced in the schedule to assure similar work activities can be accomplished with efficient crew sizing.

This category predominately focuses on the construction phase and the optimization of equipment and labor forces for similar and consecutively executed work elements. The aerial guideway structure by far is the best opportunity to optimize economies of scale and related efficiencies with crew sizing. The Basis of Schedule includes logical assumptions for crew sizing and optimization related to pier, bent and aerial structure installation. The MPS construction activities do not address this category in elaborate detail because the Project is in the planning phase.

Moreover, the construction activities are too summary in nature to adequately review and evaluate this category. The MPS is not resource loaded so resource "smoothing", "squeezing", "crunching" and related resource utilization and concurrency analysis cannot be conducted and evaluated.

PMOC Finding
The MPS and Basis of Schedule adequately address the requirements of this review category to support entry into the PE phase. MPS revisions will continue during the PE phase and will understandably better address the construction phase requirements of this PG-34A review category as the project development continues.

(6) Work durations can be validated from many different perspectives - from the program level; from the contract level; design periods; procurement cycles; time for civil and

systems contracts; and finally to the detailed activity durations for performing the work.

PMOC Finding
The MPS and Basis of Schedule adequately address the requirements of this review category to support entry into the PE phase. MPS revisions will continue during the PE phase and will understandably better address the construction phase requirements of this PG-34A review category as the project development continues.

(7) Consistency with the project scope adopted in the Records of Decision (FTA and FAA).

PMOC Finding
The project is currently in the pre-PE Phase. The City anticipates that the Record of Decision will be issued October 1, 2009.

(8) It is logical and appropriately detailed with tasks.

The MPS is fundamentally sound presented in a logical manner through the use of an intuitive WBS and descriptive activity tasks and milestones. As a result of the PMOC's September 2008 request to revise the City's previous MPS, the MPS does now include more detail for the FTA New Starts process including the requirements for readiness to enter PE, EIS & PE, Design/Build contract procurement, Readiness to Enter Final Design, and the Full Funding Grant Agreement process. The MPS contains more activity detail than the two earlier versions reviewed by the PMOC; however, the number of activities in the MPS seems very low considering the magnitude of the Project scope and budget.

PMOC Finding
The MPS and Basis of Schedule adequately address the requirements of this review category to support entry into the PE phase. MPS revisions will continue during the PE phase and will understandably better address the construction phase requirements of this PG-34A review category as the project development continues.

(9) That schedule detail beneath the 'hammock' or summary level is task based, reflecting work elements that are structured by project (i.e., Initial Segment), contract package, phase (e.g., PE, Final Design, Permits, ROW, etc.), tasks and milestones.

The detail below the summary levels generally does provide adequate detail to differentiate between major project segment and contracting areas. The MPS can be sorted by major project phase (PE / Design / Construction / Startup & Testing) and contains a minimal number of milestones for each project element. While the schedule's detail activities represent "task based" work by description and duration, the MPS does not contain resources and therefore does not provide quantification of necessary manpower and equipment resources needed to perform the activity task.

PMOC Finding
The MPS and Basis of Schedule adequately address the requirements of this review category to support entry into the PE phase. MPS revisions will continue during the PE phase and will understandably better address the construction phase requirements of this PG-34A review category as the project development continues.

(10) Basic Predecessors and Successors are identified for all material tasks.

The MPS does not contain enough detail to identify "material" tasks related to the construction phase. This information will become available as the Project and the MPS progresses during the PE and Final Design phases.

PMOC Finding
The MPS and Basis of Schedule adequately address the requirements of this review category to support entry into the PE phase. MPS revisions will continue during the PE phase and will understandably better address the construction phase requirements of this PG-34A review category as the project development continues.

(11) More complex relationships have been developed and input in that tasks are assigned multiple predecessors and successors in order to define more complex task relationships-or schedule integration.

Since the fall of 2008, the PMOC has reviewed four MPS revisions. The most recent MPS revision *"MA5E.xer"* includes more activities and logic ties (relationships) especially for the earlier project activities related to ROW and contract procurements. The activity detail and relationship complexity is satisfactory for a project in pre-PE. The MPS activity detail and relationship complexity is expected to substantially increase during the PE phase as the Project scope and project documentation in general are refined.

PMOC Finding
The MPS and Basis of Schedule adequately address the requirements of this review category to support entry into the PE phase. MPS revisions will continue during the PE phase and will understandably better address the construction phase requirements of this PG-34A review category as the project development continues.

(12) Float at the critical interfaces, assumed progress rates are identifiable and adequate.

The CPM network contains many activities and logic paths that are exhibiting positive float. The MPS activities are very summary in nature and therefore generally contain large durations. The MPS does not contain an excessive amount of float and the critical path is partially discernible. The MPS also includes reasonable "near critical paths" for activities containing float of less than one day. Some areas of construction and integration are recognized in the MPS, though the level of detail does not allow for a strong judgment as to activities that have the potential to impact interface areas. For example, separate construction contract coordination for aerial structures, track work, systems and stations do not have detailed relationships and specific tasks identifying critical interface points.

The MPS assumptions related to progress rates contained in the Basis of Schedule are very preliminary and will expand in detail as the Project refines during the PE phase. Therefore it is difficult to determine their adequacy. The Basis of Schedule does contain some assumptions for work production rates and those schedule activities are identifiable and adequate for this phase of the Project. The MPS remains under development as the Project transitions from the planning phase to the PE phase. The MPS does not completely address the construction phase requirements of this PG-34A review category as it is understandably too premature. MPS revisions are needed but can be addressed during the PE phase.

PMOC Finding
The MPS and Basis of Schedule adequately address the requirements of this review category to support entry into the PE phase. MPS revisions will continue during the PE phase and will understandably better address the construction phase requirements of this PG-34A review category as the project development continues.

(13) Embedded contingencies are identified and assessed as adequate relative to project duration.

At the request of the PMOC, the City included more detailed assumptions and supporting documentation that substantiates the major activity original durations and the built-in "time contingency" or embedded contingency. The MPS calendar structure is very preliminary in nature and under significant development and revision. Therefore, the City's methodology for incorporating embedded contingency is solely limited to the activity original durations. The MPS contains a minimal amount of activities and logic paths that exhibit positive total float. The positive total float could be considered "contingency" though the City and its consultant stated they have incorporated latent "embedded" contingency in the activity original durations.

PMOC Finding
The MPS and Basis of Schedule adequately address the requirements of this review category to support entry into the PE phase. MPS revisions will continue during the PE phase and will understandably better address the construction phase requirements of this PG-34A review category as the project development continues.

(14) Schedule contains a full range of activities starting with FTA initiating approvals (DEIS, FEIS, LONP, FFGA), procurement and performance of civil/facilities and systems Final Design, right-of-way acquisition, utility/agency agreements, utility relocation, civil and systems contract procurement, civil and systems construction, agency operations and maintenance mobilization, and integrated pre-revenue testing.

At the request of the PMOC, the City revised and re-submitted their MPS in September 2008 to correct mechanical and fundamental soundness issues. Most of the PMOC's comments were related to the Planning and PE work tasks and required FTA New Starts tasks. The following WBS categories were added to the MPS:

- Readiness for PE
- Advanced Conceptual Engineering
- EIS & Preliminary Engineering
- Readiness for Final Design
- Full Funding Grant Agreement

The MPS revision now includes more activity detail that describes the City's request for several Letters of No Prejudice (LONP) for design and construction of each Contract Section, the MSF, and the Systems/Vehicles as illustrated in Figure 6-4.

The MPS revision included more activities to describe the real estate acquisition for each construction contracting segment of the Project as illustrated in Figure 6-5.

The MPS, however, does not include enough detail for utility related tasks (see Figure 6-6). Such tasks include utility agreements, utility coordination and planning, underground utility exploration, relocation, abandonment and installation. The PMOC has identified utilities, in general, as a high risk project element containing significant cost and schedule implications. A significant amount of expanded detail is needed to address the congested utility corridors requiring adjustment prior to construction.

Considering this is a starter system extra time and attention will be needed during the testing and startup and operational commissioning of the Project and will require a significant amount of schedule detail as the MPS development continues in the PE phase.

Figure 6-4. LONP Activities

Activity ID	Activity Description	Orig Dur	Early Start	Early Finish
CONSTRUCTION & RELATED ACTIVITIES				
Core Systems DBOM				
MI920 Core Systems & Vehicles				
P960	Prepare LONP Request for DB Systems	30	31JUL09	29AUG09
P970	FTA Review / Issue LONP for DB Systems	45	30AUG09	13OCT09
Pearl Highlands Station & Garage Group				
SV245 Pearl Highlands Sta. and Garage Design				
R310	FTA Review & Issue LONP for SV 245	45	19AUG09	02OCT09
R300	Prepare LONP Request for SV245	30	01JUL09	30JUL09
Farrington Station Groups				
DBB270 Farrington Stations (3) Construction				
R201	Prepare LONP Request for DBB270	30	31JAN10	01MAR10
R202	FTA Review & Issue LONP for DBB270	45	02MAR10	15APR10
SV240 Farrington Stations (3) Design				
R110	FTA Review & Issue LONP for SV240	45	19AUG09	02OCT09
R100	Prepare LONP Request for SV240	30	01JUL09	30JUL09
West Oahu/Farrington Guideway				
DB1200 West Oahu/Farrington Guideway & Utilities				
P260	FTA Review / Issue LONP for DB Guideway FD	45	19AUG09	02OCT09
P250	Prepare LONP Request for DB Guideway FD	15	01JUL09	15JUL09
P280	FTA Review / Issue LONP for DB Guideway Constr	45	19AUG09	02OCT09
P270	Prepare LONP Request for DB Guideway Constr	15	01JUL09	15JUL09
Maintenance Storage Facility				
DB200 Maint. & Storage Facility				
P670	Prepare the LONP Request for MSF	30	24JUL09	22AUG09
P675	FTA Review and Issue LONP for MSF	45	23AUG09	06OCT09
Kamehameha Guideway				
SV330 Kamehameha Guideway & Utility Design				
K107	FTA Review & Issue LONP for SV 330	45	19AUG09	02OCT09
K105	Prepare LONP Request for SV330	30	01JUL09	30JUL09
Airport Guideway				
SV430 Airport Guideway & Utility Design				
G110	FTA Review & Issue LONP for SV430	45	19AUG09	02OCT09
G100	Prepare LONP Request for SV430	30	01JUL09	30JUL09

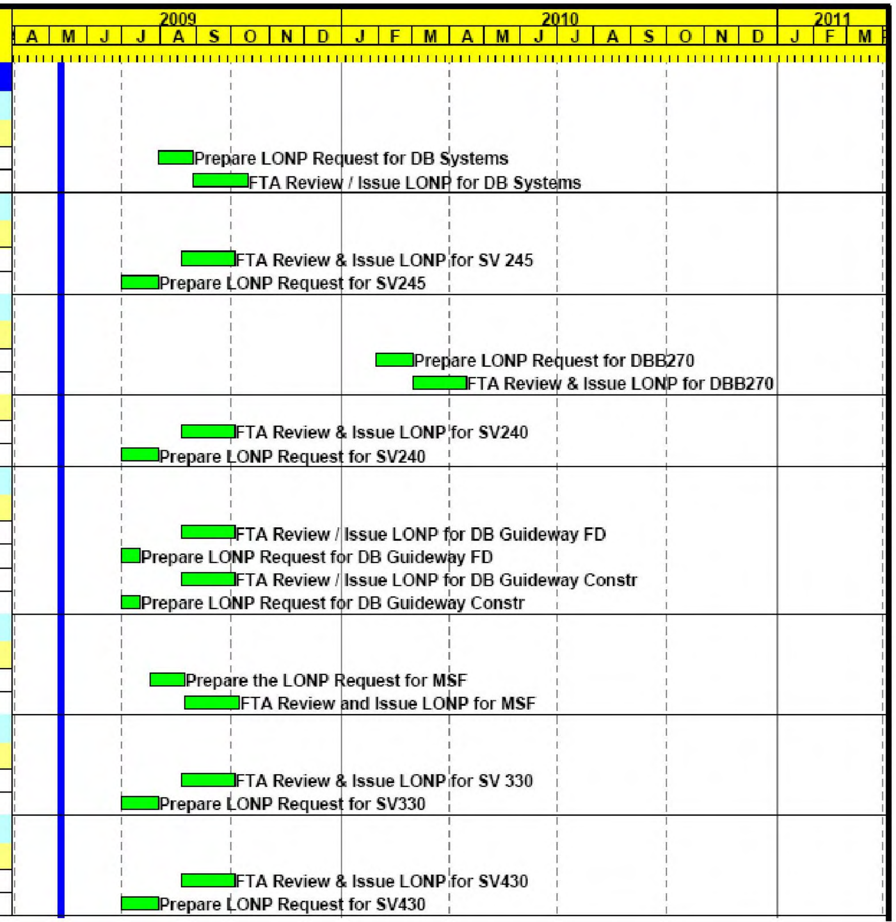


Figure 6-5. Real Estate Activities

Activity ID	Activity Description	Orig Dur	Early Start	Early Finish
CONSTRUCTION & RELATED ACTIVITIES				
Right-of-Way Acqusition				
DB1200 West Oahu/Farrington Guideway & Utilities				
W010	Prepare ROW Acq for West Oahu/Farrington G'way	365	10NOV08A	23FEB10
W020	Purchase ROW for W Oahu/Farrington G'Way	60	24FEB10	24APR10
DB200 Maint. & Storage Facility				
M010	Prepare ROW Acqusition for MSF	365	10NOV08A	25DEC09
M020	Purchase ROW for MSF	60	26DEC09	23FEB10
DBB170 West Oahu Stations (3) Construction				
X020	Purchase ROW for West Oahu Stations	60	25APR10	23JUN10
X010	Prepare ROW Acqusition for West Oahu Stations	365	10NOV08A	25DEC09
DBB260 H2 Ramps Construction				
R060	Purchase ROW H2 Ramps	60	25APR10	23JUN10
R050	Prepare ROW Acqusition H2 Ramps	365	10NOV08A	25DEC09
DBB270 Farrington Stations (3) Construction				
R020	Purchase ROW Farrington Stations	60	25APR10	23JUN10
R010	Prepare ROW Acqusition Farrington Stations	365	10NOV08A	23FEB10
DBB275 Pearl Highlands Sta & Garage Construction				
R040	Purchase ROW PH Station & Garage	60	25APR10	23JUN10
R030	Prepare ROW Acqusition PH Station & Garage	365	10NOV08A	23FEB10
DBB360 Kamehameha Guideway Construction				
K040	Prepare ROW Acqusition for Kamehameha Giudeway	365	14NOV08A	23JUN10
K050	Purchase ROW for Kamehameha Guideway Constructio	60	24JUN10	22AUG10
DBB370 Kamehameha Stations (2) Construction				
J010	Prepare ROW Acqusition for Kamehameha Stations	365	14NOV08A	23JUN10
J020	Purchase ROW for Kamehameha Stations	60	24JUN10	22AUG10
DBB460 Airport Guideway Construction				
G030	Prepare ROW Acqusition for Airport Guideway	365	14NOV08A	21OCT10
G040	Purchase ROW for Airport Guideway	60	22OCT10	20DEC10
DBB470 Airport Stations (3) Construction				
Z010	Prepare ROW Acqusition for Airport Stations	365	14NOV08A	21OCT10
Z020	Purchase ROW for Airport Stations	60	22OCT10	20DEC10
DBB560 City Center Guideway Construction				
C030	Prepare ROW Acqusition for City Center Guideway	365	14NOV08A	04JAN11
C040	Purchase ROW for City Center Guideway	90	05JAN11	04APR11
DBB570 Dillingham Stations (3) Const.				
H020	Purchase ROW for Dillingham Stations	90	05APR11	03JUL11
H010	Prepare ROW Acqusition for Dillingham Stations	365	14NOV08A	04JAN11
DBB572 City Center Stations (3) Construction				
U020	Purchase ROW for City Center Stations	90	04JUL11	01OCT11
U010	Prepare ROW Acqusition for City Center Stations	365	14NOV08A	04JAN11
DBB575 Kaka'ako Stations (3) Construction				
Y020	Purchase ROW for Kaka'ako Stations	90	02OCT11	30DEC11
Y010	Prepare ROW Acqusition for Kaka'ako Stations	365	14NOV08A	04JAN11
Milestone				
I100	Identify ROW Requirements	60	15SEP08A	07NOV08A
I110	Identify ROW Parcels	0	07NOV08A	

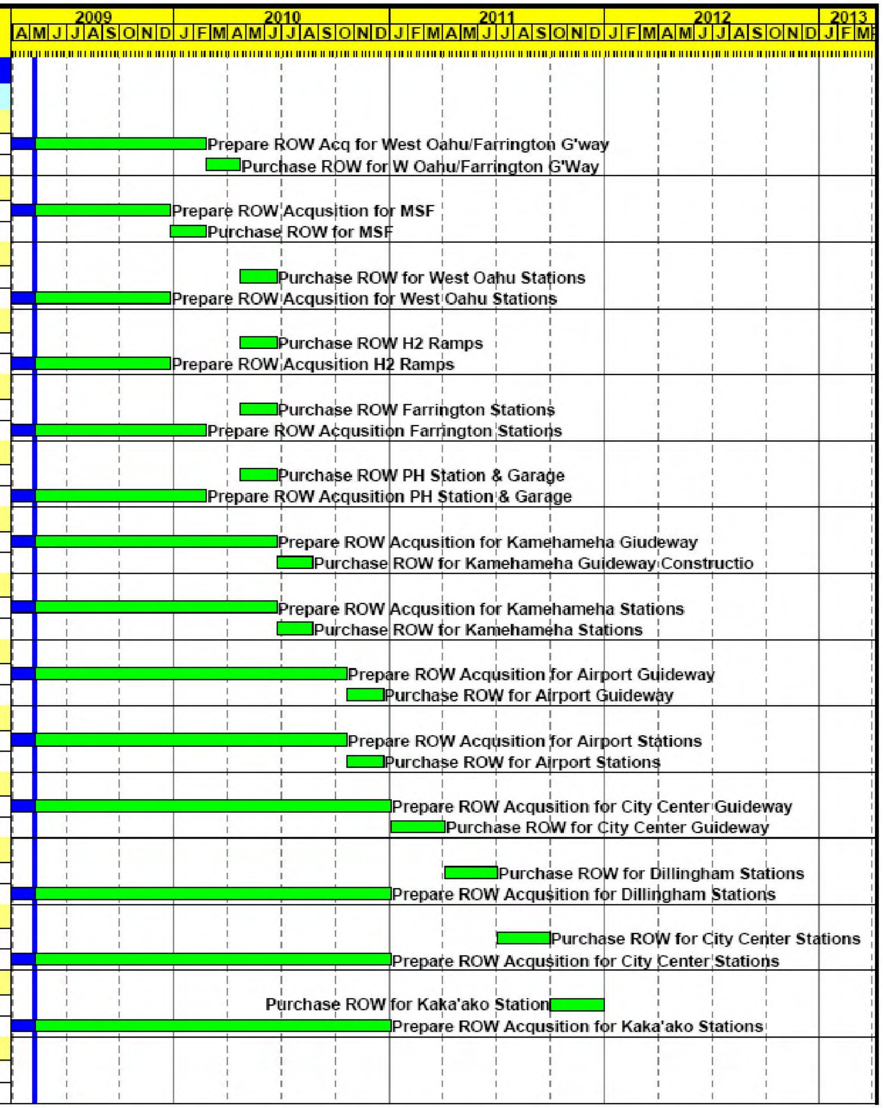
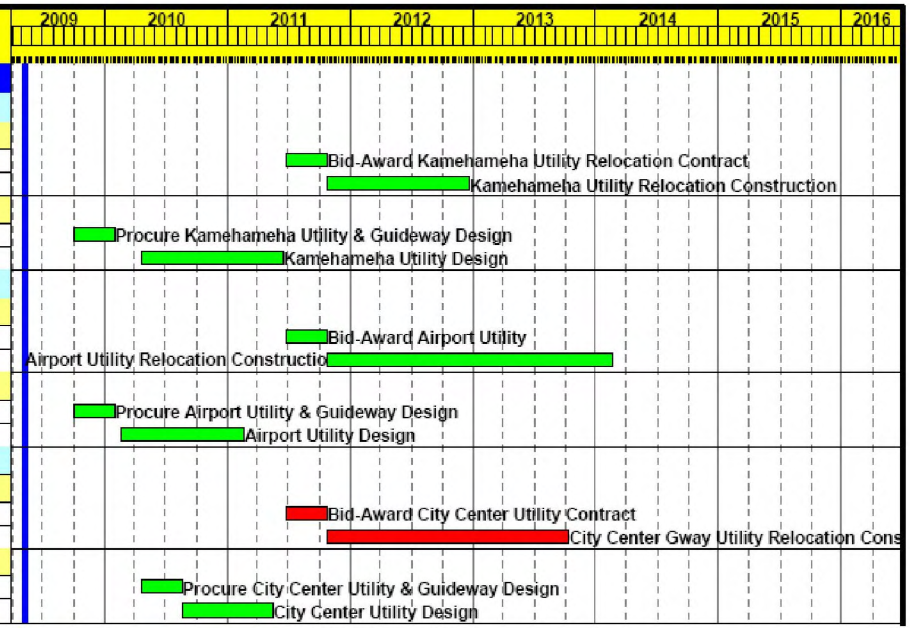


Figure 6-6. Utility Activities

Activity ID	Activity Description	Orig Dur	Early Start	Early Finish
CONSTRUCTION & RELATED ACTIVITIES				
Kamehameha Guideway				
DBB350 Kamehameha Utility Relocations				
K200	Bid-Award Kamehameha Utility Relocation Contract	120	23JUN11	20OCT11
K210	Kamehameha Utility Relocation Construction	425	21OCT11	18DEC12
SV330 Kamehameha Guideway & Utility Design				
K108	Procure Kamehameha Utility & Guideway Design	120	03OCT09	30JAN10
K110	Kamehameha Utility Design	418	22APR10	13JUN11
Airport Guideway				
DBB450 Airport Utility Relocations				
G220	Bid-Award Airport Utility	120	23JUN11	20OCT11
G230	Airport Utility Relocation Construction	850	21OCT11	16FEB14
SV430 Airport Guideway & Utility Design				
G120	Procure Airport Utility & Guideway Design	120	03OCT09	30JAN10
G130	Airport Utility Design	365	21FEB10	20FEB11
City Center Guideway				
DBB550 City Center Utility Relocations				
C200	Bid-Award City Center Utility Contract	120	23JUN11	20OCT11
C210	City Center Gway Utility Relocation Construction	720	21OCT11	09OCT13
SV530 City Center Guideway & Utility Design				
C100	Procure City Center Utility & Guideway Design	120	22APR10	19AUG10
C110	City Center Utility Design	270	20AUG10	16MAY11



AR00132087

PMOC Finding
The MPS and Basis of Schedule adequately address the requirements of this review category to support entry into the PE phase. MPS revisions will continue during the PE phase and will understandably better address the construction phase requirements of this PG-34A review category as the project development continues.

(15) Contract procurement processes and durations are adequate and complete.

The Project contract procurement delivery methods include design-build (DB) and design bid-build (DBB). The Project is divided into four segments from West to East; West Oahu/Farrington, Kamehameha, Airport, and City Center. The first operable section of the alignment will be executed through a DB contract delivery method and is planned to open December 2012. This operable section extends from Waipahu to Leeward, part of the West Oahu/Farrington Contract Segment. The City's strategy to use a DB contracting method is based primarily on time savings as they wish to achieve an operable segment as soon as possible. The other DB contracts include construction of the remaining aerial guideway structure within the West Oahu/Farrington Contract Segment, systems, and the Maintenance Storage Facility. The DB contract procurement method is divided into two parts: Part 1 and Part 2. The City stated Part 1 was similar to a Request for Qualifications process and Part 2 represents the final proposal submission and review process.

The contract procurement delivery method for all other utility relocations, guideway structure and stations for the remaining project segments (Kamehameha, Airport and City Center) is DBB.

The Systems package is a Design-Build-Operate-Maintain (DBOM) and includes vehicle procurement, manufacturing and delivery.

The durations allotted for the contract procurements seem fair and reasonable for the DB two-part process, though the PMOC recommends the MPS contain more Calendars to address specific work activities such as City Review periods, holiday and special events, City Board Meeting Dates, etc.

PMOC Finding
The MPS and Basis of Schedule adequately address the requirements of this review category to support entry into the PE phase. MPS revisions will continue during the PE phase and will understandably better address the construction phase requirements of this PG-34A review category as the project development continues.

(16) Lead times and durations for equipment and material manufacturing and delivery are adequate an

The MPS does not contain activity detail describing equipment and material procurement except for one activity representing vehicle procurement and one activity representing Systems Integration as described in item number (14) above.

Table 6-5 below identifies all of the Project contracts that require schedule activities identifying the equipment and material procurement process.

Table 6-5. Equipment and Material Procurement Activities

Activity ID	Category	Shop drawings, approvals, material acquisitions	Fabrication	Shipping, Delivery, Testing & Storage
L110	Elevators/Escalators	Yes	Yes	Yes
	Communication & OCC	Not identified	Not identified	Not identified
	Fare Collection	Not identified	Not identified	Not identified
	Track work	Not identified	Not identified	Not identified
	Traction Power	Not identified	Not identified	Not identified
	Train Control	Not identified	Not identified	Not identified
	Systems/Vehicles	Yes	Yes	Yes

The procurement process logic string typically contains a minimum of the following activities:

> Engineering Shop Drawings → Submit for Review and Approval → Mtrl. Acquisition/ Fabrication/Inspect. → Shipping and Delivery → Storage (if necessary) → (ready for installation)

The PMOC recommends a similar logic string be incorporated into each project segment and contract as these are critical to project execution, contain moderate to high risks, and most likely will impact the critical path sometime during the Project.

PMOC Finding
The MPS and Basis of Schedule adequately address the requirements of this review category to support entry into the PE phase. MPS revisions will continue during the PE phase and will understandably better address the construction phase requirements of this PG-34A review category as the project development continues.

(17) Construction work sequencing follows a typical expected work sequence for the mode such as acquire right-of-way; relocate utilities; construct roadway improvements, under-drains, duct banks and catenary pole foundations; construct station platforms and finishes; install track work; install systems components, communications, signals, traction electrification and fare collection. However, sequencing consistent with expected contractor crewing requirements may be inadequate for efficient contracting methods.

Most of the elements described in the category are not represented in the proposed construction phase of the MPS primarily because the MPS remains in development and is preliminary in nature. However, each element above should be represented in the MPS at least in summary. Other sections of this report focus on the importance of providing more detail for right-of-way and utility work as they are aligned with early and critical elements of the MPS.

PMOC Finding

The MPS and Basis of Schedule adequately address the requirements of this review category to support entry into the PE phase. MPS revisions will continue during the PE phase and will understandably better address the construction phase requirements of this PG-34A review category as the project development continues.

(18) Mechanical correctness and completeness.

The Schedule Run Report generated by Primavera scheduling software indicates the number of activities in the MPS, the overall percent complete, data date, start date and projected completion date of the schedule, all activities containing constraint dates, activities with "open-ends" having no successor and or predecessor relationship connections, and out-of-sequence progressing. Typically open-ended activities include the first start activity, the last finish activity, and sometimes finish milestone activities. Generally open-ended activities are caused by an oversight where an activity is missing a predecessor or successor. This usually occurs during schedule development and when activity relationships are revised during routine progress updating. Caution should be used during schedule progress updating because a minor oversight can create an unintentional open-ended activity. It only takes one incorrect logic connection, or open-ended activity, to severely undermine the integrity of a schedule. Routine maintenance procedures include the review of open-ended activities to ensure they are properly used and connected to the appropriate relationship chains.

The out-of-sequence progressing is an important indicator because it indicates errors, omissions and other potential problems that can distort milestone dates and general progress information thus affecting the schedule as a whole. Proper activity progress updating and review will prevent out-of-sequence progressing problems. In addition, keeping open-ended activities to a minimal amount is conducive to "good housekeeping" practices and overall a more manageable task during schedule updating. For this reason, many schedule specifications require only the start and end activities can be open-ended.

The critical path can be easily distorted by the excessive use of constraint dates, out-of-sequence progressing, open-ended activities and other improper progress update procedures. A common oversight is the misinterpretation of a schedule's true critical path. Sometimes a schedule calculation caused by the excessive or improper use of constraint dates may adversely impact the critical path software calculation. Consistent monitoring of the critical path during progress updates and variance reporting is crucial and reconciled by evaluating the Schedule Run Report.

The following verifications were used to review and evaluate the fundamental soundness:

- Verification of reasonable logic and activity relationships using the Precedence Diagram Method for predecessors and successors
- Schedule Run Report
- Verification that activity constraints are properly identified and used
- Verification that activity relationships are not "open-ended"
- Verification that activities do not contain "out-of-sequence progressing"

- Verification that activity original durations are adequate and justified by basis of schedule assumptions and by resource utilization assumptions
- Characterization of the nature of the project schedule compared to its respective Program

The PMOC generated a Schedule Run Report of the MPS "MA5E.xer". The Schedule Run Report contains sections for constraint listing, open end listing, out-of-sequence progress listing, and schedule statistics (see Figure 6-7).

Figure 6-7. Schedule Run Report

```
Primavera Scheduling and Leveling Calculations -- Scheduling Report Page:

 This Primavera software is registered to Jacobs.
 Start of schedule for project MA5E.
 User name CHARLES.

 Constraint listing -- Scheduling Report Page: 2

  Activity   Date          Constraint
 ---------- ------- ----------------------------
       9999         Finish Milestone
       9999 31MAR19 Late Finish Constraint
 D220               Start Milestone
 D250               Start Milestone
 E220               Start Milestone
 E290               Finish Milestone
 E300               Finish Milestone
 E625       15JUN09 Early Start Constraint
 E670       11JUN09 Early Start Constraint
 F240               Start Milestone
 F270               Start Milestone
 I110               Start Milestone
 I998               Finish Milestone
 I998       31DEC12 Late Finish Constraint
 I999               Finish Milestone
 I999       31JUL14 Late Finish Constraint
 J999               Finish Milestone
 J999       31JAN17 Late Finish Constraint
 M999               Finish Milestone
 M999       30JUN14 Late Finish Constraint
 N142               Start Milestone
 N250               Start Milestone
 N270               Start Milestone
 N270       01JUL09 Early Start Constraint
 P120               Start Milestone
 P160               Start Milestone
 P180               Start Milestone
 P190       13MAY09 Early Start Constraint
 P312               Start Milestone
 P340               Start Milestone
 P355               Start Milestone
 P380               Start Milestone
 P390               Start Milestone
 P460               Start Milestone
 P620               Start Milestone
 P640               Start Milestone
 P655               Start Milestone
 P680               Start Milestone
 P685               Start Milestone
 P720               Start Milestone
 P760               Start Milestone
 P945               Start Milestone
 P965               Start Milestone
 P990               Start Milestone
 R210       31DEC12 Late Finish Constraint
 T101               Hammock Activity
 Z999               Finish Milestone
 Z999       31OCT17 Late Finish Constraint
```

```
Open end listing -- Scheduling Report Page: 3
----------------
Activity         1  has no predecessors
                                          Activity       9999 has no successors

Scheduling Statistics for Project MA5E:
Schedule calculation mode - Retained logic
Schedule calculation mode - Contiguous activities
Float calculation mode    - Use start dates
SS relationships          - Use early start of predecessor


       Schedule run on Sun May 31 13:06:51 2009
                 Run Number  3.

      Number of activities..................     368
      Number of activities in longest path..      25
      Started activities....................      85
      Completed activities..................      51
      Number of relationships...............     615
      Percent complete......................     3.6
      Number of hammocks ...................       1
      Number of early constraints...........       4
      Number of late  constraints...........       7

      Data date.............................  10MAY09
      Start date............................  15SEP08
      Imposed finish date...................
      Latest calculated early finish........  04MAR19
```

Constraint Dates
The report constraint listing indicates the frequent use of constraint dates, many of which are start milestone constraints. Although the PMOC has determined that the constraint dates have been properly applied and used throughout the MPS, the PMOC recommends minimizing the amount of constraint dates used on the MPS to avoid it becoming a maintenance issue that that may inadvertently affect the critical path calculations as the MPS increases in size in future project phases.

Open-Ended Activities
The revised MPS *"MA5E.xer"* has corrected open-ended activities originally identified by the PMOC.

Out-of-Sequence Progressing
The revised MPS *"MA5E.xer"* has corrected out-of-sequence progressing originally identified by the PMOC.

PMOC Finding
The MPS and Basis of Schedule adequately address the requirements of this review category to support entry into the PE phase. MPS revisions will continue during the PE phase and will understandably better address the construction phase requirements of this PG-34A review category as the project development continues.

6.3 Technical Review

The fundamental element that supports the integrity of a schedule is the internal schedule calendar structure, including the default settings and calculations utilized with the scheduling software. Before a manager can interpret the schedule information generated from schedule reports, a check must be performed to ensure the information in the schedule is fundamentally correct and contains logical activity relationship connections. A fundamental soundness check must be performed after every schedule update to ensure that the information and logic contained in the schedule is correct and properly represent actual work performed. Once the fundamental check is performed, the schedule can be updated and generated reports can be interpreted with confidence.

6.3.1 Requirements, Conformance and Standardization

Requirements refer to the specification and contractual requirements specifically related to the Project. ***Conformance*** refers to the assurance that all parties abide by the contractual specifications and requirements. ***Standardization*** refers to the approach of requiring all scheduling parties to use the same input and output forms so that all reporting information is consistent and "standardized". The requirements and standards are typically set by the owner during the PE and Final Design phases when the project management control systems are completely defined and tailored for the program. Report standardization is crucial for upwards and downwards reporting. The data input and output must be standardized, organized and sorted in a consistent and thorough manner so they can be summarized and tailored for the appropriate reporting audiences.

This review element also includes a detailed review and evaluation of the project management control system to determine how efficiently and effectively the procedures are being implemented by the program team. Schedule contractual conformance by all parties is not only a necessity but is paramount to the ongoing avoidance and mitigation of contract modifications, change orders and claims. Contractual conformance commitment by all parties amplified from the top down is essential for a projects successful planning and timely execution.

The following verifications were used to review and evaluate the requirements, conformance and standardization:

- Verification that the project sponsor has established the technical capacity and capability and program management tools (hardware, software and procedures) to develop and maintain a Master Integrated Schedule in order to orchestrate project execution for all phases of the project
- A verification that the project sponsor has developed a CPM schedule specification and standard reporting templates and procedures for the program
- A verification that all parties are executing schedule management in accordance with the project specifications and related contractual requirements

The City began MPS development in early 2007. The Project is currently in the pre-PE Phase and project CPM schedule specifications and contractual requirements are understandably not yet developed. The PMP does describe, in detail, the various types of schedules to be developed and maintained throughout the Project's life cycle, including:

- Master Project Schedule
- Master Summary Schedule
- Planning Schedule
- ROW Schedule
- Design Schedule(s)
- Construction Schedule(s)
- Startup & Testing Schedule(s)

The PMOC has determined that the City and its consultants were not developing and maintaining the required schedules in accordance with their PMP requirements. While the Project has a very detailed EIS/PE Planning Schedule, the PMOC discovered that the MPS, Master Summary Schedule and ROW Schedule were not completely developed. The PMOC emphasized the need to develop a baseline MPS in order to better communicate the "project plan" and the necessity to frequently update the "plan" to better measure work progress. The MPS has not been updated (progress status), which indicates that the City has not utilized the MPS as a measurement tool.

PMOC Finding

The PMOC recommends that the City define a consistent WBS, reporting format and update frequency for the current MPS and carry the "standards" over to the design consultants, construction contractors and vendors to ensure schedule reporting standardization as the Project continues. The PMOC also recommends the City complete ROW Schedule development and enhance the incorporation of the GEC EIS/PE detailed schedule into the MPS. The City should also baseline the MPS and commence monthly progress status update reporting. MPS revisions are needed, but these can be addressed during the PE phase.

6.3.2 Software Settings

The most powerful schedule management tool is the scheduling software being used. This tool, like all tools, must be used properly. The predominate scheduling software programs such as Open Plan, MS Project and Primavera, all have various program calculation settings allowing the scheduler flexibility with schedule develop, progress, and alternative scenario evaluation. The schedule software contains calculation settings that apply to cost and resource loading, critical path, predecessor and successor logic connectivity, percent complete, cost and resource utilization, and actual work performed. Many, if not all of these settings are crucial for progress update and critical path calculation.

CPM schedule specifications and related contractual requirements seldom address or completely specify which scheduling software setting conditions are required for a given project or program. This oversight may lead to intentional software setting manipulation resulting in biased results of the end user. The architect/engineer should incorporate a CPM schedule specification that addresses scheduling software settings when the specifications are developed during the Final Design phase.

Special attention is needed to ensure that schedule calculations accurately generate and not distort schedule calculation data. The scheduling software calculation settings should be monitored to ensure they are consistently used and not randomly changed or manipulated, especially on large programs that require multiple design and or construction schedules.

The following verifications were used to review and evaluate the scheduling software settings:

- Verification that scheduling software settings are properly established by contractual requirements, consistently used, and reviewed by the owner.

The Project sponsor has not yet developed a CPM schedule specification for the program and has not yet established standardized schedule software settings. The current Project schedule does, however, contain the default settings and is acceptable at this time.

The PMOC reviewed the schedule and determined all settings are in compliance with the specification requirements and are consistently used for the schedule update files reviewed by the PMOC. Though the PMOC does not believe the software calculation settings have been manipulated with intent to generate false or unreliable outcomes, the PMOC emphasized that the Project sponsor should establish procedures to review and verify that all required schedule calculation settings are consistently used.

PMOC Finding
The PMOC has determined that the MPS is adequately using scheduling software setting in accordance to industry “standard of care” practices. The PMOC recommends that the City address schedule software settings in the contractual specifications and requirements when applicable during the design and construction phases.

6.3.3 Performance Measurement and Monitoring (Progress Updates)

Work performance measuring is the key to a successful and accurate progress schedule update. Most important is the accuracy of the progress information logged and entered into the schedule ensuring that logical relationships are revised and maintained. Schedule updating is the process of determining the current status of each activity and the overall Project as a whole. Schedule updating first requires an adequate method of measuring and documenting work performance typically managed by field personnel. The information is then recorded by actual start and finish dates, percent complete, and resource utilization; unexpected events or field conditions are noted as well. This information is crucial because the schedule software calculation that generates the Project milestone and completion dates relies on work performance measurements and maintenance of logical activity relationships.

The following verifications were used to review and evaluate the progress updates:

- Verification that schedule updates among all parties are performed frequently and conform to the project specifications, requirements and PMP guidelines
- Verification that performance measurement techniques and reporting are adequately implemented and incorporated into the schedule updates. Such examples include earned value, trending, forecasting and activity pacing.
- Verification of Activity Pacing during progress. This is the comparison of original durations versus actual durations to verify the reasonableness of trending and forecasting techniques based on historical work performance measured through earned value analysis
- Verification that the dispute avoidance and resolution (mitigation) techniques are a part of the schedule progress update reporting process
- Verification that change management techniques are used to track the schedule update process

The MPS is very dynamic as the scope, schedule and budget continue to be developed and refined as the Project enters the PE phase. The MPS has not been baselined though the MPS has been progressed since the last PMOC Schedule Review was conducted in the fall 2008. Actual dates and percent complete information is evident. The MPS indicates a 3.6% overall percent completion.

PMOC Finding
The MPS and Basis of Schedule adequately address the requirements of this review category to support entry into the PE phase. MPS revisions will continue during the PE phase and will understandably better address the construction phase requirements of this PG-34A review category as the project development continues.

6.3.4 Resource Loading

Cost and resource loading includes the planned utilization of material, labor and equipment resources required to perform the work. The resource library may contain material, labor and or equipment resources a basis for determining and quantifying activity original durations and remaining durations as work is performed, measured and progressed in the schedule, typically interfaced with earned value management. When resources are assigned to an activity, the quantity complete and units per time period of the driving resources determine the activity's duration. In addition the activity resources can be "leveled", "smoothed", "squeezed" or "crunched" as resource utilization, analysis and management decisions are evaluated for remaining work to be performed.

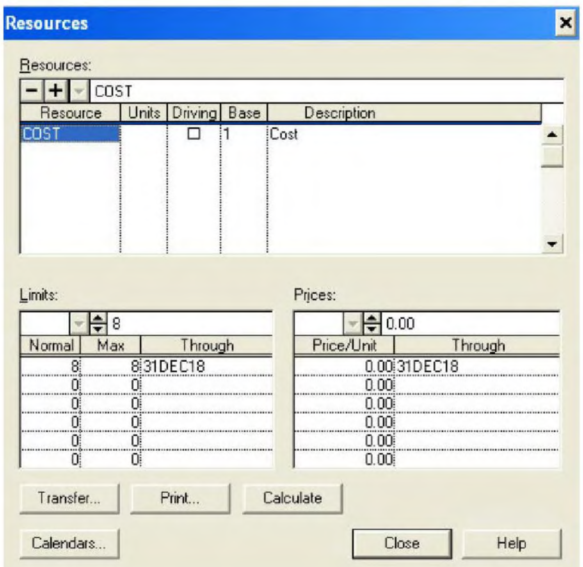
The resource library also may contain budget and cost information. The cost loaded information is generated and submitted with monthly progress updates to support monthly payment requests by the designer and or the construction contractors. An adequately resourced schedule combined with earned value management (backward looking) and trending analysis (forward looking) are prudent schedule control methods especially during the project schedule update process, regardless of the Project phase.

The following verifications were used to review and evaluate the resource utilization:

- Verification of resource planning and utilization for materials, labor, equipment, and third party impacts
- Verification of budget and cost management planning techniques associates with activities or activity groupings related to major program/project components

As shown in Figure 6-8, the MPS resource library contains one resource named "COST". This resource is intended to populate the schedule activities with a budget amount. Some activities have the "COST" resource assigned but none of the activities contain a budget amount. No other resources are used in the MPS.

Figure 6-8. Resource Library



PMOC Finding

The PMOC has determined the MPS does not contain a resource library that is cost or resource loaded. The PMOC understands that resource utilization is not prudent at this time as the MPS remains under development and refinement but advocates resource utilization immediately thereafter. The PMOC recommends the City require resource utilization in the various project schedule specifications and related contractual requirements for the design and construction phases. The resource assignments will greatly assist with activity duration calculations, and claim avoidance and mitigation reviews.

6.3.5 Project Calendars

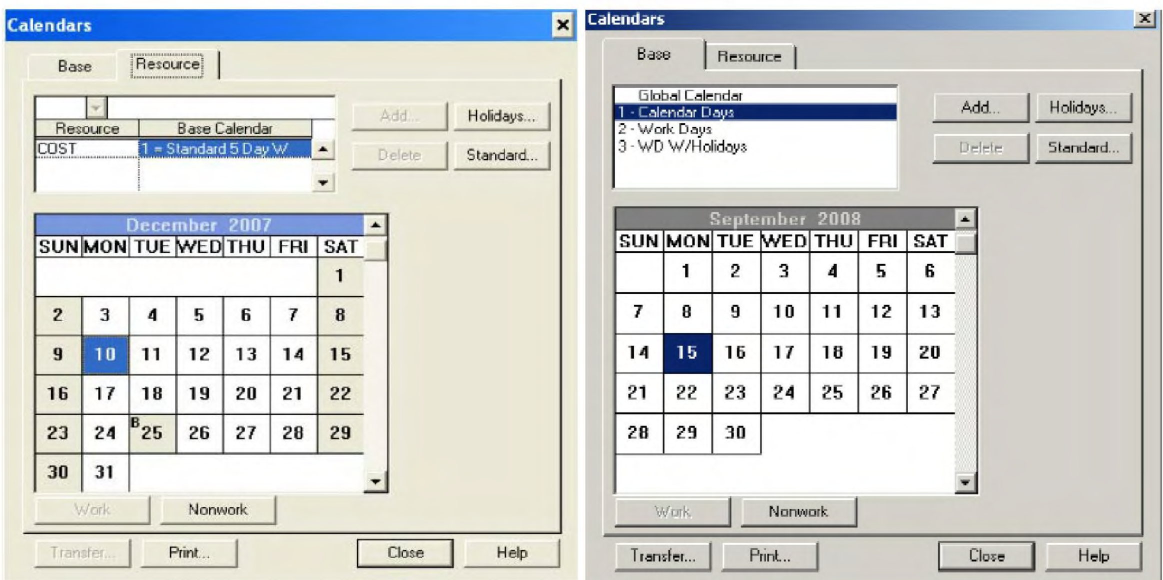
The scheduling software calendar library dictates the number of work periods and non-work periods, usually measured in units of hours or days. The calendar(s) also can be used to incorporate non-work periods such as holidays, weather days, or other seasonal restriction periods such as the installation of temperature sensitive materials. The utilization of multiple calendars is not only practical and necessary during schedule development, but also should be monitored frequently and reviewed to track historical information.

The following verifications were used to review and evaluate the calendar(s):

- Verification of the proper use of a calendar library that adequately addresses the regional weather conditions, imposed seasonal or holiday restrictions, and or temperature sensitive installation of materials, material or subcontractor restrictions, allowances to calculate periods of inefficiencies, etc.

The MPS global structure was reviewed to verify the calendar utilization. As shown in Figure 6-9, the MPS contains three (3) Base Calendars and one (1) Resource Calendar for the “Cost” Resource. The MPS utilizes 2 of the 3 Base Calendars. Base Calendars 1, 2 and 3 are all 7 work days per week with no holidays. The City stated they were not complete with Calendar development and intends to create several more Base Calendars for specific program elements and activities chains. The Calendar library does not include holidays or other periods of non-work.

Figure 6-9. Calendar Library



Moreover, the calendar library does not contain anticipated inclement weather days. The City needs to better address the allocation of non-work periods (holidays, special events, and restricted work periods) in the MPS Calendar library. These periods of non-work performance can be addressed in many ways such as in increased activity durations or accounted for in separate calendars. The City did state they incorporated latent contingency into the activity original durations, not the calendars, to account for inclement weather. They also stated Hawaii in general, does not encounter a significant amount of severe weather or undergo significant weather seasons that negatively impact construction work activity.

PMOC Finding
The MPS and Basis of Schedule adequately address the requirements of this review category to support entry into the PE phase, however significant improvements and revisions are necessary to more accurately portray anticipated periods of non-work.

MPS revisions will continue during the PE phase and will understandably better address the construction phase requirements of this PG-34A review category as the project development continues.

6.3.6 Interfaces

Program schedule interfacing includes the connectivity of granular activity detail traceable through Level 1 summary and hammock activities. It also includes contract packaging strategy and third party tasks directly impacting the Project. Scope and work interface must be coordinated between existing facilities and systems and within the design and construction itself. Schedule interface planning will be more crucial and evident as the MPS increases in detail during the PE, design and construction phases.

The following verifications were used to review and evaluate the interfaces:

- Verification that the contract packaging strategy is reflected in the schedule
- Verification that existing facilities and operable systems are coordinated and reflected in the schedule

The MPS is not in enough detail to completely address this category as the current Project phase is planning. The MPS Basis of Schedule addresses the proposed design and construction packaging strategy. The MPS WBS also separately identifies construction activity by project segment, which illustrates the sequencing among construction segment procurement and installation.

The Project is a rail starter system and therefore does not connect with an existing operable segment or facility. The system will interface with multi-modal transit centers facilities connecting to bus operations.

PMOC Finding
The MPS and Basis of Schedule adequately address the requirements of this review category to support entry into the PE phase. MPS revisions will continue during the PE phase and will

understandably better address the construction phase requirements of this PG-34A review category as the project development continues.

6.3.7 Project Critical Path

Once a schedule is determined to be fundamentally and mechanically sound, the critical path can be reviewed and evaluated for schedule reasonableness. The critical path analysis determines the existence of a discernible critical path, the activities on the critical path, and whether schedule milestones and completion dates are realistic and achievable.

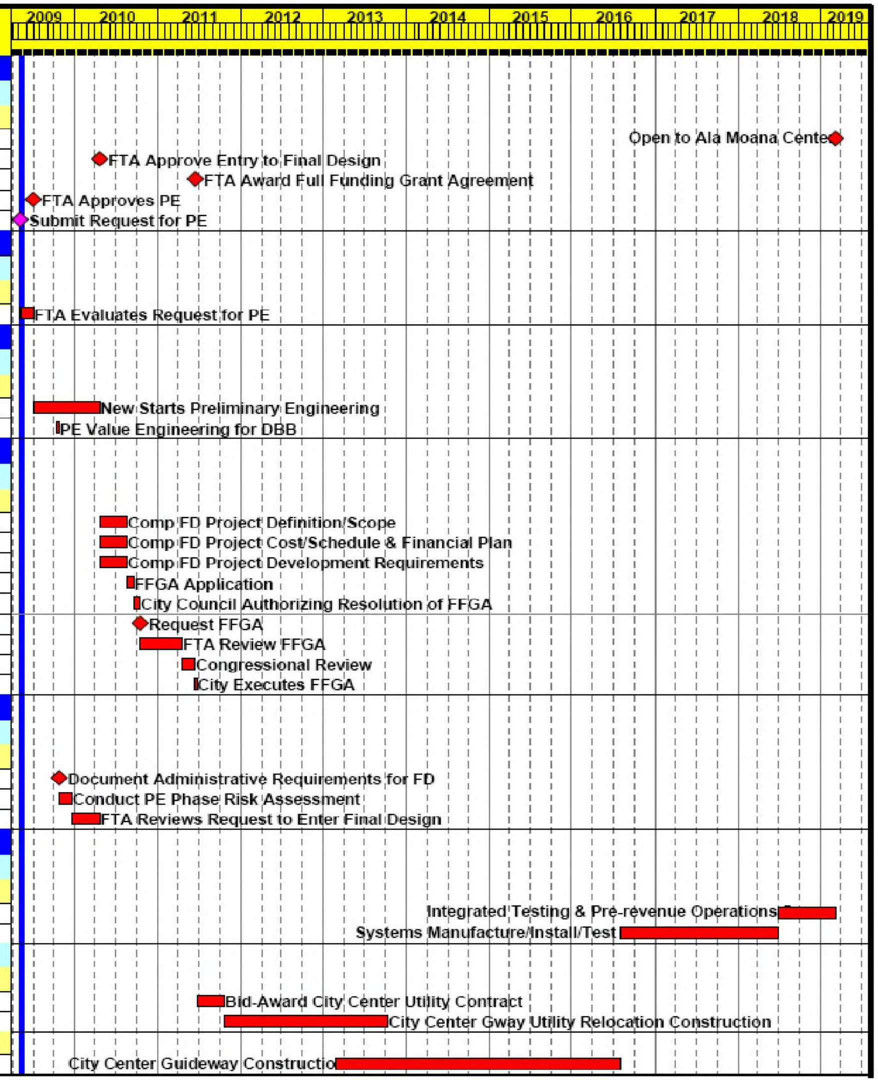
The following verifications were used to review and evaluate the critical path:

- Verification that a discernible critical path is properly generated and is not impacted by non-related activity constraints or other means of oversight or manipulation
- Verification of criticality indexing, and identification of near critical activity strings or fragnets
- Verification that the project schedule intermediate and completion milestone dates fall within a reasonable time range

The Project MPS utilizes a critical path calculation method by identifying critical activities either by their total float or by using the software setting "Longest Path". The "Longest Path" critical path calculation is the truest indication of a project's critical path because it discriminates near-critical activities from the most critical activities. The longest critical path is presented in Figure 6-10.

Figure 6-10. Longest Path

Activity ID	Activity Description	Orig Dur	Early Start	Early Finish
MILESTONE				
General				
Milestone				
9999	Open to Ala Moana Center	0		04MAR19
D250	FTA Approve Entry to Final Design	0	22APR10	
F270	FTA Award Full Funding Grant Agreement	0	16JUN11	
N270	FTA Approves PE	0	01JUL09*	
N250	Submit Request for PE	0	04MAY09A	
READINESS FOR PELIMINARY ENGINEERING				
N260	FTA Evaluates Request for PE	30	04MAY09A	30JUN09
EIS & PRELIMINARY ENGINEERING				
Preliminary Engineering				
E200	New Starts Preliminary Engineering	295	01JUL09	21APR10
E210	PE Value Engineering for DBB	15	09OCT09	23OCT09
FULL FUNDING GRANT AGREEMENT				
F190	Comp FD Project Definition/Scope	120	22APR10	19AUG10
F200	Comp FD Project Cost/Schedule & Financial Plan	120	22APR10	19AUG10
F210	Comp FD Project Development Requirements	120	22APR10	19AUG10
F220	FFGA Application	30	20AUG10	18SEP10
F230	City Council Authorizing Resolution of FFGA	30	19SEP10	18OCT10
F240	Request FFGA	0	19OCT10	
F250	FTA Review FFGA	180	19OCT10	16APR11
F260	Congressional Review	60	17APR11	15JUN11
F280	City Executes FFGA	7	16JUN11	22JUN11
READINESS FOR FINAL DESIGN				
D220	Document Administrative Requirements for FD	0	24OCT09	
D230	Conduct PE Phase Risk Assessment	60	24OCT09	22DEC09
D240	FTA Reviews Request to Enter Final Design	120	23DEC09	21APR10
CONSTRUCTION & RELATED ACTIVITIES				
Core Systems DBOM				
MI920 Core Systems & Vehicles				
T260	Integrated Testing & Pre-revenue Operations 5	250	28JUN18	04MAR19
T265	Systems Manufacture/Install/Test 5	700	28JUL16	27JUN18
City Center Guideway				
DBB550 City Center Utility Relocations				
C200	Bid-Award City Center Utility Contract	120	23JUN11	20OCT11
C210	City Center Gway Utility Relocation Construction	720	21OCT11	09OCT13
DBB560 City Center Guideway Construction				
C310	City Center Guideway Construction	1,250	24FEB13	27JUL16



The MPS generates a discernible critical path which extends through a logical sequence of activities from the current planning phase thru the FFGA Application process, construction, and startup and testing. The construction phase critical path extends through the City Center Guideway most likely because of the amount of required utility relocations needed in the area. Construction in this area is followed by Systems manufacturing, installation and testing and overall integrated testing and pre-revenue operations.

The construction phase critical path lacks detail and is very summary in nature. The PMOC has reservations about the Project's true critical path during the construction phase and cannot conduct a detailed analysis due to the lack of detail. Moreover, the City intends to incrementally open the project in five operable segments. Fore each Guideway construction contract, they intend to assign a monetary liquidated damage amount to each operable segment completion date. The current MPS critical path does not extend through these operable segment completion dates (interim milestones). These dates are not intended to represent Minimal Operable Segments (MOS) and are not politically driven by the City. The City considers these dates as opportunities to incrementally open the alignment so significant portions of the Guideway can be used by the public in lieu of having the westerly segments completed and un-used for several years.

The critical path will be scrutinized and evaluated further during the PE phase.

PMOC Finding
The MPS and Basis of Schedule adequately address the requirements of this review category to support entry into the PE phase. MPS revisions will continue during the PE phase and will understandably better address the construction phase requirements of this PG-34A review category as the project development continues.

6.3.8 Critical Areas of Concern

The critical areas of concern include project elements that contain a high level of uncertainty especially early in the project developments phases of PE and Final Design. Historically these areas include:

- Environmental and Wetland Mitigation
- Right of Way Acquisition and Relocation
- Utility Relocations
- Long Lead Material and Equipment procurement
- Third Party Agreements
- Tunneling
- Non-conventional construction methods
- Operational Adjacencies

Interestingly enough, many of the common items listed above have been identified by the PMOC as major areas of concern for the Project. They are:

- ROW Acquisitions
- Utilities – Agreements, exploration, adjustment, abandonment and or relocation
- Construction Material Procurements

- Vehicle Procurement
- Systems Integration / Startup and Testing – Not identified in the MPS

The PMOC recognizes more definitive information will evolve during the PE phase.

Real Estate Acquisition and Management (ROW)
The first draft of the Project Real Estate and Acquisition Management Plan (RAMP) has been reviewed and accepted by the PMOC (BAH). The City is currently identifying the partial and full takes, and the temporary easement associated with the Project rail alignment. To date the City has identified 189 takes along the Project alignment. The City ROW department and PMC staff are developing a detailed ROW Schedule. The PMOC reviewed the latest ROW schedule draft which concentrated on the takes associated with the first operable segment. The current MPS includes summary level activities for ROW but requires more detail to better identify critical path and near critical path activities related to early phased ROW acquisitions.

Utilities
A significant amount of above ground utilities must be adjusted or relocated prior to the construction of a considerable portion of the aerial guideway structure. Likewise, underground utilities must be explored and possibly adjusted to avoid conflict with the aerial guideway structures' drilled piers and related foundations associated with the rail alignment.

There is a schedule risk, which may be significant, arising from the fact that the utility relocation plans have not been completely developed both from a design and contractual point of view. The coordination effort will be great due to the number of utility companies that must work concurrently and at times in the same area. In addition, the time period for these relocations is aggressive, large scale, and uncommon for the island. The utility relocations and adjustments will definitely impact businesses, pedestrian and vehicular traffic, and construction traffic along the corridor. The availability of the utility company and third party resource available to accomplish the utility relocations and adjustments is also a significant PMOC concern.

Construction Material Procurements
The MPS does not contain activity detail for construction material procurement and or long-lead equipment procurements except for rail vehicle procurement. Understandably, most of these material procurement schedule activities can be incorporated into the MPS when the scope and design are refined during the PE and Final Design phases. The PMOC believes the most important material procurement items relate to the potential fabrication and storage sites for the aerial guideway structure, and site logistics for material and equipment delivery and storage.

Vehicle Procurement
The most recent MPS version "MA5E.xer" contains expanded detail for vehicle procurement and includes more multiple-activity relationships. It also has more contracting interfaces with the vehicle procurement, systems integration and maintenance storage facility activities.

The current MPS has multiple Revenue Operation Dates associated with the incremental delivery of operable segments:

- ROD 1 – Open Waipahu/Leeward (December 24, 2012)

- ROD 2 – Open East Kapolei to Pearl Highlands (July 21, 2014)
- ROD 3 – Open Kamehameha Section (January 21, 2017)
- ROD 4 – Open Airport Section (October 22, 2017)
- ROD 5 – Open Ala Moana Center (March 4, 2019)

The coordination of vehicle procurement, delivery, inspection, burn-in, and operator training is a critical component to the incremental segment RODs. The MPS identifies vehicle procurement as the critical path though the critical path is too vague and summary in nature. A significant amount of detail is needed to better represent the true relationships between vehicle procurement and other major elements of the Project.

Systems Integration
The MPS now contains summary activities describing systems integration for train control, traction power, communications and signaling, startup and testing, and operational interfacing. Considering that the Project is a starter system, extra time and attention are needed for debugging, problem solving, and facility/operations/maintenance training during the startup and testing phase. Systems Integration is a major area of concern because of inherent first time problems encountered with a starter system. In addition, the scope includes an automatic train control system that does not use train operators, a non-traditional technology. The MPS requires a considerable amount of detail to represent the many systems integration interfaces with the incremental turnover of project minimal operable segments and related coordination with the maintenance service facility.

PMOC Finding
The MPS and Basis of Schedule adequately address the requirements of this review category to support entry into the PE phase. MPS revisions will continue during the PE phase and will understandably better address the construction phase requirements of this PG-34A review category as the project development continues.

6.4 Conclusion

The City's Master Project Schedule, "*MA5E.xer*" adequately addresses the PG-34A requirements and the City has demonstrated sufficient schedule management responsibility to support entry into the PE phase. The PMOC has determined the need to revise the MPS prior to any LONP requests, issuance of the ROD and or entry into the Final Design.

6.5 Recommendations

6.5.1 Approval to Enter PE Phase

No specific recommendations necessary for conditional approval to enter PE have been identified.

6.5.2 PE Phase

The PMOC recommends the following comments be addressed and incorporated into the Master Project Schedule prior to any LONP requests, issuance of the ROD and or entry into the Final Design phase.

(1) The MPS requires more activity detail for the following critical project components:

- Utilities – exploration, adjustment, abandonment and or relocation
- Real Estate Acquisitions – identification, appraisals
- Systems Integration – traction power, signals and communications, train control
- Startup and Testing
- Operational Commissioning and Training
- Vehicle Procurement – procurement, design, manufacturing, delivery, testing
- Major Construction Material Procurements

(2) The MPS should utilize multiple schedule calendars (a feature of the scheduling software) for various types of work related to the PE, final design, procurement and construction of varying types of work, especially during the construction phase. The additional calendars can be assigned to special activities and events such as City board meetings for special actions and contract awards, public outreach meetings, FTA review periods and FTA (federal) holidays, overnight or off-peak weekends or hours for material handling and installation that impact traffic and the public in general, etc.

(3) The WBS should be modified to cross over with the Project budget and cost breakdown structure once developed and implemented.

(4) Continually update the Basis of Schedule as Project engineering and general information evolves and refines during the PE phase.

(5) Seek FTA review and comment on schedule activities that indicate "FTA Review".

7.0 SUBTASK 40A: ASSESSMENT OF PROJECT COST RISK

7.1 Methodology

The PMOC followed the requirements outlined in the *FTA PG #40: Risk Management Products and Procedures,* dated March 29, 2007 to complete a cost risk analysis of the Project.

As part of the PMOC task to provide concentrated oversight efforts and deliver products with regard to assessing risks for the Project, this section outlines the steps taken to prepare the Risk Management products under PG-40A. The PMOC in its findings will describe the project, provide FTA with a well-grounded professional opinion as to the reliability of the scope, cost, and schedule of the City's LPA, describe uncertainties, and make a statement of the potential cost range (lower/upper bound).

The PMOC evaluated the City's Base Cost Estimate (BCE) to determine what programmatic risks it poses to FTA's accomplishment of its core accountabilities to simulate mitigation scenarios and maximize the application and effectiveness of the City's contingency.

The PMOC established a programmatic "management baseline" for evaluating the reliability of the City BCE given the various elements of uncertainty associated with the effectiveness and efficiency of the City's project implementation. The PMOC identified, assessed, and evaluated the uncertainties in the project scope, schedule and cost estimate based upon the PMOC review and analysis of City's data under PG-32, 33 and 34.

Based upon this analysis, the PMOC translated those data findings and related information into Level 1 probability distributions of the project cost estimate as developed through an empirically established, random variable model. The PMOC also applied theoretical decision concepts, such as expected value of perfect information and expected value of imperfect information, to simulate the effects of grantee mitigation throughout the project implementation. This grantee mitigation is based on the premise that risk mitigation is a sequential process assuming the following risks are mitigated in the following sequence:

- Requirements Risks
- Design Risks
- Market Risks
- Early Construction Risks (composed of Geotechnical/Utility risks/ right-of-entry)
- Mid-Range Construction Risks (associated with coordination of contractors)
- Start-Up or Substantial Completion of Construction Risks

This Program Management model is to be fully scalable in terms of BCE/SCC/WBS/contract packaging levels depending upon the project phase and FTA direction. The model uses program level, prior experience, and project-specific data supplied by FTA and the grantee to estimate the impact of totally effective mitigation by the grantee for various project milestones. The procedure consists of sequentially reducing, adjusting and conditioning grantee and third-party cost and schedule data in combination with prior programmatic experience to empirically estimate parameters for the assumed distributions, and then modifying these parameters as necessary to simulate the variance reduction/mitigation potential for the specified project milestones or phases.

The PMOC identified all allocated and unallocated contingencies and escalation that represent costs most likely not to be incurred in the most optimistic scenario. Where the PMOC developed information using other risk assessment products to identify scope, cost or schedule elements with a high degree of likelihood (in excess of 90%) of required grantee cost estimate adjustment, the "unadjusted base" cost shall be modified accordingly to produce an "adjusted base" cost. The result is the Adjusted BCE, which is net of all contingency and finance costs.

The Adjusted BCE becomes the input for the 10^{th} percentile of the assumed distribution, considered as the cost estimate for the ***most optimistic scenario*** (stripped of all contingency). The costs are presumed to follow a lognormal distribution, and the 90^{th} percentile of the distribution is determined by the product of the 10^{th} percentile value times a factor of β or Beta Risk Factor (BRF). The 90^{th} percentile is equal to a value that represents a 90% likelihood that the actual project cost at completion will be equal to or less than this number. The mean and variance of the empirical distribution are fully determined using the assumed distribution, the 10^{th} percentile and the parameter BRF.

A fully dependent, or perfectly correlated, distribution assumes positive correlation between the cost elements (correlation coefficient of 1.0) while the independent distribution assumes the cost elements are not correlated (correlation coefficient of 0.0). The BCE/SCC/Budget elements are developed and summed, assuming a "first order approximation" that comes in at a step-off of $1/3^{rd}$ of the total difference in variance between the fully independent and fully dependent scenarios.

FTA program experience has shown that the $1/3^{rd}$ step-off between the best- and worst-case scenarios is an appropriate statistical estimate for the total project cost estimate. This follows the guidance provided by PG-40 and accommodates the development of a picture of risks that will, under normal circumstances and strong risk-informed project management by the Grantee, capture the risk reducing impacts as detailed engineering, construction/procurement bidding and actual contracts performance proceeds.

The empirical parameter BRF can vary by project element and through project implementation, and is estimated in conformance with the criteria summarized in Table 7-1.

Variances within the grantee BCE were evaluated using various BRFs to simulate the expected value of totally effective mitigation. These targets represent data inputs for scheduled and triggered mitigation requirements to be developed in the near future, but mitigation plans are not part of the PMOC scope of work under this task order.

Table 7-1. Range of Beta Risk Factor (BRF)

BRF Value or Range *	Description	Notes
Above 2.5	Implies increasing uncertainty associated with project requirements.	Design risks cannot be greater than 2.5 and may reflect a need to increase the adjusted base rather than for a higher BRF.
2.5	All requirement risks have been mitigated.	
…	Implies increasing mitigation of design risk.	
…	Implies increasing uncertainty associated with project design.	
2.0	All design risks have been mitigated.	Market risk cannot be greater than 2.0 and may reflect a need to increase the adjusted base rather than force a higher BRF.
…	Implies increasing mitigation of market/bidding risk or availability of increasingly reliable market data short of a project specific firm price.	Transitioning through 1.9, 1.85, 1.8, etc. reflects the increasing availability of reliable market pricing data on the high end to more specific pricing data on the lower end.
…	Implies increasing uncertainty associated with market risks;	
1.75	All market risks inclusive of bidding risk have been mitigated through availability of a firm price/quote.	
…	Implies increasing mitigation of early construction risk	
…	Implies increasing uncertainty associated with geotechnical/utility/claim risks/ROW right-of-entry (early construction risks).	
1.5-1.35	All early construction risks composed of geotechnical/utility/major claims, usually associated with 20% complete, have been mitigated.	The reason for the allowable variation of 1.5-1.35 is to reflect that certain element-specific mitigation (such as guideway or systems require 1.5 for fully mitigated, where as simple bus pads require only 1.35 for fully mitigated).
…	Implies increasing mitigation in the areas of normal change order activity.	
1.35-1.20	All mid-construction risks inclusive of major claims, delays, impacts, etc., usually associated with 75% complete, have been mitigated.	The reason for the allowable variation is the same.
1.05-1.15	All start-up / substantial completion of construction risks, usually associated with 90% complete, have been mitigated.	The reason for the allowable variation is the same.
…	Implies increasing mitigation in the areas of start-up and pre-revenue operations activity.	
1.0	Implies there is no risk or uncertainty of any kind associated with this item and represents the perfectly mitigated state of the project scope item, or the expected value of perfect mitigation.	

7.2 Risk Identification for SCC/Baseline Cost Estimate Units

The PMOC team reviewed the capacity, delivery methodology, cost, and schedule documents supplied from the City as part of the assigned tasks under PG-32A, 32E, 33A, and 34A. The results and findings of these reviews are contained in other sections of this PMOC Spot Report.

A summary of the Cost Risk Model Input (Adjusted BCE) is presented in Table 5-19. These PMOC adjustments include deducting the estimated contingencies (creating the "unadjusted base"); estimating the "adjusted base" as a result of the cost, schedule and scope risk review; and evaluating the variance of the estimate under the most optimistic and the worst-case scenarios.

The City's BCE of $5.172 billion (YOE) includes $989.30 million in allocated contingency, $281.97 million in unallocated contingency, and $230.87 million in finance charges. The BCE appears to also have some latent contingency, but the amount cannot be easily quantified at this stage of the project because the SCC line items are based primarily on Cost Estimating Relationships. To condition the BCE, the PMOC identified adjustments as discussed in detail in Section 5.0. The result is an Adjusted BCE of $3.826 billion (Table 5-19).

It should be noted that the Cost Risk Model does not perform any analysis with regard to finance costs. The City's estimated finance costs are stripped to develop the Adjusted BCE so no compounding occurs. However, once the Cost Risk Model results are determined, the finance costs must be added back.

The project baseline cost estimate was characterized based on the type of estimate and the extent of detail to support the data. The costs for each project element were categorized as unit cost quantities, lump sums and Cost Estimating Relationships (CER). The baseline estimate costs were also categorized based on the extent of details and the type of risk associated with each cost element:

- Requirements Risk
- Market Risk
- Design Risk
- Construction Risk

This categorization of the baseline estimate provides support for the development of estimate adjustments and the evaluation of project risks as reflected through the BRF.

The findings of the cost, schedule and scope reviews and the potential cost impacts identified during these reviews are reflected in the risk assessment model by means of adjustments (as may be warranted) and the BRF applied to each SCC. These adjustments result in forecasts for the most likely value of the total project cost in specific phases of the Project. The Project is currently at the "End of AA" and near "Entry to PE" phase. Therefore, the Level 1 project baseline has been set to Q2/2009, which corresponds to the current phase of the project in terms of planning/design and grantee cost estimating/budgeting.

Since the Project is still in the pre-PE Phase, much of the technical data regarding the project scope, schedule, and cost estimates are open to further development. Therefore, it should be emphasized that all risks are currently categorized as "Requirements Risks" (i.e. minimum BRF of 2.5) as a result of the stage of the project. This is a normal state at this stage of project planning and early design. Nonetheless, as the product of the pre-PE Phase, the Project as presented appears in adequate condition for federal consideration of funding further analyses and progression into the PE Phase. In cases where the BRF exceeded the minimum value per PG-40 for specific SCCs, prior program experience was utilized to develop the appropriate BRF at the pre-PE Phase.

The basis of each associated Beta Risk Factor (as summarized in Table 7-2) is detailed below. A Risk Register summarizing these findings is included as Appendix D.

Table 7-2. Honolulu Project Beta Risk Factors

SCC	Decription	Pre PE	Entry to FD	FFGA	50% Const	90% Const
10	**Guideways & Track**					
10.01	Guideway: At-grade exclusive right-of-way	1.01	1.01	1.01	1.01	1.01
10.02	Guideway: At-grade semi-exclusive (allows cross-traffic)	1.01	1.01	1.01	1.01	1.01
10.03	Guideway: At-grade in mixed traffic	1.01	1.01	1.01	1.01	1.01
10.04	Guideway: Aerial structure	3.00	2.50	1.75	1.35	1.15
10.05	Guideway: Built-up fill	1.01	1.01	1.01	1.01	1.01
10.06	Guideway: Underground cut & cover	1.01	1.01	1.01	1.01	1.01
10.07	Guideway: Underground tunnel	1.01	1.01	1.01	1.01	1.01
10.08	Guideway: Retained cut or fill	3.00	2.50	1.75	1.35	1.15
10.09	Track: Direct fixation	3.00	2.50	1.75	1.35	1.15
10.10	Track: Embedded	1.01	1.01	1.01	1.01	1.01
10.11	Track: Ballasted	1.01	1.01	1.01	1.01	1.01
10.12	Track: Special (switches, turnouts)	3.00	2.50	1.75	1.35	1.15
10.13	Track: Vibration and noise dampening	1.01	1.01	1.01	1.01	1.01
20	**Stations, Stops**					
20.01	At-grade station, stop, shelter, mall, terminal, platform	1.01	1.01	1.01	1.01	1.01
20.02	Aerial station, stop, shelter, mall, terminal, platform	3.00	2.50	1.75	1.35	1.15
20.03	Underground station, stop, shelter, mall, terminal, platform	1.01	1.01	1.01	1.01	1.15
20.04	Other stations, landings, terminals: Intermodal, ferry, trolley, etc.	1.01	1.01	1.01	1.01	1.01
20.05	Joint development	1.01	1.01	1.01	1.01	1.01
20.06	Automobile parking multi-story structure	1.01	1.01	1.01	1.01	1.01
20.07	Elevators, escalators	3.00	2.50	1.75	1.35	1.15
30	**Support Facilities**					
30.01	Administration Building: Office, sales, storage, revenue counting	3.50	2.50	1.75	1.35	1.15
30.02	Light Maintenance Facility	1.01	1.01	1.01	1.01	1.01
30.03	Heavy Maintenance Facility	3.50	2.50	1.75	1.35	1.15
30.04	Storage or Maintenance of Way Building	1.01	1.01	1.01	1.01	1.01
30.05	Yard and Yard Track	1.01	1.01	1.01	1.01	1.01
40	**Sitework**					
40.01	Demolition, Clearing, Earthwork	3.00	2.50	1.75	1.35	1.15
40.02	Site Utilities, Utility Relocation	3.50	2.50	1.75	1.35	1.15
40.03	Haz. Mat'l, contam'd soil removal/mitigation, ground water treatments	3.50	2.50	1.75	1.35	1.15
40.04	Environmental mitigation, e.g. wetlands, historical/archeologic, parks	3.50	2.50	1.75	1.35	1.15
40.05	Site structures including retaining walls, sound walls	1.01	1.01	1.01	1.01	1.01
40.06	Pedestrian / bike access and accommodation, landscaping	1.01	1.01	1.01	1.01	1.01
40.07	Automobile, bus, van accessways including roads, parking lots	3.00	2.50	1.75	1.35	1.15
40.08	Temporary Facilities and other indirect costs during construction	1.01	1.01	1.01	1.01	1.01
50	**Systems**					
50.01	Train control and signals	3.50	2.50	1.75	1.35	1.15
50.02	Traffic signals and crossing protection	3.00	2.50	1.75	1.35	1.15
50.03	Traction power supply: substations	3.50	2.50	1.75	1.35	1.15
50.04	Traction power distribution: catenary and third rail	3.50	2.50	1.75	1.35	1.15
50.05	Communications	3.50	2.50	1.75	1.35	1.15
50.06	Fare collection system and equipment	3.00	2.50	1.75	1.35	1.15
50.07	Central Control	3.50	2.50	1.75	1.35	1.15
60	**Right-of-Way**					
60.01	Purchase or lease of real estate	3.50	2.50	1.75	1.35	1.15
60.02	Relocation of existing households and businesses	3.50	2.50	1.75	1.35	1.15
70	**Vehicles**					
70.01	Light Rail	1.01	1.01	1.01	1.01	1.01
70.02	Heavy Rail	3.00	2.50	1.75	1.35	1.15
70.03	Commuter Rail	1.01	1.01	1.01	1.01	1.01
70.04	Bus	1.01	1.01	1.01	1.01	1.01
70.05	Other	1.01	1.01	1.01	1.01	1.01
70.06	Non-revenue vehicles	3.00	2.00	1.75	1.35	1.15
70.07	Spare parts	3.00	2.50	1.75	1.35	1.15
80	**Professional Services**					
80.01	Preliminary Engineering	2.00	1.01	1.75	1.35	1.15
80.02	Final Design	3.00	2.00	1.75	1.35	1.15
80.03	Project Management for Design and Construction	3.00	2.00	1.75	1.35	1.15
80.04	Construction Administration & Management	3.50	2.00	1.75	1.35	1.15
80.05	Insurance	3.00	2.00	1.75	1.35	1.15
80.06	Legal; Permits; Review Fees by other agencies, cities, etc.	3.00	2.00	1.75	1.35	1.15
80.07	Surveys, Testing, Investigation, Inspection	3.00	2.00	1.75	1.35	1.15
80.08	Agency Force Account Work	3.00	2.00	1.75	1.35	1.15

7.2.1 SCC 10 – Guideway and Track

The system is, effectively, all aerial in nature except for one station. The AA Phase planning and design has concluded that the elevated guideway would be located primarily within existing thoroughfare right-of-way, built using segmental construction for the most part, with aerial stations, many having concourses below. The primary elements of work under this SCC include guideway and track, and miscellaneous special trackwork. The following BRF for Q2/2009 have been applied in the associated risk categories:

Requirements Risk

- SCC 10.04 – Guideway and Track Elements ***[BRF = 3.0]***
  - The design is incomplete and requirements risks still exist.
  - Coordination of the guideway/structures and vehicles has not occurred.
  - The interface and coordination with the Hawaii Department of Transportation will be challenging and a MOU has yet to be executed. Also, the City must address all FHWA requirements.
  - Geotechnical information is incomplete.
  - ROW takes are not completely known, and the alignment can change.
  - An operating plan has not been developed and could affect the guideway configuration.
  - The location of MSF is not certain, potentially affecting the line section contractors' costs.
  - The PMOC has identified some concerns with the proximity of the guideway to end of the runways specifically with regard to the Runway Protection Zone, Part 77 Approach surface, the runway departure surface, and the One Engine Inoperative Surface. The PMOC understands the Project staff has been coordinating with the Airports Division of HDOT with regard to the portion of the fixed guideway near the airport. We also understand that a coordination meeting will be held in July 2009 that involves both HDOT and the Federal Aviation Administration.
- SCC 10.08 – Guideway: Retained Cut or Fill ***[BRF = 3.0]***
  - The design is incomplete and requirements risks still exist.
- SCC 10.09 – Track: Direct Fixation ***[BRF = 3.0]***
  - With regard to the vehicle and consist maximum weight and dynamic load considerations, the car is assumed to be Heavy Rail, though some specifics and its capacity (and train length) are yet to be defined.
- SCC 10.12 – Track: Special (switches, turnouts, etc.) ***[BRF = 3.0]***
  - The design and operating plan not sufficiently developed to establish track configuration; additional design must be performed to identify specifics.

Design Risk

- SCC 10.04 – Guideway and Track Elements
  - With regard to gantry approach for curves, the construction methods will ultimately be determined by contractors; however, estimators need to work with

constructability professionals to account for techniques available and factor likely costs.
    - Aerial structures design development cannot be refined until additional geotechnical data are available; supplemental boring program with approximately 750-foot spacing will aid analysis. Pilot holes may also be required where complex strata or utilities are unclear.
    - ROW alignments and track geometry not fully defined or captured in current estimate. Also, final consideration cannot be determined until the revenue vehicle and actual decisions on ROW can be determined.

Construction Risk

- SCC 10.04 – Guideway and Track Elements
    - Construction inefficiencies adjacent to waterways must be addressed. A technical paper should be prepared relative to constructability, permitting and maintenance of navigation rights.
    - Construction inefficiencies & liabilities over live traffic (street & highways) must be addressed. A technical paper should be prepared and included in contract documents addressing Maintenance of Traffic (MOT); however, it may be necessary in some locations for the City to prescribe MOT to effect satisfactory community and/or business response and not have disruptions of work.
    - Construction access (material handling and installation) inefficiencies must be addressed. A technical paper should be prepared relative to constructability, permitting, safety for the traveling public (vehicular and pedestrian) and MOT.
    - Plinth pads and rail are to be constructed by line section prime contractor. The qualification of the contractor (likely a subcontractor) should be combined with robust quality inspections and testing rather than prescribed means & methods to ensure proper control of track geometry.
    - Precast yard locations must be identified, which is a contractor responsibility.
    - Laydown areas have not been identified. The City should identify locations where it currently owns the land, leaving final decisions with the contractor. Availability of public lands should be included in the contract documents.
- SCC 10.09 – Track: Direct Fixation
    - Plinth pads and rail are to be constructed by line section prime contractor. The qualification of the contractor (likely a subcontractor) should be combined with robust quality inspections and testing rather than prescribed means & methods to ensure proper control of track geometry.
- SCC 10.12 – Track: Special (switches, turnouts, etc.)
    - Procurement of special track will be MSF contractor and installation will be by line segment contractor. The location of MSF may impact cost. Estimating must carefully and comprehensively incorporate material handling, security and quality.

7.2.2 SCC-20 – Stations, Stops

The design of the station facilities is at the pre-PE Phase level of detail. As planned, stations are aerial with the exception of one (Leeward Community College Station) and would be accessed from grade via stairs, elevators and/or escalators, with concourses provided at some stations as necessary below the station platform(s). The following BRFs for Q2/2009 have been applied in the associated risk categories:

Requirements Risk

- SCC 20.02 – Aerial Station, Stop, Shelter, Mall, Terminal, Platform ***[BRF = 3.0]***
  - Stations have large lump sum allowances in the assembly cost developed.
  - No cost is assigned for the at-grade section (SCC 20.01). The Leeward Station, whose costs are included in SCC 20.02, includes a retaining wall on one side and possibly an underpass.
  - Parking Structure costs are not included in SCC 20.06 as is customarily done.
  - Security Measures are not clearly identified.
- SCC 20.07 – Elevators, Escalators ***[BRF =3.0]***
  - Scope, requirements and quantity are not defined.
  - PMOC cannot identify vertical circulation requirements on station-by-station basis. Required details must be developed.

Design Risk

- SCC 20.02 – Aerial Station, Stop, Shelter, Mall, Terminal, Platform
  - Drawings reflect integration between station supports and segmental guideway, but guideway and stations are to be constructed under two separate contracts (per Guideway Superstructure Study – Summary Report; p. 16; Fig. 11 and 13).
  - A large lump sum amount is shown for station canopy with no detail to support cost. A breakdown of the cost estimate must be provided.
  - Security Measures are not clearly defined. The cost estimate does not reflect the progression of this element.

Construction Risk

- SCC 20.02 – Aerial Station, Stop, Shelter, Mall, Terminal, Platform
  - Laydown areas have not been identified. The City should identify locations where it currently owns the land, leaving final decisions with the contractor. The availability of public lands should be included in the contract documents.

7.2.3 SCC 30 – Support Facilities

The support facilities include a heavy/light maintenance and storage facility as well as yard and storage track facilities (with some storage track at each end of the system). The risks associated with this SCC are, again, primarily requirements risks, with one design risk identified even after requirements risks are mitigated. The design of the MSF is quite generic, and certain requirements risks exist because much information on design functions and features that has yet been determined, and many of these are dependent on the ultimate contract used to acquire vehicles and systems (planned as either a design-build or a comprehensive furnish-install contract). Typically these types of decisions occur later in the design process. The following BRFs for Q2/2009 have been applied in the associated risk categories:

Requirements Risk

- SCC 30.01 – Admin Bldg: Office, Sales, Storage, Revenue Counting ***[BRF =3.5]***
    - Scope is not defined. Functional definition and requirements must be developed.
- SCC 30.03 – Heavy Maintenance Facility ***[BRF =3.5]***
    - Vehicle Basis of Design and functional sizing have not been fully developed, which could affect the MSF configuration.
    - Two locations for the MSF are being considered. Schedule impacts are possible if the Navy Drum Site acquisition is delayed.
    - The scope of earthwork for the Navy Drum Site is unknown.

Design Risk

- SCC 30.05 – Yard & Yard Track
    - No cost was contained within this SCC as it was included in SCC 30.04. However, there is an impact on the rail alignment along Navy Drum location if property is not acquired. Additional analysis and design are needed.

7.2.4 SCC 40 – Sitework

Sitework design is largely encountered at the station locations (for access/egress), under the guideway and at the MSF. There have been recent updates of portions of the sitework planning. However, there is still significant development required to adequately assess the costs for this work. The following BRFs for Q2/2009 have been applied in the associated risk categories:

Requirements Risk

- SCC 40.01 – Demolition/Clearing And Earthwork ***[BRF = 3.0]***
    - The scope is not fully defined. The estimate is based on route foot cost (parametric).
    - Landscaping is a Lump Sum item with minimum definition of scope. Pricing is based upon derived cost from the *1992 Original Estimate* and is not properly separated into SCC 40.06 as is customarily done.
- SCC 40.02 – Site Utilities, Utility Relocation ***[BRF = 3.5]***
    - Utility Agreements are not in place with private or public owners, including the military.
    - Schedule of relocations has not been developed.
- SCC 40.03 – Hazardous Materials ***[BRF = 3.5]***
    - Hazardous Materials is a Lump Sum item, with minimum definition of scope.
- SCC 40.04 – Environmental Mitigations ***[BRF = 3.5]***
    - Environmental Mitigations are a Lump Sum item, with minimum definition of scope.
- SCC 40.07 – Automobile, Bus, Van Accessways ***[BRF = 3.0]***
    - Pedestrian/Bike Accessways are a Lump Sum item, with minimum definition of scope.

Construction Risk

- SCC 40.02 – Site Utilities, Utility Relocation

- Schedule of relocations are not developed. It requires development through integrated design, geotechnical data and exploratory work with key areas where issues may be present.

7.2.5 SCC 50 – Systems

The elements of work under this SCC include train control and signals, traffic signals and crossing protection, traction power and distribution, fare collection, central control and communications for the Project. Because of the revenue passenger vehicle the City is proposing (a Heavy Rail vehicle similar to those currently used in activity center applications and typically delivered as part of a design-build or comprehensive furnish-install type of procurement with all requisite systems elements included from same contractor), this SCC review takes the vehicle and potential procurement mechanism into consideration. The following BRFs for Q2/2009 have been applied in the associated risk categories:

Requirements Risk

- SCC 50.01 – Train Control And Signals ***[BRF = 3.5]***
  - Scope is not fully defined.
  - Specific vehicle technology has not been defined.
  - Operations Plan has not been fully developed.
  - The responsible entity for state safety oversight in Hawaii has not been determined.
- SCC 50.02 – Traffic Signals And Crossing Protection ***[BRF = 3.0]***
  - Scope is not fully defined
  - Adjustments to and relocations of existing traffic signals will be required.
- SCC 50.03 – Traction Power Supply: Substations ***[BRF = 3.5]***
  - Scope is not fully defined
  - ROW takes are not defined for substation pads. The cost estimate does address substation as currently scoped. Relocations or reductions in numbers may occur.
- SCC 50.04 – Traction Power Distribution: Catenary And Third Rail ***[BRF = 3.5]***
  - Scope is not fully defined.
- SCC 50.05 – Communications ***[BRF = 3.5]***
  - Scope is not fully defined.
- SCC 50.06 – Fare Collection Systems And Equipment ***[BRF = 3.0]***
  - Scope is not fully defined.
  - Technology has not been selected.
  - This SCC item is not adequately identified in the Master Project Schedule.
- SCC 50.07 – Central Control ***[BRF = 3.5]***
  - Scope is not defined.

Construction Risk

- SCC 50.01 – Train Control And Signals
  - Likely mobilization/de-mobilization will be required between initial DB segment and subsequent segments will add costs to Project.

7.2.6 SCC 60 – Right-of-Way

The right-of-way planning done to date has heavily utilized information from the earlier (1990s) attempt by the City to implement a rail project. This information, together with AA Phase planning to keep the guideway and most of each station within existing public thoroughfare rights-of-way leads the City to conclude that its ROW program will be limited and relatively inexpensive. PMOC does not totally disagree but does question the realism of not encroaching on private properties, the extent of adversely impacted residences and businesses, the current viability of ROW information from 1990s, and several other areas where uncertainties appear to exist. In the instances of access to, over and/or through, and from such existing ROW as that owned by HDOT and other non-City entities, PMOC considers these as high-risk land or air rights acquisition areas. The following BRFs for Q2/2009 have been applied in the associated risk categories:

<u>Requirements Risk</u>

- SCC 60.01 – Purchase Or Lease Real Estate ***[BRF = 3.5]***
  - Basis of Estimate is not clearly defined.
  - Potential negative court judgments can occur.
  - ROW schedule is still being developed for 189 property acquisitions that have been identified to date.
  - Resource technical capacity of the ROW Department to maintain schedule is a concern. Other than having authority and relative experience, staffing requirements and accountability with project requirements are unclear.
  - ROW acquisitions may require "economic remainder" judgments or full takes.
  - Temporary and permanent easements scope is unknown. The PMOC recognizes that this is typically more definitively addressed during PE.
  - Schedule of property acquisitions is necessary to assess potential impacts to construction and design.
  - Coordination with HDOT will be necessary, which will require an MOU. The PMOC recognizes that this MOU can be more definitively addressed during PE.
- SCC 60.02 – Relocation Of Existing Households And Businesses ***[BRF = 3.5]***
  - Schedule for property acquisition is necessary for assessment of potential impacts to construction and design. The PMOC recognizes that this can be more definitively addressed during PE.
  - Resource technical capacity of the ROW Department to maintain schedule is a concern.

7.2.7 SCC 70 – Vehicles

The risk for this cost item is mainly attributable to the acquisition of what the City and its design team are calling a "light metro" vehicle for revenue operations. Heavy Rail Vehicles (SCC 70.02) is used in this review as the features of the City desired vehicles would tend to be more aligned thereto. The proposed vehicle acquisition risk is relatively high, as such vehicles for use in the urban rail transit manner being proposed are not currently in production or scheduled for delivery. Most such vehicle applications are in activity center (e.g., airports) use and not in mainline services. Furthermore, most current applications have been procured together with all requisite systems components (communications, signals, power and power distribution, etc.) and not as vehicle-only procurements. The City is leaning toward a similar procurement for its vehicles. The following BRFs for Q2/2009 have been applied in the associated risk categories:

Requirements Risk

- SCC 70.02 – Heavy Rail (Vehicles) ***[BRF = 3.0]***
  - Technical specifications for rail vehicles have not been fully defined.
- SCC 70.06 – Non-Revenue Vehicles ***[BRF = 3.0]***
  - No basis is shown for needs or type of equipment.
- SCC 70.07 – Spare Parts ***[BRF = 3.0]***
  - No basis is shown yet for needs, type or method of procurement.

Market Risk

- SCC 70.02 – Heavy Rail (Vehicles)
  - Combining the Vehicles and Systems into a single contract may lower the number of potential bids that can be received and could limit competition for future procurements.

7.2.8 SCC 80 – Professional Services

The City's cost estimate includes a general budget for most of the items contained in this category, though the GEC contract does provide a reasonable breakdown of work to be performed and the first PMC contract is intended only to provide personnel until the City hires staff through the PE Phase. Professional Services include Preliminary and Final Design, Project Management for Design and Construction, Construction Administration and Management, Insurance, Legal/Permits, Surveys/Testing and Inspection and Agency Force Account Work. Because of the stage of the project, the risks associated with this SCC include only requirements risks at this time. The following BRFs for Q2/2009 have been applied in the associated risk categories:

Requirements Risk

- SCC 80.01 – Preliminary Engineering ***[BRF = 2.0]***
  - Professional service costs are not based on staffing plans or detailed estimates.
  - There are limited or no performance metrics relative to all participants for control of budget and adherence to schedule.
  - There is no scope definition or identification of permits required or third party approvals.
  - The PMOC did not include adjustments to SCC 80 lines items as a result of the adjustments made to lines items in SCC 10-70.
- SCC 80.02 – Final Design ***[BRF = 3.0]***
  - No Basis of Estimate is developed. Costs are based on a percentage of construction value.
  - Final Design cost growth is likely until PE scope, schedule and budget are more fully developed.
- SCC 80.03 – Project Management For Design And Construction ***[BRF = 3.0]***
  - No Basis of Estimate is developed. Costs are based on a percentage of construction value.

- No staffing plan is shown for City or consultants.
    - Identification of performance metrics relative to all participants should be developed to ensure control of budget and adherence to schedule.
- SCC 80.04 – Construction Administration & Management ***[BRF = 3.0]***
    - No Basis of Estimate is developed. Costs are based on a percentage of construction value.
- SCC 80.05 – Insurance ***[BRF = 3.0]***
    - Insurance methodology is not yet defined.
    - No Basis of Estimate is developed. Costs are based on a percentage of construction value.
- SCC 80.06 – Legal: Permits, Review Fees By Other Agencies, Cities, Etc. ***[BRF = 3.0]***
    - No Basis of Estimate is developed. Costs are based on a percentage of construction value.
    - No scope definition or identification of permits required, third party approvals, etc. is provided.
    - Un-anticipated litigation may add cost to the Project (e.g., protests from adversary groups, community groups, adjacent landowners, and other affected parties).
- SCC 80.07 – Surveys, Testing, Investigation, Inspection ***[BRF = 3.0]***
    - No Basis of Estimate is developed. Costs are based on a percentage of construction value.
- SCC 80.08 – Start-Up ***[BRF = 3.0]***
    - No Basis of Estimate is developed. Costs are based on a percentage of construction value.

7.2.9 Miscellaneous Areas of Risk Applicable to Multiple SCCs

There are a number of project elements, including grantee authorities, roles and responsibilities, where a substantial amount of uncertainties with respect to execution of the Project exist today and will have potential adverse impact on the project. As with specific SCC categories of work, these elements and consequent areas of uncertainty are not unexpected at this early stage (pre-PE) of a project being planned. Nonetheless, each has risk consequences, and until and unless the issues are satisfactorily resolved, they should be taken into consideration with respect to the ultimate estimate of total costs for the project, and therefore the baseline project budget. Following are those elements and relative uncertainties:

<u>Requirements Risks</u>

- There are several MOUs that will be developed for the Project. The PMOC is unclear what force they will have and who will be the ultimate arbiter in event of disagreements.
- Design is more advanced than cost estimate, and the scope is not fully traceable to estimate. The current estimate may not capture all design elements.
- Soft costs are only calculated as a percentage of construction value (no basis or staffing plans). For example, PE scope of work is exceptionally detailed, but no staffing plan is provided for the City or its consultants. Additionally, it appears that the City has had difficulties in hiring necessary staff, which may be an indication of

non-competitive salaries, fringe benefits, moving allowances, etc. It also appears that retention of consultant staff may be an issue.

- The project documentation with respect to project control lacks real metrics to monitor performance in cost or time, except by broad, end-product oriented deliverables and due dates. In real terms, such lack of performance metrics and the mechanism (e.g., "earned value" techniques) to measure them portends inability to effectively and timely monitor trends and avoid budgetary or schedule problems.
- Coordination/Approvals of both design concepts and construction staging by HDOT and the City must be fully addressed. This is one of the areas where MOUs can be useful. Failure to bring the HDOT and City agencies into the project management scoping will miss the opportunity to inform these entities about the timing and coordination issues and the negative impact delays can cause.
- The designer is developing the estimates with no independent oversight and without having experienced estimating staff within the City staff reviewing and assessing the consultant's work. Estimating should be overseen and assessed by some other entity who is not the designer.
- No identifiable configuration management/change control mechanism is in place, though it is adequately addressed in the PMP.
- Contract packaging must be refined. The City has identified an initial packaging and delivery method. However, they acknowledged that it requires refinement.

Design Risks

- Schedule for contracting DBB work is very tight due to workload, insufficient time to recover from poor bids, etc. The City shows more concern over DB schedule and contracting issues than those of DBB. Planning must provide reasoned, practical contingency in schedules to handle setbacks.

Market Risks

- Steel, concrete, rail, aggregate, fuel and all construction materials may increase in price due to volatile and unpredictable market conditions. Current estimates and projected inflationary factors must more definitively reflect actual industry and materials cost increases of the recent past.
- The availability of skilled and unskilled labor will require more detailed analysis of the local labor market as it relates to the overall construction being planned in Oahu and the remainder of the State.
- The General Conditions have not been fully developed.

Construction Risks

- Change Orders during construction (varies from 3% ~ 12%) can be accommodated in robust risk-informed estimating.

7.3 Cost Risk Model Results

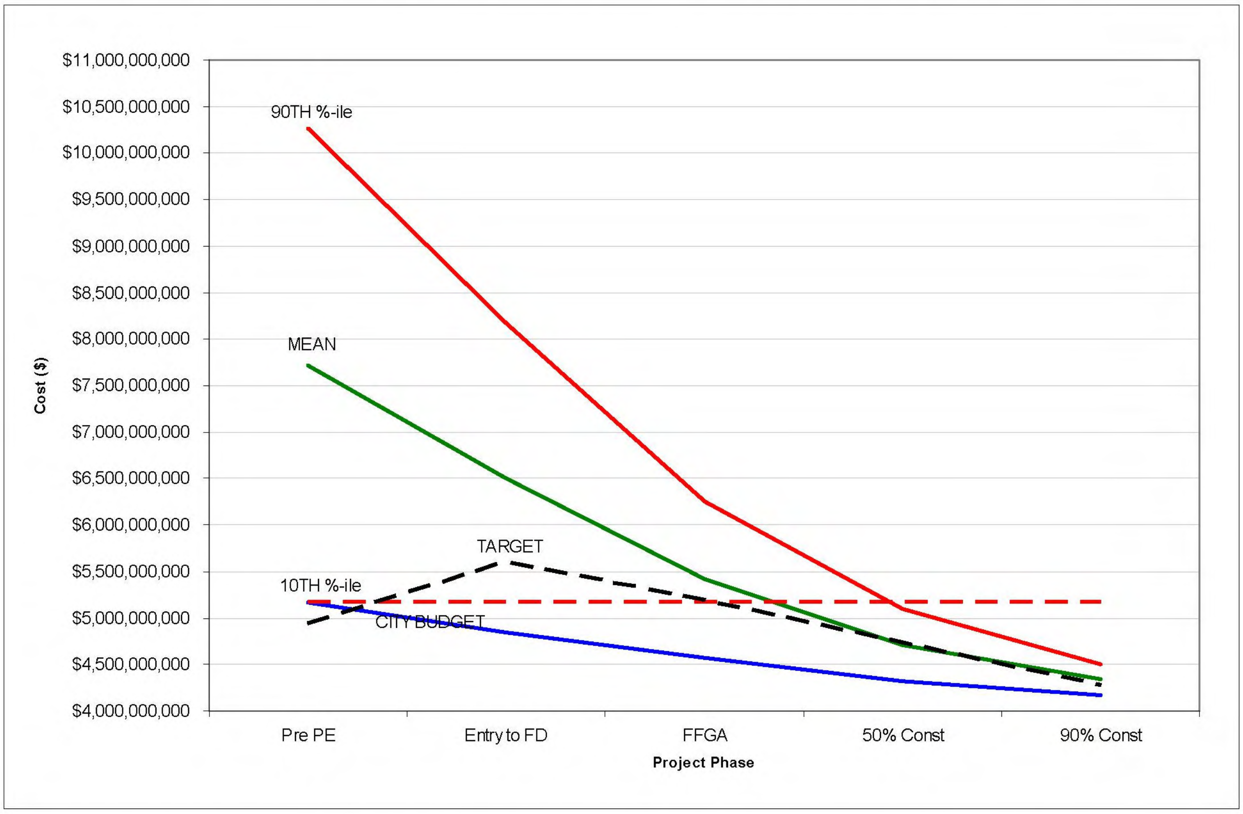
Using the Adjusted BCE values for each SCC and the BRFs identified above, the Cost Risk Model was used to calculate the possible optimistic (10%), median (50%), and pessimistic (90%) project costs. This Level 1 statistical risk analysis results in a most optimistic total project cost of $4.937 billion at this pre-PE phase (or the baseline phase of the project). After adding back the finance costs of $230.87 million, the statistically most optimistic Total Project Cost becomes $5.168 billion at this early project stage of development. The statistically most pessimistic estimate for the total project cost at this pre-PE phase is $10.036 billion. After adding back the finance costs of $230.87 million, the statistically most pessimistic Total Project Cost becomes $10.267 billion.

The Level 1 statistical risk analysis was used to forecast the total project cost at the following Project phases:

- Baseline – Entry into PE (Q2/2009)
- Entry into Final Design (Q2/2010)
- FFGA Award (Q3/2011)
- 50% Construction (Q4/2013)
- 90% Construction (Q4/2016)

In this risk-informed dynamic analysis, the BRF values for the different project phases were applied in accordance with PG-40 and in part through FTA program experience with other projects and the identified risks that could cause cost escalation. Figure 7-1 depicts how the values of the 10th, 50th (mean), and 90th percentiles of the total project cost change during the life of the project (including financing). These values (i.e., projected costs) drop as the requirements, design, and market risks are eliminated from the project through the advancement of the design analysis, engineering applications and the availability of firm bids. The City budget is shown as $5.171 billion.

Figure 7-1. Plot of Cost Risk Model Project Forecasts and Target Values



As shown in Figure 7-1, with totally effective mitigation it is possible for the Project to be implemented within the current budget. At the pre-PE Phase of project development, where detailed design analyses and engineering conclusions have yet to be accomplished and bids have not yet been received to actualize market conditions of prices, a significantly wide range typically exists between best and worst case scenarios for a project cost. The primary method for mitigation of risks and narrowing the statistical range of potential final cost is through investigations and analyses with risk-informed design and engineering development. Secondary mitigation is the amount of additional contingency that must be funded based on the expected risks, as discussed in Section 8.0.

There is a period of time in the project life cycle where the risks can be mitigated. However, after a certain point the risks cannot be mitigated and, therefore, must be paid for through the project contingency. This point is identified as the project "Break Point". The FTA program experience shows that the break point for a project is around the 20% construction phase where most of the design and market risks have been substantially mitigated or eliminated.

Design development is the primary mitigation method and the preferred method to achieve project cost targets. Secondary mitigation is the amount of additional contingency that must be funded based on the expected risks. The percentage of coverage needed varies by project phase. Mitigation coverage requirements recommended in PG-40 are shown in Table 7-3. The Target Value is determined from the Cost Risk Model as the required budget at each phase for the corresponding Level of Confidence as defined by PG-40. The required capacity (minimum contingency) is then calculated as the difference between the Target Value (shown as the dashed black line in Figure 7-1) and the Adjusted BCE of $3.827 billion (as summarized in Table 7-3).

Table 7-3. Required Mitigation Capacity

Project Phase	Coverage Target	Target Value	Required Capacity
Baseline – Entry into PE	10%	$4,950,862,006	$1,112,474,678
Entry into Final Design	30%	$5,613,954,170	$1,775,566,841
FFGA Award	50%	$5,200,190,891	$1,361,803,563
50% Construction	80%	$4,745,107,534	$906,720,205
90% Construction	90%	$4,287,656,727	$449,269,398

7.4 Conclusion

Based solely on the Cost Risk Model analysis, the Project should include $1.112 billion in total contingency, or 29.0% of the Adjusted BCE, at the pre-PE Phase (or the baseline phase of the project). When considering all adjustments, escalation, contingency, and financing costs, the statistical result is an estimated Total Project Cost of $5.181 billion. It should be noted that the Cost Risk Model indicates that the required contingency may increase during FD but eventually could decrease. This is the result of the remaining risks and their impacts on the overall budget at the various stages of the project.

This analysis must be supported by an assessment of the contingency per PG-35 to confirm the adequacy of the total Project budget, as is done in Section 8.0, following. In addition, the estimate must undergo significant refinement once the project advances into the PE phase.

7.5 Recommendations

With this Adjusted BCE and the Beta Risk Factors applied in the Cost Risk Model, using both more static statistical and more dynamic risk-informed analyses, the end result is a pre-PE Phase Total Project Budget of $5.181 billion. *However, this analysis must be supported by an assessment of the contingency per PG-35 to confirm the adequacy of the total Project budget as discussed in Section 8.0.*

It is recognized that estimate will undergo significant refinement once the project advances into the PE phase. Over the course of the Project, the Cost Risk Model indicates that it is possible for the Project to be implemented within the current budget with totally effective mitigation. Design development is the primary mitigation method and the preferred method to achieve project cost targets. Secondary mitigation is the amount of additional contingency that must be funded based on the expected risks, as discussed in Section 8.0.

It should be noted that the Schedule Risk Assessment, as discussed in Section 9.0, indicates that there is an 85% probability of achieving ROD by August 13, 2019, which is a delay of approximately five (5) months from the City's plan. Although a delay in the Project schedule would typically correlate to increased costs, the overall impact cannot be determined at this time because the primary cost drivers resulting from schedule delays are "soft costs". Since these "soft costs" are only a percentage of the construction value of the Project, their impact cannot be assessed until a staffing plan or more detailed estimate is developed.

8.0 SUBTASK 35A: PROJECT COST CONTINGENCY BASELINE REVIEW

8.1 Methodology

The PMOC followed the requirements outlined in the *FTA PG #35: Project Contingency and Third Party Profit Review Procedures,* dated March 29, 2007 to assess and evaluate the City's cost contingency. Per PG-35, the PMOC shall fully identify, describe, and analyze the adequacy of the City's cost contingencies. For PG-35A products, this means three steps:

(1) Forward Pass –The working target for total contingency (defined as the aggregate of allocated and unallocated cost contingency, net of allowances and financing) is determined at key milestones:
- Entry into Preliminary Engineering = 30%
- Entry into Final Design = 20%
- Award of an FFGA = 15%
- 90-100% bid = 10%
- 50% construction complete = 5%

(2) Backward Pass – The PMOC developed estimates of the minimum amount of total cost contingency that is reasonably expected to be necessary at that point in time for the Project to be completed within budget and on time. The following parameters were used per the guidelines outlined in PG-35.
- At the Revenue Operations Date (ROD), the demand for total cost contingency has been reduced to a minimum requirement for scope changes or clarifications and schedule delays or changes. The PMOC identified a working target for this point as 3% total contingency based on prior experience.
- At "substantially complete" (90% construction), an estimate of the exposure as a result of extended overhead and management soft costs is developed.
- At 75% construction, the calculated median of the contingency at 50% and 90% construction is calculated.
- At 50% construction, the project is typically exposed to cost changes in the range of 6% of YOE$.
- At 20% construction, the project is typically exposed to cost changes in the range of 12% of YOE$.

(3) Cost Risk Model – Based on the results of the Cost Risk Model, the percentage of coverage needed varies by project phase. The Target Value is determined from the Cost Risk Model as the required budget at each phase for the corresponding Level of Confidence as defined by PG-40. The required capacity (minimum contingency) is then calculated as the difference between the Target Value and the Adjusted BCE.

The PMOC then reconciles the various sets of data to develop recommended contingency minimums for the key project milestones.

8.2 Review of Project Cost Contingency

The PMOC team used the *2009 SCC Estimate* to complete the contingency analysis. The estimate is summarized by FTA Standard Cost Category (SCC) in Table 5-8.

The Base Year (2008 dollars) and Year-of-Expenditure (YOE) contingencies for the Project are shown in Table 5-8. For the purposes of this analysis, the allocated contingency for each SCC category was individually escalated using the inflation factors by cost category from the SCC workbook to YOE. The PMOC used the same inflation factors identified by the City within the SCC Workbook for escalation of the individual line items in developing their YOE estimates. The unallocated contingency was escalated as well from Base Year to YOE using the same methodology. The charts and tables in this report are based on YOE and the City's ROD of 2019.

As noted in Section 5.0, the PMOC made adjustments to the Project's direct costs due to omissions in scope or under valuation of certain cost items. In addition, the PMOC attempted to identify latent contingencies included in the direct cost estimate. However, given that the estimate is based solely on Cost Estimating Relationships, latent contingency amounts were not readily identified. The PMOC Adjustments and Cost Risk Model Inputs are shown in Table 5-19.

8.3 Analysis of Project Cost Contingency

8.3.1 Forward Pass

The Project contingency dollar amounts were reviewed by the PMOC. The minimum values calculated based on the PG-35 guideline percentages are shown in Table 8-1. From these values, minimum contingency hold points were determined for the Project by multiplying the guideline percent recommended and the construction cost in YOE dollars (excluding contingency or financing cost).

Table 8-1. PG-35 Contingency Percentages and Calculated Hold Points

Project Milestone	FTA Guideline Percentage	Calculated Hold Point
Entry to PE	30%	$1,151,516,199
Entry to FD	20%	$767,677,466
FFGA Award	15%	$575,758,099
90-100% Bid	10%	$383,838,733
50% Construction	8.0%	$307,070,986
75% Construction	6.0%	$230,303,240
90% Construction	4.0%	$153,535,493
Revenue Operations Date	3.0%	$115,151,620

At Entry into PE, the minimum contingency should be 30% of the Project's Adjusted BCE. This results in an estimated contingency of $1.15 billion based on the Adjusted BCE of $3.827 billion.

When considering all adjustments, escalation, contingency, and financing costs, the result is an estimated Total Project Cost of $5.221 billion based solely on FTA guideline minimum contingency percentages per PG-35.

8.3.2 Backward Pass

The following is a summary of the "backward pass" process used for this Spot Report:

(1) The PMOC estimated approximately 3.0% of the construction YOE dollars should be available for claims during project closeout.

(2) The total duration for the project from Entry into PE through project closeout was calculated at 128 months (July 2009 to December 2019) with contingencies needed for 26 months of delay (20% per PG-35).

(3) Extended overhead for the various contractors was estimated at $4,000,000 per month. Program support costs for the City are estimated at $5,900,000 per month.

(4) 90% Construction was calculated as 18 months of construction overhead at $4 million per month + 18 months of soft cost at $5.9 million per month + Remaining Change Orders at 1%.

(5) 50% Construction was calculated as 6% of YOE dollars. This estimate is considered reasonable because all final design, right-of-way acquisition, vehicle/systems procurement, utility relocation, and the majority of geotechnical differing site conditions risks will have passed.

(6) 20% Construction was calculated as 10% of YOE dollars. This estimate is considered reasonable because all final design, right-of-way acquisition, and utility relocation risk will have passed, but construction phasing and systems risks remain.

(7) The design period was not used during this analysis as it was determined that any delays occurring prior to the start of construction would have a cost comprised of contract escalation for the number of months the project was delayed prior to the start of construction.

Table 8-2. Backward Pass Values

Project Timeframe	Backward Pass Value	Notes
20% Construction	$461,000,000	Calculated Target 10% YOE (rounded)
50% Construction	$230,000,000	Calculated Target 6% YOE (rounded)
75% Construction	$214,000,000	Calculated Median
90% Construction	$199,000,000	18 Months of Construction overhead at $4M/month + 18 Months of Soft Cost at $5.9M/month + Remaining Change Orders of 1%
Revenue Operations Date	$115,000,000	Approximately 3% for claims
Total	**$1,219,000,000**	

The total result is $1.219 billion contingency, or 31.8% of the Adjusted BCE. When considering all adjustments, escalation, contingency, and financing costs, the result is an estimated Total Project Cost of $5.288 billion based on the Backward Pass analysis.

8.3.3 Contingency Calculation Using Cost Risk Model (PG-40A)

Based on the Cost Risk Model analysis discussed in Section 7.0 , the Project should include $1.112 billion in total contingency, or 29.0% of the Adjusted BCE, at the pre-PE Phase (or the baseline phase of the project). When considering all adjustments, escalation, contingency, and financing costs, the result is an estimated Total Project Cost of $5.181 billion. It should be noted that the Cost Risk Model indicates that the required contingency may increase during FD but eventually would decrease. This is the result of the remaining risks and their impacts on the overall budget at the various stages of the project.

8.4 Conclusion

The purpose of this section of the Spot Report is to provide an analysis of the project contingency requirements using various methods. The estimation of the required cost contingency needs to recognize the mitigation capacity available at each phase of project development throughout the life of project. The recommended contingency in the BCE must be adequate to support the project through project close-out. In this Spot Report, a contingency amount is recommended for inclusion in the BCE at the current phase of the project. Table 8-3 summarizes the results of the contingency analyses performed for this Project.

Table 8-3. Contingency Analysis Summary

Analysis Method	Resulting Percentage of Adjusted BCE	Calculated Contingency (YOE)	Calculated Total Project Cost (YOE)
Forward Pass	30.0%	$1,151,516,199	$5,220,776,798
Backward Pass	31.8%	$1,219,000,000	$5,288,349,368
Cost Risk Model	29.0%	$1,112,474,678	$5,181,735,277

8.5 Recommendations

Based on these analyses, the PMOC recommends a minimum contingency of $1.219 billion (YOE), which is 31.8% of the Adjusted BCE amount of $3.838 billion (YOE). This results in a Total Project Budget of $5.288 billion (YOE), which is an increase of $116.76 million (YOE) or 2.3% of the City's current budget.

9.0 SUBTASK 35C: PROJECT SCHEDULE CONTINGENCY REVIEW & SUBTASK 40B: ASSESSMENT OF PROJECT SCHEDULE RISK

9.1 Methodology

The PMOC followed the requirements outlined in the *FTA PG #35: Project Contingency and Third Party Profit Review Procedures,* dated March 29, 2007 to assess and evaluate the City's schedule contingency. The PMOC followed the requirements outlined in the *FTA PG #40: Risk Management Products and Procedures,* dated March 29, 2007 complete a schedule risk analysis of the Project.

The role of the PG-40B product is to establish a programmatic management baseline for evaluating the reliability of the grantee project schedule and its components given the various elements of uncertainty associated with the effectiveness and efficiency of the grantee's project schedule for project implementation. The PMOC identified, assessed and evaluated the uncertainties in the project schedule using a Monte Carlo simulation model. Input for the model was based on observational data, professional judgment, and intermediate analysis. The result was probability distributions of the project schedule. The PMOC then identified and analyze the adequacy of the City's schedule contingencies per the requirements of PG-35C.

9.2 Review and Analysis of Project Schedule Contingency

9.2.1 Project Schedule Characteristics

The City submitted a Master Project Schedule (MPS) titled "HHCTP As of August 25.xer" in early August 2008. The PMOC conducted a preliminary schedule review and produced a list of comments to the City during the Risk Assessment workshop site visit on September 11, 2008. The City incorporated the PMOC comments in a revised schedule, titled "*CITY.prx*", on September 20, 2008. The City submitted a revised and progressed MPS *"MA5A.prx"* to the PMOC in May 2009. The PMOC provided preliminary schedule review comments to the City in late May 2009. As a result, the City addressed most of the PMOC's comments and submitted a revised MPS *"MA5E.xer"* on May 29, 2009. The PMOC used this MPS to conclude the PG-34A Project Schedule Review, PG-35C Schedule Contingency Review, and the PG-40B Assessment of Project Schedule Risk Report(s).

The MPS contains updated work progress, deletion of the Salt Lake Alternative, and inclusion of the new airport corridor alignment. The technical schedule data is included in
The technical schedule data is included in Table 9-1.

Table 9-1. Technical Schedule Data

Schedule Item	MPS
Number of activities	368
Number of activities in longest path	25
Started activities	85
Completed activities	51
Number of relationships	615
Percent complete	3.6 %
Number of hammocks	1
Number of early constraints	4
Number of late constraints	7
Number of mandatory constraints	0
Data date	10MAY09
Start date	15SEP08
Imposed finish date	N/A
Latest calculated early finish	04MAR19

In order to assess the schedule progress and the timing of cost contingency reductions, the schedule needs milestones established at the completion of activities which posed risks to the project. These milestones are either associated with project phase (PE, final design, or construction) or related to one of the five project segment Revenue Operation Dates. The City plans to incrementally open individual project segments in an easterly direction. While these milestones are critical to the City, the PMOC is most concerned with cost and schedule impacts to the final project completion date (ROD). The PMOC used the incremental ROD dates as critical measuring points for the evaluation of schedule contingency.

Based on the MPS "*MA5E.xer*" revision, the milestone completion dates shown in Table 9-2 were indicated.

Table 9-2. Schedule Summary Dates

Description	Start Date	Finish Date
Preliminary Engineering		
PE Request thru FTA Approval	04MAY09A	07JUL09
PE thru ROD	07JUL09	01OCT09
Design Build Procurement		
MSF (thru issuance of NTP)	29MAY09A	30MAR10
West Oahu/Farrington Guideway (thru issuance of NTP)	04FEB09A	13MAR10
Systems (thru issuance of NTP)	09APR09A	25MAY10
Final Design		
Final Design (FD) Request thru FTA Approval	29DEC09	28APR10
Full Funding Grant Agreement (FFGA)		
Application thru Approval	26AUG10	28JUN11
Construction		
Start	13DEC09	
Open Waipahu / Leeward Section		24DEC12
MSF Contract Complete		07MAY14
Open East Kapolei to Pearl Highlands Section		21JUL14
Open Kamehameha Section		21JAN17
Open to Airport Section		22OCT17
Open to Ala Moana Center		04MAR19

9.2.2 Analysis

A quantified schedule risk analysis was performed on the MPS. This technique provides a means to determine schedule risk as a function of risk associated with the activities that make up the schedule. The CPM schedule is comprised of a network or activities logically sequenced to identify the longest critical path, start to completion. The schedule risk assessment techniques takes the planning process another step further accounting for uncertainty by using a range of durations to complete each activity instead of a single point duration. It calculates the overall schedule duration by developing a probabilistic distribution for each activity's duration, then totals the durations on the longest critical path. These ranges are then combined to determine the overall schedule duration.

The activity duration probability distributions were aggregated using PertMaster, a simulation program that uses a Monte Carlo type probability algorithm. The Monte Carlo sampling technique method is described below:

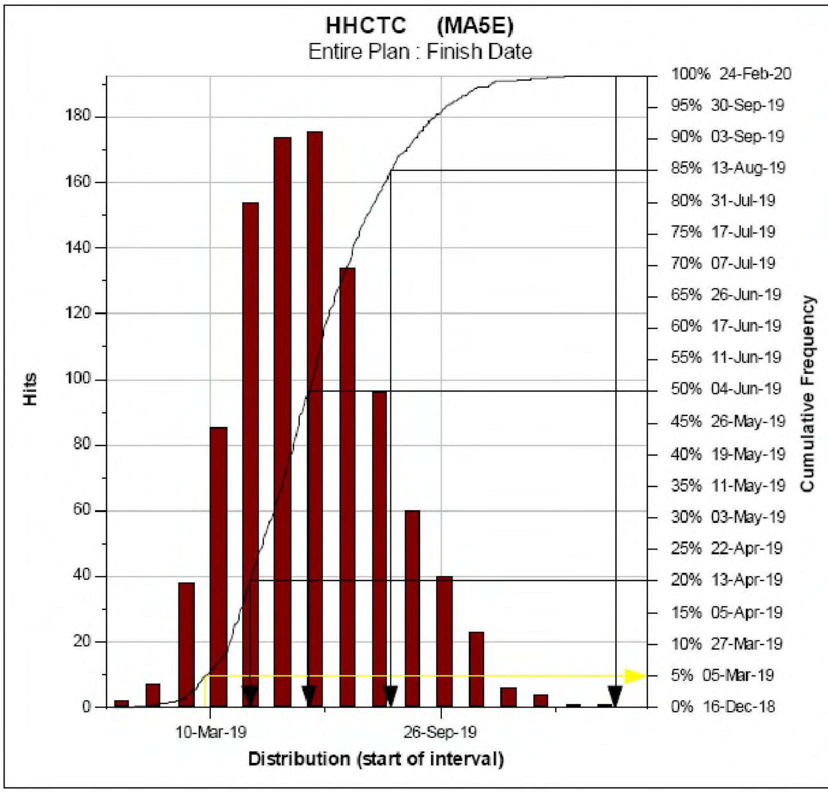
- Activity durations are randomly selected from an appropriate frequency distribution
- Project length and critical path data are calculated based on the sampled durations
- The procedure is repeated several thousand times (simulation runs) using a computer and a record is kept of the critical path data generated
- An average project duration and standard deviation are calculated based on the simulated data
- The probability of meeting a certain date is then calculated

The computer simulation gives a more reliable estimate since it takes into account the effect of near-critical paths. For each activity, a record is kept of the proportion of simulation runs in which the activity is critical. This proportion is called the “Criticality Index”. For instance, if an activity was critical in 3,000 simulation runs out of 10,000 total simulation runs, the Criticality Index = 0.3.

Before running the PertMaster program, the PMOC assigned three durations to each schedule activity in the MPS. The three durations for each activity represent the best case, most likely, and worst case). The PMOC reviewed the activity Original Durations (OD) in the MPS schedule and made an objective determination of the adequacy of each activity Original Duration (OD). The PMOC used many of the schedule OD durations as the most-likely durations. However, in some cases the PMOC determined the OD was too aggressive. The duration assignments are based on PMOC experience and program understanding. The value ranges (differences in activity durations) reflect levels of uncertainty. Based on the three durations, a triangular distribution was assigned to each activity.

Using the above probabilistic durations and triangular distribution, the schedule was recalculated 1,000 times, selecting random durations for each task, to estimate the completion date/ROD. This analysis yields the results shown in Figure 9-.

Figure 9-1. Finish Date Distribution



Data	
Finish Date of:	
Entire Plan	
Analysis	
Simulation:	Latin Hypercube
Iterations:	1000
Convergence at mean	
Mean Plan Finish Date:	
Converged in 200 iterations	
(variation < 0.1% over 100 iterations)	
Mean Total Plan Cost:	
Converged in 200 iterations	
(variation < 0.1% over 100 iterations)	
Statistics	
Minimum:	16-Dec-18
Maximum:	24-Feb-20
Mean:	08-Jun-19
Bar Width:	4 weeks
Highlighters	
85%	13-Aug-19
50%	04-Jun-19
Selected: 100%	24-Feb-20
20%	13-Apr-19
Deterministic (04-Mar-19)	5%

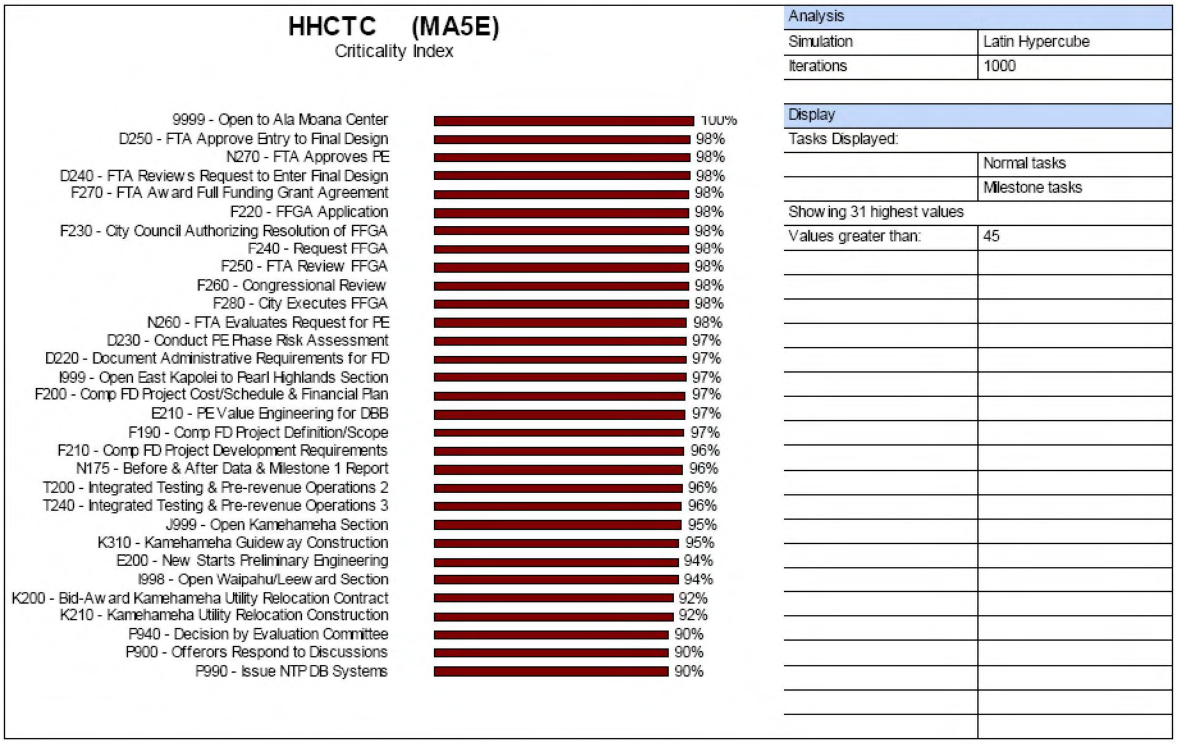
Figure 9- demonstrates that, based on the estimated range of activity durations, there is less than a 5% chance of achieving ROD by the project completion date/ROD of March 4, 2019 as

calculated in the PMOC's *"35C3.prx"* schedule developed, which is based on the City's MPS. The analysis indicates there is an 85% probability of achieving ROD by August 13, 2019. The earliest calculated date for achieving ROD is December 16, 2018. The latest calculated date for achieving ROD is February 24, 2020.

The analysis also determined the "Criticality Index". The Criticality Index quantifies how often a task was on the critical path. It helps identify those tasks that are most likely to be critical. As the schedule is recalculated using the different durations, the critical path may change with each iteration; therefore, the critical path calculated in the update to the Baseline CPM schedule may not necessarily have the highest Criticality Index. Those activities with higher Critically Indexes are more likely to impact project completion.

Figure 9- illustrates the activities criticality based on the percentage of time that the activity appeared on the critical path with each schedule iteration. The schedule contains a high amount of activities on the critical path calculations primarily because the schedule activities are linear, non concurrent, and are very summary in nature.

Figure 9-2. Criticality Index – Highest Values



9.2.3 Estimation of Project Schedule Mitigation Capacity

In addition to calculation of the ROD date, to assess the schedule mitigation capacity of the project, the schedule distribution was calculated for each of the schedule milestones described in Table 9-3. The distribution for these milestones was calculated in the same manner as for the ROD date. An optimistic date for achieving the milestone is the 20th percentile; high confidence of achievement is at the 85th percentile. Data are also shown for the median date (50th percentile) and the maximum date from the calculation. Table 9-3 shows a compilation of these dates. Figure 9-1 through Figure 9-3 illustrate the completion date probability distribution for each of the milestone activities.

Table 9-3. Probability of Achievement Date of Schedule Milestones

Project Timeframe	Activity ID	Schedule Finish Date	Milestone Achievement Date – Percentile Rank			
			20th	50th	85th	Maximum
Entry into PE	N270	01JUL09	30JUN09	30JUN09	17JUL09	14AUG09
Entry into Final Design	D250	22APR10	02MAY10	17MAY10	05JUN10	05AUG10
FFGA Award	F270	16JUN11	09JUL11	05AUG11	01SEP11	17NOV11

Figure 9-1. Activity N270 Finish Date Distribution

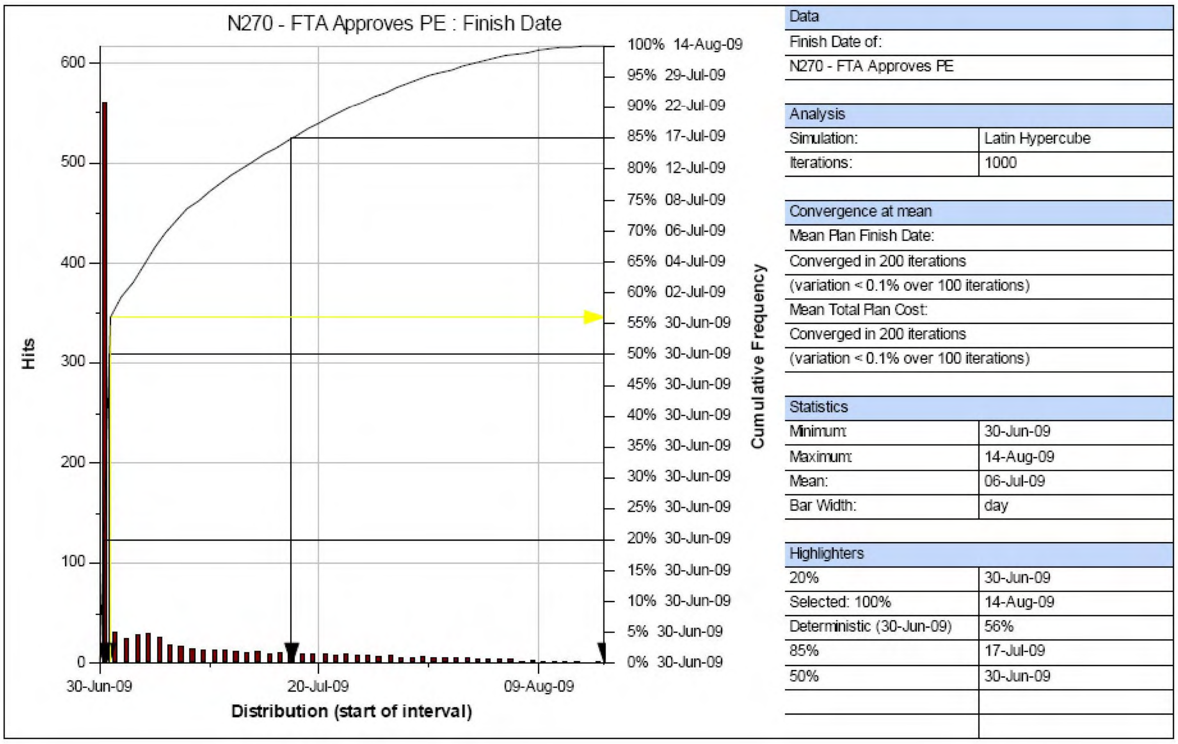
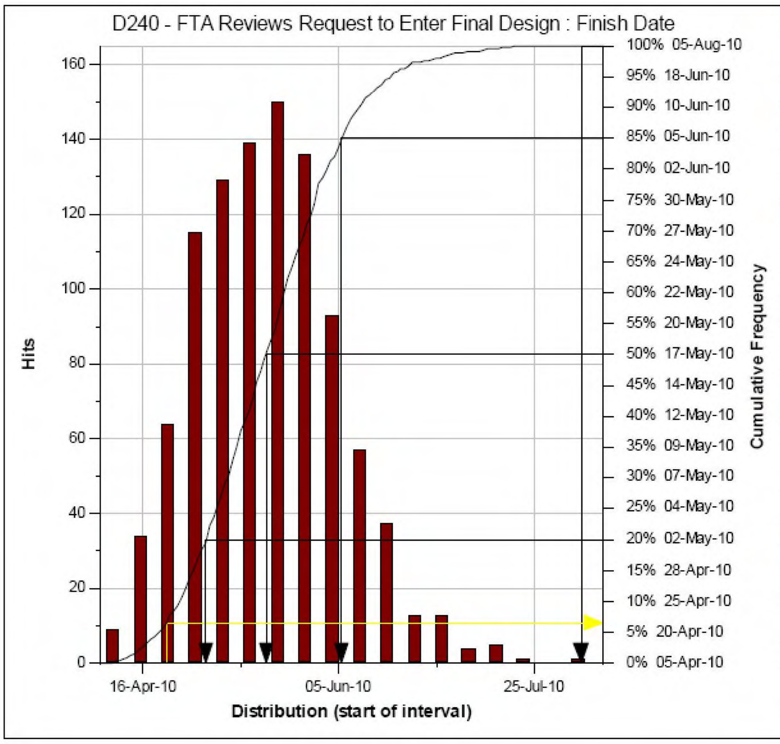
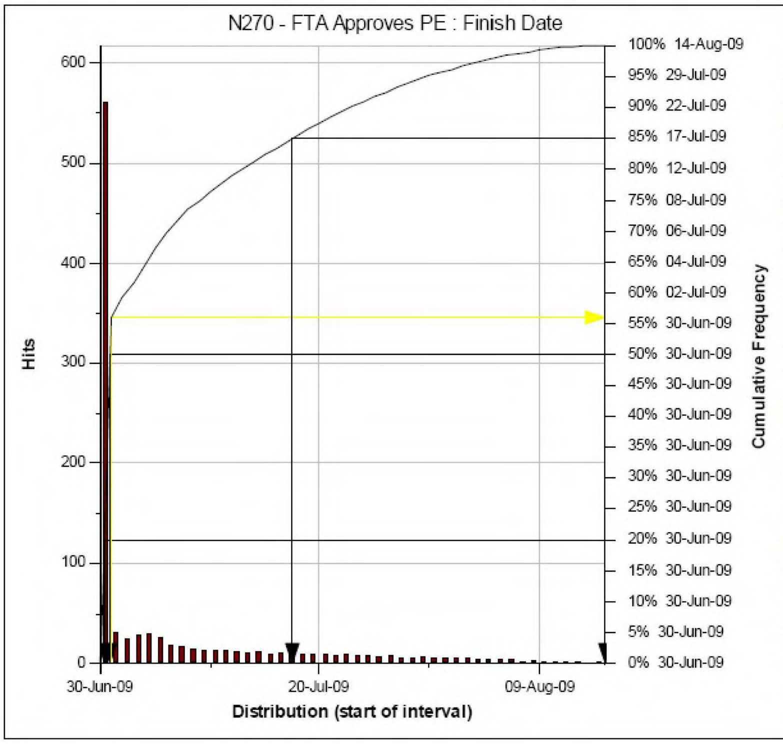


Figure 9-2. Activity D240 Finish Date Distribution



Data	
Finish Date of:	
D240 - FTA Reviews Request to Enter Final Design	
Analysis	
Simulation:	Latin Hypercube
Iterations:	1000
Convergence at mean	
Mean Plan Finish Date:	
Converged in 200 iterations	
(variation < 0.1% over 100 iterations)	
Mean Total Plan Cost:	
Converged in 200 iterations	
(variation < 0.1% over 100 iterations)	
Statistics	
Minimum:	05-Apr-10
Maximum:	05-Aug-10
Mean:	17-May-10
Bar Width:	week
Highlighters	
20%	02-May-10
Deterministic (21-Apr-10)	7%
Selected: 100%	05-Aug-10
50%	17-May-10
85%	05-Jun-10

Figure 9-3. Activity F270 Finish Date Distribution



Data	
Finish Date of:	
N270 - FTA Approves PE	
Analysis	
Simulation:	Latin Hypercube
Iterations:	1000
Convergence at mean	
Mean Plan Finish Date:	
Converged in 200 iterations	
(variation < 0.1% over 100 iterations)	
Mean Total Plan Cost:	
Converged in 200 iterations	
(variation < 0.1% over 100 iterations)	
Statistics	
Minimum:	30-Jun-09
Maximum:	14-Aug-09
Mean:	06-Jul-09
Bar Width:	day
Highlighters	
85%	17-Jul-09
Deterministic (30-Jun-09)	56%
50%	30-Jun-09
20%	30-Jun-09
Selected: 100%	14-Aug-09

9.2.4 Schedule Risk Summary

The PMOC has identified several schedule drivers that have the potential to delay the project completion date (95% to 100% Criticality Index):

- Open to Ala Moana Center
- Entry to PE (Request, FTA Review & Approval)
- PE Phase Risk Assessment
- Value Engineering for Design-Bid-Build Contracts
- Entry to Final Design (Request, FTA Review & Approval)
- Final Design Cost, Schedule & Financial Plan
- Final Design Project Definition & Scope
- Final Design Project Development Requirements
- Before & After Data & Milestone 1 Report
- FFGA (Application Request, FTA/Congress Review & Approval Process)
- Integrated Testing & Pre-revenue Operations

9.2.5 Schedule Risk Mitigation Plan

Based on the PMOC's review of the current MPS schedule and analysis using probabilistic modeling, there are many project components that should be pursued to increase the probability of achieving an early project completion date/ROD, the most critical are identified below:

(1) City & FTA Coordination – Development and submittal of LONP Requests and Record of Decision.
(2) City – Expedient development, quality control and submittal of Final Design engineering and supporting documents.
(3) City & FTA Coordination – Development, quality control and submittal of FFGA Application and supporting documents.
(4) City – Execution of construction contract procurement for design-build and design-bid-build delivery methods.
(5) Evaluation of optimizing Incremental contract segment openings during continuous Project construction.
(6) Systems (DBOM) and vehicle procurement and contract execution.

9.3 Conclusion

The schedule risk analysis was based on the City's MPS *"MA5E.xer"*. The PMOC's schedule risk analysis, generated by the aggregation of activity duration probability distributions determined there is less than a 5% chance of achieving Revenue Operation Date (ROD) by the project completion date/ROD of March 4, 2019. The analysis indicates there is an 85% probability of achieving ROD by August 13, 2019. The earliest calculated date for achieving ROD is December 16, 2018. The latest calculated date for achieving ROD is February 24, 2020. Based on the current MPS and the results of the schedule risk analysis and contingency analysis, the PMOC recommends a project completion date (ROD) no earlier than August 2019.

9.4 Recommendations

9.4.1 Approval to Enter PE

No specific recommendations necessary for conditional approval to enter PE have been identified.

9.4.2 During the Early PE Phase

The PMOC recommends the following comments, in addition to the PG-34A recommendations, be addressed and incorporated into the Master Project Schedule during the PE phase.

(1) Self perform PertMaster or similar Schedule Risk Analysis on the Master Project Schedule at least once per quarter. In addition, seek consultant, vendor and construction contractor input on critical schedule activity durations (Best Case, Worst Case, Most Likely) to support the Schedule Risk Analysis.

(2) Incorporate for schedule activity detail for early construction packages such as interagency agreements, early site-work packages, early utility adjustment packages, etc.

(3) Allow more latent float contingency for construction contractor bid and award process for Design-Bid-Build and for Design-Build procurements to allow for bidding extensions, contract document addendums, etc.

(4) Develop and submit a schedule mitigation plan for at least three (3) months of schedule recovery for the following project milestones:
- Request to Enter Final Design
- FFGA Application, Review and Award Process
  - Open Farrington Section
  - Open East Kapolei Pearl Highlands
  - Open to Aloha Stadium
  - Open to Ala Moana Center

(5) Develop and submit a schedule mitigation plan for at least four (4) months of schedule recovery for the following project phases:
- Start-up and Testing (MSF)
- Start-up and Testing (Entire project alignment)

(6) Develop and submit a project contingency management procedure that identifies how and at what level the City senior management will control the contingency levels for the project.

10.0 SALT LAKE ALTERNATIVE VS. AIRPORT ALTERNATIVE COST ASSESSMENT

The following table provides a comparison of the cost estimates and PMOC assessment results for the Salt Lake Alternative and Airport Alternative.

Table 10-1. Comparison of Cost Assessment for Salt Lake and Airport Alternatives

Description	Salt Lake Alternative (YOE)	Airport Alternative (YOE)
City Cost Estimate	$5,258,434,182	$5,171,503,897
Contingency	($1,161,213,774)	($1,271,272,632)
Finance Charges	($484,070,860)	($230,873,271)
BCE	**$3,613,149,548**	**$3,669,357,994**
Line Item Adjustments	$193,579,830	$36,569,304
General Excise Tax Adjustment	$49,091,399	$0
Escalation Adjustment	$197,102,727	$132,460,030
Adjusted BCE	**$4,052,923,504**	**$3,838,387,328**
Recommended Contingency	$1,216,000,000	$1,219,000,000
Percentage of Adjusted BCE	30.0%	31.8%
PMOC Recommended Project Budget	**$5,752,994,364**	**$5,288,260,599**

The difference between the recommended budgets for the two alternatives was the result of the following factors:

- Line Item Adjustments – During the review of the Salt Lake Alternative, the PMOC identified Line Adjustments for Utility Relocation (SCC 40.02) and Professional Services (SCC 80). Since that initial review of the Project, the GEC has developed more detailed estimates for the Utility Relocations that have eliminated the need for an adjustment. Professional Services were estimated as a percentage of the costs under SCC 10 through 70. Once the other line item adjustments were eliminated, there was no longer a need to adjust SCC 80. Any adjustment to SCC 80 as a result of the adjustments identified for the Airport Alternative would be minimal.

- General Excise Tax Adjustment (GET) – During the review of the Salt Lake Alternative, the PMOC identified a need to include an adjustment for the GET, including an amount associated with real estate acquisition. However, since the initial review, the City has provided information clarifying that real estate acquisition was not subject to the GET. The GEC then provided the PMOC with a memorandum that detailed its inclusion of a GET component to the cost estimate. Finally, a substantial portion of the GET adjustment was the result of the Line Item Adjustments that had been previously identified. With the overall reduction in the Line Item Adjustments, there was no longer a need to include a GET Adjustment.

- Escalation – A detailed assessment of the escalation factors used by the GEC for development of the Airport Alternative cost estimate was completed by the PMOC. Recommended escalation factors are discussed in Section 5.0.

- Finance Costs – There has been a $253.2 million reduction in the Finance Costs. The PMOC recommends that the Financial Management Oversight Contractor review the Financial Plan and substantiate the current projected finance costs.

11.0 CONCLUSION

The PMOC recognizes that components of this Project are further advanced than for a typical project in the pre-PE Phase. The PMOC is of the opinion that the Project scope, schedule, and budget are sufficiently developed to allow the Project to advance into the PE phase. ***However, based on the cost risk and contingency analyses completed and presented within this Spot Report, the PMOC concludes that the Total Project Budget at the pre-PE Phase should be $5.288 billion (YOE). This total includes $1.219 billion (YOE) total contingency or 31.8% of the Adjusted BCE. The net increase of $116.76 million over the City's current budget is the primarily the result of line item adjustments to the Base Cost Estimate for vehicle quantity and escalation rates used to estimate Year of Expenditure costs.***

It is recognized that the estimate will undergo significant refinement once the project advances into the PE phase. Over the course of the Project, the Cost Risk Model indicates that it is possible for the Project to be implemented within the current budget with totally effective mitigation. Design development is the primary mitigation method and the preferred method to achieve project cost targets. Secondary mitigation is the amount of additional contingency that must be funded based on the expected risks.

The Schedule Risk Assessment indicates that there is an 85% probability of achieving ROD by August 13, 2019, which is a delay of approximately five (5) months from the City's plan. At this phase of the Project (per-PE), 85% probability is a reasonable basis for determination of the ROD. ***Therefore, based on the current MPS and the results of the schedule risk analysis and contingency analysis, the PMOC recommends a project completion date (ROD) no earlier than August 2019.***

APPENDICES

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*Participated in workshop via conference call

Appendix B: Documents Reviewed

Document	Date	Author
1992 Honolulu Rapid Transit Development Project System Procurement Contract & Methodology *[1992 Original Estimate]*	August 30, 1991	Kaiser Engineers / Lea+Elliott Engineers
Basis of Capital Cost Escalation Rates	September 17, 2008	Parsons Brinckerhoff (PB)
Basis of Current Airport DEIS Estimate	May 12, 2009	PB
Basis of Schedule.doc	September 20, 2008	City
Bus Fleet Management Plan (BFMP), Revision 0	April 4, 2008	City
Capital Cost Breakdown with GET 09-Jun-09.xls	June 9, 2009	PB
Constr Sched Assumption Notes.pdf	August 28, 2008	City
Construction Workshop Frequently Asked Questions (FAQ)	June 12, 2008	City
Construction Workshop Presentation	June 12, 2008	City
CPM Schedule (CITY.pdf)	September 20, 2008	City
Current Geotechnical Investigation Program boring logs and boring location map		PB
DEIS-FEIS Audit Trail	June 4, 2009	PB
DRAFT Contract Packaging Plan, Revision 2	February 5, 2009	City
DRAFT Design Criteria		PB
Chapter 1 – General	February 23, 2009	
Chapter 2 – Operations	February 3, 2009	
Chapter 3 – Environmental	February 23, 2009	
Chapter 4 – Track Alignment and Vehicle Clearances	January 2009	
Chapter 5 – Trackwork	December 15, 2008	
Chapter 6 – Civil	January 2009	
Chapter 7 – Traffic	January 2009	
Chapter 8 – Utilities	March 2009	
Chapter 9 – Structural	March 2009	
Chapter 10 – Architecture	October 20, 2008	
Chapter 11 – Landscape Architecture	September 18, 2008	
Chapter 12 – Revenue Vehicle	March 2009	
Chapter 13 – Traction Electrification	February 17, 2009	
Chapter 17 – Corrosion Control	December 15, 2008	
Chapter 19 – Facility Mechanical	January 2009	
Chapter 20 – Facilities Electrical	January 2009	
Chapter 22 – Elevators and Escalators		
Chapter 23 – Fire Life Safety	February 2, 2009	
Chapter 26 – Sustainability	March 2006	
Draft Environmental Impact Statement (DEIS) Honolulu High-Capacity Transit Corridor Project	October 30, 2008	City
DRAFT HHCTCP Cost Escalation Forecast Report FY 2009-2019	March 2009	PB
EIS_Appendix A Plan and Profile March 2009.pdf	March 2009	PB
Escalation Build-up.xls	June 10, 2009	PB
FEIS Conceptual Alignment Plan and Profile	March 2009	PB
Final Capital Costing Memorandum *[October 2006 Memo]*	October 23, 2006	PB
Final Evaluation of Project Delivery Options	November 2, 2006	PB
Financial Plan For Entry Into Preliminary Engineering Submittal	May 1, 2009	City
Fixed Guideway Fleet Sizing Report	June 2009	PB/L+E
General Conditions Of Construction Contracts	July 1999	City

Document	Date	Author
General Excise and Use Tax in Hawaii	February 16, 2006	Ray K, Kamikawa and Thomas Yamachika
Geotechnical and Geological Reconnaissance, Honolulu Rapid Transit System, Ewa and Honolulu, Hawaii	August 31, 2991	Geolabs-Hawaii
Geotechnical Engineering Exploration, North-South Road, Phase 1B, F.A.I. Project No. STP-8930(2), Ewa, Hawaii	February 8, 2007	Geolabs, Inc.
GET Forecast FY 2009-2023 Memo (Update)	March 27, 2009	PB
Guideway Superstructure Study – Summary Report	May 22, 2008	PB
HHCTC Project Basis of Capital Cost Escalation Rates	September 17, 2008	PB
HHCTC Project Letter on cost of Leeward Community College Underground station	September 19, 2008	PB
HHCTCP Post Alternative Analysis Estimate Methodology	August 26, 2008	PB
Quality Management Plan, Revision 1	May 8, 2009	City
Honolulu High-Capacity Transit Corridor Project, Steel Wheel Technology - Evaluation of Vehicle Types	June 12, 2008	PB
Honolulu Linear Schedule	June 2009	City
Honolulu Linear Schedule 01 jun 09.pdf	June 1, 2009	City
Honolulu Rapid Transit Development Project; System Design, Supply, Construction, and Operation & Maintenance; Geotechnical Engineering Exploration	March 1991	Geolabs-Hawaii
Honolulu Rapid Transit Program; Hotel Street Subway Design, Supply, and Construction; Geotechnical Basis for Proposal	July 1991	Dames & Moore
Honolulu Rapid Transit Program; Hotel Street Subway Design, Supply, and Construction; Geotechnical Engineering Exploration	July 1991	Dames & Moore
Honolulu Rapid Transit Program; Task 17.01– 40, Preliminary Geotechnical Exploration Report, King Street Subway Alignment Study	March 1992	Pacific Geotechnical Engineers, Inc.
MA5A.PRX		City
Master Program Schedule MA5E.pdf	May 10, 2009	City
Master Project Schedule Basis of Schedule	March 26, 2009	City
Model Assumptions, ProjectSolve\Technical\Alignment Information	September 11, 2008	PB
Modified AA Estimate (assembly & parametric summary), filename "Baseline 30 w T2.xls" *[2008 SCC Support Spreadsheet]*	August 19, 2008	PB
MU Airport Alignment 3-27-09.xls	March 27, 2009	PB
PB Cost Estimate and Estimating Methodology *[2006 Parametric Estimate]*	June 30, 2006	PB
Procurement Methods / Project Delivery / Schedule Presentation	September 9, 2008	
Project Management Plan, Revision 2	March 1, 2009	City
Project Orientation Presentation	September 9, 2008	
Proposed Construction Schedule, "HHCTP As of August 25.xer"	August 25, 2008	City
Rapid Transit Division Standard And Directive Drawings	April 3, 2009	PB
Real Estate Acquisition Management Plan, Revision 2	April 14, 2009	City
Revised Construction Schedule w Assumptions.pdf	August 28, 2008	City
RFP-DTS-0900015 – West Oahu/Farrington Highway Guideway Design-Build Contract and Addenda 1-6	February 4, 2009	City
RFP-DTS-198413 - Core Systems Design-Build-Operate-Maintain Contract and Addenda 1-5	April 9, 2009	City

Document	Date	Author
RFP-DTS-213102 – Maintenance and Storage Facility Design-Build Contract and Addenda 1	May 29, 2009	City
Safety and Security Management Plan (SSMP), Rev 0	March 11, 2008	City
SCC New Starts Estimate for Airport Alternative *[2009 SCC Estimate]*	June 9, 2009	PB
SCC New Starts Estimate for Salt Lake Alternative *[2008 SCC Estimate]*	September 3, 2008	PB
SCC vs Time 3-27-09 rev.xls	March 27, 2009	PB
Schedule Progress Submittal 7.pdf	September 2, 2008	City
Structures Workshop Summary Report	January 7-10, 2008	PB
Subsurface Geology of Waikiki, Moiliili and Kakaako With Engineering Application, Masters Thesis submitted to the University of Hawaii	August 1976	C.J. Ferral
Systems Workshop Presentation	August 22, 2008	City
Takeoff Audit Report/HHCT/Modified AA Estimate (assembly examples)	September 9, 2008	PB
Technical Memorandum on Utility Relocations *[2007 MK Utility Estimate]*	May 14, 2007	MK
Transportation Technical Report	August 1, 2008	PB
West Oahu/Farrington Highway Guideway Design-Build Contract Structural Plan and Profile Drawings	March 24, 2009	PB

Appendix C: SCC Worksheet

MAIN WORKSHEET-BUILD ALTERNATIVE (Rev.11, May 2, 2008)

City and County of Honolulu								Today's Date	6/9//2009
Honolulu Rail Transit Project, East Kapolei to Ala Moana Center via Airport								Yr of Base Year $	FY 2009
Application for P.E.								Yr of Revenue Ops	FY 2019

	Quantity		Base Year Dollars w/o Contingency (X000)	Base Year Dollars Allocated Contingency (X000)	Base Year Dollars TOTAL (X000)	Base Year Dollars Unit Cost (X000)	Base Year Dollars Percentage of Construction Cost	Base Year Dollars Percentage of Total Project Cost	YOE Dollars Total (X000)
10 GUIDEWAY & TRACK ELEMENTS (route miles)	**20.48**		1,126,982	281,746	**1,408,728**	**$ 68,773**	**49%**	**32%**	**1,651,635**
10.01 Guideway: At-grade exclusive right-of-way					0				0
10.02 Guideway: At-grade semi-exclusive (allows cross-traffic)					0				0
10.03 Guideway: At-grade in mixed traffic					0				0
10.04 Guideway: Aerial structure	20.14		988,466	247,116	1,235,582	$ 61,350			1,448,634
10.05 Guideway: Built-up fill					0				0
10.06 Guideway: Underground cut & cover					0				0
10.07 Guideway: Underground tunnel					0				0
10.08 Guideway: Retained cut or fill	0.34		5,527	1,382	6,909	$ 20,098			8,100
10.09 Track: Direct fixation			123,329	30,832	154,162				180,744
10.10 Track: Embedded					0				0
10.11 Track: Ballasted					0				0
10.12 Track: Special (switches, turnouts)			9,660	2,415	12,075				14,158
10.13 Track: Vibration and noise dampening					0				0
20 STATIONS, STOPS, TERMINALS, INTERMODAL (number)	**21**		244,504	61,126	**305,630**	**$ 14,554**	**11%**	**7%**	**383,399**
20.01 At-grade station, stop, shelter, mall, terminal, platform					0				0
20.02 Aerial station, stop, shelter, mall, terminal, platform	21		186,269	46,567	232,836	$ 11,087			292,082
20.03 Underground station, stop, shelter, mall, terminal, platform					0				0
20.04 Other stations, landings, terminals: Intermodal, ferry, trolley, etc.					0				0
20.05 Joint development					0				0
20.06 Automobile parking multi-story structure					0				0
20.07 Elevators, escalators			58,236	14,559	72,795				91,317
30 SUPPORT FACILITIES: YARDS, SHOPS, ADMIN. BLDGS			97,280	24,320	**121,600**	**$ 5,936**	**4%**	**3%**	**137,263**
30.01 Administration Building: Office, sales, storage, revenue counting			16,665	4,166	20,831				23,514
30.02 Light Maintenance Facility					0				0
30.03 Heavy Maintenance Facility			80,615	20,154	100,769				113,749
30.04 Storage or Maintenance of Way Building					0				0
30.05 Yard and Yard Track					0				0
40 SITEWORK & SPECIAL CONDITIONS			575,617	181,639	**757,256**	**$ 36,969**	**27%**	**17%**	**884,830**
40.01 Demolition, Clearing, Earthwork			25,630	8,970	34,600				40,429
40.02 Site Utilities, Utility Relocation			331,739	116,109	447,848				523,296
40.03 Haz. mat'l, contam'd soil removal/mitigation, ground water treatments			10,139	3,549	13,687				15,993
40.04 Environmental mitigation, e.g. wetlands, historic/archeologic, parks			9,835	3,442	13,278				15,514
40.05 Site structures including retaining walls, sound walls					0				0
40.06 Pedestrian / bike access and accommodation, landscaping					0				0
40.07 Automobile, bus, van accessways including roads, parking lots			198,275	49,569	247,843				289,597
40.08 Temporary Facilities and other indirect costs during construction					0				0
50 SYSTEMS			203,330	50,833	**254,163**	**$ 12,408**	**9%**	**6%**	**310,834**
50.01 Train control and signals			34,610	8,652	43,262				52,909
50.02 Traffic signals and crossing protection			24,225	6,056	30,281				37,033
50.03 Traction power supply: substations			41,990	10,497	52,487				64,191
50.04 Traction power distribution: catenary and third rail			68,478	17,119	85,597				104,683
50.05 Communications			20,811	5,203	26,013				31,813
50.06 Fare collection system and equipment			4,361	1,090	5,452				6,667
50.07 Central Control			8,856	2,214	11,070				13,538
Construction Subtotal (10-50)			2,247,714	599,663	**2,847,377**	**$ 139,007**	**100%**	**64%**	**3,367,962**
60 ROW, LAND, EXISTING IMPROVEMENTS			85,634	42,817	**128,452**	**$ 6,271**		**3%**	**118,044**
60.01 Purchase or lease of real estate			83,264	41,632	124,897				114,777
60.02 Relocation of existing households and businesses			2,370	1,185	3,555				3,267
70 VEHICLES (number)	**67**		243,236	58,377	**301,614**	**$ 4,502**		**7%**	**344,655**
70.01 Light Rail					0				0
70.02 Heavy Rail	67		216,582	51,980	268,563	$ 4,008			306,887
70.03 Commuter Rail					0				0
70.04 Bus					0				0
70.05 Other					0				0
70.06 Non-revenue vehicles			4,996	1,199	6,195				7,079
70.07 Spare parts			21,658	5,198	26,856				30,689
80 PROFESSIONAL SERVICES (applies to Cats. 10-50)			589,972	157,398	**747,370**	**$ 36,486**	**26%**	**17%**	**827,997**
80.01 Preliminary Engineering			17,752	4,736	22,488				24,914
80.02 Final Design			99,334	26,501	125,836				139,411
80.03 Project Management for Design and Construction			97,623	26,045	123,668				137,009
80.04 Construction Administration & Management			220,743	58,892	279,635				309,802
80.05 Professional Liability and other Non-Construction Insurance			33,111	8,834	41,945				46,470
80.06 Legal; Permits; Review Fees by other agencies, cities, etc.			33,111	8,834	41,945				46,470
80.07 Surveys, Testing, Investigation, Inspection			11,037	2,945	13,982				15,490
80.08 Start up			77,260	20,612	97,872				108,431
Subtotal (10 - 80)			3,166,557	858,255	**4,024,813**	**$ 196,488**		**90%**	**4,658,658**
90 UNALLOCATED CONTINGENCY					**241,489**			**5%**	**281,973**
Subtotal (10 - 90)					**4,266,302**	**$ 208,277**		**96%**	**4,940,631**
100 FINANCE CHARGES					**194,327**			**4%**	**230,873**
Total Project Cost (10 - 100)					**4,460,628**	**$ 217,764**		**100%**	**5,171,504**
Allocated Contingency as % of Base Yr Dollars w/o Contingency					27.10%				
Unallocated Contingency as % of Base Yr Dollars w/o Contingency					7.63%				
Total Contingency as % of Base Yr Dollars w/o Contingency					34.73%				
Unallocated Contingency as % of Subtotal (10 - 80)					6.00%				
YOE Construction Cost per Mile (X000)									$164,421
YOE Total Project Cost per Mile Not Including Vehicles (X000)									$235,643
YOE Total Project Cost per Mile (X000)									$252,469

Appendix D: Risk Register

Risk Number	Description	Risk Category
SCC 10	**Guideway and Track**	
10.04-1	The design is incomplete and significant requirements risks still exist.	Requirements
10.04-2	Coordination of the guideway/structures and vehicles cannot occur until selection of Core Systems contractor.	Requirements
10.04-3	The interface and coordination with the Hawaii Department of Transportation will be onerous and a MOU has yet to be executed. Also, the City must address all FHWA requirements.	Requirements
10.04-4	Geotechnical information is incomplete.	Requirements
10.04-5	ROW takes are not completely known, and the alignment can change.	Requirements
10.04-6	An operating plan has not been developed, which could affect the guideway configuration.	Requirements
10.04-7	The location of MSF is not certain, potentially affecting the line section contractors' costs.	Requirements
10.04-8	There are potential runway clearance issues with regard to the guideway near the airport.	Requirements
10.04-9	With regard to gantry approach for curves, the construction methods will ultimately be determined by contractors; however, estimators need to work with constructability professionals to account for techniques available and factor likely costs.	Design
10.04-10	Aerial structures design development cannot be refined until additional geotechnical data are available; supplemental boring program with approximately 750-foot spacing will aid analysis. Pilot holes may also be required where complex strata or utilities are unclear.	Design
10.04-11	ROW alignments and track geometry not fully defined or captured in current estimate. Also, final consideration cannot be determined until the revenue vehicle and actual decisions on ROW can be determined.	Design
10.04-12	Construction inefficiencies adjacent to waterways must be addressed. A technical paper should be prepared relative to constructability, permitting and maintenance of navigation rights.	Construction
10.04-13	Construction inefficiencies and liabilities over live traffic must be addressed. A technical paper should be prepared and included in contract documents addressing MOT; however, it may be necessary in some locations for the City to prescribe MOT to effect satisfactory community and/or business response and not have disruptions of work.	Construction
10.04-14	Construction access (material handling and installation) inefficiencies must be addressed. A technical paper should be prepared relative to constructability, permitting, safety for the traveling public (vehicular and pedestrian) and MOT.	Construction
10.04-15	It is anticipated that the plinth pads and rail will be constructed by line section prime contractor. The qualification of the contractor (likely a subcontractor) should be combined with robust quality inspections and testing rather than prescribed means and methods to ensure proper control of track geometry.	Construction
10.04-16	Precast yard locations must be identified, which is a contractor responsibility.	Construction
10.04-17	Laydown areas have not been identified. The City should identify locations where it currently owns the land, leaving final decisions with the contractor. Availability of public lands should be included in the contract documents.	Construction
10.08-1	The design is incomplete and significant requirements risks still exist.	Requirements
10.09-1	With regard to the vehicle and consist maximum weight and dynamic load considerations, the car is assumed to be Heavy Rail, though some specifics and its capacity (and train length) are yet to be defined.	Requirements
10.12-1	The design and operating plan not sufficiently developed to establish track configuration; additional design must be performed to identify specifics.	Requirements

Risk Number	Description	Risk Category
10.12-2	Procurement of special track will be by MSF contractor and installation will be by line segment contractor. Estimating must carefully and comprehensively incorporate material handling, security and quality.	Construction
SCC 20	**Stations, Stops**	
20.02-1	Stations have large lump sum allowances in the assembly cost developed.	Requirements
20.02-2	Costs for the at-grade (Leeward Community College) have been included in the aerial station SCC and is priced as an aerial station in the estimate.	Requirements
20.02-3	Parking Structure costs are not included in SCC 20.06 as is customarily done.	Requirements
20.02-4	Security Measures are not clearly identified.	Requirements
20.02-5	Drawings reflect integration between station supports and segmental guideway, but guideway and stations are to be constructed under two separate contracts – Guideway Superstructure Study – Summary Report; p. 16; Fig. 11 and 13.	Design
20.02-6	A large lump sum amount is shown for station canopy with no detail to support cost. A breakdown of the cost estimate must be developed.	Design
20.02-7	Security Measures are not clearly defined. The cost estimate does not reflect the progression of this element.	Design
20.02-8	Laydown areas have not been identified. The City should identify locations where it currently owns the land, leaving final decisions with the contractor. The availability of public lands should be included in the contract documents.	Construction
20.07-1	Scope, requirements and quantity are not fully defined.	Requirements
20.07-2	PMOC cannot identify vertical circulation requirements on station-by-station basis. Required details must be developed.	Requirements
SCC 30	**Support Facilities**	
30.01-1	Scope is not defined. Functional definition and requirements must be developed.	Requirements
30.03-1	Vehicle Basis of Design and functional sizing have not been fully developed, which could affect the MSF configuration.	Requirements
30.03-2	Two locations for the MSF are being considered. Schedule impacts are possible if the Navy Drum Site acquisition is delayed.	Requirements
30.03-3	The scope of earthwork for the Navy Drum Site is unknown.	Requirements
30.05-1	No cost was contained within this SCC as it was included in SCC 30.04. However, there is an impact on the rail alignment along Navy Drum location if property is not acquired. Additional analysis and design are needed.	Design
SCC 40	**Sitework**	
40.01-1	The scope is not fully defined. The estimate is based on route foot cost (parametric).	Requirements
40.01-2	Landscaping is a Lump Sum item with minimum definition of scope. Pricing is based upon derived cost from the *1992 Original Estimate* and is not properly separated into SCC 40.06 as is customarily done.	Requirements
40.02-1	Utility Agreements are not in place with private or public owners, including the military.	Requirements
40.02-2	Schedule of relocations has not been fully developed.	Requirements
40.03-1	Hazardous Materials is a Lump Sum item, with minimum definition of scope.	Requirements
40.04-1	Environmental Mitigations are a Lump Sum item, with minimum definition of scope.	Requirements
40.07-1	Pedestrian/Bike Accessways are a Lump Sum item, with minimum definition of scope.	Requirements
SCC 50	**Systems**	
50.01-1	Scope is not fully defined.	Requirements

Risk Number	Description	Risk Category
50.01-2	Specific vehicle technology has not been defined.	Requirements
50.01-3	Operations Plan has not been developed.	Requirements
50.01-4	The responsible entity for state safety oversight in Hawaii has not been determined.	Requirements
50.01-5	Likely mobilization/de-mobilization will be required between initial DB segment and subsequent segments will add costs to Project.	Construction
50.02-1	Scope is not fully defined.	Requirements
50.02-2	Significant adjustments to and relocations of existing traffic signals will be required.	Requirements
50.03-1	Scope is not fully defined.	Requirements
50.03-2	ROW takes are not defined for substation pads. The cost estimate does address substation as currently scoped. Relocations or reductions in numbers may occur.	Requirements
50.04-1	Scope is not fully defined.	Requirements
50.05-1	Scope is not fully defined.	Requirements
50.06-1	Scope is not fully defined.	Requirements
50.06-2	Fare collection technology has not been selected.	Requirements
50.07-1	Scope is not defined.	Requirements
SCC 60	**Right-of-Way**	
60.01-1	Basis of Estimate is not clearly defined.	Requirements
60.01-2	Potential negative court judgments can occur.	Requirements
60.01-3	ROW schedule has not been developed for 189 property acquisitions that have been identified to date.	Requirements
60.01-4	Resource technical capacity of the ROW Department to maintain schedule is a concern. Other than having authority and relative experience, staffing requirements and accountability with project requirements are unclear.	Requirements
60.01-5	ROW acquisitions may require "economic remainder" judgments or full takes.	Requirements
60.01-6	Temporary and permanent easements scope is unknown.	Requirements
60.01-7	Schedule of property acquisitions is necessary to assess potential impacts to construction and design.	Requirements
60.01-8	Coordination with HDOT will be necessary, which will require an MOU.	Requirements
60.02-1	Schedule for property acquisition is necessary for assessment of potential impacts to construction and design.	Requirements
60.02-2	Resource technical capacity of the ROW Department to maintain schedule is a concern.	Requirements
SCC 70	**Vehicles**	
70.02-1	Technical specifications for rail vehicles have not been fully defined.	Requirements
70.06-1	No basis is shown for needs or type of equipment	Requirements
70.07-1	No basis is shown yet for needs, type or method of procurement.	Requirements
SCC 80	**Professional Services**	
80.01-1	Professional service costs are not based on staffing plans or detailed estimates.	Requirements
80.01-2	There are limited or no performance metrics relative to all participants for control of budget and adherence to schedule.	Requirements
80.01-3	There is no scope definition or identification of permits required or third party approvals.	Requirements
80.02-1	No Basis of Estimate is developed. Costs are based on a percentage of construction value.	Requirements
80.02-2	Final Design cost growth is likely until PE scope, schedule and budget are more developed.	Requirements
80.03-1	No Basis of Estimate is developed. Costs are based on a percentage of construction value.	Requirements

Risk Number	Description	Risk Category
80.03-2	No staffing plan is shown for City or consultants.	Requirements
80.03-3	Identification of performance metrics relative to all participants should be developed to ensure control of budget and adherence to schedule.	Requirements
80.04-1	No Basis of Estimate is developed. Costs are based on a percentage of construction value.	Requirements
80.05-1	Insurance methodology is not yet defined.	Requirements
80.05-2	No Basis of Estimate is developed. Costs are based on a percentage of construction value.	Requirements
80.06-1	No Basis of Estimate is developed. Costs are based on a percentage of construction value.	Requirements
80.06-2	No scope definition or identification of permits required, third party approvals, etc. is provided.	Requirements
80.06-3	Un-anticipated litigation may add cost to the Project (e.g., protests from adversary groups, community groups, adjacent landowners, and other affected parties).	Requirements
80.07-1	No Basis of Estimate is developed. Costs are based on a percentage of construction value.	Requirements
80.08-1	No Basis of Estimate is developed. Costs are based on a percentage of construction value.	Requirements
General		
G-1	There are several MOUs that will be developed for the Project. The PMOC is unclear what force they will have and who will be the ultimate arbiter in event of disagreements.	Requirements
G-2	Design is more advanced than cost estimate – Current (Q2/2009) estimate may not capture all design elements (scope is not traceable to estimate).	Requirements
G-3	Soft costs are only calculated as a percentage of construction value with no basis or staffing plans.	Requirements
G-4	The project documentation with respect to project control lacks real metrics to monitor performance in cost or time, except by broad, end-product oriented deliverables and due dates.	Requirements
G-5	Coordination/Approvals of both design concepts and construction staging by HDOT and the City must be full addressed.	Requirements
G-6	The designer is developing the estimates with no independent oversight and without having experienced estimating staff within the City staff reviewing and assessing the consultant's work.	Requirements
G-7	No identifiable configuration management/change control mechanism is in place, though it is adequately addressed in the PMP.	Requirements
G-8	Contract packaging must be refined.	Requirements
G-9	Schedule for contracting DBB work is very tight due to workload, insufficient time to recover from poor bids, etc.	Design
G-10	Steel, concrete, rail, aggregate, fuel and all construction materials may increase in price due to volatile and unpredictable market conditions.	Market
G-11	The availability of skilled and unskilled labor will require more detailed analysis of the local labor market as it relates to the overall construction being planned in Oahu and the remainder of the State.	Market
G-12	General Conditions have not yet been fully developed.	Market
G-13	Change Orders during construction (varies from 3% ~ 12%) can be accommodated in robust risk-informed estimating.	Construction

Note: The descriptions corresponding to the Risk Number sub-categories listed above are presented in Appendix C.