U.S. Department
Of Transportation
**Federal Transit
Administration**

Headquarters

1200 New Jersey Avenue S.E.
Washington DC 20590

FEB 13 2012

Cliff Slater
3105 Pacific Hts. Road
Honolulu, HI 96813

Our File No. FY12-0127

Dear Mr. Slater:

This letter is in response to your e-mail of February 7, 2012, requesting information under the Freedom of Information Act (FOIA). Specifically, you requested copies of "the Risk and Contingency Management Plan for the Honolulu Rail project."

A search of the FTA files has disclosed a document responsive to your request which is enclosed. The duplication fee is negligible and is waived pursuant to the FOIA and the Department of Transportation regulations, 49 C.F.R. § 7.44 (c). I hope this information meets your needs.

Sincerely,

Tommy Carter
Director, Office of Management
Planning

Enclosure

PMOC REPORT

OP 32A – Project Transit Capacity Review
OP 32C – Project Scope Review
OP 32D – Project Delivery Method Review
OP 33 – Capital Cost Estimate Review
OP 34 – Project Schedule Review
OP 40 – Risk and Contingency Review

Honolulu High-Capacity Transit Corridor Project
City and County of Honolulu
Honolulu, HI

October 2011 (FINAL)

PMOC Contract Number: DTFT60-09-D-00012
Task Order Number 4: Programmatic
Work Order Number 7: Honolulu
Project No. DC-27-5181
OPs Referenced: OP 1, OP 32A, 32C, OP 32D, OP 33, OP 34

Jacobs Engineering Group, Inc., 501 North Broadway, St. Louis, MO 63102
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Length of Time Assigned: Five Years (November 18, 2009 through November 17, 2014)

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1.0 EXECUTIVE SUMMARY

1.1 Introduction

The City and County of Honolulu ("grantee") is requesting to enter into Final Design 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 Ala Moana Center. The Project would provide faster, more reliable public transportation services than those currently operating in mixed-flow traffic.

FTA assigned Jacobs as a Project Management Oversight Contractor (PMOC) on September 24, 2009, for the purpose of monitoring the Project and providing FTA with "information and well-grounded professional opinions regarding the reliability of the project scope, cost, and schedule" of the Project. That effort continues with this report, which represents the PMOC's assessment of the Project's Transit Capacity, Scope, Delivery Method, Cost Estimate, Schedule, and Risk and Contingency.

1.2 Project Description

The Project is an approximately-20-mile-long elevated fixed guideway rail system along Oahu's south shore between East Kapolei and Ala Moana Center. The alignment is elevated, except for a 0.6-mile at-grade portion at the Leeward Community College station. The proposed investment includes 21 stations (20 aerial and 1 at-grade), 80 "light metro" rail transit vehicles, administrative/operations facilities, surface and structural parking, and maintenance facilities. The grantee plans to deliver the Project in four guideway segments:

- Segment I (West Oahu/Farrington Highway) – East Kapolei to Pearl Highlands (6 miles/7 stations)
- Segment II (Kamehameha Highway) – Pearl Highlands to Aloha Stadium (4 miles/2 stations)
- Segment III (Airport) – Aloha Stadium to Middle Street (5 miles/4 stations)
- Segment IV (City Center) – Middle Street to Ala Moana Center (4 miles/8 stations)

Additional Project information:

- **Additional Facilities:** Maintenance and Storage Facility (MSF) and parking facilities
- **Vehicles:** 80 vehicles, supplied by the Core Systems Contractor (CSC), which is also responsible for systems design and construction and operations. The CSC is a Design-Build-Operate-Maintain (DBOM) contract.
- **Ridership Forecast:** Weekday boardings – 97,500 (2019); 116,300 (2030).
- **Base Cost Estimate (BCE):** \$5.213 Billion in Year-of-Expenditure (YOE) dollars, including \$865.58 million in allocated and unallocated contingency and \$230 million financing costs.
- **Target Revenue Service Date (RSD):** March 2019

1.3 Jacobs Scope of Work

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

- OP 32A: Project Transit Capacity Review
- OP 32C: Project Scope Review
- OP 32D: Project Delivery Method Review
- OP 33: Capital Cost Estimate Review
- OP 34: Project Schedule Review
- OP 40: Risk and Contingency Review

This report presents each of these deliverables in an individual section and summarizes them here.

1.3.1 OP 32A: Project Transit Capacity Review

Methodology

The PMOC followed the requirements outlined in the *FTA OP 32A – Project Transit Capacity Review,* dated May 2010, to assess and evaluate operational capacity of the 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 grantee. The effective date for the completion of this analysis by the PMOC is June 2011.

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 (i.e., passengers per hour) without unreasonable delay, hazard, restriction or uncertainty. 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).

Summary of Findings

(1) Car Capacity

The hourly passenger capacities specified by the grantee were calculated in a manner that eliminated virtually all capacity for peak of the peak surges in ridership. The proposal from the selected CSC bidder, Ansaldo Honolulu Joint Venture (AHJV) offers service with an annually increasing frequency in response to annually increasing peak demand is very attractive until it is realized that the proposed frequency is not supported by the proposed train control system. Close inspection of the pattern of boardings and alighting raises concerns over the small number of seats and the likelihood of most rush hour customers having to endure long rides while standing.

(2) Running Times

Estimates of station-to-station running times vary between the AHJV's O&M proposal, vehicle performance simulations, and train control simulations. It is understood why the various estimates would not agree but it is not clear why the most conservative estimates from the train control simulation are not used in the O&M proposal.

(3) Dwell Times

The grantee's approach to forecasting station dwell time has changed several times since the last formal capacity review. Each change has added dwell time to the overall travel time. The cumulative effect of the changes has (in the aggregate) virtually eliminated earlier discrepancies between PMOC estimates based on TCRP 100 standards and the dwell times proposed by the grantee or its operator, AHJV. While it is not clear whether the grantee's method is justified, it does yield credible estimates of aggregate dwell time.

(4) Round Trip Time and Terminal Turnback Time

The grantee's specifications indicate that the round trip time necessary for a train to complete one circuit around its route should not exceed 90 minutes. AHJV's Technical Proposal calls for a round trip time of 89:33 or 89:51. However, the time necessary to turn the train between revenue trips is not explicitly discussed by AHJV in its O&M proposal.

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[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.

AHJV's Train Control Simulation Report more explicitly considers how turnbacks at East Kapolei and Ala Moana will be accomplished. It determines and illustrates that, at headways of less than 240 seconds (four minutes), the following train behind any train turning at either terminal presents a conflict for its turning leader until the second train arrives at the terminal (i.e., the first train either must make a very quick turn or else it can't leave for its return trip until its follower clears the terminal interlocking). Operationally, this circumstance sets the minimum turn time at terminal stations to a value roughly equivalent to the prevailing service headway. This margin of time is much greater than had been considered in the O&M proposal and its resulting fleet size estimates.

The timing and sequencing of turnbacks at stations must be explicitly considered in determining the number of consists required to provide service. None of the simulations documented in the AHJV simulation report integrate line operations with terminal turnbacks. Consequently, the PMOC can only speculate how terminal turnbacks will affect peak round trip times delivered on the network. It is possible that, when terminal time is fully considered in operations planning, one additional peak consist beyond AHJV estimates may be required in each year of full operation.

(5) Maximum Line and Person Capacity
The Minimum Operating Headway of 154 or 155 seconds represents the most frequent service that could be reliably offered within the grantee's 45 minute end-to-end travel time goals. A four-car train is the longest consist that can be accommodated by the HHCTC station design. Using a Comfort Load capacity of 32 seated and 127 standing passengers and the grantee-specified Peak Hour Factor of 0.9, the maximum person capacity of the HHCTC is 13,381. This provides for 50% growth over the design-year peak flow of 8,982 passengers.

(6) Staffing Capacity
The staffing review found areas of concern with respect to fare enforcement, infrastructure maintenance staffing, safety management, and revenue processing. It also suggests that further benchmarking of operations relative to the small field of established driverless metros operating in locations such as Denmark, Canada, France, Malaysia, and Singapore may be warranted.

Recommendations
PMOC recommends that the grantee and AHJV confer regarding plans to operate at frequencies that violate the minimum operating headway. A likely possible response will be to offer service with longer trains operating at four-minute headways. The change in overall fleet size necessary to operate with three-car trains at slightly longer headways should be negligible. The fleet would also include a number of presumably less expensive middle cars and the level of comfort (seats/passenger) afforded passengers that are not riding in the peak of the peak would be increased. Operating at four-minute peak headways would also provide more capacity for surges in demand during the first several years of the contract. Changes in the proposed consist size

may, however, require modification to the vehicle order if some middle cars would have to be substituted for an equivalent number of end cars in the final contract.

Due to long operating runs at capacity, PMOC recommends that the grantee consider having the CSC alter its proposal to add more seats in each car, to improve passenger comfort and the quality of the transit experience.

For capacity planning purposes, PMOC recommends that the grantee and AHJV prepare a simulation report showing how peak operations with dwells and turnbacks will be delivered in the last year of the proposed O&M contract (2028) or the design year (2030).

1.3.2 OP 32C: Project Scope Review

Methodology

The PMOC followed the requirements outlined in the *FTA OP 32C – Project Scope Review,* dated May 2010, to assess and evaluate the scope of the project.

Summary of Findings

The Final Environmental Impact Statement (FEIS) was published on June 25, 2010, and a Record of Decision (ROD) was issued on January 18, 2011. The scope as contained in the project's FEIS and ROD is reflected in the Preliminary Engineering (PE) plans, specifications, estimates, and the Project Management Plan (PMP).

The current design meets the capacity and operational objectives established in the FEIS, although details are subject to modification upon award of the CSC. The only item that changed since the ROD was issued is the total number of vehicles. At the time of the ROD, it was expected that the number of vehicles would be 76, but the BAFO by the selected CSC includes 80 vehicles. That is not change in project scope, however, as the CSC bidders were allowed flexibility in order to meet the ridership projections defined in the CSC Request for Proposals (RFP) document and amendments. Thus, the number of vehicles may change from 76 to 80 and the minimum headway may change from 3 minutes to around 2-1/2 minutes, but the capacity and operational objectives are still met.

Attachment A to ROD, dated January 2011, listed 197 mitigations to which the Project is committed. These mitigations deal with subjects such as real estate acquisitions, easements, relocations, landscaping, design details, protection of historic and environmental sensitive resources, noise abatement, lighting, safety, security, public health, and the treatment of Hawaiian iwi. The grantee is committed to implementing all mitigation measures specified by the ROD and all terms of the Project's Programmatic Agreement (PA), also instituted in January 2011. The grantee is in the process of hiring a Kako'o Consultant to ensure compliance with the PA.

While the actual implementation of many of the detailed mitigations will not occur until Final Design and construction, the grantee has included requirements for their design in RFPs already issued. Thus, the grantee has contractual assurances that the ROD's requirements will be met.

The grantee and its consultants and contractors are actively working to acquire other necessary permits and approvals from federal, local, and state agencies.

In order to minimize the risk normally related to differing site conditions, the grantee's engineers have conducted adequate site reconnaissance, performed sufficient subsurface investigation and field and laboratory testing, and prepared geotechnical data and baseline reports. Buried structures and utilities have been identified to the extent known. The location of potential contaminated soils has been identified in general.

Much of the work for subsurface investigation will take place during Final Design, although a comprehensive geotechnical investigation is taking place now on the West Oahu/Farrington Highway (WOFH) Design-Build (DB) Contract. For sitework, the PE drawings and reports show a sufficient amount of project definition and justify moving into Final Design.

The PE drawings, specifications and other documentation exceed the "schematic" threshold stated as a minimum requirement. The project is well-defined for a PE-level design. Section 4.0 of this report describes the status of the project documentation and how it defines the scope of the project at the PE level.

Recommendations

The PMOC recommends the following actions be taken during Final Design:

(1) Once the CSC is on board, the grantee must work with that contractor to resolve capacity issues (see OP 32A) and implement project controls to coordinate CSC work with that of other contractors.

(2) The grantee needs to expand its review and project management staff as planned in order to maintain control of the various concurrent projects.

(3) The grantee must manage the schedule and budget by implementing controls as described in its project management plans early in Final Design. This is particularly true for those DB projects already let, as Final Design overlaps with early construction.

(4) The grantee should resolve its Ala Moana Station design, whether by incorporating suggestions made by the Stations Value Engineering (VE) team or by other means, perhaps with the operational assistance of the CSC.

(5) The grantee should incorporate the accepted VE proposals for the stations and Airport and City Center Guideway Segments at its earliest opportunity (during Advanced PE or early in Final Design).

(6) The grantee should complete any unfinished effort to acquire agreements with all affected agencies and begin the process of cooperation that those agreements entail. While most of these agencies have shown a willingness to cooperate with the grantee, nothing can be guaranteed about the success of these relationships until agreements are in place. The Final Design Roadmap includes a list of agreements that is being tracked by the PMOC and the grantee on a monthly basis.

(7) The grantee should continue the process of updating the Project budget and schedule, incorporating information from contracts-in-progress and from completed tasks.

(8) The grantee should ensure that proper action is taken to resolve the issue of the location of the precast yard. Such action is necessary to assure that the Project's critical path is not impacted and to determine what environmental documentation, if any, may be required by the FTA.

(9) The grantee should continue to be proactive in assuring that all of its contractors meet the requirements of Buy America and Ship America.

1.3.3 OP 32D: Project Delivery Method Review

Methodology

The PMOC followed the requirements outlined in the *FTA OP 32D Project Delivery Method Review,* dated May 2011, to assess and evaluate the grantee's technical approach for delivering the proposed Project within the constraints of its existing or proposed statutory or organizational procurement authority and in the context of its 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 PMP minimize project risks and provide the greatest likelihood of implementation success. Specifically, the OP 32D review provides an overview of the contracting methodology to be employed during the design, construction, and procurement phases of the project.

Summary of Findings

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

(1) The PMOC is concerned with the number of concurrent contracts that will be underway during the Project. The PMOC recognizes that this risk can be mitigated with proper coordination of contracts. However, the grantee must continue to demonstrate that it has assembled a cohesive team during the early contracts and continues to expand the staff as required to meet the contract management demands as described in its PMP. PMOC will continue to monitor staffing as part of its monthly reviews.

(2) The grantee must not presume that the unit costs associated with work for the DB segments early in the project will equate to the unit costs for the DBB segments later on. Further, given that the spread of bidding for the DB and DBB segments will occur over a period of several years, the grantee must ensure that it has adequate contingency to account for construction market changes relative to labor, material, and equipment. The ongoing risk mitigation process, if properly executed by the grantee, will assure that contingencies are adequate to cover market changes.

(3) The PMOC shares the grantee's concern that the availability of major materials (fuel, cement, steel, copper, lumber, etc.) will be an issue for the Project and expects the bids to reflect such uncertainty. The concern is two-fold: First, there is uncertainty in the global construction market that is affecting 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. Secondly, the limitation of

available materials for an island market may influence cost and schedule. There is a significant cost and time component associated with shipping materials to Hawaii.

(4) The PMOC shares the grantee's concern regarding the availability of construction equipment 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.

(5) It is a real possibility that prospective later-segment DBB contractors will perceive the DB contractor to have a significant competitive advantage during the bidding for the Airport and City Center segments, since the DB contractor will have already made an investment in the necessary equipment. Such an assessment by prospective DBB bidders could result in a decision not to submit bids for the later DBB contracts, thereby adversely influencing the competitive bid environment.

Despite certain questions and risks, the PMOC concludes that the Project as planned and designed is constructible under the grantee's current contract packaging plan. As stated, the PMOC is concerned that prices for the yet-to-be-let DBB contracts may not come in at the same favorable prices as experienced in the earlier DB contracts. Additionally, the already-bid DB contracts could end up spending a higher percentage of contingency than hoped for due to delays in acquiring project approvals. The success of the Project will depend on the performance of the CSC. These issues were included in the development of a Risk Matrix and addressed at a Risk Workshop held in April 2011. The grantee will be expected to set contingencies and establish risk mitigation in response to that risk management exercise.

The PMOC concludes that the Project is ready to enter the Final Design Phase with regard to the Project Delivery Method (OP 32D) assessment.

Recommendations

Many of the issues identified within the OP 32D report would typically be addressed during the Final Design Phase. The PMOC recommends that the grantee utilize the Risk Register as the basis for action items. These action items should be prioritized and addressed early in Final Design. The PMOC believes this approach will protect the Federal interests, should Final Design Phase funding be approved, and enable the grantee to embark on Final Design efforts with a far more definitive scope of work and overall budget and schedule.

1.3.4 OP 33: Capital Cost Estimate Review

Methodology

The PMOC followed the requirements outlined in the *FTA OP 33 – Capital Cost Estimate Review,* dated May 2010, to assess and evaluate the grantee's cost estimate. Specifically, the review addresses:

- Soundness of the grantee's cost estimating methods and processes compared with proven professional quantity surveying and cost estimating practices for projects of this scale
- Congruence of the project cost estimate with the project scope and schedule

- Reliability of the estimate for procurements, contract bids, and contract closeout

Summary of Findings

The PMOC evaluated the cost estimates for each Standard Cost Category (SCC) for mechanical soundness and consistency. These mechanical checks are used to determine if there are any material inaccuracies within the estimate. The *2011 SCC Estimate* was found to be mechanically correct in the tabulation of the unit cost, application of factors, and translation to the SCC workbook. The PMOC randomly sampled cost estimate line items to determine if the cost estimate backup cross-walked into the SCC workbook. In each instance, the PMOC found the calculated values translated to the SCC workbook and back to the cost estimate backup without variance or mechanical issues.

The estimate is reflective of the sequencing identified in the Master Project Schedule (MPS). The schedule was used to calculate escalation at reasonable rates and for the durations contained in the MPS activity codes. The bids contain Year of Expenditure (YOE) escalation, so the grantee was able to develop base year and YOE costs mathematically for the 2011 SCC Estimate from a combination of bids and estimate values.

The PMOC did not find any significant discrepancies between the MPS and cost estimate line items within SCC or contract package Work Breakdown Structure (WBS) sorts. Furthermore, no significant issues were identified for missing scope or erroneous schedule durations.

PMOC has identified 22 suggested adjustments to the cost estimate, totaling $101 million.

Recommendations

The PMOC recommends the following actions be taken before Final Design:

(1) The grantee should incorporate the adjustments identified during the PMOC Risk Assessment Workshop 2, which total $101 million (additive) prior to Final Design.

(2) The grantee must submit the complete SCC Workbook in the format required by the FTA as a condition to enter Final Design.

The PMOC recommends the following actions be taken during Final Design:

(3) The grantee should update the Right-of-Way portion of the 2011 SCC Estimate and Basis of Estimate, as it is not current with the drawings or planned methodology to acquire the Real Estate for the Project. The cost estimate can be revised during the Final Design phase to account for more detail and definitive real estate pricing. The PMOC has determined that the cost estimate contingency amounts sufficiently cover similar items that lack definitive information at this phase of the Project.

(4) The grantee should address any cost-related issues regarding slippage of Notice to Proceed (NTP) dates for the selected or awarded DB contracts. The cost estimate can be revised during the Final Design phase to account for more detail and definitive information related to future contract award and NTP. The PMOC has determined that the cost estimate contingency amounts sufficiently cover similar items that lack definitive information at this phase of the Project.

(5) The grantee should segregate the costs for Maintenance of Traffic (MOT) and Temporary Facilities for the "not awarded" contracts into SCC 40.08, similar to the segregation that occurred for this work scope in the "awarded" contracts within the SCC Summary Sheet. This can be completed when updating the cost estimate during Final Design.

(6) The grantee should improve its implementation of internal quality control and review of General Engineering Consultant (GEC) developed deliverables (cost estimates) prior to issuance to the FTA/PMOC. The PMOC noted similar issues with the schedule and related project control deliverables as they lacked consistency with naming conventions, transmittals, incomplete information and non-conformance to its procedures

(7) The grantee should revise its staffing plan when major revisions are made to the Project scope, MPS or Cost Estimate in order to synchronize the adjustments with resource allocation planning. Major revisions include significant delay to contract letting or execution, contract package revisions, changes to contract delivery methods, etc., or the addition of professional service contracts, etc.

1.3.5 OP 34: Project Schedule Review

Methodology

The PMOC followed the requirements outlined in the *FTA OP 34 Project Schedule Review,* dated May 2010, to assess and evaluate the grantee'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 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 Final Design phase. The review of the Project schedule addresses seven subcategories:

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

Summary of Findings

It is the PMOC's professional opinion that the Master Project Schedule (MPS) is mechanically sound and meets the minimal technical requirements of fundamental soundness. This determination is based on the OP 34 guidelines and requirements.

The PMOC has identified a significant number of recommendations and opportunities to strengthen the integrity of the grantee's Project Controls organization, procedures, plans, technical schedule input, and technical capacity and capability. The PMOC expects the grantee to holistically and conclusively incorporate these recommendations during the Final Design phase and prior to submission of refreshed cost estimate and schedule documents in support of a Full Funding Grant Agreement (FFGA) Application.

Recommendations

The PMOC recommends the following actions be taken during Final Design:

Structure, Quality & Detail

(1) The PMOC recommends that the grantee combine all of the various schedule types into one all-encompassing schedule file to make it a true MPS. The PMOC does, however, recommend keeping the construction contractor schedules separate and integrating only summary level information from these schedules into the MPS. The Scheduling Procedures and PMP require revision to address any Schedule Breakdown Structure (SBS) changes.

(2) The grantee's Organizational Breakdown Structure (OBS), specific to the Project Controls department, needs to align with the positions, schedule types, SBS, and references made in all PMP and related project control procedures and contractual requirements.

(3) More detail is needed in the MPS to address construction activity, utility work, real estate acquisition, long-lead material and equipment procurement, and milestone integration among the construction contracts.

(4) The grantee needs to institute a formal schedule file naming convention for the MPS and for all the other Feeder Schedules including the Contract Project Schedules (CPS).

(5) The grantee should identify a means to utilize its document management system to formally transmit its Schedule Submittal Packages to the FTA and PMOC.

Mechanically Correctness

(6) Incorporate the Permit Schedule, Procurement Schedule and Utility Schedule into the MPS as addressed in the grantee's Project Scheduling Procedure.

(7) The grantee should further reduce the amount number of activity logic ties that contain an excessive amount of lag due to Start-Start (SS), Start-Finish (SF), and Finish-Finish (FF) relationship types. Most of this can be accomplished with the addition of more activity detail using Finish-Start (FS) relationship ties greatly improving the logic.

(8) Expand proposed construction activity detail to a level which that better connects the multiple contract and key interface logic points.

Phasing and Sequencing, Critical Path, Material Tasks and efficient work sequence

(9) Additional activity detail is necessary to more accurately represent document preparation, risk assessment, financial capacity plan preparation and review, entry into Final Design, and FFGA application activities.

(10) More material tasks detail should be incorporated into the MPS.

Cost/Resource Loading

(11) Ensure that resource and cost loading requirements are included in all construction contractor contractual requirements.

Schedule control, methods, tools and organization.

(12) The grantee should develop a Responsibility Assignment Matrix (RAM) and include it in the PMP and relevant companion documents.

(13) The key project control positions should be consistently referred to in the PMP and companion documents and project control procedures.

(14) The grantee project controls department should be co-located with all GEC project control management support staff (not including the GEC Resident Engineer team field staff, once construction begins).

(15) The grantee should implement all schedule management procedures and guidelines as documented in the PMP and its respective project control companion documents.

(16) The grantee should define a standardized reporting format and distribution for all Project Scheduling parties.

(17) The grantee should standardize all scheduling software settings and incorporate the requirements in all construction contractual documents.

Schedule Sequencing, similar activities, labor and materials, sequencing of ROW activities, temporary construction and site logistics

(18) The MPS needs more activity detail for all construction contract activities, as the MPS typically includes only one activity for each construction contract. More construction activity detail is required to better enable integrated connection points among the various design and construction contracts.

(19) The MPS needs activities representing the logistics of site access and management and general planning and use of staging yards, including pre-cast concrete yards.

(20) Provide more justification for the construction activity durations for station, elevator and escalators, utilities, and core system contract elements.

1.3.6 OP 40: Risk and Contingency Review

Methodology

The PMOC followed the requirements outlined in the *FTA OP 40 Risk and Contingency Review,* dated May, 2010, to complete a risk analysis of the Project. This review requires an evaluation of the reliability of the grantee's project scope, cost estimate, and schedule, with special focus on the elements of uncertainty associated with the effectiveness and efficiency of the grantee's project implementation and within the context of the surrounding project conditions.

The grantee's Base Cost Estimate (BCE), dated March 25, 2011, is \$5.213 billion in Year-of-Expenditure (YOE) dollars, including \$865.58 million in allocated and unallocated contingency and \$230 million financing costs.

Summary of Findings

(1) The early bidding for DB guideway and MSF work and design-build-operate-maintain systems and vehicles work has significantly reduced market risk, since competitive pricing has been received and incorporated into its estimates.

(2) Most design risk and much construction risk associated with this work has been

transferred to the contractors through their pricing, and therefore the budget already includes these risks.

(3) However, the early contracting of this work has created a potential for technical performance risk, since the grantee must develop a new project organization to manage a quickly-developing and very large construction effort.

(4) In addition, this is an extremely large project, and historically such projects are found to exhibit high-risk profiles.

(5) Other project-specific risks include inefficiencies due to a potentially high number of individually-awarded station, design, and guideway contracts for the remaining work, and a potentially un-competitive bid market due to market perceptions of advantages held by the current contractor.

(6) Further, the remaining work on this project extends into increasingly-dense urban areas, increasing the risk of third-party interferences and unexpected underground utility and archaeological conditions.

(7) The grantee has developed a formal Risk and Contingency Management Plan (RCMP) that:

- conforms to the structure suggested in OP 40
- includes a corresponding organizational structure that will ensure full, unbiased risk management throughout the project life
- monitors and mitigates high-risk rated items through implementation of the RCMP
- establishes a management structure for risk identification, assessment, and mitigation that has sufficient independence to manage risk without bias and to provide reliable risk reports to agency upper management
- includes a contingency management, release, and tracking mechanism
- includes cost and schedule contingency draw-down curves
- establishes corrective action plans to be used if it becomes evident that its contingency levels may fall below the limits established in the contingency draw-down curve
- identifies potential Secondary Mitigations and the timing at which these mitigation options are no longer available (such secondary mitigations should not materially impact service and operating commitments)
- Targets a possible $267 million in secondary mitigation options

(8) Grantee and the PMOC have identified a total of YOE $865.6 million of grantee contingency within the Project estimate. A further $48.9 million of latent contingency was also identified and was removed to arrive at the PMOC's "stripped, adjusted" estimate that was the basis of the risk assessment.

(9) The PMOC prepared a "weighted" contingency evaluation and determined that, in consideration of the findings of the risk review, the PMOC recommends that the grantee's budget not change.

(10) The Schedule Contingency Review Analysis calculation generates a Revenue Service Date (RSD) date of December 2019. The PMOC believes that this calculation is within reason as it falls on the 60th percentile of the PMOC's schedule risk assessment model.

Recommendations

The PMOC recommends the following actions be taken before Final Design:

(1) The grantee should hold its current budget of $5.213 billion. This budget should include $230.0 million in finance costs and $813.5 million in contingency (allocated and unallocated), or 19.5% of the Adjusted BCE.

(2) The Revenue Service Date should be no earlier than the first quarter of calendar year 2020.

2.0 INTRODUCTION

Report Date	October 31, 2011 (FINAL)
Project Name / Location	Honolulu High-Capacity Transit Corridor Project 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 November 18, 2009

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 also provides PMO services for FTA's Regional Offices' grantees and their major capital projects to the extent that the PMOC has no conflicts of interest.

FTA assigned Jacobs as a PMOC for the City and County of Honolulu's ("grantee") Honolulu High-Capacity Transit Corridor Project ("Project") on September 24, 2009, for the purpose of monitoring the Project and providing FTA with "information and well-grounded professional opinions regarding the reliability of the project scope, cost, and schedule" of the Project. That effort continues with this report, which represents the PMOC's assessment of the Project's Transit Capacity, Scope, Delivery Method, Cost Estimate, Schedule, and Risk and Contingency.

2.1 Project Sponsor

The City and County of Honolulu ("grantee") is sponsoring the Honolulu High-Capacity Transit Corridor Project ("Project").

2.2 Project Description

The proposed Project is a 20.5-mile light metro rail line in a grade-separated right-of-way that will provide high-capacity transit service on the island of Oahu from East Kapolei in the west to the Ala Moana Center in the east. The alignment is elevated except for a 0.6-mile at-grade portion adjacent to the Leeward Community College station. In addition to the guideway superstructure and trackwork, major physical elements of the Project include: 21 stations; one maintenance and storage facility; numerous right-of-way parcel acquisitions; and 80 light metro vehicles and associated core systems.

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

- Segment I (West Oahu/Farrington Highway) – East Kapolei to Pearl Highlands (6 miles/7 stations)

- Segment II (Kamehameha Highway) – Pearl Highlands to Aloha Stadium (4 miles/2 stations)
- Segment III (Airport) – Aloha Stadium to Middle Street (5 miles/4 stations)
- Segment IV (City Center) – Middle Street to Ala Moana Center (4 miles/8 stations)

East Kapolei is the western terminus of the Project. The alignment begins at North-South Road north of Kapolei Parkway. The alignment follows North-South Road in a northerly direction to Farrington Highway where it turns east following Farrington Highway and crosses Fort Weaver Road. The alignment is elevated along North-South Road and along Farrington Highway. The alignment continues in a north-easterly direction following Farrington Highway in an elevated structure. South of the H-l Freeway, the alignment descends to grade as it runs alongside the Maintenance & Storage Facility at the former Navy Drum Site. The alignment continues at-grade to Leeward Community College and then returns to an elevated configuration to cross over the H-l Freeway. North of the Freeway, the alignment turns eastward along Kamehameha Highway. Segment I includes seven stations: East Kapolei, University of Hawaii at West Oahu, Ho'opili, West Loch, Waipahu Transit Center, Leeward Community College and Pearl Highlands.

Segment II carries the alignment from Pearl Highlands to Aloha Stadium, running mostly above the median of Kamehameha Highway. At the highway interchange 'Ewa of the stadium, the alignment crosses over to the mauka side of Kamehameha Highway, in land adjacent to the roadway that is currently used for stadium parking. Segment II includes two stations: Pearl Ridge and Aloha Stadium. East of Aloha Stadium Station, the segment features a third track for temporary train layovers or storage.

The Airport Segment, or Segment III, takes the alignment from Aloha Stadium to Middle Street. This entirely elevated section of the route starts on the mauka side of Kamehameha Highway, then transitions to the median of that street. As the route proceeds in the Koko Head direction, it leaves Kamehameha Highway to run on the makai side of the elevated H-1 Freeway. At Honolulu International Airport, the alignment swings out over the median of the H-1, then down Aolele Street to a station site adjacent to the main airport terminal. The route then continues Koko Head on Aolele and, eventually, the parallel Ualena Street to Lagoon Drive. At that point, the alignment crosses a corner of Ke'ehi Lagoon Park and threads through another highway interchange to Kamehameha Highway again at Middle Street. Segment III includes four stations: Pearl Harbor, Airport, Lagoon Drive, and Middle Street.

The City Center Segment, Segment IV, is also entirely-elevated as it carries the alignment from Middle Street to the Ala Moana Center. Segment IV features guideway structures above Dillingham Boulevard, Nimitz Highway, Halekauwila Street, Queen Street, and Kona Street. Above Kona Street at the Ala Moana Center Station, the segment includes a third track to serve that station, which serves as the eastern terminus of the initial system. The segment includes eight stations: Kalihi, Kapalama, Iwilei, Chinatown, Downtown, Civic Center, Kaka'ako, and Ala Moana.

The Project also includes one Maintenance & Storage Facility (MSF), two park and ride lots, one park and ride structure and two bus transit centers. The rail vehicles will be fully-automatic and driverless.

The anticipated weekday boardings for the line are as follows:

- 97,500 (in 2019)
- 116,300 (in 2030)

2.3 Project Status

A Locally Preferred Alternative (LPA) was adopted in July 2008. The grantee was provided approval to begin Preliminary Engineering (PE) on October 16, 2009. The Final Environmental Impact Statement (FEIS) was published on June 25, 2010, and a Record of Decision (ROD) was issued on January 18, 2011. The grantee is preparing to request approval to enter into Final Design for the Project in accordance with the FTA New Starts requirements.

2.4 Project Budget

The grantee's Base Cost Estimate (BCE), dated March 25, 2011, is $5.213 billion in Year-of-Expenditure (YOE) dollars, including $865.58 million in allocated and unallocated contingency and $230 million financing costs. The YOE budget for the project, including allocated and unallocated contingency, is shown in the following table.

Table 1. 2011 SCC Estimate

SCC	Description	YOE $	
		Total (Incl. Cont,)	Contingency
10.04	Guideway: Aerial structure	1,210,392,000	178,396,000
10.08	Guideway: Retained cut or fill	7,401,000	965,000
10.09	Track: Direct fixation	85,256,000	10,403,000
10.11	Track: Ballasted	3,102`,000	404,000
10.12	Track: Special (switches, turnouts)	2,204,000	366,000
20.01	At-grade station	8,345,000	1,418,000
20.02	Aerial station	449,606,000	75,779,000
20.06	Automobile parking multi-story structure	77,918,000	12,853,000
20.07	Elevators, escalators	78,732,000	13,117,000
30.02	Light Maintenance Facility	8,511,000	979,000
30.03	Heavy Maintenance Facility	42,778,000	4,921,000
30.04	Storage or Maintenance of Way Building	8,741,000	1,005,000
30.05	Yard and Yard Track	43,774,000	5,035,000
40.01	Demolition, Clearing, Earthwork	19,916,000	2,679,000
40.02	Site Utilities, Utility Relocation	358,376,000	67,161,000
40.03	Haz. mat'l, contam'd soil removal/ mitigation	7,533,000	811,000
40.04	Environmental mitigation	30,802,000	4,078,000
40.05	Site structures (retaining walls, sound walls)	22,935,000	3,159,000
40.06	Pedestrian / bike access, landscaping	44,675,000	7,136,000
40.07	Automobile, bus accessways (roads, parking)	212,928,000	31,598,000
40.08	Temporary Facilities/other indirect costs	324,289,000	36,849,000
50.01	Train control and signals	92,601,000	9,921,000
50.02	Traffic signals and crossing protection	13,043,000	2,315,000
50.03	Traction power supply: substations	33,800,000	3,632,000
50.04	Traction power distribution	37,347,000	4,489,000
50.05	Communications	60,602,000	6,499,000
50.06	Fare collection system and equipment	10,324,000	1,106,000
50.07	Central Control	3,868,000	414,000
	CONSTRUCTION SUBTOTAL (10 - 50)	**3,299,809,000**	**487,504,000**

(Table Continued below)

SCC	Description	YOE	
		Total (Incl. Cont,)	Contingency
[redacted]			
60.01	Purchase or lease of real estate	224,649,000	64,185,000
60.02	Relocation of existing households/businesses	23,293,000	6,655,000
[redacted]			
70.01	Light Rail	191,657,000	20,534,000
70.06	Non-revenue vehicles	14,589,000	1,563,000
70.07	Spare parts	6,214,000	665,000
[redacted]			
80.01	Preliminary Engineering	58,996,000	4,756,000
80.02	Final Design	222,177,000	22,403,000
80.03	Project Management for Design/Construction	350,329,000	28,507,000
80.04	Construction Administration & Management	187,914,000	17,083,000
80.05	Professional Liability/Non-Construction Ins.	56,103,000	5,100,000
80.06	Legal; Permits; Review Fees by other agencies	69,918,000	6,355,000
80.07	Surveys, Testing, Investigation, Inspection	6,072,000	527,000
80.08	Start up	79,534,000	8,088,000
	SUBTOTAL (10 - 80)	**4,791,260,000**	**673,930,000**
[redacted]			
	SUBTOTAL (10 - 90)	**4,982,910,000**	**865,580,000**
[redacted]			
	TOTAL PROJECT COST (10 - 100)	**5,212,910,000**	**865,580,000**

2.5 Project Schedule

Table 2 presents the grantee's target dates for key milestones of this New Starts Project as identified in its Master Project Schedule.

Table 2. Target Milestone Dates

Milestone Description	Grantee Target Date
FTA Approve Entry into Final Design	14-Nov-11
FTA Award Full Funding Grant Agreement	01-Aug-12
WOFH/KH Revenue Service	27-Dec-15
Airport Segment Revenue Service	29-Oct-17
City Center Revenue Service	20-Sep-18
Grantee FFGA Revenue Service Date	17-Jun-19

Note: MPS Data Date of September 30, 2011

2.6 Project Background

The grantee is preparing to request approval to enter into Final Design for the Project in accordance with the FTA New Starts requirements. The Project is intended to provide improved mobility in the highly-congested east-west corridor along Oahu's south shore. The Project would provide faster, more reliable public transportation services than those currently operating in mixed-flow traffic.

The Alternatives Analysis (AA) for the Project 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

2.7 Project History

Following is a list of important dates in the history of the Project:

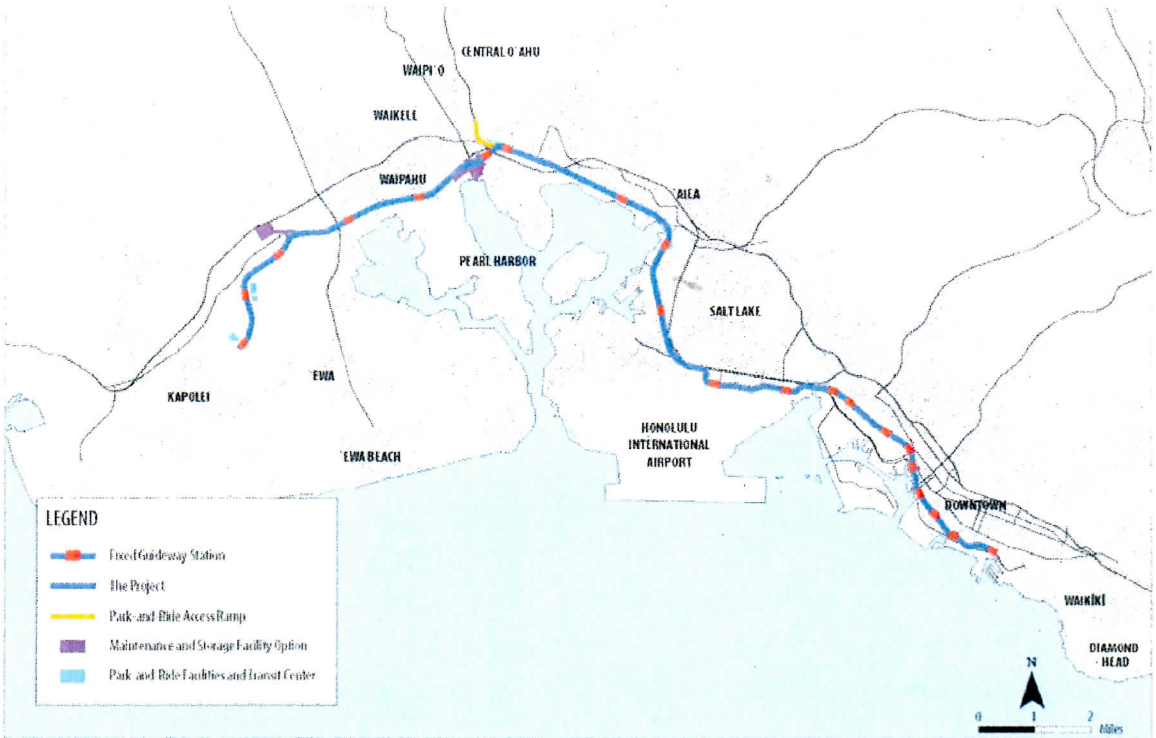
- August 2005 – AA is begun.
- October 2006 – AA Report presented to the Honolulu City Council.
- November-December 2006 – Public Meetings discussing the AA.

TASK F.

- December 22, 2006 – Honolulu City Council enacts 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.
- January 1, 2007 – A 0.5% surcharge on the Hawaii General Excise Tax (GET) went into effect (until December 31, 2022).
- February 27, 2007 – Honolulu City Council approved as the Minimum Operable Segment (MOS), East Kapolei to Ala Moana Center, via Salt Lake Boulevard (Resolution 07-039, FD1(c)).
- July 1, 2007 – The grantee created the Rapid Transit Division (RTD) within the Department of Transportation Services (DTS) through enactment of the grantee's Fiscal Year 2008 Executive Operating Budget and Program.
- August 24, 2007 – The grantee executed a GEC contract for $85 million to perform National Environmental Policy Act (NEPA) documentation, AA, and PE activities.
- February 22, 2008 – The grantee'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- 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 and County of Honolulu.
- January 28, 2009 – City Council voted to revise the MOS alignment to the Airport Alternative.
- May 2009 – Request to Enter PE submitted.
- June 2009 – Pre-PE Risk Assessment performed for Airport Alternative.
- October 12, 2009 – FTA grants Entry into PE.
- June 25, 2010 – FEIS published.
- December 16, 2010 – FEIS approved by Governor of Hawaii.

- January 18, 2011 – Project receives ROD from FTA.
- May 24, 2011 – FTA approves the grantee's request for a Letter of No Prejudice (LONP) to incur costs for limited Final Design activities for the WOFH DB contract in the amount of $4.72 million.
- July 1, 2011 – Honolulu Authority for Rapid Transportation (HART) became effective.

Figure 1. Project as Identified in FEIS



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

<u>Guideway</u>

- Exclusive guideway:
  - Majority of guideway will be elevated structure consisting of concrete box sections
  - 0.6-mile at-grade section in location of M will include no grade crossings
- Double-track mainline
- Maximum speed: 55 miles per hour (mph)
- Crossovers spaced at approximately 2 miles
- Third Track at Aloha Stadium Station
- Third Track at Ala Moana Station

<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: 80
- Standard gauge, steel wheel on steel rail
- Fully automated, manual operation possible (hostler panel)
- Nominal vehicle dimensions:
  - Length: 64 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 grantee's existing bus system
  - Proof of payment system

2.8 Project Management Oversight Contractor (PMOC)

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

Table 3. Jacobs Deliverables

OP	Description
32A	Project Capacity Review
32C	Project Scope Review
32D	Project Delivery Method Review
33	Capital Cost Estimate Reviews
34	Project Schedule Review
40	Risk and Contingency Review

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

2.9 Evaluation Team

The following table presents the PMOC Evaluation Team and the respective roles associated with the assessment of the Project.

Table 4. PMOC Evaluation Team

Name	Location	Phone	Email Address	Role
Tim Mantych	St. Louis, MO	314-335-4454	tim.mantych@jacobs.com	Program Manager
Bill Tsiforas	Las Vegas, NV	702-676-1568	William.tsiforas@jacobs.com	Task Order Manager
Keith Konradi	St. Louis, MO	314-335-4464	Keith.konradi@jacobs.com	Rail Engineering
Bob Niemietz	St. Louis, MO	314-335-4484	Robert.niemietz@jacobs.com	Structural Engineering
Ahmad Hasan	St. Louis, MO	314.335.4103	Ahmad.hasan@jacobs.com	Geotechnical Engineering
Allan Zreet	Dallas, TX	214-424-8511	Allan.zreet@jacobs.com	Architect
Greg Crocombe	Houston, TX	832-351-7271	Greg.crocombe@jacobs.com	Systems (Train Control)
Charles Neathery	Dallas, TX	214-424-7519	Charles.neathery@jacobs.com	Construction Management, Project Controls, Schedule Risk Assessment
Sabit Ghosh	Arlington, VA	410-837-5840	Sabit.ghosh@jacobs.com	Construction Management
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Jonnie Thomas	Denver, CO	303-953-0320	jonnie.thomas@triunityeng.com	Systems (Communications)
Dennis Newman	New York, NY	212-490-9090	anoldsaw@aol.com	Safety
Dorothy Schulz	New York, NY	212-490-9090	dms10024@aol.com	Security
JR Casner	Centennial, CO	303-790-8474	hcasner@lsgallegos.com	Construction Management, QA/QC
Bob Merryman	St. Louis, MO	636-949-2125	rmerryman@orcolan.com	Real Estate
Emma Kowalenko	Chicago, IL	312-853-0500	ekowalenko@kowalenkogroup.com	Planning/Environmental
David Sillars	Corvallis, OR	541-737-8058	dsillars@sillars.com	Risk Manager

2.10 Documents Reviewed

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

3.0 OP 32A: PROJECT TRANSIT CAPACITY REVIEW

3.1 Purpose and Objective

This Project Transit Capacity Review seeks to ensure that sufficient service capacity is being programmed, contracted, and constructed to provide safe and reliable transit service to the Honolulu community, and to answer the questions: Can the system carry the anticipated passenger volumes? Can the system deliver the required vehicle throughput? Is the proposed system staff sufficient to sustain operations?

Many analytical approaches are 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. This on-going, evolving process improves project accountability and ensures that the scale of investment in major infrastructure systems is adequate for 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 to establish 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 *OP 32A, Project Transit Capacity Review,* Rev. 2, dated May 2010, 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 grantee in March and April 2011. It includes documents employed in the procurement of the Core System Contractor (CSC) and submissions by the selected bidder for that contract.***

At the most basic level, rail transit capacity is a seemingly simple concept that addresses the question of how many persons can be moved along a 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 (i.e., passengers per hour) under specified operating conditions without unreasonable delay, hazard, restriction or uncertainty[4]. 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).

It also reviews the staffing plans for the proposed service to determine if the staffing levels and management organization are sufficient to sustain operations.

3.2.1 Document Review

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

3.2.2 Project Specifications

The Honolulu High Capacity Transit Corridor (HHCTC) Project will provide high-capacity rail transit service along an east-west corridor of approximately 20 miles from East Kapolei to Ala Moana Center. Nearly all of the transit guideway will be elevated and most of that will be constructed in the medians of existing roadways. It is proposed that the service will be offered with a fleet of two-car driverless metro trains operating in a fully automated mode with an interval to 2:28[6] to 8:24 between trains depending upon time of day during the last year of the ten year O&M contract. The grantee forecasts that the Project will attract approximately 116,000 daily weekday passengers by the year 2030.

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[3] Ibid. pp. 5-2
[4] Ibid. pp. 5-5
[5] Ibid. pp. 5-27
[6] m:ss AHJV Technical Proposal Volume 3 C9M HNL 00003 02 February 24, 2011 Page 3-327

Table 5. Forecast Passenger Volumes[7]

Forecast Travel Volumes	2019	2030
Daily Riders	99,110	116,340
Peak Hour Riders	11,418	13,739
Peak Hour Peak Link Riders	6,429	8,083

The selected bidder for the service is a joint venture led by two Italian firms (Ansaldo STS and AnsaldoBreda) controlled by Finmeccanica SpA of Rome. The Ansaldo Honolulu Joint Venture (AHJV) proposes to deliver vehicles, train control, traction power, communications, fare collection equipment, and operations and maintenance services for a grantee-specified rail transit system. The basic infrastructure (elevated guideway and stations) is to be built by others under different contracts with the grantee. AHJV proposes to install and operate vehicles and systems proven with several years of successful operation in Copenhagen, Denmark.

Because of its exclusive right of way, high level platforms, frequent service and third rail power distribution system, the PMOC applied heavy rail system standards in preparing the capacity analysis.

Car Specifications

AHJV specifications for the proposed rail vehicles are summarized below.

Table 6. AHJV Car Specifications[8]

Length	64.1	Feet
Width	10.0	Feet
Fixed Seats	32	Passengers
Flip up Seats	6	Passengers
Standing Space	427.4	Square Feet
Maximum Acceleration	3	Miles per hour per second (mphps)
Average Acceleration	2.7	mphps - (from zero to 25 mph)
Deceleration	3.2	mphps - (from 55 to 45 mph)
	3.0	mphps - (from 45mph to stop)
Maximum Speed	55	mph
Door Width	55.11	inches
Number of Doors	3	per side

Train Control

AHJV's AF-902 Train Control System will control revenue train operation throughout the 21 passenger stations and non-revenue operations through most of the maintenance and storage facility. The installation will provide for automated driverless operation, including:

(1) Train protection - prevention of collisions and derailments
(2) Train operation - control of train movement and stopping at stations

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[7] Honolulu High-Capacity Transit Corridor Project, Draft Operations and Maintenance Plan Dated August 2009 (Updated Draft April 2011) Page 4-10
HHCTCP/PMOC Meetings, June 2, 2009.
[8] AHJV Proposal for HHCTCP – Core Systems DBOM: Vehicle General Characteristics and Performance C9M HNL 1X 002 Feb 24, 2011 Pages 1-3 to 1-5

(3) Train supervision - direction of train movement in relation to schedule and
(4) Communication - interchange of information among elements of the system

AHJV's Technical Specification and Automatic Train Control (ATC) Simulation Report purports to demonstrate that the "moving block" installation will support the operating parameters listed in Table 7.

Table 7. AHJV System Headway Parameters[9]

Headway	Seconds	Comments
Safe Separation Headway	<90 seconds	With minimum (20 second) dwell
Non-Interference Headway	133.9 seconds (2:14)	With city specified nominal dwells
Minimum Operating Headway	155 seconds (2:35)	Non interference headway plus 15% for normal service perturbations.
Operating Headway	=>155 seconds	To be varied with passenger demand

When operating in passenger service with headways less than the non-interference parameter, speeds are reduced to maintain safe operations. At reduced train speeds, the service will not achieve travel time goals.

Limited service is proposed to start on a partial system in 2015 with full service starting upon completion of the entire 20 mile system in 2019. The grantee has developed specifications and AHJV has proposed operating plans for service through the first ten years of full operation (to the end of 2028). After that time, the grantee plans to award a new service operating contract based on new competitive bids.

The grantee specified that the total round trip travel for the full service should not exceed 90 minutes (1:30:00)[10]. AHJV proposes to operate the service with a round trip travel time of 89 minutes and 33 seconds (1:29:33).

Table 8. AHJV Proposed Travel Times[11]

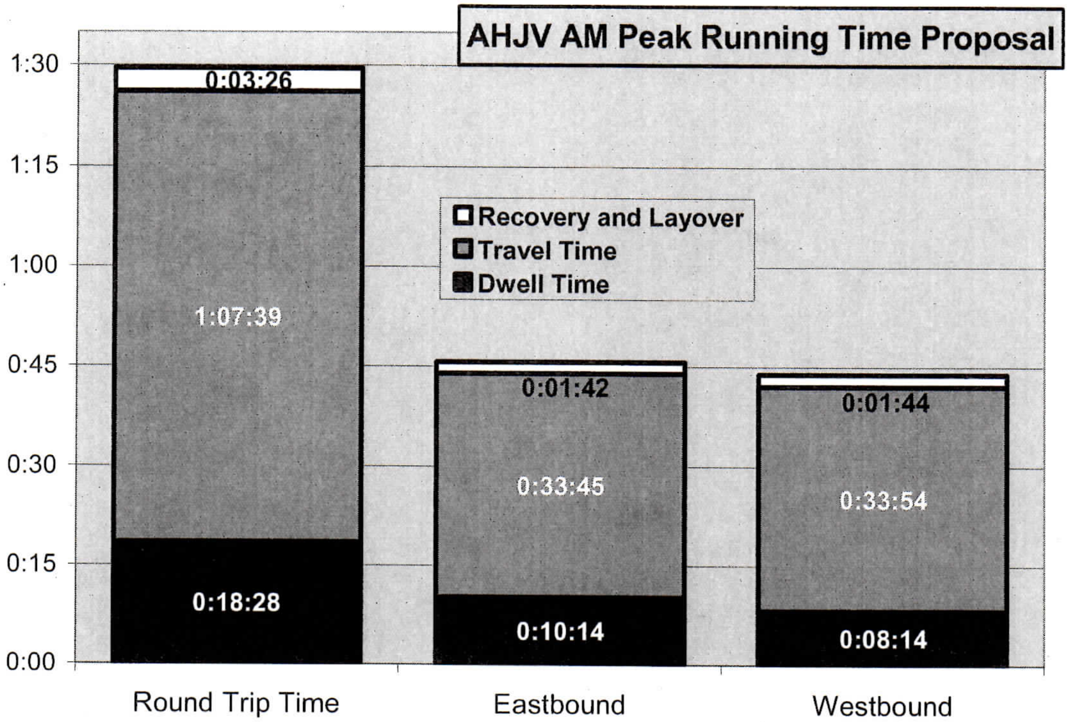
Morning Peak Service	Dwell Time	Travel Time	Recovery and Layover	Total
Eastbound	0:10:14	0:33:45	0:01:42	0:45:41
Westbound	0:08:14	0:33:54	0:01:44	0:43:52
Round Trip Time	0:18:28	1:07:39	0:03:26	1:29:33
Percent of Total	20.6%	75.5%	3.8%	100%

9 AHJV. TECHNICAL SPECIFICATION AF-902 Train Control System C9M HNL 2X 001 Rev. 01 January 18, 2011 Page 43

10 This reflects a somewhat longer trip time than earlier estimated at the environmental impact statement phase of planning primarily due to longer (and more realistic estimates) of required dwell times by HHCTC.

11 BAFO2\AHJV BAFO Feb 24 Clean Files\Technical Proposal Volumes 1-6 and Appendix A\Volume 3\Part 2\Volume 3 - Part 2 Pages 305 to 327.pdf

Figure 2. Proposed Morning Peak Running Times

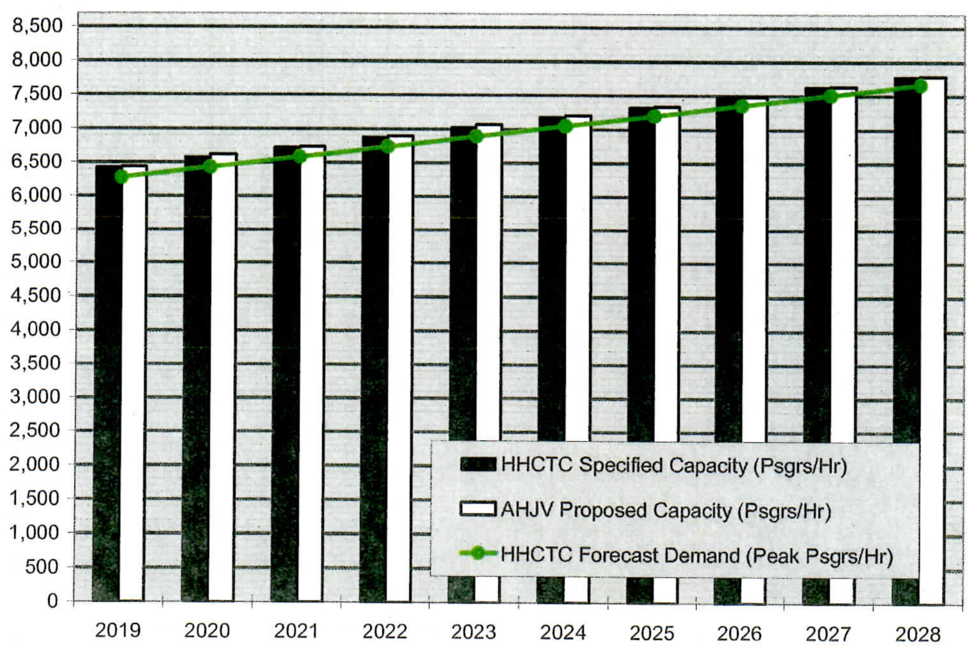


Over the first twelve years of full service, typical weekday ridership is projected to grow from 99,110 in the first year of full operations (2019) to 116,340 in the design year (2030). AHJV proposes to operate the service with a fleet of two-car trains running at headways set to keep forecast ridership generally at or below a "comfort level" of crowding at the peak-load point on the line. Each two-car train is projected to hold 318 passengers (64 seated and 254 standing at a density of 3.4 ft^2 per standee.)

Table 9. Proposed Headways and Peak Passenger Capacities

	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
AHJV Proposed Base Headway (Seconds)	356	347	340	332	325	318	312	306	300	294
AHJV Proposed Base Trains	16	16	16	17	17	17	18	18	18	19
AHJV Proposed Peak Headway (Secs)	178	173	170	166	162	159	156	153[12]	150	147[13]
AHJV Proposed Peak Trains	31	32	32	33	34	34	35	36	36	37
Comfort Capacity Peak Hour Loads (Psgrs/Hr)										
Grantee Specification	6,429	6,580	6,730	6,880	7,031	7,181	7,331	7,482	7,632	7,782
AHJV Proposal	6,431	6,617	6,734	6,896	7,066	7,200	7,338	7,482	7,632	7,735
Grantee Forecast Hour Peak Demand	6,277	6,458	6,638	6,819	7,000	7,181	7,361	7,542	7,723	8,084

Figure 3. Peak Capacity Specifications and Peak Demand Forecasts



Inspection of Table 9 and Figure 3 shows that the grantee's specified peak period hourly capacity closely tracks the forecast growth in peak hourly demand and that AHJV's proposal for each year exceeds the grantee specification by a marginal increment of standing room.

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[12] Note: Proposed peak headway is less than minimum operating headway for proposed train control system.

[13] Based on its calculations PMOC presumes there is a typo in the AHJV documentation which shows a headway of 148 seconds. All other figures in the table indicate that 147 is the appropriate headway,

It is concerning that the headways required to supply necessary peak capacity in 2026 and subsequent years are below the Minimum Operating Headway supported by the train control system.

Traction Power[14]

- Using the revenue vehicle and auxiliary equipment power consumption specifications and data from the AHJV proposal, the PMOC has performed an independent analysis on the traction power requirements.
- AHJV provides a description of the results of the electrical simulation study that has been done to analyze the Traction Electrification System of the Honolulu High-Capacity Transit Corridor Project (HHCTCP). Two load flow analyses have been performed as part of the AHJV design activities:
  - Service conditions load flow analysis: The first load flow analysis is based on the Service conditions of the Project. This simulation has been performed on the basis of the TPSS and GBS described in the RFP documentation, consistently with the proposed vehicle and with the operational conditions used to determine the fleet size. The following main operating characteristics (both for normal and contingency operation) are listed below and are in accordance with the service conditions proposed by AHJV:
    - Peak hour passenger capacity: 7200 pphpd
    - Peak hour headway: 159 s
    - Two-car train with 318 passengers at the comfort load capacity
    - Station Dwell Time in accordance with TP 3.4.2.3
  - Design criteria load flow analysis: The second load flow analysis has been performed on the basis of the requirements included in Chapter 13 of Design Criteria (TP9 - Design Criteria - §13.5.3.Train Operations Plan). The purpose of this study is to verify the behavior of the Traction Electrification System provided for the Honolulu High-Capacity Transit Corridor Project under the following conditions, updated as per AHJV:
    - Headway:
      (1) 90 seconds operating for 2 hours (only for Normal Operation)
      (2) 180 seconds operating continuously (both for Normal and Contingency Operation)
    - Four-car train with 770 passengers at the design load capacity
    - Station Dwell Time in accordance with TP 3.4.2.3
- The grantee has developed specific requirements and AHJV has provided preliminary design to comply with the RFP guidelines that require sufficient traction power to operate the maximum number of trains at designated speeds and projected load requirements.[15] According to the RFP Technical Documents, the traction electrification system must be designed in compliance with the following requirements:
  - with the substations operating normally, the power system shall be designed to support the system capacity (refer to § 1.1 of this document) with no overload

[14] *The system configuration proposed by AHJV has been slightly modified and the outcome of the sample simulations shows these changes have an impact of the order of magnitude of 1%, which are negligible.*

[15] HHCTCP Design Criteria – Traction Power, June 26, 2008[15] AHJV CSC Proposal, February 24, 2011

- the failure of one TPSS shall not lead to any operational disturbance to the scheduled revenue service, even momentarily, and shall not require line personnel to carry out any emergency action
    - the line voltage as seen at the transit vehicle power collector shall not fall below the recommended values; for a nominal traction voltage of 750 V, the lowest permanent voltage is fixed at 525 V
    - during the outage of one Traction Power Substation, the loads on the transformer rectifier units of the adjacent substations shall be within the normal rating of the equipment in order to accommodate instantaneous or transient overloads during contingency situations,
    - The nominal power of the TPSS have to be sized such that these higher loads shall be within the following and the transformer-rectifier sets shall withstand: 1.5-In rated power for 2 hours maximum 3-In for 5 period of 1 minute, and 4.5-In for 15 seconds at the end of the 2 hours-hours load cycle period.
    - The overload capability of the transformer-rectifier units is only used for transient overload such as traction motor starting, not for back up of failure.
    - The TPSS out-of-service condition considered involves loss of the primary utility power or of the substation's transformer/rectifier unit. It is assumed in such condition that the dc bus remains energized, with the dc feeder breakers staying closed.
- The main electrical quantities taken into consideration in this simulation are:
    - The rms currents and average power delivered by each substation related to a time period equal to the headway, according to the different phases corresponding to the different required system capacities
    - The line voltage distribution, measured at the transit vehicle power collector, with the respective maximum and minimum values.
    - Track to ground potentials (equivalent to train touch potentials) being within acceptable limits: not exceeding 75 V dc in normal operations, and 100 V dc in contingency conditions
- Initial review of the preliminary plans shows electrical sub-stations at approximately one to one-and-one-half mile intervals along the corridor. The Traction Electrification System is serviced by 13 mainline traction power substations (TPSS) rated at 3000 kW nominal each. In addition, there are also three gap breaker stations (GBS), located at double crossovers where a TPSS is not required. The full list of traction power facilities, counting from West to East, is provided in the table below:

Table 10. **Traction Power Facilities**

Substations	Name	Stations UP Chainage [foot]	TPSS/GBS UP Feeders Positive Connect Points [foot]
TPSS 1	EAST KAPOLEI	397+65	40900
TPSS 2	WEST OAHU	448+24	45000
GBS 1	HO'OPILI	500+43.6	49800
TPSS 3	WEST LOCH	583+80.62	58600
TPSS 4	WAIPAHU T.C.	651+99.79	69900
GBS 2	LEEWARD CC	725+62.86	73050
TPSS 5	PEARL HIGHLANDS	748+48.97	77250
TPSS 6	PEARLRIDGE ST	885+48.28	89000
TPSS 7	ALOHA STADIUM	973+82.95	98850
GBS 3	PEARL HARBOR	1047+11.99	104950
TPSS 8	HONOLULU AIRPORT	1141+48.98	114400
TPSS 9	LAGOON DRIVE	1192+83.21	119550
TPSS 10	MIDDLE STREET T.C.	1266+39.05	127000
TPSS 11	CHINA TOWN	1393+57.15	138550
TPSS 12	CIVIC CENTER	1440+31.19	144250
TPSS 13	ALA MOANA CENTER	1504+65.2	150200

Traction Electrification Systems will include the following Traction Power substations (TPSS), all within prefabricated enclosures:

- Eight (8) TPSS (East Kapolei, West Loch, Pearlridge, Airport, Lagoon Drive, Middle Street, Chinatown, and Civic Center) are provided with one traction group supplying 3000 kW
- 750 Vdc to the third rail, an LV section supplied by an auxiliary transformer and five (5) DC feeders;
- Two (2) TPSS (West Oahu, and Pearl Highlands) are provided with one traction group supplying 3000 kW - 750 Vdc to the third rail, an LV section supplied by an auxiliary transformer and two (2) DC feeders;
- One (1) TPSS at Ala Moana with one traction group supplying 3000 kW - 750 Vdc to the third rail, a LV section supplied by an auxiliary transformer and six (6) DC feeders;
- One (1) TPSS at Waipahu with one traction group supplying 3000 kW - 750 Vdc to the third rail, an LV section supplied by an auxiliary transformer and seven (7) DC feeders;
- One (1) TPSS at Aloha Stadium with one traction group supplying 3000 kW - 750 Vdc to the third rail, an LV section supplied by an auxiliary transformer and eight (8) DC feeders;

The system will also include the following track parallel points within prefabricated enclosures:

- 3 Gap Breaker Stations (Leeward, Ho'opili, and Pearl Harbor Naval Base), including five (5) DC feeders.

For each positive feeder and negative return connection, the quantity of cable is based on Part 6 – RFP Drawings – Volume 1- Rev. 01

- The specific data provided in the RFP for simulations are preliminary. The grantee 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."[16] The following are simulation and motor results provided by AHJV based on the RFP documents:
  - AHJV Simulation results analysis for Service Condition – 159 Seconds Headway -- The analysis of the simulation results obtained through the input data described in § "*4 - Honolulu power load flow simulation - input data*" and in § "*4.3.1 First scenario – Service Condition simulation*" shows that, for each configuration of the Traction Power System (normal operation or out of service of one TPSS), the following conditions are always verified:
    - The minimum line voltage measured at transit vehicle power collector is always greater than 525 V, during both the normal operation of all substations and the contingency operation.
    - The rms traction current delivered by each TPSS, during both the normal operation of all substations and the contingency operation, is always lower than the continuous current rating corresponding to one transformer-rectifier group (3000 kW - 4000 A).
    - The maximum rail potential calculated, during both the normal operation of all substations and the contingency operation, is always lower than the permissible touch.
    - Voltage limit (75 Vdc for normal operation and 100 Vdc in contingency operation).
  - AAHJV Simulation results analysis for Service Condition – 90 Seconds Headway - The analysis of this simulation results obtained through the input data described in § "*4 -Honolulu power load flow simulation - input data*" and in § "*4.3.2 Second scenario – Design Criteria simulation*" at 90 seconds of headway shows that, for the Traction Electrification System (only during normal operation), the following conditions are always verified:
    - The TPSS and GBS can support the system power demand (some TPSS rectifier are in overload < 150% as allowed and foreseen by Design criteria).
    - The minimum line voltage measured at transit vehicle power collector is always greater than 525 V.
    - The maximum rail potential is always under 75 Vdc.
  - AAHJV Simulation results analysis for Service Condition – 180 Seconds Headway – The analysis of this simulation results obtained through the input data described in § "*4 - Honolulu power load flow simulation - input data*" and in § "*4.3.2 Second scenario – Design Criteria simulation*" at 180 seconds of headway shows that the following conditions are always verified:

[16] Ibid. pp. 4AHJV CSC Proposal, February 24, 2011

Normal Operation

- TPSS and GBS can support the system power demand.
- Minimum line voltage measured at transit vehicle power collector is always greater than 525 V.
- Maximum rail potential is always under 75 Vdc.

Contingency Operation

As far as contingency operation at 180 s is concerned, simulations show that, also in such a situation, the TPSS and GBS can support the system power demand (only in one case simulation results have identified one TPSS rectifier in a situation of limited overload, <110%; however, PMOC is confident that, during the development of the design and on the basis of more consolidated inputs, this condition will be solved by a more detailed technical analysis).

Regarding the minimum line voltage measured at the transit vehicle power collector, some scenarios have been found where the voltage, being always greater than 500 V (in case of TPSS 3 -West Loch is out of service), is lower than 525 V. Regarding the rail potential, other scenarios have been found where a peak potential exceeds the limit of 100V, such effect being limited only to the line (not in the platform area) and 100 Vdc (in particular between West Loch and Waipahu T.C).

It should be noted that the above results in terms of line voltage and rail potential are not cause for concern, because they occur in very limited and particular cases of a single out-of-service TPSS and because the system has means to mitigate such situations. In fact, because the substations will be equipped with negative grounding devices (NGDs), which will temporarily ground the running rails if the track potential exceeds the NGD set point, the running rails' potentials in contingency operations will be significantly reduced and the above theoretical values will not be of concern.

As an additional result of the performed simulation, it was found out that by exchanging the Ho'opili GBS position with the UH-West Oahu TPSS position, the minimum line voltage measured at transit vehicle power collector would be always greater than 550V (also in case of TPSS 1 "East Kapolei" Out of Service.) and rail potentials values would also improve.

- AAHJV Motor results for Service Conditions – 159 Seconds Headway – The paragraph below includes the simulation results relevant to the following operational configurations:
  - Normal operation
  - Out of service TPSS#13
  - Out of service TPSS#3

  During the AHJV preliminary design, all the "Out of service" scenarios related with the operational conditions described in this document have been subject to a simulation study. As stated, in the following paragraph, the results relevant to the

TPSS#3 and TPSS#13 being out of service will be included. These two scenarios have been chosen because they are the most significant and are the worst-case scenarios from the following points of view:

- TPSS Energy load
- Line Voltage
- Rail Potential

It must be pointed out that these AHJV results are based on an initial analysis, which will be fully and extensively developed during the detailed design stage; for this reason, their results must be considered preliminary.

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. The PMOC used available project specific information. Where data are not available, *TCRP 100* provides general default values derived from representative rail transit systems.

This capacity analysis focuses on peak system demand, since that drives the requirements for maximum capacity. For many urban transit systems, there is an established 15-minute period during the morning weekday period, or the "peak-of-the-peak," during which maximum regular utilization can be projected. However, recent demographic and employment trends have challenged the classic "9 to 5" commutation model, causing this 15 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 grantee and AHJV dwell time and running time estimates, and generates analyses of cycle time and vehicle requirements. Finally, the peak line and person capacity of the Project are calculated following *TCRP 100* methodologies.

3.3.1 Forecast Design Year Peak Period Passengers

The 2030 forecast ridership for the Project is 116,000 daily weekday passengers. The ridership forecast also estimates the number of passengers boarding and alighting at each station and in each direction during the morning peak hour.

As discussed in an earlier spot report[17], typical 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 grantee indicated it would employ a PHF of 0.90, which is more moderate and less intensive that the *TCRP 100* default PHF of 0.80 for a heavy rail system.[18] This PHF

[17] FEDERAL TRANSIT ADMINISTRATION, PROJECT MANAGEMENT OVERSIGHT PROGRAM, Contract No. DTFT60-04-D-00015; Project No. DC-27-5044; FTA Task Order 12 – Programmatic Services; Work Order 5G; CLIN 0005: Spot Report; Subtask 32A: Project Capacity Review HONOLULU HIGH-CAPACITY TRANSIT CORRIDOR PROJECT (Airport Alternative) Date Issued: July 2009

[18] TCRP Report 100. pp. 5-68

implies that 28% of peak hour passengers will ride in the peak 15 minutes. The TCRP default value implies 31% of peak hour riders using the system during the peak 15 minutes.

In the summer of 2009, the PMOC recommended further refinement and calibration of ridership utilization to fully substantiate grantee's current and future use of the higher PHF. *The grantee has presented no documentation concerning further refinement or calibration.*

The peak-of-the-peak 15-minute ridership estimate from the morning peak hour forecasts is derived 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 15-minute peak boardings. The net effect of this adjustment is to add 11% more riders to the peak-of-the-peak above the average 15-minute peak ridership, in order to reflect the non-uniformity of passenger arrivals at the stations. This factoring provides capacity for the surge of riders that is commonly observed during the peak of the peak on mature systems. Table 11 shows the forecast morning peak hour and the forecast 15-minute peak-of-the-peak passenger activity.

Table 11. 2030 Station Passenger Morning Peak Hour[19]

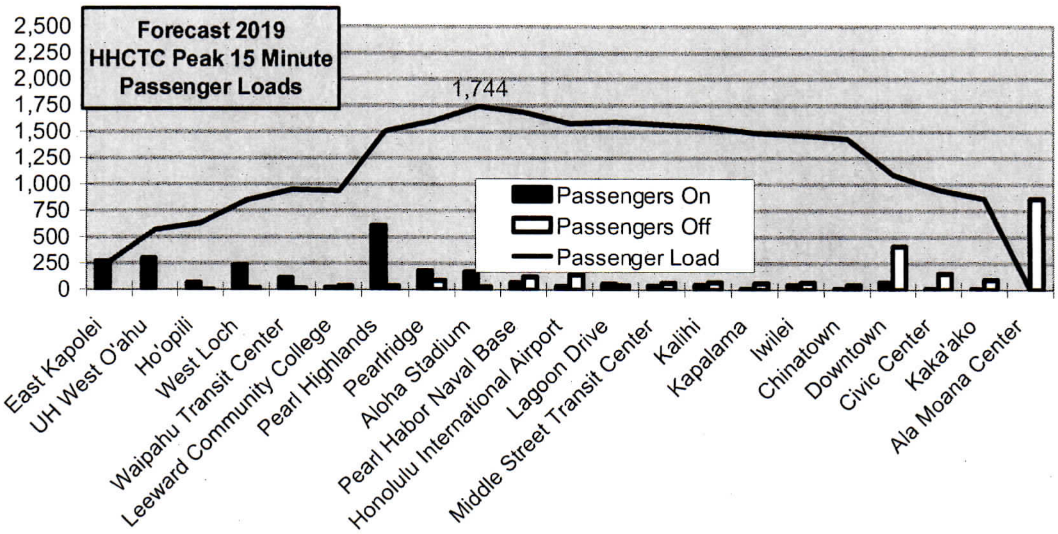
Eastbound	1 Hour peak		15 minute peak		
Station	**Ons**	**Offs**	**Ons**	**Offs**	**Line Volume**
East Kapolei	1,546	0	429	0	429
West Oahu	1,588	4	441	1	869
Ho'opili	439	20	122	6	986
West Loch	1004	104	279	29	1,236
Waipahu Cntr	466	61	129	17	1,348
Leeward CC	83	156	23	43	1,328
Pearl Highlands	2,712	148	753	41	2,040
Pearlridge	630	368	175	102	2,113
Aloha Stadium	591	114	164	32	2,246
Pearl Harbor	241	488	67	136	2,177
Airport	146	539	41	150	2,068
Lagoon Drive	211	156	59	43	2,083
Middle Street	154	232	43	64	2,061
Kalihi	174	311	48	86	2,023
Kapalama	45	277	13	77	1,959
Iwilei	162	331	45	92	1,912
Chinatown	43	202	12	56	1,868
Downtown	272	1,778	76	494	1,449
Civic Center	48	633	13	176	1,287
Kaka'ako	28	422	8	117	1,178
Ala Moana	0	4,239	0	1,178	0

Westbound	1 Hour Peak		15 minute peak		
Station	**Ons**	**Offs**	**Ons**	**Offs**	**Line Volume**
Ala Moana	1,004	0	279	0	279
Kaka'ako	83	41	23	11	291
Civic Center	101	98	28	27	291
Downtown	278	252	77	70	299
Chinatown	48	41	13	11	301
Iwilei	240	66	67	18	349
Kapalama	34	82	9	23	336
Kalihi	86	141	24	39	320
Middle Street	172	75	48	21	347
Lagoon Drive	47	177	13	49	311
Airport	62	193	17	54	275
Pearl Harbor	62	284	17	79	213
Stadium	145	100	40	28	226
Pearlridge	123	256	34	71	189
Highlands	443	119	123	33	279
Leeward CC	22	232	6	64	220
Waipahu Cntr	108	133	30	37	213
West Loch	40	290	11	81	144
Ho'opili	61	34	17	9	151
West Oahu	1	225	0	63	89
East Kapolei	0	321	0	89	0

The morning peak direction is eastward, or 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 are shown in Figure 4 and Figure 5 for the first and last year of the ten year AHJV operating contract ending in 2028.

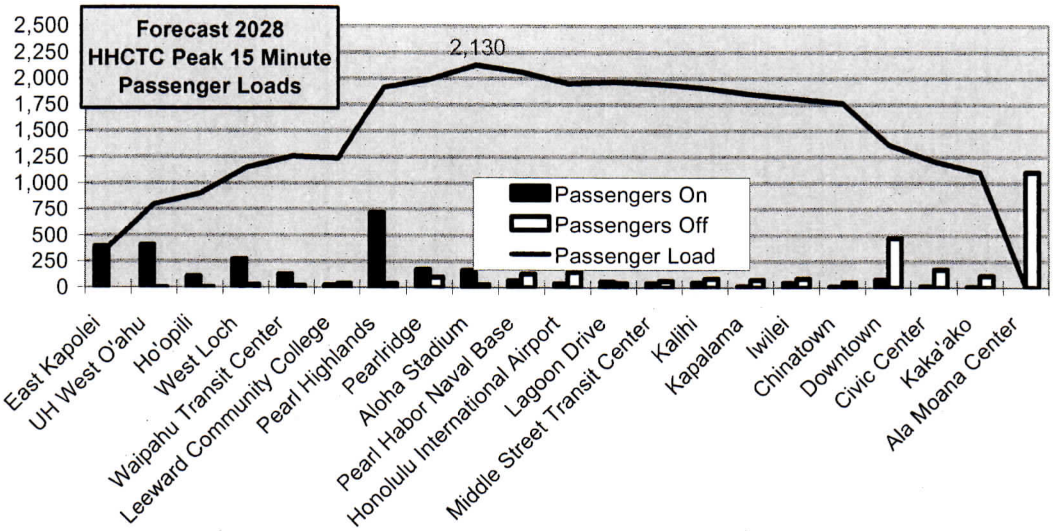
[19] Honolulu High-Capacity Transit Corridor Project Draft Operations and Maintenance Plan (Feb 2010) pp 4.4, 4.5, 4.6 and 5-2 Found at J:\Hawaii\Honolulu Procurement Documents\Addendum 23\Reference Documents\HHCTCP Draft Operations and Maintenance Plan (Revised).pdf

Figure 4. Eastbound Peak 15 Minute Period: First Full Year of Operation



Aloha Stadium is the eastward peak load point of the line. The peak line segment will be between Aloha Stadium and Pearl Harbor with 1,744 passengers forecast to be traveling east on the line during the morning 15-minute peak-of-the-peak in the first year of full operation. That volume is projected to grow 22% to 2,130 in the first ten years of operation. Nearly 40% of the eastbound peak period passengers are projected to alight at the eastern terminal at Ala Moana. Another 17% will disembark at the Downtown station. Eastbound passenger boarding will be concentrated on the western end of the line with 56% of the total peak boardings forecast to load at just three stations.

Figure 5. Eastbound Peak 15 Minute Period: Tenth Year of Full Operation



3.3.2 Forecast Year Peak System Capacity

The grantee specifications and the AHJV proposal describe a service plan intended to provide sufficient person capacity, with only minor exceptions, to meet its adopted loading standard. That standard is well within acceptable limits on passenger crowding for a typical US rapid transit service. However, the circumstance that plans for operations in the out years[20] of the O&M contract call for peak service frequencies that violate the "minimum operating headway" is cause for concern. The assumption that peak passengers will stand for as many long trips as forecast is also questionable. Given that the forecast average trip length on the Project is twice the length of the typical US rapid transit journey, it is possible that standards based on industry averages may not be appropriate to attract and retain the volumes for traveler forecast to use the system.

<u>Capacity and Crowding</u>
Grantee passenger capacity planning is based on a "Comfort Load" of crowding as defined below:

> **Vehicle Comfort Load Capacity ($L^{Comfort}$)** is the number of passenger spaces within a vehicle represented by the sum of the passenger seating spaces, except flip-up and stowable seats, no wheelchair passengers, no baggage, no surfboards, and no bicycles, plus the effective standee passenger spaces remaining, calculated at 3.2 passengers per square meter (3.4 square feet per standing passenger).

The grantee Comfort Load is slightly more generous than the 3.2 standees per square foot characterized as "reasonable" by *TCRP 100.* This TCRP standard is termed "TCRP Optimal" for the purposes of this capacity analysis

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[20] After seven years of full operation

Grantee capacity planning also relies on a "Design Load" Level of crowding as defined below.

> **Vehicle Design Load Capacity (L^{Design})** is the number of passenger spaces within a vehicle represented by the sum of the passenger seating spaces, except flip-up and stowable seats, no wheelchair passengers, no baggage, no surfboards, and no bicycles, plus the effective standee passenger spaces remaining, calculated at four (4) passengers per square meter (2.7 square feet per standing passenger)

TCRP 100 characterizes the level of crowding implied by the grantee Design Load as an "uncomfortable near-crush load." It is considered allowable for short segments for limited periods of time during the peak-of-the-peak and is generally been accepted as an absolute upper bound on acceptable levels of passenger crowding.[21]

Table 12. Passenger Standing Room Summary

Loading	Passengers per Sq Meter	Sq Feet per Passenger
Comfort Load ($L^{Comfort}$)	3.2	3.4
TCRP Optimal Load	3.4	3.2
Design Load (L^{Design})	4	2.7

Grantee Capacity Specifications

During its planning in the spring and summer of 2009, the grantee developed a Fleet Sizing Plan and operating regime that would operate a mix of two- and three-car trains every three minutes during peak periods. Capacity requirements were met by changing train length while holding headways constant. Under this plan and its assumptions, the grantee showed how it intended to carry the projected 2030 peak hour load at three-minute headways with all passengers traveling with at least 3.4 ft^2 of space per standing passenger. Furthermore, the grantee's plan indicated that, during the first few years of operation, the grantee would set the loading standard for the peak of the peak to 90% of the load that could be accommodated at the "comfort load" level.[22]

During the ensuing months, the initial operating specifications published for the proposed system were less specific than outlined in the June 2009 Fleet Sizing report. The grantee specified a prescribed level of peak hour comfort level capacity to be provided by the operator during each year of the contract, as shown in Table 7 and Figure 3.

The PMOC was not able to determine exactly how required capacities were estimated, but it is evident that the required peak hourly volume is a blend of the capacity that would accommodate a surge in the peak of the peak and the balance of the forecast peak hour ridership during the balance of the hour. By subtracting the surge riders from the balance of the hour and averaging required capacities over the entire hour, capacity set aside for any surge in ridership is sharply reduced and spread across the entire peak. In fact, after Year Five "extra" capacity to accommodate any surge in forecast ridership is completely eliminated.

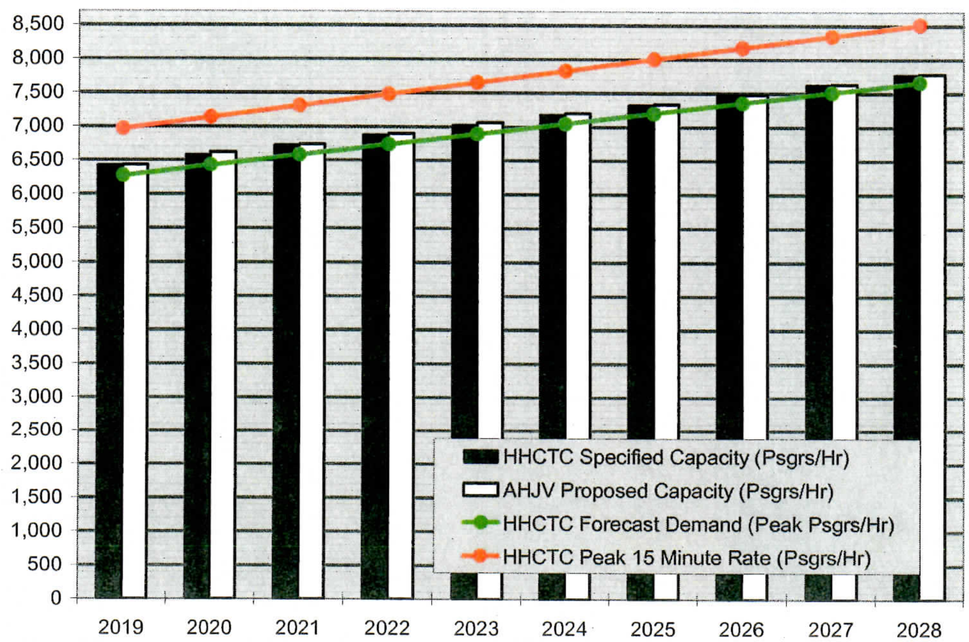
[21] TCRP 100, (pp 5-27)

[22] Fleet Sizing Report June 2009

AHJV responded to the grantee's specification by proposing to operate a growing fleet of two-car trains at shorter and shorter headways each year to provide the specified capacity. It is a matter of concern that AHJV proposes, in 2026 and subsequent operating years, to operate peak service at headways less than its own calculated minimum operating headway.

Figure 6 illustrates the gap between average hourly peak flows and the ridership that would be expected if passengers arrived at a rate 3% higher than the typical peak hour forecast during any rush hour period.

Figure 6. Peak Capacity Specifications and Peak Demand Forecasts with Peak 15 Minute Rate shown



The overall effect of this approach is forecast to adversely affect the comfort of some peak passengers, but, since the desired level of crowding set by grantee is relatively generous, the system should still be able to physically carry all forecast passengers in each year of forecast operation.

AHJV has proposed to operate the service with two-car trains providing 64 fixed seats and 854.8 feet of useable standing space. Table 13 shows the capacity provided by the AHJV two-car train at each of the three capacity levels.

Table 13. AHJV Two Car Train Capacity by Loading Density Level[23]

Loading Density Level	Grantee "Comfort Load"	TCRP "Optimal Load"	Grantee "Design Load"
Space per Standing Passenger *(sq/ft per standee)*	3.4	3.2	2.7
Space per Standing Passenger *(standees/sq meter)*	3.2	3.4	4.0
Fixed Seats	64	64	64
Standees	254	268	318
Total capacity per train	**318**	**331**	**382**

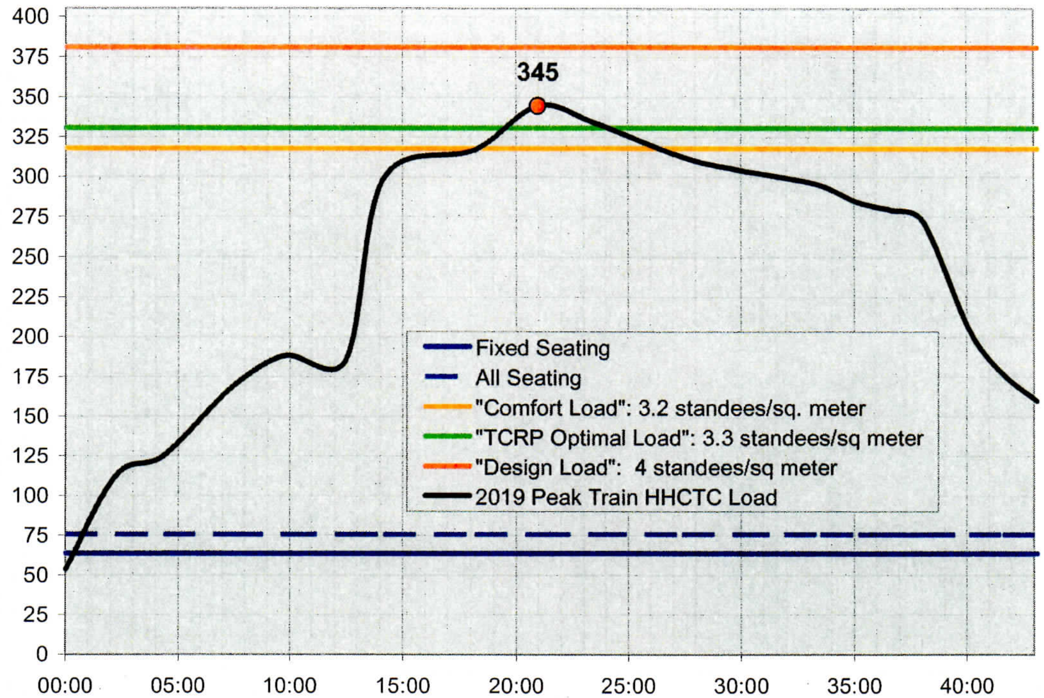
Figure 7 illustrates how the peak morning train on a typical weekday during the first year of full operation would be expected to load relative to various capacity standards. The figures relate forecast peak-of-the-peak passenger volumes to the peak service headways and vehicles proposed by AHJV in conformity with grantee O&M specifications.

Figure 8 shows how the typical peak train would be likely to load in 2028 if AHJV found an acceptable way to operate peak service more frequently than the minimum operating headway. Since the proposed peak headway is reduced by 17% between 2019 and 2028 while the forecast peak ridership increases by 22% over the same period, the magnitude and extent of crowding is forecast to increase slightly over the life of the contract.

[23] Assumes 427.4 sq/ft of floor space in each car as documented by AHJV

Figure 7. Forecast Passenger Loads and Capacity (2018)

Typical Eastbound Peak of Peak Train

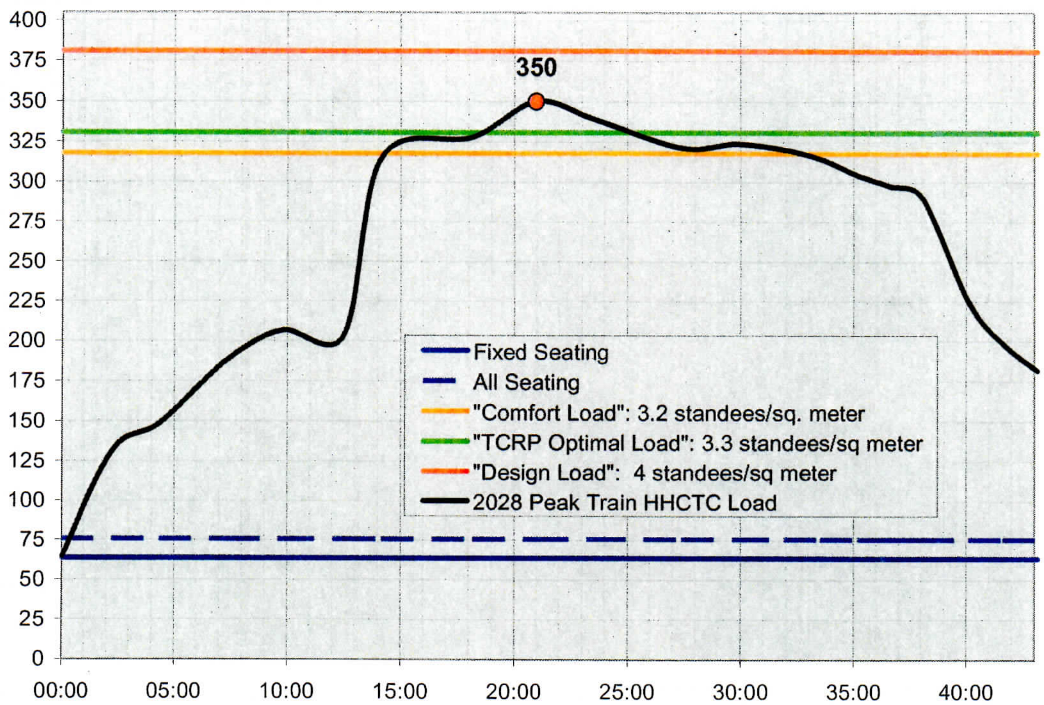


In the first full year of operation, the typical train in the peak of the peak will carry a maximum load of 345 passengers, which is below the crushing "Design Load" of 382 passengers but slightly above the "TCRP Optimal Load" of 331 passengers. Peak passengers on eastbound trains moving between the Stadium and the Airport would be on trains exceeding the "Comfort" standard of crowding for up to 6 minutes. It is estimated that 1,813 passengers would ride on "overcrowded" peak trains each morning. This would constitute only 4% of the total forecast weekday ridership[24] but 21% of all eastbound peak hour passengers.

[24] presuming that the afternoon peak would mimic the morning in reverse.

Figure 8. Forecast Passenger Loads and Capacity (2028)

Typical Eastbound Peak of Peak Train



Should AHJV and the grantee agree on a plan to operate service at frequencies that exceed the minimum operating headway, the peak train in the last year will carry a maximum load of 350 passengers. Peak passengers on eastbound trains moving between the Pearl Ridge and Kalihi would be on trains exceeding the "Comfort" standard of crowding for up to 15 minutes. It is estimated that 2,368 passengers would ride on "overcrowded" peak trains. This would still constitute only 4% of the total forecast weekday ridership[25] but 23% of all eastbound peak hour passengers.

Trip Duration and Passenger Crowding

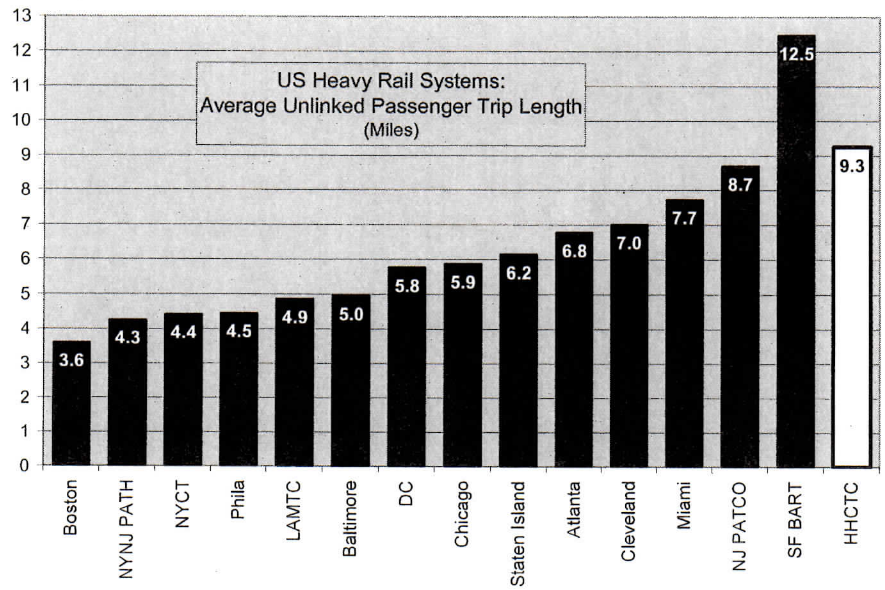
Despite the analysis offered above, the PMOC has a lingering concern with respect to crowding and the passenger experience on the proposed system. TCRP 100 is based on best practices and experience of the North American transit industry. In that experience, the typical passenger makes a much shorter trip than forecast for the system. Figure 9 shows the length of the average passenger trip (unlinked) for all heavy rail rapid transit services in the US as reported to the FTA's National Transit Database. It also shows the average passenger trip length forecast for the system.

Inspection of the figure shows that only San Francisco's BART, Philadelphia/NJ's PATCO and Miami's Metrorail serve average passenger journeys in the vicinity of those forecast for

[25] presuming that the afternoon peak would mimic the morning in reverse.

Honolulu's system. Since BART and PATCO opened approximately 40 years ago they've been characterized as functioning almost like commuter rail due in part to the long trip lengths of their passengers. To provide comfort for passengers making longer trips, the configuration of the BART and PATCO cars provide a higher *"Comfort Rate"* with 64 to 80 seats per car. Miami's rapid transit cars offer a similar level of comfort providing for 70 seated and 90 standing passengers per car. By contrast, the grantee plans to carry 32 seated and 127 standing passengers in each car.

Figure 9. US Heavy Rail Passenger Trip Lengths



Most (74%) of the forecast system AM peak eastbound ridership boards west of Pearl Ridge. About 67% of these riders are forecast to disembark at destinations east of Chinatown. This indicates that most peak hour passengers will be expected to stand for well more than 20 minutes on the most common journeys. Given the geographic spread between the locus of trip origins and the locus of trip destinations, the grantee may wish to reconsider the train and car configuration planned for the system to ensure that the system supplies the degree of comfort necessary to actually attract and satisfy forecast passengers.

The PMOC is concerned that, given the length of time that most passengers would be expected to stand on most trips, the system might fail to achieve forecast ridership levels. After trying the system, many passengers may decide that they are unwilling to endure such crowded conditions for such long trips.

<u>Overall Car Capacity Assessment</u>

The PMOC has three concerns with respect to planned capacity.

- First, despite assurances to the contrary, the operating plan provides no capacity for a surge in ridership after the fifth year of operations and falls well short of the surge that would have been accommodated by the 2009 Fleet Sizing Report. The level of forecast peak crowding fails to meet AHJV's stated standards but lies within a range that is generally considered acceptable for peak rapid transit passenger comfort.

- Second, AHJV's proposal to provide required capacity for 2026 and subsequent years calls for it to operate service at less than the minimum operating headway. Since the minimum headway includes a 15% cushion above the non-interference headway, it is possible that service could be operated without degradation on some days. But, on many days, service would be degraded with longer trip times and more uneven service than had been specified as acceptable.

- The final concern is more qualitative. When fully operational, the system is forecast to carry some of the longest average passenger trips of any US rapid transit system. The vehicles planned for the service do not seem to offer a degree of comfort suitable for the journey length. So while the capacity of the proposed system falls within the average range for typical rapid transit systems, it falls well short of the seating and capacity offered by the transit lines that carry passengers for journeys of similar length and duration.

It is recommended that the grantee and AHJV confer regarding plans to operate at frequencies that violate the minimum operating headway. A likely possible response will be to offer service with longer trains operating at four-minute headways. The change in overall fleet size necessary to operate with three-car trains at slightly longer headways should be negligible. The fleet would also include a number of presumably less expensive middle cars and the level of comfort (seats/passenger) afforded passengers that are not riding in the peak of the peak would be increased. Operating at four-minute peak headways would also provide more capacity for surges in demand during the first several years of the contract.

3.3.3 Running, Station Dwell, and Cycle Time Assessment

The running, dwell, layover/recovery, and resultant cycle times determine the number of trains and cars necessary to serve forecast passenger loads.

3.3.4 Running Time

Station-to-station running time estimates for the planned service were prepared by AHJV using train performance calculation software and the known characteristics of the proposed vehicle and route. Table 14 shows the inter-station running time forecasts proposed by AHJV. The grantee specified that these estimates reflect trains carrying a "Design Load' (aka AW2) weight of passengers to help ensure that the cars and traction power system can more than handle anticipated loads.

Table 14. AHJV Proposed Inter-station Running Times[26]

EASTWARD			
From	To	Miles	Time
EAST KAPOLEI	WEST OAHU	0.97	0:01:30
WEST OAHU	HO'OPILI	0.99	0:01:40
HO'OPILI	WEST LOCH	1.58	0:02:16
WEST LOCH	WAIPAHU T.C.	1.29	0:01:51
WAIPAHU T.C.	LEEWARD CC	1.38	0:02:14
LEEWARD CC	HIGHLANDS	0.43	0:00:57
HIGHLANDS	PEARLRIDGE	2.28	0:03:13
PEARLRIDGE	STADIUM	1.45	0:02:08
STADIUM	PEARL HARBOR	1.26	0:01:59
PEARL HARBOR	AIRPORT	1.85	0:03:11
AIRPORT	LAGOON DR	1.18	0:01:59
LAGOON DR	MIDDLE ST	1.04	0:01:39
MIDDLE ST.	KALIHI	0.49	0:01:05
KALIHI	KAPALAMA	0.75	0:01:15
KAPALAMA	IWILEI	0.48	0:01:01
IWILEI	CHINATOWN	0.38	0:00:59
CHINATOWN	DOWNTOWN	0.45	0:01:15
DOWNTOWN	CIVIC CENTER	0.41	0:00:53
CIVIC CENTER	KAKA'AKO	0.47	0:01:01
KAKA'AKO	ALA MOANA	0.74	0:01:39
		19.90	0:33:45

WESTWARD			
From	To	Miles	Time
ALA MOANA	KAKA'AKO	0.74	0:01:39
KAKA'AKO	CIVIC CENTER	0.47	0:01:01
CIVIC CENTER	DOWNTOWN	0.41	0:00:54
DOWNTOWN	CHINATOWN	0.45	0:01:14
CHINATOWN	IWILEI	0.38	0:01:00
IWILEI	KAPALAMA	0.48	0:01:03
KAPALAMA	KALIHI	0.75	0:01:16
KALIHI	MIDDLE ST	0.49	0:01:05
MIDDLE ST	LAGOON DR	1.04	0:01:38
LAGOON DR	AIRPORT	1.18	0:01:59
AIRPORT	PEARL HARBOR	1.85	0:03:09
PEARL HARBOR	STADIUM	1.26	0:02:00
STADIUM	PEARLRIDGE	1.45	0:02:08
PEARLRIDGE	HIGHLANDS	2.28	0:03:14
HIGHLANDS	LEEWARD CC	0.43	0:00:58
LEEWARD CC	WAIPAHU T.C.	1.38	0:02:13
WAIPAHU T.C.	WEST LOCH	1.29	0:01:51
WEST LOCH	HO'OPILI	1.58	0:02:22
HO'OPILI	WEST OAHU	0.99	0:01:40
WEST OAHU	EAST KAPOLEI	0.97	0:01:30
		19.90	0:33:54

The station-to-station running times found in the Section 3.16.2.4 of the AHJV proposal vary slightly from running time estimates reported elsewhere in the AHJV proposal. The car performance simulation results indicate that, overall, the eastbound service is actually 50 seconds faster and the westbound is 10 seconds faster than reported in AHJV proposal Section 3.16.2.4. These two sets of figures disagree with the Train Control Simulation Results,[27] which indicate a running time of 35:19 Eastbound and 35:11 Westbound. It appears that "recovery and layover" roughly corresponds to the signal system impacts on running times when operating at 178-second headways. Other simulations in the train control simulation report indicate that operations at shorter headways have a negative effect on running times[28].

PMOC recommends that the grantee work with AHJV to develop station-to-station running time estimates that reflect impacts of the train control system and terminal turnback operations. These more robust and realistic estimates should be the basis for future fleet plans and capacity planning.

[26] BAFO2\AHJV BAFO Feb 24 Clean Files\Technical Proposal Volumes 1-6 and Appendix A\Volume 3\Part 2\Volume 3 - Part 2 Pages 305 to 327.pdf Pages 3-15 and 3-16

[27] J:\Hawaii\Honolulu Spring 2011\BAFO 2\BAFO2\AHJV BAFO Feb 24 Clean Files\Technical Specifications\5 Train Control\C9M HNL 2X 002_Train Control AF-902 Simulation_02.pdf
C9M HNL 2X 002 02 13 February 24, 2011 Pages 13 and 16

[28] For instance compare Table 6 with Table 8 and Table 8 with Table 11 to see how shorter headways (with the mitigating impact of shorter dwell times) affect forecast inter-station running time.

Table 15. AHJV Running Time Estimates

Source	Eastward	Westward	Total
Section 3.16 Travel Time Only	0:33:45	0:33:54	1:07:39
Section 3.16 Travel Time w/ Recovery and Layover[29]	0:35:17	0:35:28	1:10:45
Passenger Vehicle Performance Simulation Results[30]	0:32:35	0:33:24	1:05:59
Train Control System Simulation Results[31]	0:35:19	0:35:11	1:10:30

3.3.5 Station Dwell Time

The grantee approach to forecasting dwell time has changed several times since the last formal capacity review. Each change has added dwell time to the overall travel time. The cumulative effect of the changes has (in the aggregate) virtually eliminated earlier discrepancies between PMOC estimates based on TCRP 100 standards and the dwell times proposed by AHJV.

As discussed in the 2009 Spot Report, *TCRP 100* presents three methods[32] to estimate station dwell times. The grantee did not employ any of these methods. Instead, a fourth approach is applied. While it is not clear whether the method is justified, it does yield credible estimates of aggregate dwell time.

Grantee Proposed Station Dwell Time

The grantee's specified methodology for estimating station dwell times used a novel approach that integrated car characteristics (such as comfort level capacity and door configuration) with generous assumptions concerning the turnover of passengers on cars to provide a dwell time estimation algorithm that could be used by a variety of proposers offering different equipment and operating plans.

Nominal station dwell times for each station were to be calculated by the Core Systems Contractor on the basis of the following criteria:

(1) Vehicle loaded to the vehicle comfort load capacity ($L^{Comfort}$), as described earlier.

(2) At all stations, the following percentages of the vehicle comfort load capacity board and alight each vehicle through the doors on only one side:

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29 See Section 1.3.6.

30 J:\Hawaii\Honolulu Spring 2011\BAFO 2\BAFO2\AHJV BAFO Feb 24 Redlined Files\Technical Specifications\4 Passenger Vehicle\1 General Characteristic\Performance Specification. Page 2-20

31 J:\Hawaii\Honolulu Spring 2011\BAFO 2\BAFO2\AHJV BAFO Feb 24 Clean Files\Technical Specifications\5 Train Control\C9M HNL 2X 002_Train Control AF-902 Simulation_02.pdf
C9M HNL 2X 002 02 13 February 24, 2011 Pages 13 and 16

32 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.[32] 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." The second methodology presented in *TCRP 100* uses a traditional "mean plus two standard deviations, while the third method utilizes professional peer system performance and experience.

Table 16. Fraction of Comfort Load Passengers Expected to Board/Alight at Each Station

	Eastward (Read Down)		Westward (Read Up)	
Station	Board	Alight	Board	Alight
East Kapolei	100%	25%	*Turnback*	
UH West Oahu	100%	25%	25%	25%
Ho'opili	25%	25%	25%	25%
West Loch	100%	25%	25%	50%
Waipahu Transit Center	50%	25%	25%	25%
Leeward Community College	25%	25%	25%	25%
Pearl Highlands	100%	25%	50%	25%
Pearl Ridge	75%	50%	25%	25%
Aloha Stadium	75%	25%	25%	25%
Pearl Harbor	25%	50%	25%	50%
Honolulu International Airport	25%	75%	25%	25%
Lagoon Drive	25%	25%	25%	25%
Middle Street Transit Center	25%	25%	25%	25%
Kalihi	25%	50%	25%	25%
Kapalama	25%	25%	25%	25%
Iwilei	25%	25%	25%	25%
Chinatown	25%	25%	25%	25%
Downtown	50%	100%	50%	25%
Civic Center	25%	75%	25%	25%
Kaka'ako	25%	50%	25%	25%
Ala Moana Center	*Turnback*		75%	100%

(3) Vehicle door size represents the actual dimensions of the proposed car.

(4) The passenger load/unload rate assumes that one passenger per second can move through each 25-inch unit of clear width at each doorway. The effective clear width of each doorway is divided by 25 inches and rounded downward to the nearest 0.1 units. (Partial door width adds to estimated throughput.)

(5) A time allowance that represents actual equipment performance is included for all ATP interlock functions, plus door unlocking/opening and closing/locking times; this time allowance shall not include door fully-open time. This allowance may not exceed ten seconds.

(6) No station shall have a nominal doors fully-open period of less than five (5) seconds.

The grantee specified that these calculated nominal station dwell times would be used to determine the round trip travel time and the headways to be offered in the proposer's operating plan. AHJV's proposed train holds a comfort load of 318 passengers with six 55.1 inch doors (13.2 door equivalents) on each side. Based on these parameters, AHJV's dwell time estimates are summarized in Table 17. Calculations for each stop include 4.5 seconds for door opening and 5.5 seconds to close and lock doors before departing.

Table 17. AHJV Dwell Time Calculation Summary

Station	Eastward (Read Down)			Westward (Read Up)		
	Psgrs Served	Psgr Service Time (secs)	Total Dwell including door time (seconds)	Psgrs Served	Psgr Service Time (secs)	Total Dwell including door time (seconds)
East Kapolei	398	30.2	40.2	*Turnback*		
UH West Oahu	398	30.2	40.2	160	12.1	22.1
Ho'opili	160	12.1	22.1	160	12.1	22.1
West Loch	398	30.2	40.2	239	18.1	28.1
Waipahu Transit Center	239	18.1	28.1	160	12.1	22.1
Leeward Community College	160	12.1	22.1	160	12.1	22.1
Pearl Highlands	398	30.2	40.2	239	18.1	28.1
Pearl Ridge	398	30.2	40.2	160	12.1	22.1
Aloha Stadium	319	24.2	34.2	160	12.1	22.1
Pearl Harbor	239	18.1	28.1	239	18.1	28.1
Honolulu Airport	319	24.2	34.2	160	12.1	22.1
Lagoon Drive	160	12.1	22.1	160	12.1	22.1
Middle Street Transit Center	160	12.1	22.1	160	12.1	22.1
Kalihi	239	18.1	28.1	160	12.1	22.1
Kapalama	160	12.1	22.1	160	12.1	22.1
Iwilei	160	12.1	22.1	160	12.1	22.1
Chinatown	160	12.1	22.1	160	12.1	22.1
Downtown	477	36.1	46.1	239	18.1	28.1
Civic Center	319	24.2	34.2	160	12.1	22.1
Kaka'ako	239	18.1	28.1	160	12.1	22.1
Ala Moana Center	*Turnback*			557	42.2	52.2
Total	**5,500**	**416.7**	**616.7**	**3,913**	**296.4**	**496.4**
			10:17			08:16

This approach grossly overestimates that number of passengers forecast to use any train with the equivalent of 2,750 unique passengers riding portions of the 20 mile eastbound peak trip. But the overall approach yields aggregate dwell time estimates that are much closer to TCRP 13 estimates than estimated earlier. See Table 18 for current estimates.

Table 18. Comparison of AHJV and PMOC 2028 Dwell Time Estimates

Station	Eastward (Read Down)			Westward (Read Up)		
	AHJV Estimate	PMOC Estimate[33]	Difference	AHJV Estimate	PMOC Estimate	Difference
East Kapolei	40.2	29.2	11.0	*Turnback*		
UH West Oahu	40.2	29.3	10.9	22.1	27.0	-4.8
Ho'opili	22.1	27.3	-5.2	22.1	26.8	-4.7
West Loch	40.2	28.4	11.7	28.1	27.1	1.0
Waipahu Transit Center	28.1	27.4	0.7	22.1	27.0	-4.9
Leeward CC	22.1	27.0	-4.8	22.1	27.0	-4.9
Pearl Highlands	40.2	32.5	7.7	28.1	27.6	0.5
Pearl Ridge	40.2	28.2	11.9	22.1	27.2	-5.1
Aloha Stadium	34.2	27.8	6.4	22.1	27.1	-4.9
Pearl Harbor	28.1	27.6	0.5	28.1	27.2	0.9
Honolulu Airport	34.2	27.5	6.6	22.1	27.0	-4.9
Lagoon Drive	22.1	27.2	-5.0	22.1	27.0	-4.9
Middle Street	22.1	27.2	-5.0	22.1	27.1	-5.0
Kalihi	28.1	27.3	0.8	22.1	27.0	-4.9
Kapalama	22.1	27.0	-4.9	22.1	26.8	-4.7
Iwilei	22.1	27.3	-5.2	22.1	27.2	-5.1
Chinatown	22.1	26.9	-4.8	22.1	26.8	-4.7
Downtown	46.1	29.7	16.4	28.1	27.6	0.5
Civic Center	34.2	27.5	6.7	22.1	27.0	-4.8
Kaka'ako	28.1	27.2	0.9	22.1	26.9	-4.7
Ala Moana Center	*Turnback*			52.2	28.7	23.5
Total	616.7	559.4	57.3	496.4	543.1	-46.6
mm:ss	10:17	09:19	00:57	08:16	09:03	-00:47
			Grand Total	**18:33**	**18:22**	**00:10**

For the eastbound peak trip, the overall AHJV estimate is 57 seconds longer than the PMOC estimate based on TCRP 13. For the westbound trip, the PMOC estimate is 47 seconds longer than the overall AHJV estimate. Combining both directions the net difference is a negligible 10 seconds over 18+ minutes of estimated dwell time.

3.3.6 Recovery and Layover Time

AHJV's station-to-station travel time estimates include an allowance for "recovery and layover" at each station that is not explicitly called for in the grantee specification. The allowances range from 4.0% to 5.7% of estimates of inter-station travel times. AHJV's proposal does not indicate how these allowances were derived. The overall effect is to add slightly more than 3 minutes to overall travel times in addition to estimated travel time and dwell time.

Recalling Table 15, it is notable that "recovery and layover" allowance roughly corresponds to the additional travel time estimated by the Train Control Simulation for operations at 178-second headways. As headways grow shorter, the chance that the movements of leading trains will influence their followers increases, resulting in longer simulated running times.

[33] Based on method described in Parkinson, Tom and Fisher, Ian. Rail Transit Capacity (TCRP Report 13). Transportation Research Board, Washington DC. 1996. pp. 48

Table 19. Recovery and Layover Time[34]

Eastward (Read Down)				Westward (Read Up)		
Travel Time	Added Allowance for Recovery and Layover	% Recovery and Layover	Arrival Station	Travel Time	Added Allowance for Recovery and Layover	% Recovery and Layover
			East Kapolei	01:39	00:04	4.0%
01:30	00:04	4.4%	UH West Oahu	01:01	00:03	4.9%
01:40	00:05	5.0%	Ho'opili	00:54	00:03	5.6%
02:16	00:06	4.4%	West Loch	01:14	00:03	4.1%
01:51	00:05	4.5%	Waipahu Transit Center	01:00	00:03	5.0%
02:14	00:06	4.5%	Leeward College	01:03	00:03	4.8%
00:57	00:03	5.3%	Pearl Highlands	01:16	00:03	3.9%
03:13	00:08	4.1%	Pearlridge	01:05	00:03	4.6%
02:08	00:06	4.7%	Aloha Stadium	01:38	00:04	4.1%
01:59	00:05	4.2%	Pearl Harbor Naval Base	01:59	00:06	5.0%
03:11	00:08	4.2%	Honolulu Airport	03:09	00:08	4.2%
01:59	00:05	4.2%	Lagoon Drive	02:00	00:06	5.0%
01:39	00:04	4.0%	Middle Street Transit Center	02:08	00:06	4.7%
01:05	00:03	4.6%	Kalihi	03:14	00:09	4.6%
01:15	00:04	5.3%	Kapalama	00:58	00:03	5.2%
01:01	00:03	4.9%	Iwilei	02:13	00:06	4.5%
00:59	00:03	5.1%	Chinatown	01:51	00:05	4.5%
01:15	00:04	5.3%	Downtown	02:22	00:07	4.9%
00:53	00:03	5.7%	Civic Center	01:40	00:05	5.0%
01:01	00:03	4.9%	Kaka'ako	01:30	00:04	4.4%
01:39	00:04	4.0%	Ala Moana Center			
33:45	**01:32**	**4.5%**	**TOTAL**	**33:54**	**01:34**	**4.6%**

3.3.7 Cycle Time & Vehicle Requirements

Cycle time is the sum of the inter-station running time, dwell time and recovery and layover time, as a multiple of the headway. The vehicle requirement (number of trains) is a function of the headway and cycle time.

The grantee's specifications indicate that the round trip time necessary for a train to complete one circuit around its route should not exceed 90 minutes. The grantee further specifies the round trip time as the sum of all inter-station travel times (at AW2 or "L^{Design} weights) and station dwell times (based on the nominal estimates described earlier).

AHJV's Technical Proposal (Volume 3: Part 2: Section 3.16.2.4) calls for a round trip time of 89:33, as summarized in Table 20. As discussed above, the inter-station running times and dwell times at intermediate stations appear to be reasonable estimates of real world performance. The

34 BAFO2\AHJV BAFO Feb 24 Clean Files\Technical Proposal Volumes 1-6 and Appendix A\Volume 3\Part 2\Volume 3 - Part 2 Pages 305 to 327.pdf. Pages 315-316

inline recovery time allowance of nearly 3 minutes seems prudent, especially in light of the train control system simulation results.

Table 20. AHJV Round Trip Times

	Eastward	Westward	Total
Terminal Time	00:53	0:41	01:34
Inter-station Running Time	33:45	33:54	01:07:39
Dwell times at Intermediate Stations	10:00	07:40	17:40
Inline Recovery and Layover Time	01:28	01:30	02:58
Total	46:06	43:45	1:29:51

The terminal time necessary to turn the train between revenue trips is not explicitly discussed by AHJV in Volume 3 of the Technical Proposal. The figures presented in Table 19 are the PMOC's sum of the calculated dwell allowance at each terminal station, the AHJV recovery/layover allowance at the terminal station (4 seconds), and the ten seconds at each end of the line noted by AHJV as "extra time for turnback."

Terminal Turnback Capacity

Terminal operations are considered in more detail in AHJV's Train Control System Simulation Report[35]. This report does not entirely agree with Volume 3: Part 2. Table 21 shows the "Operational Round Trip Time" posited by the train control simulation.

Table 21. Operational Round Trip Time

	Eastward	Westward	Total
Terminal Dwell	0:00:52	0:00:40	0:01:32
Inline Time	0:44:53	0:42:33	1:27:26
Total	0:45:45	0:43:13	1:28:58

More importantly, the simulation considers how turnbacks at East Kapolei and Ala Moana Center will be accomplished. The simulation determines and illustrates that at headways of less than 240 seconds (four minutes), the following train behind any train turning at either terminal presents a conflict for its turning leader until the second train arrives at the terminal (i.e., the first train can't leave for its return trip until its follower clears the terminal interlocking that the first train needs to depart.) The operational effect of this circumstance is to set the minimum turn time at terminal stations to a value roughly equivalent to the prevailing service headway[36].

This constraint is relaxed when the follower is four or more minutes behind the turning train since the headway is long enough to allow the turning train to turn and depart before its follower seizes the interlocking for its approach to the terminal. The constraint is exacerbated by the fact that the end of track is close to the terminal platforms, causing the train control system to retard the train approaching the end of track to ensure that it will be able to stop in the unlikely (but theoretically possible) event that it overruns the terminal platform.

[35] AHJV, AF-902 TRAIN CONTROL SYSTEM SIMULATION REPORT, C9M HNL 2X 002 Rev. 02 Pages 25-31

[36] For more detail consult Train Control Simulation Report C9M HNL 2X 002 02 32 February 24, 2011 pages 26-31

With the short (sub-three-minute) headways, the terminal configuration also constrains maximum turnback times to ensure that the third train to arrive at the terminal does not conflict with the departing first train. The first train must be out of terminal 60 to 90 seconds before the third train is due to arrive.

The time and sequencing of turnbacks at stations must be considered in determining the number of trainsets required to provide service. AHJV's tabulations showing the number of trainsets required to provide peak service in each of the ten years of full service do not appear to account for the conflict between leading and following trains at terminals. *The PMOC estimates that, when terminal time is fully considered in operations planning, one peak consist beyond AHJV estimates may be required in each year of full operation.*

None of the simulations documented in AHJV simulation report integrate line operations with terminal turnbacks. Consequently, the PMOC can only speculate how terminal turnbacks will affect peak round trip times delivered on the network. PMOC recommends that the grantee provide a simulation report showing how peak operations with dwells and turnbacks will be delivered in the last year of the proposed O&M contract (2028) or in the design year (2030).

Note: Some documents show a third (and sometimes a fourth) station track at Ala Moana terminal. However, no operations planning document describes any use for the additional tracks.

3.4 Maximum Line Capacity

Line capacity is a function of track configuration, passenger activity, station characteristics, vehicle characteristics (performance and length), and the minimum following distance between trains.

AHJV train control simulations purport to demonstrate a Safe Separation Headway of less than 90 seconds with minimal 20-second dwell times in conformity with grantee specifications.[37] No analysis is specifically provided by the grantee or AHJV showing how terminal turnbacks or dwell times at busy stations affect line throughput and capacity maximums.

AHJV did conduct simulations that it interpreted to indicate that the "**Non-Interference Headway**" with AW2 passenger loads and nominal peak dwell times is "about 133.9 seconds." At headways tighter than 133.9 seconds,[38] commercial velocity is compromised as trains are retarded enroute by conflicts with preceding trains. The grantee sets the "**Minimum Operating Headway**" at 115% of the Non-Interference Headway to allow "multiple trains, station stops, normal disturbances, passenger interference, etc." and to "ensure" smooth normal operations without train bunching and unscheduled stopping on the guideway.[39] This works out to 154 seconds during peak operations on the system.

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[37] AHJV Train Control Simulation Report C9M HNL 2X 002 02 February 24, 2011 Page 12
[38] AHJV Train Control Simulation Report C9M HNL 2X 002 02 February 24, 2011 Page 25
[39] HHCTC. TP-3 OPERATIONS & MAINTENANCE PERFORMANCE REQUIREMENTS October 2010 Page 25

Using the methodology specified in TCRP 100 and TCRP 8 Reports with parameters derived from the AHJV proposal, the PMOC was able to independently estimate the minimum sustainable headway along the line at **89** seconds. This methodology is described in an earlier spot report. Parameters employed are listed in Table 22. Note: This headway assumes substantial interference between trains.

Table 22. Minimum Headway Calculation Input Variables

Term	Units	Description	Source	Value
L	meters	length of the longest train	AHJV Spec	78.2
D	meters	distance—front of train to exit block	TCRP Default	10
K	constant	% service braking rate	TCRP Default	75
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	AHJV Spec	1.19
d_s	m/s^2	service deceleration rate	AHJV Sped	1.32
t_{br}	seconds	brake system reaction time	TCRP Default	1.5
v_{max}	km/h	maximum line velocity	Grantee Spec	88.5
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	Grantee Spec	0.0
Margin	seconds	Operating Margin	TCRP Default	20
Max Dwell	Seconds	Estimated dwell at busiest non-terminal station	AHJV Calculations	46

The PMOC could not determine whether the terminals pose a more severe headway constraint than 89 seconds. The question of terminal turnback impacts on minimum headways should be explored with the grantee.

Based on the discussion above, it is possible to report several minimum headways for the proposed infrastructure.

Table 23. Minimum Headway Estimates

Headway	Seconds	Comment
Minimum Operating Headway	154	Provides capacity to avoid interference between trains under a range of normal operating conditions
Non Interference Headway	133.9	Theoretical minimum headway avoiding interference between trains
Minimum Sustainable Headway	89	Based on TCRP formulae and PMOC calculations. Presumes substantial interference between trains. Does not consider the possibility of more severe conflicts at terminals

3.5 Maximum Person Capacity

Person capacity is the product of car capacity and line capacity. AHJV proposes to supply cars that will carry 32 seated and 127 standing passengers. The Project is designed to allow trains up to four cars in length for a "Comfort Load" of 636 passengers per train. Based on the minimum headways reviewed above and a peak load factor of 0.9, the maximum unidirectional person capacity of the Project as proposed is summarized in Table 24.

Table 24. Maximum Persons Per Hour Per Direction

Headway	Trains per Hour	Comfort Load per Train	Peak Hour Factor	Hourly Person Capacity
Minimum Operating Headway	23.4	636	0.9	13,381
Non Interference Headway	26.9	636	0.9	15,389
Min Sustainable Headway	40.4	636	0.9	23,153

From a practical perspective, the capacity estimate based on Minimum Operating Headway is the most realistic of the three figures since it provides the most substantial allowance to avoid interference between trains following one another down the line.

Should AHJV chose to operate four-car trains at a rate of 23.4 trains per hour, the service could accommodate up to 50% growth in peak ridership above the design year (2030) forecast peak flow of 8,982[40]. Once 50% growth in peak ridership has been reached, it will likely be necessary for the grantee to extend station platforms to accept longer trains.

3.6 Staffing

Per the requirements specified in OP 32A, this document also reviews the sufficiency of staffing proposed for the Project. The review summarizes and compares the staffing levels proposed by the grantee's selected vendor of O&M services (AHJV) with the universe of other "metro" systems operated in the United States. Separate benchmarks are reviewed for vehicle operations, vehicle maintenance, non-vehicle maintenance and administration.

3.6.1 Grantee Staffing Overview

During the sixth through tenth years of full operation of the system, AHJV proposes to operate the service with a staff of 289 full time employees, supplemented with a subcontracted cleaning force of unspecified size and a variety specialty contract support staff employed on an as-needed basis.

[40] Based on 8,084 peak hour passengers adjusted with a PHF of 0.9.

Table 25. AHJV Staffing Summary (2028)

Function	FTEs
AHJV Staff	
Operations	121
Vehicle Maintenance	67
Non Vehicle Maintenance	62
Management and Administration	39
Subtotal	**289**
Cleaning Contractors (PMOC Estimates)	
Vehicles	9.5
Stations and Facilities	22.5
Subtotal	**32**
Grand Total	**321**

3.6.2 Operations

Operations staff will be responsible for train control from the Operations Control Center (OCC) and customer service/vigilance in stations and on board trains. AHJV will assign 35 of the 121 operations staff to the OCC, to be responsible for oversight of train operations, support of the OCC functions, and dissemination of public information. Another 85 members of the operations staff will deliver or manage "steward" services. "*Stewards will ... provide customer service to passengers on-board and on station platforms, report errors, defects, failures and irregularities to the control room, provide assistance to the police and fire personnel in case of incidents or emergencies, rescuing and driving trains, if needed, provide monitoring of the cleanliness of trains and stations, open and close stations. Assistance to passengers includes, conflict management and crowd-control.*[41]"

Grantee specifications call for two field functions: service attendants (onboard trains) and station attendants (in stations) with minimum staffing levels for both functions. AHJV has combined the two job functions into a single roving job while adhering to the minimum staffing levels.

The typical heavy rail metro operation uses several more classes of personnel to provide onboard and station services. Operators run each train. (The system is "driverless".) On many systems guards/conductors are responsible for train door operation and onboard announcements. Station attendants/fare collectors are usually responsible for station oversight and fare collection. Inspectors rove to provide supervision and respond to emergencies and unusual circumstances as station attendants are often "tied" to their fare collection posts. With the level of automation proposed for the line (driverless trains, automatic fare vending and proof of payment), many of these job functions are superfluous. Most of the remaining functions are combined in the steward's job description, which is roughly analogous to the typical rapid transit inspector.

It is notable, and of no small concern, that neither the grantee's specifications nor AHJV's proposal specifically mention the essential fare inspection/enforcement role that is critical to stem fare evasion with the proof of payment fare regime. Fare inspection/enforcement is NOT included in the steward's job description. It is implied that fare inspection and enforcement may

[41] AHJV Proposal C9M HNL 00003 2 February 24, 2011 Page 3 – 184

be handled by the municipal police force. Information concerning the fare inspection/ enforcement process should be developed and supplied by the grantee.

Table 26. Operations Staffing Benchmarks

State	System	Number of Trains in Operation (Average Weekday)	Annual Train Miles (x1000)	Annual Vehicle Revenue Miles (x1000)	Annual Vehicle Operations Staff Hours	Train Miles per Operating Staff Hour	Revenue Vehicle Miles per Operating Staff Hour
MA	MBTA	58	3,976	22,475	2,209,553	1.80	10.17
NY	NYCT	589	40,266	352,524	20,475,891	1.97	17.22
NJ	PATCO	14	1,064	4,432	157,393	6.77	28.16
NJ	PATH	38	1,840	12,203	868,099	2.12	14.06
NY	SIRR	11	675	2,336	176,704	3.82	13.22
PA	SEPTA	50	3,296	16,887	1,382,599	2.38	12.21
DC	WMATA	131	12,228	71,803	3,727,978	3.28	19.26
MD	MD MTA	9	1,150	5,285	279,147	4.12	18.93
GA	MARTA	33	4,500	24,565	1,904,028	2.36	12.90
FL	Miami Dade	14	1,270	6,691	232,633	5.46	28.76
OH	GCRTA	11	1,125	1,789	174,811	6.44	10.23
IL	CTA	138	12,348	68,592	3,041,751	4.06	22.55
CA	BART	62	9,772	67,843	2,250,024	4.34	30.15
CA	LA MTA	11	1,373	6,077	297,936	4.61	20.40
HI	**HHCTC**	**37**	**4,411**	**8,402**	**251,680**	**17.53**	**33.38**

Notwithstanding the omitted revenue protection functions, the proposed staffing of the system heavily leverages the labor saving economies of automatic train operation, modern surveillance technologies and communication tools to field a very lean transport operation. Table 26 benchmarks the proposed staffing levels against the universe of other US heavy rail systems operating on the mainland. Data concerning existing operations are derived from National Transit Database Reports for 2009. Staffing for system is based on the year 2028 staffing plan provided by AHJV. All system staff members were presumed to work 2,080 hours per year.

The system will be the nation's first driverless metro. Owing to a combination of the staffing economies available from automated operations (vehicles and fare vending) and the very short two-car trains proposed by the system, the ratio of train miles to operating staff hours is forecast to be an order of magnitude more favorable than the most labor intensive operations. See Figure 10.

Figure 10. Train Miles per Operating Staff Hour

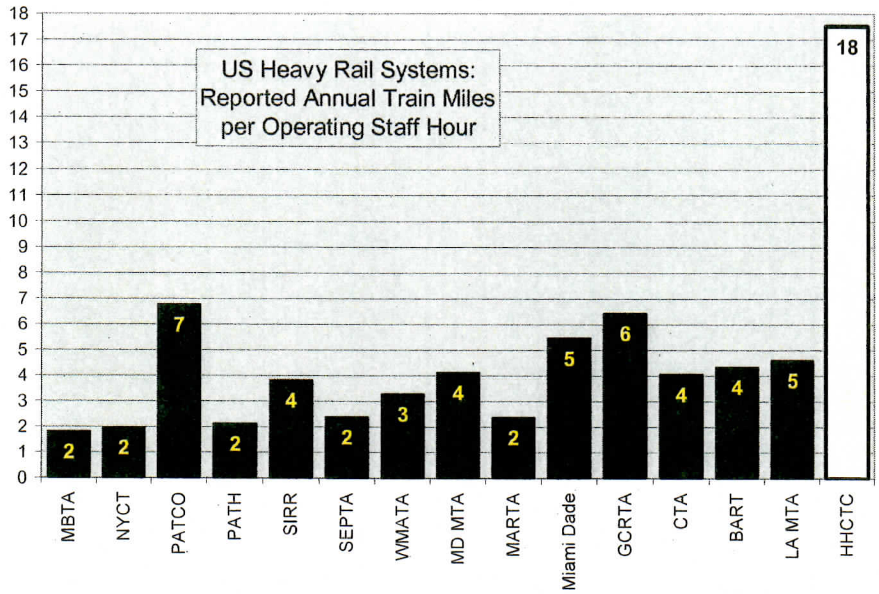
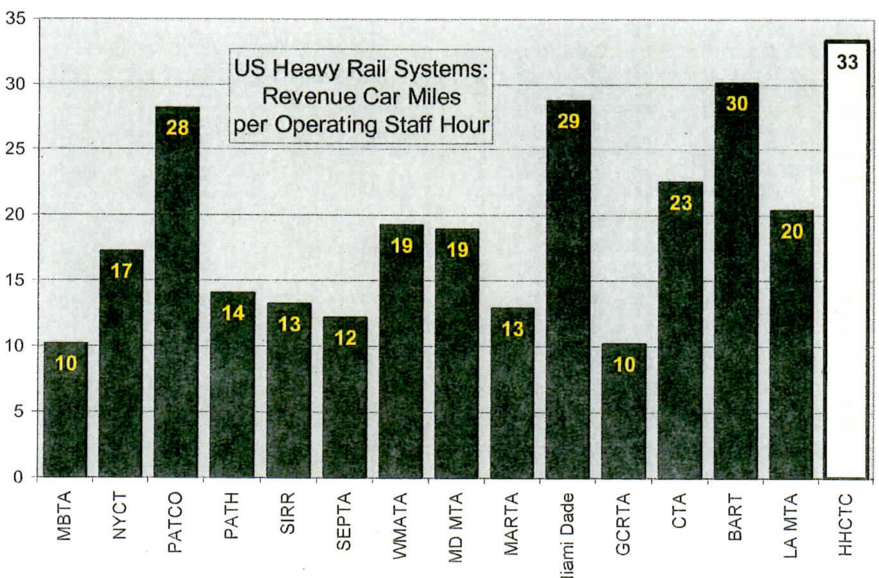


Figure 11 controls for train length by comparing the systems in terms of vehicle miles per staff hour. With this control in place, the comparison between Honolulu system and legacy systems is less stark. The Honolulu system is projected to be comparable to some of the other more heavily automated systems including BART, PATCO, Miami Dade, WMATA and MD MTA.

Figure 11. Vehicle Miles per Operating Staff Hour



When plans and staffing responsible for fare inspection and enforcement are finalized and included in the staffing estimates, it is expected that the benchmark forecasts for system will be reduced but remain favorable. This benchmark could be revisited when the fare enforcement questions are resolved.

Further work benchmarking the operations staff levels for Honolulu system against other driverless metros in Copenhagen, Vancouver, numerous French cities, Kuala Lumpur, and Malaysia would be useful to consider how mature driverless systems staff to provide station and car attendants that are not integral to routine train operation and fare collection functions.

3.6.3 Vehicle Maintenance

AHJV proposes a staff of 67.5 directly responsible for maintaining the 80-car fleet. The CSC expects to contract for vehicle cleaning services with an as-yet unidentified firm. Based on review of cleaning contracts and operations for other rapid transit operations, the PMOC estimates that nine (9) managers, supervisors, and cleaners will be employed for vehicle cleaning[42]. This yields an estimated 76.5 staff members assigned to vehicle maintenance and cleaning.

The staff estimates do not include specialty subcontractors and out-sourced services included on AHJV's preliminary list of vehicle maintenance activities that may be sub-contracted[43] including:

- Support Vehicle Maintenance: Service of Cars, Trucks, Forklifts
- Overhaul of Rolling Stock Components & Assemblies
- Vehicle Glass Replacement

Component overhauls and support vehicle maintenance are commonly outsourced, especially at smaller and newer systems. The PMOC is not aware of any rail transit operation that makes special arrangements for vehicle glass replacement.

Compared with US rapid transit properties, this represents an ambitious, but potentially achievable maintenance staffing program. Table 27 benchmarks that Honolulu system against mainland metro operations.

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[42] Jacobs Engineering, Management Audit of Contract Cleaning Services, prepared for Massachusetts Bay Transportation Authority, Boston, MA 2007

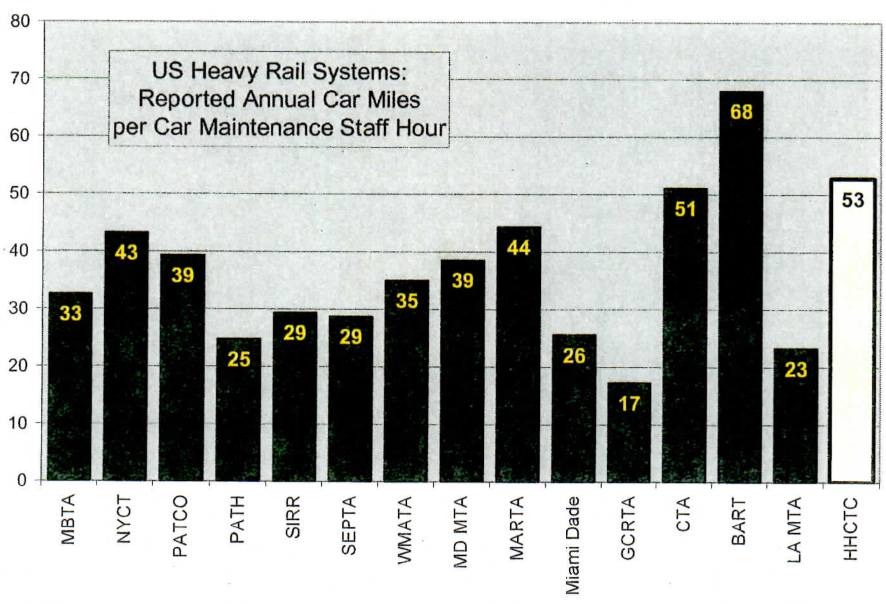
[43] AHJV Proposal C9M HNL 00003 2 February 24, 2011 Page 3 – 275

Table 27. Vehicle Maintenance Staffing Benchmarks

State	System	Vehicles in Maximum Service	Total Fleet	Annual Revenue Vehicle Miles (x1000)	Annual Vehicle Maintenance Staff Hours	Vehicle Miles per Maint. Hour	Thousands of Maintenance Hours per Fleet Vehicle	Thousands of Maintenance Hours per Peak Vehicle
MA	MBTA	334	440	22,475.0	690,567.0	32.55	1.57	2.07
NY	NYCT	5,388	6,317	352,524.6	8,155,918.0	43.22	1.29	1.51
NJ	PATCO	84	96	4,432.5	112,732.0	39.32	1.17	1.34
NJ	PATH	266	383	12,203.0	493,961.0	24.70	1.29	1.86
NY	SIRR	46	63	2,336.8	79,672.0	29.33	1.26	1.73
PA	SEPTA	278	369	16,887.3	588,504.0	28.70	1.59	2.12
DC	WMATA	850	1,128	71,803.3	2,050,283.0	35.02	1.82	2.41
MD	MD MTA	54	100	5,285.4	137,028.0	38.57	1.37	2.54
GA	MARTA	182	338	24,565.8	554,317.0	44.32	1.64	3.05
FL	Miami Dade	84	130	6,691.5	261,554.0	25.58	2.01	3.11
OH	GCRTA	22	60	1,789.0	103,338.0	17.31	1.72	4.70
IL	CTA	1,002	1,190	68,592.2	1,341,169.0	51.14	1.13	1.34
CA	BART	534	669	67,843.1	996,934.0	68.05	1.49	1.87
CA	LA MTA	70	104	6,077.7	261,111.0	23.28	2.51	3.73
HI	**HHCTC**	**74**	**86**	**8,402.2**	**159,120.0**	**52.80**	**1.85**	**2.15**

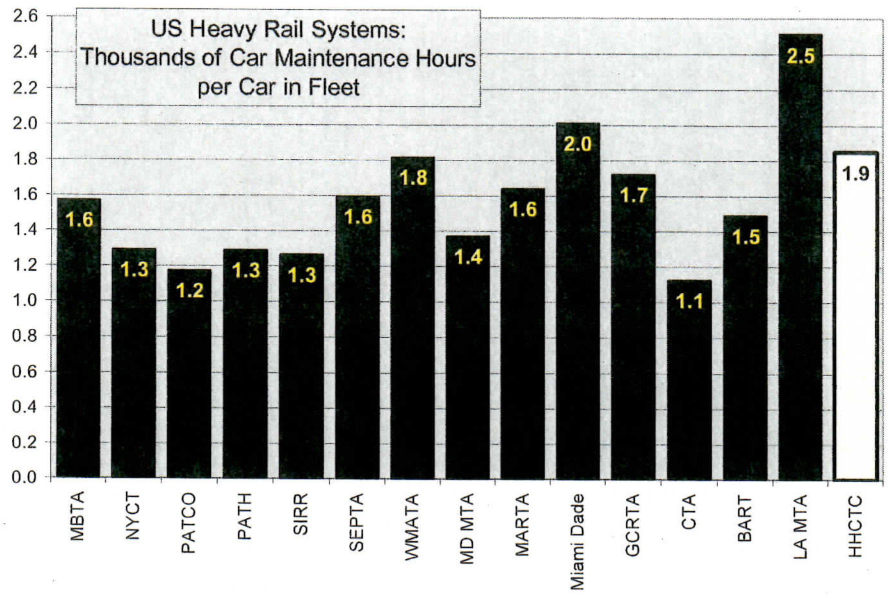
AHJV expects to be among the most efficient US rapid transit car maintenance operations, getting 53 miles of car operation per hour of maintenance and cleaning services. This level of performance is comparable to Chicago's CTA and the Bay Area's BART system.

Figure 12. Car Miles per Car Maintenance Staff Hour



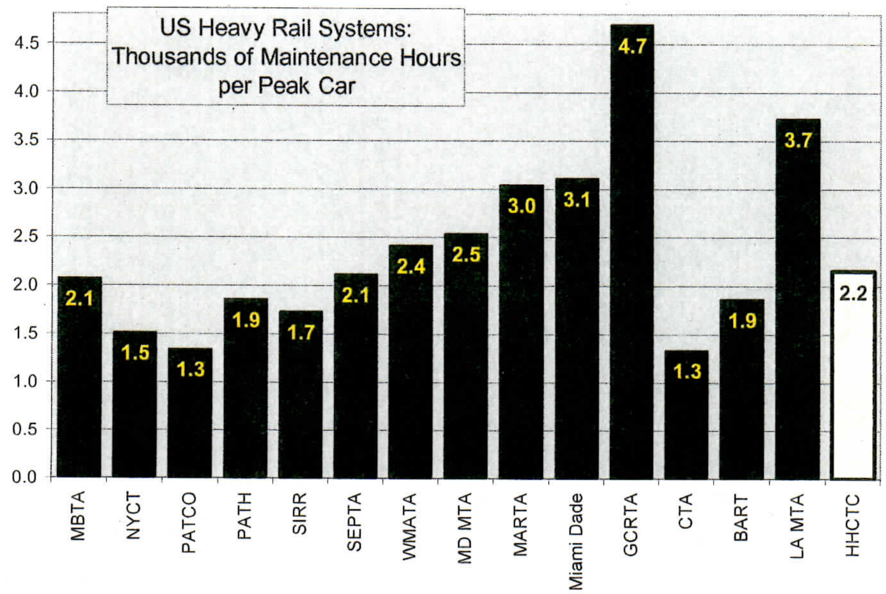
Some of AHJV's planned efficiency for the system reflects a "right sized fleet" with a minimum of number of vehicles requiring periodic maintenance and inspection. Figure 13 shows that AHJV actually plans to deliver more maintenance staff hours per vehicle in the fleet than most US heavy rail properties.

Figure 13. Maintenance Staff Hours per Fleet Vehicle



When maintenance hours per peak vehicle are benchmarked, the system falls near the industry norm. PATCO and CTA are the industry leaders, closely followed by NYCT. Cleveland and Los Angeles are unfavorable outliers (See Figure 14).

Figure 14. Maintenance Hours per Peak Vehicle



At this stage in the project development process, the PMOC is satisfied with grantee's proposed car maintenance staffing levels.

3.6.4 Infrastructure Maintenance

AHJV proposes 62.5 staff members directly responsible for maintaining the 20-mile, 21-station infrastructure network necessary to operate the system. The CSC expects to contract for station and facilities cleaning services. AHJV envisions four teams of station cleaners and a special projects cleaning team. Based on review of cleaning contracts and operations for other rapid transit operations, the PMOC estimates that 22 managers, supervisors and cleaners will be employed to clean stations, parking lots and other facilities. This yields an estimated staff of 84.5 assigned to infrastructure maintenance and cleaning.

The staff estimates do not include specialty subcontractors and out-sourced services included on AHJV's preliminary list of infrastructure maintenance activities that may be sub-contracted,[44] including:

- Heavy Track Maintenance: Possible expertise support from track maintenance companies
- Rail Grinding
- Geometrical Survey: Gauging, vertical and horizontal alignment
- Rail Welding
- Maintenance of Lifts, Escalators and other safety related devices such as cranes and fire alarm system in the Maintenance and Storage Facility (MSF)

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[44] AHJV Proposal C9M HNL 00003 2 February 24, 2011 Page 3 – 275

- Maintenance of MSF Specialized Equipment (e.g. Wheel Truing Machine, Under floor Lifts)
- MSF Facility's maintenance, such as emptying and cleaning of water treatment tanks, painting
- Specialist Civil Works Inspections and Maintenance

Most of these functions are commonly outsourced, especially at smaller and newer systems. Systems with extensive investment in vertical circulation equipment have tended to find that in-sourcing escalator and elevator maintenance produces superior system availability and higher customer satisfaction. With large numbers of elevators and escalators, in house maintenance can also be more cost effective. Given the lack of other rail systems on Oahu, it is possible that the grantee may find that the use of specialty rail firms for functions such as welding, grinding and testing may not be as cost effective as it is on the mainland.

Compared with other US rapid transit properties, the grantee's infrastructure staffing plans are very ambitious, especially given the proposed hours of operation. With 20 hours of service each weekday and a patrol train required each day before the start of service, it may be especially difficult to reconcile system availability goals with track outages required for some maintenance operations. Additional staff may be necessary to provide the resources for high levels of availability over the long haul. With the passage of time, the O&M contractor (and the grantee) may realize that it has underestimated the magnitude of the infrastructure maintenance workload. Table 28 benchmarks the Honolulu system against mainland metro operations.

Table 28. Infrastructure Maintenance Staffing Benchmarks

State	System	Directional Route Miles	Total Track Miles	Annual Non Vehicle Maintenance Staff Hours	Thousands of Maintenance Staff Hours per Directional Route Mile	Thousands of Maintenance Staff Hours per Track Mile
MA	MBTA	76.3	108.0	1,276,822	16.73	11.82
NY	NYCT	493.8	829.9	15,194,468	30.77	18.31
NJ	PATCO	31.5	38.4	197,850	6.28	5.15
NJ	PATH	28.6	43.1	807,838	28.25	18.74
NY	SIRR	28.6	32.7	174,199	6.09	5.33
PA	SEPTA	74.9	99.8	612,602	8.18	6.14
DC	WMATA	211.8	269.8	3,201,928	15.12	11.87
MD	MD MTA	29.4	34.0	284,868	9.69	8.38
GA	MARTA	96.1	103.7	987,486	10.28	9.52
FL	Miami Dade	45.0	55.9	437,269	9.71	7.82
OH	GCRTA	38.1	41.9	185,786	4.88	4.43
IL	CTA	207.8	287.8	1,647,338	7.93	5.72
CA	BART	209.0	267.6	1,283,648	6.14	4.80
CA	LA MTA	31.9	34.1	301,337	9.45	8.84
HI	**HHCTC**	**39.9**	**45.6**	**175,760**	**4.40**	**3.86**

Figure 15 illustrates how AHJV's infrastructure staffing plans call for it to be the most parsimonious of all US rapid transit operations. This may be unrealistic in the long run, especially in light of the system's high reliance on precision automation tools to replace operating manpower.

Figure 15. Thousands of Infrastructure Maintenance Hours per Route Mile

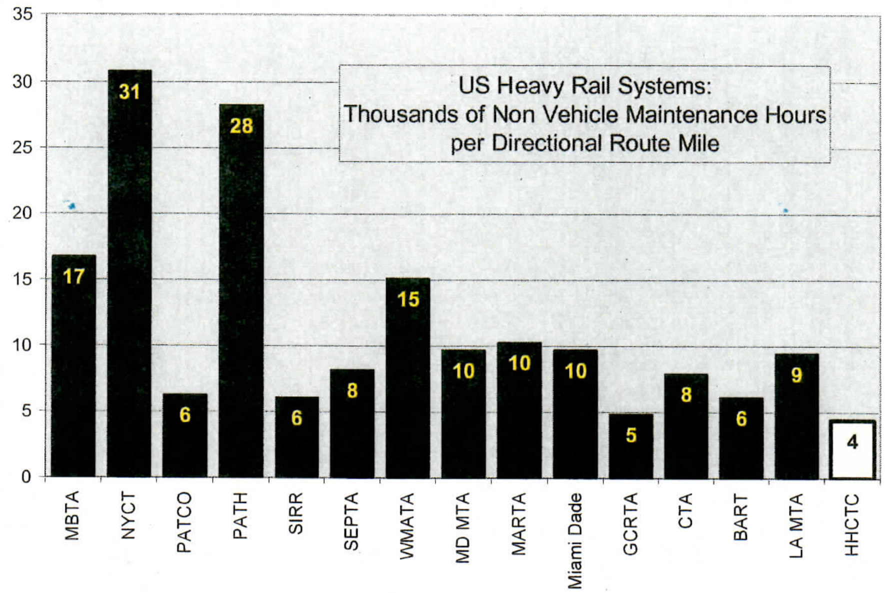
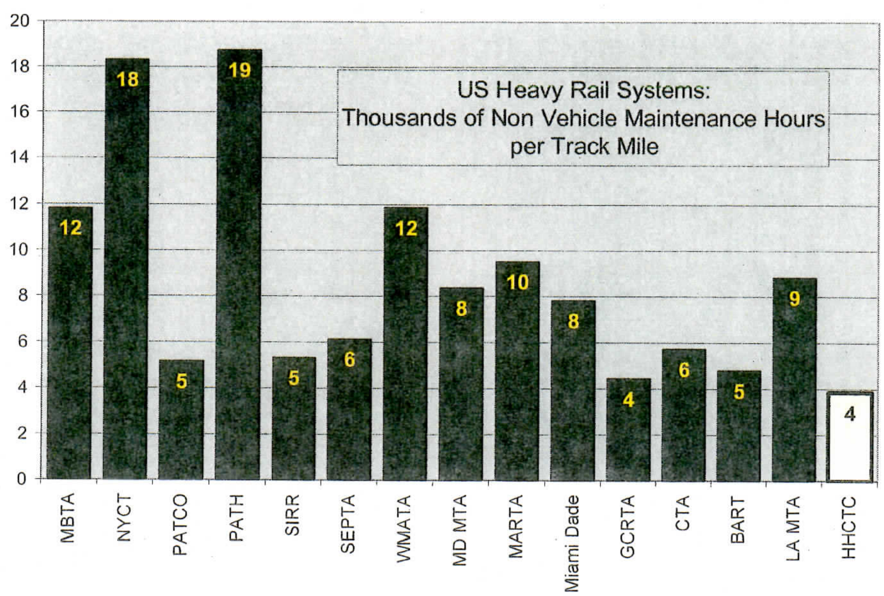


Figure 16 reinforces the suspicion that AHJV and the grantee may be underestimating the maintenance workload required to sustain the system infrastructure and operation.

Figure 16. Thousands of Infrastructure Maintenance Hours per Track Mile



The PMOC suggests that the grantee may wish to review infrastructure maintenance staffing assumptions with AHJV to ensure that expectations are realistically aligned with service availability and customer service goals.

3.6.5 Management and Administration

AHJV proposes a staff of 39 responsible for management and administration of the O&M contract.

Table 29. O&M Management and Administration Staffing

Function	Staff
General Management	3
Safety and Security	4
Safety, Quality Assurance and Environment	4
Human Resources	6
Customer Service	6
Public Relations	1
Finance	8
Engineering	3
Information Technology	4
Total	**39**

The proposed organization chart is confusing in one detail: Two sub-departments are identified as responsible for Safety. AHJV and the grantee may wish to revisit the organization structure to eliminate the potential for confusion, rivalry, overlap, and duplicative effort concerning this critical dimension of service provision.

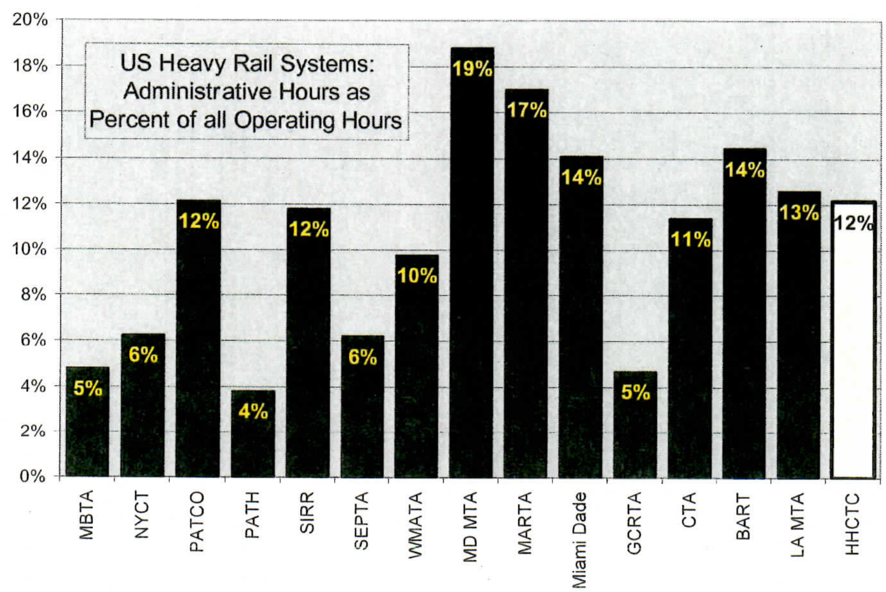
AHJV's proposal indicates that it is considering outsourcing two administrative functions: Maintenance of information technology hardware, and security at the maintenance and storage facility. These functions are routinely outsourced by transit agencies.

The grantee's specifications imply that the grantee will be responsible for crime fighting and fare enforcement on the system. Staffing levels for these functions are not identified in the grantee's plans. The grantee should not underestimate the staffing and diligence necessary to administer an effective fare evasion prevention program.

The grantee and AHJV plan to share revenue management responsibilities in a relatively unique and potentially awkward way. Grantee forces will service the TVMs, lifting cash and replenishing ticket stock. AHJV will be responsible for TVM maintenance and repair. AHJV will be responsible for preparing revenue reports from the TVM system. The grantee will hold and deposit all revenue. The parties should obviously pay close attention to the process of coordinating revenue processing and accounting functions to avoid embarrassing opportunities for leakage and resultant finger pointing.

Notwithstanding the omission of passenger security and revenue management from the administrative functions, the aggregate level of staffing planned for management and administration seems reasonable in comparison with peer agencies, as shown in Figure 17. Approximately 12% of the staff and full time contractors to be hired by AHJV will be responsible for management and administrative functions. This is generally in line with other US rapid transit properties. It is especially notable that AHJV's 12% is quite close to its two closest peers, BART and PATCO, which are also uni-modal "rail-only" transit operations. Most other peers are generally part of much larger transportation agencies that generally run related bus operations. (Although RTD runs Honolulu's The Bus operation, the grantee will not be involved in that mode of transportation.) The larger multi-modal agencies tend to enjoy economies of scale that are not available to smaller and single-mode operations.

Figure 17. Administrative Staff as Percent of Total Staff



3.6.6 Key Findings and Recommendations

Operations - With 121 full time staff, AHJV plans to heavily leverage the labor saving economies of automatic driverless train operation, ticket vending machines, modern surveillance technologies, and communication tools to field a very lean transport operation. One oversight of no small concern is the failure to mention the essential fare enforcement role that is critical to stem fare evasion. When plans and staffing responsible for fare inspection and enforcement are finalized and included in the staffing estimates, it is expected that the forecast staffing benchmarks for system will be reduced but remain favorable. This benchmark could be revisited when the fare enforcement questions are resolved.

Further work benchmarking staffing relative to the small field of established driverless metros operating in Denmark, Canada, France, Malaysia, and Singapore would be useful to consider how mature driverless systems staff to provide station and car attendants that are not integral to routine train operation and fare collection functions.

Vehicle Maintenance - AHJV proposes 67.5 staff members directly responsible for maintaining the 86 car fleet. The PMOC estimates another nine (9) managers will be employed for vehicle cleaning, for a total staff of 76.5 assigned to vehicle maintenance and cleaning. Comparing this with mainland rapid transit operations, the PMOC is satisfied with grantee's proposed car maintenance staffing levels at this stage in the project development process.

Infrastructure Maintenance - Including cleaning contractors, the PMOC estimates that 84.5 staff members will be assigned to infrastructure maintenance and cleaning. Compared with other US rapid transit properties, the infrastructure staffing plans are very ambitious. With the passage of time, the O&M contractor (and the grantee) may realize that it has underestimated the magnitude of the infrastructure maintenance workload. The PMOC suggests that the grantee review infrastructure maintenance staffing assumptions with AHJV to ensure that expectations are realistically aligned with service availability and customer service goals.

Management and Administration - AHJV proposes a staff of 39 for management and administration of the O&M contract. The proposed organization chart is confusing in one detail. Two sub-departments are identified as responsible for Safety. AHJV and the grantee may wish to revisit the organization structure to eliminate the potential for confusion concerning this critical dimension of service.

The grantee's specifications imply that the grantee will be responsible for crime fighting and fare enforcement. Staffing levels for that function are not identified in the grantee's plans. The grantee should not underestimate the staffing and diligence necessary to administer an effective fare-evasion prevention program.

The grantee and AHJV plan to share revenue management responsibilities in a relatively unique and potentially awkward way. The parties should closely coordinate shared revenue processing and accounting functions to avoid embarrassing opportunities for leakage and resultant finger pointing.

Notwithstanding the omission of passenger security and revenue management from the administrative functions, the aggregate level of staffing planned for management and administration seems reasonable in comparison with peer agencies. Approximately 12% of the staff and full time contractors to be hired by AHJV will be responsible for management and administrative functions. This is generally in line with other transit systems.

3.7 Other Capacity Topics

FTA's OP 32A guidance raises a number of other transit capacity topics, not all of which are discussed in detail within this report. Although some of these topics are not applicable to this Project, beyond the purview of the PMOC, or applicable only to other project phases, this report section attempts to address them.

3.7.1 Capital versus Operating Cost and Service Trade-offs

Federal Guidance

Assess long-term vs. short-term capital and operating cost and service trade-offs inherent in capacity choices.

Findings

The grantee's decision regarding trade-offs between capital costs and operating costs and level-of-service was made early in the project, when the grantee decided to proceed with design of a grade-separated, rail-on-rail, driverless system. In making that decision, the grantee assured that the finished project would not be subject to the same traffic problems that it was attempting to alleviate, as sometimes happens in lesser-cost capital programs. That decision being well thought out and firmly entrenched in the environmental documents, it is no longer subject to discussion.

The grantee has also made a long-term capital cost investment in building platforms that are already long enough for the eventual use of four-car trains, thus assuring capacity beyond its currently-projected needs.

3.7.2 Impact upon the Capacity of the Existing Transit System

Federal Guidance

If the project will become part of an existing transit system, assess the project's impact upon the capacity of the existing transit system, for example, will the project boost the carrying capacity of the entire system, overload the system or create bottlenecks. Consider whether the grantee can build, operate, and maintain its entire system without reducing existing public transportation services or level of service to operate the proposed project. Consider the grantee's financial and staffing capabilities to operate and maintain the project in addition to its existing system.

Findings

Since this is the first rail system to be implemented by the grantee, there are no adverse effects on the "existing transit system," which consists only of rubber tired road vehicles (buses and paratransit services). The rail line will actually boost the capacity of the bus network by providing express service along the service network's main east-west trunk. The project is not causing any physical obstacles to the grantee's ability to maintain or even expand its bus system.

Staffing capabilities to operate and maintain the project are the subject of Section 3.6 ("Staffing") of this report.

The grantee's financial capabilities are more properly the subject of the FMOC's oversight. While the PMOC does not know of any reason to doubt the grantee's financial strength, it nevertheless defers to the FMOC's judgment in those matters.

3.7.3 Guideway Route and Station Design

Federal Guidance

The PMOC shall gain an understanding of the following with respect to the project:

- *Route information*
  - *Selection*
  - *Route and station coordination for ease of transferring among passenger transport agencies*
  - *Requests and requirements by customers, public officials, other departments, or the general public*
  - *Paratransit operations*
- *Schedule and Staffing*
  - *Headways*
  - *Schedule adherence*
    - *During construction*
    - *During full revenue service*
    - *Due to weather-related emergencies and other unexpected occurrences*
    - *Sufficiency of staffing*
    - *Sufficiency of funding for operations considering agency finances*
- *Station design*
  - *Pedestrian access from public way; intermodalism or connectivity with other passenger transport*
  - *Fire exiting design criteria for public areas, platforms, and stairways*
  - *Capacity of escalators, elevators, stairs,*
  - *Dimensional and clearance requirements of ADA*

The PMOC shall evaluate grantee's documentation for route information, schedule and staffing for proposed operations and station design.

Findings

The selection of the route was essentially complete, except for a couple of later adjustments, at the end of Alternatives Analysis. The PMOC has certainly made itself aware of most of the route's features, which are described in Chapter 2. Section 3.3 of this report discusses the issues of the scheduling of trains and headways and Section 3.6 deals with staffing. While issues with station design have been and will continue to be a constant subject of PMOC scrutiny, they are not addressed in this report, since the stations are not expected to be a controlling factor in this project's transit capacity. If constraints to capacity become apparent as station designs progress, they will be addressed by the grantee and its designers, with oversight provided by the PMOC.

3.7.4 Maintenance Infrastructure

Federal Guidance

The PMOC's evaluation shall include capacity of the project's maintenance infrastructure (as-built) such as shops, yards, secondary maintenance, component *rebuilds or capital inventory requirements using a structured and methodical approach that makes maximum use of previous TRB work and other existing engineering data.*

Findings

In the course of its ongoing Project reviews, PMOC has given consideration to the MSF complex and found it to be reasonably sized and efficiently organized. Given the fact that both the MSF and the CSC are soon to be under contract, there is a likelihood that the currently planned MSF configuration will undergo some changes as the DB and DBOM contracts move into Final Design. The selected CSC has, for example, expressed its desire to convert some of the yard to unmanned operations, which will likely lead to other changes in the complex. In short, PMOC expects the DB and DBOM contractors, who have the contractual responsibility to do so, to address and resolve shop, yard, and maintenance issues as they arise.

3.7.5 Build Out Approach

Federal Guidance

Assess for cost effectiveness the proposed "build out" approach for the transit project given the revenue operations date, and the 20-year, 50-year, and 100-year horizons. Recommendations should account for the time value of money as well as the costs associated with various construction approaches.

Findings

The PMOC has not received much information on the grantee's proposed build out approach beyond the current project. It is known that the grantee intends to eventually extend the rail system to Kapolei on the 'Ewa end and to UH Manoa and Waikiki on the Koko Head end, although neither the routing nor the mode for those extensions has been finalized. The Stations VE team and the PMOC offered suggestions in how the grantee could reconfigure its Ala Moana Station to allow more flexibility in design for the UH Manoa and Waikiki extensions, but the grantee will not pursue that idea further until grantee Center Segment designers are under contract.

PMOC would prefer that at least the two high demand Koko Head extensions be given consideration at this time, but understands the grantee's plans to postpone them, likely to at least the 20-year horizon. Any planned build out beyond those discussed would likely fall into the 50-year or 100-year horizon.

3.8 Conclusion and Recommendations

3.8.1 Car Capacity

The grantee's peak hour capacity specifications, as stipulated to vendors, fall considerably short of the capacity that had been contemplated and discussed when the 2009 Fleet Sizing Report was prepared. The hourly passenger capacities specified by the grantee were calculated in a manner that eliminated virtually all capacity for peak-of-the-peak surges in ridership. AHJV's proposal to offer service with an annually increasing frequency in response to annually increasing peak demand is very attractive until it is realized that the proposed frequency is not supported by the proposed train control system. Close inspection of the pattern of boardings and alighting raises concerns regarding passenger trip duration and comfort standards.

- Despite assurances to the contrary, the operating plan provides no capacity for any surge in peak ridership after the fifth year of operations and falls well short of the surge that would have been accommodated by the 2009 Fleet Sizing Report. The level of forecast peak crowding fails to meet AHJV's stated standards but lies within a range that is generally considered acceptable for peak rapid transit passenger comfort for a typical rapid transit system.

- AHJV's proposal to provide required capacity for 2026 and subsequent years calls for it to operate service at less than its reported minimum operating headway. Since the minimum headway includes a 15% cushion above the non-interference headway, it is possible that service could be operated without degradation on some days. But on many days service would be degraded with longer trip times and more uneven service than had been specified as acceptable.

- The PMOC's final car capacity concern is more qualitative. When fully operational, the Project is forecast to carry some of the longest average passenger trips of any US rapid transit system. The vehicles planned for the service do not seem to offer a degree of comfort suitable for the journey length. Thus, while the capacity of the proposed system falls within the average range for typical rapid transit systems, it falls well short of the seating capacity offered by the transit lines that carry passengers for journeys of similar length and duration. The expectation that passengers in Honolulu would be willing to endure such long trips standing on crowded trains may not be realistic. Substantial fractions of the forecast ridership base may chose to avoid the system under such conditions.

It is recommended that the grantee and AHJV confer regarding plans to operate at frequencies that violate the minimum operating headway. A possible response would be to offer service with longer trains operating at four-minute headways. The change in overall fleet size necessary to operate with three-car trains at slightly longer headways should be negligible. The fleet would also include a number of presumably less expensive middle cars and the level of comfort (seats/passenger) afforded passengers that are not riding in the peak of the peak would be increased. Operating at four-minute peak headways would also provide more capacity for surges in demand during the first several years of the contract. Changes in the proposed consist size may, however, require modification to the vehicle order if some middle cars would have to be substituted for an equivalent number of end cars in the final contract.

3.8.2 Running Times

Estimates of station-to-station running times vary between the AHJV's O&M proposal, vehicle performance simulations, and train control simulations. It is understood why the various estimates would not agree, but it is not clear why the most conservative estimates from the train control simulation are not used in the O&M proposal.

3.8.3 Dwell Times

The grantee's approach to forecasting station dwell time has changed several times since the last formal capacity review. Each change has added dwell time to the overall travel time. The cumulative effect of the changes has (in the aggregate) virtually eliminated earlier discrepancies between PMOC estimates based on TCRP 100 standards and the dwell times proposed by the grantee or its operator, AHJV. While it is not clear whether the grantee's method is justified, it does yield credible estimates of aggregate dwell time.

3.8.4 Round Trip Time and Terminal Turnback Time

The grantee's specifications indicate that the round trip time necessary for a train to complete one circuit around its route should not exceed 90 minutes. AHJV's Technical Proposal calls for a round trip time of 89:33 or 89:51. However, the time necessary to turn the train between revenue trips is not explicitly discussed by AHJV in its O&M proposal.

AHJV's Train Control Simulation Report more explicitly considers how turnbacks at East Kapolei and Ala Moana will be accomplished. It determines and illustrates that, at headways of less than 240 seconds (four minutes), the following train behind any train turning at either terminal presents a conflict for its turning leader until the second train arrives at the terminal (i.e., the first train either must make a very quick turn or else it can't leave for its return trip until its follower clears the terminal interlocking). Operationally, this circumstance sets the minimum turn time at terminal stations to a value roughly equivalent to the prevailing service headway. This margin of time is much greater than had been considered in the O&M proposal and its resulting fleet size estimates.

The timing and sequencing of turnbacks at stations must be explicitly considered in determining the number of consists required to provide service. None of the simulations documented in the AHJV simulation report integrate line operations with terminal turnbacks. Consequently, the PMOC can only speculate how terminal turnbacks will affect peak round trip times delivered on the network. It is possible that, when terminal time is fully considered in operations planning, one additional peak consist beyond AHJV estimates may be required in years of full operation.

For capacity planning purposes, PMOC recommends that the grantee and AHJV prepare a simulation report showing how peak operations with dwells and turnbacks will be delivered in the last year of the proposed O&M contract (2028) or the design year (2030).

3.8.5 Maximum Line and Person Capacity

The Minimum Operating Headway of 154 or 155 seconds represents the most frequent service that could be reliably offered within the grantee's 45-minute end-to-end travel time goals. A four-car train is the longest consist that can be accommodated by the station design. Using a Comfort Load capacity of 32 seated and 127 standing passengers and the grantee-specified Peak Hour Factor of 0.9, the maximum person capacity of the system is 13,381. This provides for 50% growth over the design-year peak flow of 8,982 passengers. Once 50% growth in peak ridership has been reached, it will likely be necessary for the grantee to extend station platforms to accept longer trains.

3.8.6 Staffing Capacity

The staffing review found areas of concern with respect to fare enforcement, infrastructure maintenance staffing, safety management, and revenue processing. It also suggests that further benchmarking of operations relative to the small field of established driverless metros operating in locations such as Denmark, Canada, France, Malaysia, and Singapore may be warranted.

3.8.7 Final Observations

- The Project meets its stated purposes and goals, to provide safe and reliable transit service to the Honolulu community.
- The project is both "right-sized" and justifiable in its choice of technology.
- The project has rightly taken advantage of its substantial scale as evidenced by its obtaining bids that are favorable in relation to expectations.
- By locking in operating and maintenance costs with the CSC and by using a driverless vehicle, the grantee has assured reasonable operating and maintenance costs.
- Rebuild costs could be another issue, as the track structure would be difficult to replace under traffic.
- The grantee needs to resolve a number of issues with its Car Builder/Systems Designer and Builder/Operator, the CSC, particularly as they relate to
  - Seating capacity
  - Train Headways in the Peak Period and the Maximum Operating Headway
  - 2-car versus 3-car or 4-car trains
  - Possible substitution of M-cars (middle cars) for some of the E-cars (end cars) in the vehicle order
  - Terminal operations and efficient turnbacks.
  - Adequacy of maintenance staffing.

4.0 OP 32C: PROJECT SCOPE REVIEW

4.1 Purpose

Per FTA Oversight Procedure 32C, Project Scope Review, the PMOC is expected to verify that the scope of the project:

- is represented by the totality of all contract plans and specifications
- is internally consistent
- is defined to a level appropriate for the project development phase
- is consistent with the estimated cost and schedule

Monitoring scope through the various phases of project development should benefit cost control and aid in the management of risks inherent in the design and construction process. The scope is initially established through development of alternatives and the selection of a Locally Preferred Alternative (LPA). At that point, the scope is defined only in general terms; it is not fully developed until after the completion of the subsequent preliminary engineering (PE) and Final Design phases. The ultimate scope is then the one established and funded by the FTA through an FFGA.

The objective of this review is, in the words of OP 32C, "to assess the grantee's definition of the project scope through drawings, specifications, narratives, third party agreements, plans for project delivery, etc., for adequacy and completeness, given the phase." PMOC will also be looking for the documentation's internal consistency, compliance with laws, regulations, and policies, bid-ability and constructability.

4.2 Methodology

OP 32C provides, in narrative and checklist form, lists of questions that must be answered and requirements that must be met prior to a project's approval to graduation into its next phase of project development. PMOC's process of this review began over two years ago when it was first assigned the oversight role on the Project. That process has continued through site visits, monthly meetings, workshops, review of documents, and continuous monitoring.

This report builds on that ongoing process of project development and attempts to answer, in report form, how well the grantee is meeting the requirements of the FTA and, perhaps more importantly, those of the public and the local constituency that the Project aims to serve.

Because the project includes contracts of different types that are at different levels of completion, this report will often provide multiple answers to the questions posed by OP32C document, as the circumstances of the varying contracts will elicit different responses.

The grantee is utilizing both traditional (Design/Bid/Build or DBB) and alternative (Design/Build or DB and Design/Build/Operate/ Maintain or DBOM) project delivery methods for the various contracts. The WOFH Segment DB Contract, Kamehameha Highway Segment DB Contract, and the MSF DB Contract have all been awarded, and the Core Systems DBOM Contractor has been selected by the time of this report. The former three are all DB contracts, while the latter, the CSC, is a DBOM-type contract, wherein the contractor will be responsible for designing and building the vehicles and the systems-related project elements while also being responsible for operations and maintenance of the same for a specified period after the Revenue Service Date (RSD). Only the two eastern line sections (Airport and City Center) and the stations have not yet been bid, as these are the contracts to be designed and built using the traditional DBB method.

The OPs describe the importance of a good performance specification for projects using alternative contract delivery methods. Through this document, the grantee both specifies the construction contractor deliverables and cedes to the contractor certain of its own rights to make detailed design decisions. Because of the nature of a design-build (or other alternative delivery) contract, changes in scope occurring after contract award can be much more costly than similar changes made during implementation of more traditional DBB contracts. For these reasons, this report differentiates between reviews of parts of this Project that use traditional DBB methods and parts that use alternative project delivery methods. Clearly, there is less leeway in the expectations for PE in a DB or DBOM contract than there is for a traditional contract entering into Final Design. The bid documents of a DB or DBOM contract must be more explicit in defining the expectations for the contractor, as the grantee will have less say after contract award.

This review consists of a text description of the findings along with an item-by-item check-off using the checklists and requirements of OP 32C and OP 51 ("Project Scope Review" and "Readiness to Enter Final Design," respectively).

4.3 Review

4.3.1 Changes in Project Scope Since Last Major Milestone

The project has incorporated one major alignment change since the project's last major milestone, entry into PE, which was the incorporation of the Ualena Street Option into the alignment. This change was made to avoid complications with landing and takeoff patterns associated with Honolulu International Airport's Runways 4R and 22L and to save an estimated $43 million in extra costs that would have resulted from modifications to those runways. Another major change underway is the reconfiguration of the Ala Moana Station, in response to a Value Engineering (VE) workshop proposal and the desire to create a simpler, less expensive, and easier-to-expand station at the eastern terminus of the line. Various other changes have been proposed in response to both VE proposals and Alternative Technical Concepts (ATC) proposed by contract bidders.

The change to the Segment III (Airport) contract PE plans to accommodate the Ualena option has been incorporated. All the other changes are still in varying stages of development and are to be incorporated during Final Design.

Another major change was the withdrawal of the initial shuttle service from the PE scope, which was originally designated as Operating Segment 1. Project milestones and schedule were impacted and subsequently redressed with the project schedule being reworked. This initial operating service will no longer be provided. Benefits were realized from this, allowing for more flexibility within the schedule for the first two construction segments. Per the Rail Fleet

Management Plan (RFMP), the commencement of revenue service will take place in three progressive stages beginning in 2015, with initial service between East Kapolei and Aloha Stadium Station, then expanding to Middle Street Transit Center Station in 2017. In 2019, the system is expected to serve all 21 stations for the full 20-hour operating day. The grantee does not anticipate this revised schedule of phased openings to adversely affect overall service.

There has also been a Core Systems Contractor (CSC) scope change to automate the Maintenance and Storage Facility (MSF). The scope now calls for full ATO within the limits of the MSF. This is a fundamental change to the CSC deliverables and will impact both the operations and performance of the MSF.

An entirely new set of Value Engineering (VE) alternatives was introduced into the project dialog by the Airport and City Center VE Workshop, held April 11-15, 2011. These alternatives included varying methods of foundation construction, substitution of pre-cast girders for segmental trapezoidal boxes, modifications to the alignment, restructuring of contract packaging, and elimination of the Owner Controlled Insurance Program (OCIP). The official VE report was issued in August 2011, with accepted alternatives including profile changes, minor realignments, application of a number of foundation-related methodologies, and the elimination of OCIP.

4.3.2 Additional Known or Anticipated Changes in Project Scope

The grantee has accepted numerous changes proposed by its Stations VE Workshop and a number of DB bidders on contracts for which RFPs have already been solicited. For those changes proposed by DB bidders (Alternative Technical Concepts or ATC), accepted changes will be implemented into the design and eventual construction by the winning bidders after contract award and Notice to Proceed (NTP). VE concepts will be referred to station designers as they are contracted. The proposed and accepted VE changes include:

- Modifying Ho'opili Station, reducing its footprint and delay construction of an overhead pedestrian walkway
- Modifying West Loch Station to better connect bus transit area to station entry plaza and reduce building footprints, canopy coverage and number of escalators
- Modifying Waipahu Transit Center Station, reducing its footprint, canopy coverage and number of escalators
- Modifying Pearlridge Station, moving fare gates and reducing its footprint and canopy coverage
- Modifying Aloha Stadium Station, revising its stair and escalator orientation, ground floor enclosures, entry point, and platform and bus canopy coverage
- Modifying Pearl Harbor Station, minimizing its mauka entrance, moving its platforms, and reducing its canopy coverage
- Adding elevators and making other improvements to Airport Station
- Modifying Middle Street Transit Center Station by reducing concourse bridge width and platform canopy coverage and reconfiguring stair routes and fare gate provisions. This station is also affected by an alignment change proposed by the guideway VE.
- Modifying Kalihi Station by adding a concourse, minimizing the station entry area, reconfiguring the platform, and reducing the canopy coverage

- Modifying Kapalama Station by adding a concourse, minimizing the station entry area, reconfiguring the platform, and reducing the canopy coverage
- Modifying Chinatown Station by minimizing the station entry area, reducing the platform canopy and providing for future fare gates at the concourse and platform
- Modifying Downtown Station, eliminating concourse, adding pedestrian bridge, providing end loaded platform, adding emergency stair exit to median and reducing canopy coverage
- Modifying Civic Center Station by minimizing station entry area and reducing the platform canopy
- Modifying Kaka'ako Station by eliminating ground-level enclosures, minimizing station entry area, channeling to single entry point, and reducing platform canopy coverage
- Changing stair riser finish at all stations to concrete rather than granite veneer
- Using exposed aggregate rather than colored and stamped concrete at all station plazas

The grantee is not revising its PE station drawings to reflect these changes. The grantee will give direction to its station package Final Designers regarding how and where these and other review comment changes are to be incorporated, once permission to enter Final Design is granted and the station design contracts are let.

ATCs proposed by bidders and accepted by the grantee include:

- Using photovoltaic cells on roofs of MSF buildings
- Installing Blue Light Stations/Emergency Telephones
- Using a mobile data system
- Adding train detection
- Using the Thales system to prioritize merging train traffic according to the operating schedule
- Eliminating wayside indicators
- Circuitless secondary tracks
- Sliding doors
- Plinthless track construction

The grantee also gave conditional approval for other ATCs proposed by DB or DBOM bidders. The implementation of these ATCs is the responsibility and discretion of the winning DB or DBOM contractors, since they are, by definition, alternatives to the design specified by the grantee. While the DB or DBOM contractors will take over the functions of design and eventual construction for these proposed changes, the grantee must continue to perform its necessary oversight and review functions as these changes are implemented.

The final VE Report for Stations and the Alternative Technical Concepts (ATC) Report from the DB proposals were provided to the PMOC in October 2010. The final VE Report for the Airport and City Center Guideways was provided to the PMOC in August 2011. These reports included a list of the VE recommendations that the grantee intends to implement. The PMOC has reviewed the final VE report to ensure that the purpose and objectives were met, the findings were adequately summarized, and an action plan was developed. The table below presents the summary of VE results provided by the grantee:

Table 30. Value Engineering and Alternative Technical Concept Proposals

Source	No. of Proposals Received	Estimated Value (M)	No. of Proposals Accepted	Estimated Value (M)
VE Workshop for Stations	30	$318.5	26	$104.1
ATC Proposals – WOFH DB Contract	29	$85.4	13	$60.5
ATC Proposals – KH DB Contract	16	$29.0	7	$18.3
ATC Proposals – MSF DB Contract	11	$16.1	5	$2.7
ATC Proposals – CSC	41	$35.6	15	$15.5
VE Workshop for Airport & City Ctr.	27	$225.6	13	$109.2
TOTAL	**154**	**$710.2**	**79**	**$310.3**

Since the grantee has decided to require platform edge screens at the stations, it is anticipated that there will be ramifications to the CSC, all station contracts, and, possibly, to each of the four line segment designs. Utilization of platform screens may require redesign of the station platform as the current station design provides no supporting structure for the screens. As platform screens provide a secondary function of weather protection, typically the platform edge is enclosed from above to provide an "enclosed" passenger environment and weather protection for the screen operating mechanism. Significant redesign of the canopies may be anticipated to accommodate this enclosure. Since the grantee only recently implemented this change, none of the PE designs currently show any work to accommodate these screens. The selected CSC bidder, however, has provided for the possibility of platform screen doors as well as an alternative intrusion detection system.

4.3.3 Correlation of Cost Estimate and Schedule to Scope

The cost estimate will require revisions after the awarding of the contracts currently under bid and after inclusion of the many changes acceded to after review of the Stations VE and Design-Build ATC proposals. Fortunately, many of those cost revisions may be beneficial to the baseline cost of the project, although the grantee may choose to hold those funds in the overall project budget as part of contingency.

From all appearances, the current cost estimate does fairly represent the project scope at the completion of PE; however, it will need to be adjusted per recent bid information as well as any changed conditions or scope revisions that are underway.

The schedule is another issue entirely; since the grantee already has three DB contracts in progress, the PMOC is concerned that delays in issuing NTPs may end up having a detrimental effect on both the final project budget and the project schedule. The project schedule would need to account for the known pending changes in scope, were the DBB contracts already in progress. As most of the changes anticipated are related to station designs and since most of these station designs are not yet under contract, there is no harm to the schedule unless the design contracts were to be delayed until revision of the PE documents, which is unlikely.

4.3.4 Unknown or Uncertain Conditions

Some of the aspects of the Project that could be described as unknown or uncertain match the examples given in OP 32C. Real Estate acquisitions, permitting, third-party agreements, and unknown underground or archeological findings are likely to be troublesome at times. There is potential for hazardous materials on the MSF site, but their exact locations, extent of contamination and need for on-site treatment or disposal to off-site locations might not be fully defined until excavations begin on the site. The grantee will need to negotiate, finalize, or update agreements with Hawaii Department of Transportation (HDOT), Honolulu International Airport (NNL), the Federal Aviation Administration (FAA), the Department of Hawaiian Homelands (DHHL), United States Navy (USN), and all the various utility companies. The real estate market, of course, can be very turbulent and can cause unforeseen delays and additional costs, especially if negotiations break down and eminent domain is employed.

The contract documents for the DB contracts stipulate responsibilities of the contractors to stop work in the case of encountering unforeseen hazardous materials or archeological or historical artifacts, but specify fiscal responsibility for those items to the grantee, except in cases where the condition was caused by the contractor's actions.

4.3.5 Likely Changes in Scope

The decision to require station platform edge screens could affect a number of contracts, including the CSC, all line section contracts, and all station contracts. The addition of this requirement may also cause the need for careful analysis of operations, as the travel time could be increased due to the need to spot the vehicle doors opposite the platform doors. Train door operation will also be subject to the delays incurred by incorporating platform edge screen interlocks that provide the detection logic required for safe synchronized platform door operations. If that impact is too great, this change could influence fleet capacity and cause a need for additional trainsets during normal operations.

4.3.6 Completeness of Project Information

The completeness of project information varies by contract, with the DB contracts that are underway showing a design that has advanced from its starting PE level. Those contract's designs have been modified due to structural, guideway alignment and profile, and track construction decisions made by the DB contractors. The other line segments reflect the original intent of the grantee, but not any subsequent changes that could occur be identified during Final Design. The CSC, as a DBOM contract, is defined by a performance specification without the details one would expect and need in a traditional contract.

The PE level drawings for the four line segments present right-of-way plans, drainage plans and details, demolition plans, guideway plans and profiles, typical cross sections, utility plans, roadway plans, signing and striping plans, maintenance of traffic plans, traffic signal plans, street lighting plans, structural drawings, landscaping plans, station drawings, and contact rail installation plans. The WOFH DB Contract has progressed beyond the others, since its DB contractor has made revisions to alignments, profiles, track details, and structural definitions following receipt of its limited NTPs.

Through PE plans and performance specifications, the grantee has provided enough project information to fully illustrate the scope, capacity, level of service, functionality, and expected reliability of the completed project. They sufficiently characterize elements of the design and exceed the requirements of a PE design.

4.3.7 Review and Characterization of Project Scope

Consistency with ROD

The Record of Decision was issued on January 18, 2011.

Support Grantee's Typical Level and Quality of Service

Since the grantee's proposed automated light metro rail system is such a significant upgrade from its existing bus-only system, it can fairly be said that the Project exceeds mere "support for the level and quality of (existing) revenue service."

Proprietary Systems and Methods Permit Reasonable Number of Contractors

None of the contracts advertised thus far has had a problem with attracting at least two bidders. Although the DBOM CSC involves proprietary systems, the method of qualification and ultimate making of a "Best and Final Offer" (BAFO) has attracted multiple bidders. The line segment and MSF contracts already awarded received interest from a small but sufficient number of capable bidders.

From the onset of the Project, PMOC has contended that the size and type of the Project and the challenge of attracting experienced contracting help either locally or from the mainland are major issues. This, rather than the proprietary systems and methods, is likely to be the force driving down the number of bidders on the contracts advertised to date.

Completeness and Definition of Major Work Details, Dimensions, and Interfaces

Systems elements lack detail in their definition, although the implementation of the CSC will allocate responsibility for creating definition to the contractor. The MSF complex is another area where details (e.g., building layouts, machinery, systems interfaces, earthwork, and track configuration) are either incompletely determined or may be subject to change as different contractors begin work.

Interfacing between the various contracts will be a logistical and quality challenge. The project will have one contractor supplying the track material, another designing and building the guideway, another designing the stations for construction by yet another firm, and one more, the CSC contractor, designing, building, and operating both the vehicle and all the systems elements. The PMOC is concerned that changes to the CSC will affect station and MSF designs, which will have an impact on details in a line segment's design, even if that line segment may already be completely designed and under construction.

In short, much work needs to be done in Final Design or the "design" portion of DB in order to bring all parts of the project to the level of completion that will be needed to justify an FFGA at the end of Final Design. Of itself, this would not be a problem if the contract was being implemented in a traditional DBB manner. Given the fact that many of the DB contracts are now, or will shortly be, underway, there is likelihood that changes at interface points will cause project delays or extra costs. The potential impact to schedule and cost at interfaces between contracts could be exacerbated if project controls are not maintained.

Content, Presentation, Clarity, Cross-Referencing, and Detail of Plans and Drawings
The plans and drawings provided for the Project all provide a suitable level of quality in their presentation, clarity and cross-referencing, although there is room for additional content and detail. Structural drawings, except for those in the WOFH DB contract, appear to be conceptual in nature, as they lack key dimensions and connection details. Station drawings and line section structural drawings need to be fully coordinated with each other to show staging of the work and a clear delineation of interfaces between different contractors.

Definition of Contractors/Grantee Roles and Responsibilities
Through contract documents pending or already in force, the grantee has established definition of grantee and contractor roles and responsibilities in implementing the DB contracts. The grantee has reserved for itself final say in any matters that depart from the project baseline design. In the case of the CSC, the grantee had to cede much more responsibility to the contractor, as the turnkey nature of the project requires that the vehicle, systems, and operations are all fully compatible with each other.

For those parts of the project to be implemented by traditional DBB contracting, the responsibility for the design remains with the design engineering/architecture firms that are contracted to produce the Final Design contract documents, while the contractor's responsibility is to build to those contract documents. The grantee's responsibility remains one of review and oversight no matter which contracting method is undertaken, although in the traditional method, that process can be more deliberate and the grantee can maintain greater control over the end product.

Constructibility
The Project is constructible as designed and organized. For such a massive project, there are certain to be some difficulties and unforeseen circumstances, but the grantee has put controls in place to handle such situations. The greatest challenge is likely to be coordination between the different entities on the project – between those working on different line segments, the MSF, CSC, and the various station contracting packages. The CSC, in particular, will be interfacing with all the other contracts, both as a systems and vehicle contractor and as the ultimate operator of the entire transit system.

Systems and Vehicle Design
The RFP Part 1 documents for the CSC were issued on April 8, 2009. RFP Part 2 was issued on August 17, 2009. The PMOC received the RFP Part 2 documents for the CSC on May 12, 2010. Technical and price proposals were received on June 7, 2010, with price proposals valid until December 4, 2010. The grantee held a first meeting with each

offeror during the week of August 8, 2010 to address technical and quality components of their respective proposals. Informational meetings with the offerors were also held the week of September 20, 2010. The grantee issued a Request for Best and Final Offers (BAFO) on November 4, 2010. On March 22, 2011, the grantee announced the award of the CSC to Ansaldo Honolulu Joint Venture (AHJV).

Each of the three bidders had Proven System Technology and had provided systems technology in accordance with the specification, including its major critical elements and subsystems such as Automatic Train Control, Traction Power, Security, Communication Infrastructure, and Vehicles.

By its process of choosing a CSC, the grantee has put the final determination of the systems design and vehicle design compatibility in the hands of the entity that is ultimately selected for the CSC task. While details of the systems and vehicle design are unknown until finalization of that selection, it is certain that the technologies used will be compatible with the planned operations of the Project. The OP 32C expectations for "the best performance at a reasonable cost" are the whole premise of the CSC selection process. "Reasonable cost" for anything on this project is a relative term, as the construction of an entirely grade-separated and automated rail line in such a setting will far exceed the cost of most light rail systems. There is greater hope for a system that can realize "best performance," as the grantee's selection of its type of vehicle and guideway are quite appropriate for this corridor.

The PMOC also participated in a workshop on August 31-September 1, 2010 with the grantee, PMC and the GEC to discuss the CSC Terms and Conditions and obtain a general understanding of how the RFP Part II documents were developed. The grantee provided a list of the makeup of the evaluation and technical committees to allow a better assessment of the grantee's approval process.

It is the PMOC's professional opinion that the CSC is currently written in various levels of detail for the various technical and Operation and Maintenance (O&M) portions of the CSC. Vehicles, O&M, Fare Vending and the like are written as performance criteria (or an expansion of the design criteria), while the Signals, Communications, Traction Power, and Verification Testing and Acceptance/Safety and Security are written in specification format that includes very basic conceptual drawings with limited performance criteria or operational requirements. This indicates that the grantee has left significant parts of the vehicle and systems design for the CSC to determine. Utilizing a series of "must have", "highly desirable" and "nice to have" criteria would have helped vendors in proposal preparation and grantee staff in technical evaluations.

The PMOC has identified numerous issues and questions related to the systems design that require grantee clarification. These items were identified during a review of the selected CSC proposal and will need to be resolved during Final Design. A future workshop will be held to discuss these issues.

Comparison to Industry Norms

The transit system being installed by the grantee is more akin to a grade-separated elevated heavy rail line or an automated airport people mover than it is to the now-ubiquitous light-rail system that has become prevalent in the US. Vancouver, BC's SkyTrain is the touted example of a North American system more closely related to the Project. The SkyTrain is a system that has proven to be capable of reliably serving passenger counts in excess of those anticipated in Honolulu.

Findings/Recommendations in Order of Importance

(1) Implementation of the CSC is essential and critical to Final Design, as the vehicle, systems design, and operations planning will dictate critical features of all the other contracts. The grantee has selected a CSC but has not yet executed the contract.

(2) Coordination between the grantee and its various contractors and between different contractors remains one of the foremost challenges of the project. The letting of some contracts much earlier than others could affect the way that subsequent work can be done.

(3) Controlling schedule costs in early-issue contracts is a crucial need, since one DB contract is already underway and several others are imminent, even though the project still lacks an FFGA.

(4) The grantee must resolve the Ala Moana Station configuration, taking into account the needs of the public both now and during eventual extension of the line in the Koko Head direction.

(5) Implementation of all the other approved VE-related changes will be key to the process of Final Design of the stations.

(6) The grantee will need to establish agreements with all government bodies or public agencies affected by the project, including HDOT, FAA, HNL, DHHL, and USN, and with all utilities whose lines parallel or intersect the alignment. Lines of communications will be essential with each of those entities to assure efficient project implementation.

(7) Through the process of Final Design, the grantee will need to finalize its project budget and schedule.

(8) If the WOFH contractor is not successful in obtaining the GPRM site for its precast yard, a substitute site must be identified, which could result in changes to the environmental documentation to reflect a substitution.

(9) Procurement activities must adequately address Buy America requirements for escalators and elevators, major system components (>$100,000), rail, steel, vehicles, and Ship America.

4.3.8 Scope Review Checklist

From OP 32C, Appendix B:

Project Delivery Method, Contract Packaging

1) Site investigation and geotechnical studies will be available to construction contractors.

The grantee provided bidders site and geotechnical data in the form of Geotechnical Data Reports and Geotechnical Baseline Reports.

2) *The General Conditions, Supplementary Conditions, Division 1 of the Specifications and other contract documents adequately describe, for bidding construction contractors, project site access; schedule; unit prices; provisions for increased and decreased compensation through incentives and liquidated damages; risk allocation as related to unforeseen conditions including geotechnical conditions; the construction contractor's design/engineering scope of work; mobilization costs; cash flow in general including pay schedule; requirements for bonds, insurance, taxes; maintenance and warranty provisions; contractor field management and supervision; socio-economic requirements related to bidding; among other things.*

   The General Conditions specifications adequately describe all of the above requirements that apply. Geotechnical Baseline Reports for each segment adequately assign risk responsibility and outline how the baseline will be applied to "Differing Site Conditions."

3) *Market conditions are considered*
   a. *Market conditions for the state/regional/local construction economy for the general contractors/subcontractors on public works and private;*
   b. *Market conditions for the national construction economy for transit general contractors/subcontractors.*
   c. *Availability of labor for various trades such as electricians, etc.*
   d. *Availability of major materials at the bulk commodity level (fuel, cement, steel, copper, plywood/lumber, etc.) and the finished component level (traction power supply and distribution, train control elements, vehicles, microprocessor equipment, etc.)*
   e. *Availability of construction equipment/sequencing/timeframe requirements for specially designed, or project specific equipment such as cranes, launching girders, pre mix plants, barges, etc.*

   The Project has considered the market conditions and, apparently for that reason, has expedited the issuance of its DB contracts. The Hawaiian Islands economy will likely always pay a premium for commodities and for specialized labor, particularly if imported, but the grantee has so far been able to contain costs by contracting during a soft economy.

   There is still a fear that as the project moves into its later-issued contracts, the economy may have rebounded and commodity/labor costs increased beyond expectations. These are risks to account for in the proper setting of contingencies.

   There is also the possibility that the specialized construction of the elevated guideway may not attract multiple bidders, which could happen if contractors that were not successful in bidding on the earlier contracts decide that they cannot or choose not to compete with those contractors already engaged in project work. The resultant lack of competition could lead to higher prices on those later contracts.

4) *Accessing and occupancy of project construction sites*

Most of the guideway route and, hence, most of the project, is to be built within public street and highway rights-of-way. For that reason, an agreement and a good working relationship and understanding is necessary with the agencies that own and manage those rights-of-way, including HDOT, HNL, Leeward Community College, USN, Ala Moana Center, and other departments within the grantee (City and County of Honolulu) organization. While most of these agencies have shown a willingness to cooperate with the grantee, nothing can be guaranteed about the success of these relationships until agreements are in place. The Final Design Roadmap includes a list of agreements that is being tracked by the PMOC and the grantee on a monthly basis. To date, there have not been schedule issues associated with such agreements for the WOFH DB Contract. Other properties upon which construction will occur will need to be purchased before they can be occupied; access may be made available before purchase for surveying purposes. One known issue to date is the acquisition of the required property to establish a concrete pre-cast facility.

5) *Contract packaging and structuring:*
   a. *Tradeoffs have been considered between large size contracts which are often more efficient due to coordination and scheduling constraints and small contracts that can attract industry interest and increase the number of bidders. Where small contract packages are used, they have been kept small enough to allow mid-sized contractors to bid without teaming as joint ventures (which tends to yield higher costs);*

Contracts that have been bid or awarded so far have trended toward large contractors, and there have been a limited number of bidders. Remaining contracts for the Airport, City Center and stations are yet to be advertised (that will follow Final Design in these traditional DBB contracts). Chances for smaller bidders are best in the stations contracts.

   b. *Construction industry information sessions have been held after advertisement in industry publications in order to attract regional, national, and international contractors.*

The grantee has held sessions where it has invited contractors to learn about work opportunities resulting from the Project. These have been held in conjunction with the Pacific Resource Partnership and sponsors of other large projects on Oahu. Nearly 100 contractors attended one such session on March 17, 2009.

   c. *Timing of major bid activity, within schedule constraints, will be managed to maximize contractor competition, with consideration to other major project(s) status in the region such as highway or redevelopment projects;*

The Project will be the largest single construction project in Oahu during this decade, allowing it first choice of contract scheduling. Other highway or redevelopment projects may well wish to account for the bidding schedule of Project contracts when deciding on their own efforts to maximize contractor competition.

d. *Prequalification of general contractors or subcontractors has been considered to ensure quality, e.g., prequalification for experience with a type of construction, safety record, claims history, etc.*

The grantee has successfully used prequalification for its contracts issued or bid to date, and will do so again for future construction contracts, many of which will require specialized expertise.

e. *"Procurement only" contracts have been minimized, recognizing there is a higher claims risk when the installation contractor does not have full control of the materials.*

No "procurement only" contracts have been proposed to date on the Project. The MSF contractor has the responsibility to procure all trackwork material (rail, special trackwork, and the like), but that includes a great amount of track to be constructed in its own contract. The combination of all trackwork material procurement into one contract allows the project to obtain the best possible price, based on volume, while minimizing the work involved with specifying, approving, handling, welding, and storing trackwork material. It is true that the line section contractors will have to coordinate their work installing track with the availability of that material from another contractor, but that requirement should simplify the work of the line section contractors and should not affect the overall project schedule's critical path.

f. *Third parties:*
   i. *Contract packaging for third-party construction contracts has been structured to maximize competition;*
   ii. *Third party procurement contracts have been utilized only where long lead time items will impact project schedule if purchased by construction contractor;*

No third-party contracts have been proposed for the Project.

<u>Design Relative to Site and Geotechnical Conditions</u>

1) *Site investigation*
   a. *Pre-construction site reconnaissance visits have been made;*
   b. *Site boundary and existing conditions surveys are complete;*
   c. *Geotechnical investigations are complete;*
      i. *Subsurface exploration or laboratory testing program;*
      ii. *Identification of buried structures and utilities;*
      iii. *Identification of contaminated soils and other hazardous material;*

In order to minimize the risk normally related to differing site conditions, the grantee's engineers have conducted adequate site reconnaissance, performed sufficient subsurface investigation and field and laboratory testing, and prepared geotechnical data and baseline reports. Buried structures and utilities have been identified to the extent known. The location of potential contaminated soils has been identified in general.

Much of the work for subsurface investigation will take place during Final Design, although a comprehensive geotechnical investigation is taking place now on the WOFH DB Contract. For sitework, the PE drawings and reports have done a sufficient amount of work to provide project definition and justify moving into Final Design.

2) *Design in response to geotechnical and other below-grade conditions is appropriate.*
   a. *Structural approach to ground conditions, subsidence, etc. is identified and resolved;*
   b. *Design of the rock support in the station caverns, the crossover caverns, the TBM tunnels, drill/blast tunnels, etc. is appropriate to rock characteristics (fracture planes, hardness and cleavage);*
   c. *Relative to subsurface conditions, selection of building type, foundation, and methods of construction is reasonable;*
   d. *Mass balance diagrams have been completed for vertical alignments on fill or cut;*
   e. *The design appropriately responds to identified buried structures and utilities, contaminated soils and other hazardous material on site, and provision for removal or remediation has been made.*

Geotechnical Data Reports for each segment provide sufficient data for preliminary design of foundations for aerial guideway structures. Project specific detailed geotechnical investigations are being performed or will be conducted during Final Design to develop enough geotechnical data to complete structural design of stations and other building foundations.

Since the stations will be mostly elevated with no underground construction for support facilities, little rock excavation is required. Adequate geotechnical baseline is provided for the preliminary design of anticipated foundation types.

The amount of borrow or waste material is not defined. Even though most of the grading for the project is restricted to one line section and the MSF, there will be some earthwork involved for each of the stations.

Potential contaminated materials have been identified in the proposed MSF area. In the case of contaminated soils and other hazardous material, when encountered on site, the contractors are responsible for stopping work and making plans for removal or remediation at a cost to be borne by the grantee. The grantee is aware of this issue and will include this item in its Risk Contingency Management Plan (RCMP) to account for this risk.

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

Major or critical design decisions are defined, including rehabilitation or reuse of existing infrastructure, structures, facilities, or systems, including, but not limited to the following:

1) *Major or critical work details, structural element dimensions, design interfaces and physical interfaces are complete and well defined in terms of drawings, standards, criteria, specifications and contract package scopes;*

   Not all critical work details are complete and structural element dimensions are generally lacking. Increased descriptions and definitions are required at interface points between the various contracts. In general, more work is needed before any of the line sections' guideway design can be finalized. Nevertheless, the work done to date provides a project definition that exceeds what is normally expected at the end of PE. The remainder of the design will be completed in Final Design.

2) *Structural systems are established and dimensioned to show number of spans, span length, substructure design, etc.; structural elements are advanced beyond simple span design.*

   Except on the WOFH segment, structural elements have advanced only slightly beyond simple span layout. From the plans, one can discern the number of spans and the design loading, intended composition, and approximate length of each, but detail and dimensioning are clearly lacking. The section designers or design/build contractors will be required to perform a formidable amount of design to bring these documents up to Final Design expectations. For a project almost entirely built on structure, this status is a significant challenge and inevitable risk.

3) *Work descriptions and definitions used in designs or specifications are consistent and uniformly applied;*

   PMOC has observed no inconsistencies in the documents prepared to date, but the grantee should be advised to continue to strive for uniformity as details and specifications are added during Final Design.

4) *Trackwork is advanced to a level where single line schematics of the track layout, plan and profile drawings, dimensioned layouts of turnouts and crossovers, and tabulations of track geometry (horizontal and vertical curve data) have been defined; alignment of tunnel structure referenced to the center line of track and base of rail; guideway sections inclusive of tunnel and station cross sections consistently show the distance from centerline of track to critical clearance points such as walls, walkways and edges of platforms;*

The trackwork design is advanced to a level consistent with this description. The key factor in trackwork design, however, is the ability to adapt it as requirements of later-developed disciplines become known. It is not unusual for trackwork design, except for miscellaneous details and specifications, to be complete at the time of PE completion. This is useful, in that the other disciplines, e.g., civil, drainage, utilities, structures, systems, architecture and landscaping, can then begin their tasks of Final Design based on the established guideway configuration. It is normal then for the trackwork design to undergo changes to accommodate the needs of those other disciplines.

5) *Special trackwork is adequately defined;*

   The locations and some typical detail drawings for special trackwork are available, although agreed-to VE changes at Ala Moana Station will cause changes on the Koko-Head end of the project. Depending on operational considerations, other special trackwork changes may also be implemented after the initiation of the CSC.

6) *Tunnels are well defined in terms of access and egress, construction access and laydown, openings for stations, passage chambers, ventilation or emergency access shafts or adits, sections and profiles depicting cross sections of major tunnel features; cross checked to adjacent building foundations and coordinated with the vehicle's dynamic envelope, walkways, lighting, systems elements such as ventilation, communications and traction power and egress.*

   There are no guideway tunnels proposed for the Project. There is one pedestrian/station mezzanine tunnel to be built by cut and cover method as part of the Leeward Community College Station, but that feature is not part of this category (SCC 10 Guideway and Track Elements).

SCC 20 Stations / SCC 30 Support Facilities

Major or critical design decisions are defined, including rehabilitation or reuse of existing structures, facilities, or systems. Major or critical operational, maintenance (heavy and light, wayside, facilities, and vehicle), fire/life safety, security, and logistics (spares, rebuild, training, documentation) requirements, whether in the existing system or the project, have been defined.

Major design decisions are well defined by the project documentation. The system is a new, automated, fully grade-separated light metro transit line that is backed by extensive sets of criteria, specifications, and drawings at this PE level; those documents cover all those expected aspects plus many that were not mentioned in the OP 32C guidance.

1) *Station and support facility architecture is established. The drawing package consists of site plans, floor plans, longitudinal and cross sections, elevations and details illustrating typical and special conditions; finish schedules;*

Station drawings appear to be well developed for PE. The typical set of drawings (there's a set for each of the 21 stations) includes plans for parking lots, sidewalks, landscaping, right-of-way, demolition, grading, pavement parking, signing and striping, utilities, foundations and framing. The drawings also include elevations, equipment layout, and details for vertical circulation.

A major question exists as to how these drawings will change to adhere to accepted VE recommendations. It is already known that the Ala Moana Station, at least, will undergo significant design changes. Final Design and incorporation of those recommendations will be the responsibility of the station design A&E firms just now being employed.

The support facilities in the MSF complex include the Operations and Service Building, the Maintenance of Way Building, the Train Wash Facility, and the Wheel Truing Facility. All of the buildings have been extensively detailed, down to the equipment and furniture level. The only concern about that design is whether it will need to be modified once the requirements of the CSC are known.

2) *Within the site context, the building footprints are shown. The relationship of the building to grade and to adjacent facilities is clearly defined, as is provision for pedestrians and bicycles to access the public way from the building. Provision for motorized vehicles is also shown. Access to the buildings and within the buildings complies with ADA.*

   The station and support facility drawings meet these requirements. Station integration with proposed new facilities (transit oriented development) is not defined at this time but is anticipated to advance during Final Design as the project's pedestrian linkages are defined.

3) *Station building floor plans show vertical circulation systems including stairs, elevators, escalators, dimensioned platforms, work bays in maintenance facilities, support spaces for mechanical and maintenance access; agent area, fare gate area, etc.; the building structural system is established and dimensioned. Structural elements are advanced beyond simple span design.*

   The station and support facility drawings meet these requirements.

4) *Building sections and elevations illustrate the relationship of the station to grade (below, on-grade, elevated structure);*

   The station and support facility drawings meet these requirements.

5) *Level boarding between the transit vehicle and the boarding platform complies with ADA.*

The system is specified to meet this requirement. It will be crucial to assure that this requirement is met once the CSC is on board and the actual vehicle characteristics are known. If the vehicle supplied requires some modification to the station dimensions, those changes will have to be made during Final Design of the stations.

6) *Mechanical, electrical and communications systems are described, including station, support facility and track area drainage, piped utilities, heating ventilation and air conditioning, smoke evacuation, power and lighting for the station, fire/life safety including NFPA, security systems, passenger information systems (PIS), fare vending machines, etc.*

   The drawings include some plans and diagrams for mechanical, signal, communications, electrical, drainage, HVAC, power and lighting, but the entire list of items will likely need to be better defined and detailed during Final Design. Items in the communications, signal, and fare collection categories will be the most likely to change after selection of the CSC contractor.

7) *Equipment is shown on floor plans and described in schedules on drawings or specifications;*

   Equipment rooms and provisions for equipment locations are shown on the floor plans. Detailed specifications for the equipment did not appear to be available, nor are they expected, at this stage.

8) *Design interfaces among disciplines are defined on drawings, in standards, design criteria, specifications and contract package scopes.*

   There are clear lines of demarcation for work in one contract and work to be done by an adjacent contractor. As the design progress, it will be doubly important to continue to make these distinctions and to assure that the work is done most efficiently in the manner as shown on the drawings. If certain work is better done by another contractor (to avoid having to remove or replace elements already in place, for example), the work division should be adjusted.

<u>SCC 40 Sitework and Special Conditions</u>

Major drainage facilities, flood control, housing types, street crossings, traffic control, and utilities are defined and physical limits and interfaces are identified, based upon site-specific surveying with digitized data integrated into alignment base mapping plan and profile drawings.

The Project defines all of these elements in its line section drawings, which are based on digitized base mapping plans and profiles. Since it uses an elevated guideway almost exclusively, the Project has little effect on drainage or flooding. Where the alignment crosses streams, it usually does so within the limits of a single span, so even its piers do not inhibit stream flow. Plans for street crossings, except within the MSF, are all for streets going under the guideway. Roadway plans are supplemented by traffic control plans and staged detour drawings. Utilities appear to be completely identified, although detailed design of relocations has not been completed.

Major or critical design decisions are defined, including rehabilitation or reuse of existing structures, facilities, or systems, including, but not limited to the following:

1) *Refer to Design Relative to Site and Geotechnical Conditions above;*

   The PE design as presented does not differentiate between differing site and geotechnical conditions. The guideway construction is very much standardized, except for a handful of locations where longer spans are required to navigate the route over infrastructure already in place, such as where long flyover bridges are used to cross over limited access highways. The existing limited access roadways are essentially left in place and the guideway profile is adjusted to go over them.

   Any differing geotechnical conditions will be accounted for during the evaluation of the project-specific geotechnical investigation and during Final Design. Extensive geotechnical testing is in progress for the WOFH DB contract.

2) *Structural elements for retaining walls and other site structures are advanced in design.*

   Structural elements are designed in a cursory manner – by size and type, but not in detail and dimension. Connections, rebar locations, and other structural detail design will follow during Final Design.

3) *Major or critical work details, structural element dimensions, design interfaces, and physical interfaces are complete and well defined in terms of drawings, standards, criteria, specifications, and contract package scopes.*

   More detail is required during Final Design, particularly regarding structures and physical interfaces.

4) *Mass balance diagrams complete for vertical alignments on fill or cut are supported by complete site-specific surveys and soil investigations;*

   PMOC did not observe the presence of a mass balance diagram. Due to the nature of the guideway (mostly elevated), most of the significant grading to be done is in or near the MSF. The question then becomes, not how to move earth material from one end of the job to the other, but rather, just how much borrow or spoil will result from the construction. Ecologically, of course, it would be best if the project's earthwork was in approximate balance, unless a known source (for borrow) or destination (for excess soil) is available. The grantee's DB contractors, through their determination of means and methods, will need to account for the movement of borrow or spoil during Final Design.

5) *The presence of buried structures, utilities, and contaminated soils which may have to be backfilled or which would otherwise be unavailable for backfilling, has been taken into account;*

   Since PMOC did not observe a mass balance diagram or other earthwork quantification, it cannot state whether such calculations have accounted for unusable backfill or voids. The grantee and its on-board contractors will need to account for these situations during Final Design.

6) *Adequate construction access;*

   Access on public rights-of-way will be controlled in part by the agencies in charge of the streets or highways that the guideway is affecting. Access on private property is not allowed until the real estate in question is acquired.

   The more congested parts of the corridor – Airport and Downtown -- have not yet been prepared for bid; these are clearly the line segments in which construction access will be most difficult. This must be addressed in the general provisions of those future construction contracts.

7) *Access and staging areas are defined.*

   The DB contractors are to determine access and staging areas for their own line segments, but the DBB contracts may be served by pre-establishment of those sites by the grantee and its GEC. They are not currently available.

   The WOFH DB Contractor intends to utilize an existing facility (GPRM Prestress) for pre-casting and prestressing of the concrete guideway segments. This facility was identified in the ROD. The contractor is negotiating with the owner and the current lease-holder to obtain use of the property. However, if the GPRM facility is not secured, another facility will be required. Any impacts to the budget and/or schedule cannot be assessed until a decision is made on the site to be used for pre-casting activities. If another site is selected, the grantee is aware that it must coordinate with FTA to determine the extent of any environmental documentation that may be required.

<u>SCC 50 Systems</u>

1) *System (Wayside and Facilities), Trackwork (Running and Special)and Vehicle (revenue and non-revenue) descriptions, functionalities, reliabilities, technologies (level identified and cost effectiveness known) and performances are defined. Major equipment (for the control room, substations , crossings, tunnel ventilation and traction power) is well defined and identified in terms of specifications, bills of materials, standard drawings and specifications, general arrangements and standard details, and single line drawings (similar to industry process and instrumentation diagrams, high level logic design).*

Much of the systems design will be determined by the CSC after that contractor is given Notice to Proceed. By using a DBOM contract for vehicles, systems, and operations, the grantee has transferred responsibility to that contractor for most of the systems design, construction, installation, and testing. The grantee did express its requirements for the system in its bid documents for the CSC, but the CSC contractor will have some leeway in the actual definition of the systems. The result will be a state-of-the-art system that is tailored to the actual vehicle being used.

The Train Control requirements identified in the CSC RFP Part 2 documents detail the functional requirements for turnkey services, including the design, manufacture, installation, and test for an Automatic Train Control (ATC) system on the Project system.

2) *Signaling and Train Control*
   a. *Operations analysis has determined the most efficient location of interlockings based on track layout, headways, train lengths, braking tables as well as requirements of each interlocking and its control limits.*

Operations analyses have been used in determining interlocking locations and requirements. Further operations analysis has been completed by the CSC contractor as part of its proposal documentation, to determine final track circuit locations, control limits and operational timing of interlockings. It is likely that as the design progresses through Final Design, additional operational analysis will be required to further refine the operational parameters, and more closely address the phased incremental delivery of revenue services.

Guideway interlockings, crossovers and turnouts will be provided with an Automatic Train Protection (ATP) function to allow trains on adjacent tracks to traverse the interlocking areas safely, whether for straight routing or for crossing from one track to another. The ATP will prevent the automatic or remote manual unlocking and movement of track switches until the train has cleared the interlocking.

The Project uses Number 10 double and single crossovers, Number 10 turnouts for the east and west yard leads, Number 8 turnouts for yard transfer track leads and Number 15 turnouts for some future extensions. The Project uses Number 6 turnouts for the yard. Maximum speed in the yard is 10 mph. Maximum rated diverge move speeds are 20 mph for Number 8 equilateral and Number 10 turnouts except that, where the civil design imposes restrictions, a switch layout may be modified such that it must be rated for a lower turnout speed. Trains approaching switches set for a diverging move will reduce their speed under control of the ATP system such that the train speed does not exceed the rated speed for the turnout when the head end of the train enters the switch. The restricted train speed will be maintained by the ATP system until the last car of the consist is clear of the switch area of the turnout, conditional on any affiliated civil restrictions with the switch area.

b. *Track plans have been sufficiently developed to define and identify vertical grades, horizontal and vertical curves, elevation, station platforms, switch point stationing, rail bonding and connection requirements as well as typical track circuit drawings.*

The PE drawings sufficiently detail the track plans, grades, horizontal and vertical curves, elevations, station platforms, and switch point stationing. The subsequent determination of signal requirements will dictate rail bonding, connection requirements and track circuitry. This work will be done by the CSC with some coordination between it and the line section designers or contractors to assure that the proper infrastructure is in place to meet the systems' needs.

c. *Site specific requirements are defined (for signal structural work) and location drawings for signal enclosures*

Signal structures are not defined in the line section drawings. These will need to be incorporated after the CSC determines locations for signal enclosures. Per the Core Systems Design-Build-Operate-Maintain Design Criteria, wayside route indicators for interlockings are to be installed between the rails. This will require a high level of coordination between contracts and disciplines and may escalate costs.

In the CSC RFP Part 2 Plans, housings for signal equipment are shown to be of weathering steel or aluminum construction and will be equipped with shelves, racks, doors, and all associated hardware to properly secure the equipment. The house will be double insulated to reduce transfer of heat. Signal equipment housings will be pre-wired and prefabricated to the greatest possible extent. To facilitate maintenance, all racks will be accessible both front and back (hinged racks are permitted for wall mounted racks). Aisle way and /or rack spacing in signal houses and relay rooms will measure at least three feet between equipment. Cases will be made of aluminum, fiberglass, or stainless steel and equipped with neoprene sealing gaskets. Houses and cases will be grounded. The junction boxes are to be fiberglass or plastic with a captive hinged cover and sealing gaskets. Any openings for air circulation will be screened to prevent animal or insect incursion.

d. *Central instrument rooms (CIR), central instrument huts (CIH), central instrument locations (CIL), relay rooms; locations and sizes as well as room layouts (relay, termination, central instrument, power) are identified and defined.*

Some effort was made to show signal equipment within the Operations and Service Building in the MSF contract PE drawings. The assumptions made in determining the size and location of this equipment will be subject to final review by the CSC contractor and subsequent changes by the MSF contractor. Similar work will be necessary at many of the stations, where space is set aside for non-descript systems functions. The project has provided a room at all stations which is to be used exclusively as a local systems equipment room. The concept of using these train control and communications rooms (TCCR) has been adopted as part of the overall systems integrated design solution, which forms the basic structure for the service control implementation.

e. *Signal cable routing methodology as well as power supply and distribution are identified and defined*

It is not clear at the present time how the signal and power supply cables will be integrated into the design of the guideway structures.

The train control system will support main line operations at 2-minute, 35- second headways between terminals, with maximum operating speed of 55 mph. End-of-line terminals are to be designed to accommodate the ultimate capacity of the System. Stations will have equipment rooms with space for wayside train control apparatus. OCC service controllers will have the capability to monitor and control train movements on the mainline and on MSF ready/layover tracks, but vitality will reside in field equipment.

The power distribution system will be such as to provide redundant power to operational critical equipment. Critical equipment will include UPS equipment, transfer switches and multiple, redundant power supplies. The UPS will have a two-hour capacity minimum. An outlet is also to be available for a connection to a portable generator. All power will be of a quality to assure safe and reliable operation of the train control equipment. All transformers and rectifiers will be rated to operate with a load at least 25% greater than the maximum circuit design load to which they are applied. Surge arresters and equalizers will be used on electronic equipment to protect against damage caused by lightning and electrical transients. A definitive comprehensive redundancy/backup plan for both AC and DC power will be needed to determine the final requirements of this provision. This must be addressed during Final Design. The Project has already taken some steps to initiate this requirements definition by introducing some level of provision in the specs during the BAFO phases of the CSC procurement.

f. *Software and interface requirements (to facilities, existing system, and other system elements) are identified and defined*

The new transit system control systems are being proposed as near 95% turnkey solution/implementation as there are no existing systems currently in place with which they will interface. There are a number of discrete interfaces that exist between system components that can be considered "inclusive" or internal to the new set of subsystems being delivered, which are already completely defined.
There may be a requirement during the Final Design phase to examine external (to the transit control system) systems interface requirements, such as data and voice radio systems.

All interfaces have been adequately identified at this stage of design development. As the design progresses through Final Design, any external interfaces will be further refined and defined in more detail through a comprehensive set of interface control documents (ICD), specifying critical and non-critical interfaces existing both internally and externally to the new transit system. The required level of software integration will be determined from the ICDs, and the coding requirements and functional specifications for those interfaces developed as necessary.

g. *Maintenance, testing and training requirements are identified and defined (factory acceptance, site acceptance, field integration, start up, etc.)*

Equipment will be functionally tested at the supplier's or vendor's facility. Upon completion of installation, equipment is to be fully tested as integral components of systems to verify proper operation as designed.

3) *System Description*

a. *Built-in-place substations are identified, numbered and located with approximate spacing along the system route, ratings (MW) as well as the details (e.g. three-phase nominal 12.47–13.2 kV distribution circuit [Hawaiian Electric Company (HECO)]) and any exceptions.*

Substations are identified, numbered, and located at approximately a mile or mile and a half spacing along the system route. Final determination of the substation and GBS locations, spacing, and ratings will be performed by the CSC using a load flow study calculation of the rail electrification network and a computer based simulation model to validate the quantities and ratings of the substations, gap breaker stations and the locations indicated in the RFP Part 2 Plans. TPSS facilities serve the purpose of transforming the 12.47 kV or 11.5 kV ac power from the Hawaiian Electric Company (HECO) utility system to a nominal 750 VDC system voltage, which is then distributed to the contact rail system. TPSS include medium voltage ac switchgear, rectifier transformers, traction rectifiers, dc switchgear, and auxiliary equipment and devices as indicated in the RFP Part 2 Plans. Details of the exact incoming voltage will be established by HECO once the TPSS locations have been finalized by the grantee and the CSC.

b. *Nominal (full-load Vdc) project voltage is identified and basis of design and choice of project nominal voltage relative to system voltage is identified, voltage drop minimization, maximization of vehicle propulsion system performance, and train regeneration issues have been addressed.*

Nominal voltage for operations has been identified as 750 V dc. The CSC will be responsible for calculating voltage drops, maximizing vehicle propulsion system performance, and addressing train regeneration issues.

The Train Electrification System (TES) simulation model will resolve many of the electrical network dynamic needs, accounting for train movements and using a resolution of one-second as the minimum time interval.

For the given train operations plan, the simulation analysis will consider operations with different dispatch times from the terminal stations, resulting in all possible timing offsets between trains moving in opposite directions. The analysis will account for the worst-case minimum train voltages and maximum RMS currents possible for the specified headways.

c. *Overhead contact system (OCS) is defined including conductor sizes relative to existing parts of system, as well as any supplementary parallel feeders to meet design requirements for substation out of service scenario.*

The Project will not use OCS since the vehicles will travel on an elevated guideway and rail vehicles will be powered from a contact rail system (third rail) as indicated in the CSC RFP Part 2 Plans. The sizing and characteristics of the conductor rail may have been pre-determined by the GEC, as this requirement has become part of the MSF in supplying the conductor rail. Unless the materials are not currently specified and fixed, the CSC will need to interface with the MSF supplier to ensure that the correct conductor rail is specified.

d. *AC Switchgear type (i.e. indoor, metal clad vacuum circuit type breaker, etc.), ratings (i.e., 15 kV, 500 MVA, etc.), relay protections provided (Phase overcurrent protection, Ground overcurrent protection, Negative sequence voltage relay, Rectifier overload relay, AC lock-out relay, etc.)*

The 15-kV class AC switchgear will be of the metal-clad, draw-out type. The AC circuit breakers will be vacuum type, 500 MVA class minimum, suitable for the available utility voltage and short circuit current. Details of the relay protection system will be determined by the CSC.

e. *Traction Power Transformer type (i.e. vacuum pressure impregnated dry type, etc.), ratings (i.e., 1110 kVA 65°C rise at 100% load, three phase, 60 Hz., ANSI and NEMA standards for extra heavy-duty service).*

All traction power substations will have one transformer-rectifier unit. The main components of the transformer-rectifier unit (TRU) will be rectifier transformer, traction rectifier, and interface transformer. The latter is required only in case of a diode rectifier.

The rectifier transformer will be three-winding, dry type, convection cooled, with one primary and two secondary windings suitable for double-way rectification per ANSI Circuit 31. The transformer is to be furnished with no-load taps providing for +/- 2.5% and +/- 5% transformation ratio adjustments relative to the neutral tap. The rectifier transformer is to be housed in a NEMA 1 indoor enclosure and installed as part of the substation equipment lineup.

The traction rectifier will be silicon diode based type, connected in accordance with Circuit 31 of ANSI Standard C34.2, to deliver a 12-pulse, double-way output.

The rectifier will be installed in a freestanding metal enclosure, and shall be air-cooled by natural convection.

The TRU rating will be in accordance with an extra heavy-duty traction load cycle defined as follows: After reaching a steady state temperature, the TRU shall run at 150% of its rated load for two hours. During this two-hour period, five equally spaced loads of 300% shall be imposed on the unit for a one-minute duration each. At the end of the two-hour cycle, a 450% load shall be imposed for 15 seconds. At the end of this duty cycle, there shall be no damage to the TRU or any of its components, and the equipment temperature shall be within acceptable limits.

The traction rectifier will be designed to provide the full power rating in case of failure of one diode in each bridge of the rectifier.

Safety interlocks will be provided for the transformer and rectifier doors, automatically de-energizing the equipment if opened.

f. *Power rectifiers are matched and assemblies capable of providing a stated output such as "twelve pulse, 825 VDC output at rated 100% load with the overload capabilities as specified in NEMA RI-9 for extra heavy-duty traction service." Harmonics in the utility power lines and the interference voltages due to residual ripple issues have been addressed in the design.*

System equipment is designed to avoid being adversely affected by radiated or conducted electromagnetic or electrostatic interference from trains or fixed sites and other electric/electronic equipment on or near public transit areas, including, but not limited to, the following: Trains operating within the guideway, fixed site equipment, cellular telephones, mobile radios, incidental (spurious) radiation equipment, ignition noise, lighting fixture, electrical power system transients, vehicular systems, and electrostatic discharge.

g. *DC Switchgear basis of design and choice of switches, busses and feeder breakers is identified and equipment list is complete.*

The grantee has identified switchgear requirements, but the CSC will provide final resolution of the equipment list after that contract is awarded and NTP is given.

The DC switchgear will be metal-enclosed type with safety enhancements, including automatic shutters on the stationary contacts of the DC circuit breakers. The maximum operating voltage of the DC switchgear will be 1000 V DC.

DC circuit breakers will be specifically designed for DC transit service and will be used to provide fault clearing and isolation capability for the substations and contact rail sections.

The DC circuit breakers will be single-pole, metal-enclosed, draw-out type, rated for 800 V dc nominal, and with maximum operating voltage of 1,000 V dc. The circuit breaker will be high-speed type, with short circuit interrupting capability per applicable IEEE standards.

DC feeder circuit breakers will be equipped with direct-acting instantaneous over-current release, load measuring, and automatic re-closure relaying. Transfer trip between adjacent traction power facilities shall also be provided.

h. *Programmable Logic Controller (PLC) system, if provided, integrates and controls intercubicle functions and provides control, monitoring, and data logging at each substation.*

Programmable Logic Controllers (PLC) or microprocessor based devices, Multifunction Protective Relays (MFPR) furnished under this Contract will require external computers to reprogram the application software or change device settings. The CSC Contractor is to provide two sets of the required programming equipment, including all hardware, software, software license accessories, and related instruction manuals and label all software program versions to be used.

Interior equipment consisting of PLC, LCD Screen, and MFPR and all other components required to support the TPSS and GBS operation is to operate without performance degradation while operating within the parameters identified within the specifications. The equipment and devices inside traction power facilities will be designed and rated for operation at 122 degrees Fahrenheit ambient temperature.

i. *Substation grounding system basis of design and choice of separate AC and DC ground mats as well as stray current monitoring or testing, lightning arresters and protective relays and fault current contribution from the AC equipment to the DC equipment issues and utility system faults have been addressed.*

Ground test stations, located near the opposite ends of the TPSS and GBS, will be provided for testing of the equipment ground grid. RFP Part 2 Plans.

All DC switchgear cubicles, and the rectifier enclosure, are to be isolated from the ground and bonded to a common copper ground bus connecting them to the substation ground mat through a protective device. The protective device may be either of the high-resistance or low-resistance grounding type. In either case, the protective device will detect positive-to-enclosure faults, upon which the entire facility shall be de-energized. It will also detect "enclosure grounded" type faults, upon which an alarm shall be raised.

For lightning and associated Isoceraunic Conditions, the design includes lightning protection of the TPSS and GBS for a 7 thunderstorm-days-per-year isoceraunic zone in accordance with UL 96 A – Lightning Protection, and NFPA 780 lightning protection requirements. The HECO medium voltage underground and open power supply cables and the Track Running Rail will be provided with properly coordinated lightning arresters as required in the CSC RFP Part 2 documents.

j. Minimum voltage at the pantograph is identified and the basis is established for locations during the sustained project headways with substations operating, or with "..." substations out of service. If substations are required, under-voltage conditions are identified with one substation out of service and the operation plan identifies mitigation measures.

The Project will not use Pantographs since the vehicles will travel on an elevated guideway and rail vehicles will be powered from a contact rail system (third rail) as indicated in the CSC RFP Part 2 Plans.

The positive side will comprise a contact rail system, and positive DC feeders connecting the contact rail system to the substations and gap breaker stations. The negative side will comprise running rails, track impedance bonds (if necessary, depending on the train control system), cross-bonds, and negative return feeders connecting the running rails to the substations.

The contact rail will be top-running with electrical resistance not exceeding 0.002 ohms/1000ft at 20 degrees Celsius. The contact rail will be able to carry 4,000 amperes continuously with temperature rise not exceeding 45 degrees Celsius above ambient air, assuming 2 ft/sec wind velocity.

The CSC will determine the minimum acceptable train voltage based on calculations and load flow analysis that is performed to meet the requirement needed when one TPSS is out-of-service.

k. Overhead Contact Systems (OCS)

Not applicable.

4) Major or critical design decisions are defined, including rehabilitation or reuse of existing structures, facilities or systems, including but not limited to the following:

a. Pre-construction, site reconnaissance, geotechnical and soil resistivity surveys are complete;

These surveys will be completed during Final Design, although reconnaissance and geotechnical studies have been on-going activities.

b. Ground subsidence and structural protections issues have been resolved;

In the aerial structure guideway sections, potential subsidence can be addressed by foundation modifications. However, the cost of such modifications cannot be fully addressed until final geotechnical investigations are complete.

c. *Structural elements are advanced beyond simple span design, or simply supported.*

Except on the WOFH segment, structural elements are not advanced much beyond simple span layout. From the plans, one can discern the number of spans and the design loading, intended composition, and approximate length of each, but detail and dimensioning are clearly lacking. The section designers or design/build contractors will be required to perform a formidable amount of design to bring these documents up to Final Design expectations. For a project almost entirely built on structure, this status is a significant challenge and inevitable risk. With the conditional acceptance of some ATCs for the WOFH segment, it may be difficult to maintain a satisfactory level of homogeneity between segments without incurring significant addition cost.

5) *Major or critical work details; structural element dimensions, design interfaces and physical interfaces are complete and well defined in terms of drawings, standards, criteria, specifications and contract package scopes.*

Not all critical work details are complete and structural element dimensions are generally lacking. Increased descriptions and definitions are required at interface points between the various contracts. In general, more work is needed before any of the line sections' guideway design can be finalized. Nevertheless, the work done to date provides a project definition that exceeds what is normally expected at the end of PE. The remainder of the design will be completed in Final Design. Significant coordination between different disciplines and contracts using the same space must be maintained throughout Final Design in order to avoid redesign and additional cost.

SCC 60 ROW, Land and Existing Improvements

1) *The real Estate Acquisition and Management Plan is complete. Real Estate documents and drawings identify the full takes, partial takes, easements and other right, possible eminent domain actions.*

The Real Estate Acquisition and Management Plan (RAMP) was accepted for entry into Final Design by the FTA on February 8, 2011.

2) *Site surveys include property lines and identify structures for building, site features, utilities; surface improvements such as streets and rights-of-way.*

Project documentation provides sufficient detail to define properties, structures, utilities, and other site improvements along the right of way.

3) *The real estate information and survey information is fully coordinated with drawings of structures for guideways and buildings, site features, utilities, streets, railroads, transitways, construction easements, site access, and staging areas.*

   Real estate information is fully coordinated with the design as shown on the preliminary engineering drawings.

SCC 70 Vehicles

Vehicle (revenue and non-revenue) descriptions, functionalities, reliabilities, technology and performances are defined and drawn to the upper level of assembly, major equipment, (and) general arrangements of cabin and cab:

1) *System Functional Description has been developed and advanced to include the following:*
   a. *Definition of the subsystems that constitute the overall system*
   b. *Description, graphic depiction of each interface between subsystems*
   c. *Description of how each subsystem will meet the requirements of the specification.*

   The vehicle requirements identified in the CSC RFP Part 2 documents detail the functional requirements for vehicle characteristics, performance, reliability, and maintainability. These definitions include critical vehicle dimensions, aesthetic design, ADA compliance, supply voltages, noise & vibration levels, ride quality, acceleration/braking, weight, and subsystem Mean Distance between Component Failure (MDBCF) and Mean Time to Repair (MTTR). The functional requirements for vehicle critical subsystems such as carbody, trucks, couplers, doors, communications, lighting, propulsion, braking, and HVAC are also defined.

   In addition to describing interfaces between vehicle subsystems, interfaces between the vehicle and the project system interfaces are also defined. These include trackwork and alignment details, wheel-to-rail interface, traction electrification requirements, automatic train control interfaces, vehicle / shop interfaces, wireless LAN / high speed data link interfaces, and vehicle static and dynamic envelopes vis-à-vis station and other alignment clearances.

   Much of the vehicle detail design will be determined by the CSC after that contractor is given Notice to Proceed. By using a DBOM contract, the grantee has transferred responsibility to that contractor for most of the vehicle design, manufacturing, assembly, and testing. The grantee did express its requirements for a service-proven vehicle in its bid documents for the CSC, but the CSC will have some leeway in the actual definition of the vehicle subsystems.

2) *Materials specifications have been developed and advanced to include lists of qualified materials, such as brake shoe composition, electrical components, refrigerants, lubricants, cleaners, paints/coatings, wiring, etc.*

3) *Testing requirements have been developed and advanced to include the following:*
   a. *High level Test Program Plan for both production and on-site acceptance should be underway (including requirements for factory inspection and testing, First Article and Pre-shipment inspections, static and dynamic testing and conditional acceptance).*
   b. *Maintenance and Training Requirements should be defined and identified, including development of maintenance and training requirements for new system elements.*

Material specifications are described in respective subsystem functional requirements; examples include: Electrical coupler contact block fabricated of a non-hygroscopic insulating material; passenger side windows of laminated, clear safety glass; interior lighting to utilize LEDs; high efficiency disposable, pleated media filters for HVAC; etc. Additionally, requirements for materials compliance are specified with mandatory codes & standards (e.g. ADA, ASHRAE, ANSI, ASCE, ASME, ASTM, APTA, IEEE, NFPA, UL, and MIL).

Much of the vehicle detail testing will be determined by the CSC. By using a DBOM contract, the grantee has transferred responsibility to that contractor for most of the vehicle testing. The grantee did express its requirements for a high level Test Program Plan in its bid documents for the CSC. The CSC is required to prepare a Verification, Test, and Acceptance (VTA) Plan for grantee's approval. It will identify VTA organization, qualified personnel, and assigned responsibilities for all test planning, scheduling, performance, analyses, review of data and reporting efforts. This plan will not only describe vehicle inspections & performance / acceptance testing, but will also define software verification and vehicle integration with the system elements involving trackwork, electrification, automatic train control system, and communications equipment.

By using a DBOM contract, the grantee has transferred responsibility to that contractor for all of the vehicle maintenance and training. The grantee did express its requirements for the needed maintenance and training in its bid documents for the CSC. These include preparation of a maintenance plan, maintenance manuals, training plan & program, safety & security programs, emergency plan, failure management, dependability monitoring and epidemic failures, and spares provisioning.

SCC 80 Professional Services

The roles and responsibilities of (the) grantee's professional consultants (design, engineering, and construction management) may be distinguished from (the) grantee's own professional staff and manual labor. When (the) grantee's manual labor, equipment, and facilities are used to facilitate construction or to assist in construction of the project, a Force Account Plan and cost estimate should be provided.

The division of work in alternative delivery contracts properly obligates the DB contractors for both construction and design support during construction. For traditional

DBB contracts, the grantee itself or its own representatives will perform these CM and design support functions. Force account work will need to be identified in later versions of the project estimate.

Cost associated with construction – building contractors' management, labor, indirect costs, overhead, profit, and construction insurance should not be included in SCC 80 but in SCC 10 through 50 as appropriate. Cost estimates should conform to this allocation of cost.

Compliance with this guidance has been confirmed based on a review of the Project estimate.

4.4 Additional Questions and Answers

Following initial review of this document by FTA, PMOC has added this section to answer specific questions regarding the level of completion and adequacy of the project documentation.

(1) *Does the project cover the design criteria, standards, and specifications and are they sufficiently complete at this stage of the project?*

PMOC concludes that the project documentation, in the form of design criteria, standards, design drawings, specifications, and reports is at a level of completion and a level of sufficiency that equals or exceeds expectations at this stage of the project (completion of preliminary engineering).

(2) *What is PMOC's overall assessment of the project drawings, both as to completeness and quality of presentation and did PMOC identify any technical issues that require resolution?*

PMOC believes the project drawings are complete, readable, clear, and understandable in what they present. There are some technical issues that remain to be settled, as described in the Conclusions section, which follows.

(3) *What is PMOC's assessment of the project's Value Engineering program? How many recommendations were received, how many does the grantee intend to implement, and what savings are expected to result?*

The grantee sponsored VE workshops on station design and Airport and City Center Guideway design. The grantee also benefited from a program of ATCs, which have been received from bidders on the project's DB and DBOM contracts. To date, the grantee has accepted or conditionally accepted 79 of 154 such VE and ATC proposals, with an estimated value of up to $310 million in net savings. Such savings, of course, depend on the actual implementation of the changes and may be affected by the "conditions" in the "conditionally accepted" category and the amount of overlap between similar VE or ATC proposals. PMOC does not expect the savings or the implementation percentage to meet the projected totals, but does feel that the efforts were effective in at least inducing serious study of the project's assumptions.

(4) *What is PMOC's assessment of the design of the aerial guideway and the appropriateness, constructibility, and cost effectiveness of its cross section, height and location of columns, and depth and design of footings and foundations?*

The use of a precast, post-tensioned concrete box (single-cell) superstructure to support both tracks of the alignment provides a very good structural solution for the aerial guideway, if a single structural system is to be universally used for the alignment. It provides an economical and constructible design that can be applied for span lengths from 100 feet to 200 feet, which will be adequate for about 80% of the aerial guideway spans. The exceptions to its general use would be for certain stream and highway crossings where longer spans are required. The open single cell box provides a relatively safe path for inspection of the superstructure and allows for strengthening, where required, by the addition of post-tensioning strands. This type of superstructure through this range of span lengths also allows for the employment of single columns founded on a single large-diameter drilled shaft deep foundations for substructure support.

Similar to the superstructure, the proposed large diameter drilled shaft deep foundations provide an economical and constructible system for the aerial guideway if a single system of support is needed. Using a single drilled shaft instead of piling with a pile cap should limit disruption to adjacent properties during construction. Regarding column height, PMOC agrees with the recent guideway VE study that concluded that the guideway profile could be lowered and the height of columns reduced with a relaxation of certain alignment criteria, thereby reducing construction and operating costs and lessening the visual impact of the guideway on the community.

If it is not necessary to employ a single superstructure type, the use of alternate superstructure types for the Airport and City Segments such as prestressed, concrete girders should be investigated as a potential alternate. As suggested by the recent guideway VE study, use of prestressed, pre-cast girders with a cast-in-place deck could be more cost-effective, given site congestion and access issues. With the use of somewhat shorter spans (80' – 90'), multiple spans could be erected simultaneously without having to use an erection truss or gantry. This VE alternative was rejected by the grantee in the interest of uniformity and since further study showed that the financial advantages were not as great as the VE study first suggested.

(5) *Are the grantee's geotechnical design reports adequate?*

Geotechnical Data Reports and Geotechnical Baseline Reports are provided for Segments 1 and 2. Geotechnical data reports and foundation technical memorandums are provided for Segments 3 and 4. The data, geotechnical interpretations, and the geotechnical parameter baselines provided for these segments are adequate for preliminary engineering design and conceptual cost estimates for various foundation types. The data and analyses are preliminary in nature, but adequate to limit or minimize any cost risk. The design/build contractor for any segment or Final Design consultant for the design-bid-build segments will require additional detailed geotechnical investigation to verify preliminary data, to independently take ownership of any and all recommendations included in the reports, and to develop new designs.

Preliminary geotechnical information provided for the MSF included only Geotechnical Data Reports. This information is not adequate for the design. At a minimum, a foundation technical memorandum should have been provided to minimize risk. Detailed geotechnical investigation will be required to verify preliminary data and to prepare Final Design for foundations and flat works. The DB contractor will be responsible for acquiring and applying additional required geotechnical information. This can be completed during Final Design.

(6) *Are the grantee's station design drawings satisfactorily complete and acceptable, considering the phase of the project? Do the drawings reflect compliance with the Americans with Disabilities Act (ADA)?*

PE Drawings dated September through December 2009 provide sufficient level of detail for PE and conceptual cost estimates. The drawings will require significant changes to address numerous review comments, cost reduction items and further refinement to "right size" the facilities as these proposed modifications were developed after completion of the PE Phase. These modifications will be completed during Final Design.

The station structures appear to be in compliance with ADA; however, site development was not to sufficient detail at PE to verify site compliance in terms of handicapped parking, accessible paths, grades, and curb ramps. Note that while the facilities may meet ADA, local community "buy-in" is often required to satisfy the local mobility impaired community. The station designers, and ultimately, the grantee, will need to take responsibility to ensure the completed station complexes comply with all federal legislation, including meeting ADA Requirements. This can be accomplished during Final Design.

(7) *What is the PMOC's assessment of the systems design for the fully automated driverless train operation, considering review of the CSC RFP, CSC workshop proceedings, design specifications, track configuration, headways, etc.?*

- Service Level Performance Capability

  The selected CSC has identified certain inherent weaknesses in the original general design concept and has modified the train control design accordingly. One such modification was the introduction of the AFOIIC subsystem, to address accurate platform stopping and platform interlock dwell time rationalization. Further development of the train control system introduced the absolute permissive block (APB) operation, creating virtual interlocking sites to improve headways and provide for additional degraded mode functionality.

The CSC has successfully advanced this system over time and extended the underlying coded track based technology platform very effectively and sufficiently to maximize its' potential. With increasingly more demands placed upon system capacity and service performance metrics, the PMOC has some concern that the system may now be seen to be developed near to its limits and will not be able to meet the contractual performance requirements and any further demands imposed by future line extensions and capacity upgrades. PMOC recommends that the grantee, with its CSC and MSF contractors, determine the performance requirements of an ATO yard and correlate them with proposed and future demand during Final Design.

- Proven Technology and Keeping Pace with Industry

  The specifying and use of "proven technology" always comes at a premium. Utilizing older established equipment that has proven to be reliable over many years of successful operational service often means using outdated technology. With today's focus on the importance of service performance and the rate of development and rollout of new control system standards and technologies, system solutions simply cannot keep pace with the rate of new and rapid technological advances. In this constantly technologically evolving climate, transit operators often find that new equipment becomes obsolete before reaching its natural or original design life expectancy.

  The selected CSC has specified a composite distributed train control system based on traditional fixed block jointless track circuit technology that is dynamically velocity data encoded. Although proven to be safe and reliable in operation, flexible in configuration, and robust in nature, it is limited in its capability for future enhancement. As an example, the proposed system utilizes outdated standard interfaces such as IEEE RS232 asynchronous serial communications ports, where new Commercial off-the-Shelf (COTS) systems use improved USB 2.0+ and IEEE 802.1x RF WIFI interface ports. Since current leading edge computer hardware is not backwards-compatible with these older interfaces, there may also be some currently unidentified compatibility issues to resolve.

  The selected CSC offered, for the same price, the option of an alternative train control system utilizing a more recently introduced "state-of-the-art" design solution and commercially accepted technology called Communications-Based Train Control (CBTC). This system solution, although it cannot be represented as "proven technology," adds significantly more scope for future enhancement, inherently more flexibility in the physical layer (installed infrastructure) to accommodate changes, and provision for better cost-effective future upgrades. Radio block-centered (RBC) CBTC is now being accepted and adopted by the global transit industry as the ERTMS (European Rail Traffic Management System), and in the U.S. as the preferred platform for PTC. A CBTC moving block implementation can more ably absorb any additional required changes necessary to keep pace with future changes in technology, operating protocols, regulatory requirements, performance metrics and industry standards.

As CBTC solutions gain more common acceptance and, over time, become fully 'proven' as a technology, operators will gain more comfort in choosing them as a preferred option. It may be pertinent to investigate this option further and evaluate the longer-term benefits of implementing this more modern train control design solution option.

- System Implementation

  The majority of the train control and interrelated subsystems and interfaces offered by the selected CSC have been proven by various installations currently operating on many international transit systems. Each target implementation has its own nuances and specifics that make it unique, as would be the case with the Project.

  Although a great deal of the configuration called for in the requirements has been previously designed and proven, some new subsystems and interfaces that are required have not. It is important that these new subsystems are integrated at the correct level and that they provide for optimal operability in terms of safety, functionality, and automation.

- Train Control Assessment Synopsis

  The selected CSC has offered a centrally operated distributed train control system that meets the baseline functional and technical requirements of the desired system as specified by the grantee. Specific aspects of this composite set of subsystems have been modified and refined to align with the needs of this specific target implementation as required for the Project.

  A more advanced and modern CBTC option has been offered by the CSC to the grantee at no additional cost, however, this is not presented as "proven technology" at this time, and as such cannot meet the grantee design requirements as currently specified. The PMOC suggests that the grantee evaluate this alternative solution proposed by the selected CSC to determine if any long term benefits can be realized over the original technology offered.

  Although the proposed system purports to be satisfactory in terms of meeting the key baseline requirements outlined by the grantee about the physical infrastructure and assets utilized, the PMOC has concern regarding the design solutions' overall level of operability, front end automated functionality and service performance capability. The PMOC suggests further work to examine more closely the ability of the proposed system to meet the performance expectations of each operating line segment as it opens into revenue service, and determine the full peak service capacity, phased (partial) operating capability, and limitations to future system upgrades. The PMOC also recommends further work to fully define and evaluate the full operational and performance requirements of the MSF working in ATO and its relationship and impact to proposed mainline services and the system level operations plan. PMOC's OP32A review contains a more detailed performance and operations synopsis.

It is essential to determine the most appropriate, safe, and effective methodology of interfacing new Project specific subsystems to the offered proven train control base system provision. The correct application of safety-related subsystems at the highest level of automation is very desirable. The PMOC recommends that the grantee review this area for optimal functionality as part of its due diligence.

The PMOC has identified numerous issues and questions related to the systems design that require grantee clarification. These items were identified during a review of the selected proposal and will need to be resolved during Final Design. A future workshop will be held to discuss these issues.

(8) *List documents that are acceptable or that still need to be revised in order to move the project into Final Design.*

All documentation is acceptable for entry into Final Design; however, certain actions must take place, as described in the following Conclusions section, prior to or early in Final Design.

4.5 Conclusion

The scope of the Project is well-defined and at a level of completeness that is equal to or in excess of that required at the completion of PE.

4.6 Recommendations

The PMOC recommends the following actions be taken during Final Design:

(1) Once the CSC is on board, the grantee must work with that contractor to resolve capacity issues (see OP 32A) and implement project controls to coordinate CSC work with that of other contractors.

(2) The grantee needs to expand its review and project management staff as planned in order to maintain control of the various concurrent projects.

(3) The grantee must manage the schedule and budget by implementing controls as described in its project management plans early in Final Design. This is particularly true for those DB projects already let, as Final Design overlaps with early construction.

(4) The grantee should resolve its Ala Moana Station design, whether by incorporating suggestions made by the Stations Value Engineering (VE) team or by other means, perhaps with the operational assistance of the CSC.

(5) The grantee should incorporate the accepted VE proposals for the stations and Airport and City Center Guideway Segments at its earliest opportunity (during Advanced PE or early in Final Design).

(6) The grantee should complete any unfinished effort to acquire agreements with all affected agencies and begin the process of cooperation that those agreements entail. While most of these agencies have shown a willingness to cooperate with the grantee, nothing can be guaranteed about the success of these relationships until agreements are in place. The Final Design Roadmap includes a list of agreements that is being tracked by the PMOC and the grantee on a monthly basis.

(7) The grantee should continue the process of updating the Project budget and schedule, incorporating information from contracts-in-progress and from completed tasks.

(8) The grantee should ensure that proper action is taken to resolve the issue of location of the precast yard. Such action is necessary to assure that the Project's critical path is not impacted and to determine what environmental documentation, if any, may be required by the FTA.

(9) The grantee should continue to be proactive in assuring that all of its contractors meet the requirements of Buy America and Ship America.

5.0 OP 32D: PROJECT DELIVERY METHOD REVIEW

5.1 Methodology

The PMOC followed the requirements outlined in the *FTA OP 32D: Project Delivery Method Review,* dated June 2009 to assess and evaluate the grantee's technical approach for delivering the proposed Project within the constraints of its existing or proposed statutory or organizational procurement authority and in the context of its 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 being employed during the design, construction, and procurement phases of the project.

The primary document utilized for this review and referenced herein in the Contract Packaging Plan (CPP) Revision 2, dated February 24, 2011. Additional files, reports and documents used for this review are identified in Appendix B.

5.2 Review

The Project, which runs from East Kapolei to Ala Moana Center, has been divided into four (4) line segments as shown in Figure 18. The grantee intends to implement the Project in a phased, west-to-east manner. The earliest section to be opened consists of the West Oahu/Farrington and Kamehameha Highway segments, upon which the Project is scheduled to begin operations by the end of 2015. The Airport segment is scheduled to begin operations in October 2017, and the final segment, City Center, is scheduled to begin operations in March 2019. The grantee intends to utilize a combination of traditional and alternative contract delivery methods to implement the Project as described herein.

Figure 18. Construction Segments

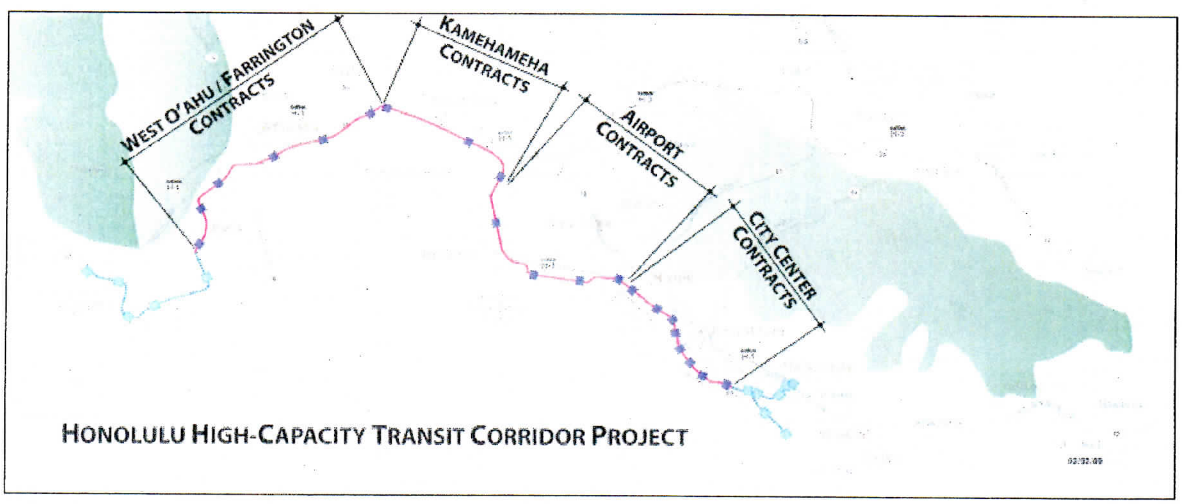


Table 2 presented the grantee's target dates for key milestones of this New Starts Project as identified in its Master Project Schedule.

The grantee has indicated that it will be requesting a Letter of No Prejudice (LONP) to expedite construction ahead of an FFGA. In a December 1, 2009 letter to the grantee, the FTA clarified its policies and procedures related to Letters of No Prejudice (LONP). The letter states, "After completion of NEPA, FTA will consider LONPs for activities not covered by automatic pre-award authority on a case by case basis. Absent of pre-award authority or an LONP, no project cost can be incurred and be eligible for reimbursement or as local matching for any portion of the entire 20 mile alignment." The grantee submitted a White Paper to FTA on January 6, 2011 regarding an approach it would like to consider for LONPs. The PMOC met with the grantee in early July 2011 to discuss the information required for a construction-related LONP request. The FTA will consider LONPs for activities not covered by automatic pre-award authority on a case-by-case basis since the NEPA process has now been completed.

5.2.1 Consultant Services

SCC 80.01 – Preliminary Engineering
The grantee contracted with Parsons Brinkerhoff (PB) to serve as the General Engineering Consultant (GEC) in completing PE/EIS efforts for the Project. The scope of work for this contract includes PE for all Project components. For those items that will be constructed utilizing DB methodology, the GEC was required to prepare contract documents that would be included in a two-step Best Value procurement package.

The grantee issued an NTP for the GEC I contract on August 27, 2007. The GEC contract began August 2007. Eight contract amendments have been issued extending the period of performance through July 2011and authorizing total budget of approximately $168 million. The pre-PE costs for the GEC I contract per the City's Contract Packaging Plan (CPP) is approximately $88 million.

SCC 80.02 – Final Design
The second GEC contract (GEC II) will provide services related to elevated guideway engineering, systems engineering, rail station design, construction management oversight, procurement, contract administration, configuration control, claims support, scheduling, project financing and environmental planning.

The grantee executed the GEC II contract with Parsons Brinkerhoff on June 30, 2011. The contract amount is $300 million ($150 million base amount plus $150 million allowance amount). It is anticipated that the $150 million allowance for additional work will be used after the initial three-year term of the contract. However, it is possible with a contract amendment to expend a portion of the allowance amount any time during the term of the contract. Notice to Proceed (NTP) #1 was issued on August 2, 2011. It should be noted that the cost for the first year of the contract is still being negotiated. The results of these negotiations should not increase the value of the $300 million total contract amount. HART anticipates issuing a contract amendment to the GEC II contract for the first year of the contract in October 2011. The GEC II contract should transition smoothly as most of the key management personnel are already on board through the GEC contract.

The grantee intends to award ten separate Engineering Design Consultant (EDC) contracts to complete Final Design for those components that are to be constructed utilizing Design-Bid-Build (DBB) methodology as identified in Table 31. Management of these contracts would be performed by the grantee with support from the Program Management Consultant (PMC) and the GEC II. It should be noted that the contract dates identified in Table 31 and Table 32 were based on the Contract Packaging Plan and MPS with a Data Date of June 24, 2011. Some of the contract dates have subsequently been revised.

The selected DB or DBOM contractors will complete Final Design of Phase I line segments (WOFH and Kamehameha), the Maintenance and Storage Facility (MSF), and Core Systems Contract.

SCC 80.03 – Project Management for Design and Construction

The grantee awarded a contract to InfraConsult LLC in November 2009 to provide Project Management Support Services (PMC). The consultant will serve as a program manager in providing oversight of the PE, Final Design, and construction activities for all contracts. The scope of the PMC contract includes the following: assisting the grantee with specialized support during design and construction; assisting the grantee with oversight of design, construction, manufacturing, precast concrete operations, installation, testing, and commissioning; and assisting the grantee with high-level management support for financial and political issues. In general, the PMC contract serves as a staff augmentation contract for the grantee. It must be noted that the PMC contract was not solicited with the required Federal clauses based on the Fiscal Year 2010 Procurement System Review Final Report prepared for the FTA. The FTA has notified the grantee that it must proceed with timely re-procurement of the PMC contract, which includes Federal clauses. The grantee issued an RFP on August 2, 2011 and anticipates issuing NTP to the selected PMC by December 2011. The terms of the NTP will be determined during negotiations with the selected firm.

SCC 80.04 – Construction Administration & Management

The overall responsibility for construction management will be assigned to the GEC II for Final Design and Construction. The GEC II will provide general engineering consultant services to the grantee during Final Design, construction, and transition-to-operation phases. The contractor will manage the DB, DBB (both Final Design and construction), and DBOM contracts, including schedule reviews, quality, safety monitoring, inspections, environmental compliance, and contractor monthly payments, claims, and changes. The GEC II will provide Final Design for landscaping, signage and wayfinding, hydraulic and storm runoff, and other tasks as directed by the grantee. The GEC II will also coordinate interfaces between designers, contractors and the CSC and will perform oversight of the Construction Engineering and Inspection (CE&I) contractors, who will provide field services for the DBB construction activities.

Table 31. Consultant Contract Packaging

SCC	Description	Contract Package	Contract #	NTP	Contract End	Notes
80.01	PE/EIS	Project-wide	MM-905	Aug-07	Jun-11	NTP given to PB in August 2007 for EIS
80.02	Final Design	West Oahu/ Farrington Guideway/Utilities Contract (Phase I)	DB-120	Dec-09	Sep-14	Final Design to be completed by DB contract team
		Maintenance and Storage Facility	DB-200	Jun-11	May-14	Final Design to be completed by DB contract team
		Core Systems	DBOM-920	Aug-11	Mar-19	Final Design to be completed by DB contract team
		West Oahu Station Group	FD-140	Jul-11	Aug-12	3 stations
		Farrington Station Group	FD-240	Jun-12	Jun-13	3 stations
		Pearl Highlands Garage & Ramps	FD-245	May-14	Aug-15	Station not included
		Kamehameha Utility & Guideway Design	DB-320	May-11	Sep-14	
		Kamehameha Station Group	FD-340	Oct-11	Nov-12	3 stations
		Airport Utility & Guideway Design	FD-430	Jul-11	Mar-13	
		Airport Station Group	FD-440	Mar-13	Jun-14	3 stations
		City Center Utility & Guideway and Ala Moana Station Design	FD-530	Dec-11	Nov-13	
		Dillingham Station Group	FD-540	Aug-13	Nov-14	3 stations
		City Center Station Group	FD-542	Oct-13	Jan-15	3 stations
		Kaka'ako Station Group & Ala Moana Station Finishes	FD-545	Aug-14	Nov-15	3 stations, plus Ala Moana Station finishes

SCC	Description	Contract Package	Contract #	NTP	Contract End	Notes
80.03	Project Management for Design and Construction (1st Contract)	Project-wide		Apr-07	Oct-09	
	Project Management for Design and Construction (2nd Contract)	Program Management Support Consultant (PMC)	MM-900	Oct-09	Dec-14	
80.04	Construction Administration & Management	General Engineering Consultant for Final Design & Construction (GEC II)	MM-910	Jul-11	Mar-19	
		West Oahu/Farrington Highway Stations CE&I	MM-180	Nov-12	Jan-15	
		Pearl Highlands & Kamehameha Hwy Stations CE&I	MM-380	Mar-13	Mar-15	
		Pearl Highlands Garage & Ramps CE&I	MM-385	Jan-16	Jan-18	
		Airport Segment Utility & Guideway CE&I	MM-480	Jul-13	Oct-16	
		Airport & Dillingham Highway Stations CE&I	MM-485	Oct-14	Apr-17	
		City Center Segment Utility & Guideway CE&I	MM-580	Jul-13	Jul-17	
		City Center & Kaka'ako Stations CE&I	MM-585	May-15	Jun-18	
		HDOT Traffic Mgt Coordination Consultant	MM-915	Jul-11	Jan-15	
		HDOT Design/Construction Coordination Consultant	MM-920	Jul-11	Mar-15	
		HDOT Coordination Consultant Oversight	MM-925	Apr-11	Mar-15	
		HDOT State Oversight Agency (SOA) Consultant	MM-930	Jul-11	Mar-19	
		Real Estate Services Consultant	MM-935	Jun-11	Feb-14	
		Kako'o Consultant	MM-940	Oct-11	Mar-19	
		On-Call Contractor	MM-945	Oct-11	Mar-19	
		OCIP	MM-950	Sep-11	Mar-19	

5.2.2 Construction and Major Material and Equipment Procurement

SCC 10 – Guideway and Track Elements

The Project is divided into four (4) line segments: West Oahu/Farrington, Kamehameha, Airport, and City Center. The West Oahu/ Farrington and Kamehameha segments will be completed under DB contracts. The grantee utilized a two-step Request for Proposals (RFP), or Best Value, contract procurement process. Under these DB contracts, the grantee 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. The grantee awarded the WOFH DB Contract on October 21, 2009 and the Kamehameha Highway DB Contract on March 21, 2011, both to Kiewit Infrastructure West Company.

The two remaining line segments (Airport and City Center) will be constructed using the DBB delivery method. The two line segment contracts will each include guideway construction and trackwork. The grantee anticipates awarding the first of these DBB line segment construction contracts in mid-2013. Utility relocations for these segments will be performed under separate DBB construction contracts that will begin before the guideway construction and trackwork contracts are issued.

While elevated guideway substructure and superstructure details have not yet been finalized, 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 two parapets acting as sound barriers. 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 grantee intends to utilize the DBB delivery method for all stations, resulting in a total of eight (8) construction contract packages involving stations. Seven of the construction packages each involve construction of three stations, although the Kaka'ako Stations package includes only the finishes for Ala Moana Station, the bulk of which's construction is included within the guideway package for the City Center Segment. A separate construction package has been identified for construction of the garage and ramps (but not the station) at the Pearl Highlands Station. The earliest of the station construction packages is anticipated to start construction in May 2012, with later packages beginning construction as late as March 2016.

The grantee intends to issue a separate Manufacture & Install (M&I) 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 grantee has established its MSF at the former Navy Drum Site between Waipahu High School and the Leeward Community College. Due to known environmental issues with the site, the grantee obtained an Environmental Condition of Property (ECP) Report regarding the history and current condition of all known hazardous materials on the site. That report concluded that, "based on the current environmental condition of the site, there are no land use controls or restrictions necessary for the proposed real estate transaction."

The Navy Drum Site topography is very steep and will require an extensive amount of cut and fill. Earthwork, retaining walls, and other structures are shown in the yard plans.

The MSF contract will include design and construction of the maintenance shop, the storage yard, all trackwork, the Operations Control Center, the vehicle wash building, the maintenance-of-way facility, and the administration facilities. The contract was awarded to Kobayashi Kiewit, A Joint Venture in July 2011.

The grantee is including procurement of all the project's 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 WOFH and KH line segment contractors will be responsible for relocation of all utilities within their respective contract limits. For the other line segments, the grantee anticipates awarding two separate Advanced Utility Relocation contracts using the DBB project delivery method starting in late 2012. Execution of utility relocation agreements between the grantee and the respective utility owners has begun.

SCC 50 – Systems and SCC 70 – Vehicles
The grantee utilized a Best Value approach for selection of a Core Systems Design-Build-Operate-Maintain contractor. The scope included: Design / manufacture / testing of approximately light metro rail 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 grantee believes that this would reduce its risk in integrating new revenue vehicle technology with third-party systems components. The grantee held a workshop on August 22, 2008 to solicit input and feedback from the contracting and manufacturing community on this approach.

The Operations and Maintenance contract will extend 5 years beyond the full build revenue date (2019), with an additional 5 year option. The Operations and Maintenance contractor will be responsible for Intermediate Operating Section Openings.

The grantee issued RFP Part 1 on April 9, 2009. RFP Part 2 was issued on August 17, 2009. A Best and Final Offer (BAFO) was requested on January 15, 2011, and Ansaldo Honolulu Joint Venture (AHJV) was selected on March 21, 2011. AHJV will be providing 80 AnsaldoBreda driverless vehicles.

Delivery of revenue vehicles would be scheduled to support the start of revenue service along the western portion of the guideway in December 2015. Opening of the entire length of the line to revenue service would occur in March, 2019.

The grantee intends to award a separate furnish and install contract for all fare collection equipment.

SCC 60 – Right-of-Way

The grantee intends to hire a Professional Real Estate Services Consultant. RFP Part 1 was issued on April 1, 2011, and RFP Part 2 will be issued in May 2011. The grantee anticipates completing the final selection and issuing NTP in July/August 2011.

Table 32 summarizes the preliminary methodology that the grantee is considering for each Standard Cost Category (SCC) construction element.

Table 32. 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	Dec-09	Oct-14	Includes installation of running/third rail
		Kamehameha Contract	DB	May-11	Sep-14	Includes installation of running/third rail
		Airport Contract	DBB	Jul-13	Oct-16	
		City Center Contract	DBB	Apr-14	Feb-14	
20	Stations	West Oahu Station Group	DBB	Dec-12	Dec-14	3 stations
		Pearl Highlands Garage and H2 Ramps	DBB	Oct-16	Jan-18	
		Farrington Station Group	DBB	Jun-12	Jun-14	3 stations
		Kamehameha Station Group	DBB	Feb-13	Mar-15	3 stations
		Airport Station Group	DBB	Oct-14	Jan-17	3 stations
		Dillingham Station Group	DBB	Mar-15	Apr-17	3 stations
		City Center Station Group	DBB	May-15	Dec-17	3 stations
		Kaka'ako Station Group	DBB	Mar-16	May-18	2 stations, plus Ala Moana finishes
		Elevators and Escalators (SCC 20.07)	DB	Nov-11	Jan-18	Procure, install, test, and commission
30	Support Facilities	Maintenance Facility and Storage Yard (SCC 30.01 and 30.03)	DB	Mar-11	Jun-14	Includes procurement of rail for full alignment
40	Sitework and Special Conditions	Airport Utility Relocation (SCC 40.02)	DBB	Mar-13	Sep-14	
		City Center Utility Relocation (SCC 40.02)	DBB	Jun-13	Sep-15	

SCC	Description	Contract Package	Contract Type	NTP	Contract End	Notes
50	Systems	Train Control and Signaling (SCC 50.01)	DB	Mar-11	Mar-19	Included in CSC
		Traction Power Supply (SCC 50.03)	DB	Mar-11	Mar-19	Included in CSC
		Traction Power Distribution (SCC 50.04)	DB	Mar-11	Mar-19	Included in CSC
		Communications (SCC 50.05)	DB	Mar-11	Mar-19	Included in CSC
		Central Control (SCC 50.07)	DB	Mar-11	Mar-19	Included in CSC
		Fare Equipment (SCC 50.06)	Furnish & Install	Not yet defined	Not yet defined	
70.01	Vehicles	Rail Vehicles	DB	Mar-11	Mar-19	Included in CSC

5.3 Findings

The following sections provide the PMOC findings for each SCC.

General

The contract delivery methodology proposed by the grantee can be successfully executed. The grantee 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, specifically:

- The PMOC is concerned with the number of concurrent contracts that will be underway during the Project. The PMOC recognizes that this risk can be mitigated with proper coordination of contracts. However, the grantee must continue to demonstrate that it has assembled a cohesive team during the early contracts and continues to expand the staff as required to meet the contract management demands as described in its PMP. PMOC will continue to monitor staffing as part of its monthly reviews.

- The grantee must not presume that the unit costs associated with work for the DB segments early in the project will equate to the unit costs for the DBB segments later on. Further, given that the spread of bidding for the DB and DBB segments will occur over a period of several years, the grantee must ensure that it has adequate contingency to account for construction market changes relative to labor, material, and equipment. The ongoing risk mitigation process, if properly executed by the grantee, will assure that contingencies are adequate to cover market changes.

- The PMOC shares the grantee's concern that the availability of major materials (fuel, cement, steel, copper, lumber, etc.) will be an issue for the Project and expects the bids to reflect such uncertainty. The concern is two-fold. First, there is uncertainty in the global construction market that is affecting 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. Secondly, the limitation of available materials for an island market may influence cost and schedule. There is a significant cost and time component associated with shipping materials to Hawaii.

- The PMOC shares the grantee's concern regarding the availability of construction equipment 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.

- It is a real possibility that prospective later-segment DBB contractors will perceive the DB contractor to have a significant competitive advantage during the bidding for the Airport and City Center segments, since the DB contractor will have already made an investment in the necessary equipment. Such an assessment by prospective DBB bidders could result in a decision not to submit bids for the later DBB contracts, thereby adversely influencing the competitive bid environment.

Despite certain questions and risks, the PMOC concludes that the Project as planned and designed is constructible under the grantee's current contract packaging plan. As stated, the PMOC is concerned that prices for the yet-to-be-let DBB contracts may not come in at the same favorable prices as experienced in the earlier DB contracts. Additionally, the already-bid DB contracts could end up spending a higher percentage of contingency than hoped for due to delays in acquiring project approvals. These issues were included in the development of a Risk Matrix and addressed at a Risk Workshop held in April 2011. The grantee has set contingencies and established risk mitigation in response to that risk management exercise.

In keeping with FTA guidance, PMOC presents further review of constructibility and contract packaging issues by Standard Cost Category, as follows:

SCC 10 – Guideway and Track Elements

- The grantee 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 grantee, 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 set conservatively, given the variability of the subsurface conditions and the access restrictions, particularly within Airport and City Center segments.

  The grantee is utilizing Geotechnical Baseline Reports 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 the Airport and City Center segments, 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 grantee will require the contractors to identify the laydown, or staging, areas for each individual contract.

- Final Design of the WOFH and KH line segments will be performed by the same DB contractor, concurrent with the systems design, which will be performed by the CSC. The grantee has developed an acceptable Interface Management Plan to help ensure necessary coordination between the DB line segment contractor and the CSC can be achieved adequately to minimize schedule delays or cost impacts.

- The 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 the WOFH and KH segments and an EDC complete the line segment design for the Airport and City Center segments, the grantee may not realize any potential cost savings from a more efficient design, should one be developed during Final Design of the DBB segments. The PMOC understands that 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.

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 Final Design 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 become available after the CSC begins its work.

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

- The grantee has adequately defined the yard, site, and building requirements for Final Design on the former Navy Drum Site.

- The major concern for the MSF design-build contract will be coordination with the CSC, as the design and maintenance of the vehicle and operating systems may require some changes. The PMP provides a framework for much of the coordination needed between contracts, including continuous contract oversight, weekly (or more frequent, as required) coordination/progress meetings, joint technical meetings, design reviews, contacts with permitting agencies, and procedures for Interface Management and Coordination, Configuration Management, Change Control, and Communications. In addition, the grantee has developed a separate Interface Management Plan that discusses management and coordination of all contractors.

SCC 40 – Sitework and Special Conditions

- The grantee has not incorporated all detailed utility adjustment and relocation activities in the Master Project Schedule. The PMOC recognizes that more definitive information will evolve during the Final Design phase. This effort should be a primary focus early in Final Design.

SCC 50 – Systems and SCC 70 – Revenue Vehicles

- The scope and criteria for the systems components and revenue vehicles are well-defined, but more detail is now available since the CSC has been selected.

- It appears that there may be limited de-mobilization required by the CSC between beginning of operations within the first two segments (WOFH and KH) and within the final segments (Airport and City Center). However, it is unclear what amount of lag time will be required before the systems contractor can re-mobilize to complete the remaining segments. It is expected that the bids reflected this uncertainty. For that reason, the risk involved in re-mobilization of the CSC testing and startup tasks has been transferred to the CSC; the grantee must, however monitor the work to assure that re-mobilization does not have an adverse effect on the overall project critical path. The MPS does include float that should be sufficient to cover any expected lag time to prevent impact to the critical path.

SCC 60 – Right-of-Way

- The PMOC has concerns with the technical capacity (resource availability) of the grantee's ROW Department to maintain schedule. Staffing with expertise in acquiring property and improvements under various strategies based on project requirements will require proficiency and capacity for easements, partial takes, full takes, eminent domain, relocation and relocation assistance, etc. To mitigate this concern, the grantee has elected to hire a Real Estate Professional Services Consultant, which will enhance the Technical Capacity and Capability of the Manager of Real Estate.

- 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 grantee may discover the necessity to acquire more partial or full takes and/or temporary or permanent construction easements than initially planned, thus affecting the project budget and schedule. This was addressed in development of the project Risk Matrix and in the subsequent development of contingency amounts and risk mitigation requirements. It should be noted that the grantee 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.

5.4 Review and Assessment

FTA's OP 32D, Project Delivery Method Review, Section 6.4, Review and Assessment, requires the PMOC to provide specific answers to questions regarding the grantee's project delivery method. This section presents those answers.

- ***The PMOC should review for the adequacy and timing of the checks planned and implemented by the Grantee. Checks may be in the form of peer reviews and/or independent or internal process reviews that ensure the strategies employed and processes used to select and ultimately deliver the project are both sound and comprehensive.***

  The grantee has implemented a technology selection panel, a structures forum, a contractor's forum and workshop, a systems forum, and two construction round tables to help resolve and verify project implementation strategies. The process goes beyond "adequacy" and can certainly be described as both sound and comprehensive.

- ***The PMOC shall fully identify, describe, and analyze the grantee's individual contract packages and anticipated or actual pricing/compensation components inclusive of overheads, contingency and "contingency like" components, and any negotiated profit/fee values.***

  PMOC has identified and described the various contract packages in the text preceding this section. While PMOC has also seen and reviewed anticipated pricing or compensation components, it cannot publish those data now for any of the pending or future contracts, as that information is considered confidential and proprietary by the grantee. The following is an analysis of the varying contract package types:
  - Program Management Support Consultant (PMC): The description of this contract's function, essentially, is to assist the grantee in a number of management support and oversight functions. The contractor (InfraConsult) has become, in effect, an extension of grantee staff. The relative lack of grantee staff and experience makes this contract essential for this project.
  - GEC II: Following its first contract's functions as developer of PE documents and the FEIS, the GEC will continue in its second contract as engineering manager, with oversight of all design, construction, inspection, and coordination contractors. The GEC is a common feature in projects of this magnitude. The use of a large international firm (Parsons Brinckerhoff) for this role should mitigate concerns with sufficient technical resources.
  - Design-Build Contracts (MSF and WOFH and Kamehameha Highway Guideway Segments): These contracts have all been openly procured and awarded. Although the grantee introduced certain risks to the project by awarding these contracts without benefit of either an FFGA or LONP from the FTA, it did so to expedite the project and lock in recession-influenced lower prices. The grantee has thus transferred much of the project risk to the DB contractors for these three significant contracts, although the grantee is at risk for the possibility of delay

claims if it is unable to allow the contractors to proceed with their work in a timely manner.

  - CSC (Core Systems Contract): This DBOM contract arranges for one entity to take responsibility for design, construction, and operations of the vehicles, systems, and ticket vending for a period of 5-10 years. This contract will transfer most of the systems/vehicles risk onto the selected contractor (AHJV), once that contract is executed. The most difficult aspect of this contracting method may have been in the resolution of the final RFP, a process that produced over 40 addenda. At this writing, it is impossible to tell if the grantee was successful in fully defining the requirements of the CSC. Any failures during that process would possibly result in unfavorable contract products or expensive change orders to correct same.
  - Design-Bid-Build Contracts: These would include separate design and construction contracts in this traditional project delivery method, covering the final two (easternmost) line segments and all stations. DBB will allow the grantee more control over the designs, albeit at a cost in time and, perhaps, money, since this method will likely delay bids by several years over the DB contracting method. DBB contracting will likely allow smaller design firms to participate in the project and will, perhaps, encourage more competition for the remaining construction contracts.
  - Other Contracts: These would include CE&I contracts, coordination contracts, and other miscellaneous specialty contracts. These are acceptable and expected smaller contracts that farm out responsibilities for specialists who act as the owner's representative.

- ***The PMOC shall assess and evaluate the degree to which such pricing/compensation components are themselves aligned with the grantee's project strategy/risk management plan and their effectiveness in terms of minimizing costs (and cost overruns) and schedule (and schedule slippages).***

  The grantee has presented its own risk assessment document, identifying key risks and using current risk assessment processes to determine ranges of project cost and schedule expectations. The PMOC, however, completed an independent FTA-sponsored risk workshop. The grantee has developed a Risk and Contingency Management Plan (RCMP) that includes a mitigation strategy that can make use of these analyses to better define project cost and schedule contingencies.

- ***Does the grantee have a comprehensive project delivery strategy?***

  Through its latest Contract Packaging Plan, dated February 24, 2011, the grantee has presented its plan for a total of 46 contracts, including design, construction, construction support, design-build, design-build-operate-maintain, and manufacture-and-install contracts, as well as seven miscellaneous specialty consulting, administrative, and task order contracts and one on-call construction contract. This plan presents the grantee's total project delivery strategy with the possible exceptions of an additional fare collection contract. As presented, the plan qualifies as a comprehensive project delivery strategy.

- ***Was a sound process used to develop the strategy?***

  The grantee used a sound process to determine and implement its strategy. The grantee first determined that the very large size of the project would preclude competition and bonding if let as a single ($3 billion) package. Using research into the bonding market, the grantee then aimed for contract values of no more than $500 million, to assure competition. Then, the grantee decided on an early-delivery DB approach for several packages, in order to assure that the tax-paying citizens of the community could see early tangible progress on the project. The recession that began in December 2007 was a further impetus for the grantee to both take advantage of a favorable bidding climate and provide stimulus to construction employers by expediting the letting of DB contracts.

  The grantee made further reasoned decisions in breaking up the guideway into geographically-similar areas and to proceed with traditional DBB methods for the stations. The stations were separated from the guideway contracts due to their different natures of construction. The grantee will rely heavily on its GEC to control interface between the various construction contracts.

  Lastly, the grantee used a sound process to determine the advantages of combining vehicles, systems, operations, and maintenance into a single DBOM contract for the CSC, thereby allowing prepackaged integration from suppliers.

- ***Is the grantee's strategy likely to satisfy the overall project objectives as well as the unique objectives of individual elements?***

  The grantee's strategy is likely to satisfy the overall project objectives, although the objectives of all the individual elements are less of a certainty. As is typical, the project may involve circumstances that cost excessive amounts of contingency or float in one or several areas, but the overall project, if budgeted and planned for such contingencies, may still come in within those allotments.

- ***Did the selected delivery method(s) consider relevant risks associated with the project element(s)?***

  PMOC believes that the grantee, in choosing its delivery methods, did consider most relevant risks, although some risks remain or were possibly exacerbated by the choices. For example, the grantee chose to reduce the risks of higher bid prices at a later date by locking in prices early with Design-Build contracting. As a result, some of the early contracts could risk additional costs if the grantee is delayed in issuing requisite NTPs in a timely manner or if further study or design induces changes in scope.

- ***Is (Are) the selected delivery method(s) appropriate for use with the particular project element?***

PMOC finds that the combination of different methods for the various contracts is appropriate, although not without its own set of risks.

- ***Is the strategy, including the contract packaging plan, appropriately documented in the Project Management Plan?***

  The PMP, by referring to the Contract Packaging Plan (Revision 2 dated February 24, 2011), appropriately documents the strategy.

- ***Does the project schedule reflect the project delivery strategy, including sufficient preparation time?***

  The project schedule reflects the project delivery strategy, and it includes the NTP and completion dates for each of the contracts identified in the Contract Packaging Plan. As the completion dates will be contractual obligations, it is presumed they will be met, unless problems arise or the grantee fails to issue the NTPs in a timely manner. Once contractors are working, they will supply and provide updates to their own internal contract schedules, which will be uploaded into the overall MPS. Using that document, the grantee will be able to identify issues with the schedule on a continuing basis and, if necessary, implement mitigation strategies to correct problems.

- ***Does the grantee currently possess, or have a plan to acquire, the staff resources to successfully execute the project delivery strategy?***

  The PMOC has identified some Technical Capacity and Capability issues that must be addressed prior to start of Final Design as identified in the OP 21 review. However, in general, the grantee has a plan to acquire all staff resources necessary to execute the project delivery strategy. This has been an ongoing topic of discussion at the monthly project meetings with the PMOC. The grantee has gradually added staff over the past several years, but supplements its personnel with employees of its GEC and PMC. PMOC finds that the grantee's plan to add staff, as described in the PMP and supporting sub-plans, is sufficient, if successfully implemented, to assure that the project management has the necessary Technical Capacity and Capability to complete the project. Staffing will be a continuing topic of discussion in monthly project reviews.

5.5 Conclusion

The PMOC concludes that the Project is ready to enter the Final Design Phase with regard to the Project Delivery Method (OP 32D) assessment.

5.6 Recommendations

Many of the issues identified within the OP 32D report would typically be addressed during the Final Design phase. The PMOC recommends that the grantee utilize the Risk Register as the basis for action items. These action items should be prioritized and addressed early in Final Design. The PMOC believes this approach will protect the Federal interests, should Final

Design Phase funding be approved, and enable the grantee to embark on Final Design efforts with a far more definitive scope of work and overall budget and schedule.

6.0 OP 33: CAPITAL COST ESTIMATE REVIEW

6.1 Introduction

6.1.1 Purpose and Objectives

Per the current Federal Transit Administration (FTA) Oversight Procedure (OP) 33, the following statements concisely state the focus of the PMOC's review of the grantee's *2011 Standard Cost Category (SCC) Estimate* for Entry into Final Design:

(1) ***Soundness of the grantee's cost estimating methods and processes compared with proven professional quantity surveying and cost estimating practices for projects of this scale:***
The grantee's *2011 SCC Estimate* was prepared utilizing standard industry practice with recognizable Timberline estimating software and a reasonable and reliable data base. The estimate is substantiated in part from bid results obtained from the award of the Design-Build (DB) portions of the work during 2010/2011. The $1.8 billion in aggregate contract value awarded to date is approximately 43% of the project's contract value, not including contingency.

(2) ***Congruence of the project cost estimate with the project scope and schedule, i.e. do these three elements fully reflect each other?***
The grantee's estimate is reflective of the environmental documents and the project scope. As discussed in the OP 34 section of this report, the PMOC found the Master Project Schedule (MPS) to be mechanically sound but lacking in detail to sufficiently address all topics within the OP 34 review. However, the estimate is reflective of the sequencing identified in the MPS. The schedule was used to calculate escalation at reasonable rates and for the durations contained in the MPS activity codes. The bids contain Year of Expenditure (YOE) escalation, so the grantee was able to develop base year and YOE costs mathematically for the *2011 SCC Estimate* from a combination of bids and estimate values.

As noted above, 43% of the *2011 SCC Estimate* value is associated with awarded DB contracts. The remaining estimate value is based on advanced Preliminary Engineering (PE) documents which were reviewed by the PMOC in support of OP 32C review (conformance with Environmental documents). The PMOC reviewed the Basis of Cost Estimate and the Basis of Schedule to verify transparency and traceability of assumptions used to justify the costs and durations associated with each Project scope element and SCC.

The work scope, the schedule, and estimate are coordinated and fully integrated with the exception of the adjustments identified within this report.

(3) ***Reliability of the estimate for procurements, contract bids, and contract closeout, i.e. will the project budget prove to be adequate at these milestone events?***
The grantee's engineer's estimates have proven reliable as they have been in the range of the currently awarded DB contract amounts. The remaining DB contract engineer's

estimates have been slightly adjusted to match the unit priced derived from the successful DB contract bids. In some cases, the unit prices were not changed to reflect bid prices, as the site-specific nature of the work may dictate that higher or lower prices should be utilized. The only caveat about using the bid prices from the DB contracts is that they do not reflect the delay claims that the contractors will likely submit to the grantee. The successful bidders may claim to have suffered from schedule delays due to the grantee being unable to issue timely NTPs for Final Design and construction work. The grantee plans to request Letter of No Prejudice (LONP)'s for select portions of the work to mitigate the delay and reduce potential costs. It should be noted that the FTA granted an LONP on May 24, 2011 to allow Final Design activities to begin for the WOFH DB Contract.

The FTA's objective is to assess the consistency of cost estimating information, understand its characteristics, and confirm that the estimate adequately reflects the overall project scope, estimating quantities shown on the design documents, the anticipated market conditions, and the project schedule.

The PMOC 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 OP 40 (Risk and Contingency Review). These adjustments included scope items as well as a value for grantee identified latent contingency.

The PMOC reviewed and evaluated the general uniformity of the grantee's escalation from base year to YOE dollars, the escalation factors used, and the soundness of the economic forecasts and escalation factors. This is presented in greater detail in the escalation portion of the report.

6.1.2 Format, Date, and Level of Design

The grantee's *2011 SCC Estimate* was prepared utilizing Timberline estimating software.

The PMOC received the grantee's Estimate in draft format version in November 2010. A second revised version was received in December 2010. These two versions were in 2010 dollars and matched the original PE budget of $5.348 billion in YOE. The PMOC received the final version of the grantee's SCC Estimate on March 25, 2011 in base year 2011 dollars with a revised YOE amount of $5.213 billion. The cost estimate includes $865.58 million in allocated and unallocated contingencies and $230 million in finance costs (revised from an initial $180 million projection). The PMOC reviewed the March 25, 2011 cost estimate to support the OP 33 review. Table 33 presents a summary of the *2011 SCC Estimate* in both base year and YOE dollars, including allocated and unallocated contingency amounts (for comparative purposes).

The project is currently in Advanced PE as the grantee is seeking entry into the Final Design phase. The SCC 2011 Estimate includes advanced PE level of design further supported with the inclusion of three awarded Design Build (DB) contract amounts.

Table 33. 2011 SCC Estimate

SCC	Description	Base Year $ Total (Incl. Cont.)	Base Year $ Contingency	YOE $ Total (Incl. Cont.)	YOE $ Contingency
10	**Guideway & Track Elements (Route Miles)**	**1,134,343,000**	**163,893,000**	**1,308,357,000**	**190,536,000**
10.04	Guideway: Aerial structure	1,048,855,000	153,346,000	1,210,392,000	178,396,000
10.08	Guideway: Retained cut or fill	6,943,000	905,000	7,401,000	965,000
10.09	Track: Direct fixation	74,068,000	8,997,000	85,256,000	10,403,000
10.11	Track: Ballasted	2,799,000	365,000	3,102,000	404,000
10.12	Track: Special (switches, turnouts)	1,676,000	278,000	2,204,000	366,000
20	**Stations, Stops, Terminals, Intermodals**	**496,915,000**	**83,420,000**	**614,602,000**	**103,170,000**
20.01	At-grade station	7,445,000	1,265,000	8,345,000	1,418,000
20.02	Aerial station	365,033,000	61,520,000	449,606,000	75,779,000
20.06	Automobile parking multi-story structure	59,393,000	9,797,000	77,918,000	12,853,000
20.07	Elevators, escalators	65,043,000	10,837,000	78,732,000	13,117,000
30	**Support Facilities: Yards, Shops, Admin.**	**95,998,000**	**11,044,000**	**103,805,000**	**11,942,000**
30.02	Light Maintenance Facility	7,874,000	905,000	8,511,000	979,000
30.03	Heavy Maintenance Facility	39,576,000	4,553,000	42,778,000	4,921,000
30.04	Storage or Maintenance of Way Building	8,087,000	930,000	8,741,000	1,005,000
30.05	Yard and Yard Track	40,461,000	4,654,000	43,774,000	5,035,000
40	**Sitework & Special Conditions**	**904,682,000**	**134,943,000**	**1,021,457,000**	**153,475,000**
40.01	Demolition, Clearing, Earthwork	17,439,000	2,321,000	19,916,000	2,679,000
40.02	Site Utilities, Utility Relocation	320,471,000	59,728,000	358,376,000	67,161,000
40.03	Haz. mat'l, contam'd soil removal/ mitigation	6,791,000	726,000	7,533,000	811,000
40.04	Environmental mitigation	26,829,000	3,526,000	30,802,000	4,078,000
40.05	Site structures (retaining walls, sound walls)	18,897,000	2,588,000	22,935,000	3,159,000
40.06	Pedestrian / bike access, landscaping	36,865,000	5,878,000	44,675,000	7,136,000
40.07	Automobile, bus accessways (roads, parking)	174,146,000	25,581,000	212,928,000	31,598,000
40.08	Temporary Facilities/other indirect costs	303,240,000	34,590,000	324,289,000	36,849,000
50	**Systems**	**207,539,000**	**23,404,000**	**251,586,000**	**28,379,000**
50.01	Train control and signals	77,305,000	8,282,000	92,601,000	9,921,000
50.02	Traffic signals and crossing protection	10,568,000	1,875,000	13,043,000	2,315,000
50.03	Traction power supply: substations	27,082,000	2,911,000	33,800,000	3,632,000
50.04	Traction power distribution	31,698,000	3,806,000	37,347,000	4,489,000
50.05	Communications	49,194,000	5,276,000	60,602,000	6,499,000
50.06	Fare collection system and equipment	8,382,000	898,000	10,324,000	1,106,000
50.07	Central Control	3,307,000	354,000	3,868,000	414,000
	CONSTRUCTION SUBTOTAL (10 - 50)	**2,839,478,000**	**416,706,000**	**3,299,809,000**	**487,504,000**

SCC	Description	Base Year		YOE	
		Total (Incl. Cont.)	Contingency	Total (Incl. Cont.)	Contingency
60	**ROW, Land, Existing Improvements**	**241,850,000**	**69,100,000**	**247,942,000**	**70,840,000**
60.01	Purchase or lease of real estate	220,546,000	63,013,000	224,649,000	64,185,000
60.02	Relocation of existing households/businesses	21,303,000	6,086,000	23,293,000	6,655,000
70	**Vehicles**	**175,528,000**	**18,806,000**	**212,461,000**	**22,763,000**
70.01	Light Rail	156,967,000	16,817,000	191,657,000	20,534,000
70.06	Non-revenue vehicles	13,243,000	1,418,000	14,589,000	1,563,000
70.07	Spare parts	5,317,000	569,000	6,214,000	665,000
80	**Professional Services**	**922,107,000**	**82,699,000**	**1,031,047,000**	**92,821,000**
80.01	Preliminary Engineering	55,911,000	4,728,000	58,996,000	4,756,000
80.02	Final Design	214,323,000	21,227,000	222,177,000	22,403,000
80.03	Project Management for Design/Construction	309,060,000	24,874,000	350,329,000	28,507,000
80.04	Construction Administration & Management	160,256,000	14,568,000	187,914,000	17,083,000
80.05	Professional Liability/Non-Construction Ins.	47,925,000	4,356,000	56,103,000	5,100,000
80.06	Legal; Permits; Review Fees by other agencies	61,319,000	5,574,000	69,918,000	6,355,000
80.07	Surveys, Testing, Investigation, Inspection	5,603,000	484,000	6,072,000	527,000
80.08	Start up	67,707,000	6,883,000	79,534,000	8,088,000
	SUBTOTAL (10 - 80)	**4,178,965,000**	**587,312,000**	**4,791,260,000**	**673,930,000**
90	**Unallocated Contingency**	**167,158,000**	**167,158,000**	**191,650,000**	**191,650,000**
	SUBTOTAL (10 - 90)	**4,346,123,000**	**754,470,000**	**4,982,910,000**	**865,580,000**
100	**Finance Charges**	**200,607,000**	**0**	**230,000,000**	**0**
	TOTAL PROJECT COST (10 - 100)	**4,546,731,000**	**754,470,000**	**5,212,910,000**	**865,580,000**

6.2 Grantee Submittals

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

6.3 Methodology

The following describes the PMOC methodology and approach for reviewing the grantee cost estimate and related documents.

The PMOC followed the requirements outlined in the *FTA OP 33: Capital Cost Estimate Review,* dated May, 2010 to assess and evaluate the grantee's cost estimate. Specifically, the PMOC completed a review of the project cost estimate to ensure it was:

- Procedures Review – Grantee's Cost Estimate Review Process
- 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 focus of this evaluation is the grantee's 2011 Standard Cost Category (SCC) Estimate, referred to within this Report as the *2011 SCC Estimate.* The grantee's *Main Worksheet – Build Alternative* from the *SCC Worksheet* was provided as Appendix C1 along with the previous version from 2009. This estimate was prepared by the grantee's General Engineering Consultant (GEC) with input from its sub-consultant(s). 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 of this report.

The grantee provided only the estimate summary sheets in SCC format and not the standard SCC workbook that will be required as a submittal for the Entry into Final Design. A series of "escalation" sheets were also provided and these total to the main summary values. However, these summary sheets do not utilize the standard formulas from the FTA Standard Escalation sheet. In most cases, data values are "hard entered" and used to calculate the yearly escalation percentages. This is understandable as some of the YOE values were supplied by the awarded contractor's schedule of values, but this is not true in all cases. The grantee has indicated that these values were extracted from a Microsoft (MS) Access database. The grantee transmitted the database file to the PMOC to support this review.

Per Section 6.3 of OP 33, the PMOC approach in reviewing the project cost estimate should "regardless of the level of development of the estimate, provide FTA with reliable findings and recommendations". The PMOC determined a course of action for review and sampling once the cost estimate classification and characterization have been determined.

An important step in the PMOC's approach to reviewing project cost data is quantifying the volume of cost data available as well as identifying the type of estimate prepared by the grantee (characterization). The PMOC must use its best judgment and professional expertise to determine a sampling size for quantity and unit price reviews, or determine whether another approach might be prudent. Since the process is subjective, a percentage approach, although scientific, may not be applicable for all projects. It is important to select an optimum sampling method to provide for sufficient cost review to obtain reliable analysis results. Use of Pareto style approach could be used to identify high cost elements or quantities, and the PMOC could focus on these line items as they have the most impact to cost. The PMOC verified that the correct executed DB contract amounts were used in the cost estimate. The PMOC also verified that correct escalatory adjustments and contingencies were applied and distributed across the applicable SCC line items.

Following is the PMOC's approach in reviewing the Project cost estimate as outlined in OP 33:

(1) Review previous Risk Assessment analysis, adjustments and recommendations and verify these were addressed in the grantee's revised estimate(s).

(2) Review drawings, specifications, environmental documents, Basis of Estimate, Contract Packaging Plan, Master Project Schedule, SCC Workbook, etc. to characterize the estimate.

(3) Once the estimate characterization is complete, the PMOC determines whether a statistical approach (percentage basis) or more custom approach for sampling is most suitable. In the case of the Project, the PMOC first verified that the grantee accurately incorporated the awarded bids, and then segregated the not awarded and awarded costs into separate categories.

(4) A Pareto style analysis was used to identify the high cost drivers of the remaining un-awarded work. Specifically, the PMOC examined all line items exceeding \$200,000, the costs for the stations, utilities, and cost for the remaining two guideway sections. The PMOC focused the review on items having the largest cost impact.

(5) Review and determine validity of grantee's proposed adjustments from its internal Risk Assessment. Incorporate any significant findings from the OP 32C review as adjustments into the conditioned estimate.

(6) Analyze the grantee's proposed individual escalation rates and the coordination of the escalated cost elements as compared to the Master Project Schedule, which incorporates some of the awarded contractor schedules and adjust the conditioned estimate if required

(7) Verify the unit prices used in the Timberline Estimate as reasonable and check for adjustments or modifiers for differing conditions along the alignment and inclusion of General Conditions' elements. Sample quantities for un-awarded segment to verify number of stations, rail quantities, pre-cast segment length, etc. An example of this is the overall unit price for the remaining guideway sections in a dense urban setting is 50% higher than the two awarded sections in less congested rural areas.

(8) Sampling to include a comparison of overall stations costs, unit prices for track and special trackwork, comparison of General Condition markups, verification of appropriate escalation, plus a check of unit prices in excess of \$200,000 and comparison of soft cost from the staffing plans against the Master Project Schedule.

(9) Identify additional adjustments to condition the grantee's estimate for omitted or changed items.

(10) Confirm all items on checklist included as Appendix D of OP 33 are addressed in this review.

(11) Identify "atypical" market forces such as remote geographic location, mega project size, extended project life-cycle, and constrained urban setting.

6.3.1 Sampling

As noted above, the PMOC approach first completed the estimate characterization to determine if an appropriate statistical analysis (percentage basis) or more custom approach for sampling was most suitable. The PMOC verified the grantee appropriately incorporated the awarded bids and performed a segregation of these line items from the Timberline estimate into a separate category. The remaining, un-awarded, cost estimate line items were then exported from Timberline cost estimating software into a MS Excel spreadsheet so they could be sorted and analyzed with comparative ease.

The PMOC used a Pareto style approach for sampling of construction line item unit prices and quantities contained within the grantee's Timberline estimate. The PMOC used the Excel spreadsheet to filter and develop a list of construction line items greater than $200,000. The Timberline estimate contained 7,390 line items. This Pareto-like sampling resulted in 801 line items greater than $200,000, which were the focus of the PMOC since these costs account for more than 70% of the construction estimate amount.

Table 34. Sampling Table

Description	Approx. No. of Estimate Line Items	Value ($)	% Based on Value	% Based on Line No.
	7,390	**3,515,380,495**		
All Line Items in Timberline				
Awarded Contracts	48	1,465,721,197	41.69	0.65
Soft Costs (not included awarded Contracts)	46	648,594,245	18.45	0.62
ROW & Private Utility	17	274,356,405	7.80	0.23
Guideway (Not Awarded)	1,569	560,287,425	15.94	21.23
Utilities (Not Awarded)	328	66,387,032	1.89	4.44
Stations (Not Awarded)	5,104	443,036,323	12.60	69.07
Elev. & Escalators	87	51,766,670	1.47	1.18
Owner Furnished Plants	191	5,231,198	0.15	2.58
Sampled Items (Construction Line Item Value >$200K)				
Guideway Line Items	318	523,251,516	93.39	20.27
Utility Line Items	27	59,105,952	89.03	8.23
Station Line Items	364	306,040,422	69.08	7.13
Elevator/Escalator Line Items	87	51,766,670	100.00	100.00
OF Plants Items	5	1,754,460	33.54	2.62
Total	**801**	**941,919,020**	**26.79**	**10.84**
Non-Sampled Items (Construction Line Item Value <$200K)				
Guideway Line Items	1,251	37,035,894	6.61	79.73
Utility Line Items	301	7,281,075	10.97	91.77
Station Line Items	4,740	136,995,977	30.92	92.87
Elevator/Escalator Line Items	0	0	0.00	0.00
OF Plants Items	186	3,476,736	66.46	97.38
Total	**6,478**	**184,789,682**	**5.26**	**87.66**

Note: Unit Prices are in 2011 Base Year. No contingency or GET are included.

The total value of $3.52 million in the above table does not include some work elements. The following table demonstrates what is omitted.

Table 35. Calculation Proof

PROOF OF CALCULATION & TRACEABILITY	**$3,515,380,495**
ADD GET TAX (not awarded work)	$76,272,612
ADD ALLOCATED CONTINGENCY	$587,312,251
ADD UNALLOCATED CONTINGENCY	$167,158,615
ADD ESCALATION	$636,786,855
TOTAL	**$4,982,910,828**
Check: FROM SCC WORKBOOK TOTAL 2011 BASE YEAR	**$4,982,910,834**

The PMOC checked all of the unit costs in the "Greater than $200,000" list as well as the 6,589 line items in the "Less than $200,000 list". Some issues were identified, but no significant costs impacts were found. The following table presents an example of the Timberline data sampled for the Airport Guideway. This table includes the following information for line items with a value greater than $200,000:

(1) SCC Designation
(2) Quantity
(3) Unit prices for labor and material and extensions (totals)
(4) Overall Unit price to include labor, material, subcontract & other
(5) Total line item price

Table 36. Timberline Data > $200K for DBB-460 Airport Guideway

SCC	Description	Qty	Unit	Labor Unit	Labor Total	Mat'l. Unit	Mat'l. Total	Equip. Amount	Line Item Total	Unit Cost
10.04	Dewatering During Construction (minor)	60	mo						585,804	9,763.40
10.04	Temp stairway w handrail section average ht 50 ft	57	ea	659.20	37,794	3,164.04	181,404		219,198	3,823.24
10.04	Splice rebar, mechanical coupler, #11 bars	16,757	ea	22.00	368,650	19.71	330,248	2,339	701,237	41.85
10.04	Structural concrete, in place, elev slab, 4" slab, incl, finishing	53,918	sf	7.51	405,125	2.97	160,278	95,687	661,090	12.26
10.04	Elastomeric Bearings, 34in x 15in x 8 in	752	ea	435.44	327,454	1,994.68	1,499,996		1,827,450	2,430.12
10.04	Expn Jnt assy, elast with studs & galv mtl plate cover	5,190	lf	14.50	75,241	74.94	388,944	16,183	619,962	119.45
10.04	Guideway Lighting	1	LS						2,740,277	2,740,277
10.04	Drill Shafts 8' Dia. (Inc. Install & Case)	12,424	vlf	868.37	10,788,674			6,724,812	17,513,486	1,409.65
10.04	Buy 4000 PSI Concrete	23,130	cy			183.94	4,254,574		4,254,574	183.94
10.04	Install Concrete (Tremie)	28,912	cy	7.76	224,316			148,559	372,875	12.90
10.04	Buy Concrete - Overbreak 4500 PSI-20%	5,782	cy			190.51	1,101,535		1,101,535	190.51
10.04	Buy Prefabricated Reinforcing Cages	4,819,566	lbs						4,834,287	1.00
10.04	Install Reinforcing & Lap Splice	311	ea	2,862.46	890,225			231,631	1,121,856	3,607.25
10.04	Radiograph Tubes	49,696	vlf	11.58	575,396	5.36	266,164	358,657	1,200,216	24.15
10.04	Drill Rig Movements	129	ea	3,473.49	448,081			279,298	727,379	5,638.60
10.04	Haul & On-site Disposal of Shaft Spoils	19,810	lcy	23.95	474,520			399,588	874,108	44.13
10.04	Casing Handling	199	ea	2,758.44	548,929			523,509	1,072,438	5,389.13
10.04	Site Casing Fabrication	199	ea	5,724.92	1,139,258			955,136	2,094,395	10,524.60
10.04	Purchase 9.5 ft. dia 1" thk. Casing	1,698,475	lbs			2.17	3,682,366		3,682,366	2.17
10.04	Place & Strip Forms, Columns	23,905	sf	8.91	213,023	2.97	71,062	54,790	338,874	14.18
10.04	Place & Strip Forms, Beam	48,882	sf	9.72	475,194	1.98	96,873	122,221	694,288	14.20
10.04	Formliner, Columns and Bent Cap	112,627	sf			2.31	260,400		260,400	2.31
10.04	Reinforcing in Place, Spread Footing	184,397	lb	0.71	130,956	0.79	146,344		277,300	1.50
10.04	Reinforcing in Place, Columns	2,501,863	lb	1.07	2,665,176	0.79	1,985,572		4,650,748	1.86
10.04	Reinforcing in Place, Beams	829,729	lb	0.95	785,681	0.79	658,504		1,444,185	1.74
10.04	Prestressing Steel, Grouted Strand	272,021	lb	4.91	1,334,924	2.75	748,405	28,946	2,112,275	7.77
10.04	Placing Concrete, Columns	9,526	cy	47.76	454,996	184.96	1,761,975	154,701	2,371,671	248.97
10.04	Placing Concrete, Beam	4,149	cy	77.62	322,028	184.96	767,419	109,491	1,198,938	288.97
10.04	Concrete Finishing, Vert Surface	198,205	sf	2.33	461,188	0.40	78,559	117,622	657,369	3.32
10.04	Concrete Finishing, Anti-Graffiti Coating	31,707	sf						209,272	6.60
10.04	Furnish Typical Pier/Expansion Joint Segment	2,229	ea						45,672,741	20,490.24
10.04	Furnish Balanced Cantilever Joint Segment	78	ea						3,196,477	40,980.48
10.04	Erect Typical Double Track Segment - Span by Span	1,885	ea	1,792.74	3,379,305			1,715,071	5,094,376	2,702.59

SCC	Description	Qty	Unit	Labor Unit	Labor Total	Mat'l. Unit	Mat'l. Total	Equip. Amount	Line Item Total	Unit Cost
10.04	Erect Pier/Expansion Joint Segment - Span by Span	344	ea	2,016.83	693,788			352,113	1,045,901	3,040.41
10.04	Buy Concrete Class V (6500 PSI) for Intrnl + Ext Diaphrams	4,087	cy			217.99	890,938		890,938	217.99
10.04	Form and Strip Internal & External Diaphragm Forms	94,256	sf	16.08	1,515,346			30,628	1,545,975	16.40
10.04	Form and Strip Blockouts in Diaphrams	17,200	sf	48.23	829,569	6.61	113,621	16,767	959,958	55.81
10.04	Pour & Cure Diaphragm	3,891	cy	118.83	462,322			168,175	630,497	162.06
10.04	Point, Patch & Whip Blast Structure	1,002,915	sf	1.16	1,166,851			156,578	1,323,429	1.32
10.04	Overtime (Labor and Equipment) for Erecting Precast Segments	1	LS	2,208,308	2,208,308	127,659	127,659		3,816,522	3,816,522
10.04	Overtime (Labor and Equipment) for Foundations	1	LS	4,220,434	4,220,434	132,243	132,243		4,818,118	4,818,118
10.04	Buy Forms - Closure Joint Steel Forms	17,640	sf			13.21	233,056		233,056	13.21
10.04	Build & Assemble Closure Joint Forms	17,640	sf	16.08	283,597			5,732	289,329	16.40
10.04	Form & Strip Closure Joint Forms	52,920	sf	48.23	2,552,372			51,589	2,603,961	49.21
10.04	Set & Strip Stem Walls	114,736	sf	9.65	1,106,765			22,370	1,129,135	9.84
10.04	Pour, Finish & Cure Closure Joint	2,492	cy	118.83	296,146			107,727	403,873	162.06
10.04	Pour, Finish & Cure Stem Walls	1,673	cy	118.83	198,830			72,327	271,156	162.06
10.04	Tie & Place Reinforcing Steel for Diaphragm (inc 5% for lap bars)	1,376,703	lb	0.06	88,099			34,742	1,522,491	1.11
10.04	Install, Stress & Grout Longitudinal Post-tensioning Steel	3,298,476	lb						18,739,899	5.68
10.04	Furnish Prcst Conc Noise Barrier ($15/sf plain) & (inc minor arch facia trtmt $15/sf)	172,536	sf			38.48	6,638,596		6,638,596	38.48
10.04	Install Precast Concrete Noise Barrier	43,134	LF	4.20	180,958			53,474	234,432	5.44
10.09	Unload Track Material & Distribute Along Line	52,241	tf	5.49	286,631			91,735	378,365	7.24
10.09	Electric (Flash Butt) Welding	1,206	ea	292.23	352,431			125,332	477,763	396.16
10.09	Place Running Rail with Fasteners (Temp. Supported)	52,241	tf	13.78	720,099			263,608	983,707	18.83
10.09	Raise, Shim & Align Rail	52,241	tf	11.03	576,079	2.58	134,877	210,886	921,842	17.65
10.12	No. 10 Double Crossover, DF	3	ea	132,328	396,984			145,325	542,309	180,770

6.3.2 Checking Costs Against Scope and Schedule

The estimate is based on the grantee's current PE drawings and DB contract award amounts as of March 2011. The PMOC reviewed the remaining (un-awarded) line items according to contract packaging plan and SCC to verify scope inclusivity, inadvertent scope omissions, and potential doubling-up of scope among the various design document packages. The PMOC also referred to the MPS used to conduct the OP review when performing the scope inclusivity review. The MPS is cost loaded and contains a WBS that can be filtered and sorted to view all contract packages scheduling and cost information. The PMOC did not find any significant discrepancies between the MPS and cost estimate line items within SCC or contract package WBS sorts. Furthermore, no significant issues were identified for missing scope or erroneous schedule durations; detailed discussions are contained within the individual SCC portions of this report.

6.3.3 Identifying Allowances

The PMOC exported the cost estimate line items from the Timberline cost estimating software to MS Excel in an effort to identify all allowance amounts. The first sort filtered the various line item unit measures such as Lump Sum, Allowance, Each, etc. The PMOC used the information to effectively and efficiently support onsite workshop discussions with the grantee's project control and cost estimating staff. In cases where the PMOC identified excessive cost amounts with Lump Sum unit measures, the grantee agreed to provide more detail and justification supporting the line item amount. This information was then incorporated into the Basis of Estimate. Further discussion on allowances is included in other report sections in accordance to the OP 33 recommended report outline.

6.3.4 Identifying Patent and Latent Contingencies

The grantee did not clearly document its assumptions used to support the justification and use of patent and latent contingency in the cost estimate. In fact, when the PMOC interviewed the various grantee and GEC cost estimators, they each expressed differing contingency amounts; many of which were not identifiable in the cost estimate. Latent contingency is rarely identified in a cost estimate as it is associated with "hidden" cost to mostly account for an estimator's confidence level with the amount of information provided to perform the quantity takeoff and pricing exercise. These types of contingencies are not usually identified in a cost estimate as they are somewhat subjective and purposely not documented. Many times, buried latent contingency produces "overly" conservative amounts for certain line items either difficult to quantify, highly specialized work, underground and utility work, real estate acquisition, and renovation work. The grantee did include line items for allocated and unallocated contingency amounts, although these descriptor line items do not conform to the definition of patent and latent contingency.

The grantee performed an internal Risk Assessment in the fourth quarter of 2010, and completed its analysis in final draft form in January 2011. During the preparation of its report, the grantee's staff prepared documentation of latent contingency and included a downward adjustment of the November 2010 PE Estimate used in its risk assessment analysis. The latent contingency was suggested by the risk assessment staff, noting the bids to date for the guideway work were less than the "engineer's estimates" and that a deduction or adjustment could be taken due to overly conservative unit prices. The grantee developed a spreadsheet documenting proposed adjustments for work not awarded at the Stations, Elevators & Escalators, City Center & Airport Guideway segments, Right of Way or Real Estate parcels, Core Systems Design Build Operate Maintain (DBOM), Utilities and Landscaping not yet bid. The value the grantee deducted for latent contingency in its internal risk assessment in December 2010 was $271.6M in YOE$. This action was taken prior to incorporation of the awarded work for the Core Systems, MSF or Kamehameha bids that occurred in the March 2011 SCC Estimate, as its risk assessment was based on the November 2010 PE estimate.

The grantee also noted the bids indicated another downward adjustment for "market conditions" for the upcoming Station bids could be taken. The staff believed there would be substantial competition during the bidding phase due to the downturn in Honolulu's economy. This "market conditions" value was based on a much smaller overall quantity of work and a deduction to the estimate for the risk assessment analysis of $28.5 million was proposed and taken by the grantee in its risk assessment analysis.

There were additive adjustments to the grantees risk assessment analysis for delay claims and other activities, but these are not a part of a latent contingency deduction.

6.3.5 Accepting Grantee Cost

The PMOC considered the grantee's proposed latent contingency values discussed during the PMOC risk assessment workshops in early 2011 and decided to adopt a portion of the latent contingency the grantee had proposed. Some of the latent contingency was eliminated as the March 2011 Estimate incorporated bids and new information which superseded the grantee's previous analysis. In addition, the PMOC determined that the proposed "Market Adjustments" were not valid as they were based on DB bid information and not Design-Bid-Build (DBB) bid information.

After taking into account awarded bids and the revised March 2011 estimate, the PMOC adopted $48.9 million as a latent contingency adjustment for the following SCC categories:

- SCC 20.02 – Latent Contingency (deduct) of <$18.57 million> (Stations)
- SCC 20.07 – Latent Contingency (deduct) of <$6.56 million>(Elevators & Escalators)
- SCC 40.06 – Latent Contingency (deduct) of <$0.198 million> (for Owner Furnished Plants and Shrubs)
- SCC 60.01 – Latent Contingency (deduct) of <$23.60 million> (ROW)

6.4 PMOC Review

6.4.1 Description of Structure, Quality, Level of Detail

Procedures – Grantee's Cost Estimate Review Process

The PMOC reviewed the grantee's PMP and companion documents, and related procedures in support of the OP 21 review and the grantee's request to enter the Final Design phase. The PMOC met with the grantee to discuss its cost estimating procedure, "*4.PC-06 Cost Estimating*

*Procedure Rev 0 03.-10-11"*and the Basis of Estimate as they both describe how cost estimates are developed, scrubbed and maintained. The Basis of Estimate describes all of the assumptions and parameters used to support and justify the cost estimate format and content.

The grantee has developed various procedures which address how project control deliverables are developed, revised, and reviewed according to internal quality control and quality assurance procedures. While the PMOC has not observed the grantee perform independent cost estimates or check estimates, the PMOC has verified that internal quality review procedures are being implemented. For example the PMOC has verified the grantee performs an internal review of the project schedules each time they are baselined and submitted to the Project team's Change Control Board. While conducting the various OP reports, the PMOC has observed several gaps in the grantee's internal quality assurance and quality control process as evidences by inconsistencies with naming conventions, document control and transmittals, estimate reviewer disposition and revision history documentation. Some of the issues were related to the dynamic nature of the advanced PE phase since the engineering documents are constantly evolving and issued through numerous revisions. The PMOC recommends the grantee improve its internal quality control implementation and possibly seek the outside subject matter expert consultant services in or to meet peak demands or address critical project control deliverables or information.

<u>Contract Packages and Estimating Approach</u>
The grantee has an acceptable Contract Packaging Plan (CPP) Rev, 2, dated February 24, 2011 which includes the incorporation of PMOC comments when the document was under development. The Cost estimate, Basis of Estimate, MPS and Basis of Schedule correctly address the CPP and also include summary cost totals that correctly add to the appropriate contract levels and summary total.

The CPP contains separate sheets for each contract package and includes work elements, contract type, estimated value plus other relevant information. The contracting approach described is consistent for each work package and procurement is 43% complete based on costs.

<u>Coordination of Estimate with SCC</u>
The PMOC team reviewed the *2011 SCC Estimate* and supporting data provided by the grantee, which included information regarding civil, architectural, track work, utilities, vehicles, and systems components. The estimate is well organized and corresponds to the scope described in the Environmental Documents and Project Record Documents (engineering). The level of development of the estimate is more advanced than the pre-PE review performed by the PMOC in 2009 and depends less heavily on unit measures: Allowances, Lump Sums, and CERs. A major portion (43%) of the estimate (budget) is based on "actuals" from construction bids/awards and the remaining *not awarded* portions of the work utilize some of the unit prices from the local bids received.

The grantee has now prepared a more detailed Public Utility Estimate and a separate Right of Way Estimate, along with Staffing Plans for Soft Costs (SCC 80) and has incorporated these values in the current budget. These actions tend to increase the accuracy of the estimate.

The cost estimate contains normalized unit pricing for most of the line items. The unit pricing does not contain productivity factors to account for varying conditions and inefficiencies. Typically the adjustments are made within the cost estimating software which can then be applied to the unit pricing as a separate and controlled calculation. The PMOC observed these adjustments in the more detailed cost estimate assemblies. For instance, the Guideway unit pricing was up to 50% higher in the easterly Project segments where downtown urban density is greatest. The cost estimate does not include line items for modifiers for unforeseen ground conditions or related unusual geotechnical conditions as the design build award portions include these risks in their bids. Considerations should be given structurally to account for variability in grades, structure heights, span lengths, and known geological conditions. The Basis of Estimate does address some of these inefficiencies but is not completely traceable in the Timberline cost estimate.

The PMOC confirmed the grantee's cost estimate development and assembly methodology was sufficient but did note the station markups needed correction to account for an inadvertent formula error for prime contractor markup. The PMOC did not find significant quantity variances or busts and did not find other formula or mechanical errors.

6.4.2 Market Conditions Survey

The PMOC included this section to supplement the cost estimate technical review and emphasize the contracts that have been awarded and how the unit prices were analyzed and applied across other sections of the cost estimate.

Honolulu has experienced the same sluggish economy as the rest of the county since the 2008 downturn. The unemployment rate is often cited as a good indicator of the economy and in Honolulu it is around 6 to 8% (varies by island), which is better than the US average of 9%. However, construction work has been hit especially hard across the country including Honolulu as the national unemployment average is over 16% for construction.

The bids received thus far for Project have been favorable for the grantee, with three of the four bids awarded for less than the Engineer's Estimate. The project budget could benefit from a continued slow economy, if the majority of work is awarded within the next 12 to 24 months to take advantage of the favorable bidding climate. The same construction contractor has been awarded three of the four let contracts and most likely has an advantage over other future bidders, especially for the upcoming Airport and City Center Segment Guideway contracts. This perceived advantage could quell competition and this will likely offset the favorable bidding climate. The grantee will need to actively solicit bidders and structure construction packages to encourage competition. This possibility was treated as a risk versus a contract cost adjustment in the PMOC's risk assessment.

<u>Post Bid Analysis (43% of Packages Awarded)</u>
The CPP indicates 46 planned procurement contracts for the subject program. Procurement of management, design and construction services began in the 3rd quarter of 2008 with the first award in the 4th quarter of 2009. To date, eight contracts have been negotiated and awarded, four Design / Management services and 4 Design-Build construction components.

Table 37. Contract Package Delivery

Contract Package	No. of Planned Packages	No. Awarded to Date
Management Services (MM)	18	3
Final Design (FD)	10	1
Design-Build (DB)	3	3
Design-Bud-Build (DBB)	12	
Design-Build-Operate-Maintain (DBOM)	1	1
Manufacture and Install (MI)	1	
Owner Furnish Materials and Equipment (OF)	1	
Total	**46**	**8**

Table 38 reflects the awarded contracts to date, indicating the general timeline of the procurement period as well as the contract values associated with each. Base year dollar amounts were obtained from the latest Timberline estimate provided by the grantee on March 25, 2011. Total programmed YOE costs for each contract package are identified in the various SCC Workbook Summary Sheets provided to the PMOC on March 25, 2011. The Base Year Dollars – March 2011 Estimate (D) values reflect total construction cost less the assigned latent contingency values carried in each of the contracts as well as associated escalation. Contract proposals provided by the DB contractors include anticipated escalation cost, which is reflected in column (E). PMOC was unable to verify the Design / Management contract amounts with the grantee estimate and the contract values reflected in the following table may vary from "official totals".

Table 38. Awarded Contracts

Contract	Description	Base Year Total – Mar-11 Estimate (A)	Contract Value with Escalation (B)
DB-120	West Oahu /Farrington Highway Guideway DB	$459,415,043	482,924,000
DB-200	Maintenance & Storage Facility DB	179360530	195,648,000
DB-320	Kamehameha Guideway DB	343,182,567	372,150,000
DBOM-920	Core Systems DBOM	483,763,057	573,782,793
	Construction Total	**1,405,721,197**	**1,624,504,793**
FD-240	Farrington Stations (3) Final Design	5,403,902	5,500,035
MM-900	PMC	34,786,714	36,728,363
MM-905	GEC I	55,093,853	55,094,000
MM-910	GEC II	216,861,163	254,705,793
	Professional Services Total	**312,145,632**	**352,026,191**

DB-120 West Oahu / Farrington Highway Guideway

- *Correlate and Analyze bids or proposal amounts against the estimated values for each bid or proposal. Assess the impact of each on the overall estimate, risk assessments, cost risk-cost ranges and risk mitigations:*

  Table 39 reflects the DB-120 contract SCC totals in the March 2011 estimate compared to the SCC totals identified in the October 10, 2010 Timberline estimate provided by the grantee. Construction Cost totals (B) calculated in the data base estimating software do not include breakout costs for escalation values included in the DB contract. The PMOC computed the escalation amounts and verified the total contract values were consistent with the proposal documents provided by the grantee.

Table 39. DB-120 West Oahu/Farrington Highway Guideway DB

SCC	Description	Construction Cost – 10-20-10 Estimate (A)	Construction Cost – DB Contract (B)	Escalation w/in DB Contract (C)	Total Contract Value (D)	Delta (B-A)	% Dev.
10.04	Guideway: Aerial structure	222,013,185	250,081,161	16,856,230	266,937,391	28,067,976	
10.08	Guideway: Retained cut or fill	7,187,912	6,037,951	398,570	6,436,521	-1,149,961	
10.09	Track: Direct fixation	17,042,333	13,903,349	1,900,999	15,804,348	-3,138,984	
10.11	Track: Ballasted	2,909,267	2,434,273	263,988	2,698,261	-474,994	
40.01	Demolition, Clearing, Earthwork	3,559,898	3,012,547	142,236	3,154,783	-547,351	
40.02	Site Utilities, Utility Relocation	32,160,850	28,887,142	861,989	29,739,131	-3,283,708	
40.04	Environmental mitigation	1,403,737	5,100,173	65,914	5,166,087	3,696,436	
40.05	Site structures (retaining walls, sound walls)	5,880,107	4,998,150	454,893	5,453,043	-881,957	
40.06	Pedestrian / bike access, landscaping	1,671,919	1,372,311	178,123	1,550,434	-299,608	
40.07	Automobile, bus accessways (roads, parking)	13,528,541	11,535,056	1,010,162	12,545,218	-1,993,485	
40.08	Temporary Facilities/other indirect costs	97,435,721	88,628,963	376,255	89,005,218	-8,806,758	
80.01	Preliminary Engineering	28,707,421	31,524,898	183,797	31,708,695	2,817,477	
80.02	Final Design	21,107,030	11,909,069	817,018	12,726,087	-9,197,961	
	Total	**454,607,921**	**459,415,043**		**482,925,218**	**4,807,122**	**1.06**

The WOFH DB guideway contract was the first executed "construction" contract on the Project and occurred before the October 2010 estimate was finalized. Planned costs indicate values removed from the majority of the SCC categories and incorporated into the Guideway Aerial Structure (SCC 10.04).

- *Characterize and evaluate the grantee's bid process (plan sets distributed, pre bid conference attendance, bid question activity, exit conference, telephone interviews, analytical products, bid tabulations:*

The subject contract was delivered under a two-part best value selection process. Potential contractors are invited to participate in the contracts Request for Proposal (RFP) followed by a sort listing of qualified contractors. The contractors then provide their proposal of services to the grantee in the second part of the contracting plan. The RFP was released in two parts. Part 1: September 2008 – March 2009 and Part 2: April 2009 – August 2009.

- *Where significant variances between bid received and estimates are discovered: Trace variances on bid tabulation elements back to the cost estimate and risk register:*

SCC estimate values for the DB-120 contract are represented by lump sum values in both the October 2010 and March 2011 estimates and are not traceable as the bidders maintain their backup data is proprietary and confidential.

- *Sample unit cost and quantity information to evaluate the reliability of estimate compared with bid pricing; obtain independent market data and adjust as necessary to compare pricing and estimate. Sample scope elements from the contract documents to support conclusions;*
- *Develop an estimated allocation between unit cost and quantity variance;*
- *Organize causal factors into groups such as market factors, general conditions, risk transfers, etc.*

DB proposal documentation does not provide sufficient schedule of values breakdown to assess unit costs or estimated quantities. The four contract packages assessed here-in are design-build delivery contracts and the same comment is applied accordingly.

<u>DB-200 Maintenance and Storage Facility</u>

- *Correlate and Analyze bids or proposal amounts against the estimated values for each bid or proposal. Assess the impact of each on the overall estimate, risk assessments, cost risk-cost ranges and risk mitigations:*

The DB-200 contract SCC totals in the March 2011 estimate compared to the SCC totals identified in the October 10, 2010 Timberline estimate are within 1.08% deviation of each other. Although the total values are rather close, SCC separate totals show significant deviations in cost.

Table 40. DB-200 Contract Values vs. Estimated values

SCC	Description	Construction Cost – 10-20-10 Estimate (A)	Construction Cost – DB Contract (B)	Escalation w/in DB Contract (C)	Total Contract Value (D)	Delta (B-A)	% Dev.
10.09	Track: Direct fixation	11,987,183	35,658,458	4,760,126	40,418,584	23,761,275	
10.11	Track: Ballasted	426,761	0	0	0	-426,761	
10.12	Track: Special (switches, turnouts)	4,655,430	0	0	0	-4,655,430	
30.02	Light Maintenance Facility	9,112,802	6,968,204	563,654	7,531,858	-2,144,598	
30.03	Heavy Maintenance Facility	36,344,483	35,023,487	2,833,150	37,856,637	-1,320,996	
30.04	Storage or Maintenance of Way Building	7,258,175	7,156,889	579,394	7,736,283	-101,286	
30.05	Yard and Yard Track	70,208,166	35,806,244	2,931,809	38,738,053	- 34,401,922	
40.06	Pedestrian / bike access, landscaping	6,077,412	1,648,275	196,857	1,845,132	-4,429,137	
40.07	Automobile, bus accessways (roads, parking)	0	574,609	68,754	643,363	574,609	
40.08	Temporary Facilities/other indirect costs	0	29,627,776	1,765,144	31,392,920	29,627,776	
50.03	Traction power supply: substations	0	1,055,557	132,939	1,188,496	1,055,557	
50.04	Traction power distribution	21,682,280	14,577,304	1,830,660	16,407,964	-7,104,976	
50.05	Communications	0	651,391	82,237	733,628	651,391	
80.02	Final Design	9,684,311	10,612,336	153,150	10,765,486	928,025	
	Total	**177,437,003**	**179,360,530**		**195,258,405**	**1,923,527**	**1.08**

The October 2010 estimate contains more detail for scope elements. However, estimate detail reflected in the March 2011 Timberline file indicates many SCC totals as lump sum values, making it difficult to fully correlate many line items. Redistribution of SCC costs appears to have been incorporated into the program cost estimate based on the proposal documents provided by the DB contractor.

The PMOC reviewed the DB proposed cost breakdown in order to identify discernment of SCC categories and scope items provided. Several SCC cost categories identified in the contractor breakdown of cost are not present in the grantee's SCC assignment, some of which include:

- Site Preparation, Subgrade Prep (SCC 40.01)
- Utilities, drainage and electrical (SCC 40.02)
- Train Control Duct Banks (SCC 50.01)
- Special Track (SCC 10.12)
- Roadway pavements, lighting, signals, signs and Painting (SCC 40.04)

Additionally, the contractor's proposal includes $28.0 million in general requirements, public information and coordination activity that belongs in SCC 80.04, Construction Administration & Management. Although these costs are not categorized correctly, the estimate comparison of the total Contract value and October estimate value are very close.

- *Characterize and evaluate the grantee's bid process (plan sets distributed, pre bid conference attendance, bid question activity, exit conference, telephone interviews, analytical products, bid tabulation:*

  The two-part best value procurement process previously described was used for DB-200. Part 1: May 2009 – July 2009 and Part 2: July 2009 – February 2010.

- *Where significant variances between bid received and estimates are discovered: Trace variances on bid tabulation elements back to the cost estimate and risk register:*

  SCC Variances are due to misinterpretation of SCC coding by the grantee. Project estimate total costs are based on contract values.

<u>DB-320 Kamehameha Guideway</u>

- *Correlate and Analyze bids or proposal amounts against the estimated values for each bid or proposal. Assess the impact of each on the overall estimate, risk assessments, cost risk-cost ranges and risk mitigations:*

  Table 41 reflects the General Contractor contract values (B) with the October 2010 estimated values (A). A deviation of $94M (37.75%) between the two totals.

Table 41. DB-320 Kamehameha Guideway DB

SCC	Description	Construction Cost – 10-20-10 Estimate (A)	Construction Cost – DB Contract (B)	Escalation w/in DB Contract (C)	Total Contract Value (D)	Delta (B-A)	% Dev.
10.04	Guideway: Aerial structure	176,866,707	150,304,637	16,341,309	166,645,946	-26,562,070	
10.09	Track: Direct fixation	3,111,766	9,145,882	1,337,902	10,483,784	6,034,116	
10.12	Track: Special (switches, turnouts)	410,634	0	0	0	-410,634	
40.01	Demolition, Clearing, Earthwork	926,744	6,090,296	646,640	6,736,936	5,163,552	
40.02	Site Utilities, Utility Relocation	11,554,960	36,101,121	2,643,023	38,744,144	24,546,161	
40.02 ET	Site Utilities, Utility Relocation Electrical Telecom	12,886,973	0	0	0	-12,886,973	
40.03	Hazardous Material, contam'd soil, mitigation	457,970	5,060,962	440,840	5,501,802	4,602,992	
40.04	Environmental mitigation	2,334,240	5,417,133	455,840	5,872,973	3,082,893	
40.05	Site structures (retaining walls, sound walls)	1,194,400	1,392,528	154,319	1,546,847	198,128	
40.06	Pedestrian / bike access, landscaping	3,991,834	56,910	7,054	63,964	-3,934,924	
40.07	Automobile, bus accessways (roads, parking)	3,991,772	30,274,266	2,840,149	33,114,415	26,282,544	
40.08	Temporary Facilities/other indirect costs	0	60,288,154	2,397,432	62,685,586	60,288,154	
50.02	Traffic signals and crossing protection	4,729,573	167,658	22,432	190,090	-4,561,915	
50.04	Traction power distribution	1,626,793	0	0	0	-1,626,793	
80.01	Preliminary Engineering	9,945,262	38,883,020	1,680,043	40,563,063	28,937,758	
80.02	Final Design	15,099,095	0	0	0	-15,099,095	
	Total	**249,128,673**	**343,182,567**		**372,149,550**	**94,053,894**	**37.75**

The contractor proposal was reviewed by the PMOC for accurate SCC cost category assignment prior to assessing deviations in cost. Although there were some category assignments not recommended by the reviewer, the majority of scope is properly assigned to the SCC listing.

Category costs were compared between the estimate and proposal values for significant deviations. The following SCC categories indicate where the difference in cost resides in the contract scope:

Table 42. Significant Cost Deviations by SCC

SCC	Description	Cost Over/Under
10.04	Guideway Aerial Structure	- $14 M
40.01	Demolition, clearing, earthwork	+ $5 M
40.02	Site utilities, utility relocation	+ $12 M
40.03	Haz. mat'l., contam'd. soil removal/mitigation, ground water treatment	+ $4 M
40.04	Environmental mitigation, e.g. wetlands, historical/archeological, parks	+ $3 M
40.07	Automobile, bus, van access ways, including roads, parking lots	+ $22 M
80.02	Final Design	+ $28 M
80.04	Construction Administration & Management	+ $35 M

90% of the cost overrun, or $84M, is attributed to design, construction management and roadway construction.

- *Characterize and evaluate the grantee's bid process (plan sets distributed, pre bid conference attendance, bid question activity, exit conference, telephone interviews, analytical products, bid tabulations;*

  The two-part best value procurement process previously described was used for DB-320. Part 1: November 2009 – January 2010 and Part 2: March 2010 – October 2010.

- *Where significant variances between bid received and estimates are discovered: Trace variances on bid tabulation elements back to the cost estimate and risk register:*

  The grantee indicated in its post bid analysis, the unit prices/overall cost for the guideway were essentially accurate, but the bidder increased the design and construction management portions of the work. It is unclear if this is from front end loading or perception by the bidder the design costs are higher than the grantee estimated.

<u>DBOM-920 Core Systems</u>

- *Correlate and Analyze bids or proposal amounts against the estimated values for each bid or proposal. Assess the impact of each on the overall estimate, risk assessments, cost risk-cost ranges and risk mitigations:*

  Table 43 reflects the October 2010 estimated systems costs with the contracted value stipulated in the contractor's proposal. SCC totals reflected in column B have been significantly manipulated by the GEC in order to properly assess and distribute costs. The percent deviation between the estimated value and the contract value is less than the Kamehameha Highway difference; however, contract values are significantly higher.

Table 43. DBOM-920 Core Systems DBOM

SCC	Description	Construction Cost – 10-20-10 Estimate (A)	Construction Cost – DB Contract (B)	Escalation w/in DB Contract (C)	Total Contract Value (D)	Delta (B-A)	% Dev.
40.08	Temporary Facilities/other indirect costs	0	90,105,505	14,249,852	104,355,357	90,105,505	
50.01	Train control and signals	88,115,474	69,022,693	13,656,771	82,679,464	-19,092,781	
50.03	Traction power supply: substations	49,598,420	23,116,064	5,864,293	28,980,357	-26,482,356	
50.04	Traction power distribution	14,460,559	9,358,987	2,264,228	11,623,215	-5,101,572	
50.05	Communications	29,762,979	43,266,061	10,103,582	53,369,643	13,503,082	
50.06	Fare collection system and equipment	16,379,469	7,484,269	1,733,588	9,217,857	-8,895,200	
50.07	Central Control	27,507,214	2,953,322	500,249	3,453,571	-24,553,892	
70.01	Light Rail	297,731,040	140,149,232	30,973,089	171,122,321	-157,581,808	
70.06	Non-revenue vehicles	11,858,634	11,824,978	1,201,808	13,026,786	-33,656	
70.07	Spare parts	3,651,521	4,748,075	800,139	5,548,214	1,096,554	
80.02	Final Design	44,453,057	41,689,676	1,522,824	43,212,500	-2,763,381	
80.08	Start up	52,717,879	40,044,195	7,149,555	47,193,750	-12,673,684	
	Total	**636,236,246**	**483,763,057**		**573,783,037**	**-152,473,189**	**-23.96**

Category costs were compared between the estimate and proposal values for significant deviations. The following table presents the significant cost deviations by SCC.

Table 44. Significant Cost Deviations by SCC

SCC	Description	Cost Over/Under
40.08	Temporary facilities and other indirect costs during construction	+ $90 M
50.01	Train control and signals	- $20 M
50.03	Traction power supply: substations	- $31 M
50.05	Communications	+ $13 M
50.06	Fare collection system and equipment	- $8 M
50.07	Central control	- $24 M
70.01	Light Rail	- $157 M
80.02	Final Design	- $3 M
80.08	Start-up	- $12 M

The systems contract proposal indicates $90 million more than the budgeted amount for general requirements and management costs while the GEC costs include additional monies for train control, power and central control. It is not uncommon for a contractor to unbalance construction value and front load management / mobilization costs in order to advance the revenue stream, which is most likely the case here. The significant cost deviation lies in the procurement of the Light Rail Vehicles at $157 million.

- *Characterize and evaluate the grantee's bid process (plan sets distributed, pre bid conference attendance, bid question activity, exit conference, telephone interviews, analytical products, bid tabulations:*

  The two-part best value procurement process previously described was used for DBOM-920. Part 1: April 2009 – June 2009 and Part 2: August 2009 – January 2011.

- *Where significant variances between bid received and estimates are discovered: Trace variances on bid tabulation elements back to the cost estimate and risk register:*

  The Core Systems Contract (CSC) is a DBOM contract, with large material components, complex factory assemblies, complex train control, signaling & communications, including initial operations & maintenance. The contract period of performance is more than 10 years, and the precise method a contractor distributes costs on such a contract is not typically traceable. The successful bidder allocated lower cost for vehicles in its payment structure, which did not match the Engineers Estimate. This is not unusual, particularly since the proposed vehicle is in production for other transit properties. This was treated appropriately as a risk event and not an estimate adjustment.

6.4.3 Characterization or Stratification of Cost Items

The PMOC reviewed the grantee's *2011 SCC Estimate*, which correlates to the scope and values included in the Record of Decision (ROD) and Final Environmental Impact Statement (FEIS). The PMOC Cost Estimate Review consists of two primary functions: (1) review and evaluation of project scope inclusively, as identified in the Environmental Documents; and (2) 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 *2011 SCC Estimate*. The cost elements were also reviewed for accuracy and applicability to the project.

The cost estimate includes both a summary sheet and detailed backup in Timberline format 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, or Basis of Estimate, describes the assumptions that were made in developing the estimate. It does not describe integration with the project schedule or documentation of productivity, unit costs, indirect costs, or overhead and profit. Some of this relevant information is described in the contracting plan from a contract standpoint but not in a detail-oriented aspect.

PMOC reviewed the detailed estimate sheets for the individual line items of each SCC and performed quantity spot checks on line items or quantities, as these are now directly traceable back to the Project Documents.

The PMOC determined that the estimated length of the project to be 105,888 Route Feet, somewhat inconsistent with the value contained in the SCC Summary sheet of 106,095 feet.

However, the Basis of Estimate in Appendix "B" notes a length of 105,880 feet, which is essentially equal to the PMOC calculation. This value was critical during the development of the original parametric estimate, as the cost units were based on this quantity for many calculations. This value is not as critical with the current bottoms-up detailed style estimate by the grantee because the estimate is based on individual cost elements and quantities for the various line segments. Nevertheless, the grantee should correct the SCC Summary Sheet so that its length matches the value included with the Basis of Estimate.

The PMOC divided the 2011 SCC Cost Estimate into classifications as suggested by OP 33 to segregate cost into a range from least risky categories to more risky segregations, and for this estimate most of the work is of the least risky variety:

- Lump Sum (Most Risks)
- Cost Estimating Relationships (CER)
- Unit Costs (based on bottoms up style quantities)
- Awarded Contracts (due to DB approach for 43% of the work)

The grantee developed a detailed bottoms-up cost estimate for the project in 2010 during the PE Phase. The PMOC prepared a Cost Estimate Classification Table (See Table 45) to distribute the project costs from the grantee's Timberline cost estimating software (estimate). Since a large portion of the work is DB, these values were segregated in the Cost Estimate Classification Table along with the standard FTA prescribed categories of Estimated Quantities, Cost Estimating Relationships (CER) and Allowances.

The estimate includes Lump Sum allowance line items for Allocated and Unallocated Contingencies, but does not readily identify latent contingency values. Table 45 summarizes the estimate into the chosen classification. The allowances identified following this discussion were not included in the Cost Estimate Classification Table. As explained these values are not true allowances and in the case of the 40.02 utility line items ($46.0 million) lower level supporting detail was provided by the grantee and reviewed by the PMOC.

It should be noted that the table below does not include PMOC adjustments.

Table 45. Cost Estimate Classification

SCC	Description	Qty.	UM	Bid/ Awarded ($)	Unit Pricing ($)	CER	LS/ Allowance	Total ($)	SCC %
10	**Guideway & Track Elements**	**20.09**	**RM**	**577,945,000**	**730,412,000**	**$0**	**$0**	**1,308,357,000**	
10.04	Guideway: Aerial structure	19.75	RM	491,955,000	718,437,000			1,210,392,000	92.51
10.08	Guideway: Retained cut or fill	0.34	RM	7,402,000	0			7,402,000	0.57
10.09	Track: Direct fixation			75,485,000	9,771,000			85,256,000	6.52
10.11	Track: Ballasted			3,103,000				3,103,000	0.24
10.12	Track: Special (switches, turnouts)			0	2,204,000			2,204,000	0.17
	Percent of SCC10 Total			**44.17%**	**55.83%**	**0%**	**0%**	**100%**	**100%**
20	**Stations, Stops, Terminals, Intermodals**	**21.00**	**EA**	**0**	**614,602,000**	**$0**	**$0**	**614,602,000**	
20.01	At-grade station	1.00	EA	0	8,346,000			8,346,000	1.36
20.02	Aerial station	20.00	EA	0	449,606,000			449,606,000	73.15
20.06	Automobile parking multi-story structure			0	77,918,000			77,918,000	12.68
20.07	Elevators, escalators			0	78,732,000			78,732,000	12.81
	Percent of SCC 20 Total			**0%**	**100.00%**	**0%**	**0%**	**100%**	**100%**
30	**Support Facilities: Yards, Shops, Admin.**	**20.09**	**RM**	**103,805,000**	**0**	**$0**	**$0**	**103,805,000**	
30.02	Light Maintenance Facility			8,511,000	0			8,511,000	8.20
30.03	Heavy Maintenance Facility			42,778,000	0			42,778,000	41.21
30.04	Storage or Maintenance of Way Building			8,742,000	0			8,742,000	8.42
30.05	Yard and Yard Track			43,774,000	0			43,774,000	42.17
	Percent of SCC 30 Total			**100%**	**0%**	**0%**	**0%**	**100%**	**100%**
40	**Sitework & Special Conditions**	**20.09**	**RM**	**495,006,000**	**526,452,000**	**$0**	**$0**	**1,021,458,000**	
40.01	Demolition, Clearing, Earthwork			11,106,000	8,811,000			19,917,000	1.95
40.02	Site Utilities, Utility Relocation			77,206,000	281,171,000			358,377,000	35.08
40.03	Haz. mat'l, contam'd soil removal/ mitigation			6,107,000	1,426,000			7,533,000	0.74
40.04	Environmental mitigation			12,460,000	18,343,000			30,803,000	3.02
40.05	Site structures (retaining walls, sound walls)			7,988,000	14,948,000			22,936,000	2.25
40.06	Pedestrian / bike access, landscaping			3,939,000	40,735,000			44,674,000	4.37
40.07	Automobile, bus accessways (roads, parking)			51,911,000	161,018,000			212,929,000	20.85
40.08	Temporary Facilities/other indirect costs			324,289,000				324,289,000	31.75
	Percent of SCC 40 Total			**48.46%**	**51.54%**	**0%**	**0%**	**100%**	**100%**

SCC	Description	Qty.	UM	Bid/ Awarded ($)	Unit Pricing ($)	CER	LS/ Allowance	Total ($)	SCC %
50	**Systems**	**20.09**	**RM**	**232,967,000**	**18,620,000**	**$0**	**$0**	**251,587,000**	
50.01	Train control and signals			92,601,000	0			92,601,000	36.81
50.02	Traffic signals and crossing protection			211,000	12,832,000			13,043,000	5.18
50.03	Traction power supply: substations			33,801,000	0			33,801,000	13.44
50.04	Traction power distribution			31,559,000	5,788,000			37,347,000	14.84
50.05	Communications			60,603,000	0			60,603,000	24.09
50.06	Fare collection system and equipment			10,324,000	0			10,324,000	4.10
50.07	Central Control			3,868,000	0			3,868,000	1.54
	Percent of SCC 50 Total			**92.60%**	**7.40%**	**0%**	**0%**	**100%**	**100%**
60	**ROW, Land, Existing Improvements**	**20.09**	**RM**	**0**	**247,942,000**	**$0**	**$0**	**247,942,000**	
60.01	Purchase or lease of real estate			0	224,649,000			224,649,000	90.61
60.02	Relocation of existing households/businesses			0	23,293,000			23,293,000	9.39
	Percent of SCC 60 Total			**0%**	**100%**	**0%**	**0%**	**100%**	**100%**
70	**Vehicles**	**80.00**	**EA**	**212,461,000**	**0**	**$0**	**$0**	**212,461,000**	
70.01	Light Rail			191,657,000	0			191,657,000	90.21
70.06	Non-revenue vehicles			14,590,000	0			14,590,000	6.87
70.07	Spare parts			6,214,000	0			6,214,000	2.92
	Percent of SCC 70 Total			**100%**	**0%**	**0%**	**0%**	**100%**	**100%**
80	**Professional Services**	**20.09**	**RM**	**310,838,000**	**720,210,000**	**$0**	**$0**	**1,031,048,000**	
80.01	Preliminary Engineering			56,123,000				56,123,000	5.44
80.02	Final Design			125,392,000	100,981,000			226,373,000	21.96
80.03	Project Management for Design/Construction			74,982,000	274,032,000			349,014,000	33.85
80.04	Construction Administration & Management			0	187,914,000			187,914,000	18.23
80.05	Professional Liability/Non-Construction Ins.			0	56,104,000			56,104,000	5.44
80.06	Legal; Permits; Review Fees by other agencies			0	69,913,000			69,913,000	6.78
80.07	Surveys, Testing, Investigation, Inspection			631,000	5,442,000			6,073,000	0.59
80.08	Start up			53,710,000	25,824,000			79,534,000	7.71
	Percent of SCC 80 Total			**30.15%**	**69.85%**	**0%**	**0%**	**100%**	**100%**
90	**Unallocated Contingency**	**1.00**	**LS**	**0**	**0**	**0**	**191,650,417**	**191,650,417**	
90.01	Unallocated Contingency			0	0		191,650,417	191,650,417	100%
100	**Finance Charges**	**1.00**	**LS**	**0**	**0**	**0**	**230,000,000**	**230,000,000**	
100.01	Finance Charges			0	0		230,000,000	230,000,000	100%
	GRAND TOTAL	**20.09**	**RM**	**1,933,022,000**	**2,858,238,000**	**0**	**421,650,417**	**5,212,910,417**	
	PERCENT OF TOTAL			**37.08%**	**54.83%**	**0%**	**8.09%**	**100%**	

(1) SCC 10 – Guideway and Track Elements

Quantity Review

PMOC checked the overall length of the guideways, calculating an average length for the alignment of 105,888 feet, not counting 1,729 feet of railroad siding at Aloha Stadium and Ala Moana stations. The grantee's March 2011 estimate includes a length of 105,880 feet in Appendix B of the Basis of Estimate document. The PMOC did note there is a calculation error in Appendix B of the Basis of Estimate related to conversion of feet to miles for the City Center segment. However, this error did not affect the estimate. The SCC Summary estimate included 20.09375 miles or 106,095 feet, which does not match its Basis of Estimate Appendix B quantity or the PMOC value. This does not have an impact to the budget or require an estimate adjustment, but it should be corrected to be consistent in all documents and avoid confusion.

Value Engineering Analysis

The grantee held a Value Engineering (VE) workshop for the Airport and City Center guideway line segments during the week April 11-15, 2011. This workshop resulted in \$225 million in potential cost savings associated with alternative alignments, foundations, superstructures, and contracting methods. The grantee has not yet formally considered and analyzed these alternatives, so counting on any cost savings which may occur due to this VE workshop would be premature at this writing.

Unit Measure Pricing Review

The PMOC determined the SCC line item quantities are reasonable and the average unit pricing fall within the mid to high range. The material price for various types of track work is trending high as compared to industry standard pricing but this may be a result of most of the alignment being elevated and located in existing roadway ROW. Since the track work quantity is definitive and the design falls within industry standards, the material and labor costs are easily traceable and justified.

The PMOC compared the unit pricing from the two award DB contract bids, West Oahu/Farrington Highway (WOGH) and Kamehameha Highway, to the remaining contract segments yet to be bid. The PMOC determined the remaining segment cost estimates contained unit pricing averaging 50% higher than the two DB awarded DB contract bid unit pricing. Some of the higher pricing is attributable to the inefficiencies associated with the more dense urban downtown area.

The PMOC did not find any significant issues through the analysis of segregated line item pricing above \$200,000 for this SCC. Approximately 44.2% (577.95 million) of the SCC 10 budget amount is under award.

The PMOC determined the cost estimate SCC 10 budget is fair and reasonable as no major discrepancies or issues were found.

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

Quantity Review

Those portions of the station estimate that were checked relative to the numbers of major station-related elements observed on the preliminary station plans, are accurate. The PMOC made an overall comparison of the individual station costs to identify any potential discrepancies or issues. The table below illustrates station cost comparison in an effort to identify cost variances and errors.

The Farrington Highway and Airport station package costs are significantly less than the other stations groups. The values are $11 to $12 million as compared to $16 to $18 million. The grantee verified that the scopes of work for the Farrington Highway and Airport station packages are significantly less that the other stations located closer to the downtown area.

The PMOC did find an error due to the omission of prime contractor markup from the station contracts (estimate). The grantee indicated the omission was intentional as the stations are a different "type" of work element than the guideways and the markup would be less. The grantee contended the compact station sites do not justify the higher markups used for alignments and utility work, which are linear and requiring of frequent moves by the General Contractors to progress the work.

In general, the stations (SCC20.01 & 20.02) contain anywhere from 5-10% less general condition mark-up applied than the remainder of the estimated construction. The PMOC expects a typical General Condition mark-up to include: 2-3% for Home Office Overhead, 10% general requirement (cell phones, permit, trailers and such) and 10-12% profit. This totals an anticipated General Conditions mark-up of approximately 25%. Normal General Conditions mark-up on other grantee estimated work averaged 23%. However, the stations in question included 15-18% markup. This amount is insufficient to capture the anticipated cost of construction. Therefore PMOC included an adjustment for this element to condition the grantee's estimate for the Risk Assessment model and subsequent analysis.

Table 46. Station Cost Comparison

Description	WOFH	Farrington Highway	Kamehameha	Airport	City Center/ Ala Moana	Dillingham Hwy	City Center	Kaka'ako/ Ala Moana
Contract No.	**DB-120**	**DB-320**	**DBB-270**	**DBB-470**	**DBB-560**	**DBB-570**	**DBB-572**	**DBB-575**
Number of Stations	3	3	3	3	1-1/2	3	3	2-1/2
Stairs, Site, Fences, Windscreens	2,051,149	1,762,199	921,973	640,398	0	2,361,665	1,342,079	840,619
Benches, Granite, Pavers	0	0	305,018	347,299	0	397,809	200,019	508,494
Various Walls	1,062,732	163,857	557,836	629,674	0	660,362	426,710	744,427
Conc. Finishes	0	0	26,857	875,091	0	48,669	236,354	44,875
Roofing, Siding	6,726,624	4,058,226	9,259,871	1,021,414	0	7,822,251	3,064,573	2,316,729
Doors, Windows	1,484,564	1,448,528	1,175,834	1,062,592	0	1,487,288	995,216	1,517,881
Finishes, Ancillary Space (sf)	1,858,214	1,597,669	2,006,360	1,067,430	0	1,047,746	1,118,427	8,542,351
Transit Agent Booth	2,244,216	1,496,144	1,496,144	1,496,144	0	1,870,180	1,122,108	1,122,108
Plumbing, MEP	148,919	168,901	508,096	761,740	40,982	743,231	761,247	803,671
Electrical	2,695,789	1,787,713	3,346,896	3,379,350	0	3,119,116	3,227,672	4,328,890
Structural, Excav, Foundations	22,324,736	14,386,403	29,921,876	20,983,015	47,893,027	29,716,310	36,754,770	16,906,576
Elev./Escal. Trusses and Sitework	9,292,143	6,551,164	5,392,470	2,837,646	157,250	2,682,847	2,565,268	1,764,651
Total	**49,889,086**	**33,420,804**	**54,919,231**	**35,101,793**	**48,091,259**	**51,957,474**	**51,814,443**	**39,441,272**
Avg. Cost per Station	16,629,695	11,140,268	18,306,410	11,700,598	32,060,839	17,319,158	17,271,481	15,776,509

Note: Contract No. DBB-560 also includes cost for platform structure.

Unit Measure Pricing Review

The documents are now developed sufficiently to allow generation of a mostly bottoms-up estimate. The PMOC noted the station costs are higher than average elevated stations on other projects but agrees the costs are reasonable due to the geographic location of the project, amount of vertical circulation and the complexity of the stations. Some savings may be realized if a portion of the VE recommendations are included during Final Design.

The cost estimate includes several line item lump sum unit measures for elements such as undefined finishes, painting and hardscape allowances. These are usually intended to be "not to exceed" values and are designated so the designer knows the budget range for design development. The SCC 20 costs are distributed with the plan quantity representing 100% of the estimate. The PMOC did not find any significant discrepancies or issues with SCC 20 line item pricing.

Value Engineering Analysis

The grantee held a VE workshop in the summer of 2010. The results of this workshop indicated some significant potential savings, but, other than minor "finish" type changes, the VE station elements have not been incorporated into the project or project budget. The grantee intends to incorporate the appropriate VE elements during the Final Design phase.

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

Quantity Review

The PMOC did not conduct a quantity survey or sampling because the Project Maintenance and Storage Facility (MSF) design build contract is under award. The cost estimate line items for this SCC have been replaced by the Contractor's Schedule of Values.

Unit Measure Pricing Review

The SCC 30 costs ($103.81 million) are completely distributed among the DB contract currently under award. The cost estimate line items for this SCC have been replaced by the Contractor's Schedule of Values.

The PMOC determined the cost estimate SCC 30 budget is fair and reasonable as no major discrepancies or issues were found.

(4) ***SCC 40 – Sitework & Special Conditions***

Quantity Review

Almost 49% of the SCC 40 work is under contract award. The remaining work contains a 25% contingency factor as it contains more uncertainty and higher risks than other work elements. The PMOC incorporated higher beta factors for SCC 40 work with an emphasis on the uncertainties associated with underground utility abandonment, relocations, and installation.

Unit Measure Pricing Review

The PMOC performed a unit price review of all work elements in excess of $200,000 (Pareto). The PMOC did not find any significant discrepancies or issues with SCC 40 line item pricing.

Unit Measure Pricing Review

Almost 49% ($495 million) of the SCC 40 work is under contract award. The PMOC review of the SCC 40 line items resulted in the following observations:

- *SCC 40.02 Site Utilities, Utility Relocation ($358,376,287 in YOE)*
  The PMOC questioned why the supplied estimates for the utilities were provided as Lump Sum values. The grantee subsequently supplied supporting detail for the utility estimates that was found to be adequate. Any discrepancies were treated as risks and not Budget Cost Estimate (BCE) adjustments.

- *SCC 40.04 Environmental Mitigations ($30,802,045 in YOE)*
  Some requirements identified in the Programmatic Agreement (PA) that were not traceable to the cost estimate. The grantee indicated that the estimate included the PA requirements. However, the detail to support inclusion of the work efforts associated with the PA requirements has not yet been received by the PMOC.

- *SCC 40.08 Temp facilities & indirect costs during construction($324,289,668 YOE$)*
  The values the grantee included in the estimate for this Temporary Facilities category are based solely on the value of the "Awarded Contracts" with no allocation for the "Not Awarded" work. The value of this item is instead included as a lump sum and spread within other unit prices. The PMOC recommends the grantee segregate the 40.08 Maintenance of Traffic and other temporary costs from the Timberline Estimate into the appropriate SCC items under the contract packages yet to be bid and awarded.

(5) SCC 50 – Systems

Quantity Review

The PMOC did not conduct a quantity survey or sampling because the Core Systems Contract (DBOM) has been bid and currently under evaluation for contract execution. Most of the cost estimate line items for this SCC have been replaced by the Contractor's Schedule of Value.

The values shown in Table 33 and Table 57 are primarily from a bid and award result from the CSC. The PMOC initially had difficulty following the methodology the grantee used to determine the value used in the BCE as compared to the CSC proposal amounts. A write-up and table was provided in Appendix "U" in the Basis of Estimate; however, the grantee should provide an explanation for how this amount calculated in the BCE. The PMOC requested a more thorough explanation, which was provided by the grantee.

The PMOC ultimately found the grantee's approach to be reasonable once the information became more traceable.

SCC 50 is based on a CSC proposal from AHJV, who was selected by the grantee on March 21, 2011.

Unit Measure Pricing Review
Almost 93% ($232.97 million) of the SCC 50 work is under contract award and represented by the Contractors SOV contract line items. The remaining work is represented by cost estimate line items.

The PMOC determined the cost estimate SCC 30 budget is fair and reasonable as no major discrepancies or issues were found.

(6) ***SCC 60 – Right-of-Way***

Quantity Review
The real estate easement and parcel quantities equal the quantities and descriptions identified in the grantee's Real Estate Acquisition Management Plan (RAMP). Likewise, the quantities are consistent as represented in the MPS.

Unit Measure Pricing Review
The costs are distributed with the Plan Quantity items ($247.94 million). A review of the SCC line items resulted in the following observations:

- *SCC 60.01 Purchase or lease of real estate*
  The grantee's basis for determining real estate costs was derived from the City or County tax assessment database values which are updated bi-annually.

  The grantee has performed some appraisals and recently purchased one of the previously identified potential "problem" parcels, locally referred to as the "Banana Patch" parcel. At the time of the PMOC analysis, a definitive breakdown cost for the acquired parcel(s) and appraised ROW was not available for analysis.

  The PMOC determined the grantee's initial real estate parcel cost estimate methodology and amounts were outdated and needing "refreshing" with up-to-date appraisals and or analyzed with more recent comparisons purchases. The grantee did note that most all appraisals and purchases made to date have been within the most recent SCC 460 budget.

  The grantee provided additional information to support the latent contingency amounts it removed from its own internal Risk Assessment, which the PMOC agreed to adopt as an adjustment. Additionally, the "outdated" ROW estimate was revised via a subsequent table in the Basis of Estimate (Appendix H) to remove most of the lump sum allowances included for condemnation costs and lower the estimate. The grantee's current belief is that there will be few properties requiring this method of acquisition.

Additionally, the table (Appendix H) supplied in the Basis of Estimate does not support the values shown in the SCC Summary, but the value in the Appendix is less than the SCC summary, so the conservative approach using the SCC Summary is acceptable.

The PMOC recommends that the grantee update the cost estimating basis for the remaining parcels to be purchased as soon as possible and no later than the grantee's request for an FFGA during the Final Design phase.

(7) SCC 70 – Vehicles

Quantity Review

The *2011 SCC Estimate* includes the procurement of eighty (80) rail vehicles. This work is part of the CSC, which has been awarded to AHJV. The vehicle quantity is variable as the final quantities depend upon the successful DBOM bidders' approach and technology.

Unit Measure Pricing Review

The SCC 70 costs ($212.5 million) are completely distributed among the DBOM contract currently under award. The SCC 70 cost estimate line items have been replaced by the Contractor's Schedule of Value line items.

The PMOC determined the cost estimate SCC 70 budget is fair and reasonable as no major discrepancies or issues were found.

(8) SCC 80 – Professional Services

Quantity Review

The basis used to determine the SCC 80 line item amounts is calculated using staffing plans combined with the validation of the DB bids received and awarded for PE work. The PMOC determined the cost estimate matches the current staffing plan and planned work represented in the MPS. The PMOC recommended the grantee revise the staffing plan once the MPS. The MPS required a revision as an outcome to the PMOC's OP 34 draft report. The PMOC did recommend the grantee add a contract manager to oversee the PMC and GEC professional service contracts to ensure more control of financial responsibility and oversight of consultant services. More information can be found in the PMOC OP 20 review.

Unit Measure Pricing Review

Professional Services is one of the largest cost categories in the *2011 SCC Estimate* and as such can be a source for variability in project costs, especially if delays occur. It is anticipated that once the project is advanced into Final Design, more detailed staffing plans will be developed to improve the accuracy of these estimates and mitigate the potential for costs overruns.

Almost 31% ($310.8 million) of the SCC 80 work is under contract award and distributed and replaced in the cost estimate by the Contractor's Schedule of Value line items.

The total for SCC 80 for the estimated and Bid Item values equal the SCC Summary Value for the Base Year & YOE, but the individual categories vary from the Timberline and or Contract Packaging amounts. The values in SCC 80.01, 80.02 and 80.03 have been "shuffled" as to their individual values during the escalation process. However, the aggregate total for the three SCC items is the same when compared to the SCC Summary to the Timberline Estimate or the Contract Packaging plan amounts. The PMOC suspects that the issue lies in the contract amendments for the GEC, as the amounts allocated between Preliminary Engineering and Final Design are changing monthly. The "shuffling" will not significantly impact the Risk Assessment analysis or modeling of costs.

The PMOC determined the cost estimate SCC 30 budget is fair and reasonable as no major discrepancies or issues were found.

(9) SCC 100 Finance Charges

Quantity Review
Not Applicable for Finance Costs.

Unit Measure Pricing Review
The SCC 100 line item costs are distributed with the Estimated Quantity items ($230.0 million) representing 100% of the estimate for this portion of the work. This was moved from the Lump Sum category to the Estimated Quantity category as the value is based on calculations within the grantee's revised Financial Plan.

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.

Detailed Review of Cost Items
The PMOC reviewed and sampled quantities for alignment lengths, comparative station prices, unit prices for items totaling more than $200,000 and examined the various markups utilized within the estimate. The cost estimate includes specific allowances or lump sums for line items (work scope), but a portion of the allowances are supported by separate stand-alone estimates. Additionally, the values for escalation, finance and contingency are percentages or calculations from other values and could be considered lump sums or allowances. The cost estimate includes a value for Maintenance of Highway or Traffic (MOT) as a lump sum for each separate construction package. As noted elsewhere in this report (see discussion on SCC 40) the grantee should expound upon the values included for MOT in more detail and appropriately include the value into the SCC 40.08 category versus in SCC 40.07.

Evaluation of Allowances

As noted above the grantee's estimate includes some values with unit measures as lump sum, all, location or allowance. The PMOC identified these values in its review of the grantee's cost estimate during the sorting of line item costs for comparative purposes. The costs discussed in this section are in base year 2011$ without contingency or GET.

During the Scope, Cost and Schedule review as well as during the workshop that occurred in 4Q2010 and 1Q2011 the PMOC initially identified within the estimate lump sum values of $46.0 million for Utility and Electrical work (SCC 40.02ET). The grantee provided additional documentation in the form of detailed estimates for these allowance values which were reviewed by the PMOC and determined to be reasonable. These values are contained within the grantee's SCC 40.02 ET (Electrical & Telecommunications).

The PMOC also identified allowances within the Pearl Highlands Station & H2 Ramp estimate of $28.9 million. Additionally, various "not awarded" station contracts included allowances found by the PMOC during the overall comparison check for these stations. The allowances are in the PMOC's opinion intended to be not to exceed values, to "cover" undefined or un-designed finishes, painting and hardscape. This is normal in design development and essentially sets a parameter or range the designers can use to choose finishes.

Finally, the Airport & City Center guideway segment cost estimate line items contain several lump sum and allowance unit measures, which are illustrated in the table below.

Table 47. List of Allowances and Lump Sums

SCC	Contract	Estimate Description	Qty.	Unit	2011 Base ($)	Comments
		Utilities - Elect. & Telecom			**46,024,458**	
40.02ET	DBB450 & 550	Electrical & Telecommunication Private Utility Work	1	LS	46,024,458	Grantee provided details
		Pearl Highlands Station/Ramp			**28,856,287**	
40.05	DBB275	Pearl Highlands Station & Ramp Building Reconstructions (4 separate allowances)	1	LS	9,337,515	
40.07	DBB275	Pearl Highlands Station & Ramp Maint. of Highway	1	LS	18,675,029	
Various	DBB275	Pearl Highlands Station & Ramp Signage & Misc	1	LS	843,743	
		Un-awarded Station			**10,349,170**	
20.02	DBB170 to 575	Remaining not awarded Station Signage	1	LS	4,531,231	Parametric Style Assy $
20.02	DBB170 to 575	Remaining not awarded Station undefined Architectural Finishes	1	LS	2,157,916	Parametric Style Assy $
20.02	DBB170 to 575	Remaining un-bid Station Painting	1	LS	1,677,035	Parametric Style Assy $
20.02	DBB570	Ualena Shift Allowances	2	LS	1,982,988	Parametric Style Assy $
		Un-bid Guideway Contracts			**48,818,874**	
10.04	DBB460 & 560	Airport & City Center Site Lighting	1	LS	6,022,865	Overall Unit price reasonable
10.04	DBB460 & 560	Airport & City Center Overtime for Foundations and Erection of Superstructure	1	LS	21,338,737	Overall Unit price reasonable
40.03	DBB460 & 560	Airport & City Center Hazardous Materials Mitigation	1	LS	965,118	Overall Unit price reasonable
40.04	DBB460 & 560	Airport & City Center Environmental Mitigation	1	LS	12,297,827	Overall Unit price reasonable
Various	DBB460 & 560	Airport & City Center Signage & Traffic Signals	1	LS	8,194,327	Overall Unit price reasonable
				TOTAL	**134,048,789**	

Note: No contingency or GET is included.

Excessive use of unquantifiable unit measures such as lump sum or allowances are typically cause for concern, so the PMOC further investigated the justification. As noted the first allowance of $46 million for Electrical and Telecommunications (40.02 ET Utilities) was supported by subsequent detailed estimates not included in the cost estimate. These lump sum items were erroneously identified in the estimate as allowances, but in fact are summations from a separate detailed estimate. The other lump sum items in the Stations category of $39 million are represented the same but are mostly "not to exceed" values for finishes, painting & hardscapes. The values included in the Pearl Highlands Station group are listed as lump sum as well, but appear due to their odd valuation (not round numbers) to have supporting lower level detail estimates similar to what was found with the 40.02 ET estimates. The grantee should provide the lower level detail as attachments with its final estimate submittal for entry into Final Design as supporting documentation to better justify and support the cost quantification and pricing.

The lump sum amount of $48.8 million within the guideway portion of the estimate is justified by using the average pricing from the previously awarded DB contract bids. The grantee increased the unit costs by approximately 50% for the City Center and Airport Guideway segments. The price adjustment includes inefficiency factors for the most easterly Guideway segments located in the corridor's most densely populated urban area. The PMOC believes the price adjustments are conservative and reasonable. The grantee should provide the lower level detail, or the engineer's estimate with supporting documentation of how the lump sums were derived. Following is a table identifying the unit price in the awarded guideway contracts compared to the not awarded work for the Airport and City Center segments, these unit costs are in escalated YOE$ with contingency versus 2011$.

Table 48. Guideway Unit Cost Review

Guideway Segment	Qty	Unit	YOE Cost	Unit Cost	Comments
WOFH (Awarded)	**36,230**	**FT**			
Elevated Guideway Cost (fnd. & superstructure)			$306,978,000	$8,473	
Kamehameha Highway (Awarded)	**20,494**	**FT**			
Elevated Guideway Cost (fnd. & superstructure)			$184,977,000	$9,026	
Airport (Un-awarded)	**27,301**	**FT**			
Elevated Guideway Cost (fnd. & superstructure)			$406,589,000	$14,893	Unit cost higher in more dense urban area
City Center (Un-Awarded)	**21,854**	**FT**			
Elevated Guideway Cost (fnd. & superstructure)			$311,848,000	$14,270	Unit cost higher in more dense urban area

Note: Includes allocated contingency. All values are in YOE$ and are based on grantee SCC Summary.

6.4.4 Mechanical Check of Estimate

The PMOC evaluated the cost estimates for each SCC for mechanical soundness and consistency. These mechanical checks are used to determine if there are any material inaccuracies within the estimate. The *2011 SCC Estimate* was found to be mechanically correct in the tabulation of the unit cost, application of factors, and translation to the SCC workbook. As discussed elsewhere in this report, the PMOC randomly sampled cost estimate line items to determine if the cost estimate backup cross-walked into the SCC workbook. In each instance the PMOC found the calculated values translated to the SCC workbook and back to the cost estimate backup without variance or mechanical issues.

6.4.5 Comparison to Industry Standards

The PMOC summarized and rated the cost estimate in aggregate by using one of the more widely-used industry standards in cost estimation and cost engineering (*AACE International Cost Estimate Classification System, Recommended Standard 17-R97*). This standard generally describes cost estimates relative to the project level of definition, where "5" represents the least defined and "1" represents the most defined. Along with the Level of Project Definition, the recommended practice establishes the expected Accuracy Range for five estimate classifications (Table 49). An estimate's quality can be measured by its overall accuracy range.

Table 49. AACE 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 percent.

The PMOC believes the grantee's *2011 SCC Estimate* and supporting documentation is an AACE "Class 2" estimate as many of the values are based on actual bid results or unit cost based on recent bid results applied to quantities derived from "engineered" documents. It is understood that the project documents (drawings) may be more or less advanced than this classification would normally indicate. Since the bids received to date are for DB type contracts, many of the project drawings may be less detailed than is normal for a Class 2 estimate one would normally see for the typical Design-Bid-Build contracts (DBB). Certain portions of the estimate may exceed the "Class 2" categorization as the estimate includes actual bid values, and this fact should significantly improve the percentages of an expected accuracy range as noted in the above table. However, due to delays in receiving the ROD and an expected delay in receipt of the FFGA, this increase in accuracy is offset by anticipated construction delay claims from the successful bidders. Early settlement of these issues after receipt of Permission to Enter Final Design and/or the FFGA (or interim LONPs) could mitigate or temper the impacts.

6.4.6 Correspondence with Scope Review

The PMOC performed a review of the PE-level drawings, Basis of Estimate and corresponding *2011 SCC Estimate* to:

(1) Cross check sampled quantity estimates with the project scope contained in the design documents.

(2) Perform a "sanity check" of the estimate to ensure all major components are captured.

(3) Review sample quantities for reasonableness and representation of industry standards.

The review of the cost estimate yielded that each of the major elements for the project included an estimated cost. As noted within this report, the PMOC checked a sampling of quantities from the cost estimate. The values were found to be consistent with the scope drawings. Quantity take offs were performed by the grantee estimating team. Documentation of these take-offs was supplied to the PMOC via the Timberline cost estimate electronic file.

6.4.7 Evaluation of Contract Package Elements

Due to the complex nature of this mega project, a variety of contracts delivery method strategies are used to account for the long term Core System DBOM procured under a Best Value approach, to the three Design Build construction packages, standard construction bids, standard design packages, plus specialty engineering and management contracts. Essentially, the procurements are under the City and County of Honolulu requirements that apply to all prospective offers. The city has standards and over time this creates a familiarity with contractors with the process and avoids surprises for both entities.

QA/QC is required by both the grantee and the contractor for the construction and engineering contracts, with varying scope dependent on the type of contract.

For the most part, the DB, DBB and Design contracts contain Lump Sum unit measure line items, not unit prices. The Design and CM contracts include clauses for items such as salary increases, but this is limited by a maximum percentage.

Certain contracts (but not all) include Liquidated Damages, restrictive work hours and escalation clauses to name a few constraints that may affect the bid values or final contract Estimate at Completion costs. These sorts of contract language are necessary to maintain schedule and control the work progress as without these management tools chaos would quickly arise on most projects. So there is an argument that without the restrictive language it could cost more.

Certainly, necessary elements such as the need for a precast yard (either on the island or the mainland) will affect pricing and create scheduling issues because of the permitting process required. Similarly, the need for specialty equipment or the Buy America requirements can affect price, but these are inherent in this project and although somewhat unique are not overly restrictive requirements.

All contracts have clauses for changed conditions and a process is in place within the grantee's management structure to address change orders, again this varies from contract to contract. Contract delivery method strategy usually contemplates the value of DB and the ultimate costs of changes stemming from DB because offerors may inflate their prices to cover potential issues in a DB scenario, where the DBB simply submit the more scrutinized change orders after the contract is executed.

6.4.8 Costs Associated with General and Supplementary Conditions

The GEC generated detailed assemblies for the *2011 SCC 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 along with other specific markups as follows:

- Lump Sum values for Maintenance of Traffic for all contracts
- 6.0% for Mobilization/Demobilization
- 4.712% General Excise Tax (GET)

All line items in the *2011 SCC Estimate* include contractor indirect costs, overhead & profit, and allocated design and construction contingencies; the percentages are described in minor detail in the Basis of Estimate document (Appendix Q) and in greater detail within the Timberline format. The *2011 SCC Estimate does* include separate categories or line item(s) for indirect costs within the Timberline Estimate detail. Information typically contained in a General Conditions estimate includes:

- Detailed Construction Schedule
- Contracting and delivery strategy (i.e. DB, CM-at-Risk, Multiple Prime, Fast-track)
- Necessary equipment lists and durations
- Contract requirements for Quality Control/Assurance, Scheduling, Traffic Control, Liquated Damages, and Assignment of Risks

The PMOC recognizes that a detailed line item estimate for General Conditions is normal for this stage of the project and appropriate percentages are included within the grantee's estimate.

The Timberline cost estimate matrix the grantee utilized in its estimate development is based on detailed costs for labor, materials, equipment and subcontractors which represents the PE Estimate "direct costs". Additional costs, such as general contractor overhead costs, profit, construction risk insurance and other non-direct project implementation costs are categorized as "indirect costs" or General Condition costs. These costs are identified within the Timberline cost estimate as "mark-ups" and are applied based on the estimator's judgment during preparation of the estimate. The estimator chooses what categories such as labor, materials, equipment, subcontractor, and which line items or groups of work to apply the various markup factors. These markups are hand entered or set as defaults during estimate development and entry of quantities into the Timberline cost estimating software program. It is therefore difficult to determine without extensive reverse engineering how the markups are exactly applied.

Table Q-2 (Appendix Q) in the Basis of Estimate illustrates the various "mark-up" percentages. It is the PMOC's professional opinion these percentages are reasonable for application to the remaining work yet to bid.

6.4.9 Contingencies

Contingencies are included within the *2011 SCC Estimate* in both patent and latent form. The allocated and unallocated contingencies are described in detail in the grantee's Basis of Estimate. Latent contingencies were identified separately during the grantee's internal Risk Assessment analysis, and the values were refined with the grantee's input during the PMOC's Risk Assessment process.

Allocated Contingency
The allocated contingency for the project is $673,930,239 (YOE), or 16.37%.

Allocated contingency is included in the unit price estimate on individual estimate lines where appropriate. Allocated contingency represents the stated included in the base pricing. It is a clear contingency add to the price as noted in the build-up or shown in the estimate line as a specific factor. Allocated contingency is reported with the category total to which it applies. It is separated in the SCC cost summary sheets for the purposes of reporting and risk analysis.

The following table presents the amount of allocated contingency included in the 2011 SCC Estimate for each SCC. It should be noted that sufficiency of total project contingency is assessed as part of the FTA risk review.

Table 50. Allocated Contingency

SCC	Allocated Contingency (YOE $M)	% Contingency	PMOC Assessment*
10	190.54	17.05	Reasonable given amount of SCC scope that has been awarded under DB contract
20	103.17	20.17	Reasonable since design development is at PE-level
30	11.94	13.00	Reasonable since there is a bid price under MSF contract
40	153.48	17.68	Reasonable given amount of SCC scope that has been awarded under DB contract
50	28.38	12.71	Reasonable since there is a bid price under CSC
60	70.84	40.00	Reasonable based on review of basis of estimate
70	22.76	12.00	Reasonable since there is a bid price under CSC
80	92.82	9.89	Potentially low; professional services contracts must be effectively managed to ensure there is sufficient contingency

*Total recommended project contingency is discussed in the OP 40 review.

Unallocated Contingency
The unallocated contingency for the project is $191,650,417 (YOE), or 4.66%.

Project unallocated contingency is developed in a built-up method by applying contingency factors to each corresponding line in the estimate, and then pooling the resulting total in the unallocated contingency cost code. The percentages are based on the grantee's subjective view of the inherent risk associated with the particular work type. Sufficiency of the total contingency, both allocated and unallocated, is assessed as part of the FTA risk review.

Latent Contingency

Latent contingency represents the difference between the estimator's "safe" price and the optimistic price for that item. The PMOC did identify latent contingency in the grantee's *2011 SCC Estimate*, and this issue was discussed at the April 2011 Risk Assessment Workshop and then coordinated, with the grantee's help, in the form of supporting documentation. The grantee stated in several onsite meetings that the estimate likely contains latent contingency, as the bids received to date were less than the budgeted values for these contract portions. In fact, the grantee adjusted portions of its own internal risk assessment estimate to lower the BCE value. The PMOC did not accept all latent contingency identified by the grantee, as no bids had been received for any DBB work and thus market conditions from the awarded DB bids should not be utilized in the PMOC's professional opinion.

Of additional concern is the fact that one General Contractor won three of the four major bids thus far and may have developed an advantage over other potential bidders as a result of being now "entrenched" or established on site. This holds true especially for the remaining line segments that have not bid, due to the specialized equipment needed to construct the work.

Competition for the non-guideway contracts such as the Stations and Elevators/Escalator should be adequate and, as a result, the PMOC agreed to adjust the grantee's estimate for latent contingency for these specific contracts. However, the PMOC did not agree to the market conditions adjustment for any contract, as this deduction was viewed as a duplication of the latent contingency deduction. The PMOC deducted $48,926,000 from the grantee's estimate for latent contingency to condition the BCE.

6.4.10 Escalation and Inflation Review

Review of Sources and Methodology Used in the Grantee Forecasts

The cost escalation forecasts developed for the Project are summarized in the "Basis of Escalation: Honolulu High-Capacity Transit Corridor Project" prepared by the grantee on March 25, 2011. This report updated the previous cost escalation forecasts that were prepared by the City and County in 2009 and 2010. The grantee's most recent cost escalation forecast is based on a number of generally accepted sources of data, including the U.S. Bureau of Labor Statistics (BLS), Engineering News Record (ENR), Global Insight Inc., and the University of Hawaii Economic Research Organization (UHERO). Table 51 summarizes the sources and methodology used by the grantee in determining its cost escalation forecast.

Table 51. Escalation Factors Sources and Methodology

Factor	Sources	Assumptions
Labor	Bureau of Labor Statistics (BLS) and University of Hawaii Economic Research Organization (UHERO), Economic Information Service	• Project Labor Agreement (PLA) will apply to construction contracts • After labor contract negotiations, wage rate escalation will be set at a rate slightly below current rates due to relatively high unemployment levels in Hawaii
Steel	BLS Producer Price Index for	• Steel sourced from U.S. mainland (Buy America regs.)

Factor	Sources	Assumptions
	Steel and the American Iron and Steel Institute, Capacity Utilization	• Transportation comprises a high percentage of total costs • No capacity utilization issues • Sustained global growth, led by emerging economies
Concrete	BLS Producer Price Index for Concrete and Industry Data	• Aggregates sourced locally with capacity issues • Cement sourced from South Korea • Transportation costs modest share of total costs
Other Materials	BLS Producer Price Index and Industry Data, UHERO, and the Hawaii Dept. of Business, Economic Development, and Tourism (DBEDT)	• Construction Cost Index (CCI) for high-rise building developed by UHERO was used as a proxy • CCI was pegged to Honolulu Consumer Price Index (CPI) forecasts developed by DBEDT to account for the differential between CCI and CPI
ROW	N/A	• No update provided. Cost estimates use 2.52% cumulative escalation throughout the entire forecast period
Construction Equipment	BLS Producer Price Index for Construction Equipment	• Equipment sourced from Asia and U.S. mainland • Transportation costs are a modest 5 to 10% of total costs • Stable exchange rates
Vehicles	BLS Steel Mill Products PPI, Moody's, Global Insight, IMF, and Energy Information Administration (EIA)	• Compliance with Buy America regulations • PPI for steel mill products for imported shells • Remaining materials escalated using Global Insight CPI and IMF CPI • Assembly costs are based on Global Insight's Manufacturing Wage forecast • Transportation costs expected to be minimal
Professional Services	BLS, Global Insight, BDEDT	• Permanent Residents (25% of professional services): Escalated at average wage rate for professional services with forecast from Global Insight • Temporary Residents (42% of professional services): Avg. wage rate for professional services in U.S. with forecast from Global Insight. Fringe (e.g. relocation, per diem, etc) escalated using DBEDT CPI forecast • Mainland Labor (33% of professional services): Escalated at average wage rate for U.S. professional services with forecast from Global Insight

Source: City and County of Honolulu, HHCTP Cost Escalation (DRAFT), January 9, 2009

In developing its forecast, the grantee took into account changes in international and national economy, the local market for labor and materials, and supply chain logistics. The main points and finding from the review of the City and County's cost escalation forecast include the following:

- Low, high, and "most probable" cost escalation forecasts were provided for each cost factor with the "most probable" forecast used to escalate costs in the SCC worksheet. The inclusion of low and high forecasts provided a useful range of values that helped to support the "most probable" forecast.
- To escalate base year costs into YOE$, a composite cost escalation factor was used for each year. Based on the information provided, it was extremely difficult to determine how the composite escalate factor was estimated for each year and the relative weights each cost factor. In this manner, the methodology used to develop the composite cost index was difficult to trace and to replicate.

- With the exception of Right-of-Way (ROW) and professional services, the cost escalation rates developed in the "most probable" forecast appear to be reasonable, albeit with a minor adjustment for concrete. Higher adjustments are recommended for ROW and professional services to account for potential cost increases during project construction.
- With the exception for ROW, most of the cost escalation factors appear to be consistently applied. The City and County of Honolulu did not provide an updated forecast for ROW. In some of the spreadsheets provided, a 2.52% cumulative escalation was used for the entire forecast period. Other worksheets implied that ROW was being escalated by 1% per annum. If ROW takes places within 3 to 4 years, then may be only a marginal difference between these escalation rates.
- The average annual cost escalation rate of 3.77% for professional services likely underestimates professional services costs during the forecast period. The City and County indicated that it would rely heavily (approximately 75%) on professional services from the mainland U.S. A higher cost escalation factor would better account for growth in professional services salaries, benefits, temporary housing, and travel costs.
- "Other materials" was used as a catch-all category in the forecast. The other materials category appears to include different types of materials and some services. There was limited information provided as to the component elements within this category.
- The cost escalation factors for labor, steel, construction equipment, and rail vehicles are appropriate and do not require further adjustments.

Labor and professional services comprise two of the three largest factor costs, which collectively account for approximately 43% of total project costs. Another important cost is other materials which accounts for 22% of total costs. Concrete and steel collectively account for 19% of total costs. Table 52 summarizes project factor costs as a percent of total costs. These estimated percentages assume that legal reviews and permits (SCC 80.06) and surveying (SCC 80.07) fall under professional services rather than other materials. The inclusion by the grantee of professional liability and construction insurance under other materials seems reasonable. Multi-year contracts can be used to lock in premiums.

Table 52. Factor Costs by Category ($M) and as Percentage of Total Costs (%)

Unit	Labor	Concrete	Steel	Other Materials	Cons. Equip.	ROW	Vehicles	Prof. Services	Total
$M	1096.6	389.2	529.7	1023.6	340.1	224.7	212.5	947.9	4,791.3
% Total	22.9	8.1	11.1	21.4	7.1	4.7	4.4	20.3	100.0

In the grantee's forecasts, adjustments were made to the escalation rates for labor to account for the five-year union contracts, which are scheduled to be executed in 2013 and 2018. In anticipation of improved economic conditions, adjustments have been made in the escalation rates for steel and concrete which are higher from FY 11 to FY 14 compared to later years. Finally, the grantee's forecast assumes that escalation rates for professional services will increase slightly over time. Table 53 summarizes the cost escalation factors used by the grantee to develop the 2011 forecast.

Table 53. Forecast Summary Table

Factor	FY11	FY12	FY13	FY14	FY15	FY16	FY17	FY18	FY19	Avg.
Concrete	3.90	4.50	4.80	4.50	4.20	3.90	3.80	3.60	3.40	4.07
Labor	3.70	4.00	3.80	3.80	3.80	3.80	3.80	3.80	3.80	3.81
Other Materials	4.50	4.80	4.80	4.80	4.80	4.80	4.80	4.80	4.80	4.77
Steel	6.80	6.50	6.80	6.30	5.80	5.60	5.40	5.10	4.80	5.91
ROW	2.52 Cumulative			N/A						
Construction Equipment	2.40	3.60	4.10	3.70	3.20	3.10	2.90	2.80	2.60	3.16
Vehicles	3.00	2.90	3.00	3.10	3.20	3.20	3.20	3.30	3.30	3.13
Professional Services	3.20	3.80	3.60	3.80	3.80	3.80	3.90	4.00	4.00	3.77

Source: City and County of Honolulu, HHCTCP Cost Escalation Forecast, FY 2011-19, all numbers are percentages.

Recommendations

In order to review and assess the viability of the escalation rates provided by the grantee, the PMOC evaluated historical and forecast macroeconomic data as well as industry trends for each cost factor. This was used to develop an escalation forecast for each cost factor. These forecasts were then compared to the cost escalation rates developed by the grantee. The PMOC's forecast factored in the recent downturn in global and national output, the timing and magnitude of the ongoing economic recovery in the U.S., and local economic conditions in Hawaii, and other factors.

From 2000 to 2010, real Gross Domestic Product (GDP), industrial production, and the Consumer Price Index (excluding energy) in the U.S. increased by an annual average of 1.8%, 0.6%, and 2.4%. This includes the recession that began and ended in 2001 and the 2007-09 recession. The latter resulted in zero growth in real GDP and a -3.3% decrease in industrial production in 2008. Real GDP decreased by an additional 2.6% in 2009, but recovered in 2010 with a 2.9% annual increase. Due to a lag in economic activity, industrial production decreased by 9.3% in 2009, but rebounded with a 5.8% increase in 2010. These historical rates are summarized in Table 54.

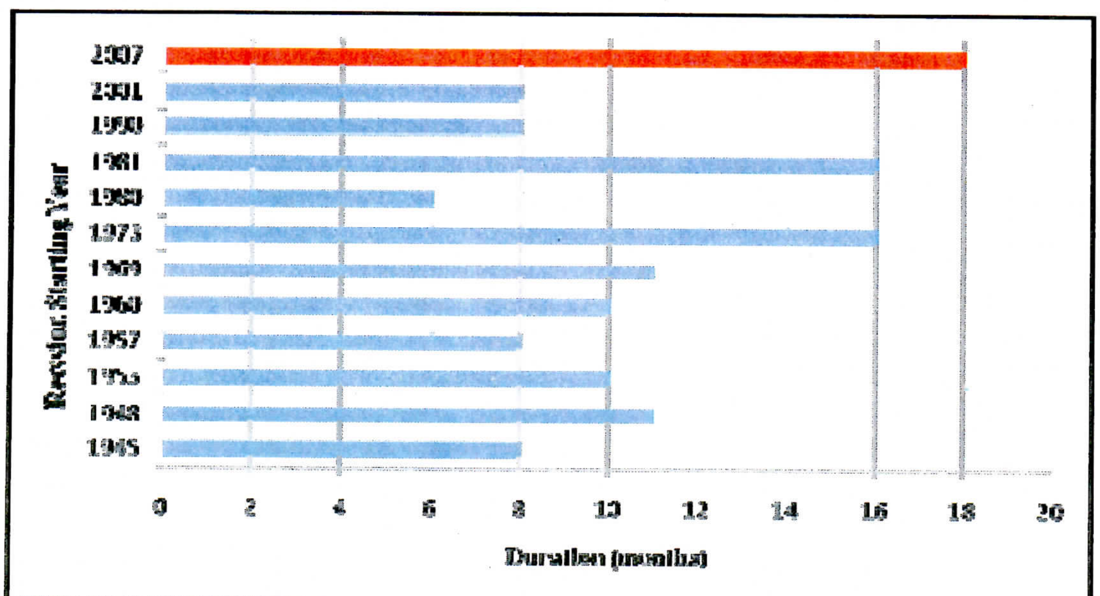
Table 54. Historical U.S. Real GDP and Industrial Production, 2000 – 2010

Historical	Real GDP Growth (Year/Year) (%)	Industrial Production (Year/Year)* (%)	Consumer Price Index (%
2000	3.7	5.2	2.8
2001	0.8	0.4	1.6
2002	1.6	-3.3	2.3
2003	2.5	1.1	2.7
2004	3.6	2.5	3.4
2005	2.9	3.3	3.2
2006	2.8	2.2	2.8
2007	2.0	1.7	3.8
2008	0.0	-3.3	-0.4
2009	-2.6	-9.3	1.6
2010	2.9	5.8	2.9

Source: Bureau of Economic Analysis (BEA)

Estimating the timing and magnitude of the economic recovery is critical to the development of a realistic escalation rate forecast. This is because recessions and the subsequent recovery periods will affect construction materials prices and labor wage escalation. Based on data from the National Bureau of Economic Research (NBER), the most recent recession occurred December 2007 to June 2009 and lasted 18 months, the longest economic downturn since the Great Depression. The following figure compares the most recent recession with previous recessions since 1945.

Figure 19. Comparison of Major U.S. Recession Durations



Source: National Bureau of Economic Research (NBER)

Economic activity has historically increased sharply shortly after a recessionary period has ended due to increased consumption and employment. However, the 2007-09 recessions and the post-recession recovery have not conformed to these trends. In contrast to previous recessions, the 2007 - 2009 recession was triggered by the near collapse of the financial system and the reduced availability of capital. The increase in economic activity in the U.S. has been significantly lower compared to previous post-recessionary periods and unemployment has remained at 9.1% as of May 2011. Notwithstanding, real GDP is forecasted to increase by 2.6% in 2011 and 3.1% in 2012. Longer term forecasts of economic growth prepared by the Congressional Budget Office (CBO) anticipate that real GDP will increase by 3.4% per year from 2013-16 and 2.4% annually from 2017-21. CPI has been forecasted to increase by 3.0% in 2011, 2.2% in 2012, and approximately 2.0%, thereafter. Table 55 provides a 10-year forecast for real GDP, industrial production and CPI.

Table 55. Forecast U.S. Real GDP, Industrial Production, and CPI 2011 – 2021

Forecast	Real GDP Growth (Year/Year) (%)	Industrial Production (Year/Year)* ‡ (%)	Consumer Price Index
2011*	2.6	4.5	3.0
2012*	3.1	4.1	2.2
2013-16	3.4**	N/A	2.0
2017-21	2.4**	N/A	2.1

** Blue Chip Economic Indicators, Consensus Forecast, June 2011*
***U.S. Congressional Budget Office, January 2011*
‡ Annual Energy Outlook 2011 with Projections to 2035, U.S. Energy Information Administration, April 2011

In this manner, the PMOC's escalation forecasts for the Project have attempted to take into account the possible impact on factor prices as a result of the economic recovery in Hawaii and in the U.S. These forecasts have also attempted to factor in the strong growth in Brazil, Russia, India and China (BRIC) and other emerging markets, which has had a considerable impact on commodity prices in recent years. In its most recent forecast prepared in April 2011, the International Monetary Fund (IMF) estimated that real GDP in the BRIC countries would continue to increase at relatively high rates in 2011 and 2012. (Brazil: 4.5% in 2011 and 4.1% in 2012; Russia: 4.8% in 2011 and 4.5% in 2012; India: 8.2% in 2011 and 7.7% in 2012; China: 9.6% in 2011 and 9.5% in 2012). The PMOC's cost escalation forecasts also incorporates the additional costs of transporting materials and services to Hawaii. Table 56 summarizes forecast growth in real GDP, industrial production, and inflation in the U.S.

Table 56. Recommended Base Escalation Factors

Cost Escalation Factor	City and County Average Annual Escalation Rate (%)	PMOC Recommended Escalation Rate FY 2011 to FY 2019 (%)	Difference between PMOC and City/ County (%)
Concrete	4.07	4.42	+0.35
Labor	3.81	3.71	-0.10
Other Materials	4.77	4.80	+0.03
Steel	5.90	5.91	+0.01
ROW	0.84	4.07	+3.23
Construction Equipment	3.16	3.00	-0.16
Vehicles (rail)	3.13	3.12	-0.01
Professional Services	3.77	5.61	+1.84

Source: Jacobs Consultancy

(1) *Concrete*

The average annual increase in the PPI for concrete manufacturing from 1965 through February 2011 was 4.42%. The PMOC typically recommends using a similar benchmark as the cost escalation factor for concrete.

(2) *Labor*

The U.S. BEA reported that wages and income in the state of Hawaii increased by 8.31% from 1970 through 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 3.71% from 1990 to 2009. This period captures the economic downturn at the start of the decade and the increase in economic activity during the middle part of the decade. For this reason, the PMOC recommends using the 1990 to 2009 benchmark as the base cost escalation factor for labor, since it is representative of recent economic trends.

(3) *Other Materials*

Without having complete information on the factor costs that comprise the other materials category, it is difficult to develop an independent forecast for this cost factor. However, the 4.8% annual escalation developed by the grantee appears to be reasonable considering that U.S. CPI has increased by 3.43% per annum (including energy) from 1980 to 2010. Additionally, the real cost/barrel of crude oil, which may be a strong driver of other materials costs, has increased by an annual average of 4.55% this same period.

(4) *Steel*

The forecasted escalation rate of 5.91% for steel combines the PPI for iron and steel 1967 to 2002 and the PPI for steel product manufacturing for purchased steel from 2003 to April 2011. These ranges reflect a modification of commodity categories for steel products made by the BLS. This estimated escalation rate is slightly below the revised forecast of 5.90% prepared by the grantee. Both of these updated forecasts are expected to capture potential volatility in steel prices due to increased demand in the BRIC countries and in other emerging markets.

(5) *Right-of-Way (ROW)*

The Standard & Poors'/Case-Shiller index for 10 U.S. cities increased by 4.07% from January 1987 through March 2011. Although real estate and ROW prices tend to reflect local economic factors, this benchmark includes cities such as Los Angeles, San Diego and Miami, which have similar economic characteristics (e.g. tourism). The grantee anticipates that ROW acquisition would be conducted from FY11 through FY13. As a result, the PMOC's recommended cost escalation factor would not apply from FY14 onward.

(6) *Construction Equipment*

The forecast of 3.00% per annum represents the average increase in the Producer Price Index (PPI) for construction equipment 2003 through May 2011.

(7) *Vehicles*

The forecasted escalation represents the average increase for the Producer Price Index (PPI) for railroad equipment, which was 3.12% from 2001 to 2010.

(8) *Professional Services*

The forecasted escalation rate of 5.61% reflects a weighted average of the average annual increase in professional services wages in Hawaii and the US compiled by the Bureau of Economic Analysis (BEA) from 1990 to 2009. The weighted average incorporates the percentage of the total the amount professional services provided by local firms (25%) and from the mainland (75%). Additional observations on professional services include:

- The grantee has included Legal; Permits; Review Fees by other agencies, cities, etc. (SCC 80.06) and Surveys, Testing, Investigation, Inspection (SCC 80.07) under other materials and has escalated these items at this escalation rate. These costs (8% of professional services) could be considered to be professional services and escalated at this rate.

- The grantee has procured and awarded contracts for the WOFH DB Contract, the MSF DB Contract, the Kamehameha Guideway DB Contract, the GEC, PMC, and the Farrington Highway Stations Final Design. These contracts account for approximately 29% of total estimated professional services costs. These contracts should have built-in cost escalation increases and excluded from further escalation.

- The grantee has also selected AHJV as the contractor for the CSC.

Findings

The PMOC concurs with the amount of escalation contained within the cost estimate for the Project. However, the PMOC offers the following specific findings of the grantee's approach for cost escalation:

- With the exception of professional services, ROW and concrete, most of the cost escalation factors are in line with current macroeconomic trends and historical benchmarks.
- The PMOC had difficulty tracing or replicating the composite rate for the project.
- There are minor consistency concerns for the ROW escalation rates.
- Oversight is needed for the procurement and implementation of professional services contracts to ensure that costs do not increase significantly during project development.

6.5 Adjusted Base Cost Estimate

The PMOC has identified the following Line Item Adjustments due to omissions in scope, under-valuation of certain cost items, or deduction for latent contingency.

SCC 10 – Guideway and Track Elements

- SCC 10.04 – $35.0 million adjustment (add) for WOFH DB Contract.
- SCC 10.09 – $9.6 million adjustment (add) for increase cost for Rail Materials Escalation and NTP Milestone Adjustments for MSF DB Contract.

SCC 20 – Stations, Stops, Terminals, Intermodal Facilities

- SCC 20.01 and 20.02 – $14.04 adjustment (add) for omitted Prime Contractor Markups for SCC 20.01 and 20.02 of $14.04 million.
- SCC 20.01 and 20.02 – $6.16 million adjustment (add) for Arts in Transit Program.
- SCC 20.02 – Latent Contingency (deduct) of <$18.57 million>.
- SCC 20.07 – Latent Contingency (deduct) of <$6.56 million>.

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

- SCC 30.05 – $0.121 million adjustment (add) for Environmental Compliance.
- SCC 30.05 – <$0.064 million> adjustment (deduct) for Automated Yard/Layout Changes.
- SCC 30.05 – $0.390 million adjustment (add) for Photovoltaic Power Service.

SCC 40 – Sitework & Special Conditions

- SCC 40.06 – Latent Contingency (deduct) of <$0.198 million> for Owner Furnished Plants and Shrubs.

SCC 50 – Systems

- SCC 50.01 – $20.0 million adjustment (add) for Platform Screen Doors.

SCC 60 – Right-of-Way

- SCC 60.01 – Latent Contingency (deduct) of <$23.60 million>.

SCC 70 – Vehicles

- No adjustments were made by the PMOC.

SCC 80 – Professional Services

- SCC 80.02 – $1.6 million (add) for Design Criteria Changes to WOFH Contact.
- SCC 80.03 – $1.0 million Adjustment (add) for Kako'o Contractor (MM-940).
- SCC 80.05 – $13.04 million (add) for OCIP Changes to WOFH Contract.
- SCC 80.05 – $2.56 million (add) for OCIP Insurance Changes to MSF Contract.
- SCC 80.05 – $5.6 million (add) for OCIP Insurance Changes to KHG Contract.
- SCC 80.05 – <$11.71 million> Adjustment (deduct) for OCIP Insurance Changes to "Not Awarded Work".
- SCC 80.06 – $5.0 million Adjustment (add) for Job Order Contractor (MM-945).
- SCC 80.06 – $3.76 million (add) for Hawaii Department of Transportation (HDOT) Master Agreement to WOFH.
- SCC 80.08 – <$5.12 million> Adjustment (deduct) for reduction in agency start-up cost to reflect three openings.

These adjustments are used to develop an Adjusted Base Cost Estimate. 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. To develop the Adjusted BCE (YOE), the following steps were taken:

- Grantee's' BCE – $5,212,910,000
- Deduct Allocated Contingency – $673,930,000
- Deduct Unallocated Contingency – $191,650,000
- Deduct Latent Contingency – $48,926,000
- Deduct YOE financing costs – $230,000,000
- Apply PMOC Adjustments – $100,989,000 (add)
- Adjusted BCE – $4,169,393,000.

Table 57 provides a summary of the BCE and Adjusted BCE.

Table 57. Adjusted BCE (YOE $)

SCC	Description	BCE	Allocated Contingency	Latent Contingency	Total Contingency	Total w/o Contingency	Adjustments	Adjusted BCE
10	**Guideway & Track Elements**	**1,308,357,000**	**190,536,000**	**0**	**190,536,000**	**1,117,820,000**	**44,600,000**	**1,162,420,000**
10.04	Guideway: Aerial structure	1,210,392,000	178,396,000	0	178,396,000	1,031,995,000	35,000,000	1,066,995,000
10.08	Guideway: Retained cut or fill	7,401,000	965,000	0	965,000	6,436,000	0	6,436,000
10.09	Track: Direct fixation	85,256,000	10,403,000	0	10,403,000	74,852,000	9,600,000	84,452,000
10.11	Track: Ballasted	3,102,000	404,000	0	404,000	2,697,000	0	2,697,000
10.12	Track: Special (switches, turnouts)	2,204,000	366,000	0	366,000	1,838,000	0	1,838,000
20	**Stations, Stops, Terminals, Intermodals**	**614,602,000**	**103,170,000**	**25,131,000**	**128,301,000**	**486,300,000**	**20,202,000**	**506,502,000**
20.01	At-grade station	8,345,000	1,418,000	0	1,418,000	6,926,000	323,000	7,250,000
20.02	Aerial station	449,606,000	75,779,000	18,569,000	94,349,000	355,256,000	19,878,000	375,134,000
20.06	Automobile parking multi-story structure	77,918,000	12,853,000	0	12,853,000	65,064,000	0	65,064,000
20.07	Elevators, escalators	78,732,000	13,117,000	6,561,000	19,679,000	59,053,000	0	59,053,000
30	**Support Facilities: Yards, Shops, Admin.**	**103,805,000**	**11,942,000**	**0**	**11,942,000**	**91,863,000**	**447,000**	**92,310,000**
30.02	Light Maintenance Facility	8,511,000	979,000	0	979,000	7,531,000	0	7,531,000
30.03	Heavy Maintenance Facility	42,778,000	4,921,000	0	4,921,000	37,857,000	0	37,857,000
30.04	Storage or Maintenance of Way Building	8,741,000	1,005,000	0	1,005,000	7,735,000	0	7,735,000
30.05	Yard and Yard Track	43,774,000	5,035,000	0	5,035,000	38,738,000	447,000	39,185,000
40	**Sitework & Special Conditions**	**1,021,457,000**	**153,475,000**	**198,000**	**153,674,000**	**867,783,000**	**0**	**867,783,000**
40.01	Demolition, Clearing, Earthwork	19,916,000	2,679,000	0	2,679,000	17,237,000	0	17,237,000
40.02	Site Utilities, Utility Relocation	358,376,000	67,161,000	0	67,161,000	291,214,000	0	291,214,000
40.03	Haz. mat'l, contam'd soil removal/ mitigation	7,533,000	811,000	0	811,000	6,721,000	0	6,721,000
40.04	Environmental mitigation	30,802,000	4,078,000	0	4,078,000	26,723,000	0	26,723,000
40.05	Site structures (retaining walls, sound walls)	22,935,000	3,159,000	0	3,159,000	19,776,000	0	19,776,000
40.06	Pedestrian / bike access, landscaping	44,675,000	7,136,000	198,000	7,335,000	37,339,000	0	37,339,000
40.07	Automobile, bus accessways (roads, parking)	212,928,000	31,598,000	0	31,598,000	181,330,000	0	181,330,000
40.08	Temporary Facilities/other indirect costs	324,289,000	36,849,000	0	36,849,000	287,439,000	0	287,439,000
50	**Systems**	**251,586,000**	**28,379,000**	**0**	**28,379,000**	**223,207,000**	**20,000,000**	**243,207,000**
50.01	Train control and signals	92,601,000	9,921,000	0	9,921,000	82,679,000	20,000,000	102,679,000
50.02	Traffic signals and crossing protection	13,043,000	2,315,000	0	2,315,000	10,727,000	0	10,727,000
50.03	Traction power supply: substations	33,800,000	3,632,000	0	3,632,000	30,168,000	0	30,168,000
50.04	Traction power distribution	37,347,000	4,489,000	0	4,489,000	32,857,000	0	32,857,000
50.05	Communications	60,602,000	6,499,000	0	6,499,000	54,102,000	0	54,102,000
50.06	Fare collection system and equipment	10,324,000	1,106,000	0	1,106,000	9,218,000	0	9,218,000
50.07	Central Control	3,868,000	414,000	0	414,000	3,453,000	0	3,453,000
	CONSTRUCTION SUBTOTAL (10 - 50)	**3,299,809,000**	**487,504,000**	**25,330,000**	**512,834,000**	**2,786,974,000**	**85,249,000**	**2,872,223,000**

SCC	Description	BCE	Allocated Contingency	Latent Contingency	Total Contingency	Total w/o Contingency	Adjustments	Adjusted BCE
60	**ROW, Land, Existing Improvements**	**247,942,000**	**70,840,000**	**23,596,000**	**94,436,000**	**153,505,000**	**0**	**153,505,000**
60.01	Purchase or lease of real estate	224,649,000	64,185,000	23,596,000	87,781,000	136,867,000	0	136,867,000
60.02	Relocation of existing households/businesses	23,293,000	6,655,000	0	6,655,000	16,637.000	0	16,637,000
70	**Vehicles**	**212,461,000**	**22,763,000**	**0**	**22,763,000**	**189,697,000**	**0**	**189,697,000**
70.01	Light Rail	191,657,000	20,534,000	0	20,534,000	171,122,000	0	171,122,000
70.06	Non-revenue vehicles	14,589,000	1,563,000	0	1,563,000	13,026.000	0	13,026.000
70.07	Spare parts	6,214,000	665,000	0	665,000	5,548,000	0	5,548,000
80	**Professional Services**	**1,031,047,000**	**92,821,000**	**0**	**92,821,000**	**938,225,000**	**15,740,000**	**953,966,000**
80.01	Preliminary Engineering	58,996,000	4,756,000	0	4,756,000	54,240,000	0	54,240,000
80.02	Final Design	222,177,000	22,403,000	0	22,403,000	199,774,000	1,600,000	201,374,000
80.03	Project Management for Design/Construction	350,329,000	28,507,000	0	28,507,000	321,822,000	1,000,000	322,822,000
80.04	Construction Administration & Management	187,914,000	17,083,000	0	17,083,000	170,831,000	0	170,831,000
80.05	Professional Liability/Non-Construction Ins.	56,103,000	5,100,000	0	5,100,000	51,003,000	9,499,000	60,503,000
80.06	Legal; Permits; Review Fees by other agencies	69,918,000	6,355,000	0	6,355,000	63,562,000	8,756,000	72,318,000
80.07	Surveys, Testing, Investigation, Inspection	6,072,000	527,000	0	527,000	5,545,000	0	5,545.000
80.08	Start up	79,534,000	8,088,000	0	8,088,000	71,445,000	(5,115,000)	66,330,000
	SUBTOTAL (10 - 80)	**4,791,260,000**	**673,930,000**	**48,926,000**	**722,856,000**	**4,068,403,000**	**100,989,000**	**4,169,393,000**
90	**Unallocated Contingency**	**191,650,000**	**191,650,000**	**0**	**191,650,000**	**0**	**0**	**0**
90	**Latent Contingency**	**0**	**0**	**48,926,000**	**0**	**0**	**0**	**0**
	SUBTOTAL (10 - 90)	**4,982,910,000**	**865,580,000**	**48,926,000**	**914,506,000**	**4,068,403,000**	**100,989,000**	**4,169,393,000**
100	**Finance Charges**	**230,000,000**	**0**	**0**	**0**	**230,000,000**	**0**	**0**
	TOTAL PROJECT COST (10 - 100)	**5,212,910,000**	**865,580,000**	**48,926,000**	**914,506,000**	**4,298,403,000**	**100,989,000**	**4,169,393,000**

Note: All numbers in $.

6.6 Project Cost Estimate Review Checklist

A Definitive Project Cost Estimate Review Checklist is included as Table 58 to respond to Appendix D of OP 33. The items were addressed throughout this report, but it is convenient to respond to each question in the following checklist format.

Table 58. Definitive Project Cost Estimate Review Checklist

Description	Yes	No	Comments
Review of Grantee's Cost Estimate			
Estimate was developed by those with substantial experience in the type of construction under consideration	X		Grantee's estimators and consultants have relevant experience.
Sufficient judgment was applied to forecast design development, especially during early design stages	X		Project is in advanced PE Phase
Evidence exists indicating sufficient collaboration with design team, especially in the application of value engineering		X	VE workshop occurred in two phases, but has not been fully implemented into the project.
Work Breakdown Structure has been formatted to conform to the FTA Standard Cost Categories (SCC)	X		Timberline Estimate is coded so it can be "cross-walked" into SCC Format
SCC 10-50: Fixed Construction			
Construction Materials			
Quantities have been calculated with appropriate conservatism to accommodate development to a more advanced stage of design if appropriate	X		
Allowances for material quantities have been included for commodities which cannot be fully quantified at the present level of design	NA		Estimate is a bottoms-up style estimate with only minor allowances
Unit Prices have been developed using the best available local market information	X		Grantee adjusted unit prices from the DB contract awards. Grantee used mean and not the low bids, so an inherent conservatism exists in the unit prices.
Project sales tax exemption status has been established if appropriate and incorporated in materials costs		X	No sales tax required in Hawaii, but the estimate includes the appropriate percentage for the General Excise Tax of 4.712% (GET).
Quotes have been obtained for specialty and price-sensitive materials	X		
Materials costs reflect market volatility	X		
Construction Labor			
Local wage rates, fringe benefits, and work rules are incorporated	X		
Local payroll taxes and insurance rates are incorporated	X		
Holiday / show-up / vacation pay is incorporated	X		
Crew productivity is appropriate and conservative for the task under evaluation	X		
Availability and variability of utility and railroad outages and "track time" have been incorporated in a conservative manner in determining the crew productivities for impacted work	X		This applies to future phases of work, but the Grantee developed construction strategies to avoid this issue, such as extending alignment past set coordination or end of construction points.
Construction Equipment			

Description	Yes	No	Comments
Local equipment rental rates and current fuel costs are incorporated	X		
Quotes have been obtained for specialty equipment (TBM's, etc) and currency adjustments as applicable have been made.	**X**		The main specialty equipment is the casting yards, oversize drill pier rigs, and gantry cranes necessary for elevated guideway segments. These are based on recent quotations from successful bidders.
Escalation			
Confirm that adequate escalation rates have been applied to estimates of material, labor and equipment costs to anticipate prices at the time of project bid. Cost escalation can be due to increased global or local demand (example is China's construction boom results in high demand for copper, steel, cement) or reduced supply (example is the reduced labor pool in neighboring states when construction workers flocked to New Orleans after Hurricane Katrina).	X		PMOC economist reviewed escalation factors and found them to be reasonable. At least 43% of the work is under contract, which mitigates some risk from unanticipated escalation.
Special Considerations			
Utility and Railroad labor, equipment, and overhead rates have been verified and incorporated in third party or "force account" work pricing, as well as local utility/RR work and safety rules	X		
Special consideration has been given to support operations and facilities for tunneling operations, facilities to support operations in contaminated/hazardous materials, etc.	X		
Construction Indirect Costs, Multipliers for Risks			
Contractor indirect and overhead costs are advanced beyond a percent of the associated construction direct costs and should be analyzed based on field and home office indirect costs such as contract duration, appropriate levels of staffing (including project managers, engineers, safety engineers, schedulers, superintendents, QA/QC engineers, craft general foreman, labor stewards / nonproductive labor, warehousing, project trucking, survey layout, purchasing, timekeeping, etc.), mobilization / demobilization costs, equipment standby / idle time costs, reviewer office / lab / tool facilities, safety equipment, QA/QC testing equipment, temporary utilities (sanitary / power / light / heat), jobsite and public security measures, etc	X		PMOC reviewed percentages utilized within the project estimate. As noted previously 43% of the work is bid. However, PMOC determined markup for Station Contracts was missing the Prime Contractor markup and thus an upward adjustment was included.
Appropriate costs have been included for payment and performance bonds and special insurance requirements (RR protective, pollution liability, etc.).	X		
Other construction insurance costs and/or project-wide coverage (Owner Controlled Insurance Policy) has been included based on quotes from appropriate carriers.	X		An adjustment was made to the estimate as the grantee decided to use the OCIP methods. This was contrary to the insurance included in already awarded contracts and certain portions of the bid
Contractor profit / risk costs have been incorporated that reflect the expected level of competition by contract package (higher profit margin where few competitors will bid).	X		This is a potential risk as Kiewit was the successful bidder on the first two guideway contracts and could have an advantage.

Description	Yes	No	Comments
SCC 60 – Real Estate			
Costs for professional services (contracted and in-house legal, appraisal, real estate and relocation consultants) and costs for the real estate and relocations themselves have been included. Check that easements, acquisitions, inspections, takings, etc. have been appraised or estimated by qualified professionals familiar with local real estate markets and practices. Include costs for taxes.	X		PMOC recommended the grantee update this estimate in Final Design as it is somewhat dated and should be refreshed. It was determined it had sufficient value for the SCC.
SCC 70 – Vehicles			
Costs for professional services (both contracted and in-house) for vehicle design and procurement as well as construction of prototypes and vehicles themselves. Review estimates for current purchase prices for similar vehicles or quoted prices from manufacturers; costs for spare parts and project requirements for non-revenue support vehicles are included.	X		
SCC 80 – Professional Services			
Costs both contracted and in-house for all professional, technical & management services related to the design & construction of fixed infrastructure (Cats. 10 - 50) during the preliminary engineering, Final Design, & construction phases of the project. This includes environmental work, surveying, geotechnical investigations, design, engineering and architectural services; materials & soils testing during construction; specialty services such as safety or security analyses; value engineering, risk assessment, cost estimating, scheduling, Before & After studies, ridership modeling and analyses, auditing, legal services, administration & management, etc. by agency staff or outside consultants. Professional liability insurance & other non-construction insurance should be included in SCC 80.05.	X		
Confirm that cost estimates are based on realistic levels of staffing for the duration of the project through close-out of construction contracts	X		PMOC reviewed grantee's staffing plans against the Project Schedule and the work scope, and determined it is reasonable
Confirm that costs for permitting, agency review fees, legal fees, etc. have been included	X		
Allocated Contingency			
Confirm that adequate contingency has been allocated to each of the SCC categories based on the perceived risk inherent to each.	X		This was confirmed by the Risk Assessment analysis.
SCC 90 – Unallocated Contingency			
Confirm that adequate contingency has been added to the total project cost based on the perceived project risk.	X		This was confirmed by the Risk Assessment analysis.
SCC 100 – Finance Charges			
Confirm that finance charges are included if necessary. Ensure that the Grantee and FTA's Financial Management Oversight Consultant review the reasonableness of the amount of finance charges.	X		Grantee included $230 million in YOE$.

Description	Yes	No	Comments
Escalation			
Confirm that adequate inflation rates have been applied to Base Year project costs to anticipate costs at procurement or bid. The Year of Expenditure costs should be developed thoughtfully. Reference indices that may be useful are the ENR Building Cost Index and Construction Cost Index, some with regional cost databases.	X		Grantee and PMOC economist agreed to the applicable percentages. Grantee provided an MS Access Database that was reviewed and deemed acceptable. As noted in the report the SCC Summary workbook was not in standard FTA format and this will need to be submitted prior to Final Design approval.

6.7 Conclusion

(1) The PMOC concludes that the estimate is consistent with the project scope identified in the FEIS and ROD.

(2) The PMOC has characterized the project cost data as an AACE "Class 2" estimate due to the bottoms-up style of estimate and receipt of bids for design build portions of the project scope. To date, the grantee has awarded $1.933 billion of the $4.983 billion of planned contracts, or 38.8%, including contingency. Without considering contingency, the percentage is 43.6%.

(3) Soundness & reliability of the Grantee's Estimate – The grantee's *2011 SCC Estimate* was prepared utilizing standard industry practices combined with highly regarded Timberline estimating software and a reasonable and reliable data base. The database contains adjusted local rates which include constructions, environmental, real estate, permitting, bonds and insurance, and related general conditions and soft cost markup factors. It has been proven reliable thus far, as awards of approximately 43% of the planned contracts have occurred. The project budget has been reviewed by the PMOC for congruence, incorporation and coordination of the project scope & schedule, and found to fall within a reasonable range.

(4) The PMOC accepts the percentages used by the grantee for escalation in its *2011 SCC Estimate*.

(5) The PMOC verified that the grantee appropriately included the General Excise Tax in its estimate as it has not received exemption from this requirement.

(6) The PMOC verified that the grantee included an appropriate level of detail and supportable justification in the Basis of Estimate for general condition costs.

(7) The cost estimate contained some line item "Allowance" costs which contained minimal quantification or detail backup. The Allowance line item total just over $86 million or 1.65% of the total Project estimate. The PMOC found the use of Allowance line items acceptable and not excessive for a cost estimate prepared prior to entry into the Final Design phase.

(8) The PMOC evaluated the DB bids and the grantee's approach for contract

evaluation, post bid analysis and award.

- The grantee has awarded two DB guideway sections; one was substantially less than the engineer's estimate (WOFH); and, one was not (KH). The MSF bid was within the budget, and the CSC DBOM was less than the estimate. Risk still exists for these projects due to delays in NTPs. The PMOC accounted for this risk in its analysis sensitive to the information available at the time of the modeling.
- The grantee is following their outlined procurement process, which has proven successful to date.
- Because the bids are prepared using lump sum line items, the SCC format distributions are provided after NTP, which make spot checking awarded contract line item quantification and unit pricing difficult.

(9) With the exception of the adjustments in Table 57, the PMOC has determined the current cost estimate to be mechanically and fundamentally sound and reasonable and that it meets the FTA guidance and requirements necessary to advance the Project into the Final Design phase. The grantee's *2011 SCC Estimate* was prepared utilizing standard industry practices combined with highly regarded Timberline estimating software and a reasonable and reliable data base. The estimate is substantiated in part from bid results obtained from the award of the DB portions of the work during 2010/2011. The $1.8 billion in aggregate contract value awarded to date is approximately 43% of the project's contract value, excluding contingency.

6.8 Recommendations

The PMOC recommends the following actions be taken before Final Design:

(1) The grantee should incorporate the adjustments identified during the PMOC Risk Assessment Workshop 2, which total $101 million (additive) prior to Final Design.

(2) The grantee must submit the complete SCC Workbook in the format required by the FTA as a condition to enter Final Design.

The PMOC recommends the following actions be taken during Final Design:

(3) The grantee should update the Right-of-Way portion of the 2011 SCC Estimate and Basis of Estimate, as it is not current with the drawings or planned methodology to acquire the Real Estate for the Project. The cost estimate can be revised during the Final Design phase to account for more detail and definitive real estate pricing. The PMOC has determined that the cost estimate contingency amounts sufficiently cover similar items that lack definitive information at this phase of the Project.

(4) The grantee should address any cost-related issues regarding slippage of Notice to Proceed (NTP) dates for the selected or awarded DB contracts. The cost estimate can be revised during the Final Design phase to account for more detail and definitive information related to future contract award and NTP. The PMOC has

determined that the cost estimate contingency amounts sufficiently cover similar items that lack definitive information at this phase of the Project.

(5) The grantee should segregate the costs for Maintenance of Traffic (MOT) and Temporary Facilities for the "not awarded" contracts into SCC 40.08, similar to the segregation that occurred for this work scope in the "awarded" contracts within the SCC Summary Sheet. This can be completed when updating the cost estimate during Final Design.

(6) The grantee should improve its implementation of internal quality control and review of General Engineering Consultant (GEC) developed deliverables (cost estimates) prior to issuance to the FTA/PMOC. The PMOC noted similar issues with the schedule and related project control deliverables as they lacked consistency with naming conventions, transmittals, incomplete information and non-conformance to its procedures

(7) The grantee should revise its staffing plan when major revisions are made to the Project scope, MPS or Cost Estimate in order to synchronize the adjustments with resource allocation planning. Major revisions include significant delay to contract letting or execution, contract package revisions, changes to contract delivery methods, etc., or the addition of professional service contracts, etc.

7.0 OP 34: PROJECT SCHEDULE REVIEW

7.1 Methodology

The PMOC followed the requirements outlined in the FTA *"Project Management Oversight Operating Procedure (OP) 34: Project Schedule Review"*, dated May 2010 to assess and evaluate the grantee's project schedule. The PMOC Schedule Review report format is consistent with the OP 34 and addresses all of the subcategories included under the categories listed below:

- Technical Review
  - Format
  - Structure, quality, and detail
  - Mechanical soundness
  - WBS
  - Phasing and sequencing
  - Hierarchy
  - Cost and resource loading
  - Schedule Contingency
  - Constraints
  - Schedule Control
- Project Activities and Constraints
  - Sequencing
  - Resource Loading
  - Schedule Elements

The Schedule Review categories holistically characterize each element in the project/program schedule, from schedule development and performance measurement, through post project archive record documentation. The Schedule Review will evaluate the efficiency and effectiveness of the project sponsor's project implementation during any phase of the project life cycle.

The Schedule Review 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 Final Design phase. The report findings result in a compilation of tabular and graphical reports and conclude with a list of PMOC findings and recommendations for project sponsor action.

7.2 Documents Reviewed

The PMOC used the following meeting notes, files, reports and documents to support the Schedule Review:

Table 59. Schedule Submittal Package History

Document Name	Transmitted to PMOC	Status (PMOC Comments)
First Schedule Submittal Package		
MPS Mar 26,2010.xer	1.13.11	Requires Revision.
MPS Mar 26,2010.pdf	1.13.11	
ROW Schedule Mar 26,2010.xer	1.13.11	Requires Revision.
ROW Schedule Mar 26,2010.pdf	1.13.11	
Basis of Schedule Report A_01-18-11.pdf	1.18.11	Basis of Schedule (first submission to PMOC).
Second Schedule Submittal Package		
HHCTPMPS11.xer	1.11.11	Requires Revision.
HHCTPROW111.xer	1.11.11	Requires Revision.
HHCTPROW111.pdf	1.11.11	
Master Program Schedule to PMO_01-07-11.pdf	1.13.11	
Master ROW Schedule to PMO_01-07-11.pdf	1.13.11	
Third Schedule Submittal Package		
HHCTPMPS.xer	2.23.11	Requires Revision.
HHCTPMPMOC.pdf	2.23.11	
MPS – DEC31.pdf	2.23.11	
Basis of Schedule Report A_01-18-11.pdf	2.23.11	Submitted second time by grantee
Basis of Schedule HHCTP.PDF	2.23.11	
MSF Basis of Schedule HHCTP.pdf	2.24.11	Supplemental to MPS Basis of Schedule
Fourth Schedule Submittal Package		
MPSPMOCA.xer	2.24.11	Requires Revision.
Fifth Schedule Submittal Package		
MPS31.xer	3.1.11	Requires Revision.
Sixth Schedule Submittal Package		
HHCTPROW.xer	3.9.11	Requires Revision.
ROW-BG-30911-PMOC.xer	3.9.11	Requires Revision.
HHCTPROWPMO.pdf	3.9.11	
Basis of Schedule HHCTP.PDF	3.9.11	
RTDS Master Project Schedules 3-9-11.pdf	3.9.11	Resubmitted on 3.13.11 also.
Seventh Schedule Submittal Package		
PMOCA.xer	3.15.11	Needs further revision but the PMOC agreed to use for this OP34. Does not contain an integrated ROW schedule.
IPS with CPP data 12811.xer	3.24.11	Integrated Project Schedule, first submission, requested by PMOC in January 2011. Used to support the OP34.
Eighth Schedule Submittal Package		
MPSHHCTCP 2011_6.xer	7.2.11	Incomplete, contains fatal flaws such as no discernible critical path, -420 negative float, errors and warnings, no ROW Schedule, no Permit Schedule, and no Procurement Schedule. First schedule submitted since May 11, 2001 on-site PMOC Schedule Workshop.
RTD PMOC by Major Milestones.plf	7.2.11	Report File Layout – was incorrect.

Document Name	Transmitted to PMOC	Status (PMOC Comments)
Basis of Master Project Schedule_Rev 2_063011_FINAL.pdf	7.2.11	Basis of Schedule, Revision 2 – acceptable with comments to be incorporated in next revision.
BOS_Early & Late _Rev 2_063011.xlsx	7.2.11	Graphic inserted in BOS
Network of Schedules Rev 2 063011.xlsx	7.2.11	Graphic inserted in BOS
WBS 2010-07-30-AA.xls	7.2.11	Graphic inserted in BOS
Ninth Schedule Submittal Package		
HHCTCPMPS2011_6rev2.xer	7.9.11	MPS
HHCTCPROW2011_6rev1.xer	7.9.11	ROW Schedule
HHCTCPMPS2011_6rev2 – Critical Path – Airport.pdf	7.9.11	
HHCTCPMPS2011_6rev2 – Critical Path – City Center.pdf	7.9.11	
HHCTCPMPS2011_6rev2 – Critical Path – WOFH-KH.pdf	7.9.11	
HHCTCPMPS2011_6rev2 – Critical Path – Longest Path.pdf	7.9.11	
HHCTCPMPS2011_6rev2.pdf	7.9.11	
HHCTCPROW2011_6rev1.pdf	7.9.11	
MPS - PMOC.plf	7.9.11	Report Layout File
ROW - PMOC.plf	7.9.11	Report Layout File
SCHEDLOG MPS 7-09-11.TXT	7.9.11	Schedule File Log
Supplemental MPS Revision		
HHCTCPROWandMPS_6 b.xer	7.11.11	MPS with incorporated ROW Schedule

The table above not only lists the documents reviewed to support the PMOC OP 34 review but it also illustrates a very telling story of the Schedule Submittal Package history. The PMOC rejected the Project schedule eight times before the grantee was able to develop a schedule that met the minimal FTA guidelines and requirements; see "Ninth Schedule Submittal Package" in Table 59.

During the Schedule Review process the PMOC noted several inconsistencies with schedule development and routine progress updating, including poor use of file naming conventions, incomplete information, mechanically unsound practices, poor document transmittals, incomplete submittal packages, and non-compliance with internal project control and quality control procedures. The format, quality, and detail contained within the initial MPS and BOS were unacceptable and did not match the transparency of information contained within the Basis of Estimate that supports and records the assumptions used to develop the Project Budget Cost Estimate.

The PMOC expected a more comprehensive and detailed MPS and BOS, considering that the grantee, consultant, and project control staff has been developing and revising the MPS since September 2008 when the PMOC first provide review comments to support an earlier OP 34 review for entry into the PE phase. Recognizing the grantee struggled with schedule development, the PMOC conducted a teleconference with the grantee's Project Control Manager on February 4, 2011 to discuss most recent concerns and comments, and followed up with a more detailed discussion and schedule review workshop during the PMOC February 8-10, 2011 site visit. During the workshop the grantee provided a copy of its new Project Scheduling

Procedures and asked the GEC to present the methodology and procedures used to develop and update the Integrated Project Schedule (IPS). The PMOC noted that many of its initial concerns were satisfactorily answered by the GEC, although the PMOC did detect the grantee and GEC team members did not have a comprehensive understanding of each other's roles and responsibilities. This was confirmed when the PMOC discovered the GEC had not developed an IPS with six months of progress updates as it initially claimed.

Upon being asked why it did not incorporate prior PMOC comments, the grantee stated that it was rushed to prepare the schedule and procedures. As a result of the meeting, discussions, and PMOC recommendations, the grantee issued a revised Basis of Schedule on February 23, 2011, and a revised MPS on March 15, 2011, "PMOCA.xer". After initial review, the PMOC agreed to use the "PMOCA.xer" file to conduct this Schedule Review. The PMOC presented its Preliminary Findings and Recommendations to the grantee on April 5, 2011 during its monthly site visit. The preliminary findings and recommendations were also summarized by the PMOC at the FTA/PMOC Quarterly Review Meeting held with the grantee at FTA Region IX offices on April 28, 2011. Ultimately the PMOC had to make a significant amount of "adjustments and modifications" to the MPS in order to use it for OP 40 review (schedule risk assessment).

The grantee replaced its Project Control Manager on May 9, 2001 and the PMOC conducted another on-site schedule workshop on May 11-13, 2011. The PMOC provided forensic detail and discussion about schedule management, schedule development, Schedule Breakdown Structures (SBS), master program scheduling versus project scheduling, Program controls and Procedures, measurement and control, naming conventions, configuration management for scheduling, claims avoidance and mitigation, and reporting. As a result of the workshop, the grantee agreed to revise its SBS and its internal organizational structure within the Project Controls department, co-locate the GEC project Controls staff, delete the GEC Integrated Project Schedule (IPS), and use the MPS as the main scheduling management tool. This process in discussed in more detail within this report's Technical Review section.

The PMOC receive the grantee's eighth Schedule Submittal Package on July 2, 2011, seven weeks after the last POC schedule workshop. The PMOC rejected the MPS as it contained several fatal flaws such as:

- 420 days of negative float
- no discernible critical path
- excessive "Errors and Warnings" in the Schedule File Log Report
- not containing ROW Schedule
- not containing Permit Schedule or Procurement Schedule per procedures

The grantee transmitted the ninth Schedule Submittal Package on July 9, 2011. The PMOC used this schedule to complete the OP 34 review. The PMOC findings and recommendations are included in the Report Conclusion. While the grantee met the minimal schedule guidelines and requirements necessary to enter the Final Design phase, the PMOC expected much higher deliverable quality from the grantee especially considering the time, effort and cost expended by the grantee's consultant team on this $5+ billion Project.

7.3 Technical Review

The following section includes review topics as listed in the OP 34 *"Technical Review"* subcategories. Each review topic includes a description explaining the relevant information included in the schedule and Basis of Schedule. Graphics are included when necessary to support the PMOC's explanation and determination.

7.3.1 Schedule Format

Is the schedule format consistent with relevant, identifiable industry or engineering practices? Does it use software appropriate for the size and complexity of the project?

Although the grantee's initial Basis of Schedule (BOS) did not adequately address the MPS format or software, the PMOC has found the format, WBS, hierarchy, data libraries, and report standardizations to be consistent with industry standard of care.

The grantee is using Oracle's Primavera Project Manager (P6) Version 7.0 scheduling software and is requiring all scheduling parties involved on the Project to use the same software. This software is more than acceptable and is considered a world class project management tool.

<u>PMOC Determination</u>
Grantee has satisfied the requirement. Schedule format revised and documented in Basis of Schedule according to PMOC recommendations during Schedule Review process.

<u>PMOC Recommendations</u>
None

7.3.2 Characterize Structure, Quality and Detail

(1) Schedule Breakdown Structure (SBS)

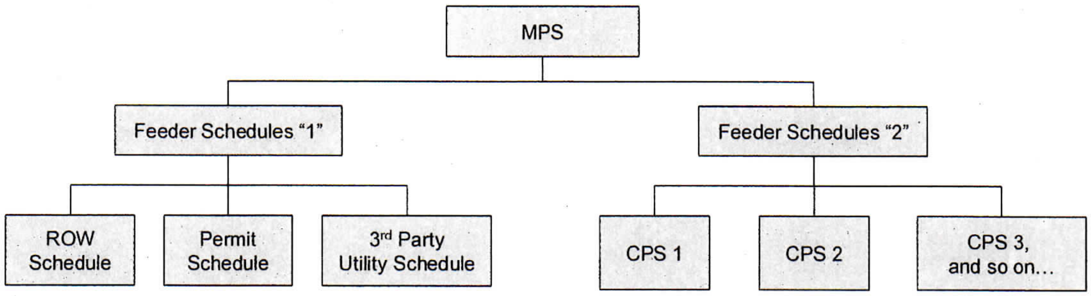
The Schedule Breakdown Structure (SBS) illustrates how all of the different types of schedules are integrated within the Project (see Figure 20). The BOS describes the relationship between schedule types and explains how the information is integrated between schedules and schedule users, including the construction contractors, vendors, real estate acquisition department, design consultants and the grantee. The highest level schedule type is the Master Summary Schedule (MSS), which is simply a summary level filter and organization of the MPS, using the same schedule data as the MPS. The MPS is developed from multiple "Feeder" schedules. Summary information from the Construction Project Schedules (CPS) is incorporated into the MPS through certain milestones designated by the grantee. The CPS schedules are managed by the field Resident Engineer teams and the GEC.

- Right-Of-Way Schedule (ROW) – by the grantee
- Permit Schedule – by the grantee (not yet developed, information included in MPS)
- 3rd Party Utility Relocation Schedule - by the grantee (not yet developed, information included in MPS)

- Contractor Project Schedules (in summary form)

The figure below illustrates the SBS taxonomy.

Figure 20. Schedule Breakdown Structure (SBS)



The Feeder Schedules "1" are separate schedule files developed and maintained by the grantee. These separate schedules can be built-in the MPS at a later time if the grantee so chooses. The grantee did successfully incorporate the ROW Schedule into the MPS after consultation with the PMOC as submitted on July 11, 2011.

The Feeder Schedules "2" consist of the multiple Contract Project Schedules (CPS), which are developed by the contractors and reviewed by the GEC. Summary information from each CPS is analyzed monthly and incorporated into the MPS through several types of milestone activities. During the PE and Final Design phase, the GEC and grantee develop "proposed" construction schedules for each contract. These schedules are then replaced by the contractor/vendor schedules after contracts are executed and the grantee has reviewed and approved each CPS.

The grantee and GEC established a standardized set of milestones that serve as the integration point between the multiple CPS schedules. The milestone types are:

- Pay Milestones
- Interface/Coordination Milestones
- Access Milestones

The grantee/GEC provides these milestones to each contractor (scheduling party) in a standardized template. After the GEC reviews each CPS for conformance and acceptance, the grantee assembles all feeder schedule information in order to update the MPS.

(2) Quality

During the Schedule Review, the PMOC noted several inconsistencies with schedule development and progress update maintenance process, use of file naming conventions, procedures for document transmittal to the PMOC, and general formatting of the project control procedures. The PMOC noted an apparent failure in the application of quality control and quality assurance procedures.

While the schedule submittal packages improved in quality over time, the PMOC still found many opportunities for the grantee to improve its project control deliverables and process as listed in the recommendations below.

(3) Detail

The MPS is presented in a logical manner through the use of an intuitive WBS and descriptive activity tasks and milestones, as requested by the PMOC during its September 2008 schedule review and subsequent reviews during the PE phase. The MPS does not contain many complex or multiple activity relationships. Most of the MPS activities do not contain multiple predecessors or successors as the schedule logic is predominately linear in nature. The schedule detail and activity count has substantially increased since the PMOC's initial Schedule Review in the fall of 2008, but still lacks the detail and logic density that would be expected, given the Project's scope, magnitude, and complexity.

While grantee improvements and revisions are ongoing, the grantee did, nevertheless, provide sufficient information and detail to support the PMOC's Schedule Review.

PMOC Determination

Grantee has satisfied the requirement. Schedule structure, quality, and detail meet the minimal FTA requirements and guidelines. The PMOC has identified several recommendations that must be addressed during the Final Design phase and prior to the grantee's submission on Cost Estimate and MPS refresher documents in support of the FFGA Application.

PMOC Recommendations

(1) The PMOC recommends that the grantee combine all of the various schedule types into one all-encompassing schedule file to make it a true Master Program Schedule. The PMOC does, however, recommend keeping the construction contractor schedules separate and integrating only summary level information from these schedules into the MPS. The Scheduling Procedures and PMP require revision to address any SBS changes.

(2) The grantee's Organizational Breakdown Structure (OBS), specific to the Project Controls department, needs to align with the positions, schedule types, SBS, and references made in all PMP and related project control procedures and contractual requirements.

(3) More detail is needed in the MPS to address construction activity, utility work, real estate acquisition, long-lead material and equipment procurement, and milestone integration among the construction contracts.

(4) The grantee needs to institute a formal schedule file naming convention for the MPS and for all the other Feeder Schedules including each CPS.

(5) The grantee should find a way to use its document management system (CMS) as a means to formally transmit Schedule Submittal Packages to the FTA and PMOC.

7.3.3 Mechanical Correctness

Is the schedule mechanically correct and complete, free of material inaccuracies or incomplete information?

The fundamental element that supports the integrity of a schedule is the internal schedule calendar structure, 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 that 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 the information and logic contained in the schedule is correct and properly represents actual work performed. Once the fundamental check is performed, the schedule can be updated and generated reports can be interpreted with confidence.

The Schedule File Log generated by the scheduling software indicates valuable technical information that must be reviewed every time the schedule is revised or progress-updated. This procedure is a critical quality control method that must be performed.

The Schedule File Log includes data categories for:

- Schedule / Leveling Settings
- Statistics
- Errors and Warning
- Result
- Exceptions

The technical data contained in the Schedule File log are summarized in the table below.

Table 60. Technical Data Summary

Schedule Log Categories with Data	MPS
Statistics	
# of Projects	2
# of Activities	2777
# of Activities Not Started	2331
# in Progress	109
# Completed	337
# of Relationships	4802
# of Constraints	14
Settings	
Scheduling	Yes
Leveling	No
Ignore relationships to / from other projects	No
Make open-ended activities critical	No
Use expected finish dates	Yes
When scheduling progressed activities	Retained Logic
Calculate start-to-start lag from	Early Finish
Define critical activities as	Longest Path
Compute total float as	Finish Float
Calendar for scheduling relationship lag	Predecessor
Errors and Warnings	
# without Predecessors	2
# without Successors	2
Out-of-sequence Activities	7
# with Actual Dates > Data Date	0
Milestone Activities with invalid Relationships	54
Scheduling/Leveling Results	
# of Projects Leveled	1
# of Activities Leveled	2777
Data date	June 24, 2011
Latest calculated early finish	May 1, 2019
Exceptions	
Critical Activities	59
Activities with unsatisfied constraints	1
Activities with unsatisfied constraints	0
Activities with external dates	0

The most common scheduling mistakes are usually indicated in the Errors and Warnings and Exceptions categories. During schedule development and updating, it is common to accidentally omit relationship connections or inaccurately enter progress update information; this report is the best method to prove and correct such mistakes.

(1) Open-ended Activities

Typically, open-ended activities should only include the first start activity and the last finish activity, although it is acceptable to also include milestone activities, usually finish milestones, open ended without a successor. Generally, open-ended activities are caused by an oversight wherein 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 quality control procedures include the review of open-ended activities to ensure that they are properly used and connected to appropriate relationship chains.

The MPS contains four (4) open-ended activities, two start and two finish activities, associated with the MPS and ROW schedules. The ROW schedule open ends should be tied to the MPS to alleviate two of the open ends. This minor revision can be addressed during the next routine monthly schedule update.

Table 61. Open-Ended Activity Count

Open Ended Type	Amount
Predecessor	2
Successor	2
Total	4

(2) Out-of-sequence Progressing

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 the amount of open-ended activities to a minimum is conducive to "good housekeeping" practices and overall a more manageable task during schedule updating. For this reason, many schedule specifications require that only the start and end activities can be open-ended.

The Schedule File Log did not indicate any out-of-sequence progressing.

(3) Activities with Actual Dates > Data Date

When activities are progressed, the early start date is changed to an "Actual Start" date indicated by the letter "A" next to the date. During progress updating, a common mistake is progressing activities beyond the Data Date. Other common mistakes include entering a percent complete in an activity without entering an Actual Start date.

The PMOC noticed numerous similar errors in the grantee's December 2010 MPS and ROW schedules. These activities contained 100% entries without Actual Finish Dates. This error produced incorrect bar chart graphics and causes incorrect schedule calculations using "retained logic".

The grantee corrected these progress update errors in its revised MPS submission.

(4) Milestone Activities with invalid relationships

This refers to certain types of milestones containing invalid predecessor or successor relationships. There are no issues identified at this time.

(5) Settings – Critical Path

The critical path can easily be distorted by 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 affect 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 File Log.

The grantee has demonstrated the correct use of critical path calculations as it has provided reports distinguishing critical path based on TF and longest path.

(6) Constraint Dates

The Schedule File Log indicates the use of one constraint date. The PMOC revised the "Drop Dead Date" completion milestone in the initial MPS submittal constraint date type from "Mandatory Finish" to "Start as Late as Possible" in order to show a more accurate schedule critical path and completion date. The PMOC recommends not using the Mandatory milestone dates as this overrides the schedule logic and usually undermines the schedule integrity during the update process. Furthermore, the upcoming risk analysis cannot be performed with this type of constraint date and, in fact, is best run with no constraint dates.

The PMOC provided the grantee a preliminary findings and recommendations list during the Schedule Review process in January and February 2011. Subsequently, the grantee revisions addressed enough of the PMOC's concerns necessary to complete the Schedule Review and support the determination that the MPS is mechanically sound.

(7) Activity Relationship Ties

Most of the MPS construction activities for each contract are represented by one activity named "Construction." Many of these activities contain durations greater than two years. The construction activity logic ties contain an excessive amount of lag due to Start-Start (SS), Start-Finish (SF), and Finish-Finish (FF) relationship types. These relationship types are used due to the lack of construction activity detail. These types of relationship ties use excessive lags to offset other activities connected with the construction activity.

The grantee incorporated more detail and structure within the construction activities during the OP 34 review, although the PMOC recommends that the grantee continue to expand the schedule detail for real estate acquisition, utilities, and construction activities during the Final Design phase.

<u>PMOC Determination</u>
Grantee has satisfied the requirement. The MPS mechanical soundness meets the minimal FTA requirements and guidelines. The PMOC has identified several recommendations that must be addressed during the Final Design phase and prior to the grantee's submission on Cost Estimate and MPS refresher documents in support of the FFGA Application.

<u>PMOC Recommendations</u>

(1) Incorporate the Permit Schedule, Procurement Schedule and Utility Schedule into the MPS as addressed in the grantee's Project Scheduling Procedure.
(2) The grantee should further reduce the amount of activity logic ties that contain an excessive amount of lag due to Start-Start (SS), Start-Finish (SF), and Finish-Finish (FF) relationship types. Most of this can be accomplished with the addition of more activity detail using Finish-Start (FS) relationship ties, greatly improving the logic.
(3) Expand proposed construction activity detail to a level that better connects the multiple contract and key interface logic points.

7.3.4 Work Breakdown Structure (WBS)

The 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. A typical Master Schedule 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

The data below the summary levels generally provide adequate detail to differentiate between major project segment and contracting areas. The MPS can be sorted by project phase (PE / Design / Construction / Startup & Testing), Project Segment, or by Project Contract, as identified in the Contract Packaging Plan. 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.

The current MPS can be summarized by major work element or contract as illustrated in the figure below.

Figure 21. Work Breakdown Structure (WBS)

WBS / OBS	Orig Dur	Start	Finish
MASTER PROJECT SCHEDULE MILESTONES	2692	15-Jun-05 A	17-Feb-19
General	2692	15-Jun-05 A	17-Feb-19
Contract Milestone	1132	16-Oct-14	16-Feb-19
Guideway Construction Contracts	697	16-Oct-14	19-Jun-17
Station Construction Contracts	884	31-Dec-14	22-May-18
Core Systems DBOM	0	16-Feb-19	16-Feb-19
State Safety and Security Oversight	3	31-Dec-10	04-Jan-11
Safety and Security Certification	3	31-Dec-10	04-Jan-11
READINESS FOR PELIMINARY ENGINEERING	274	15-Sep-08 A	11-Oct-09 A
ADVANCED CONCEPTUAL ENGINEERING	141	15-Sep-08 A	03-Apr-09 A
EIS	915	24-Aug-07 A	30-Mar-11
EIS	873	24-Aug-07 A	19-Jan-11
Preliminary Engineering	647	10-Oct-07 A	30-Mar-11
Permits	1232	30-Jan-09 A	07-Nov-13
Road Map to Final Design	331	24-Feb-10 A	13-Nov-11
FULL FUNDING GRANT AGREEMENT	444	31-Dec-10	12-Sep-12
PROJECT WIDE CONTRACTS	2972	24-Aug-07 A	17-Feb-19
General	2972	24-Aug-07 A	17-Feb-19
MMSM Start Milestone	0	15-Sep-08 A	15-Sep-08 A
City and County of Honolulu	2270	25-Sep-09 A	27-Jan-19
Utilities by Utility Companies (Elec. Telecomm.)	1043	12-Feb-11	11-Feb-15
Program Management Support Consultant	1595	15-Sep-08 A	30-Dec-14
General Engineering Consultant Contract (1st)	663	24-Aug-07 A	26-Feb-11
General Engineering Consultant Contract (2nd)	2704	15-Sep-08 A	17-Feb-19
HDOT Traffic Management Coordination Consultant	1056	04-Mar-11	22-Mar-15
HDOT Coordination Contract	1129	01-Jan-11	30-Apr-15
HDOT Coordination Consultant Oversite	1054	15-Feb-11	28-Feb-15
HDOT State Oversight Agency (SOA)	2054	01-Feb-11	15-Dec-18
Real Estate Consultant	793	02-Feb-11	16-Feb-14
Elevators & Escalators P/I/T/C	1871	19-Mar-11	21-May-18
Owner Furnished Plants and Shrubs	1776	01-Aug-11	21-May-18
MM Finish Milestone	0	17-Feb-19	17-Feb-19
	85	28-Jul-09 A	24-Nov-09 A
MAINTENANCE & STORAGE FACILITY CONTRACT	1507	15-Sep-08 A	16-Jul-14
Maintenance Storage Facility	1507	15-Sep-08 A	16-Jul-14
GUIDEWAY CONTRACTS	2269	15-Sep-08 A	18-Jun-17
West Oahu/Farrington Guideway SEC 1A SB.C	1572	15-Sep-08 A	13-Jan-15
Kamehameha Guideway SEC 1B	1334	19-Nov-09 A	13-Jan-15
Airport Guideway SEC 2 SJ	1464	26-Feb-11	06-Oct-16
City Center Guideway SEC 3 SE,G	1672	20-Jan-11	18-Jun-17
STATION CONTRACTS	2381	14-Sep-09 A	12-Nov-18
Farrington Station SEC 1 SC	1391	14-Sep-09 A	26-Jan-15
West Oahu Station SEC 1A SB	1328	15-Jan-10 A	26-Jan-15
Kamehameha Station SEC 1B SD	2038	20-Jan-11	12-Nov-18
Airport Station SEC 3 SJ	1113	08-Oct-12	11-Jan-17
Dillingham Station SEC 3 SE	1055	07-Mar-13	22-Mar-17
City Center Station SEC 3 SG	1125	06-May-13	27-Aug-17
Kaka'ako Station SEC 3 SG	1091	17-Mar-14	21-May-18
CORE SYSTEMS CONTRACT	2704	15-Sep-08 A	17-Feb-19
Core Systems DBOM	2704	15-Sep-08 A	17-Feb-19

The MPS activity detail is sufficient to determine the type of work that is being performed and is traceable and transparent with the Project Contract Packaging Plan. The MPS can be organized and sorted by contract, project segment, and opening, and is flexible and robust enough to project executive summary level reporting.

PMOC Determination

Grantee has satisfied the requirement. The MPS WBS meets the minimal FTA requirements and guidelines.

PMOC Recommendations
None

7.3.5 Phasing and Sequencing

(a) Does the schedule contain activities that adequately define the entire scope of the work performed?

The scope inclusivity is very transparent with the translation of the Contract Packaging Plan and WBS and activity coding specific to the Corridor Segments and individual contracts. In addition, the MPS is cost loaded by contract and totals to the same amount as the grantee's budget cost estimate.

PMOC Determination
Grantee has satisfied the requirement. The MPS phasing and sequencing meets the minimal FTA requirements and guidelines.

PMOC Recommendations
None

(b) Is the schedule sufficiently developed to determine the validity, stability and reasonableness of the project critical path? Are the near critical paths easily identifiable and reasonable in terms of their logic and proximity to the 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 the schedule milestones and completion dates are realistic and achievable.

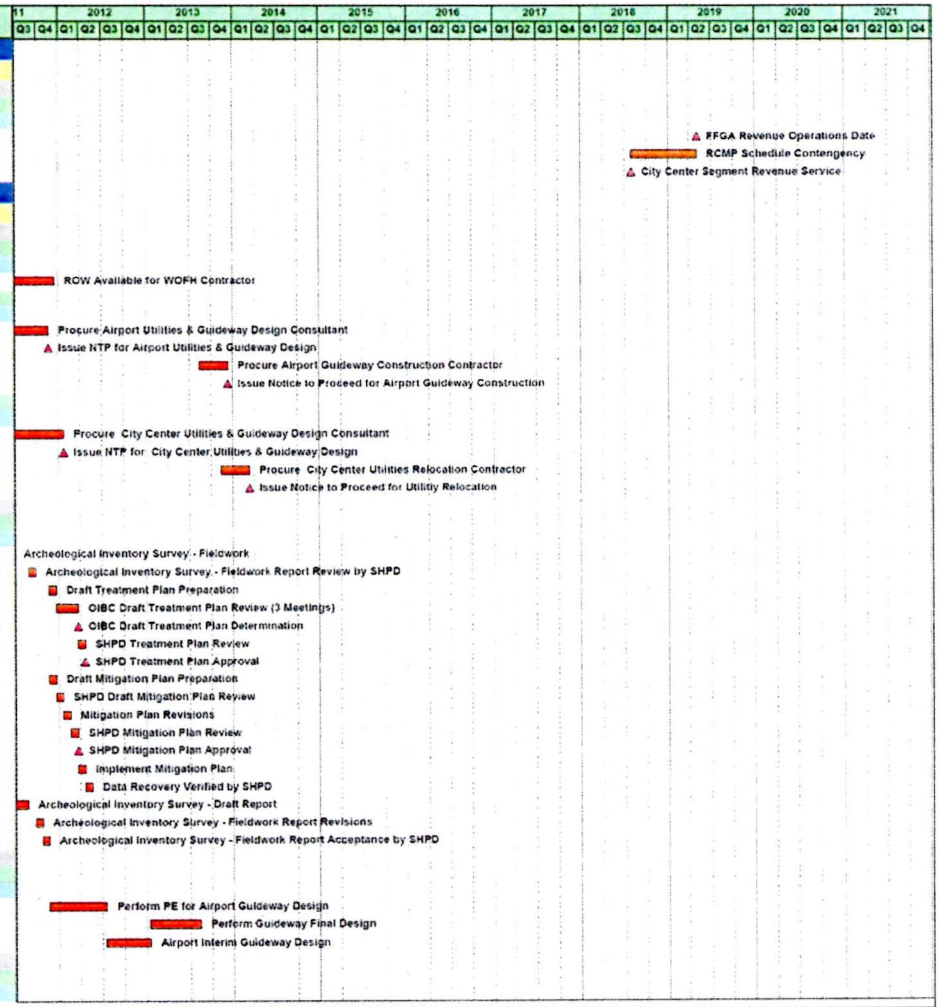
The critical path can easily be distorted by the excessive use of constraint dates, out-of-sequence progressing, open-ended activities, and other improper progress update procedures. A common oversight is the misinterpretation of a schedule's true critical path. Sometimes a schedule calculation caused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

(1) Critical Path

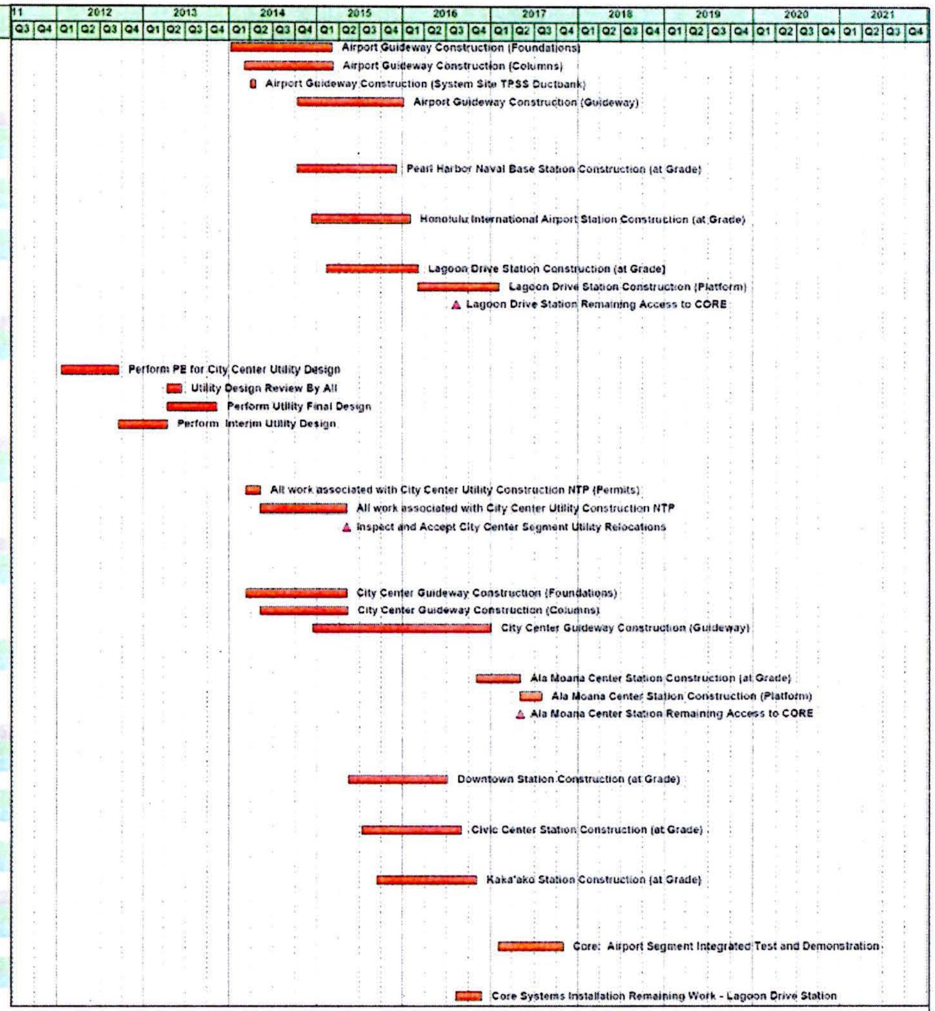
P6 utilizes a critical path calculation method by identifying critical activities either by identifying critical activities according to their total float or by using the software setting "Longest Path." The "Longest Path" calculation is the truest indication of a project's critical path because it discriminates between near-critical activities and the most critical activities. The PMOC generated a critical path "longest path" bar chart report as presented in the figure below.

Figure 22. Longest Path

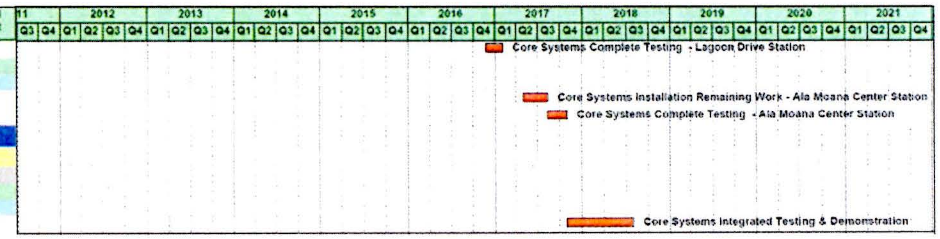
Activity ID	Activity Name	Orig Dur	Start	Finish	Total Float
MASTER PROJECT SCHEDULE MILESTONES		276	29-Jul-18	01-May-19	0
Project Wide Contracts		276	29-Jul-18	01-May-19	0
CCH-100: City and County of Honolulu		276	29-Jul-18	01-May-19	0
CCH Rapid Transit Division		276	29-Jul-18	01-May-19	0
City and County of Honolulu		276	29-Jul-18	01-May-19	0
CCH1070	FFGA Revenue Operations Date	0		01-May-19	0
CCHBUFF	RCMP Schedule Contengency	276	30-Jul-18	01-May-19	0
CCHCCGC	City Center Segment Revenue Service	0		29-Jul-18*	0
PROJECT WIDE CONTRACTS		2471	18-Jan-11 A	31-Oct-17	0
Project Wide Contracts		2471	18-Jan-11 A	31-Oct-17	0
CCH-100: City and County of Honolulu		1142	18-Jan-11 A	13-Mar-14	0
Right Of Way Acquisition West O'ahu/Farrington Highway S...		366	18-Jan-11 A	17-Dec-11	115
Right of Way Acquisition WOFH		366	18-Jan-11 A	17-Dec-11	115
ROWWOF	ROW Available for WOFH Contractor	366	18-Jan-11 A	17-Dec-11	115
Airport Utility and Guideway Design Procurement		1049	26-Jan-11 A	10-Dec-13	0
City and County of Honolulu		1049	26-Jan-11 A	10-Dec-13	0
CCHAIRG	Procure Airport Utilities & Guideway Design ...	180	26-Jan-11 A	20-Nov-11	0
CCHAIRG	Issue NTP for Airport Utilities & Guideway De...	0	21-Nov-11		0
CCHAIRG	Procure Airport Guideway Construction Contr...	120	12-Aug-13	09-Dec-13	0
CCHAIRG	Issue Notice to Proceed for Airport Guideway ...	0	10-Dec-13		0
City Center Utilities and Guideway Design Procurement		992	25-Jun-11	13-Mar-14	0
City and County of Honolulu		992	25-Jun-11	13-Mar-14	0
CCHCCGC	Procure City Center Utilities & Guideway Des...	212	25-Jun-11	22-Jan-12	0
CCHCCGC	Issue NTP for City Center Utilities & Guidewa...	0	23-Jan-12		0
CCHCCGC	Procure City Center Utilities Relocation Cont...	120	13-Nov-13	12-Mar-14	0
CCHCCGC	Issue Notice to Proceed for Utility Relocation	0	13-Mar-14		0
MM-910: General Engineering Consultant (Final Design and ...		330	25-Jan-11 A	19-May-12	453
General Construction Manager/General Engineering Consul...		330	25-Jan-11 A	19-May-12	453
City and County of Honolulu		330	25-Jan-11 A	19-May-12	453
MM910 - 1	Archeological Inventory Survey - Fieldwork	1	25-Jan-11 A	24-Jun-11	453
MM910 - 1	Archeological Inventory Survey - Fieldwork R...	30	24-Aug-11	22-Sep-11	453
MM910 - 1	Draft Treatment Plan Preparation	30	22-Nov-11	21-Dec-11	453
MM910 - 1	OIBC Draft Treatment Plan Review (3 Meetings)	90	22-Dec-11	20-Mar-12	453
MM910 - 1	OIBC Draft Treatment Plan Determination	0		20-Mar-12	453
MM910 - 1	SHPD Treatment Plan Review	30	21-Mar-12	19-Apr-12	453
MM910 - 1	SHPD Treatment Plan Approval	0		19-Apr-12	453
MM910 - 1	Draft Mitigation Plan Preparation	30	22-Nov-11	21-Dec-11	453
MM910 - 1	SHPD Draft Mitigation Plan Review	30	22-Dec-11	20-Jan-12	453
MM910 - 1	Mitigation Plan Revisions	30	21-Jan-12	19-Feb-12	453
MM910 - 1	SHPD Mitigation Plan Review	30	20-Feb-12	20-Mar-12	453
MM910 - 1	SHPD Mitigation Plan Approval	0		20-Mar-12	453
MM910 - 1	Implement Mitigation Plan	30	21-Mar-12	19-Apr-12	453
MM910 - 1	Data Recovery Verified by SHPD	30	20-Apr-12	19-May-12	453
MM910 - 1	Archeological Inventory Survey - Draft Report	60	25-Jun-11	23-Aug-11	453
MM910 - 1	Archeological Inventory Survey - Fieldwork R...	30	23-Sep-11	22-Oct-11	453
MM910 - 1	Archeological Inventory Survey - Fieldwork R...	30	23-Oct-11	21-Nov-11	453
FD-430: Airport Segment Utility and Guideway, Final Design		630	21-Nov-11	11-Aug-13	0
Airport Utility and Guideway Design Procurement		630	21-Nov-11	11-Aug-13	0
Airport Guideway Contract (27,140LF)		630	21-Nov-11	11-Aug-13	0
FD430 - 1C	Perform PE for Airport Guideway Design	240	21-Nov-11	17-Jul-12	0
FD430 - 1C	Perform Guideway Final Design	210	14-Jan-13	11-Aug-13	0
FD430 - 1C	Airport Interim Guideway Design	180	18-Jul-12	13-Jan-13	0
DBB-460: Airport Guideway Construction		727	09-Jan-14	05-Jan-16	0
Airport Utility and Guideway Design Procurement		727	09-Jan-14	05-Jan-16	0
Airport Guideway Contract (27,140LF)		727	09-Jan-14	05-Jan-16	0



Activity ID	Activity Name	Orig Dur	Start	Finish	Total Float
DB460 - 1(	Airport Guideway Construction (Foundations)	420	09-Jan-14	04-Mar-15	0
DB460 - 1(	Airport Guideway Construction (Columns)	365	10-Mar-14	09-Mar-15	0
DB460 - 1(	Airport Guideway Construction (System Site ...	20	01-Apr-14	20-Apr-14	141
DB460 - 1(	Airport Guideway Construction (Guideway)	450	13-Oct-14	05-Jan-16	0
DBB-470: Airport Stations (4)		845	13-Oct-14	03-Feb-17	0
Pearl Harbor Naval Base Station		420	13-Oct-14	06-Dec-15	0
Airport Guideway Contract (27,140LF)		420	13-Oct-14	06-Dec-15	0
DBB470 -	Pearl Harbor Naval Base Station Construction...	420	13-Oct-14	06-Dec-15	0
Honolulu International Airport Station		420	12-Dec-14	04-Feb-16	0
Airport Guideway Contract (27,140LF)		420	12-Dec-14	04-Feb-16	0
DBB470 -	Honolulu International Airport Station Constr...	420	12-Dec-14	04-Feb-16	0
Lagoon Drive Station		725	10-Feb-15	03-Feb-17	0
Airport Guideway Contract (27,140LF)		725	10-Feb-15	03-Feb-17	0
DBB470 -	Lagoon Drive Station Construction (at Grade)	390	10-Feb-15	05-Mar-16	0
DBB470 -	Lagoon Drive Station Construction (Platform)	335	06-Mar-16	03-Feb-17	0
DBB470 -	Lagoon Drive Station Remaining Access to C...	0	13-Aug-16		0
FD-530: City Center Guideway and Ala Moana Station (partia...		660	23-Jan-12	12-Nov-13	0
City Center Utilities and Guideway Design		660	23-Jan-12	12-Nov-13	0
City Center Guideway Contract (23,580LF)		660	23-Jan-12	12-Nov-13	0
FD530 -10	Perform PE for City Center Utility Design	240	23-Jan-12	18-Sep-12	0
FD530 -10	Utility Design Review By All	60	17-Apr-13	15-Jun-13	0
FD530 -10	Perform Utility Final Design	210	17-Apr-13	12-Nov-13	0
FD530 -10	Perform Interim Utility Design	210	19-Sep-12	16-Apr-13	0
DBB-550: City Segment Utility Relocations		420	13-Mar-14	06-May-15	0
City Center Utilities Contract		420	13-Mar-14	06-May-15	0
City Center Guideway Contract (23,580LF)		420	13-Mar-14	06-May-15	0
DBB550 -1	All work associated with City Center Utility C...	60	13-Mar-14	11-May-14	0
DBB550 -1	All work associated with City Center Utility C...	360	12-May-14	06-May-15	0
DBB550 -1	Inspect and Accept City Center Segment Utilit...	0		06-May-15	0
DBB-560: City Center Guideway and Ala Moana Station (part...		1237	13-Mar-14	31-Jul-17	0
City Center Guideway Construction Contract		1027	13-Mar-14	02-Jan-17	0
City Center Guideway Contract (23,580LF)		1027	13-Mar-14	02-Jan-17	0
DBB560 -1	City Center Guideway Construction (Foundati...	420	13-Mar-14	06-May-15	0
DBB560 -1	City Center Guideway Construction (Columns)	365	12-May-14	11-May-15	0
DBB560 -1	City Center Guideway Construction (Guideway)	750	15-Dec-14	02-Jan-17	0
Ala Moana Center Station Finishes		270	04-Nov-16	31-Jul-17	0
City Center Guideway Contract (23,580LF)		270	04-Nov-16	31-Jul-17	0
DBB575 -1	Ala Moana Center Station Construction (at Gr...	180	04-Nov-16	02-May-17	0
DBB575 -1	Ala Moana Center Station Construction (Platf...	90	03-May-17	31-Jul-17	0
DBB575 -1	Ala Moana Center Station Remaining Access ...	0	04-May-17		0
DBB-575: Kaka'ako Stations (4), Including Ala Moana Statio...		540	14-May-15	03-Nov-16	0
Downtown Station		420	14-May-15	06-Jul-16	0
City Center Guideway Contract (23,580LF)		420	14-May-15	06-Jul-16	0
DBB572 -1	Downtown Station Construction (at Grade)	420	14-May-15	06-Jul-16	0
Civic Center Station		420	13-Jul-15	04-Sep-16	0
City Center Guideway Contract (23,580LF)		420	13-Jul-15	04-Sep-16	0
DBB575 -1	Civic Center Station Construction (at Grade)	420	13-Jul-15	04-Sep-16	0
Kaka'ako Station		420	11-Sep-15	03-Nov-16	0
City Center Guideway Contract (23,580LF)		420	11-Sep-15	03-Nov-16	0
DBB575 -1	Kaka'ako Station Construction (at Grade)	420	11-Sep-15	03-Nov-16	0
DBOM-920: Core Systems DBOM		445	13-Aug-16	31-Oct-17	0
Airport Guideway Core Systems Installation		270	04-Feb-17	31-Oct-17	0
Core Systems		270	04-Feb-17	31-Oct-17	0
DBOM - 11	Core: Airport Segment Integrated Test and D...	270	04-Feb-17	31-Oct-17	0
Lagoon Drive Station		175	13-Aug-16	03-Feb-17	0
Core Systems		175	13-Aug-16	03-Feb-17	0
DBOM - 11	Core Systems Installation Remaining Work - ...	105	13-Aug-16	25-Nov-16	0



Activity ID	Activity Name	Orig Dur	Start	Finish	Total Float
DBOM - 1£	Core Systems Complete Testing - Lagoon Dri...	70	26-Nov-16	03-Feb-17	0
Ala Moana Center Station Finishes		181	04-May-17	31-Oct-17	0
Core Systems		181	04-May-17	31-Oct-17	0
DBOM -22	Core Systems Installation Remaining Work - ...	100	04-May-17	11-Aug-17	0
DBOM -22	Core Systems Complete Testing - Ala Moana ...	81	12-Aug-17	31-Oct-17	0
No Major Milestones		271	01-Nov-17	29-Jul-18	0
Project Wide Contracts		271	01-Nov-17	29-Jul-18	0
DBOM-920: Core Systems DBOM		271	01-Nov-17	29-Jul-18	0
City Center Guideway Core Systems Installation		271	01-Nov-17	29-Jul-18	0
Core Systems		271	01-Nov-17	29-Jul-18	0
DBOM -22	Core Systems Integrated Testing & Demonstr...	271	01-Nov-17	29-Jul-18	0



Several versions of the MPS generated a discernible critical path and partially extended it through a logical sequence of activities. The critical path did not accurately reflect the 2011 and expected 2012 critical work activities related to the PMOC risk assessment, Financial Plan preparation and review, entry into the Final Design phase, and FFGA application work activity.

It did, however, reflect what the grantee and the PMOC expect will be the construction critical path activities that extend through the City Center Guideway and stations and Core Systems contracts. The CSC includes all system integration, vehicle procurement, and automation in the Maintenance Storage Facility yard. The CSC has critical interface points with the completion of station construction, track construction on the guideway, and MSF operations.

The critical path was corrected with the latest MPS version that produces a discernible critical path that extends through project activities the PMOC would expect are most critical.

(2) Near Critical Paths

Near critical paths are, simply put, the chains of activities that contain the least amount of total float other than the longest critical path. It is possible for these activity chains to overtake the critical path activities if the critical path activities are progressed and completed more rapidly than those of the near critical paths. Management should always focus on the critical path but not lose sight of the near critical paths as they could eventually become more critical towards the end of the project than the critical path. The result is referred to as merge bias, an effect of excessive logic density and total float proximity of near critical paths. This typically occurs when schedule compression pushes an excessive number of activity chains against the project completion milestone, thereby exceeding resource availability and causing project delay.

PMOC Determination

Grantee has satisfied the requirement. The MPS critical path is discernible and meets the minimal FTA requirements and guidelines. The PMOC has identified several recommendations that must be addressed during the Final Design phase and prior to the grantee's submission on Cost Estimate and MPS refresher documents in support of the FFGA Application.

PMOC Recommendations

(1) Additional activity detail is necessary to more accurately represent document preparation, risk assessment, financial capacity plan preparation and review, entry into Final Design, and FFGA application activities.

(c) Are the schedule assumptions for project phase durations reasonable?

The grantee provided a Basis of Schedule at the request of the PMOC in order to support the general schedule assumptions. The BOS explains all schedule assumptions for the schedule structure, WBS and activity codes, calendars, crew sizing and resource limitations, hours per day, shifts per day, labor, material and equipment resource constraints, and production, inefficiency, and contingency factors which support the calculation of activity durations.

The project is planned to be delivered in four design and construction segments, which are listed starting at the west end of the 21-mile corridor and proceeding easterly, terminating at Ala Moana Center:

- Segment 1 - West Oahu / Farrington Highway (7 stations)
- Segment 2 - Kamehameha Highway (2 stations)
- Segment 3 - Airport (4 stations)
- Segment 4 - City Center (8 stations)

The grantee intends to open the system incrementally. The first opening is for the West Oahu/ Farrington Highway and Kamehameha Highway Segments (1A+B), scheduled for late 2015; the second opening is the Airport Segment scheduled for late 2017, and the last opening is for City Center, scheduled for late 2019. The PMOC risk assessment and the application for FFGA will focus only on the 2019 project completion milestone. By doing so, the FTA and PMOC will monitor the "entire" Project critical path and not contract or segment critical paths specific to the individual incremental system opening milestones. The interim opening milestones will temporarily increase resource demand for core systems, MSF, and operations while the remaining segments remain under construction. Likewise, it will cause some work inefficiencies for hardscape, landscape, MSF, guideway, and station punchlist activities on or adjacent to each operating segment(s).

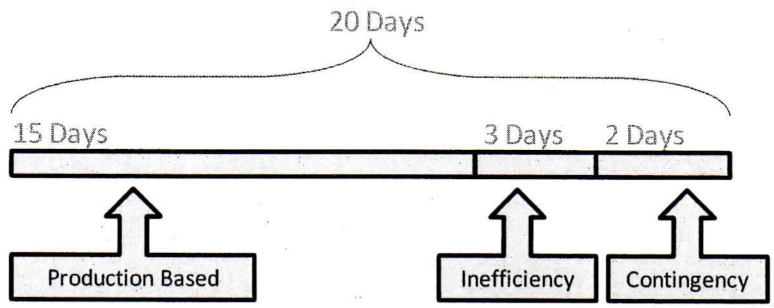
The grantee has established a standardized WBS and activity coding structure that allows all contract and consultant (feeder) schedules to roll-up into the MPS, using an organization and sorting structure flexible and robust enough to capture a variety of contract packaging plan report layouts by contract, segment, or operating segment.

The BOS describes the assumptions used to develop the activity durations. The PMOC recommended that the grantee calculate each activity duration based on three categories:

- Production
- Inefficiency
- Contingency

For example, if an activity contains an original duration of twenty (20) days, then the BOS would list the breakdown of how the duration was derived.

Figure 23. Activity Duration Breakdown



The PMOC has carefully reviewed the assumptions for each activity duration as part of the Schedule Review and also in preparation for the risk assessment which requires the independent assignment of risk uncertainty durations for each activity; e.g., Best Case, Most Likely, and Worst Case durations.

The Project's remaining life cycle phases include Final Design, construction, and startup and testing. The Final Design phase is somewhat unconventional to FTA funded transit projects, as it contains a mixture of both design-build and design-bid-build contract delivery methods. Primarily for this reason, the PMOC is treating the Final Design phase as the construction phase, since a significant amount of construction will be executed concurrently with definitive design activities specific to the design-bid-build contracts.

The most uncertainty lies within the current phase, which requires a significant number of FTA requirements and PMOC reviews for entry into Final Design and FFGA application activity. The grantee's primary challenge is related to achieving a sound post-risk-assessment Financial Plan review while maintaining adequate technical capacity and capability.

To date, the grantee has not met a milestone date on its schedule, partially due to aggressive project advancement management techniques, uncontrolled outside political influences, and technical capacity (recruiting-hiring -retention) challenges. The PMOC has recommended that the grantee continually ask the FTA Region staff for input and validation of all FTA review and approval activities included in the MPS. The grantee and the FTA/PMOC are currently using a "Roadmap" document to track activities, durations, and progress information specific to Entry into Final Design Phase. This document is reviewed by both parties on a no-less-than-monthly basis and has proven to be a good communication tool.

Though a dynamic process, the grantee has demonstrated that the MPS and BOS contain a sufficient amount of duration (production, efficiency, contingency) for each project life cycle phase. The PMOC risk assessment will account for contingencies, or lack thereof, for the current planning and Final Design phases.

<u>PMOC Determination</u>
Grantee has satisfied the requirement. The MPS phase durations and basis of durations meet the minimal FTA requirements and guidelines.

PMOC Recommendations
None

(d) Are project schedule structure and sequencing logical and reasonable?

The schedule structure is addressed in Section 7.3.2.

Regarding the schedule sequencing, the MPS contains all of the contracts, organized and sorted as described in the Contract Packaging Plan. The design and construction sequence along the corridor starting at the west and proceeding easterly is portrayed well in the schedule. The MPS contains a logical sequence of activities that represent the interface between the individual contracts and segments at a summary level.

PMOC Determination
Grantee has satisfied the requirement. The MPS structure and sequencing meets the minimal FTA requirements and guidelines.

PMOC Recommendations
None

(e) Is sequencing, through the use of predecessors and successors, identified for all material tasks? Is the work sequenced efficiently?

Initially the MPS does not contain enough detail at the construction task level to adequately represent major material and equipment procurement. The MPS does include a sufficient number of activities to represent procurement of services (bid and award) for rail vehicles, fare collection, and design-build and design-bid-build delivery methods.

The activity relationship logic (predecessors and successors) and lags were determined to be fundamentally and mechanically sound, as addressed in the Technical Review Item (4) above. A significant portion of the alignment is elevated guideway and the grantee concentrated sequencing and contract packaging plan based on the continuous and repetitive sequencing of guideway construction (piers, columns, guideway precast concrete segment casting and placement, stations platforms, trackwork and systems). The work sequence is based on the optimization of gantry cranes for precast concrete placement. Additionally, the grantee and GEC have placed an emphasis on construction contractor staging and precast yard availability to support the optimization of guideway construction. The construction is adequately sequenced in accordance to the budget cost estimate constraints.

PMOC Determination
Grantee has satisfied the requirement. The MPS sequencing of material tasks meets the minimal FTA requirements and guidelines. The PMOC has identified several recommendations that must be addressed during the Final Design phase and prior to the grantee's submission on Cost Estimate and MPS refresher documents in support of the FFGA Application.

PMOC Recommendations

(1) More material tasks detail should be incorporated into the MPS.

(f) Is the use of constraints identifiable, justified and reasonable?

The utilization of constraint dates is addressed in the Technical Review Item 3, above, to support the PMOC mechanical and fundamental soundness review. While constraint dates can be successfully managed when used properly, a Schedule Risk Analysis cannot be performed with the use of constraint dates. The PMOC has consistently recommended that the grantee should avoid using constraint dates and prohibit its sub-consultants and contractors from using them.

(g) Are work areas identified in construction and properly sequenced from the appropriate predecessor activities?

The PMOC response is included in Item (e) above.

7.3.6 Schedule Hierarchy

(a) Is the top-level summary included to facilitate understanding of phases or groups of activities?

(b) Is the schedule detail beneath the "hammock" or summary level task based?

These items are addressed in Section 7.3.4.

7.3.7 Cost/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 as 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 to 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 analysis and management decisions are evaluated for remaining work to be performed.

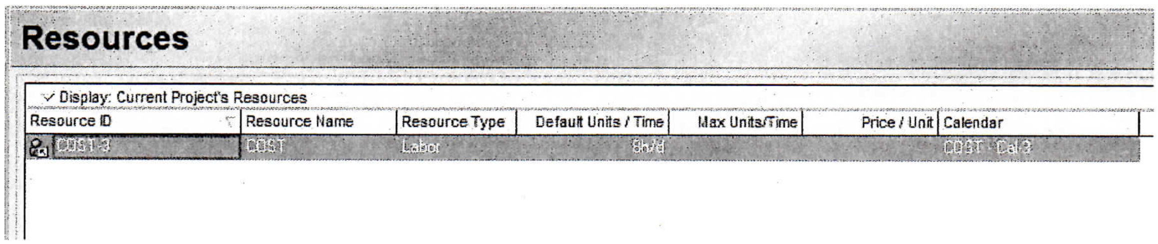
The resource library also may contain budget and cost information. Designers and construction contractors generate and submit the cost-loaded information with monthly progress updates to support their monthly payment requests. An adequately-resourced schedule combined with earned value management (backward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

The MPS resource library contains one resource named "COST." This resource is used to populate cost amounts in some summary level activities. The project costs correctly total the cost amount indicated in the Project Contract Packaging Plan and can be tracked by contract or summarized by project segment.

The MPS resource library also contains one material resource named "COST" (Figure 24). This resource is defined as $1/unit and its parameters are set to calculate costs from assigned units; however, total costs appear to be assigned to each activity without utilizing the software's calculation feature. In addition, actual costs appear to be manually entered in lieu of automatic calculation based on activity percent complete.

No other resources are used in the MPS.

Figure 24. Resource Library



The PMOC has determined that the MPS does not contain a true resource library and, therefore, is not resource loaded. The PMOC recommends that the grantee require resource loading for all construction project schedules and include this requirement within the contractual documents, specifications and General Conditions. The resource assignments will greatly assist with activity duration calculations, claim avoidance, and mitigation reviews for construction contracts. Resource loading is not preferred, cannot be effectively used in summary schedules such as the MPS, and is best used for more detailed construction schedules such as the CPS schedules.

Figure 25. Program Cost Distribution

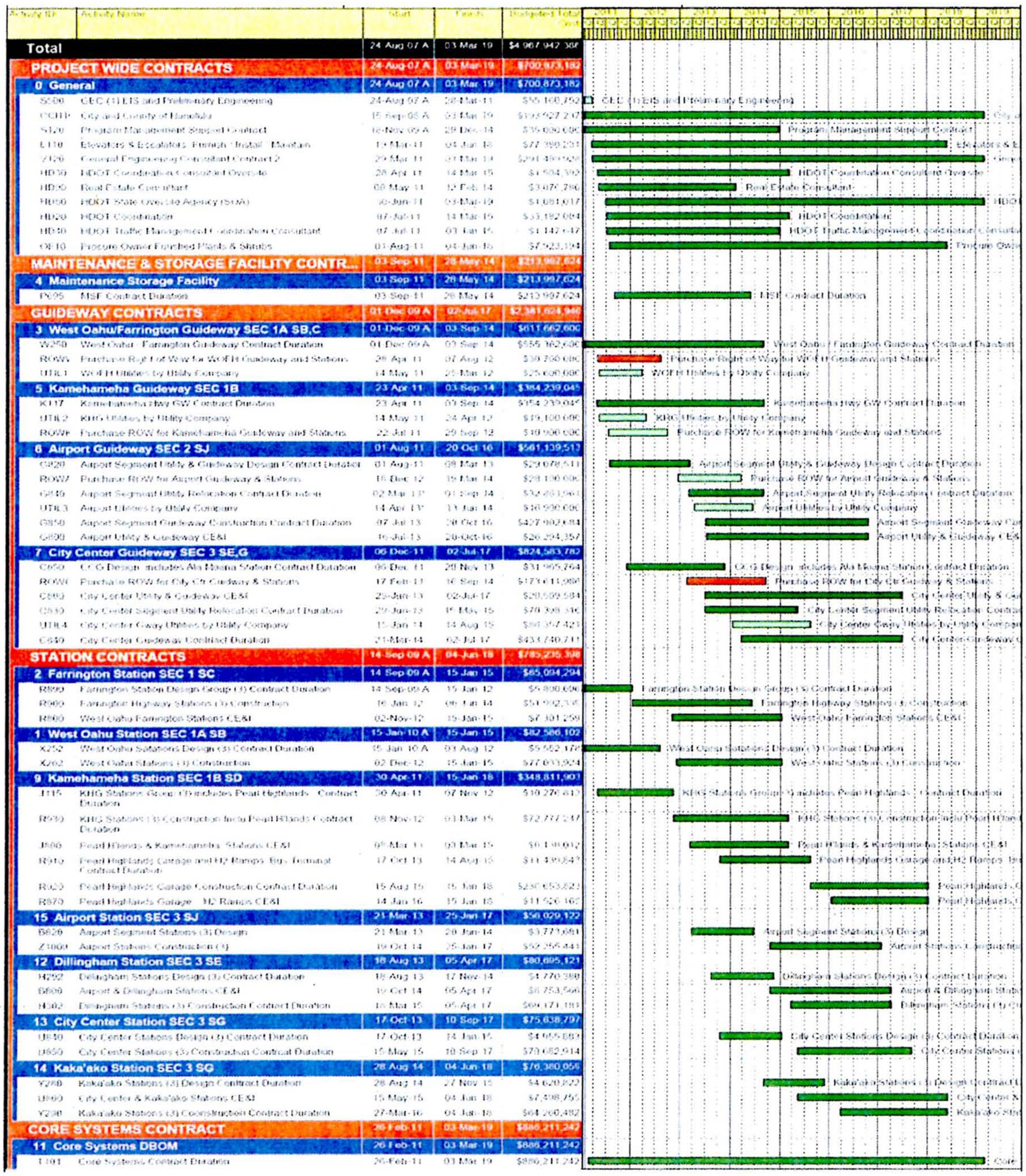
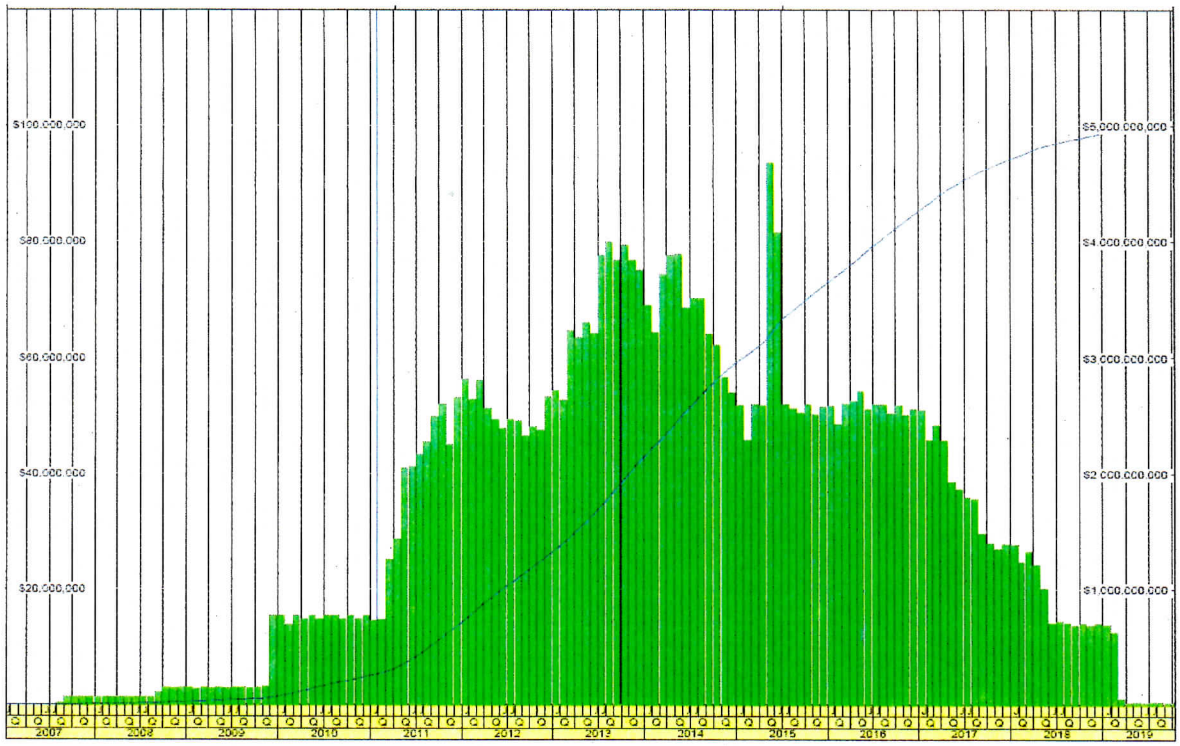


Figure 26. Budgeted Cost Expenditure Profile



PMOC Determination

Grantee has satisfied the requirement. The MPS is cost loaded but not resource loaded. The PMOC believes resource loading is more suitable for detailed CPM networks such as the construction project schedules and that the grantee should make sure it requires the contractors to use resource loading. The PMOC has identified several recommendations that must be addressed during the Final Design phase and prior to the grantee's submission on Cost Estimate and MPS refresher documents in support of the FFGA Application.

PMOC Recommendations

(1) Ensure that resource and cost loading requirements are included in all construction contractor contractual requirements.

7.3.8 Schedule Contingency

Discuss thoroughly the exposed and hidden (patent and latent) contingency in the schedule, including amounts and how it is expressed in the schedule.

(a) Is the schedule sufficiently developed to determine the validity, stability and reasonableness of the project critical path? Are the near critical paths easily identifiable and reasonable in terms of their logic and proximity to the project critical path?

(1) Contingency

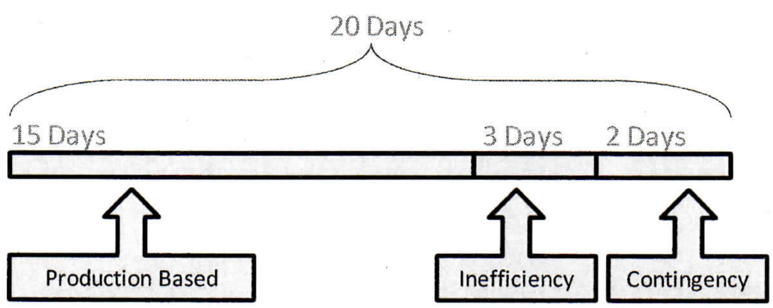
The grantee's Basis of Project Scheduling Rev. 0, dated 02-17-11, states that the MPS, IPS and all Contract Project Schedule activities include 12% contingency and that the contract durations are based on the "most probable duration," although, the grantee did not provide sufficient documentation justifying the 12% contingency factor.

The MPS contains one calendar that is based on calendar days (7 days per week) and includes holidays. The sole use of one 7 day per week calendar precludes the allowance of non-work periods that could be considered contingency reserves. For example, if the grantee used a 5 day per week calendar for construction activity, Saturdays could be considered a reserve day (contingency).

For the first seven schedule submittal packages, the grantee did not provided adequate documentation justifying how contingency amounts were derived and applied to all activity durations in the MPS. As a consequence, the PMOC derived such contingencies for the risk assessment.

In previous schedule workshops conducted on site, the PMOC recommended that the grantee calculate each activity duration based on three categories, production, inefficiency, and contingency. For example, Figure 27 shows how an activity with an original duration of twenty (20) days could be divided into those three categories, which would be supplemented by an explanation describing the justification and calculation for each duration.

Figure 27. Activity Duration Breakdown



In this example the latent/patent contingency can be expressed as two days.

The grantee adequately addressed contingency as documented in the Basis of Schedule submitted to the PMOC on July 2, 2011; see eighth Schedule Submittal Package.

(2) Critical Path

The critical path and near critical paths are discussed under Item (b) in Section 7.3.5.

PMOC Determination
Grantee has satisfied the requirement. The MPS incorporation of contingency as documented in the Basis of Schedule meets the minimal FTA requirements and guidelines.

PMOC Recommendations
None

(b) Is the use of constraints identifiable and reasonable?

The use of constraint dates is not relevant to schedule contingency unless manipulated with purpose to undermine the project schedule float. The utilization of constraint dates is addressed in the Section 7.3.3 and Item (f) in Section 7.3.5.

7.3.9 Schedule Control Methods and Tools

The PMOC conducted a detailed review and evaluation of the grantee's project management control system to determine whether the grantee was efficient and effective in implementing the project. The PMOC also evaluated the grantee's project control system and organization as part of its Technical Capacity and Capability Review and Technical Schedule Review to support the grantee's request to enter the Final Design Phase. Parts of these reviews included an evaluation of the tools, procedures, organization, and roles and responsibilities of the project control positions. The following topics address each of these items.

(1) Tools

The grantee is using Oracle's Primavera Project Manager scheduling software as mentioned in Item 1, above. It is also using Contract Manager, formerly Primavera Expedition, as its document management system. The grantee's computer hardware, server, supporting software packages, and interfaces with the grantee's existing repositories that support the project controls and project management reporting are adequate for the Project. The grantee intends to intertwine the Project Controls and Document Management systems with its existing system after the project is completed.

The most powerful schedule management tool is the scheduling software being used. This tool, like all tools, must be used properly. 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 manipulation of software settings to favor the end user.

Special attention is needed to ensure that schedule calculations accurately generate and avoid distorting schedule forward and backward pass CPM data. The scheduling software calculation settings should be monitored to ensure that they are consistently used and not randomly changed or manipulated, especially on large programs that require multiple design and or construction schedules. The grantee should make sure all software settings are standardized and consistently used by all scheduling parties on the Project. The contractual documents should clearly state which settings should be used.

The following table describes the standard default settings used within the MPS schedule software. The contract requirements do not stipulate which scheduling software settings are to be used, although the PMOC recommends that all scheduling parties consistently use the default settings as "marked" in the table below.

Table 62. Software Settings

Description	Settings		
Logic Calculation	Retained ☒	Progress Override ☐	
Start-to-Start Lag from:	Actual Start ☐	Early Start ☒	
Schedule Durations:	Contiguous ☒	Interruptible ☐	
Show Open ends as:	Critical ☐	Non-critical ☒	
Calculate total float as:	Most Critical ☐	Start float ☐	Finish float ☒
Interproject relationships:	With update ☐	Without update ☐	Ignore ☒
AutoCost Rules: % Complete link to RD	Yes ☒	No ☐	

The PMOC reviewed the schedule and observed that all settings are in compliance with industry standards of care. The grantee does not address software settings in the Project Schedule specifications or General Conditions, although the PMOC has recommended that it do so.

(2) Control Methods and Procedures

Schedule Control begins with the establishment of "standardized" project control, contractual requirements, and conformance procedures. *Requirements* refer to the contract terms and conditions, specifications, procedures, and guidelines associated with the individual contracts for the vendors, contractors, and consultants on 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. The requirements and standards are typically set by the owner during the PE and Final Design phases, when the project management control systems are 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 that it can be summarized and tailored for the appropriate reporting audiences.

Schedule contractual conformance by all parties is not only a necessity, but 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 project's successful planning and timely execution.

The PMOC reviewed all of the project control procedures submitted by the grantee in January and February 2011. The grantee's Project Scheduling Procedure "4.PC-04, Revision 0" best addresses the individual Contract Project Schedules (CPS) and how that information is reviewed and approved, analyzed, and incorporated into the Integrated Project Schedule and ultimately integrated and summarized into the MPS.

The grantee has recently begun updating the IPS and MPS schedules on a monthly basis and has issued a significant number of project control procedures this year. The PMOC has provided procedure document comments and has reviewed the grantee's schedule work performance monitoring and schedule progress update process and deliverables. The process and procedures remain under revision and will continue to be revised to support TC&C and the grantee's entry into the Final Design phase. The grantee has "baselined" the MPS, but it will need to do so again, once the grantee revises the MPS in accordance to the FTA PMOC recommendations stemming from this Schedule Review. The PMOC also recognizes the need to complete schedule report file layout and template development in order to begin routine progress updates, critical path analysis, and reporting to the appropriate reporting audiences.

(3) Organizational Breakdown Structure (OBS), Roles and Responsibilities

The OBS is included in the latest version of the PMP. The PMOC reviewed the OBS and interviewed key management staff to support the Technical Capacity and Capability Review. The PMOC also provided review comments on the PMP and Project Control procedure document during the Schedule Review process in a concurrent effort to support the grantee's request to enter the Final Design phase.

The grantee project controls organization and key management staff members continue to expand the detail and improve the quality of the project schedule and related procedures, although the PMOC has identified a significant amount of concern related to both technical capacity and capability. Capacity issues are mostly associated with the Human Resource department challenges of recruiting and hiring the right people for the key management positions across the organization, not just in project controls. Impeding factors include salary limitations and geographical isolation from the mainland. The PMOC has increased monitoring and general oversight of the grantee's project controls organization and its ability to successfully develop and effectively implement Project Controls. As a result of the schedule review and the PMOC TC&C review, the grantee has made several revisions to the OBS and, more specifically, to the Project Controls department and how it interacts with the GEC project controls support staff.

The grantee has not established a document that specifically addresses and thoroughly explains the organization's key management position descriptions, roles, and responsibilities. The PMP partially addresses the position roles and responsibilities, but not to the level recommended by the PMOC. In November, 2010 and January and February, 2011, the PMOC referenced the Project Management Institute's Body of Knowledge (PMBOK) information specific to Responsibility Assignment Matrix (RAM) and how it combines the Work Breakdown Structure (WBS) with the Organizational Breakdown Structure (OBS) to produce a RAM in order to distinguish "who does what."

When the program responsibilities are defined, the WBS and OBS are merged, forming a Responsibility Assignment Matrix. The RAM matches deliverables with the people who are responsible for them. For every piece of the program/project, the matrix shows who needs to contribute what for the project to be completed. The primary steps for constructing a RAM are:

- Define the Deliverables
- Identify the people/positions involved (OBS)
- Create the Responsibility Matrix
- Communicate

Many factors can contribute to the underperformance of a team, but, unless responsibilities and accountabilities are clear, there is a significant risk that problems will arise. The following table provides a means to clearly communicate who is responsible for what.

Table 63. Responsibility Assignment Matrix (RAM)

	WBS: Deliverable #1		WBS: Deliverable #2	
	Sub task	**Sub task**	**Sub task**	**Sub task**
OBS: Person / Department #1	C	R		I
OBS: Person / Department #2	A	R	I	C
OBS: Person / Department #3	I			R
Etc.				

P = Participant **A** = Accountable **R** = Review **I** = Input required **S** = Sign off **C** = Consulted

- **Role** – A program or project role is an assignment on the program/project team.
- **Responsibilities** – Program/project authority to take action, make decisions, and initiate action.
- **Area of Responsibility** – Areas identified as important to the success of the program/project.
- **Deliverable** – A work product produced during the course of the program/project. There are two categories of Deliverables: 1) Deliverables that lead to a finished product (i.e., requirements document) and 2) deliverables used to manage the program/project (e.g., work breakdown structure planning document).

During the fall of 2010, the grantee initially agreed to include a RAM in the next PMP version but later decided against it. During the PMOC February 7-11, 2011 site visit, the grantee stated that it had purposely omitted specific roles and responsibilities, as including them may have caused confusion and created more chaos among staff members. The PMOC disagreed and stated that definitive position descriptions, roles, and responsibilities would prevent staff member ambiguity and misunderstanding and would also benefit new employee orientation and knowledge transfer (training) course material.

The grantee has developed a meaningful and detailed WBS, although it has opportunities to increase the detail and thoroughness of the OBS with position descriptions, roles, and responsibilities. Likewise, the grantee has an opportunity to greatly improve its PMP and training materials with the addition of a RAM that links to a Table of Deliverables.

PMOC Determination
Grantee has satisfied the requirement. The MPS schedule methods and controls meet the minimal FTA requirements and guidelines. The PMOC has identified several recommendations that must be addressed during the Final Design phase and prior to the grantee's submission on Cost Estimate and MPS refresher documents in support of the FFGA Application.

PMOC Recommendations

(1) The grantee should develop a responsibility assignment matrix and include it in the PMP and relevant companion documents.
(2) The key project control positions should be consistently referred to in the PMP and companion documents and project control procedures.
(3) The grantee project controls department should be co-located with all GEC project control management support staff (not including the GEC Resident Engineer team field staff, once construction begins).
(4) The grantee should implement all schedule management procedures and guidelines as documented in the PMP and its respective project control companion documents.
(5) The grantee should define a standardized reporting format and distribution for all Project Scheduling parties.
(6) The grantee should standardize all scheduling software settings and incorporate the requirements in all construction contractual documents.

7.4 Project Activities and Constraints

The following section includes a continuation of Schedule Review subcategories as listed in OP 34.

7.4.1 Schedule Sequencing

(a) Does the schedule follow an expected work sequence?
(b) That occur concurrently identified and reasonably sequenced in the schedule to assure similar work activities can be accomplished with available labor and materials?

The MPS, the Basis of Schedule, and the project Contract Packaging Plan address 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. A majority of the alignment is on an overhead guideway structure requiring very repetitive construction installation of piers, columns, bent caps, precast units, deck work and track work.

Construction contractor crewing requirements are based on the optimization of gantry erection systems for construction of the aerial guideway structure. The sequencing will generally proceed in an easterly direction starting at the Farrington/West Oahu segment. The Project consists of three operational dates related to the incremental construction and operational turnover of the project segments.

The schedule WBS is organized and clearly segregated by the Project segments. Optimization of aerial guideway structure gantry equipment and coordination with the Core Systems Contract seems intuitive and is a reasonable work sequence approach.

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 provides, by far, 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, much of which is based on production factors supplied by the construction contractor. Construction detail is represented in the grantee's IPS and CPS, as the MPS detail is summary in nature. The MPS is not resource-loaded, so resource "smoothing", "squeezing," "crunching," and related concurrency analysis cannot be conducted and evaluated.

<u>PMOC Determination</u>
Grantee has satisfied the requirement. The MPS sequencing meets the minimal FTA requirements and guidelines. The PMOC has identified several recommendations that must be addressed during the Final Design phase and prior to the grantee's submission on Cost Estimate and MPS refresher documents in support of the FFGA Application.

<u>PMOC Recommendations</u>

(1) The MPS needs more activity detail for all construction contract activities as the MPS typically includes only one activity for each construction contract. More construction activity detail is required to better enable integrated connection points among the various design and construction contracts.

(c) Does phasing due to planned right-of-way acquisition provide sufficient time for efficient use of resources?

The grantee has developed a separate ROW schedule that includes adequate detail representing real estate acquisition of approximately 200 partial and full takes required for the project. The ROW schedule, in fact, has more activity detail than the MPS schedule, although the two schedules are not linked. The grantee had the intention to link the two schedules but, unfortunately, failed to do so in a timely manner to support the PMOC schedule review and risk assessment process. The MPS contains a few activities that represent the completion of real estate acquisition as predecessors to each Guideway and station construction contract.

The PMOC reviewed the MPS and the ROW schedules and noted very distinct differences between the activity durations and summary durations for real estate acquisition between the contracts and project segments. The two schedules lack traceability and, therefore, the PMOC does not have confidence in the ROW schedule logic, durations and dates.

The PMOC provided ROW Schedule review comments that primarily focused on real estate acquisition activity concurrency demand that greatly exceeded resource availability. Some of the concurrency was based on incorrect progress update entering and some was based on poor schedule oversight and quality control of the schedule.

The grantee incorporated the ROW Schedule into the MPS after PMOC consultation on July 11, 2011. The real estate acquisition activities and logic remain under routine scrubbing and will incorporate further revision by the next monthly schedule update.

PMOC Determination
Grantee has satisfied the requirement. The MPS real estate acquisition planning meets the minimal FTA requirements and guidelines.

PMOC Recommendations
None

(d) Are the durations and logic reasonable for temporary construction and physical construction constraints, such as transportation or site access restrictions?

The logistics of site access, transportation, material/equipment handling and storage are commonly referred to as site management. The most relevant site management elements on the project are related to traffic control, contractor material and equipment staging, and location of precast concrete casting/ storage yards.

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, though, needs more detail related to site management and access, traffic control, material storage and handling, pre-cast concrete yard, working adjacent to waterways, and operational adjacencies to third party businesses. The PMOC reviewed the grantee's IPS in order to evaluate the construction activity detail for this review topic.

A greater level of activity detail and activity duration calculations will be necessary to account for "constraining elements" that inherently impact construction staging and material handling.

PMOC Determination
Grantee has satisfied the requirement. The MPS schedule activities and logic meet the minimal FTA requirements and guidelines. The PMOC has identified several recommendations that must be addressed during the Final Design phase and prior to the grantee's submission on Cost Estimate and MPS refresher documents in support of the FFGA Application.

PMOC Recommendations

(1) The MPS needs activities representing the logistics of site access and management and general planning and use of staging yards, including pre-cast concrete yards.

(e) Are project calendars appropriately defined and utilized, including allowances for seasonal weather variances?

Calendars are used for a multitude of reasons, one of which is for varying weather conditions. 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 practical and necessary during schedule development and should be monitored and reviewed frequently to track historical information.

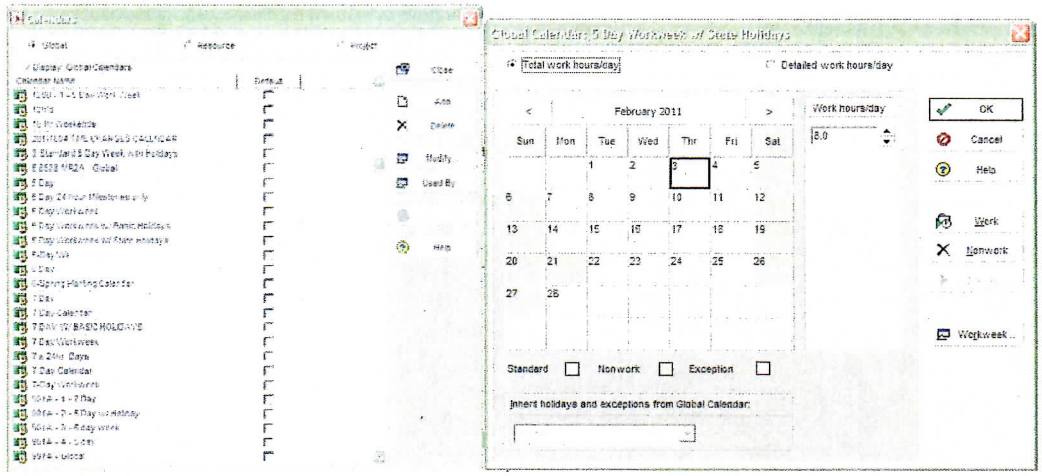
The schedule contains five (5) base calendars as listed in the table below:

Table 64. Calendars

Calendar Name	Global / Project	No. of Activities	Days / Week	Hrs / Day	Description
7 Day Workweek	G	422	7	8	Non-work periods; none, however, 2011 contains non-work periods for holidays
5 Day Workweek	G	1	5	8	Non-work periods; weekends
5 Day Workweek w/ State Holidays	G	52	5	8	Non-work periods; weekends, holidays
MA5D – Global	G	2	7	8	Non-work periods; none
Calendar Days	G	131	7	8	Non-work periods; none
I08016 - TANG Calendar	G	0	5	8	Non-work periods; weekends; Assigned to COST resource

The MPS global structure was reviewed to verify the calendar utilization. Although the calendar library contains five calendars, the MPS only uses one (1) Base Calendar and one (1) Resource Calendar for the *"Cost"* Resource. Base Calendar 1 is 7 work days per week and includes holidays as listed in the BOS.

Figure 28. Calendar Library



The calendar library does not contain anticipated inclement weather days. These periods of non-work performance can be addressed in many ways, such as by increasing activity durations or accounting for them in separate calendars. The grantee did state that it incorporated latent contingency into the activity original durations, but not the calendars, to account for inclement weather. The grantee also stated that Hawaii, in general, does not encounter a significant amount of severe weather or undergo significant seasonal conditions that would negatively impact construction work activity.

The PMOC has frequently recommended that the grantee use multiple calendars in the MPS, though the grantee has chosen not to do so. The PMOC believes that the grantee's reluctance to incorporate other calendars, such as a 5 day per week (work week) calendar, produces inaccurate schedule information and introduces unwarranted and misleading (weekend) schedule dates that can be misinterpreted by the reporting audiences. The absence of multiple calendars is not a fatal flaw but using them would be a simple and more reliable scheduling practice the grantee should implement.

PMOC Determination

Grantee has satisfied the requirement. The MPS calendar library does not meet the minimal FTA requirements and guidelines. The PMOC has identified several recommendations that must be addressed during the Final Design phase and prior to the grantee's submission on Cost Estimate and MPS refresher documents in support of the FFGA Application.

PMOC Recommendations

(1) The Calendar library needs minor corrections to clean up naming conventions, representation of holidays, and the possibility of adding more calendars to better represent professional services and other 5 workday activities.

(f) Have labor and material availability been factored into construction durations?

The MPS does not contain enough detail at the construction task level to adequately represent labor and major availability. Furthermore, the BOS does not adequately address labor and material availability specific to the MPS. The BOS refers to the construction contractor requirements to account for this topic in its Contract Project Schedules. The PMOC reviewed the IPS and related project control procedures in order to support the Technical Schedule Review and this specific review topic.

Labor availability should be evaluated for all life cycle phases of the Project, not just for construction. This has been identified and discussed during the PMOC's Technical Capacity and Capability Review and review of the grantee's staffing plan. The PMOC has identified labor availability (recruiting, hiring, and retention) as a significant problem that has adversely affected the grantee's technical capacity and budget. The grantee has admitted that it is using more outside consultants and contract employees than it originally planned to use, and it has incurred more expenses than originally planned because of the hiring and retention challenges.

Labor and material availability has been factored into the project budget cost estimate, although they are not very traceable or evident through review of the MPS or Basis of Schedule. The BOS does, however, moderately address construction durations, mostly based on production factors supplied by the WOFH construction contractor proposal, which is included as an attachment to the BOS. The PMOC has recommended that the grantee include additional information in the BOS to clarify and better explain its assumptions used for all activity durations, construction and non-construction. While the most recent BOS version better explains activity duration assumptions, the PMOC recommends the grantee provide more justification for the construction activity durations for station, elevator and escalators, utilities, and core system contract elements.

<u>PMOC Determination</u>
Grantee has satisfied the requirement. The MPS construction durations meet the minimal FTA requirements and guidelines. The PMOC has identified several recommendations that must be addressed during the Final Design phase and prior to the grantee's submission on Cost Estimate and MPS refresher documents in support of the FFGA Application.

<u>PMOC Recommendations</u>

(1) Provide more justification for the construction activity durations for station, elevator and escalators, utilities, and core system contract elements.

7.4.2 Schedule Resource Loading

Do quantities and costs as defined in the cost estimate match the resources/costs assigned to activities in the schedule?

Cost and resource loading are two different topics that must be addressed separately, especially for each project life cycle phase other than construction. The PMOC addressed resource and cost loading in Section 7.3.7.

The MPS does not contain resource loading but it is cost-loaded. The BOS addresses activity task durations, inefficiency factors, and contingency amounts.

The PMOC acknowledges that it is not necessary to resource load the MPS, that the MPS is too summary in nature, and that management of resource loaded schedules is best implemented by requiring the construction contractors to resource load each CPS.

PMOC Determination
Grantee has satisfied the requirement. The MPS construction durations meet the minimal FTA requirements and guidelines. The PMOC has identified several recommendations that must be addressed during the Final Design phase and prior to the grantee's submission on Cost Estimate and MPS refresher documents in support of the FFGA Application.

PMOC Recommendations
None

7.4.3 Schedule Elements

(a) Does the schedule reflect project scope that is described in the approved environmental document?

The scope inclusivity is very transparent with the translation of the Contract Packaging Plan and WBS and activity coding specific to the Corridor Segments and individual contracts. During the FTA PMOC Quarterly Review Meeting held at the FTA Region 9 Office on April 27, 2011, the grantee verified that the project scope and the three incremental openings described in the environmental documents remain as depicted in the MPS.

PMOC Determination
Grantee has satisfied the requirement. The MPS scope elements match the environmental document scope of work and meet the minimal FTA requirements and guidelines.

PMOC Recommendations
None

(b) Does the schedule include adequate time and appropriate sequencing for:

(1) Reviews

The MPS contains a sufficient number of activities that represent review periods for the FTA/PMOC for planning, environmental, Final Design, and FFGA application tasks. The design and construction phase also includes review periods for permitting, real estate acquisition, and Final Design review. Some of these activities and review tasks will increase in detail as the MPS is expanded and refined.

(2) Agreements

The MPS contains a sufficient number of activities that represent agreement tasks including interagency and third party agreements. The FTA and PMOC have suggested that the activity durations for various department agreements should be carefully evaluated, as the varying department resources may be too limited and constrained to meet the project's peak demands.

(3) Funding time frames and milestones

The MPS contains activity fragments that represent Request to Enter the PE phase, Final Design Phase, and FFGA Application. The PMOC has recommended that the grantee add more detail to the Entry into Final Design Phase and FFGA application to more accurately reflect the grantee's current critical path and areas of focus.

(4) Material and Equipment Procurement

The MPS does not contain activity detail describing equipment and material procurement, an omission, correction of which is included herein as a PMOC recommendation.

(5) Professional and Engineering Service Agreement Procurement

The MPS contains a sufficient number of activities that represent the procurement of professional services for planning, consultant services, general engineering consultant, Final Design, and program and construction management.

(6) Delivery methods

The MPS contains a sufficient number of activities that represent the procurement of professional services for both design-build and design-bid-build project delivery methods.

(7) Construction processes and durations and contingency buffer

The grantee has provided assumptions used to determine activity durations and built-in contingency for major Project components. While the PMOC has identified opportunities to strengthen the detail and assumptions in the BOS, it has nevertheless determined that the information provided is acceptable and meets the general intent of the OP 34 guidelines.

<u>PMOC Determination</u>
Grantee has satisfied the requirement. The MPS meets the minimal FTA requirements and guidelines as described within this review topic.

PMOC Recommendations
None

7.5 Conclusion

It is the PMOC's professional opinion that the Master Project Schedule is mechanically sound and meets the minimal technical requirements of fundamental soundness. This determination is based on the OP 34 guidelines and requirements.

The PMOC has identified a significant number of recommendations and opportunities to strengthen the integrity of the grantee's Project Controls organization, procedures, plans, technical schedule input, and technical capacity and capability. The PMOC expects the grantee to holistically and conclusively incorporate these recommendations during the Final Design phase and prior to submission of refreshed cost estimate and schedule documents in support of its FFGA Application. These recommendations are included in the section below.

7.6 Recommendations

The following summarizes the PMOC's recommendations summarized from all review topics per OP 34. All recommendations can be addressed during Final Design.

Structure, Quality & Detail

(1) The PMOC recommends that the grantee combine all of the various schedule types into one all-encompassing schedule file to make it a true MPS. The PMOC does, however, recommend keeping the construction contractor schedules separate and integrating only summary level information from these schedules into the MPS. The Scheduling Procedures and PMP require revision to address any Schedule Breakdown Structure (SBS) changes.

(2) The grantee's Organizational Breakdown Structure (OBS), specific to the Project Controls department, needs to align with the positions, schedule types, SBS, and references made in all PMP and related project control procedures and contractual requirements.

(3) More detail is needed in the MPS to address construction activity, utility work, real estate acquisition, long-lead material and equipment procurement, and milestone integration among the construction contracts.

(4) The grantee needs to institute a formal schedule file naming convention for the MPS and for all the other Feeder Schedules including the Contract Project Schedules (CPS).

(5) The grantee should identify a means to utilize its document management system to formally transmit its Schedule Submittal Packages to the FTA and PMOC.

Mechanically Correctness

(6) Incorporate the Permit Schedule, Procurement Schedule and Utility Schedule into the MPS as addressed in the grantee's Project Scheduling Procedure.

(7) The grantee should further reduce the amount number of activity logic ties that contain an excessive amount of lag due to Start-Start (SS), Start-Finish (SF), and

Finish-Finish (FF) relationship types. Most of this can be accomplished with the addition of more activity detail using Finish-Start (FS) relationship ties greatly improving the logic.

(8) Expand proposed construction activity detail to a level which that better connects the multiple contract and key interface logic points.

Phasing and Sequencing, Critical Path, Material Tasks and efficient work sequence

(9) Additional activity detail is necessary to more accurately represent document preparation, risk assessment, financial capacity plan preparation and review, entry into Final Design, and FFGA application activities.

(10) More material tasks detail should be incorporated into the MPS.

Cost/Resource Loading

(11) Ensure that resource and cost loading requirements are included in all construction contractor contractual requirements.

Schedule control, methods, tools and organization.

(12) The grantee should develop a Responsibility Assignment Matrix (RAM) and include it in the PMP and relevant companion documents.

(13) The key project control positions should be consistently referred to in the PMP and companion documents and project control procedures.

(14) The grantee project controls department should be co-located with all GEC project control management support staff (not including the GEC Resident Engineer team field staff, once construction begins).

(15) The grantee should implement all schedule management procedures and guidelines as documented in the PMP and its respective project control companion documents.

(16) The grantee should define a standardized reporting format and distribution for all Project Scheduling parties.

(17) The grantee should standardize all scheduling software settings and incorporate the requirements in all construction contractual documents.

Schedule Sequencing, similar activities, labor and materials, sequencing of ROW activities, temporary construction and site logistics

(18) The MPS needs more activity detail for all construction contract activities, as the MPS typically includes only one activity for each construction contract. More construction activity detail is required to better enable integrated connection points among the various design and construction contracts.

(19) The MPS needs activities representing the logistics of site access and management and general planning and use of staging yards, including pre-cast concrete yards.

(20) Provide more justification for the construction activity durations for station, elevator and escalators, utilities, and core system contract elements.

8.0 OP 40: RISK AND CONTINGENCY REVIEW

8.1 Purpose

Per FTA Oversight Procedure (OP) 40, PMOC has performed "an evaluation of the reliability of the grantee's project scope, cost estimate, and schedule, with special focus on the elements of uncertainty associated with the effectiveness and efficiency of the grantee's project implementation and within the context of the surrounding project conditions."[45] Through the process of risk and contingency review, the PMOC attempts to aid the grantee in its efforts to better define the project's risks and to provide avenues for recovery should those risks become reality.

The purpose of this report is to provide recommendations for adjustments to scope, cost, and project delivery options and to consider risk mitigation options and alternatives, particularly in regard to contingencies, in order to respond to established project risks. This report is produced as one of a series of reviews undertaken to establish the Project's Readiness to Enter Final Design.

8.2 Methodology

The purpose of this section is to describe the review and evaluation methodology utilized by the PMOC with regards to the grantees identification of project risk and its plans for mitigating and managing these risks, including the use of schedule and cost contingencies.

The PMOC is required to synthesize available project information; explore and analyze uncertainties and risks and provide a qualitative and quantitative assessment of ranges of forecasted cost and schedule. The PMOC reviewed risk mitigation options and alternatives, including use of cost and schedule contingencies.

The risk review requires an evaluation of the reliability of the grantee's project scope, cost estimate, and schedule, with specific focus on the elements of uncertainty normally associated with the implementation of the project. PMOC reviewed scope, cost, and schedule documents and presented these reviews in individual spot reports on each topic. The objective of this review is to assess the project risks and uncertainties associated with project conditions and the effectiveness and efficiency of Project implementation in identifying and mitigating risks in regard to scope, cost and schedule. This report provides a qualitative and quantitative assessment of the ranges of forecasted cost and schedule and project management planning in order to respond to project risk. The PMOC's review is understood to be a critical input to FTA's decision regarding project advancement and funding.

The PMOC attended a grantee-initiated risk discussion in January 2011, during which the grantee presented its risk self-assessment and its self-developed risk register. The PMOC then identified further project risks to supplement the list of risks identified by the grantee. In April, 2011, the PMOC conducted a pre-Final Design risk identification workshop with PMOC reviewers and grantee staff, who, together, worked to review, cull, and augment the combined

[45] OP 40 Risk and Contingency Review, Rev. 2, May 2010, pg. 1.

risk register. Risk items of significant uncertainties in terms of likelihood and their consequence were examined; the resulting combined grantee/PMOC risk register is included as an appendix to this report. Contingency modeling procedures as specified by OP 40 were utilized in conjunction with the PMOC's professional opinion to develop the recommended project contingencies.

8.3 Risk Identification

The Project is advanced through the preliminary engineering phase and has procured or is in the process of procuring approximately 43% of the work through DB contracts (two guideway segments and the maintenance facility) and through a yet-to-be awarded DBOM (design/build/operate/maintain) systems and vehicles contract. The estimate was based on both parametric and detailed information, including the use of unit costing obtained from already-awarded or soon-to-be awarded work. Costs for SCC 80 are based on current, but still evolving staffing and organization plans. The grantee undertook and provided to the PMOC its independent effort to identify risk events that may threaten either the project's cost or its schedule goals; the risk register was developed through the efforts of a consultant experienced in transit risk identification along with project staff. The combined Risk Register includes most of the grantee-identified items of major consequence; the grantee items included in the appendix are those that have a number listed in the "Current Project Risk ID" column.

In keeping with OP 40, the PMOC developed a risk identification tabulation for the project separately from the grantee. This was a parallel effort to the risk identification performed by the grantee, although the PMOC risk identification was prepared after joint discussions with the grantee and was further discussed and modified during a risk identification workshop held on April 5-6, 2011. Risk items from the grantee's risk assessment sheets were incorporated and supplemented with risk items identified by PMOC reviewers for scope, cost and schedule and pertinent management issues. Risk items were then amended through the risk characterization workshop to develop the consolidated Risk Register.

The PMOC facilitated the workshop, whose participants and attendees included key members of the grantee project team and representatives of FTA. The risk register was subsequently further refined by PMOC reviewers as they determined Beta factors for the FTA risk model immediately following the workshop. Importantly, the PMOC recognized that the portion of the work that had been awarded or would soon be awarded was substantial (approximately 43% of the value of the project), and that this portion of the project would have a substantially different risk profile than the remainder of the work. Therefore, the risk model was broken into two pieces, each receiving a separate risk analysis. These two separate analyses were then combined to form the project risk recommendations contained herein. Preliminary risk model results were then discussed with the grantee. Feedback did not indicate a need for estimate and risk model refinements.

8.4 Contract Packaging

The grantee is utilizing both traditional (Design/Bid/Build or DBB) and alternative (Design/Build or DB and Design/Build/Operate/ Maintain or DBOM) project delivery methods for the various contracts. The West Oahu/Farrington Highway (WOFH) Segment DB Contract has been executed. Contractors for the Kamehameha Highway Segment DB Contract, the

Maintenance and Storage Facility (MSF) DB Contract, and the Core Systems Contract (CSC) have all been selected. The CSC is a DBOM type contract, wherein the contractor will be responsible for designing and building the vehicles and the systems-related project elements while also being responsible for operations and maintenance of the same for a specified period after the Revenue Service Date (RSD). Only the two eastern line sections (Airport and City Center) and the stations have not yet been bid, as these are the contracts to be designed and built using the traditional DBB method.

8.5 Cost Risk Assessment

This section includes the PMOC evaluation concerning cost estimate adjustments from its review of grantee estimates. Details of the cost review are indicated in the Capital Cost Estimate Review. This section also describes the BRF (Beta Range Factor) assignments for the SCC Risk Assessment utilized in the FTA Risk and Contingency Review Workbook. And finally, the cost risk and schedule risk evaluations are described and the results are reported.

8.5.1 Methodology

Cost risk evaluation is a combination of the PMOC's professional judgment and objective cost data to summarize and make adjustments to the grantee's cost estimate. This is in addition to a rational and empirical application of a risk model analysis used to simulate the magnitude of project risk and establish the potential responses to manage the risk. In the context of the project risk evaluation, quantitative risk assessment is utilized in the analysis of risk exposure and the corresponding management of uncertainty. The PMOC utilized the following steps for the cost risk analysis of the project:

(1) The PMOC conducted a cost review of the estimates of the Project budget. The results of the PMOC review include an adjusted cost estimate that, in the PMOC's opinion, represents a more likely YOE base cost of the project costs. For the Project, the grantee costs are largely based on detailed and parametric estimating procedures, utilizing industry standards and pricing recently received on contracts for this project.

(2) A Stripped Cost Estimate was then developed from the adjusted cost estimate. The PMOC removed contingency funds embedded in the adjusted estimate, including both contingencies allocated by SCC and general unallocated contingencies. The PMOC interviewed the grantee's estimating staff to determine the extent to which latent (hidden) contingencies existed within the estimate, and removed those latent contingencies prior to the cost risk analysis. The resulting Stripped Cost Estimate with PMOC adjustments was then escalated to YOE dollars.

(3) A likely range of costs was then established, utilizing the FTA Risk and Contingency Review Workbook. The Stripped, Adjusted Cost Estimate (with contingency funds removed) for each SCC Cost Element was then established as the lower (or 10%) value of the SCC Element Cost Range. The upper (or 90%) SCC Cost Element Range value is established through multiplying the Lower SCC Cost Range value by a Beta Range Factor (BRF); i.e., 90^{th} percentile = BRF*10^{th} percentile.

(4) For the Project, the Stripped, Adjusted estimate was divided between: (1) the

priced DB and DBOM work; and (2) the remainder of the work (design/bid/build and agency work).

(5) BRF values are established by the PMOC through a process that initially utilized the guidelines indicated in OP 40 and then varied the Beta Factors based upon specific project situations and identified risks. An example is that, for the Project, the design and market factors for the DB and DBOM work warranted much lower beta factors than other cost categories, since design and market prices are largely established. With previously developed information from the risk registers, an assessment of appropriate beta factors for the risk worksheet was made. This assessment occurred independently for the DB/DBOM portion and for the DBB/agency portion of the estimate.

(6) Once the Beta values were assigned to each portion of work, the resulting risk profiles were combined through "weighting" each risk assignment based on the value of each work element. The establishment of the weighted average BRF enabled the identification of the SCC Cost Element Range, further resulting in an estimated range for overall project cost and development of recommended contingencies. These risk factors were used to establish the overall project cost recommendations that were presented to the grantee.

8.5.2 SCC Adjustments

The PMOC used its professional judgment as well as evaluation of objective data to develop its assessment of the Project costs and to develop the indicated adjustments. The following indicates adjustments made to the two separated portions of the estimate (the "DBB" portion and the "DB" portion). See Table 65 and Table 66 for a summary of PMOC adjusted federal Project costs without contingency by SCC. These represent the stripped project cost adjusted to $YOE.

Table 65. PMOC Adjustments – "DB" Portion Estimate $YOE

		YOE			
SCC	Description	YOE TOTAL no Contingency	PMOC adjustments	Latent Contingency	Adjusted, Stripped Total
10	Guideway & Track Elements (Route Miles)	509,424,835	44,600,000	0	554,024,836
20	Stations, Stops, Terminals, Intermodals	0	0	0	0
30	Support Facilities: Yards, Shops, Admin. Bldgs.	91,862,831	447,000	0	92,309,831
40	Sitework & Special Conditions	439,117,352	0	0	439,117,352
50	Systems	207,844,286	20,000,000	0	227,844,286
60	ROW, Land, Existing Improvements	0	0	0	0
70	Vehicles	189,697,322	0	0	189,697,322
80	Professional Services	283,489,981	26,562,000	0	310,051,981
SUBTOTAL (10 - 80)		1,721,436,607	91,609,000	0	1,813,045,608

Table 66. PMOC Adjustments – "DBB" Portion Estimate $YOE

SCC	Description	YOE TOTAL no Contingency	PMOC adjustments	Latenet Contingency	Adjusted, Stripped Total
		YOE			
10	Guideway & Track Elements (Route Miles)	608,395,167	0	0	608,395,167
20	Stations, Stops, Terminals, Intermodals	511,431,632	20,202,025	(25,131,327)	506,502,330
30	Support Facilities: Yards, Shops, Admin. Bldgs.	0	0	0	0
40	Sitework & Special Conditions	428,865,205	0	(198,900)	428,666,305
50	Systems	15,363,355	0	0	15,363,355
60	ROW, Land, Existing Improvements	177,101,428	0	(23,596,013)	153,505,415
70	Vehicles	0	0	0	0
80	Professional Services	654,736,367	(10,821,802)	0	643,914,565
SUBTOTAL (10 - 80)		2,395,893,153	9,380,224	(48,926,240)	2,356,347,137

Note that no latent contingency adjustments were made from the "DB" portion, due to the fact that the grantee has obtained competitive, negotiated pricing for this portion of the work. Detail regarding the nature of the PMOC adjustments is discussed in OP 33 – Project Cost Estimate Review.

8.5.3 Baseline Beta Values

At Entry to Final Design, the standard Beta values selected for use in this risk assessment are shown by major SCC category in the table below.

Table 67. Standard Beta Values for Risk Assessment at Entry to Final Design

SCC	R	D	M	C	Total Beta
SCC 10 - 50	0.00	0.30	0.25	0.75	2.30
SCC 60	0.00	0.90	0.80	0.30	3.00
SCC 70	0.00	0.35	0.25	0.30	1.90
SCC 80.01	0.00	0.00	0.00	0.05	1.05
SCC 80.02	0.00	0.30	0.30	0.40	2.00
SCC 80.03	0.00	0.40	0.25	0.30	1.95
SCC 80.04	0.00	0.30	0.50	0.40	2.20
SCC 80.05	0.00	0.15	0.10	0.20	1.45
SCC 80.06	0.00	0.30	0.25	0.25	1.80
SCC 80.07	0.00	0.20	0.25	0.55	2.00
SCC 80.08	0.00	0.60	0.25	0.65	2.50
R = Requirements Risk	D = Design Risk		M = Market Risk		
C = Construction Risk	Total Beta = 1 + (R + D + M + C)				

Initial Beta values for the project were developed based on the Scope, Cost, and Schedule risks identified in the project, informed by meetings held jointly, with the project grantee, the PMOC, FTA, and other interested parties in attendance. Following the meetings, the Beta values were assigned by the PMOC team and used for the final cost risk assessment. Note that the Beta value assignments occurred independently for the "DB" portion and the "DBB" portion of the work. These Beta values were assigned as outlined in FTA guidance OP 40, and generally fall within ranges expected for this character of project. Beta values were applied at the second level SCC structure.

Table 68. Beta Values Final Design Entry Phase

SCC	Description	"DB" Total Beta	"DBB" Total Beta
10	**Guideway & Track Elements (Route Miles)**		
10.04	Guideway: Aerial structure	1.77	2.52
10.08	Guideway: Retained cut or fill	1.57	-
10.09	Track: Direct fixation	1.57	2.32
10.11	Track: Ballasted	1.57	-
10.12	Track: Special (switches, turnouts)	-	2.32
20	**Stations, Stops, Terminals, Intermodals**		
20.01	At-grade station, stop, shelter, mall, terminal, platform	-	2.32
20.02	Aerial station, stop, shelter, mall, terminal, platform	-	2.47
20.06	Automobile parking multi-story structure	-	2.32
20.07	Elevators, escalators	-	2.32
30	**Support Facilities: Yards, Shops, Admin. Bldgs.**		
30.02	Light Maintenance Facility	1.57	-
30.03	Heavy Maintenance Facility	1.62	-
30.04	Storage or Maintenance of Way Building	1.57	-
30.05	Yard and Yard Track	1.57	-
40	**Sitework& Special Conditions**		
40.01	Demolition, Clearing, Earthwork	1.57	2.32
40.02	Site Utilities, Utility Relocation	1.57	2.42
40.03	Haz. mat'l, contam'd soil removal/mitigation, ground water treatments	1.57	2.32
40.04	Environmental mitigation, e.g. wetlands, historic/archeological, parks	1.57	2.62
40.05	Site structures including retaining walls, sound walls	1.57	2.32
40.06	Pedestrian / bike access and accommodation, landscaping	1.57	2.32
40.07	Automobile, bus, van accessways including roads, parking lots	1.57	2.42
40.08	Temporary Facilities and other indirect costs during construction	1.57	-
50	**Systems**		
50.01	Train control and signals	1.77	-
50.02	Traffic signals and crossing protection	1.67	2.32
50.03	Traction power supply: substations	1.67	-
50.04	Traction power distribution: catenary and third rail	1.67	2.32
50.05	Communications	1.67	-
50.06	Fare collection system and equipment	1.67	-
50.07	Central Control	1.67	-
60	**ROW, Land, Existing Improvements**		
60.01	Purchase or lease of real estate	-	1.85
60.02	Relocation of existing households and businesses	-	1.85
70	**Vehicles**		
70.01	Light Rail	1.18	-
70.06	Non-revenue vehicles	2.13	-
70.07	Spare parts	1.13	-
80	**Professional Services**		
80.01	Preliminary Engineering	1.25	-
80.02	Final Design	2.20	2.00
80.03	Project Management for Design and Construction	2.15	1.95
80.04	Construction Administration & Management	-	2.20
80.05	Professional Liability and other Non-Construction Insurance	1.45	1.45
80.06	Legal; Permits; Review Fees by other agencies, cities, etc.	1.80	1.80
80.07	Surveys, Testing, Investigation, Inspection	2.20	2.00
80.08	Start up	2.70	2.50

8.5.4 Beta Value Adjustments

The detailed results of the scope, cost, and schedule reviews are presented elsewhere; significant issues noted in those reviews are reflected in the risk assessment model by means of adjustments to the risk Beta factors (β) applied to each SCC sub-category. These adjustments result in forecasts of ranges of cost for the project; this review has focused on the *Entry to Final Design* phase.

The following sections present additional detail regarding the basis for adjustments, reflected previously in Table 65 and Table 66, beyond standard OP 40 Beta value suggestions. The purpose of this listing is to provide information regarding Beta values of note.

<u>SCC Wide Beta Value Changes</u>

Three broad SCC wide changes to the Beta values were applied to the "DB" portion as a part of the risk modeling:

- A general Beta value decrease of 0.18 (Design Risk) was deducted from SCC categories 10 through 50, due to a general recognition that this portion of the work is either contracted or selected. This reduction assumes that the design risk lies mostly with the contractors, except that some agency risk remains with performance of the agency and third parties in proper definition of design requirements, as well as in performance of design reviews.
- A decrease to the Beta values of 0.22 (Market Risk) was taken on SCC 10 through 50 to again reflect that this portion of the work is either contracted or selected. This reflects that the estimate is based on actual market pricing. Some market risk remains, however, in escalation clauses that provide relief to the contractors and remain the risk of the agency.
- A decrease to the Construction Risk Beta of 0.25 was factored into SCC 10-50 to recognize that the DB-style of contract shields the agency from much of the risk that arises due to conflict between builders and designers. However, force majeure and third-party interferences remain potential risks faced by the agency, as well as the risk of potential contract adjustments due to actions by the new agency (HART) project management staff.

Three broad SCC-wide changes to the Beta values were applied to the "DBB/agency" portion as a part of the risk modeling:

- A general Beta value decrease of 0.05 (Design Risk) was deducted from SCC categories 10 through 50, due to a general recognition that this portion of the work may take advantage of design work completed by the design-build contractors, potentially relieving risk of technical solutions.
- An increase to the Beta values of 0.10 (Market Risk) was taken on SCC 10 through 50 to reflect that the competitive nature of future bids may be reduced due to a possible perception that the major holder of the already-awarded DB contracts will be the ultimate winner of future bids. This may result in a reduction of the field of competition, driving up bid prices.
- An increase to the Construction Risk Beta of 0.05 was factored into SCC 10-50 to recognize that this project is extremely large and that the project management staff

and agency are both newly-forming. Historically, both conditions are correlated to increased costs, likely due to many factors, including potential adjustments for inefficiency.

SCC-Specific Beta Value Changes

The following list of issues then determined the final resulting Beta values for the SCC sub-categories, which is the Beta value that reflects risk across all four categories of *Requirements*, *Design*, *Market*, and *Construction* risk, including the general Beta value increases previously noted in the section above. Noted below are only those conditions where exceptional risks were noted. "Normal" risks associated with similar construction are accounted for in the base risk model.

SCC-10 – Guideway and Track ("DB")

- Requirements Risk
  - 10.04 (β) = 1.77, increase R to 0.05. Some potential for unexpected underground conditions remains, although likelihood appears reduced.
- Market Risk
  - 10.04 (β) = 1.77, increase M to 0.08. Uncertainty about casting yard location may cause adjustment request.
- Construction Risk
  - 10.04 (β) = 1.77, increase C to 0.55. Highly congested roadway conditions may foster challenges to construction and delays adjustments due to third-party interference.

SCC-10 – Guideway and Track ("DBB/agency")

- Requirements Risk
  - 10.04 (β) = 2.47, increase R to 0.10. Unexpected conditions at guideway foundations become increasingly likely in DB contracts, as project proceeds toward higher urban density
- Construction Risk
  - 10.04 (β) = 2.47, increase C to 0.85. High risk of adjustments due to third party interference in highly congested guideway alignments.

SCC-20 – Stations, Stops ("DB")

Stations are not included in the DB portion of the work.

SCC-20 – Stations, Stops ("DBB/agency")

- Requirements Risk
  - 20.02 (β) = 2.47, increase R to 0.10. Some preliminary design issues remain unresolved, such as platform width, etc. that may result in change after further systems analysis.

SCC-30 – Support Facilities ("DB")

- Design Risk
  - 30.03 (β) = 1.62, increase R to 0.09. Coordination with the core systems contract may cause changed design.

SCC-30 – Support Facilities ("DBB/agency")
No maintenance facility or yard costs are included in the DBB/agency portion of the work.

SCC-40 – Sitework ("DB")
No exceptional risks were noted for this portion and category of the work.

SCC-40 – Sitework ("DBB/agency")

- Requirements Risk
    - 40.02 (β) = 2.42, increase R to 0.10. Unexpected conditions at guideway foundations become increasingly likely in DBB contracts that are closer to the urban area.
    - 40.04 (β) = 2.62, increase R to 0.30. Continued risk exists regarding the potential discovery and resulting delay from archaeological findings.
    - 40.07 (β) = 2.42, increase R to 0.10. Unexpected conditions at guideway foundations become increasingly likely in DBB contracts that are closer to the urban area. (See also 40.02.)

SCC-50 – Systems ("DB")

- Design Risk
    - 50.01 (β) = 1.77, increase D to 0.14. Unresolved design systems questions remain, may be cause for adjustment when resolved.
- Market Risk
    - 50.01-50.07 (β) = varies, increase M to 0.13. CSC protests may cost through delayed scheduling.

SCC-50 – Systems ("DBB/agency")
No exceptional risks were noted for this portion and category of the work.

SCC-60 – Right-of-Way ("DB")
No ROW costs are included in the DB portion of the work.

SCC-60 – Right-of-Way ("DBB/agency")

- Market Risk
    - 60.01-60.02 (β) = 1.85, decrease M to 0.25. Status of RAMP and PMOC review indicates reduced risk.
- Construction Risk
    - 60.01-60.02 (β) = 1.85, decrease C to 0.50. Status of RAMP and PMOC review indicates reduced risk.

SCC-70 – Vehicles ("DB")

- *Design Risk*
    - 70.01/70.07 (β) = 1.18/1.13, decrease D to 0.03. Reduction in Beta recognizes design risk largely transferred to Core Systems contractor.
- Market Risk

- 70.01/70.07 (β) = 1.18/1.13, decrease M to 0.05. Reduction in Beta recognizes design risk largely transferred to Core Systems Contractor, although some escalation risk remains with agency.
- Construction Risk
  - 70.01 (β) = 1.17, increase Post-Construction Beta (included in C) to 0.10. Increase in Beta recognizes probability of late delivery of vehicles or problems with system start-up.

SCC-70 – Vehicles ("DBB/agency")
No vehicle costs are included in the portion and category of work.

SCC-80 – Professional Services ("DB")
- Construction Risk
  - 80.01-80.08(β) = varies, increase C by 0.2 to varies. Increase in Beta recognizes DB contract adjustments that may be requested due to project overhead inefficiencies or changed conditions caused by working with multiple contracting entities and third parties.

SCC-80 – Professional Services ("DBB/agency")
Although concern remains over finalization of the project staffing and agency development, no exceptional risks were found that would cause Beta adjustments beyond the OP 40 standards, with the assumption that a strong standard of care will occur to quickly resolve the related issues discussed elsewhere in this report.

8.5.5 Cost Risk Analysis

This section presents the PMOC's analysis of the model-based Project Cost Risk Assessment based on the FTA Risk and Contingency Review Workbook, utilizing the project adjusted BRFs. The FTA model cost risk assessment workbook served as a starting point for this project. This workbook is based on the summary organizational structure of the FTA Standard Cost Categories (SCC) 10 through 80 for the capital cost elements of a project; SCC 90 (contingency) is specifically excluded as a duplicate measure of risk. Risk for SCC 100 (finance charges) is not covered in the standard FTA risk range factors. Project-level risk is an aggregated amount of the risk associated with all of the SCC Ranges. The Workbook assumes risk to be normally distributed at the project level and partially correlated at 33% of the difference between the fully independent and fully correlated cases.

Using the Beta values in Table 68, a simulation project risk model was developed, as presented later in this report. Table 69 presents the corresponding numeric data results from the risk model.

Table 69. Risk Model Data

Phase	10%	50%	90%	Mitigation Target	Grantee YOE Stripped Estimate
FD	4,824,572,829	6,097,454,503	7,370,336,177	5,576,601,640	4,117,329,761

A review of the base YOE estimate values is presented in Table 70. The grantee's estimate of $4,982.9 million includes a contingency of $865.6 million, yielding a grantee YOE estimate without contingency of $4,117.3 million. With PMOC adjustments, the PMOC recommended estimate without contingency is $4,169.4 million.

Table 70. Base YOE Data

	Grantee values	$ Thousand	Values from "SCC Workbook Estimate"
G1	YOE Budget w/ contingency	4,982,910	
G2	YOE Budget w/o contingency	4,117,330	
G3	YOE contingency	865,581	
	PMOC values		
P1	YOE Adjusted estimate w/o contingency	4,169,393	

Table 71 indicates the FTA workbook values for the project risk assessment.

Table 71. FTA Workbook Values of Project Risk Assessment

	Risk assessment values	$ Thousand
R1	Pessimistic (P90)	7,370,336
R2	Mid	6,097,455
R3	Optimistic (P10)	4,824,573

8.6 Schedule Risk Assessment

8.6.1 Methodology

It should be noted that the Schedule Risk Assessment is based on the Master Project Schedule with a Data Date of January 28, 2011. As noted in the following discussion, the PMOC conditioned the MPS for use in the risk assessment.

This review focuses on the elements of ***schedule*** uncertainty associated with the effectiveness and efficiency of the Grantee's project implementation, the project scope, and surrounding project conditions.

The OP 40 schedule analysis output data is generated from Oracle's "*Pertmaster Risk Analysis*" software program used by the PMOC. The PMOC risk analysis process conforms to the software user manual and intent of the OP 40 as described below:

There are two kinds of project risk:

- ***Uncertainty risks*** are inherent variability that makes it impossible to predict exactly how long an activity will take. For instance, you can estimate how long it will take within a range of uncertainty, but you can never predict how long exactly.
- ***Risk events*** are events separate from an activity that can disrupt or otherwise impact the activity.

Pertmaster handles risk events by using a Risk Register to enter potential risk events and estimates of the probability and impact of the risks on activity duration, costs, and project quality. Once uncertainty and risk event impact estimates have been entered for all tasks within a project, Pertmaster performs a high number of project simulations using "Monte Carlo" or "Latin Hypercube" sampling of the estimates to select random task duration and cost values for every run-through of the simulation. These simulations generate a range of outcomes that can be used to predict project duration and costs with statistical confidence.

The Critical Path Method (CPM) is the traditional means for determining a project finish date. However, because CPM only determines a single date and does not consider potential risks, results are not always comprehensively reliable. Risk Analysis uses risk inputs to determine a range of project finish dates with more confidence and reliability. The Pertmaster risk analysis is based on the risk management process outlines in Chapter 11 of the Project Management Institute's "*A Guide to the Project Management Body of Knowledge*" and consists of the components shown below. The process is not strictly linear; there may be considerable repetition of certain steps before moving on.

Schedule Review

The purpose of the Schedule Review "Characterization" is to check the grantee project schedule, referred to as the Current Probable Schedule (CPS) for logic errors, open-ended tasks, negative lags, start-to-finish links, and other potential problems which could compromise the risk analysis. This step ensures the integrity of the schedule and improves the chances for a meaningful analysis. If mechanical or fundamental revisions are necessary based upon the schedule characterization, the risk management team makes the necessary adjustments and creates a revised schedule file, called the Adjusted Project Schedule (APS).

Pre-Analysis Check

A rudimentary analysis of the schedule is performed to identify activities that drive project duration and costs. These activities merit the closest attention during subsequent detailed risk analysis.

Build a Risk Model

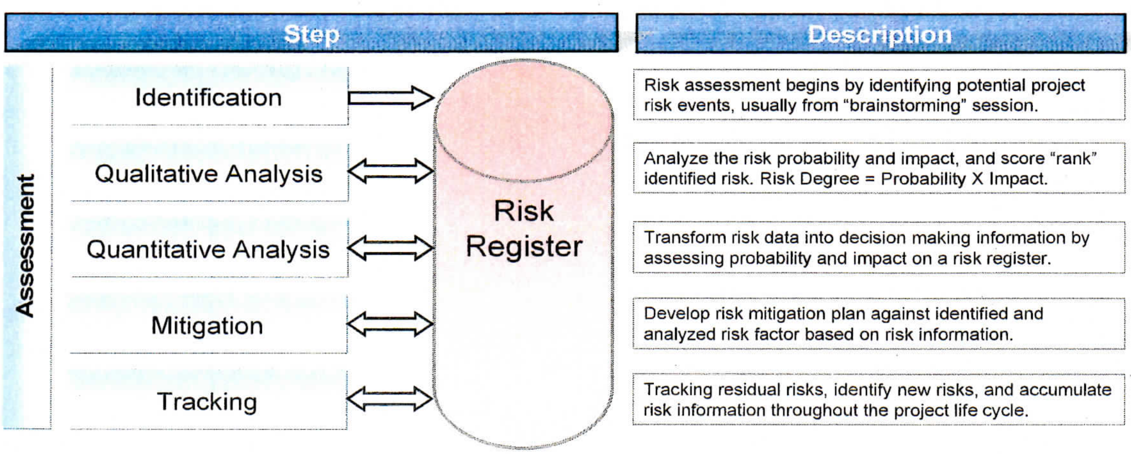
Estimates for duration, cost and resource uncertainty for each project task are identified by a specific team of experts relying on industry statistics and experience. The estimate uncertainty duration ranges are incorporated into a copy of the project schedule called the Estimate Uncertainty Model (EUM).

The team then brainstorms a list of potential risk events, evaluates the risk events as to how likely it is that they may occur and the potential impact such occurrences may have. The list of risk events is then entered into a risk register and each risk event is assigned a probability and impact, resulting in a risk degree factor, which is scored by the risk modeling software. At this point, a copy of the EUM is made, to which Pertmaster then applies the uncertainty and maps the risk events to the appropriate tasks to build a risk model, called an Impacted Risk Model (IRM).

Analyze and Review
A "Monte Carlo" or "Latin Hypercube" sampling analysis is run on the IRM. The risk analysis output can be viewed and evaluated in a wide variety of reports. The review options allow the risk management team to focus of areas of the schedule that pose the greatest risk to the overall program. This helps with the creation of an efficient and cost-effective risk mitigation plan.

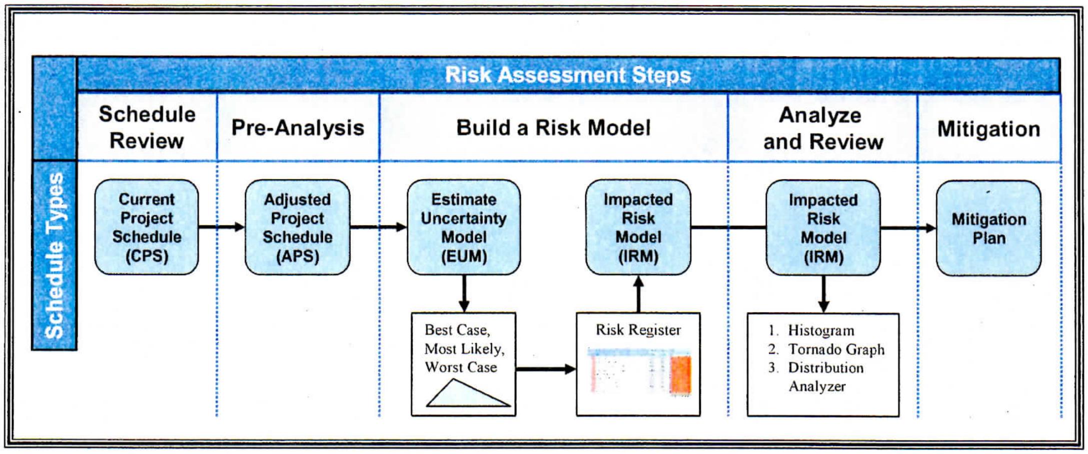
Mitigate and Report
Based on the preliminary analysis, the risk management team reviews and evaluates alternative scenarios with varying reductions to duration, resource and cost uncertainty. Ultimately, the most cost-effective risk mitigation strategy is chosen and formalized into a risk mitigation plan.

Figure 29. Schedule Risk Assessment Process



The figure below describes the various schedules that are created once the PMOC commences the OP 34 review of the grantee's project schedule, called the CPS. The final product is the Impacted Risk Model (IRM), which the PMOC uses for the risk analysis in Pertmaster.

Figure 30. Schedule Risk Assessment Steps and Schedule Types



8.6.2 Schedule Risk Analysis

<u>Project Schedule Review</u>

During the Schedule Review process, the PMOC noted several inconsistencies with schedule development and routine progress updating, including poor use of file naming conventions, incomplete information, mechanically unsound practices, poor document transmittals, incomplete submittal packages, and non-compliance with internal project control and quality control procedures. The format, quality, and detail contained within the initial Master Project Schedule (MPS) and the Basis of Schedule (BOS) were unacceptable. Beginning in January 2011, the grantee submitted seven (7) different schedule revisions, each with PMOC review and comment, to support the PMOC schedule review and schedule risk assessment. The PMOC used the March 15, 2011 schedule submittal to conduct the schedule review and risk assessment.

As part of the process, the PMOC conducted a teleconference with the grantee's Project Control Manager on February 4, 2011 to discuss concerns and comments, and followed up with a more-detailed discussion and schedule review work shop at the PMOC February 8-10, 2011 site visit. The grantee provided a copy of the Project Scheduling Procedures and asked the General Engineering Consultant (GEC) to present the methodology and procedures used to develop and update the Integrated Project Schedule (IPS). The PMOC noted that many of its initial concerns were satisfactorily answered by the GEC, although the PMOC did detect and note that some city and GEC team members did not have a comprehensive understanding of each other's roles and responsibilities and procedural requirements as established in the PMP and related project control companion documents. The grantee admitted that it was rushed to develop and transmit several of the documents specific for this review and that the documents remain under significant revision.

As a result of the meeting discussions and PMOC recommendations, the grantee issued a revised Basis of Schedule on February 23, 2011, and a revised MPS on March 15, 2011, "PMOCA.xer". After initial review, the PMOC agreed to use the "PMOCA.xer" file to conduct the Schedule Review. The PMOC presented Preliminary Findings and Recommendations to the grantee on April 5, 2011 during its monthly site visit.

In summary, the PMOC informed the grantee that further revisions are necessary to completely address the FTA guidelines and requirements to enter the Final Design Phase, although the schedule was in a condition acceptable enough to allow continuance of the schedule review and subsequent schedule risk assessment. The preliminary findings and recommendations were also summarized by the PMOC at the FTA/PMOC Quarterly Review Meeting held with the grantee at FTA Region IX offices on April 28, 2011. The PMOC conducted an additional Schedule Workshop May 10 and 11, 2011, during its routine monthly site visit.

The PMOC made a backup copy of the CPS file *"PMOCA.xer"* and incorporated several significant revisions and modifications. A summary of the modifications are listed below:

- The PMOC used the "adjusted" project schedule, herein referred to as the "Adjusted Project Schedule" (APS), to provide more realistic risk assessment and contingency analysis output.
- The PMOC concentrated its efforts on ensuring that a detailed, mechanical and fundamentally sound schedule was used for both the risk assessment and the contingency analysis. The grantee and the PMOC collaboratively worked through initial master program schedule development to ensure adequate detail and logic sufficiently support the PMOC risk analysis.

The APS is considered most optimistic as it is stripped of all latent and patent time contingency. The APS data in the table below does not include estimate uncertainty or risk events as it was generated prior to the risk analysis process step.

Table 72. CPS to APS Milestone Comparison

Activity Description	CPS - Finish Dates	APS - Finish Dates
Entry into Final Design	3-Sep-11	30-Dec-11
FFGA Award	30-Sep-12	29-Jul-13
20% Construction	N/A	22-Aug-12
50% Construction	N/A	25-Jun-14
75% Construction	N/A	17-Jun-15
90% Construction	N/A	9-Dec-16
RSD	4-Mar-19	22-Aug-18
N/A = CPS does not contain construction milestone hold-points. These are intended for the risk assessment and contingency management.		

<u>Pre-Analysis Check</u>

The PMOC performed a pre-analysis check by applying a quick risk distribution range across all schedule activities and reviewing the confidence level range, duration sensitivity, and criticality index. Preliminary notes and observations were made for specific schedule drivers. Note that this pre-analysis check was performed as a pre-impacted risk analysis, meaning that the schedule does not have risk events "built-in" the schedule at this point of the risk analysis process.

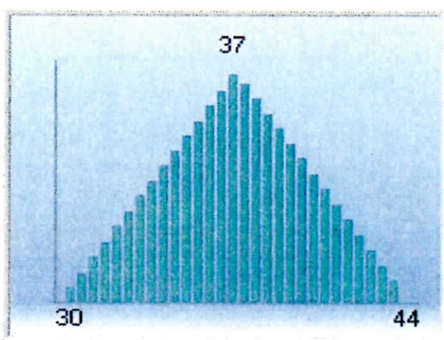
<u>Build a Risk Model "Impacted Risk Plan"</u>

(1) Estimate Uncertainty Model (EUM)

Before running the risk analysis, the PMOC assigned three durations to each activity in the schedule. The three durations for each activity represent best case "minimum", most likely, and worst case "maximum". The PMOC reviewed the activity Original Durations (OD) in the CPS and made an objective determination of the adequacy of each OD. The PMOC used most of the schedule OD durations as the most-likely durations and, in some cases, the PMOC determined certain activity OD were too aggressive. Most of the "maximum" durations the PMOC assigned are 25% to 35% greater than the OD, depending on the work task, project phase and task location. The best case durations were calculated as 95% of the OD, or "- 5%". This value is low because the EUM is already based on a stripped and "best case schedule. The value ranges (differences in activity durations) reflect levels of uncertainty. Based on the three durations, a triangular distribution was assigned to each activity.

Figure 31. Duration Distribution Type

Distribution	Triangle
Minimum	30
Most Likely	37
Maximum	44



Once the estimate uncertainty process step is complete, the result is a schedule file called the Estimate Uncertainty Model (EUM).

(2) Impacted Risk Model (IRM)

The PMOC conducted qualitative brainstorming sessions with the grantee and its consultants during Risk Workshop 2 held April 6-7, 2011, to identify a listing of program risks with both cost and schedule impacts. Before the workshop, the PMOC reviewed and modified a risk register used by the grantee's independent risk assessment. The PMOC noted that the grantee's risk register was very detailed and contained a considerable number of risks also identified by the PMOC risk assessment team. The grantee's risk register saved the PMOC a significant amount of time during the qualitative process. This risk register is referred to as the "Main Risk Register".

The PMOC conducted a review and evaluation of all risks in the Main Risk Register in order to decide which risk events should be used for the schedule risk analysis (Pertmaster) risk register. Once the risks were culled and prioritized, the PMOC summarized several similar risks into one risk event per category since the CPS and APS are summary in nature and lacked detail to distinguish the fragnet impact of similar risk events. For example, the Main Risk Register contained over ten different risks associated with utilities. The Pertmaster risk register contains one risk event, named "*Relocate, repair, betterment, hit unforeseen Utilities*", which represents most of the ten separate risks identified in the main risk register. This risk event is logically tied to the construction activity for guideway and station construction and, therefore, can be represented as one risk event.

The Risk Event ID numbers are separated into eleven (11) categories, represented in increments of ten (010 through 110). Each category is divided into three or four risks events to tie each category risk event to the appropriate Project segment; WOFH (0.1), Kamehameha (0.2), Airport (0.3), and City Center (0.4), identified by their respective Risk ID decimal points. Not all risk categories are associated with all four segments. For example, the risk category "*10 Pier Obstructions*" is associated with all four segments (10.1, 10.2, 10.2 and 10.4) while risk category "*20 Relocate, repair, betterment, hit unforeseen Utilities*" is associated with only Airport and City Center segments (20.1 and 20.2). See the Pertmaster risk register figure below.

Figure 32. Schedule Risk Register

Risk Register

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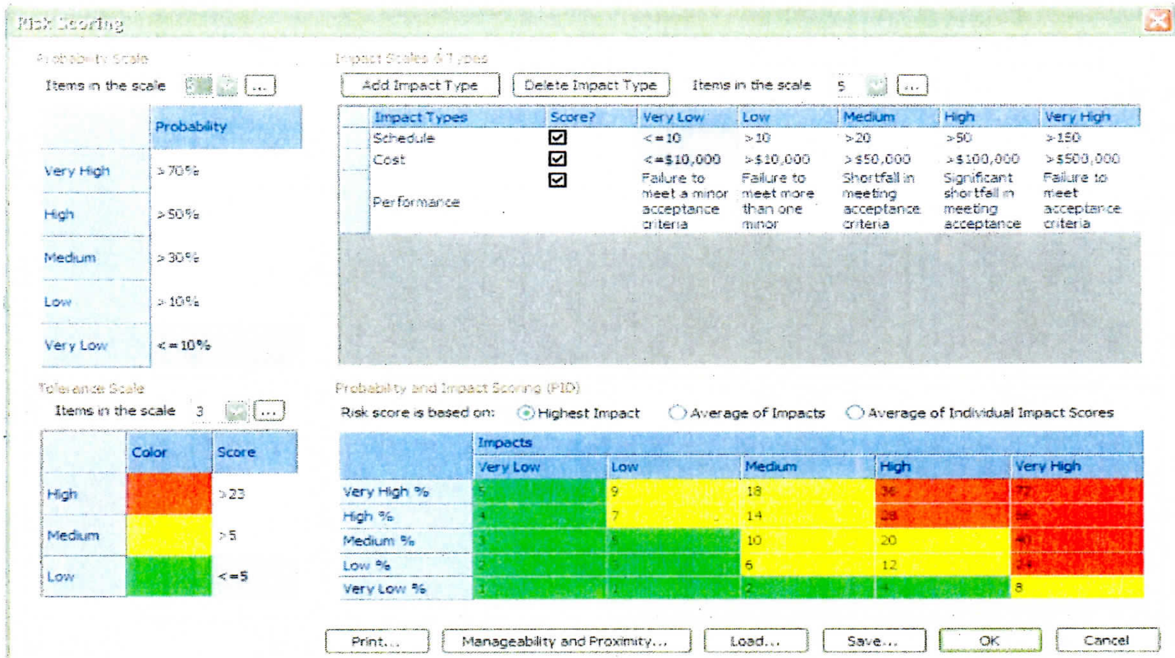
Qualitative | Quantitative

Risk			Pre-Mitigation (Data Date = 28JAN11)			
ID	T/O	Title	Probability	Schedule	Performance	Score
010.1	T	Pier Obstructions (WOFH)	L (25%)	M (47)	N	6
010.2	T	Pier Obstruction (Kamehameha)	M (40%)	M (47)	N	10
010.3	T	Pier Obstructions (Airport)	H (65%)	M (47)	VH	56
010.4	T	Pier Obstructions (City Center)	VH (85%)	H (57)	VH	72
020.2	T	Relocate, repair, betterment, hit unforeseen Utilities (Airport)	H (65%)	H (141)	VH	56
020.3	T	Relocate, repair, betterment, hit unforeseen Utilities (City Center)	VH (85%)	VH (250)	VH	72
040.1	T	Bid Protest (Core Systems)	VH (100%)	H (140)	VH	72
040.2	T	Bid Protest (Airport)	L (15%)	H (120)	VH	24
040.3	T	Bid Protest (City Center)	L (15%)	H (120)	VH	24
030.2	T	Utility company resource availability issues (Airport)	H (60%)	H (120)	VH	56
030.3	T	Utility company resource availability issues (City Center)	VH (75%)	VH (190)	VH	72
050.2	T	Archaelogical discovery and relocation delays (Airport)	H (55%)	H (126)	VH	56
050.3	T	Archaelogical discovery and relocation delays (City Center)	VH (75%)	H (126)	VH	72
060.2	T	Traffic mgmt., mitigation result in excessive work period restrictions in-force (Airport)	H (70%)	H (140)	VH	56
060.3	T	Traffic mgmt., mitigation result in excessive work period restrictions in-force (City Center)	VH (90%)	H (140)	VH	72
070.1	T	Hazardous material sampling, remediation delays (MSF)	H (65%)	H (52)	VH	56
070.3	T	Hazardous material sampling, remediation delays (Airport)	L (30%)	H (116)	VH	24
070.4	T	Hazardous material sampling, remediation (City Center)	M (45%)	H (116)	VH	40
080.1	T	Excessive change orders & disputes exceed CITY resource availability (MSF)	L (20%)	H (62)	VH	24
080.2	T	Excessive change orders & disputes exceed CITY resource availability (Airport)	M (35%)	H (62)	VH	40
080.3	T	Excessive change orders & disputes exceed CITY resource availability (City Center)	H (65%)	H (62)	VH	56
090.1	T	Delays with Core System automation and tweeking (Airport)	M (45%)	H (70)	VH	40
000.1	T	CITY Readiness challenges with Entry into Final Design Phase	VH (90%)	H (90)	VH	72
000.2	T	CITY Readiness challenges with FFGA Application	H (70%)	H (60)	VH	56
100.1	T	Additional traffic control device and road improvements by CITY (Kamehameha)	VH (85%)	H (63)	VH	72
020.1	T	Relocate, repair, betterment, hit unforeseen Utilities (Kamehameha)	M (45%)	H (141)	VH	40
030.1	T	Utility company resource availability issues (Kamehameha)	M (35%)	H (90)	VH	40
050.1	T	Archaelogical discovery and relocation delays (Kamehameha)	M (40%)	H (126)	VH	40
060.1	T	Traffic mgmt., mitigation result in excessive work period restrictions in-force (Kamehameha)	M (50%)	H (140)	VH	40
070.2	T	Hazardous material sampling, remediation delays (Kamehameha)	L (20%)	H (116)	VH	24
110.1	T	Real Estate Acquistition delays with negotiations, condemnation (City Center)	M (50%)	VH (225)	VH	40
100.2	T	Additional traffic control device and road improvements by CITY (Airport)	VH (85%)	H (63)	VH	72
100.3	T	Additional traffic control device and road improvements by CITY (City Center)	VH (85%)	H (78)	VH	72

Each risk event was scored based on a risk degree factor. The risk degree factor is calculated by the risk event probability and impact factors. The probability and impact factors for each risk event are objectively determined by the PMOC risk management team. The risk register scoring system prioritizes each risk event by the risk degree factor, see figure below.

Figure 33. Schedule Risk Scoring Chart



Once the risk events and their risk degree factors are determined, they are incorporated into a copy of the PMOC EUM, resulting in a plan file called the Impacted Risk Model (IRM). The IRM is used to produce all of the schedule analysis "output" reports.

Analyze and Review

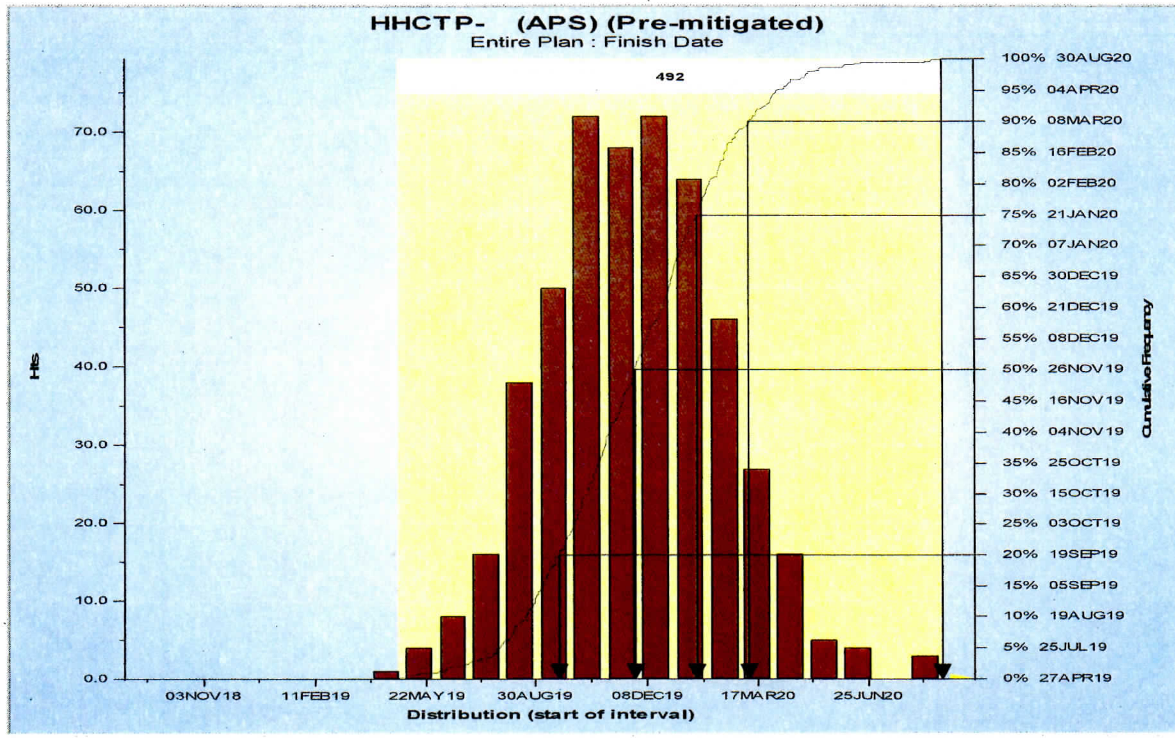
(1) Summary Results

Using the estimate uncertainty and risk events incorporated into the IRM, histogram and tornado graphs are generated to evaluate the distribution ranges and sensitivity factors stemming from the top key schedule drivers. The tornado graphs illustrate three representations of key risk drivers, which are:

- Duration Sensitivity – Size of the risk impact,
- Criticality Index – Frequency of the impact,
- Duration Cruciality – Size and frequency of the impact on the overall project.

The PMOC generated confidence level histograms and duration cruciality tornado diagrams. The IRM schedule was recalculated over 1,000 times to the point of convergence, selecting random durations for each task, to estimate the project completion date within a confidence range. This analysis yields the results shown in the figure below.

Figure 34. Project Completion Date Confidence Level



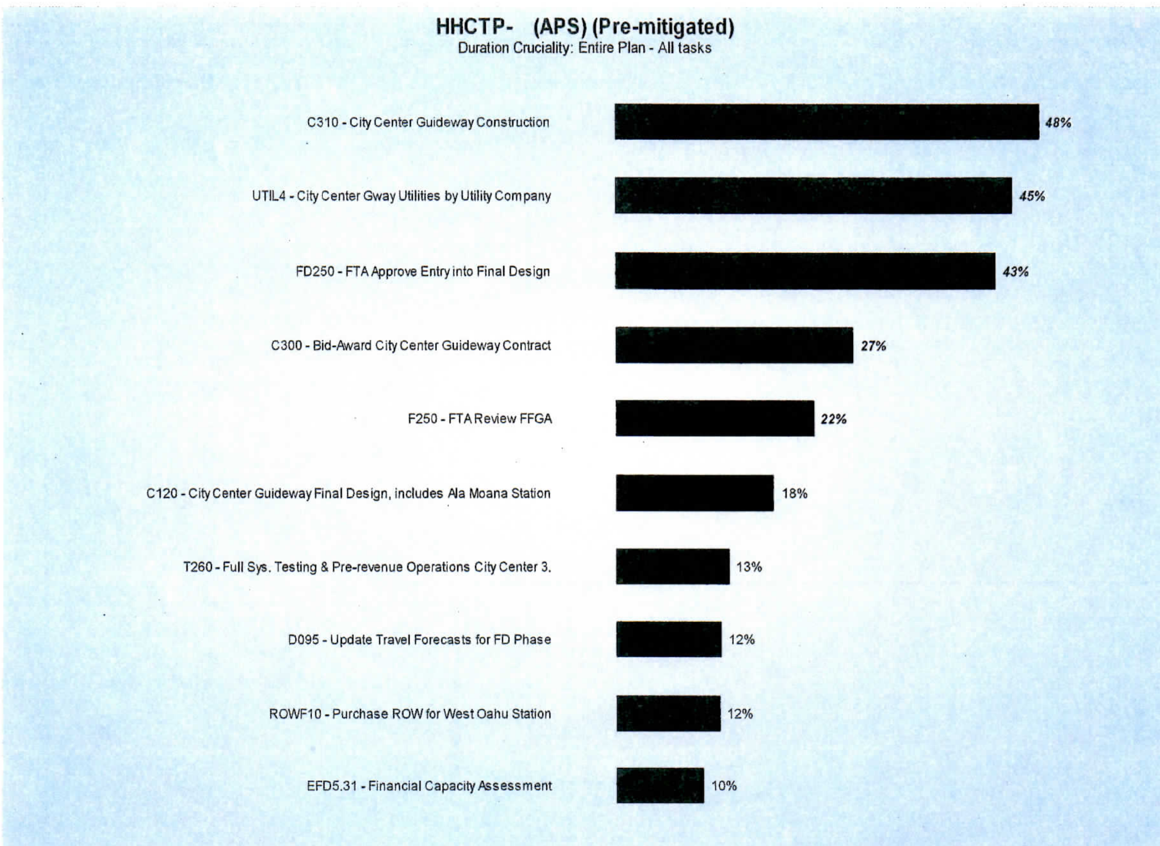
The IRM distribution range for project completion ranges from the 0% to 100% confidence levels span a 492-day period. The probability percentage points for the IRM are:

- 20% Confidence level completion date – September 19, 2019
- 50% Confidence level completion date – November 26, 2019
- 75% Confidence level completion date – January 21, 2020
- 90% Confidence level completion date – March 8, 2020
- 100% Confidence level completion date – August 30, 2020

The risk event results are produced by running a schedule analysis using the IRM which contains qualitative risk events within the software risk register. The true indication of how sensitive each risk event ultimately becomes is not realized until the analysis is performed. For example, a risk event with a very high score does not necessarily mean it will be highly sensitive to the schedule as it may only affect non-critical activities containing total float. The schedule drivers that contain the most impact potential contain a high risk degree and are on the longest critical path or near critical path.

The figure below illustrates the top schedule activities containing the highest amount of duration cruciality for the project as a whole. Duration cruciality is a better indicator than duration sensitivity because it distinguishes only the sensitive activities which also contain the highest criticality index. The higher the duration cruciality percentage the greater the likelihood the activity will affect the critical path and the project completion date. Note none of the risk events in the current model are represented in this group.

Figure 35. Project Duration Cruciality with Risk Impacts



The grantee should concentrate on the activities contained in the duration cruciality tornado diagram and related critical path items during risk mitigation and monitoring.

(2) Analysis of Interim Milestones

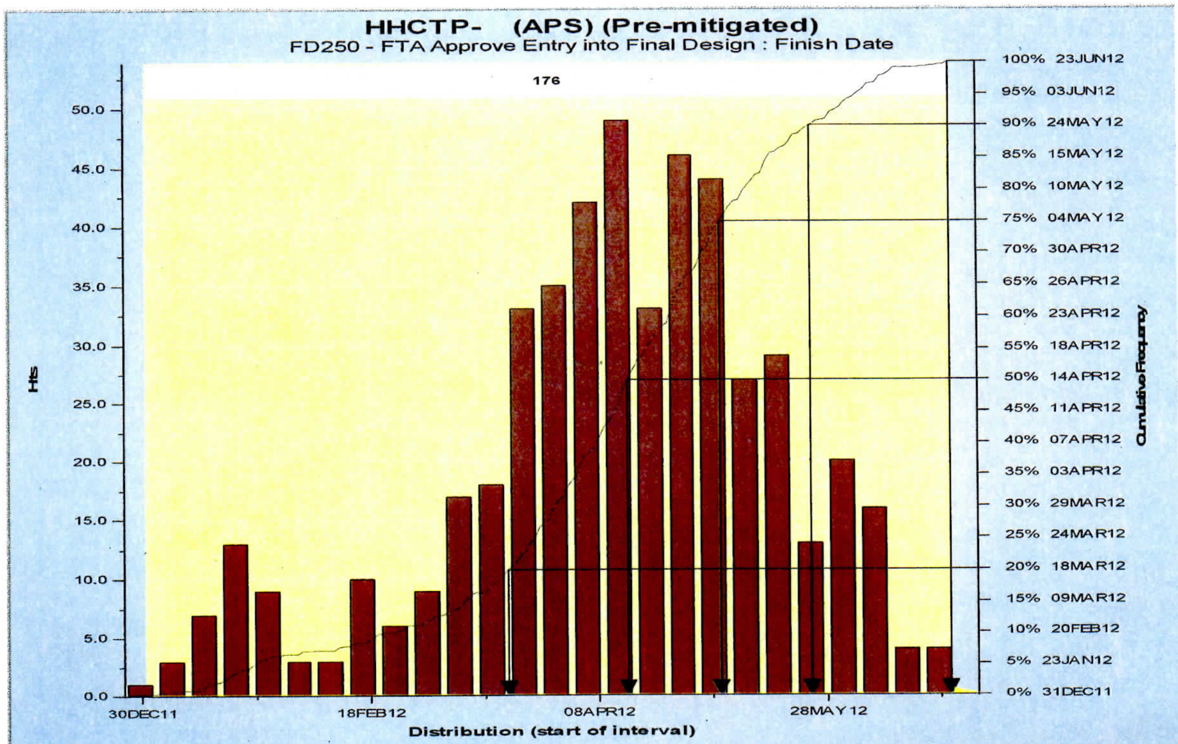
In addition to the calculation of the RSD, to assess the schedule mitigation capacity of the project, a schedule distribution was calculated for each of the schedule milestones. The table below summarizes the confidence level amounts for each of the Project milestones used in the schedule risk assessment.

Table 73. IRM Milestone Probability of Achievement Date

Project Milestone	Activity ID	IRM Milestone Dates – Percentile Rank				
		20th	50th	75th	90th	Maximum
FTA Approve Entry into Final Design	FD250	18-Mar-12	14-Apr-12	4-May-12	24-May-12	23-Jun-12
20% Construction	20	16-Jan-13	24-Feb-13	31-Mar-13	1-May-13	26-Jul-13
FFGA Award	F270	16-Dec-13	3-Feb-14	9-Mar-14	3-Apr-14	5-Jun-14
50% Construction	50	8-Sep-14	22-Nov-14	19-Jan-15	11-Mar-15	9-Jul-15
75% Construction	75	12-Oct-15	15-Nov-15	19-Dec-15	16-Jan-16	12-Mar-16
90% Construction	90	14-May-17	1-Jul-17	3-Aug-17	9-Sep-17	28-Nov-17
Open to City Center 3	9999	18-Sep-19	25-Nov-19	20-Jan-20	7-Mar-20	29-Aug-20

The following figures illustrate the Project milestone IRM confidence level distribution as summarized in the table above.

Figure 36. Activity FD250 "FTA Approval to Enter Final Design"



Deterministic Date	31-DEC-11	Range of Uncertainty 176 Calendar Days
Earliest Date	31-DEC-11	
Latest Date	23-JUN-12	
Most Likely (50 Percentile)	14-APR-12	

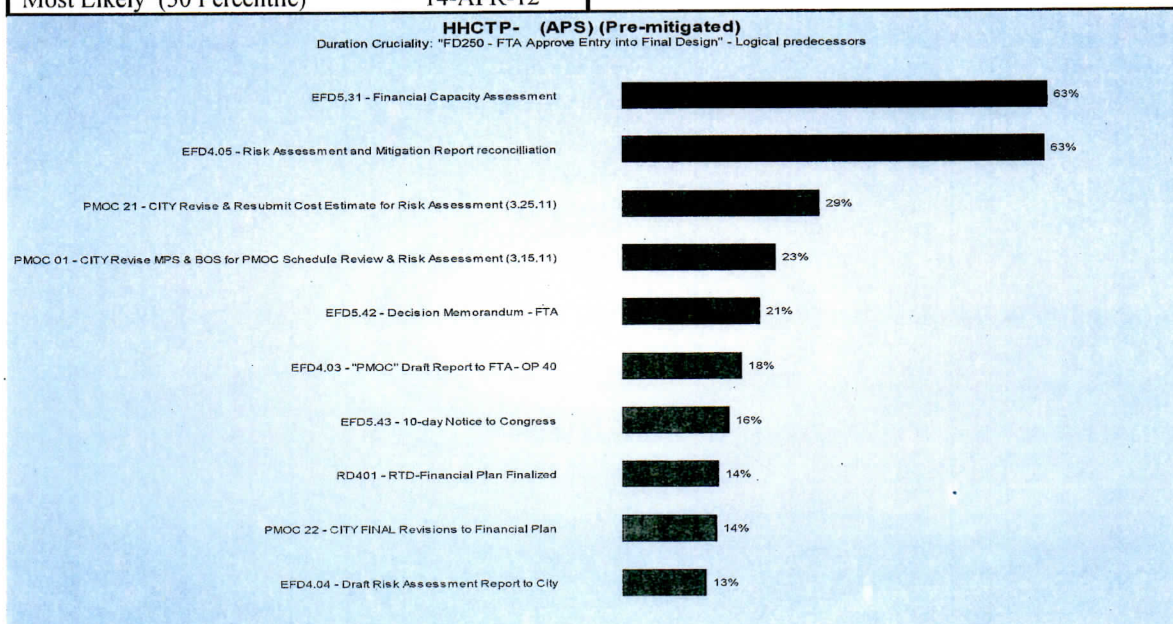
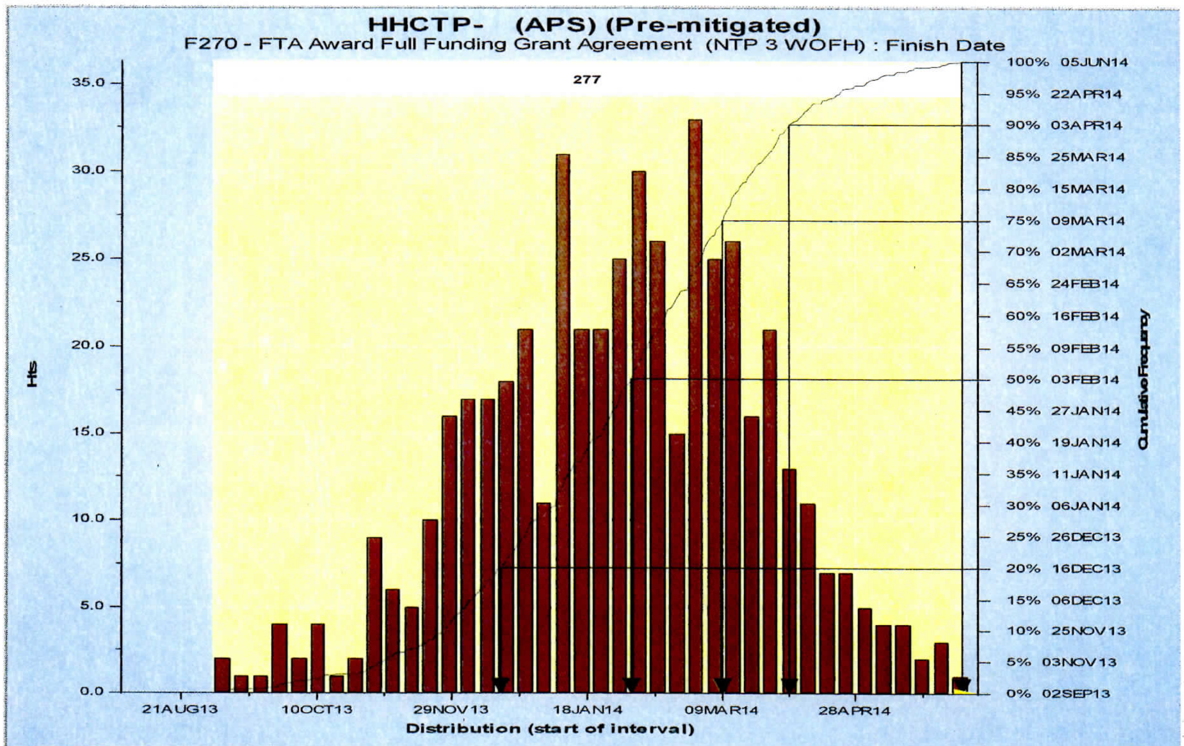


Figure 37. Activity ID F270 "FTA Approval of FFGA"



Deterministic Date	30-JUL-13	
Earliest Date	02-SEP-13	Range of Uncertainty
Latest Date	05-JUN-14	277 Calendar Days
Most Likely (50 Percentile)	03-FEB-14	

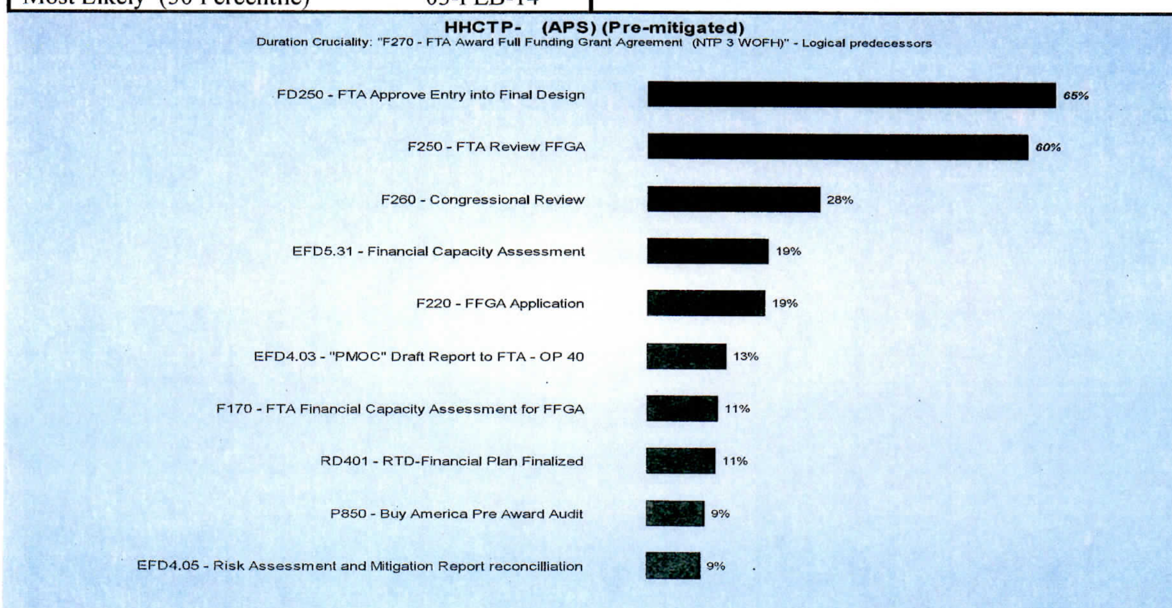
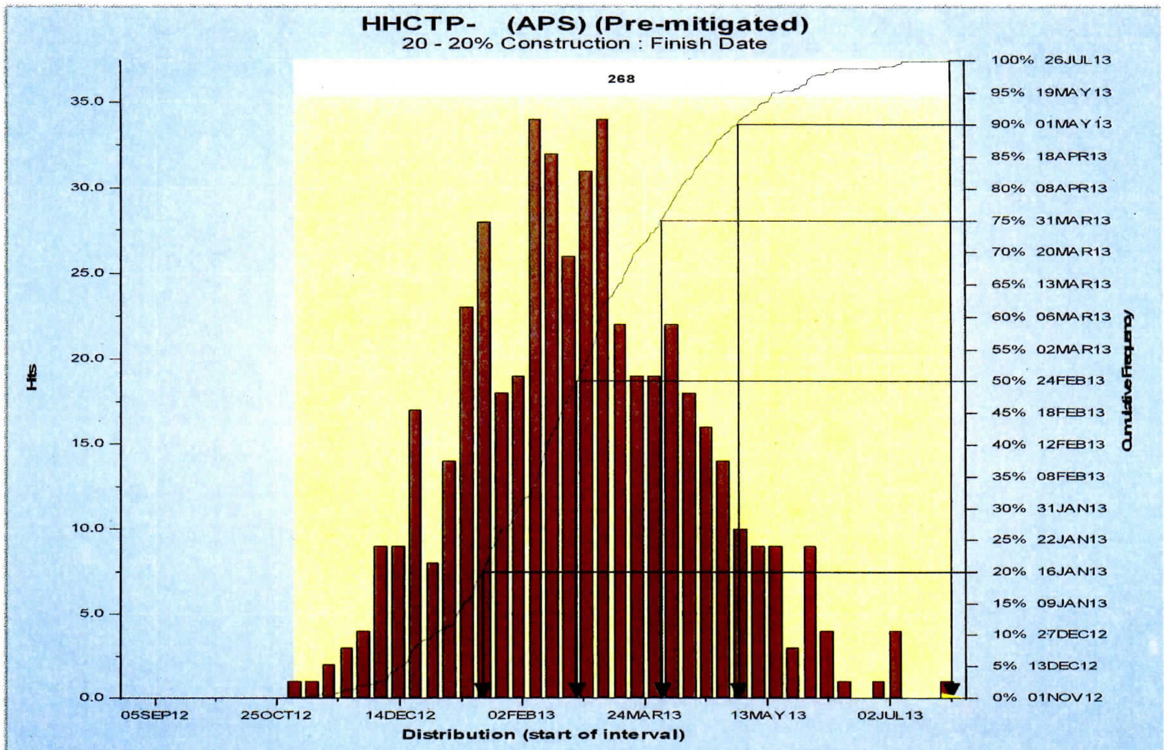


Figure 38. Activity ID 20 "20% Construction"



Deterministic Date	22-AUG-12	
Earliest Date	01-NOV-12	Range of Uncertainty
Latest Date	26-JUL-13	268 Calendar Days
Most Likely (50 Percentile)	24-FEB-13	

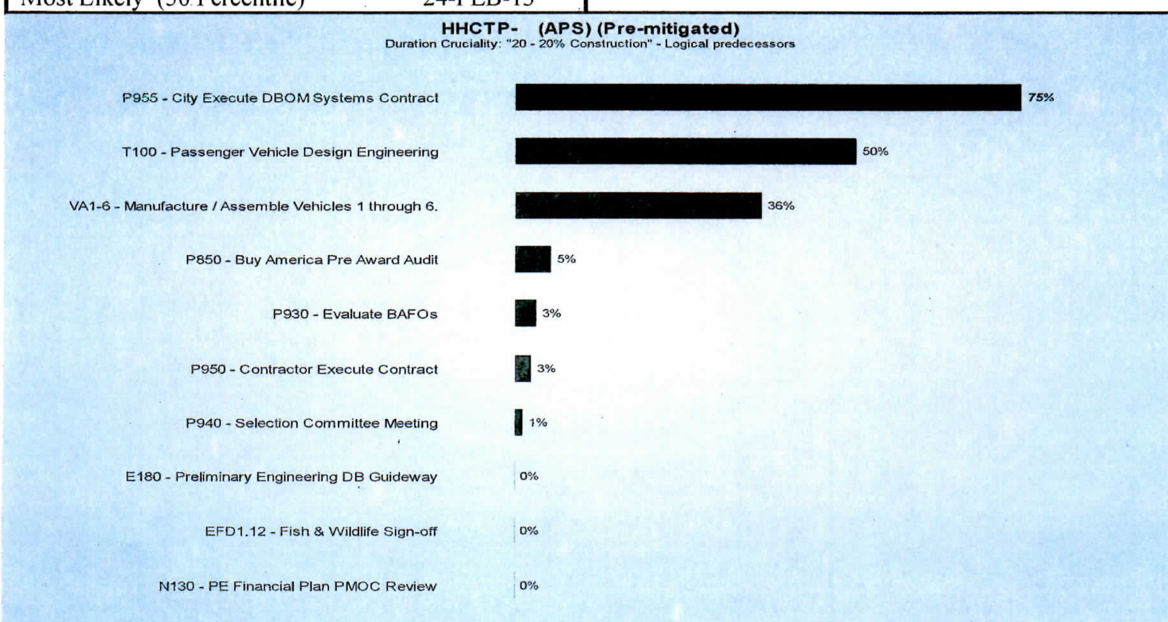
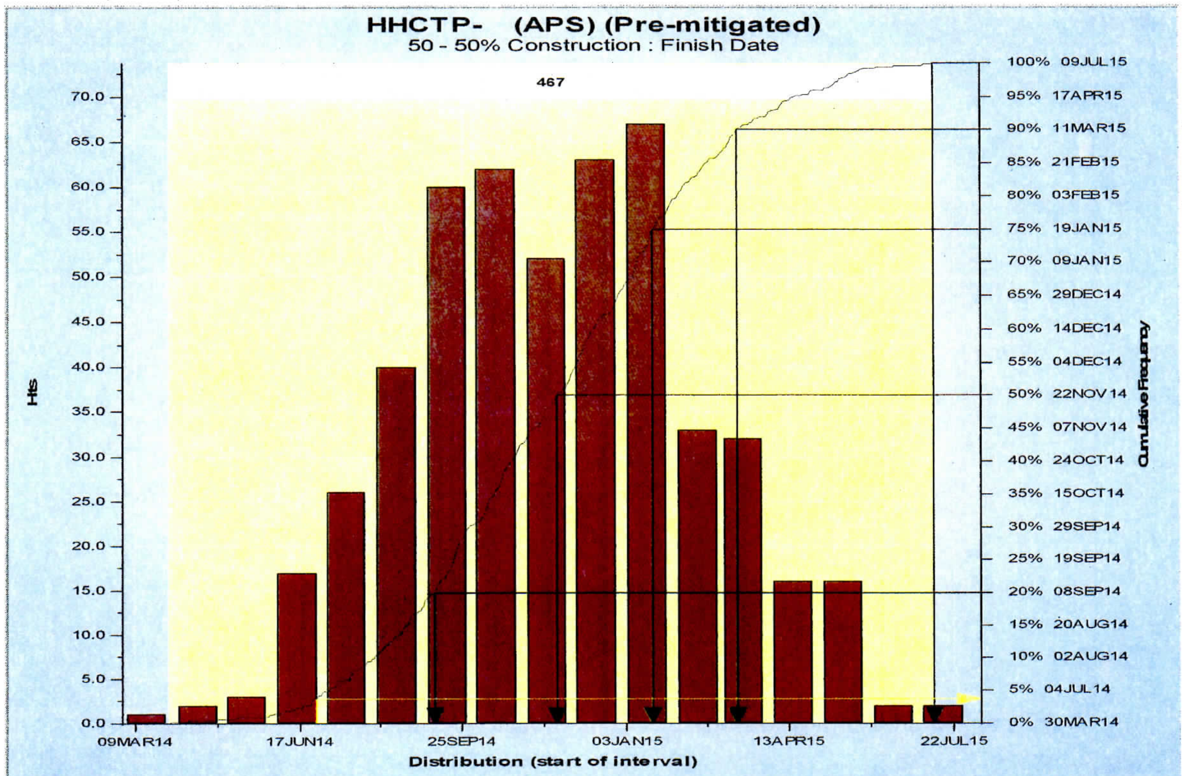


Figure 39. Activity ID 50 "50% Construction"



Deterministic Date	25-JUN-14	Range of Uncertainty 467 Calendar Days
Earliest Date	30-MAR-14	
Latest Date	09-JUL-15	
Most Likely (50 Percentile)	22-NOV-14	

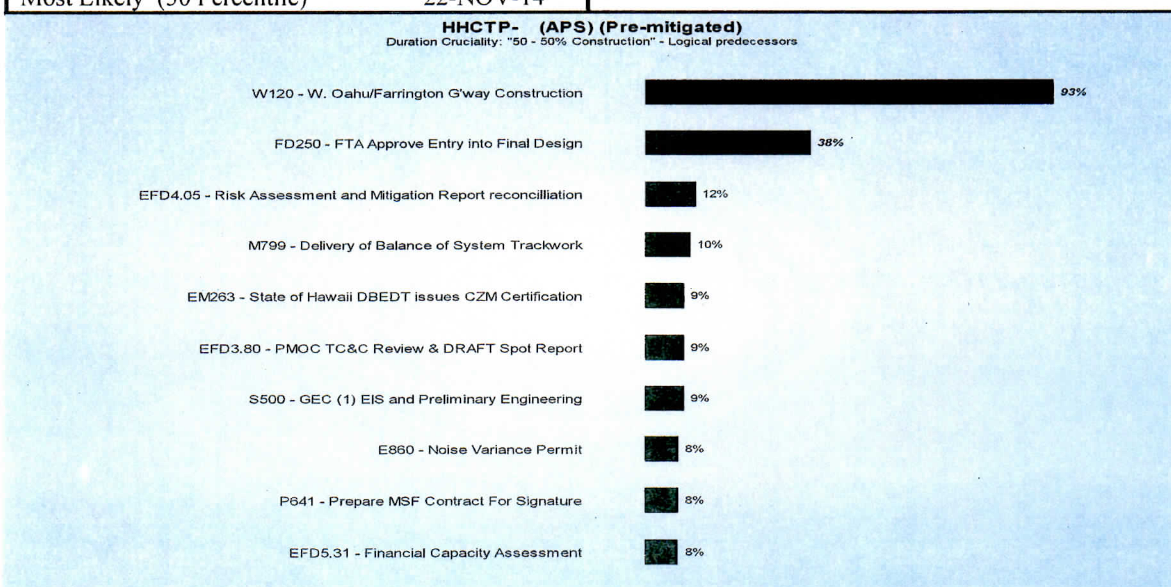
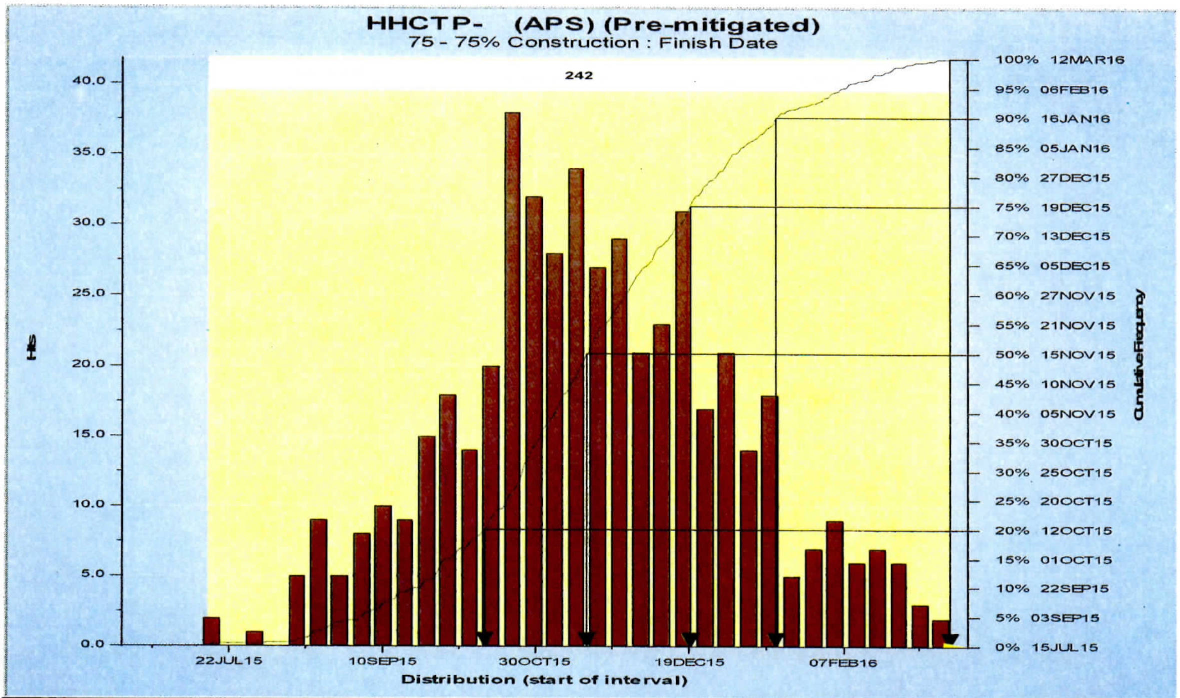


Figure 40. Activity ID 75 "75% Construction"



Deterministic Date	17-JUN-15	Range of Uncertainty 242 Calendar Days
Earliest Date	15-JUL-15	
Latest Date	12-MAR-16	
Most Likely (50 Percentile)	15-NOV-15	

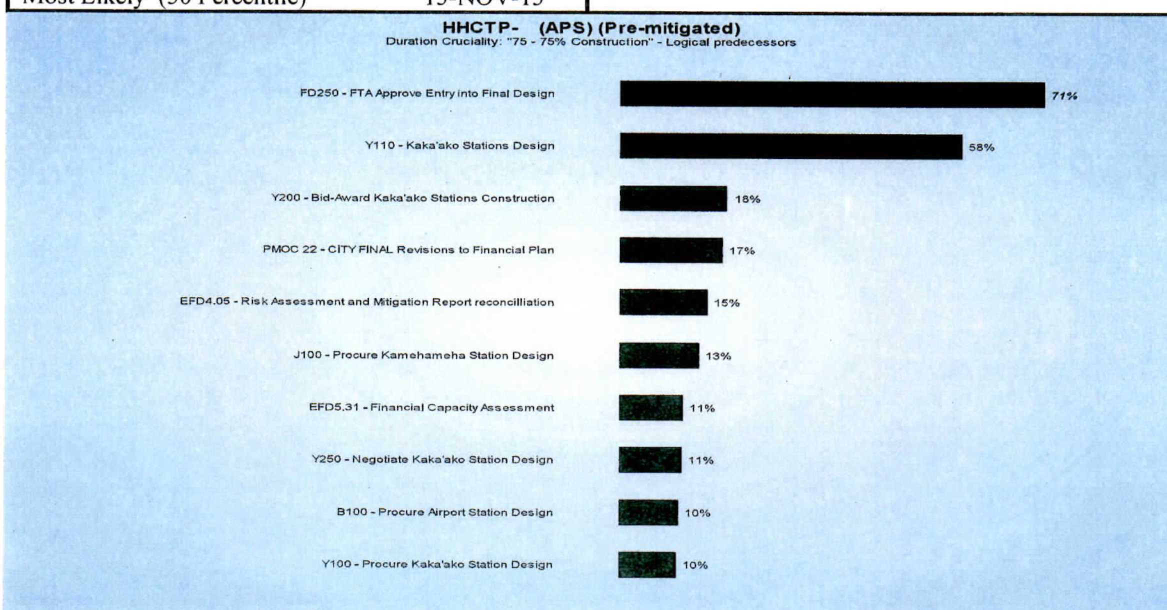
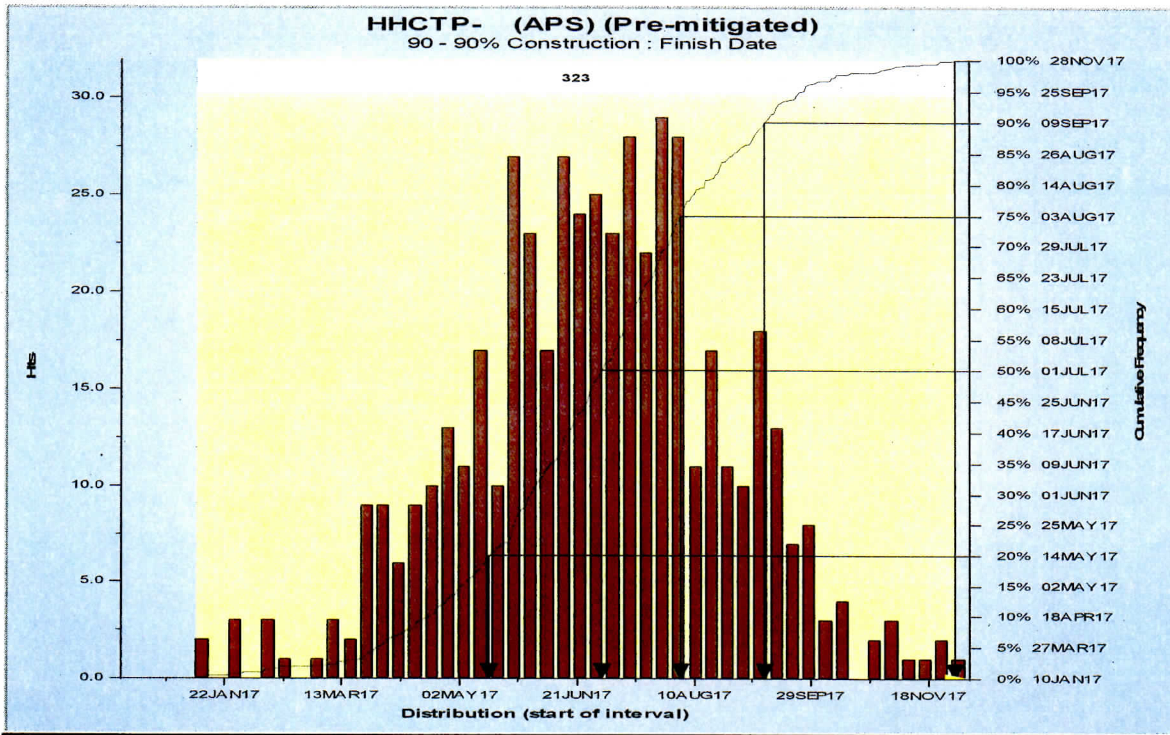


Figure 41. Activity ID 90 "90% Construction"



Deterministic Date	09-DEC-16	
Earliest Date	10-JAN-17	Range of Uncertainty
Latest Date	28-NOV-17	323 Calendar Days
Most Likely (50 Percentile)	01-JUL-17	

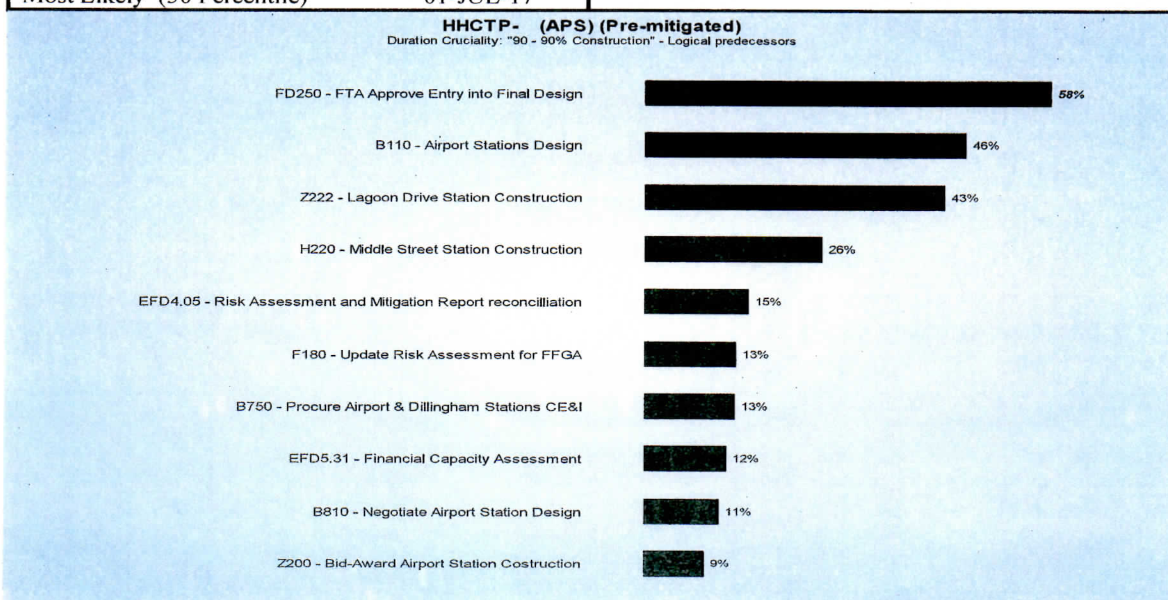
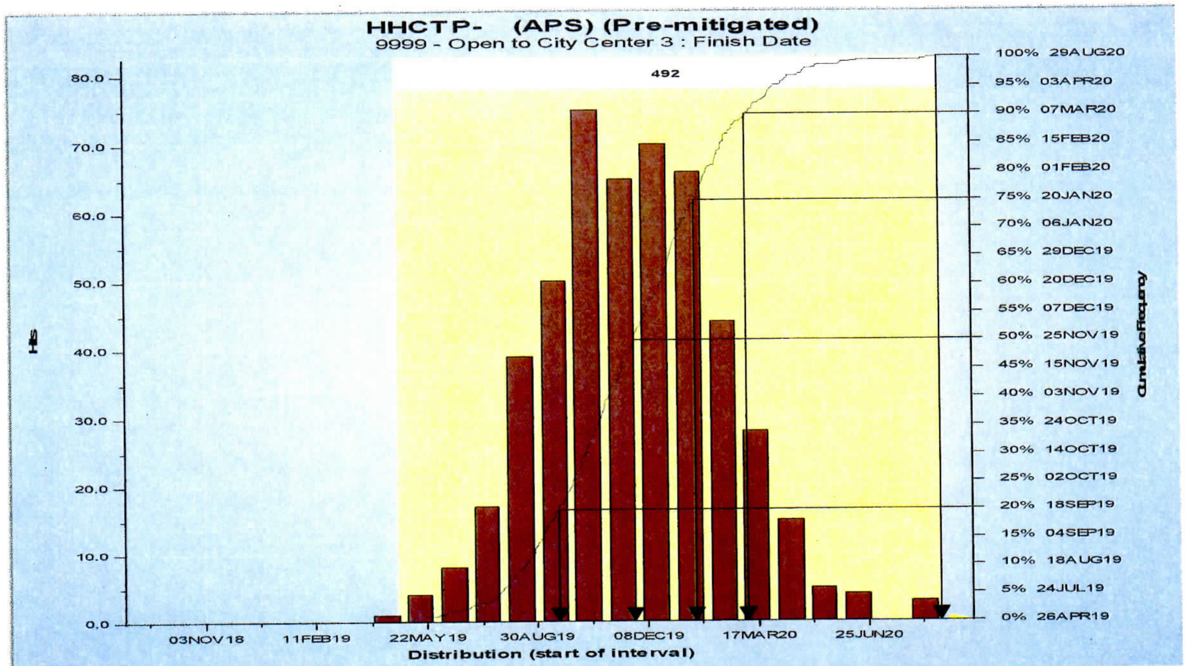
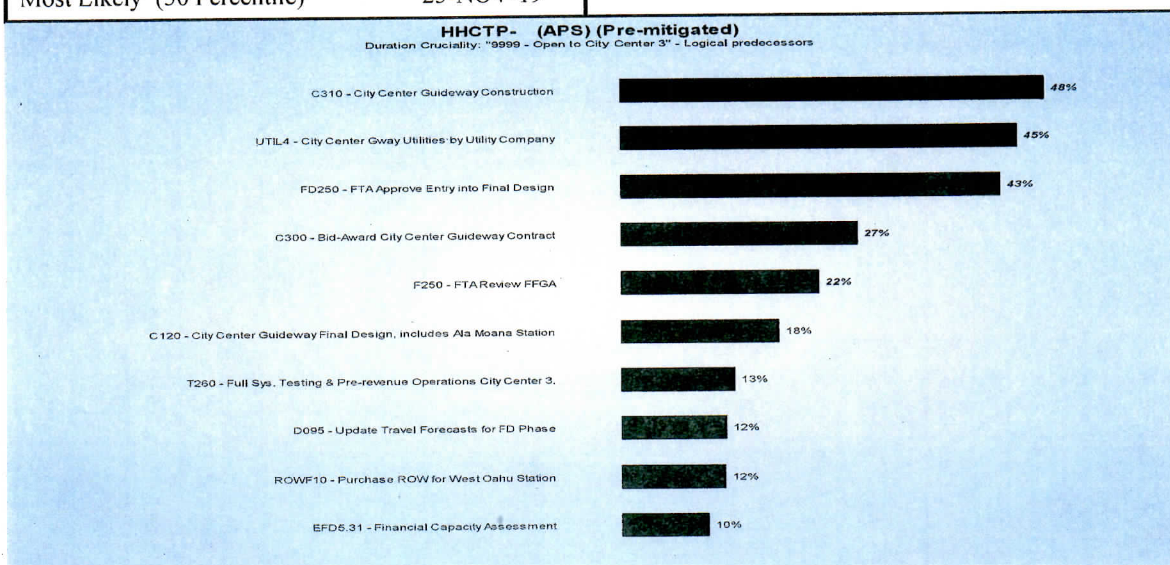


Figure 42. Activity ID 9999 "Open to City Center 3" (RSD)



Deterministic Date	23-AUG-18	
Earliest Date	26-APR-19	Range of Uncertainty
Latest Date	29-AUG-20	492 Calendar Days
Most Likely (50 Percentile)	25-NOV-19	



8.7 Risk Mitigation

8.7.1 Primary Mitigation

Grantee has provided a risk register with its identification of project risks. That list contains information related to action plans for mitigation of the identified risks. Development of a formal Risk and Contingency Management Plan (RCMP) as an integral part of the grantee's Project Management Plan is expected, including establishment within the grantee's organization of authority to ensure that the RCMP is well-managed. An acceptable RCMP was submitted on September 27, 2011. Primary mitigation is comprised of the management actions defined within the RCMP that will occur to reduce or eliminate current or future identified risks.

Findings

- RCMP includes a corresponding organizational structure that will ensure full, unbiased risk management throughout the project life
- RCMP establishes plan to monitor and mitigate high-risk rated items
- RCMP establishes a management structure for risk identification, assessment, and mitigation that has sufficient independence to manage risk without bias and to provide reliable risk reports to agency upper management
- Based on the PMOC schedule risk analysis and IRM risk plan, the following activities were identified as the most sensitive activity drivers that require the most attention during the mitigation and monitoring process. These activities and the primary Project areas that should be closely monitored for opportunities to reduce or mitigate risks and ultimately increase the probability of achieving an early project completion date/Revenue Service Date are listed below:
    - Final Design Phase
        - Provide documentation necessary to support PMOC Risk Assessment (done)
        - Revise and complete Draft Financial Plan for entry into Final Design
        - Perform Financial Capacity Assessment (FMOC)
        - FFGA Application and document preparation by grantee
        - FTA Financial Capacity Assessment (for FFGA)
        - FFGA Review by PMOC, FTA and Congressional Review
    - Construction and Startup and Testing Phase
        - Execute Core Systems Contract (DBOM)
        - Passenger Vehicle Design Engineering
        - Manufacture/Assemble Vehicles 1 through 6
        - Buy America Pre-Award Audit
        - Airport Stations Design
        - Kaka'ako Station Construction
        - Bid & Award City Center Construction
        - City Center Guideway Utilities
        - City Center Guideway Construction

8.7.2 Secondary Mitigation

Secondary mitigation consists of pre-planned potential scope or process changes that may be triggered when risk events occur that cause overruns that cannot be resolved by available project contingency. Example events that may incur secondary mitigation include right of way costs that are significantly over the estimate, or unexpected geotechnical hazards that are encountered, etc., such that the change is likely to cause a significant over-budget condition and loss of contingency for future work. Such "triggered" mitigation would enable the grantee to make cost reductions in a planned and orderly process and preserves contingencies for use later in the project. It is noted that Secondary Mitigation is not to be confused with a value engineering exercise. Value engineering is a formal, systematic, multi-disciplined process designed to optimize the value of each dollar spent.

Table 74 utilizes model information to estimate required amounts of secondary contingency. As indicated below, a weighted method was used to estimate the secondary mitigation target and recommended contingency. The weighted method took into consideration two portions of the project—the portion containing the DB and DBOM work for which the grantee has already received firm pricing, and the remaining work. These two portions were evaluated using separate risk profiles and aggregated to provide the project-level values shown. Further, after analysis of the results of this and other reviews, the PMOC evaluated the option of recommending that the grantee estimate remain static; this latter option becomes the PMOC's final recommendation.

It should be noted, however, that at this Pre-Final Design phase, secondary mitigation opportunities may have been reduced due to the state of design and the amount of work already awarded. It is recommended that the grantee quickly evaluate and maintain a list of potential secondary mitigation measures that will be available for the remainder of the work. According to OP 40 recommendations, the grantee should target a possible $594 million in secondary mitigation options, without, of course, affecting the core operational needs of the system.

Table 74. PMOC Recommended Secondary Mitigation

	Grantee values		**$ Thousand**
G1	YOE Budget w/ contingency		4,982,910
	PMOC values		
P1	YOE Adjusted estimate w/o contingency		4,169,393
	Risk assessment values		**$ Thousand**
	Target values		
T1	Secondary mitgation target (PG40)		5,576,602
T2	Wtd Contingency target (OP40 Forward pass)		4,923,485
	Analysis (Weighted method)		**$ Thousand**
A1a	F.P. Contingency % expectation	(T2-P1)/P1	18%
A2a	Available contingency	G1-P1	813,518
A3a	Recommended contingency	T2-P1	754,092
A4a	Recommended contingency shortfall	A3a-A2a	-59,425
A5a	Recommended secondary mitigation	T1-(G1+A4a)	653,117
	Analysis (Recommended static budget)		**$ Thousand**
A1b	Grantee Budget	G1	4,982,910
A2b	Available contingency	G1-P1	813,518
A3b	Recommended contingency	A2b	813,518
A4b	Recommended contingency shortfall	A3b-A2b	0
A5b	Recommended secondary mitigation	T1-(G1+A2b)	593,691

Findings

Grantee currently has only informally listed potential Secondary Mitigation options; however, grantee managers verbally recognized the need to develop secondary mitigation capacity and discussed several potential ideas in the Risk Workshop debrief.

Recommendations

Before the project advances to Final Design, the Grantee should provide a listing and a discussion of potential Secondary Mitigations and the timing at which these mitigation options are no longer available. Such secondary mitigations should not materially impact service and operating commitments.

8.7.3 Cost Contingency

The PMOC identified YOE $865.58 million in allocated and unallocated contingency. PMOC separately identified $48.9 million in latent contingency through discussions with the grantee; this amount is reflected in the "PMOC YOE Adjusted Estimate w/o Contingency" in Table 75.

Table 75. PMOC Recommended Contingency

	Grantee values		**$ Thousand**
G1	YOE Budget w/ contingency		4,982,910
G2	YOE Budget w/o contingency		4,117,330
G3	YOE contingency		865,581
	PMOC values		
P1	YOE Adjusted estimate w/o contingency		4,169,393
	Risk assessment values		**$ Thousand**
	Target values		
T1	Secondary mitgation target (PG40)		5,576,602
T2	Wtd Contingency target (OP40 Forward pass)		4,923,485
	Analysis (Weighted method)		**$ Thousand**
A1a	F.P. Contingency % expectation	(T2-P1)/P1	18%
A2a	Available contingency	G1-P1	813,518
A3a	Recommended contingency	T2-P1	754,092
A4a	Recommended contingency shortfall	A3a-A2a	-59,425
	Analysis (Recommended static budget)		**$ Thousand**
A1b	Grantee Budget	G1	4,982,910
A2b	Available contingency	G1-P1	813,518
A3b	Recommended contingency	A2b	813,518
A4b	Recommended contingency shortfall	A3b-A2b	0

The PMOC prepared a "weighted" analysis (considering work already priced –the "DB" work vs. the remainder—the "DBB/agency" work), as previously described. The weighted contingency analysis is based on historically-developed percentages that are modified by the PMOC's findings of risk. At this stage, the PMOC recommends a 13% contingency for the "DB" portion of the work and a 22% contingency for the "DBB/agency" portion of the work, equating to a weighted contingency recommendation of $754.09 million (or 18%), indicating a $59 million surplus of contingency, or 1.4%. After consideration of the risks discovered in this review, the PMOC does not recommend reducing contingency by this nominal 1.4%, however, and recommends that the grantee budget remain static, as indicated in the bottom of Table 75. Thus, it is the recommendation of the PMOC that the contingency be held at $813.5 million, with estimate adjustments made as recommended elsewhere in this report.

The following tables present a summary of the grantee's budget and the PMOC's recommended budget.

Table 76. Grantee and PMOC Budgets

Item	Grantee
YOE Budget	$5,212,910,000
Grantee Contingency (Allocated and Unallocated)	$865,580,000
Financing Costs	$230,000,000
Base Cost Estimate	**$4,117,330,000**
Contingency Percentage	21%

Item	PMOC
YOE Budget	$5,212,910,000
Grantee Contingency (Allocated and Unallocated)	$865,580,000
Financing Costs	$230,000,000
Base Cost Estimate	**$4,117,330,000**
PMOC Line Item Adjustments	$100,989,000
PMOC Accepted Latent Contingency	($48,926,000)
Adjusted BCE	**$4,169,393,000**
Recommended Contingency (Allocated and Unallocated)	$813,517,000
Contingency Percentage	19.5%

Findings

(1) Grantee and the PMOC have identified a total of YOE $865.6 million of grantee contingency within the Project estimate. An additional $48.9 million of latent contingency was also identified and was removed to arrive at the PMOC's "stripped, adjusted" estimate that was the basis of the risk assessment.

(2) The PMOC prepared a "weighted" contingency evaluation and determined that, in consideration of the findings of the risk review, the PMOC recommends that the grantee's budget not change. With estimate adjustments as recommended, the grantee's contingency would be held at $813.5 million, or 19.5%.

Recommendations

(1) The grantee should hold its current budget of $5.213 billion. This budget should include $230.0 million in finance costs and $813.5 million in contingency (allocated and unallocated), or 19.5% of the Adjusted BCE.

8.7.4 Schedule Contingency

Adjusted Project Schedule (APS)

The APS was used for both the schedule risk assessment and the Contingency Analysis Review. The APS is a backup copy of the grantee's Master Project Schedule (MPS) with adjustments made to logic, calendars and incorporation of additional activities to better represent actual critical paths and pre-construction tasks specific to entry into the Final Design phase and FFGA application. The APS is also stripped of all patent and latent contingency. Because the APS is pre-analysis, not containing estimate uncertainty or risk events, it is considered most optimistic, as it is stripped of all latent and patent time contingency.

Contingency Analysis

The objective of the contingency analysis, pursuant to OP 40 is to estimate the minimum amount of schedule contingency required to complete the project on schedule. The FTA guidance states that the contingency recommendations shall be developed using the following assumptions:

- At the Revenue Service Date, schedule contingency requirements have been reduced to a minimum requirement or possibly eliminated
- At the point of 100% complete with bid, the project should have sufficient schedule contingency available to absorb a schedule delay equivalent to 20% of the duration from Entry into Final Design through Revenue Operations.

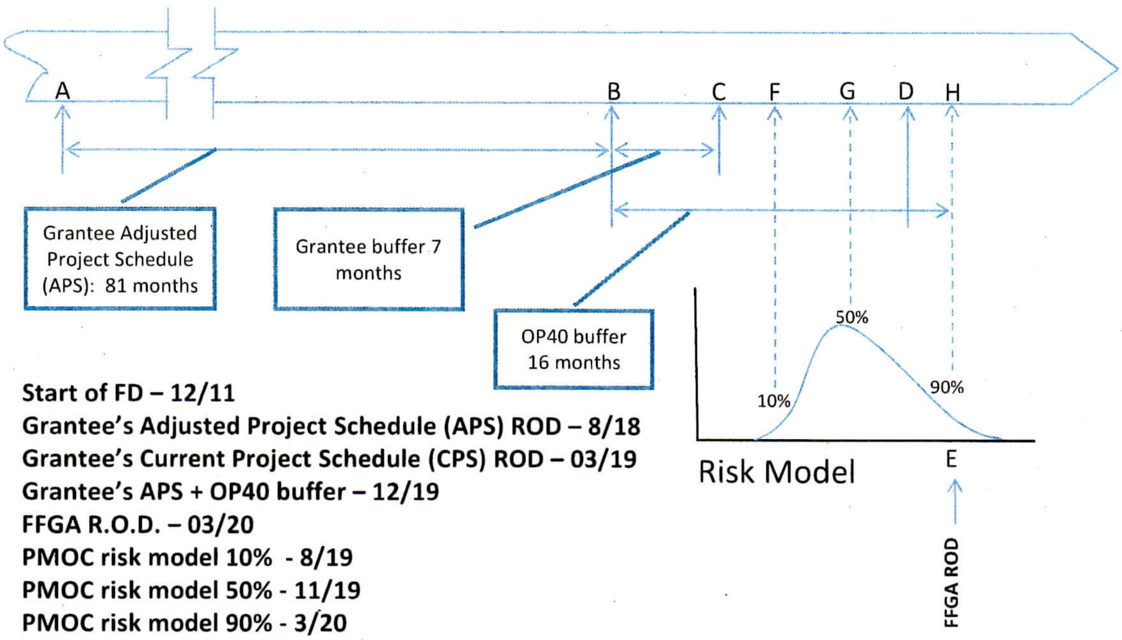
The APS indicates an 80.7-month duration from the start of the APS Final Design through RSD. According to the OP 40, the project should contain the equivalent of 20% of this duration as contingency. The result is a contingency buffer total of 16.1 months. The result of adding 16.1 months contingency to the APS RSD (22-Aug-18) is shown in the table below. The OP 40 buffer float calculation results in a projected RSD of December 20, 2019.

Table 77. Schedule Contingency Final Design through RSD

APS Entry to Final Design	APS RSD	Duration			20% Float Duration			APS RSD 20% Float added to RSD	CPS RSD Date	Additional Float Required (Variance)		
		Days	Months	Yrs	Days	Months	Yrs			Days	Months	Yrs
30-Dec-11	22-Aug-18	2,427	80.7	6.65	485	16.1	1.3	20-Dec-19	04-Mar-19	291	9.5	0.8

The figure below illustrates the same information relative to the PMOC Schedule Risk Analysis IRM dates plotted for the 10, 50 and 90th percentiles represented by letters F, G and H, respectively. The OP 40 calculation for buffer float and the PMOC IRM 90th percentile both reflect a Project Completion Date of March 2020.

Figure 43. Buffer Float and RSD Analysis



- **A. Start of FD – 12/11**
- **B. Grantee's Adjusted Project Schedule (APS) ROD – 8/18**
- **C. Grantee's Current Project Schedule (CPS) ROD – 03/19**
- **D. Grantee's APS + OP40 buffer – 12/19**
- **E. FFGA R.O.D. – 03/20**
- **F. PMOC risk model 10% - 8/19**
- **G. PMOC risk model 50% - 11/19**
- **H. PMOC risk model 90% - 3/20**

Findings

(1) The PMOC APS indicates a RSD of August 22, 2018, seven months earlier than the grantee's Current Project Schedule RSD of March 4, 2019.

(2) Per OP 40, the 20% duration calculation of the start of Final Design to RSD duration (80.7 months) equals a contingency buffer amount of 16.1 months. The OP 40 buffer float projected RSD is December 2019.

(3) The OP 40 buffer float project RSD of December 2019 equals the PMOC schedule risk assessment IRM 60th percentile level of confidence of December 2019.

(4) The PMOC risk assessment IRM 90th percentile level of confidence for RSD is March 2020.

(5) The Contingency Review Analysis calculation generates an RSD date of December 2019. The PMOC believes that this calculation is within reason as it falls on the 60th percentile of the PMOC's schedule risk assessment model.

Recommendations

(1) The Revenue Service Date should be no earlier than the first quarter of calendar year 2020.

8.8 Conclusion

(1) The early bidding for DB guideway and MSF work and design-build-operate-maintain systems and vehicles work has significantly reduced market risk, since

competitive pricing has been received and incorporated into its estimates.

(2) Most design risk and much construction risk associated with this work has been transferred to the contractors through their pricing, and therefore the budget already includes these risks.

(3) However, the early contracting of this work has created a potential for technical performance risk, since the grantee must develop a new project organization to manage a quickly-developing and very large construction effort.

(4) In addition, this is an extremely large project, and historically such projects are found to exhibit high-risk profiles.

(5) Other project-specific risks include inefficiencies due to a potentially high number of individually-awarded station, design, and guideway contracts for the remaining work, and a potentially un-competitive bid market due to market perceptions of advantages held by the current contractor.

(6) Further, the remaining work on this project extends into increasingly-dense urban areas, increasing the risk of third-party interferences and unexpected underground utility and archaeological conditions.

(7) The grantee has developed a formal Risk and Contingency Management Plan (RCMP) that:

- conforms to the structure suggested in OP 40
- includes a corresponding organizational structure that will ensure full, unbiased risk management throughout the project life
- monitors and mitigates high-risk rated items through implementation of the RCMP
- establishes a management structure for risk identification, assessment, and mitigation that has sufficient independence to manage risk without bias and to provide reliable risk reports to agency upper management
- includes a contingency management, release, and tracking mechanism
- includes cost and schedule contingency draw-down curves
- establishes corrective action plans to be used if it becomes evident that its contingency levels may fall below the limits established in the contingency draw-down curve
- identifies potential Secondary Mitigations and the timing at which these mitigation options are no longer available (such secondary mitigations should not materially impact service and operating commitments)
- Targets a possible $267 million in secondary mitigation options

(8) Grantee and the PMOC have identified a total of YOE $865.6 million of grantee contingency within the Project estimate. A further $48.9 million of latent contingency was also identified and was removed to arrive at the PMOC's "stripped, adjusted" estimate that was the basis of the risk assessment.

(9) The PMOC prepared a "weighted" contingency evaluation and determined that, in consideration of the findings of the risk review, the PMOC recommends that the grantee's budget not change.

(10) The Schedule Contingency Review Analysis calculation generates a Revenue Service Date (RSD) date of December 2019. The PMOC believes that this calculation is within reason as it falls on the 60th percentile of the PMOC's schedule risk assessment model.

8.9 Recommendations

The PMOC recommends the following actions be taken before Final Design:

(1) The grantee should hold its current budget of \$5.213 billion. This budget should include \$230.0 million in finance costs and \$813.5 million in contingency (allocated and unallocated), or 19.5% of the Adjusted BCE.

(2) The Revenue Service Date should be no earlier than the first quarter of calendar year 2020.

APPENDICES

Appendix A: List of Acronyms

A	▪ Ampere
AA	▪ Alternatives Analysis
AACE	▪ Association for the Advancement of Cost Engineering
AC	▪ Alternating Current
ACT ID	▪ Activity Identification
ADA	▪ Americans with Disabilities Act
AHJV	▪ Ansaldo Honolulu Joint Venture
ANSI	▪ American National Standards Institute
APB	▪ Absolute Permissive Block
APS	▪ Adjusted Project Schedule
APTA	▪ American Public Transportation Association
ASCE	▪ American Society of Civil Engineers
ASHRAE	▪ American Society of Heating, Refrigerating and Air-Conditioning Engineers
ASME	▪ American Society of Mechanical Engineers
ASTM	▪ ASTM International, nee, American Society for Testing and Materials
ATC	▪ Alternative Technical Concept
ATC	▪ Automatic Train Control
ATO	▪ Automatic Train Operation
BAFO	▪ Best and Final Offers
BCE	▪ Base Cost Estimate
BEA	▪ Bureau of Economic Analysis
BFMP	▪ Bus Fleet Management Plan
BLS	▪ Bureau of Labor Statistics
BOS	▪ Basis of Schedule
BRF	▪ Beta Risk Factor
BRIC	▪ Brazil, Russia, India and China
CBTC	▪ Communications-Based Train Control
CC	▪ Community College
CE&I	▪ Construction Engineering and Inspection
CER	▪ Cost Estimating Relationship
CIH	▪ Central Instrument Hut
CIL	▪ Central Instrument Location
CIR	▪ Central Instrument Room
CMP	▪ Configuration Management Plan
CMS	▪ Document Management System
COTS	▪ Commercial off-the-Shelf
CPI	▪ Consumer Price Index
CPM	▪ Critical Path Method
CPP	▪ Contract Packaging Plan
CPS	▪ Construction Project Schedule
CPS	▪ Current Probable Schedule
CSC	▪ Core Systems Contract
DB	▪ Design-Build
DBB	▪ Design-Bid-Build
DBEDT	▪ Hawaii Department of Business Economic Development and Tourism
DBOM	▪ Design-Build-Operate-Maintain
DC	▪ Direct Current
DEIS	▪ Draft Environmental Impact Statement
DHHL	▪ Department of Hawaiian Homelands
DOT	▪ United States Department of Transportation
DTS	▪ Department of Transportation Services

ECP	▪	Environmental Condition of Property
EDC	▪	Engineering Design Consultant
EIS	▪	Environmental Impact Statement
ENR	▪	Engineering News Record
ERTMS	▪	European Rail Traffic Management System
EUM	▪	Estimate Uncertainty Model
FAA	▪	Federal Aviation Administration
FAQ	▪	Frequently Asked Questions
FD	▪	Final Design
FEIS	▪	Final Environmental Impact Statement
FF	▪	Finish-Finish
FFGA	▪	Full Funding Grant Agreement
FMOC	▪	Financial Management Oversight Consultant
FS	▪	Finish-Start
ft	▪	Foot
FTA	▪	Federal Transit Administration
FY	▪	Fiscal Year
GBS	▪	Gap Breaker Station
GDP	▪	Gross Domestic Product
GEC	▪	General Engineering Consultant
GET	▪	General Excise Tax
GPRM	▪	Great Pacific Rocky Mountain
HART	▪	Honolulu Authority for Rapid Transportation
HDOT	▪	Hawaii Department of Transportation
HECO	▪	Hawaiian Electric Company
HHCTC	▪	Honolulu High Capacity Transit Corridor
HHCTCP	▪	Honolulu High Capacity Transit Corridor Project
HNL	▪	Honolulu International Airport
HVAC	▪	Heating, Ventilating, and Air Conditioning
ICD	▪	Interface Control Document
IEEE	▪	Institute of Electrical and Electronics Engineers
IPS	▪	Integrated Project Schedule
IRM	▪	Impacted Risk Model
KH (or KHG)	▪	Kamehameha Highway (or Kamehameha Highway Guideway)
kW	▪	Kilowatt
LCD	▪	Liquid Crystal Diode
LONP	▪	Letter of No Prejudice
LPA	▪	Locally Preferred Alternative
LV	▪	Low Voltage
M&I	▪	Manufacture and Install
MDBCF	▪	Mean Distance between Component Failure
MFPR	▪	Multifunction Protective Relay
MIL	▪	Military Specification
MOS	▪	Minimum Operating Segment
MOT	▪	Maintenance of Traffic
mph	▪	Miles Per Hour
mphps	▪	Miles Per Hour Per Second
MPS	▪	Master Project Schedule
MS	▪	Microsoft
MSF	▪	Maintenance and Storage Facility
MSS	▪	Master Summary Schedule
MTTR	▪	Mean Time to Repair
MVA	▪	Mega Volt Ampere
MW	▪	Megawatt
NBER	▪	National Bureau of Economic Research
NEMA	▪	National Electrical Manufacturers Association

NEPA	▪	National Environmental Policy Act
NFPA	▪	National Fire Protection Association
NGD	▪	Negative Grounding Device
NTP	▪	Notice to Proceed
O&M	▪	Operations and Maintenance
OBS	▪	Organizational Breakdown Structure
OCC	▪	Operations Control Center
OCIP	▪	Owner Controlled Insurance Program
OCS	▪	Overhead Contact System
OD	▪	Original Duration
OD	▪	Original Duration
OP	▪	Oversight Procedure
PA	▪	Programmatic Agreement
PB	▪	Parsons Brinckerhoff
PE	▪	Preliminary Engineering
PHF	▪	Peak Hour Factor
PLA	▪	Project Labor Agreement
PLC	▪	Programmable Logic Controller
PMBOK	▪	Project Management Institute's Body of Knowledge
PMC	▪	Project Management Support Consultant
PMO	▪	Project Management Oversight
PMOC	▪	Project Management Oversight Contractor
PMP	▪	Project Management Plan
PPI	▪	Producer Price Index
QA/QC	▪	Quality Assurance/Quality Control
QMP	▪	Quality Management Plan
RA	▪	Risk Assessment
RAM	▪	Responsibility Assignment Matrix
RAMP	▪	Real Estate Acquisition and Management Plan
RBC CBTC	▪	Radio Block-Centered Communications-Based Train Control
RCMP	▪	Risk and Contingency Management Plan
RFMP	▪	Rail Fleet Management Plan
RFP	▪	Request for Proposals
rms	▪	Root Mean Squared
ROD	▪	Record of Decision
ROW	▪	Right-of-Way
RSD	▪	Revenue Service Date
RTD	▪	Rapid Transit Division
SBS	▪	Schedule Breakdown Structure
SCC	▪	Standard Cost Category
SF	▪	Start-Finish
SOA	▪	State Oversight Agency
SS	▪	Start-Start
SSCP	▪	Safety and Security Certification Plan
SSMP		Safety and Security Management Plan
TC	▪	Train Control
TC&C	▪	Technical Capacity and Capability
TCCR	▪	Train Control and Communications Room
TCRP	▪	Transit Cooperative Research Program
TES	▪	Train Electrification System
TPM	▪	Office of Program Management
TPSS	▪	Traction Power Substation
TRB	▪	Transportation Research Board
TRU	▪	Transformer-Rectifier Unit
TVM	▪	Ticket Vending Machine
UH	▪	University of Hawaii

UHERO	▪	University of Hawaii Economic Research Organization
UL	▪	Underwriters Laboratories
UPS	▪	Uninterruptible Power Supply
US	▪	United States of America
USB	▪	Universal Service Bus
USDOT	▪	United States Department of Transportation
USN	▪	United States Navy
V	▪	Volt
VDC	▪	Volts, Direct Current
VE	▪	Value Engineering
VTA	▪	Verification, Test, and Acceptance
WBS	▪	Work Breakdown Structure
WOFH	▪	West Oahu/Farrington Highway
YOE	▪	Year of Expenditure

Appendix B: Documents Reviewed

Document	Rev. No.	Date
Final Environmental Impact Statement	-	25-Jun-10
Programmatic Agreement	-	18-Jan-11
Record of Decision	-	18-Jan-11
Project Management Plan	4	01-Apr-11
Quality Management Plan (QMP)	0	06-Jan-11
Real Estate Acquisition and Management Plan (RAMP)	4	01-Feb-11
Bus Fleet Management Plan (BFMP)	2	09-Jun-10
Rail Fleet Management Plan (RFMP)	0	08-Jul-11
Safety and Security Management Plan (SSMP)	2	01-Jun-11
Safety and Security Certification Plan (SSCP)	1	01-Jun-11
Configuration Management Plan (CMP)	0	05-Jan-11
Staffing Plan	3	11-Mar-11
Operating Plan		06-Apr-11
Force Account Plan	0	May-11
Mitigation Monitoring Program	0	18-Feb-11
Interface Management Plan	0	29-Mar-11
Contract Packaging Plan	2	09-Mar-11
Claims Avoidance Plan	0	06-Apr-11
Construction Management Plan	0	12-Apr-11
1.PP-02 – Procedure Development Process	0	16-Mar-11
1.PP-03 – Standard Terms, definitions, and Acronyms	0	26-May-11
1.PP-04– Baseline Documents Revision and Control	0	12-Jan-11
2.PA-01 – Security Sensitive Information (SSI)	0	26-May-11
2.PA-02 – Procurement Control	0	19-May-11
2.PA-03 – Email Management	0	05-May-11
2.PA- 04- Project Wide Document Control	0	26-May-11
2.PA-05 – Project Library	0	05-May-11
2.PA-06 – Community Relations and Media Contacts	0	16-Mar-11
2.PA-07 – RTD Training Procedure	0	26-May-11
3.PM-01 – Contract Management System	0	16-Mar-11
3.PM-04 – Public Information Communication	0	16-Mar-11
3.PM-05 Meeting/Minutes	0	16-Mar-11
4.PC-03 – Project Progress Reports	0	16-Mar-11
4.PC-04 – Program Scheduling	0	10-Jan-11
4.PC-05 – Project Accounting	0	26-May-11
4.PC-06 – Cost Estimating	0	05-May-11
4.PC-07 – Cost Control	0	05-May-11
4.PC-08 – Risk Management	0	26-May-11
4.PC-09 – Contingency Management	0	16-Mar-11
5.CA-01 – Contract Administration	0	26-May-11
5.CA-02 – Contract Change Management	0	16-Mar-11
5.CA-03 – Contractor Progress Payments	0	16-Mar-11
5.CA-04 – Contractor Progress Reports	0	08-Apr-11
5.CA-05 – Contract Change Orders	0	16-Mar-11
5.CA-06 – Contract Closeout	0	16-Mar-11
5.CA-07 – Claims and Disputes Resolution	0	05-May-11
6.CM-01 – Submittal Procedure	0	05-May-11
6.CM-02 – RFI Procedure	0	18-Apr-11

Document	Rev. No.	Date
6.CM-03 – RFC Procedure	0	16-Mar-11
6.CM-05 – Interface Management and Coordination Procedure	0	26-May-11
1992 Honolulu Rapid Transit Development Project System Procurement Contract & Methodology *[1992 Original Estimate]*		30-Aug-91
Basis of Capital Cost Escalation Rates		17-Sep-08
Basis of Current Airport DEIS Estimate		12-May-09
Basis of Schedule.doc		20-Sep-08
Bus Fleet Management Plan (BFMP), Revision 0		4-Apr-08
Capital Cost Breakdown with GET 09-Jun-09.xls		9-Jun-09
Constr Sched Assumption Notes.pdf		28-Aug-08
Construction Workshop Frequently Asked Questions (FAQ)		12-Jun-08
Construction Workshop Presentation		12-Jun-08
CPM Schedule (CITY.pdf)		20-Sep-08
Current Geotechnical Investigation Program boring logs and boring location map		
DEIS-FEIS Audit Trail		4-Jun-09
DRAFT Contract Packaging Plan, Revision 2		5-Feb-09
DRAFT Design Criteria		
Chapter 1 – General		23-Feb-09
Chapter 2 – Operations		3-Feb-09
Chapter 3 – Environmental		23-Feb-09
Chapter 4 – Track Alignment and Vehicle Clearances		Jan-09
Chapter 5 – Trackwork		15-Dec-08
Chapter 6 – Civil		Jan-09
Chapter 7 – Traffic		Jan-09
Chapter 8 – Utilities		Mar-09
Chapter 9 – Structural		22-May-09
Chapter 10 – Architecture		20-Oct-08
Chapter 11 – Landscape Architecture		18-Sep-08
Chapter 12 – Revenue Vehicle		Mar-09
Chapter 13 – Traction Electrification		17-Feb-09
Chapter 17 – Corrosion Control		15-Dec-08
Chapter 19 – Facility Mechanical		Jan-09
Chapter 20 – Facilities Electrical		Jan-09
Chapter 22 – Elevators and Escalators		
Chapter 23 – Fire Life Safety		2-Feb-09
Chapter 26 – Sustainability		Mar-06
Draft Environmental Impact Statement (DEIS) Honolulu High-Capacity Transit Corridor Project		30-Oct-08
DRAFT HHCTCP Cost Escalation Forecast Report FY 2009-2019		Mar-09
EIS_Appendix A Plan and Profile March 2009.pdf		Mar-09
Escalation Build-up.xls		10-Jun-09
FEIS Conceptual Alignment Plan and Profile		Mar-09
Final Capital Costing Memorandum *[October 2006 Memo]*		23-Oct-06
Final Evaluation of Project Delivery Options		2-Nov-06
Financial Plan For Entry Into Preliminary Engineering Submittal		1-May-09
Fixed Guideway Fleet Sizing Report		Jun-09
General Conditions Of Construction Contracts		Jul-99
General Excise and Use Tax in Hawaii		16-Feb-06
Geotechnical and Geological Reconnaissance, Honolulu Rapid Transit System,		31-Aug-91

Document	Rev. No.	Date
Ewa and Honolulu, Hawaii		
Geotechnical Engineering Exploration, North-South Road, Phase 1B, F.A.I. Project No. STP-8930(2), Ewa, Hawaii		8-Feb-07
GET Forecast FY 2009-2023 Memo (Update)		27-Mar-09
Guideway Superstructure Study – Summary Report		22-May-08
HHCTC Project Basis of Capital Cost Escalation Rates		17-Sep-08
HHCTC Project Letter on cost of Leeward Community College Underground station		19-Sep-08
HHCTCP Post Alternative Analysis Estimate Methodology		26-Aug-08
Quality Management Plan, Revision 1		8-May-09
Honolulu High-Capacity Transit Corridor Project, Steel Wheel Technology - Evaluation of Vehicle Types		12-Jun-08
Honolulu Linear Schedule		Jun-09
Honolulu Linear Schedule 01 jun 09.pdf		1-Jun-09
Honolulu Rapid Transit Development Project; System Design, Supply, Construction, and Operation & Maintenance; Geotechnical Engineering Exploration		Mar-91
Honolulu Rapid Transit Program; Hotel Street Subway Design, Supply, and Construction; Geotechnical Basis for Proposal		Jul-91
Honolulu Rapid Transit Program; Hotel Street Subway Design, Supply, and Construction; Geotechnical Engineering Exploration		Jul-91
Honolulu Rapid Transit Program; Task 17.01– 40, Preliminary Geotechnical Exploration Report, King Street Subway Alignment Study		Mar-92
MA5A.PRX		
Master Program Schedule MA5E.pdf		10-May-09
Master Project Schedule Basis of Schedule		26-Mar-09
Model Assumptions, ProjectSolve\Technical\Alignment Information		11-Sep-08
Modified AA Estimate (assembly & parametric summary), filename "Baseline 30 w T2.xls" *[2008 SCC Support Spreadsheet]*		19-Aug-08
MU Airport Alignment 3-27-09.xls		27-Mar-09
PB Cost Estimate and Estimating Methodology *[2006 Parametric Estimate]*		30-Jun-06
Procurement Methods / Project Delivery / Schedule Presentation		9-Sep-08
Project Management Plan, Revision 2		1-Mar-09
Project Orientation Presentation		9-Sep-08
Proposed Construction Schedule, "HHCTP As of August 25.xer"		25-Aug-08
Rapid Transit Division Standard And Directive Drawings		3-Apr-09
Real Estate Acquisition Management Plan, Revision 2		14-Apr-09
Revised Construction Schedule w Assumptions.pdf		28-Aug-08
RFP-DTS-0900015 – West Oahu/Farrington Highway Guideway Design-Build Contract and Addenda 1-6		4-Feb-09
RFP-DTS-198413 - Core Systems Design-Build-Operate-Maintain Contract and Addenda 1-5		9-Apr-09
RFP-DTS-213102 – Maintenance and Storage Facility Design-Build Contract and Addenda 1		29-May-09
Safety and Security Management Plan (SSMP), Rev 0		11-Mar-08
SCC New Starts Estimate for Airport Alternative *[2009 SCC Estimate]*		9-Jun-09
SCC New Starts Estimate for Salt Lake Alternative *[2008 SCC Estimate]*		3-Sep-08
SCC vs Time 3-27-09 rev.xls		27-Mar-09

Document	Rev. No.	Date
Schedule Progress Submittal 7.pdf		2-Sep-08
Structures Workshop Summary Report		7-10-Jan-08
Subsurface Geology of Waikiki, Moiliili and Kakaako With Engineering Application, Masters Thesis submitted to the University of Hawaii		Aug-76
Systems Workshop Presentation		22-Aug-08
Takeoff Audit Report/HHCT/Modified AA Estimate (assembly examples)		9-Sep-08
Technical Memorandum on Utility Relocations *[2007 MK Utility Estimate]*		14-May-07
Transportation Technical Report		1-Aug-08
West Oahu/Farrington Highway Guideway Design-Build Contract Structural Plan and Profile Drawings		24-Mar-09
Kamehameha Highway Guideway RFP Drawings, Volumes 1-3	Con-formed	Sep-10
Airport Preliminary Engineering Drawings, Volumes 1-3		1-Oct-10
City Center Preliminary Engineering Drawings, Volumes 1-4		6-Oct-10
Value Engineering – Stations Report		Sep-10
Value Enhancement Summary Report		Sep-10
Geotechnical Data Report (WOFH)		27-Mar-09
Supplement to Geotechnical Data Report (WOFH)		15-May-09
Geotechnical Baseline Report (WOFH)	2.0	Aug-09
General Conditions of Design-Build Contracts, Honolulu		Feb-09
WOFH Standard Specifications, Conformed Set		5-Aug-09
WOFH Special Provisions (RFP Addendum No. 23)		19-Oct-09
KH Segment Geotechnical Baseline Report	1.1	07-May-10
KH Geotechnical Data Report		16-Feb-10
KH Geotechnical Data Report Addendum		7-May-10
Airport Geotechnical Data Report		8-Feb-10
Airport Fixed-Guideway Foundation Technical Memorandum		6-Feb-10
City Center Fixed-Guideway Foundation Technical Memorandum		26-Feb-10
City Center Geotechnical Data Report		26-Feb-10
Environment Condition of Property, NAVFAC (Navy Drum Site)		Mar-09
Core Systems DBOM TP-9: Design Criteria		Oct-10
CSC RFP & Addenda		9-Feb-11
AHJV 2nd BAFO Proposal		24-Feb-11
Before and After Milestone 1 Report		Nov-09
East Kapolei Station PE Drawings		25-Sep-09
UH West Oahu Station PE Drawings		25-Sep-09
Ho'opili Station PE Drawings		25-Sep-09
West Loch Station PE Drawings		18-Sep-09
Waipahu Transit Center Station PE Drawings		18-Sep-09
Leeward Community College Station PE Drawings		18-Sep-09
Pearl Highlands Station & Parking Structure PE Drawings		11-Sep-09
Pearlridge Station PE Drawings		18-Dec-09
Aloha Stadium Station PE Drawings		18-Dec-09
Pearl Harbor Naval Base Station PE Drawings		15-Jan-10
Honolulu International Airport Station PE Drawings		15-Jan-10
Lagoon Drive Station PE Drawings		
Middle Street Transit Center Station PE Drawings		13-Nov-09
Kalihi Station PE Drawings		13-Nov-09
Kapalama Station PE Drawings		13-Nov-09
Iwilei Station PE Drawings		25-Nov-09
Chinatown Station PE Drawings		25-Nov-09

Document	Rev. No.	Date
Downtown Station PE Drawings		25-Nov-09
Civic Center Station PE Drawings		20-Nov-09
Kaka'ako Station PE Drawings		20-Nov-09
Ala Moana Center Station PE Drawings		8-Jan-10
Master Project Schedule (MPS)		9-Jul-11
ROW Schedule		9-Jul-11
Basis of Schedule		2-Jul-11
Various Schedule support files (*.xls, *. xer, *.pdf)		Various
PE Cost Estimate 2010 10-21.pdf		21-Nov-10
PE Cost Estimate & Basis of Estimate 2010 12-21.pdf		21-Dec-10
PE Cost Estimate & Basis of Estimate 2011 03-18.pdf		25-Mar-10
PE Cost Estimate –SCC Summary + escalation 47 separate Excel Files (Summary Sheets for Contracts)		25-Mar-10
PE Cost Estimate – Timberline Files		28-Mar-11
Identification of Latent Contingency_15April2011.pdf (includes other adjustment details for ROW, NTPs etc)		15-Apr-11
PE Cost Estimate – Station quantity takeoffs		10-Dec-10
Basis of Escalation formatted and combined.doc		25-Mar-10
Hnl Escalation June 2010 Final.pdf (White Paper)		Jun-10
Programmatic Agreement PA Jan 4 2011.pdf		5-Jan-11
HHCTP Internal Risk Assessment (handout & file)		10-Jan-11
HHCTP Internal Risk Assessment (revised)		21-Apr-11
Revised PE Estimate Final 12-9-10 Breakout GET+Alloc Cont.xls		25-Feb-11
HHCTP RE Revised Utilities_RHH 04-22-10.pdf		25-Feb-10
MOT PE Estimate.pdf		25-Feb-10
MPS_Spread.accdb (MS Access Database)		14-Apr-11
FTA B A Study Plan – Spring 2011 Update.pdf		21-Apr-11
Draft Before& After Study Plan.pdf		21-Apr-11
Contract Packaging Plan Revision 2 – 2.24.2011.pdf		24-Feb-11
Before& After Study Plan Milestone 1 Report.pdf		21-Apr-11
Price Proposals (post bid) Kiewit WOFH		11-Nov-09
Price Proposals (post bid) Kiewit MSF		16-Mar-11
Price Proposals (post bid) Kiewit Kamehameha		16-Mar-11
Price Proposals (post bid) Ansaldo Core Systems		16-Mar-11
Ansaldo explanation of FFGA calculated amount.xls		14-Apr-11

Appendix C: SCC Worksheet

MAIN WORKSHEET-BUILD ALTERNATIVE

(Rev.13, June 1, 2010)

City and County of Honolulu | Data Consistent with March Submittal and April Financial Plan | Today's Date July 2011

Honolulu Rail Transit Project, East Kapolei to Ala Moana Center | Yr of Base Year $ FY 2011

Entry into Final Design | 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)	20.05	970,450	163,893	**1,134,343**	**$ 56,567**	**40%**	**25%**	**1,308,357**
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	19.45	895,508	153,347	1,048,855	$ 53,921			1,210,392
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	0.60	6,038	906	6,944	$ 11,547			7,402
10.09 Track: Direct fixation		65,071	8,997	74,068				85,257
10.10 Track: Embedded				0				0
10.11 Track: Ballasted		2,434	365	2,799				3,103
10.12 Track: Special (switches, turnouts)		1,398	279	1,677				2,204
10.13 Track: Vibration and noise dampening				0				0
20 STATIONS, STOPS, TERMINALS, INTERMODAL (number)	**21**	413,494	83,421	**496,915**	**$ 23,663**	**18%**	**11%**	**614,602**
20.01 At-grade station, stop, shelter, mall, terminal, platform	1	6,179	1,266	7,445	$ 7,445			8,346
20.02 Aerial station, stop, shelter, mall, terminal, platform	20	303,514	61,520	365,034	$ 18,252			449,606
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		49,595	9,798	59,393				77,918
20.07 Elevators, escalators		54,206	10,837	65,043				78,732
30 SUPPORT FACILITIES: YARDS, SHOPS, ADMIN. BLDGS		84,955	11,044	**95,999**	**$ 4,787**	**3%**	**2%**	**103,805**
30.01 Administration Building: Office, sales, storage, revenue counting				0				0
30.02 Light Maintenance Facility		6,968	906	7,874				8,511
30.03 Heavy Maintenance Facility		35,023	4,553	39,577				42,778
30.04 Storage or Maintenance of Way Building		7,157	930	8,087				8,742
30.05 Yard and Yard Track		35,806	4,655	40,461				43,774
40 SITEWORK & SPECIAL CONDITIONS		769,739	134,943	**904,682**	**$ 45,114**	**32%**	**20%**	**1,021,458**
40.01 Demolition, Clearing, Earthwork		15,119	2,321	17,440				19,917
40.02 Site Utilities, Utility Relocation		260,743	59,729	320,472				358,376
40.03 Haz. mat'l, contam'd soil removal/mitigation, ground water treatments		6,064	727	6,791				7,533
40.04 Environmental mitigation, e.g. wetlands, historic/archeologic, parks		23,302	3,527	26,829				30,802
40.05 Site structures including retaining walls, sound walls		16,309	2,589	18,897				22,936
40.06 Pedestrian / bike access and accommodation, landscaping		30,987	5,878	36,865				44,675
40.07 Automobile, bus, van accessways including roads, parking lots		148,564	25,582	174,146				212,929
40.08 Temporary Facilities and other indirect costs during construction		268,650	34,590	303,241				324,290
50 SYSTEMS		184,135	23,404	**207,539**	**$ 10,350**	**7%**	**5%**	**251,587**
50.01 Train control and signals		69,023	8,283	77,305				92,601
50.02 Traffic signals and crossing protection		8,693	1,875	10,569				13,043
50.03 Traction power supply: substations		24,172	2,911	27,083				33,801
50.04 Traction power distribution: catenary and third rail		27,892	3,806	31,698				37,347
50.05 Communications		43,917	5,277	49,194				60,602
50.06 Fare collection system and equipment		7,484	898	8,382				10,324
50.07 Central Control		2,953	354	3,308				3,868
Construction Subtotal (10 - 50)		2,422,773	416,706	**2,839,479**	**$ 141,598**	**100%**	**62%**	**3,299,810**
60 ROW, LAND, EXISTING IMPROVEMENTS		172,750	69,100	**241,850**	**$ 12,061**		**5%**	**247,942**
60.01 Purchase or lease of real estate		157,534	63,013	220,547				224,649
60.02 Relocation of existing households and businesses		15,217	6,087	21,303				23,293
70 VEHICLES (number)	**80**	156,722	18,807	**175,529**	**$ 2,194**		**4%**	**212,461**
70.01 Light Rail				0				0
70.02 Heavy Rail	80	140,149	16,818	156,967	$ 1,962			191,857
70.03 Commuter Rail				0				0
70.04 Bus				0				0
70.05 Other				0				0
70.06 Non-revenue vehicles		11,825	1,419	13,244				14,590
70.07 Spare parts		4,748	570	5,318				6,214
80 PROFESSIONAL SERVICES (applies to Cats. 10-50)		839,408	82,699	**922,107**	**$ 45,983**	**32%**	**20%**	**1,031,047**
80.01 Preliminary Engineering		51,183	4,729	55,911				58,997
80.02 Final Design		193,096	21,227	214,323				222,178
80.03 Project Management for Design and Construction		284,185	24,875	309,060				350,329
80.04 Construction Administration & Management		145,688	14,569	160,257				187,915
80.05 Professional Liability and other Non-Construction Insurance		43,569	4,357	47,926				56,104
80.06 Legal; Permits; Review Fees by other agencies, cities, etc.		55,745	5,574	61,319				69,918
80.07 Surveys, Testing, Investigation, Inspection		5,118	485	5,603				6,073
80.08 Start up		60,824	6,883	67,708				79,534
Subtotal (10 - 80)		3,591,653	587,312	**4,178,965**	**$ 208,396**		**92%**	**4,791,260**
90 UNALLOCATED CONTINGENCY				**167,159**			**4%**	**191,650**
Subtotal (10 - 90)				**4,346,124**	**$ 216,732**		**96%**	**4,982,911**
100 FINANCE CHARGES				**199,824**			**4%**	**229,865**
Total Project Cost (10 - 100)				**4,545,947**	**$ 226,696**		**100%**	**5,212,775**
Allocated Contingency as % of Base Yr Dollars w/o Contingency				16.35%				
Unallocated Contingency as % of Base Yr Dollars w/o Contingency				4.65%				
Total Contingency as % of Base Yr Dollars w/o Contingency				21.01%				
Unallocated Contingency as % of Subtotal (10 - 80)				4.00%				
YOE Construction Cost per Mile (X000)								$164,554
YOE Total Project Cost per Mile Not Including Vehicles (X000)								$249,355
YOE Total Project Cost per Mile (X000)								$259,950

Appendix D: Risk Register

The Risk Register is transmitted as a separate file (Appendix D-Aug 2011 Risk Register.pdf).

PROJECT RISK REGISTER

Honolulu High-Capacity Transit Corridor Project

Date Issue: August 2011

Rev. 6

Note: Project Wide risks are evaluated both at the Project Wide level and by contract. Therefore, what may seem as repetition are actually risks as applicable to each contract.

Legend	Low (1)	Med (2)	High (3)	Very High (4)	Significant (5)
Probability	< 10%	10><50%	> 50%	75%	>90%
Cost	< $250K	$250K><$1	$1M><$3M	$3M><$10	>$10M
Schedule	< 1 Mths	1 ><3 Mths	3><6 Mths	6><12 Mths	> 12 Mths
Rating	< =3	3.1-9.49		> =9.5	

Current ID	SCC Code	Contract Package	FTA Risk Category	Risk Description	Most Current Notes and Comments	Probability Rating	Cost Impact (A)	Schedule Delay (B)	Risk Rating %x(A+B)/2	Prior Risk Rating
1	90	Project Wide	Market	Escalation may be higher than projected.		1	5	0	2.5	2.5
10	20.07	Project Wide	Design	Elevator design criteria presented to the public is unacceptable and results in additional elevators.		1	5	1	3	3
100	10.04	Airport Guideway	Requirements	This portion of the alignment crosses over Ceded land which may cause a shift of the alignment.	According to ceded land requirements, ceded land is allowed to be used for public purpose. Will be resolved by FD.	2	3	4	7	7
101	60.01	Right of Way	Design	Slight change in alignment could cause changes in required ROW which has not been included in estimate, schedule or EIS. (Depending on changes property needs could increase or decrease.)	Outstanding since design is not complete.	2	4	3	7	7
102	40.03	Airport Stations	Geotech/Early Const	Gas station at Lagoon Drive Station entrance may have contaminated material and could result in additional costs.	Once acquisition of property begins, a Phase I study will be done which will determine if a Phase II study is required.	3	1	0	1.5	1.5
103	40.03	Airport Guideway	Geotech/Early Const	Discovery of unexploded munitions disrupts construction.		1	2	1	1.5	1.5
104	10.04	Airport Guideway	Design	Staging, schedule and cost may be greater than assumed for the Keehi interchange.		2	3	0	3	3
105	40.02	Airport Guideway	Geotech/Early Const	Unforeseen Federal and/or Military cables or fuel lines may result in alignment relocation or costly column span.		2	3	2	5	5

PROJECT RISK REGISTER
Honolulu High-Capacity Transit Corridor Project
Date Issue: August 2011
Rev. 6

Note: Project Wide risks are evaluated both at the Project Wide level and by contract. Therefore, what may seem as repetition are actually risks as applicable to each contract.

Legend	Low (1)	Med (2)	High (3)	Very High (4)	Significant (5)
Probability	< 10%	10><50%	> 50%	75%	>90%
Cost	< $250K	$250K><$1	$1M><$3M	$3M><$10	>$10M
Schedule	< 1 Mths	1 ><3 Mths	3><6 Mths	6><12 Mths	> 12 Mths
Rating	<=3	3.1-9.49		>=9.5	

Current ID	SCC Code	Contract Package	FTA Risk Category	Risk Description	Most Current Notes and Comments	Probability Rating	Cost Impact (A)	Schedule Delay (B)	Risk Rating %x(A+B)/2	Prior Risk Rating
106	10.04	Airport Guideway	Requirements	The guideway has a high skew with respect to the roads in the area of the inter island terminal parking access ramp and the Paiea underpass connecting with Aolele which may require special structures.		1	1	0	0.5	0.5
107	10.08	Airport Guideway	Construction	Segment routes may suffer settlement and general damage (including utilities) to surface due to excessive loads and require replacement and or re-surfacing.		2	2	0	2	2
108	10.04	City Center Guideway	Requirements	Alignment passes near a Federal building, which may raise homeland security concerns and results in additional design and cost.	TVA completed and issue is still outstanding. Environ/Safety group met with GSA, the judges, etc. on Aug. 10th.	5	2	0	5	5
109	60.01	Right of Way	Design	Slight change in alignment could cause changes in required ROW, which has not been included in estimate, schedule, or EIS. (Depending on changes, property needs could increase or decrease).	Outstanding since design is not complete.	3	4	2	9	9
11	40.02	Project Wide	TCC	There may be insufficient utility company resources available to meet the design, approvals, and/or construction schedule. (Public Utilities - water, sewer, storm drain)		3	3	2	7.5	7.5
110	60.01	Right of Way	Design	Kaka'ako Station currently requires partial demolition which has yet to be discussed with owner and may result in additional costs and delays.	Outstanding since design is not complete.	2	3	0	3	3
111	40.03	City Center Guideway	Geotech/Early Const	Nimitz Highway (1 mile) known to be contaminated from old fuel line leaks and utility excavations may lead to significant volumes of excavated soil.		5	3	0	7.5	7.5

PROJECT RISK REGISTER

Honolulu High-Capacity Transit Corridor Project

Date Issue: August 2011

Rev. 6

Note: Project Wide risks are evaluated both at the Project Wide level and by contract. Therefore, what may seem as repetition are actually risks as applicable to each contract.

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Probability	< 10%	10><50%	> 50%	75%	>90%
Cost	< $250K	$250K><$1	$1M><$3M	$3M><$10	>$10M
Schedule	< 1 Mths	1 ><3 Mths	3><6 Mths	6><12 Mths	> 12 Mths
Rating	<=3	3.1-9.49		>=9.5	

Current ID	SCC Code	Contract Package	FTA Risk Category	Risk Description	Most Current Notes and Comments	Probability Rating	Cost Impact (A)	Schedule Delay (B)	Risk Rating %x(A+B)/2	Prior Risk Rating
112	40.04	City Center Guideway	NEPA	If numerous iwi are found constituting a burial ground, the location could be eligible for inclusion in the National Register of Historic Places, which could require realignment of guideway.		1	5	5	5	5
113	40.02	City Center Guideway	Requirements	Halekauwila Street has very limited space, and if additional relocation is identified from what is currently planned, either rerouting or additional ROW may be required.		2	3	4	7	7
114	40.02	City Center Guideway	Design	Fuel line at proposed alignment on Nimitz Highway may require alternative design solution.		2	1	2	3	3
115	40.02	City Center Guideway	Geotech/Early Const	Unforeseen Federal and/or Military cables or fuel lines may result in alignment relocation or costly column span.		2	3	4	7	7
116	40.02	City Center Guideway	Design	Assumption is water mains will be relocated around columns by addition of bends; this may not be allowed by BWS.	Quantity of impacts will not be known until final design. City standard is 5' and BWS is 10'. There is limited space available to relocate all utilities as expected by BWS and there will most likely need to be some negotiations.	5	3	2	12.5	12.5
117	40.02	City Center Guideway	Design	The relocation of the 138 kv overhead power lines may require new lines erected to provide redundancy during the 'outage.' (Temporary diversion of the 138kV line may be required if grid capacity is insufficient.)	138kV issue will not be reviewed until CC Final Designer is on board.	3	4	1	7.5	7.5

PROJECT RISK REGISTER

Honolulu High-Capacity Transit Corridor Project

Date Issue: August 2011

Rev. 6

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Legend	Low (1)	Med (2)	High (3)	Very High (4)	Significant (5)
Probability	< 10%	10><50%	> 50%	75%	>90%
Cost	< $250K	$250K><$1	$1M><$3M	$3M><$10	>$10M
Schedule	< 1 Mths	1 ><3 Mths	3><6 Mths	6><12 Mths	> 12 Mths
Rating	< =3	3.1-9.49		> =9.5	

Current ID	SCC Code	Contract Package	FTA Risk Category	Risk Description	Most Current Notes and Comments	Probability Rating	Cost Impact (A)	Schedule Delay (B)	Risk Rating %x(A+B)/2	Prior Risk Rating
118	10.08	City Center Guideway	Construction	Segment routes may suffer settlement and general damage (including utilities) to surface due to excessive construction equipment loads and require replacement and or re-surfacing.		5	4	0	10	10
119	40.08	City Center Guideway	Construction	Access to Honolulu Community College may be restricted by construction and noise levels may need to be mitigated while school is in session.		3	2	0	3	3
11a	40.02	West Oahu/Farrington Highway Guideway	Design	There may be insufficient Utility company resources available to meet the design, approvals, and/or construction schedule. (Public Utilities - water, sewer, storm drain)		3	2	2	6	6
11b	40.02	Kamehameha Highway Guideway	Design	There may be insufficient Utility company resources available to meet the design, approvals and/or construction schedule. (Public Utilities - water, sewer, storm drain)		3	2	2	6	6
11d	40.02	Airport Guideway	TCC	There may be insufficient utility company resources available to meet the design, approvals, and/or construction schedule. (Public Utilities - water, sewer, storm drain)	HECO does not have the resources for construction. BWS also does not have the required resources at this time.	3	3	2	7.5	
11e	40.02	City Center Guideway	TCC	There may be insufficient utility company resources available to meet the design, approvals, and/or construction schedule. (Public Utilities - water, sewer, storm drain)	HECO does not have the resources for construction. BWS also does not have the required resources at this time.	3	3	2	7.5	
12	40.02	Project Wide	TCC	More fiber optic cable lines than estimated may need to be relocated (number and type of cables in ducts to be relocated not known).	No more information available at this time.	4	3	2	10	10

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120	20.02	City Center Stations	Requirements	Redesign of station access for Downtown Station may be required due to objections.		1	3	3	3	3
121	40.08	City Center Guideway	Requirements	This area contains a major bus interface and access to the parking structure of Ala Moana Center. Traffic impacts must be mitigated, and bus operations must be continued.		5	3	0	7.5	7.5
122	60.01	Right of Way	Design	Kapalama Entrance may be a concern due to proximity to adjacent ROW.	Outstanding since design is not complete.	3	1	2	4.5	4.5
123	60.01	Right of Way	Design	Ala Moana Center Station has ROW issues that have yet to be discussed with owner and may result in additional costs and delays.	Do not have everything finalized with the location and design of the Ala Moana station.	5	3	0	7.5	7.5
124	40.04	City Center Stations	Requirements	Given that Downtown Station is in a historic district, community needs may cause additional costs and possible delays.		2	2	0	2	2
125	40.04	City Center Stations	Requirements	Given that Chinatown Station is in a historic district, community needs may cause additional costs and possible delays.		2	2	0	2	2
126	60.01	Right of Way	Requirements	Properties at Pearl Highlands Station and Guideway may be more difficult than currently assumed, increasing costs and ROW schedule. (Banana Patch)	All offers for the properties at Pearl Highlands have been accepted, except for 1. Relocation is also currently going along well.	3	3	0	4.5	4.5
127	60.01	Right of Way	Requirements	May need to buy property for Park and Ride at UH West Oahu.	Still outstanding.	5	3	0	7.5	7.5

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128	60.01	Right of Way	Requirements	Property required at UH currently assumes donation. However, there is a possibility that UH may require property to be bought.	Still outstanding.	2	3	0	3	3
129	20.02	Right of Way	Design	Currently designed realignment of easement at West Loch Station has not been accepted by adjacent property owners and could result in design delays if unaccepted.	This property was acquired at the end of July. Risk is removed.					1.5
12a	40.02	West Oahu/Farrington Highway Guideway	Design	More fiber optic cable lines (or other overhead lines) than estimated may be need to be relocated (number and type of cables in ducts to be relocated not known).	WOFH has a change order in right now for fiber optics.	4	3	1	8	8
12b	40.02	Kamehameha Highway Guideway	Design	More fiber optic cable lines than estimated may need to be relocated (number and type of cables in ducts to be relocated not known).		2	3	0	3	3
12d	40.02	Airport Guideway	Design	More fiber optic cable lines than estimated may need to be relocated (number and type of cables in ducts to be relocated not known).	Utility contracts for Airport and CC are separate from guideway construction contract.	3	3	1	6	
12e	40.02	City Center Guideway	Design	More fiber optic cable lines than estimated may need to be relocated (number and type of cables in ducts to be relocated not known).	Utility contracts for Airport and CC are separate from guideway construction contract.	4	3	1	8	
13	40.02	Project Wide	Geotech/Early Const	Old electrical and other utilities may contain asbestos which will require HAZMAT disposal.		4	4	1	10	10

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130	60.01	Right of Way	Design	Relocation of business at W. Loch Station may take longer than anticipated. (Farrington Stations Group)	Have made an offer at a substitute property for the business at W. Loch Station.	1	2	3	2.5	2.5
131	40.04	Kamehameha Highway Stations	Geotech/Early Const	Extensive rain could, because of potential flooding of the work site, affect construction schedule at the Pearl Highlands Station area.		2	2	1	3	3
132	40.04	West Oahu Stations	Design	Natural drainage at Ho'opili Station may need to be addressed by project if DR Horton development does not do it, which would result in additional costs to the project.		5	1	0	2.5	2.5
133	20.02	West Oahu Stations	Design	East Kapolei Station design could change, based on hydraulic and geotech study, and additional costs may be incurred.		2	3	1	4	4
134	20.02	Farrington Highway Stations	Design	Waipahu Station is located in the floodplain and the design has yet to be approved by DPP, which could result in a delay due to redesign.		5	2	1	7.5	7.5
135	20.02	West Oahu Stations	Design	UH West Oahu Station design could change, based on hydraulic and geotech study, and additional costs may be incurred.		2	3	1	4	4
136	20.02	Farrington Highway Stations	Design	Systems interfaces at Farrington stations may result in claims delay by Station designer.		4	1	2	6	6

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137	20.02	West Oahu Stations	Requirements	Current assumption is that developer adjacent to UH West O'ahu Station will build a roadway bridge and road to access the parking lot and bus transfer facility. If they do not build this, it will result in additional costs to project.		3	4	0	6	6
138	50	Core Systems Contract	Market	Core Systems Contract may require rebid based on DCCA's decision, which is expected by mid August 2011.	Risk has been deleted. Protest was denied by the City, which resulted in the contractor's appealing to DCCA. DCCA denied the appeals submitted by both Bombardier (Aug. 5) and Sumitomo (Aug. 15).					5
139	40.04	Project wide	NEPA	AIS may delay City Center Guideway and ultimately project completion.		2	4	3	7	7
139a	40.04	Airport Guideway	NEPA	AIS may delay start of guideway construction and result in additional costs and schedule delays.	Duration for the AIS of the Airport section is less than a year and is not on the critical path. Section is easier than the City Center section and AIS is not expected to impact Airport guideway construction.	2	3	2	5	
13a	40.02	West Oahu/Farrington Highway Guideway	Geotech/Early Const	Old electrical and other utilities may contain asbestos which will require HAZMAT disposal.		3	3	1	6	6
13b	40.02	Maintenance & Storage Facility Contract	Geotech/Early Const	Old electrical and other utilities may contain asbestos which will require HAZMAT disposal.	Nothing has been identified at this time. Cost has been reduced to less than $250k and schedule impact is 0 months.	1	1	0	0.5	1.5
13c	40.02	Kamehameha Highway Guideway	Geotech/Early Const	Old electrical and other utilities may contain asbestos which will require HAZMAT disposal.		3	3	1	6	6

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13d	40.02	Airport Guideway	Geotech/Early Const	Old electrical and other utilities may contain asbestos which will require HAZMAT disposal.		4	3	1	8	
13e	40.02	City Center Guideway	Geotech/Early Const	Old electrical and other utilities may contain asbestos which will require HAZMAT disposal.		4	3	1	8	
14	40.02	Project Wide	Construction	IF HDOT Use and Occupancy Agreement with utility owners is needed, it could delay utility relocations in the state ROW.		2	3	3	6	6
140	90	Project wide	Market	Based on a recently passed bill , GET exemptions would be suspended and result in additional tax payments by contractors which have not been accounted for in estimate.	Suspension of extensions would go from Jan. 1, 2012 to June 30, 2015. Based on review, city lawyers believe if a contract was executed, signed or awarded by July 1, 2011, then the basic contract and any changes to that contract are grandfathered in.	5	5	0	12.5	12.5
140d	90	Airport Guideway	Market	Based on a recently passed bill , GET exemptions would be suspended and result in additional tax payments by contractors which have not been accounted for in estimate.		5	5	0	12.5	
140e	90	City Center Guideway	Market	Based on a recently passed bill , GET exemptions would be suspended and result in additional tax payments by contractors which have not been accounted for in estimate.		5	5	0	12.5	
141	50	Project Wide	Design	Fixed facilities contracts incur additional design costs due to NTP delay for CSC.		2	3	2	5	5

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142	10.04	Project Wide	Design	Pedestrian bridge clearance over HDOT ROW may need to be raised to meet HDOT minimum requirements (17.5') which would result in additional costs due to redesign of either the pedestrian bridge or guideway.	Change Control Board approved a process forward on July 19, 2011.	4	3	1	8	8
142a	10.04	West Oahu/Farrington Highway Guideway	Design	Pedestrian bridge clearance over HDOT ROW may need to be raised to meet HDOT minimum requirements (17.5') which would result in additional costs due to redesign of either the pedestrian bridge or guideway.		4	3	1	8	8
142b	10.04	Kamehameha Highway Guideway	Design	Pedestrian bridge clearance over HDOT ROW may need to be raised to meet HDOT minimum requirements (17.5') which would result in additional costs due to redesign of either the pedestrian bridge or guideway.	Only location that will require redesign is at Pearl Ridge. Currently reviewing design to determine what is needed.	4	2	1	6	6
143	60.01	City Center Guideway	Requirements	Inability to receive all required consents to enter to do archaeological investigation of interior buildings may cause delays to AIS.	AIS for WOFH is done. AIS for KHG is complete. Issue in City Center is the numerous investigations that must be done in buildings, which require consent by the owner. If owner says no, will need to go to SHPD for an answer as to what to do. Currently mitigating the issue by working to acquire 6 properties that require AIS in interior building.	2	2	2	4	4
144	90	Project Wide	Construction	Unforeseen special events not listed in SPs may cause delays to construction or add MOW costs.	Upcoming event to be an issue would be APEC, which may result in limited construction activity due to security.	2	3	1	4	

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145	90	Kamehameha Highway Guideway	Design	Delay to issue NTP results in claims for additional costs.	Total delay is about 80 days. Expected NTP was April and received it in July. Currently awaiting schedule of milestones from Kiewit. Currently there is one station interface date that is a concern and may require an accelerated schedule or different means and method which would result in more cost.	4	2	2	8	
14a	40.02	West Oahu/Farrington Highway	Construction	IF HDOT Use and Occupancy Agreement with utility owners is needed, it could delay utility relocations in the state ROW.		2	2	2	4	4
14b	40.02	Kamehameha Highway Guideway	Construction	IF HDOT Use and Occupancy Agreement with utility owners is needed, it could delay utility relocations in the state ROW.		1	2	1	1.5	1.5
14d	40.02	Airport Guideway	Construction	IF HDOT Use and Occupancy Agreement with utility owners is needed, it could delay utility relocations in the state ROW.	Once WOFH and KHG are complete, the risk will be reduced forAirport and City Center sections.	2	2	2	4	
14e	40.02	City Center Guideway	Construction	IF HDOT Use and Occupancy Agreement with utility owners is needed, it could delay utility relocations in the state ROW.	Once WOFH and KHG are complete, the risk will be reduced forAirport and City Center sections.	2	2	2	4	
15	40.02	Project Wide	Geotech/Early Const	The Contractor may sever one or more utilities during construction resulting in a stoppage of work and impacting not only itself, but other concurrent contractors.	Probability reduced from 50% to 25% due to the preventative measures that are taken prior to construction.	2	2	1	3	4.5
15d	40.02	Airport Guideway	Geotech/Early Const	The Contractor may sever one or more utilities during construction resulting in a stoppage of work and impacting not only itself, but other concurrent contractors.	Contractors need to do one call prior to start of digging, which reduces the probability of the risk occurring.	2	2	1	3	

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15e	40.02	City Center Guideway	Geotech/Early Const	The Contractor may sever one or more utilities during construction resulting in a stoppage of work and impacting not only itself, but other concurrent contractors.	Contractors need to do one call prior to start of digging, which reduces the probability of the risk occurring.	2	2	1	3	
16	40.02	Project Wide	Requirements	Agreements with all utility owners are not yet in place, and subsequent agreements may expose the City to unforeseen costs and schedule impacts.	As process goes on with WOFH, agreements should become easier to obtain for other sections. HECO is the most critical in getting an agreement. WOFH is still working to get an agreement in place for them to do HECO's work.	3	4	3	10.5	10.5
16a	40.02	West Oahu/Farrington Highway Guideway	Requirements	Agreements with all utility owners are not yet in place, and subsequent agreements may expose the City to unforeseen costs and schedule impacts.	Have most agreements for design. The only agreements received for construction are with the gas and fuel lines at WOFH. The relocations for these started mid-August. There are a total of 9 different companies to coordinate with.	4	3	2	10	10
16c	40.02	Kamehameha Highway Guideway	Requirements	Agreements with all utility owners are not yet in place, and subsequent agreements may expose the City to unforeseen costs and schedule impacts.		2	3	2	5	5
16d	40.02	Airport Guideway	Requirements	Agreements with all utility owners are not yet in place, and subsequent agreements may expose the City to unforeseen costs and schedule impacts.		2	2	2	4	
16e	40.02	City Center Guideway	Requirements	Agreements with all utility owners are not yet in place, and subsequent agreements may expose the City to unforeseen costs and schedule impacts.		2	2	2	4	
17	40.02	Project Wide	Requirements	Current assumption that new utilities can be carried in, along, under existing bridge structures may not be allowed.		1	3	0	1.5	1.5

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17b	40.02	Kamehameha Highway Guideway	Requirements	Current assumption that new utilities can be carried in, along, under existing bridge structures may not be allowed.		1	3	0	1.5	1.5
17d	40.02	Airport Guideway	Requirements	Current assumption that new utilities can be carried in, along, under existing bridge structures may not be allowed.		1	2	0	1	
17e	40.02	City Center Guideway	Requirements	Current assumption that new utilities can be carried in, along, under existing bridge structures may not be allowed.		1	2	0	1	
18	40.02	Project Wide	Requirements	Ongoing/upcoming city and or state projects may require modifications to utility relocation designs.	Widening of Farrington Highway is currently being planned.	3	3	2	7.5	7.5
18a	40.02	West Oahu/Farrington Highway	Requirements	Ongoing/upcoming city and or state projects may require modifications to utility relocation designs.	Widening of Farrington Highway is currently being planned and will most likely require additional Project co-ordination.	4	2	2	8	8
18d	40.02	Airport Guideway	Requirements	Ongoing/upcoming city and or state projects may require modifications to utility relocation designs.	Airport FD to be complete by early 2013.	2	2	2	4	
18e	40.02	City Center Guideway	Requirements	Ongoing/upcoming city and or state projects may require modifications to utility relocation designs.	Start of CC design is still a year out.	2	2	2	4	
1a	90	West Oahu/Farrington Highway Guideway	Market	Escalation may be higher than projected.		3	4	0	6	6

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1b	90	Kamehameha Highway Guideway	Market	Escalation may be higher than projected. - Steel, Concrete and Asphalt.		3	4	0	6	6
1d	90	Airport Guideway	Market	Escalation may be higher than projected.	Risk subdivided from Project wide and scored at contract level.	1	5	0	2.5	
1e	90	City Center Guideway	Market	Escalation may be higher than projected.	Risk subdivided from Project wide and scored at contract level.	1	5	0	2.5	
2	10.04	Project Wide	NEPA	Discovery of unanticipated archeological resources could result in construction delay and/or design modification to relocate columns and foundations.		1	5	4	4.5	4.5
21	40.02	Project Wide	Design	The traffic management plan approval may compromise the utility relocation schedule.	It is on contractor for DB but there are concerns with whose jurisdiction it is.	2	3	3	6	6
21d	40.02	Airport Guideway	Design	The traffic management plan approval may compromise the utility relocation schedule.	Airport Section needs approval by HDOT. Designers will do TMP.	2	2	2	4	
21e	40.02	City Center Guideway	Design	The traffic management plan approval may compromise the utility relocation schedule.	City controlled streets need coordination with DTW. There will be less coordination with HDOT. Designer will do TMP.	2	2	2	4	
22	40.03	Project Wide	Geotech/Early Const	Excavated materials may be classed as hazardous and require special disposal.		2	3	1	4	4

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22a	40.03	West Oahu/Farrington Highway Guideway	Geotech/Early Const	Excavated materials may be classified as hazardous and require special disposal.		2	3	1	4	4
22b	40.03	Kamehameha Highway Guideway	Geotech/Early Const	Excavated materials may be classified as hazardous and require special disposal.	Draft RFP1 will be released by end of August for on call haz material disposal contractor.	1	3	1	2	2
22d	40.03	Airport Guideway	Geotech/Early Const	Excavated materials may be classed as hazardous and require special disposal.		2	3	1	4	
22e	40.03	City Center Guideway	Geotech/Early Const	Excavated materials may be classed as hazardous and require special disposal.		2	3	1	4	
24	40.04	Project Wide	Design	City is unable to process the potential comments from Section 106 Consulting Parties in a timely manner and are not in compliance with the Programmatic Agreement (PA) which could cause delays to the Project.	Have been doing well with the consulting parties and 2 that were originally opponents to rail have now become proponents.	1	1	2	1.5	1.5
25	40.04	Project Wide	NEPA	Specific burial treatment plan needed if iwi are uncovered and may remain uncertain until iwi are found and may result in project delays.		1	2	3	2.5	2.5
25d	40.04	Airport Guideway	NEPA	Specific burial treatment plan needed if iwi are uncovered and may remain uncertain until iwi are found and may result in project delays.		1	2	3	2.5	
25e	40.04	City Center Guideway	NEPA	Specific burial treatment plan needed if iwi are uncovered and may remain uncertain until iwi are found and may result in project delays.		1	2	3	2.5	

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26	40.04	Project Wide	NEPA	For the Clean Water Act, the City expects to get a 404 Nationwide Permit but, depending on the Contractors' changes, they may be required to get an individual permit, which could cause delays to the Project.		1	5	5	5	5
28	40.04	Project Wide	Requirements	Permits and approvals by other agencies may not be provided in a timely manner and delay the project - FAA, FHWA, Navy, DLNR, USACE, City and State.	Right now everything is urgent for WOFH, KHG, MSF, and CC AIS. HDOH does noise permits and are holding us up. NPDES, we have 50+ Permits we asked to have the number lowered and it expedited. They refused but have 1 dedicated staff member to look at all permits. First one that was done was sent back with numerous markups. A critical permit is needed for Leeward Community College - PRU (Land use permit).	5	3	2	12.5	10
28a	40.04	West Oahu/Farrington Highway Guideway	Requirements	Permits and approvals by other agencies may not be provided in a timely manner and delay the project - FAA, FHWA, Navy, DLNR, USACE, City and State.	Should have 401 and 404 in hand, but do not. Right now everything is urgent for WOFH, KHG, MSF, and CC AIS. HDOH does noise permits and are holding us up. NPDES, we have 50 + Permits we asked to have the number lowered and it expedited. They refused but have 1 dedicated staff member to look at all permits. First one that was done was sent back with numerous markups.	4	3	2	10	6
28b	40.04	Maintenance & Storage Facility Contract	Requirements	Permits and approvals by other agencies may not be provided in a timely manner and delay the project - FAA, FHWA, Navy, DLNR, USACE, City and State.		2	2	1	3	3

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28c	40.04	Kamehameha Highway Guideway	Requirements	Permits and approvals by other agencies may not be provided in a timely manner and delay the project - FAA, FHWA, Navy, DLNR, USACE, City and State.		2	2	2	4	4
28d	40.04	Airport Guideway	Requirements	Permits and approvals by other agencies may not be provided in a timely manner and delay the project - FAA, FHWA, Navy, DLNR, USACE, City and State, etc.	Issues with permits and approvals have already arisen with both WOFH and KHG sections.	5	2	2	10	
28e	40.04	City Center Guideway	Requirements	Permits and approvals by other agencies may not be provided in a timely manner and delay the project - FAA, FHWA, Navy, DLNR, USACE, City and State, etc.	Issues with permits and approvals have already arisen with both WOFH and KHG sections.	5	2	2	10	
29	40.04	Project Wide	Design	Code changes may result in longer spans over water courses to avoid interference with flood basin, additional flood storage capacity, regrading, or combination.		1	3	0	1.5	1.5
29a	40.04	West Oahu/Farrington Highway	Design	Code changes may result in longer spans over water courses to avoid interference with flood basin, additional flood storage capacity, regrading, or combination.		1	3	0	1.5	1.5
29b	40.04	Kamehameha Highway Guideway	Design	Code changes may result in longer spans over water courses to avoid interference with flood basin, additional flood storage capacity, regrading, or combination.		1	3	0	1.5	1.5
29d	40.04	Airport Guideway	Design	Code changes may result in longer spans over water courses to avoid interference with flood basin, additional flood storage capacity, regrading, or combination.	Could involve 404 and DPP.	1	3	0	1.5	
29e	40.04	City Center Guideway	Design	Code changes may result in longer spans over water courses to avoid interference with flood basin, additional flood storage capacity, regrading, or combination.	Could involve 404 and DPP.	1	3	0	1.5	

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2a	10.04	West Oahu/Farrington Highway	NEPA	Discovery of unanticipated archeological findings could result in construction delay and/or design modification to relocate columns and foundations.		1	4	3	3.5	3.5
2b	10.04	Maintenance & Storage Facility Contract	NEPA	Discovery of unanticipated archeological findings could result in construction delay and/or design modification to foundations.		1	2	3	2.5	2.5
2c	10.04	Kamehameha Highway Guideway	NEPA	Discovery of unanticipated archeological findings could result in construction delay and/or design modification to relocate columns and foundations.		1	3	3	3	3
2d	10.04	Airport Guideway	NEPA	Discovery of unanticipated archeological findings could result in construction delay and/or design modification to relocate columns and foundations.		1	3	3	3	3
2e	10.04	City Center Guideway	NEPA	Discovery of unanticipated archeological findings could result in construction delay and/or design modification to relocate columns and foundations.	Excavation is not required for all column locations.	1	3	3	3	3
3	10.04	Project Wide	Design	HDOT reviews of Interstate Crossings are not provided in a timely manner and delay the project. (WOFH, Kamehameha, and Airport Guideway Segments).		3	2	2	6	6
30	40.04	Project Wide	NEPA	Revision to current environmental documentation to incorporate any change in the project or identified scope not specifically covered in the EIS delays project and increases costs.		3	3	3	9	9

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31	40.04	Project Wide	NEPA	Environmental documents may be required due to scope changes that may not be covered in the FEIS and may cause delays to the project. (Particularly the Casting Yard)	Decision is still pending regarding the casting yard. This risk would also be applicable to Airport and CC in regards to other possible locations for casting yard.	5	5	3	20	20
31a	40.04	West Oahu/Farrington Highway Guideway	NEPA	Environmental documents may be required due to scope changes that may not be covered in the FEIS and may cause delays to the project. (Particularly the Casting Yard)	Issue is still ongoing. Kiewit to provide the required documentation for the sites they have located (Grace and Harbors Point) along with other identified sites that were considered not an option. Once received, the documents will then be forwarded on to the FTA for further review.	5	5	4	22.5	22.5
31b	40.04	Kamehameha Highway Guideway	NEPA	Environmental documents may be required due to scope changes that may not be covered in the FEIS and may cause delays to the project. (Particularly the Casting Yard)	Decision is still pending regarding the Casting Yard. KHG's proposal states that it will use the same area as the casting yard for WOFH.	5	4	1	12.5	12.5
31d	40.04	Airport Guideway	NEPA	Environmental documents may be required due to scope changes that may not be covered in the FEIS and may cause delays to the project.	Final Design has not yet started. At this time, it is unknown what changes may occur to the scope that would require additional environmental reviews.	2	2	2	4	
31e	40.04	City Center Guideway	NEPA	Environmental documents may be required due to scope changes that may not be covered in the FEIS and may cause delays to the project.	Final Design has not yet started. At this time, it is unknown what changes may occur to the scope that would require additional environmental reviews.	2	2	2	4	
32	40.08	City Center Guideway	Construction	Hawaii Housing Finance & Development Corporation owns this property (Kaka'ako area) and may be in construction of a new housing project while HHCTCP is in construction, which would require additional coordination.	Construction has started on this housing project.	2	1	1	2	2

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33	40.07	Project Wide	Requirements	HDOT may require replacement of all existing traffic signal equipment with new.		3	4	2	9	9
33a	40.07	West Oahu/Farrington Highway Guideway	Requirements	HDOT may require replacement of all existing traffic signal equipment (and ITS cameras) with new.		3	3	0	4.5	4.5
33b	50.02	Kamehameha Highway Guideway	Design	HDOT may require replacement of all existing traffic signal equipment with new.		2	3	0	3	3
33d	40.07	Airport Guideway	Requirements	HDOT or City may require replacement of all existing traffic signal equipment with new.		3	3	1	6	
33e	40.07	City Center Guideway	Requirements	HDOT or City may require replacement of all existing traffic signal equipment with new.		3	4	1	7.5	
36	80.06	Project Wide	Market	Unanticipated litigation may add cost to the Project (e.g., protests from adversary groups, community groups, adjacent landowners, and other affected parties).		5	5	0	12.5	12.5
36d	80.06	Airport Guideway	Market	Unanticipated litigation may add cost to the Project (e.g., protests from adversary groups, community groups, adjacent landowners, and other affected parties).	Probability lower for Airport and City Center sections due to final design and construction start at least a year away.	2	5	0	5	
36e	80.06	City Center Guideway	Market	Unanticipated litigation may add cost to the Project (e.g., protests from adversary groups, community groups, adjacent landowners, and other affected parties).	Probability lower for Airport and City Center sections due to final design and construction start at least a year away.	2	5	0	5	

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38	90	Project Wide	Design	Scope may be increased based on lessons learned from initial contracts (ex. betterment, station access, utility scope, etc.).		3	3	1	6	6
38b	50	Core Systems Contract	Design	Scope may be increased based on lessons learned from operating segments (ex. betterment, station access, utility scope, etc.).		3	2	0	3	3
38d	90	Airport Guideway	Design	Scope may be increased based on lessons learned from initial contracts (ex. betterment, station access, utility scope, etc.).		3	3	1	6	
38e	90	City Center Guideway	Design	Scope may be increased based on lessons learned from initial contracts (ex. betterment, station access, utility scope, etc.).		3	3	1	6	
39	90	Project Wide	Design	Contractors may not achieve contract required delivery dates of design information and construction interfaces to others.		2	5	2	7	7
39a	90	West Oahu/Farrington Highway Guideway	Design	Late delivery of/or acceptance of civils, stations, or systems interface to guideway results in change orders.	Designer for Farrington Stations on board to give answers to proceed with design. The GEC is available to answer any questions in place of FD not being on board for CSC, WO Stations and KH Stations.	5	3	2	12.5	12.5
39b	50.01	Airport Guideway	Construction	Late delivery of / or acceptance of civils, structures or guideway contracts may delay systems installations.		1	4	3	3.5	3.5

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39c	90	Maintenance & Storage Facility Contract	Design	Late delivery of/or acceptance of systems interface to MSF results in change orders.	Due to delay of CSC, there may be certain interface delays to MSF.	3	3	3	9	9
39d	90	Kamehameha Highway Guideway	Design	Late delivery of/or acceptance of civils, stations, or systems interface to guideway results in change orders.		3	3	2	7.5	7.5
39e	50.01	City Center Guideway	Construction	Late delivery of/or acceptance of civils, structural or guideway contracts may delay systems installations.		1	4	3	3.5	3.5
39f	90	Core Systems Contract	Design	Late delivery of/or acceptance of civils, stations, or guideway interfaces to systems results in change orders.	The more Core Systems is delayed, the less impact there will be from other contracts.	4	4	2	12	12
3a	10.04	West Oahu/Farrington Highway	Design	HDOT reviews of Interstate Crossings are not provided in a timely manner and delay the project. (WOFH, Kamehameha, and Airport Guideway Segments).		3	2	2	6	6
3b	10.04	Kamehameha Highway Guideway	Design	HDOT reviews of Interstate Crossings are not provided in a timely manner and delay the project. (WOFH, Kamehameha, and Airport Guideway Segments).		3	2	2	6	6
3d	10.04	Airport Guideway	Design	HDOT reviews of Interstate Crossings are not provided in a timely manner and delay the project. (WOFH, Kamehameha, and Airport Guideway Segments).	Have an agreement with HDOT to pay the resources for WOFH and KHG.	2	2	2	4	
4	10.04	Project Wide	Requirements	Construction of high sections of guideway, e.g. crane's lifting of segments, may be significantly impacted by wind delaying schedule increasing exposure of City to claims.		1	2	2	2	2

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40	90	Project Wide	Design	FTA may not grant an LONP for Construction prior to FFGA.		1	5	4	4.5	4.5
40a	90	West Oahu/Farrington Highway Guideway	Design	FTA may not grant an LONP for Construction prior to FFGA.		1	5	4	4.5	4.5
40b	90	Maintenance & Storage Facility Contract	Construction	FTA may not grant an LONP for Construction prior to FFGA.		1	4	4	4	4
40c	90	Kamehameha Highway Guideway	Construction	FTA may not grant an LONP for Construction prior to FFGA.		1	5	4	4.5	4.5
40d	90	Core Systems Contract	Construction	FTA may not grant an LONP for Construction prior to FFGA.		1	4	4	4	4
42	90	Project Wide	Construction	Strike by shipping contractors may impact delivery of materials.		2	3	2	5	5
42d	90	Airport Guideway	Construction	Strike by shipping contractors may impact delivery of materials.		2	3	2	5	
42e	90	City Center Guideway	Construction	Strike by shipping contractors may impact delivery of materials.		2	3	2	5	

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43	90	Project Wide	Requirements	The overall project design is incomplete and significant requirements risks still exist.		3	5	0	7.5	7.5
44	90	Project Wide	Market	Lack of bidders could increase costs.		3	5	3	12	12
44d	90	Airport Guideway	Market	Lack of bidders could increase costs.		3	5	3	12	
44e	90	City Center Guideway	Market	Lack of bidders could increase costs.		3	5	3	12	
45	90	Project Wide	Construction	Unforeseen exceptional weather may impact project.		1	4	2	3	3
45a	90	West Oahu/Farrington Highway Guideway	Construction	Unforeseen exceptional weather may impact project.		1	4	2	3	3
45b	90	Maintenance & Storage Facility Contract	Construction	Unforeseen exceptional weather may impact project.		1	0	2	1	1
45c	90	Kamehameha Highway Guideway	Construction	Unforeseen exceptional weather may impact project.		1	4	2	3	3

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45d	90	Core Systems Contract	Construction	Unforeseen exceptional weather may impact project.		1	0	2	1	1
45e	90	Airport Guideway	Construction	Unforeseen exceptional weather may impact project.		1	4	2	3	
45f	90	City Center Guideway	Construction	Unforeseen exceptional weather may impact project.		1	4	2	3	
46	90	Project Wide	Requirements	FTA review and approvals process may delay entry into Final design .		3	4	2	9	9
46b	90	Core Systems Contract	Requirements	FTA review process may delay entry into Final Design .	Risk impact on CSC is minimal.	1	2	1	1.5	1.5
47	90	Project Wide	Design	Delays due to integration of new government entities.	No delays have yet to result due to integration of HART.	2	1	2	3	3
47a	90	West Oahu/Farrington Highway Guideway	Design	Delays due to integration of new government entities.	No delays have yet to result due to integration of HART.	2	1	2	3	3
47b	90	Maintenance & Storage Facility Contract	Design	Delays due to integration of new government entities.	No delays have yet to result due to integration of HART.	2	1	2	3	3

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47c	90	Kamehameha Highway Guideway	Design	Delays due to integration of new government entities.	No delays have yet to result due to integration of HART.	2	1	2	3	3
47d	90	Core Systems Contract	Design	Delays due to integration of new government entities.	No delays have yet to result due to integration of HART.	2	1	2	3	3
48	90	Project Wide	TCC	Insufficient City resources to respond to contractors requests for change orders and claims leads to force accounting.		3	3	0	4.5	4.5
48a	90	West Oahu/Farrington Highway Guideway	TCC	Insufficient City resources to respond to contractors requests for change orders and claims leads to force accounting.		4	3	0	6	6
48b	80	Maintenance & Storage Facility Contract	TCC	Insufficient City resources to respond to contractors requests for change orders and claims leads to force accounting.		2	3	2	5	5
48c	80	Kamehameha Highway Guideway	TCC	Insufficient City resources to respond to contractors requests for change orders and claims leads to force accounting.		2	3	0	3	3
48d	80	Core Systems Contract	TCC	Insufficient City resources to respond to contractors requests for change orders and claims leads to force accounting.		2	2	0	2	2
48e	90	Airport Guideway	TCC	Insufficient City resources to respond to contractors requests for change orders and claims leads to force accounting.		3	3	0	4.5	

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Schedule	< 1 Mths	1 ><3 Mths	3><6 Mths	6><12 Mths	> 12 Mths
Rating	< =3	3.1-9.49		> =9.5	

Current ID	SCC Code	Contract Package	FTA Risk Category	Risk Description	Most Current Notes and Comments	Probability Rating	Cost Impact (A)	Schedule Delay (B)	Risk Rating %x(A+B)/2	Prior Risk Rating
48f	90	City Center Guideway	TCC	Insufficient City resources to respond to contractors requests for change orders and claims leads to force accounting.		3	3	0	4.5	
49	90	Project wide	Construction	HDOT Master Agreement clarifications - difference between perceived requirements for operation and maintenance at bid and actual - result in change orders.		5	3	0	7.5	7.5
49a	90	West Oahu/Farrington Highway Guideway	Construction	HDOT Master Agreement clarifications - difference between perceived requirements for operation and maintenance at bid and actual - result in change orders.		5	3	0	7.5	7.5
49b	90	Kamehameha Highway Guideway	Construction	HDOT Master Agreement clarifications - difference between perceived requirements for operation and maintenance at bid and actual - result in change orders.	HDOT Master Agreement is about 6 months to a year out. WOFH does not yet have an agreement. Not having an agreement in place does not slow down contract.	5	2	0	5	5
4d	10.04	Airport Guideway	Requirements	Construction of high sections of guideway, e.g. crane's lifting of segments, may be significantly impacted by wind delaying schedule increasing exposure of City to claims.		1	2	2	2	
4e	10.04	City Center Guideway	Requirements	Construction of high sections of guideway, e.g. crane's lifting of segments, may be significantly impacted by wind delaying schedule increasing exposure of City to claims.		1	2	2	2	
5	10.04	Project Wide	Design	30 inch width of walkway may be increased if safety officer will not accept 9" gap between train car and walkway.		2	1	0	1	1

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Cost	<$250K	$250K><$1	$1M><$3M	$3M><$10	>$10M
Schedule	<1 Mths	1><3 Mths	3><6 Mths	6><12 Mths	>12 Mths
Rating	<=3	3.1-9.49		>=9.5	

Current ID	SCC Code	Contract Package	FTA Risk Category	Risk Description	Most Current Notes and Comments	Probability Rating	Cost Impact (A)	Schedule Delay (B)	Risk Rating %x(A+B)/2	Prior Risk Rating
50	90	Project wide	TCC	Concurrent design reviews of numerous contracts may result in delays.		3	4	2	9	9
50a	90	West Oahu/Farrington Highway Guideway	TCC	Concurrent design reviews of numerous contracts may result in delays.		2	3	2	5	5
50b	90	Maintenance & Storage Facility Contract	Design	Concurrent design reviews of numerous contracts may result in delays.	City will respond to reviews based on agreed upon time frame and will work to manage appropriately. They also assess items that are critical and make sure to respond so that additional costs do not occur. Cost impact reduced from $250k to $1mil to less than $250k. Cost impact reduced to less than 1 month.	3	1	1	3	6
50c	90	Kamehameha Highway Guideway	TCC	Concurrent design reviews of numerous contracts may result in delays.		4	2	2	8	8
50d	90	Core Systems Contract	Requirements	Concurrent design reviews of numerous contracts may result in delays.		4	3	2	10	10
50e	90	Airport Guideway	TCC	Concurrent design reviews of numerous contracts may result in delays.		3	4	2	9	
50f	90	City Center Guideway	TCC	Concurrent design reviews of numerous contracts may result in delays.		3	4	2	9	

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51	90	Project wide	Construction	Insurance costs may be transferred to Contractor and result in change orders.		5	5	0	12.5	12.5
51a	90	West Oahu/Farrington Highway	Construction	Insurance costs may be transferred to Contractor and result in change orders.	Probability of insurance costs increased to 90% due to minimal insurance amount for WOFH allocated in Project budget.	5	5	0	12.5	7.5
51b	90	Maintenance & Storage Facility Contract	Requirements	Insurance costs may be transferred to Contractor and result in change orders.	RFC will be submitted to Contractor for a full term quote for their self insurance for life of contract. There is some insurance cost in allocated contingency but there may be a cost above the allocated amount due to lack of competition and MSF being a joint venture.	5	3	0	7.5	7.5
51c	90	Kamehameha Highway Guideway	Requirements	Insurance costs may be transferred to Contractor and result in change orders.	RFC will be submitted to Kiewit for a full term quote of their self insurance for life of contract.	4	4	0	8	8
51d	90	Core Systems Contract	Construction	Insurance costs may be transferred to Contractor and result in change orders.		3	3	0	4.5	4.5
52	90	Project wide	TCC	City review of contractor submittals may take longer than the time contractor currently assumes, resulting in Contractor delays and claims.		3	4	2	9	9
52a	90	West Oahu/Farrington Highway	TCC	City review of contractor submittals may take longer than the time contractor currently assumes, resulting in Contractor delays and claims.		2	2	1	3	3

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52b	90	Maintenance & Storage Facility Contract	Requirements	City review of contractor submittals may take longer than the time contractor currently assumes, resulting in Contractor delays and claims.	City is telling the contractor it is a 30 day turn around, for certain items it may be faster, but is not in the contract. MSF has responded to all 14 day requests that it is not acceptable since it is not in contract.	3	2	2	6	6
52c	90	Kamehameha Highway Guideway	TCC	City review of contractor submittals may take longer than the time contractor currently assumes, resulting in Contractor delays and claims.		3	2	2	6	6
53	90	Project wide	Construction	Significant design errors identified during construction results in consequential delays to opening.		1	5	3	4	4
53a	90	West Oahu/Farrington Highway Guideway	Construction	Significant design errors identified during construction results in consequential delays to interim opening.	Cost would be due to interface delays. DB is responsible for own design.	1	4	3	3.5	3.5
53b	90	Maintenance & Storage Facility Contract	Construction	Significant design errors identified during construction results in consequential delays to Interim Opening #1.	Since DB is responsible for design, cost is on contractor. Delay would only affect the interim opening #1.	1	3	3	3	3
53c	90	Kamehameha Highway Guideway	Construction	Significant design errors identified during construction results in consequential delays to opening.		1	4	3	3.5	3.5
53d	90	Core Systems Contract	Construction	Significant design errors identified during construction results in consequential delays to opening.	Any design errors found will mostly be caught early on and should result in minimum delays.	1	3	3	3	3
53e	90	Airport Guideway	Construction	Significant design errors identified during construction results in consequential delays to opening.		1	5	3	4	

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53f	90	City Center Guideway	Construction	Significant design errors identified during construction results in consequential delays to opening.		1	5	3	4	
54	90	Project wide	Construction	City maintenance of guideway and other structures, after substantial completion 1 year warranty period, may require additional remedial work (prior to systemwide opening).		1	5	2	3.5	3.5
54d	90	Airport Guideway	Construction	City maintenance of guideway and other structures, after substantial completion 1 year warranty period, may require additional remedial work (prior to systemwide opening).		1	5	2	3.5	
55	40.02	Project Wide	Construction	HDOT may require grouting of abandoned utilities left in place.	HDOT is worried about future settlement and is requiring full grouting of all utilities over 8" diameter and in the median. Once requirements are verified by HDOT a change order will be submitted.	5	4	0	10	10
55a	40.02	West Oahu/Farrington Highway Guideway	Construction	DOT may require grouting of abandoned utilities left in place.	Kiewit recently received a letter from HDOT stating they must remove all utilities abandoned except for those under median. They must also grout all abandoned utilities over 8" diameter. The city is currently in the process of reviewing and receiving clarification.	5	3	0	7.5	7.5
55b	40.02	Airport Guideway	Construction	DOT may require grouting of abandoned utilities left in place.		5	3	0	7.5	7.5

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55c	40.02	Kamehameha Highway Guideway	Construction	DOT may require grouting of abandoned utilities left in place.		5	3	0	7.5	7.5
55d	40.02	City Center Guideway	Construction	HDOT may require grouting of abandoned utilities left in place.		5	3	0	7.5	7.5
56	40.02	Project Wide	Construction	BWS and/or HDOT may not grant waiver to leave in place existing utilities to be abandoned that are not impacted by new structures requiring partial or total removal.	Kiewit received letter from HDOT regarding utilities that are to be abandoned. HDOT is more willing to work with the City than the contractor to negotiate on a case by case request to leave in place. Darrin Mar is the point of contact and has received clarification that removal is only on those in our work area, not all over.	4	5	1	12	4
56a	40.02	West Oahu/Farrington Highway Guideway	Construction	BWS and/or HDOT may not grant waiver to leave in place existing utilities to be abandoned that are not impacted by new structures requiring partial or total removal.	Kiewit received letter from HDOT stating that all abandoned utilities in the roadway of Farrington Highway must be removed. Darrin Mar received clarification that removal is only on those in our work area, not all over. Darrin is working with HDOT to get waiver on a case by case basis for WOFH. Cost impact reduced to $3 to $10 million based on rough estimate..	4	4	1	10	12

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Current ID	SCC Code	Contract Package	FTA Risk Category	Risk Description	Most Current Notes and Comments	Probability Rating	Cost Impact (A)	Schedule Delay (B)	Risk Rating %x(A+B)/2	Prior Risk Rating
56b	40.02	Airport Guideway	Construction	BWS and/or HDOT may not grant waiver to leave in place existing utilities to be abandoned that are not impacted by new structures requiring partial or total removal.	Kiewit received letter from HDOT stating that all abandoned utilities in the roadway of Farrington Highway must be removed. Darrin Mar received clarification that removal is only on those in our work area, not all over. Darrin is working with HDOT to get waiver on a case by case basis for WOFH.	4	4	1	10	4
56c	40.02	Kamehameha Highway Guideway	Construction	BWS and/or HDOT may not grant waiver to leave in place existing utilities to be abandoned that are not impacted by new structures requiring partial or total removal.	Kiewit received letter from HDOT stating that all abandoned utilities in the roadway must be removed. Darrin Mar received clarification that removal is only on those in our work area, not all over. Darrin is working with HDOT to get waiver on a case by case basis for WOFH. Cost impact reduced to $3 to $10 million based on rough estimate. SIC has an agreement w/ BWS to use abandoned waterlines for their fiber optic conduits, which should lessen the amount of removal required.	4	4	1	10	12
56d	40.02	City Center Guideway	Construction	BWS and/or HDOT may not grant waiver to leave in place existing utilities to be abandoned that are not impacted by new structures requiring partial or total removal.	Kiewit received letter from HDOT stating that all abandoned utilities in the roadway of Farrington Highway must be removed. Darrin Mar received clarification that removal is only on those in our work area, not all over. Darrin is working with HDOT to get waiver on a case by case basis for WOFH.	4	4	1	10	4

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57	40.04	Project Wide	NEPA	During excavation for new Utilities, iwi (Archeological human remains) may be found requiring revised alignment for utility relocations which would result in additional costs and possible schedule delays from Contractor.	Submitted AISP to SHPD. Project expects to start AIS on CC in Sept. 2011.	4	3	2	10	10
57a	40.04	West Oahu/Farrington Highway Guideway	NEPA	During excavation for new Utilities, iwi (Archeological human remains) may be found requiring revised alignment for utility relocations on Farrington Highway, which are likely to incur additional costs and possible schedule delays from Contractor.		1	2	2	2	2
57b	40.04	Airport Guideway	NEPA	During excavation for new Utilities, iwi (Archeological human remains) may be found requiring revised alignment for utility relocations on the Airport segment which are likely to incur additional costs and possible schedule delays from Contractor		2	2	2	4	4
57c	40.04	Kamehameha Highway Guideway	NEPA	During excavation for new utilities, iwi (archeological human remains) may be found requiring revised alignment for utility relocations on Kamehameha Highway, which is likely to incur additional costs and possible schedule delays from Contractor.		1	2	1	1.5	1.5
57d	40.04	City Center Guideway	NEPA	During excavation for new utilities, iwi (Archeological human remains) may be found, which would require revised alignment for utility relocations if iwi are preserved in place.	No change until at least September 2011.	4	3	2	10	10

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Rating	<=3	3.1-9.49		>=9.5	

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58	90	Project Wide	Design	City may require changes to baseline documents resulting in formal change orders.		5	4	1	12.5	12.5
58a	90	West Oahu/Farrington Highway	Design	City may require design changes to DB submittals resulting in formal change orders.	Cost increased from $1 to $3 million to $3 to $10 million. RFC's currently for WOFH are around $2 million. Addition costs are expected to arise.	5	4	1	12.5	10
58b	90	Maintenance & Storage Facility Contract	Design	City may require changes to baseline documents resulting in formal change orders.		5	2	0	5	5
58c	90	Kamehameha Highway Guideway	Design	City may require changes to baseline documents resulting in formal change orders.		2	2	0	2	2
58d	90	Core Systems Contract	Design	City may require changes to baseline documents resulting in formal change orders. (Covers any changes to June 2012)		5	2	1	7.5	7.5
58e	90	Airport Guideway	Design	City may require changes to baseline documents resulting in formal change orders.		2	3	1	4	
58f	90	City Center Guideway	Design	City may require changes to baseline documents resulting in formal change orders.		2	3	1	4	
59	40.08	Project Wide	Construction	Traffic disruptions may result in revised constraints imposed by City or HDOT (lane restrictions and peak time flow restrictions) .		4	4	2	12	12

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59a	40.08	West Oahu/Farrington Highway Guideway	Construction	Traffic disruption on Farrington Highway may result in revised constraints imposed by City or HDOT (ex. lane restrictions and peak time flow restrictions).		3	3	2	7.5	7.5
59b	40.08	Airport Guideway	Construction	Traffic disruptions in Airport segment may result in revised constraints imposed by City or HDOT. (Ex. lane restrictions and peak time flow restrictions)		3	3	2	7.5	7.5
59c	40.08	Kamehameha Highway Guideway	Construction	Traffic disruption on Kamehameha Highway may result in revised constraints imposed by City or HDOT, following commencement of construction. (lane restrictions and peak time flow restrictions).	Unsure if HDOT will allow traffic restrictions put in SPs. Do not have a formal agreement with them at this time.	4	3	2	10	10
59d	40.08	City Center Guideway	Construction	Traffic disruptions in City Center segment may result in revised constraints imposed by City or HDOT (lane restrictions and peak time flow restrictions) .		4	4	2	12	12
5a	10.04	West Oahu/Farrington Highway Guideway	Design	30 inch width of walkway may be increased if safety officer will not accept 9" gap between train car and walkway.		2	1	0	1	1
5b	10.04	Kamehameha Highway Guideway	Construction	30 inch width of walkway may be increased if safety officer will not accept 9" gap between train car and walkway.		2	1	0	1	1
5d	10.04	Airport Guideway	Design	30 inch width of walkway may be increased if safety officer will not accept 9" gap between train car and walkway.	Should be resolved by the end of the year.	2	1	0	1	

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5e	10.04	City Center Guideway	Design	30 inch width of walkway may be increased if safety officer will not accept 9" gap between train car and walkway.	Should be resolved by the end of the year.	2	1	0	1	
6	20.02	Project Wide	Requirements	Station Bathroom design criteria presented to the public is unacceptable and results in additional bathrooms.		1	3	1	2	2
60	10.04	Project Wide	Geotech/Early Const	Differing geotechnical conditions may be encountered and result in schedule delays and additional cost. (General Project Wide geotechnical risk)		5	5	3	20	20
60a	10.04	West Oahu/Farrington Highway Guideway	Geotech/Early Const	Geotechnical conditions actually encountered during final design differ from subsurface conditions baselined in the GBR, which, if material to the design or construction, may results in differing site condition claim(s).	No DSCs have been filed by contractor. Cost impact increased from $1 to $3 million to $3 to $10 million due to review by Geotech. Probability reduced back in April due to progressed and completed testing which did not result in any inconsistencies or DCS.	3	4	2	9	7.5
60b	10.04	Airport Guideway	Geotech/Early Const	Given limited geotechnical information available at this time, additional costs may be incurred associated with final design through construction.	Finalizing contract for Final Designer.	4	5	3	16	16
60c	10.04	Maintenance & Storage Facility Contract	Geotech/Early Const	If soil conditions extremely vary from GDR, additional costs may result.		2	3	2	5	5
60d	10.04	Kamehameha Highway Guideway	Design	Geotechnical conditions encountered during construction differ from subsurface conditions baselined during design, results in differing site condition claim(s).	Start of geotech work is still a couple months away.	4	4	2	12	12

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60e	10.04	City Center Guideway	Geotech/Early Const	Given limited geotechnical information available at this time, additional costs may be incurred associated with final design through construction.		5	5	3	20	20
61	40.02	Project wide	Geotech/Early Const	Cost exposure from unexpected utility replacements. (Ex. underground piping quality may be degraded and require extensive replacement which may not all be offset as betterment).		2	5	2	7	7
61a	40.02	West Oahu/Farrington Highway Guideway	Geotech/Early Const	Cost exposure from unexpected utility replacements. (Ex. underground piping quality may be degraded and require extensive replacement which may not all be offset as betterment).		1	3	0	1.5	1.5
61b	40.02	Airport Guideway	Geotech/Early Const	Cost exposure from unexpected utility replacements. (Ex. underground piping quality may be degraded and require extensive replacement which may not all be offset as betterment).		2	3	4	7	7
61c	40.02	Kamehameha Highway Guideway	Requirements	Cost exposure from unexpected utility replacements. (Ex. underground piping quality may be degraded and require extensive replacement which may not all be offset as betterment).		2	3	2	5	5
61d	40.02	City Center Guideway	Geotech/Early Const	Cost exposure from unexpected utility replacements. (Ex. underground piping quality may be degraded and require extensive replacement which may not all be offset as betterment).		2	3	4	7	7
62	40.02	Project wide	Construction	Delay to utility easement agreements may delay access for utility relocations and result in Contractor claims.		3	2	2	6	6

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62a	40.02	West Oahu/Farrington Highway	Construction	Delay to utility easement agreements for WOFH contracts may delay access for utility relocations and result in Contractor claims.	There are currently challenges but they are being tackled in order of importance.	3	2	2	6	6
62b	40.02	Airport Guideway	Construction	Delay to utility easement agreements may delay access for utility relocations and result in Contractor claims.		1	1	2	1.5	1.5
62c	40.02	Kamehameha Highway Guideway	Design	Additional utility easements may be required for Military or private utility companies.		5	1	0	2.5	2.5
62d	40.02	City Center Guideway	Construction	Delay to utility easement agreements for City Center may delay access for utility relocations and result in Contractor claims.		3	1	1	3	3
63	40.02	Project wide	Construction	Costs for utility relocations may increase if utility plans have deviations greater than contract stipulation.	Small impacts have been identified in WOFH and will most likely be found in other sections as well.	4	4	2	12	12
63a	40.02	West Oahu/Farrington Highway Guideway	Construction	Costs for utility relocations may increase if utility plans have deviations greater than contract stipulation.	Small impacts have been identified in WOFH and will most likely be found in other sections as well.	4	3	1	8	8
63b	40.02	Airport Guideway	Construction	Costs for utility relocations may increase if utility plans have deviations greater than contract stipulation.		2	3	3	6	6
63c	40.02	Kamehameha Highway Guideway	Requirements	Costs for utility relocations may increase if utility plans have deviations greater than contract stipulation.		3	4	2	9	9

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63d	40.02	City Center Guideway	Construction	Costs for utility relocations may increase if utility plans have deviations greater than contract stipulation.		2	3	3	6	6
64	40.04	West Oahu/Farrington Highway	Requirements	An injunction resulting from a legal challenge may take place after ROD, which would stop construction and cause delays.	Lawsuit is still being dealt with by Corp Council and their lawyers.	2	5	5	10	10
65	10.04	West Oahu/Farrington Highway Guideway	Design	Late provision of design information for station structures.	WOFH designers are proceeding without input from station designers.	3	3	2	7.5	7.5
66	10.04	West Oahu/Farrington Highway Guideway	Construction	City-supplied materials may not be provided as per contract.		2	2	2	4	4
67	90	West Oahu/Farrington Highway Guideway	Market	Delay to issue NTP results in claims for additional costs.	The cost provided in the estimate covers the delay until March 2011. This risk is to cover the delay after March 2011. NTP4 is targeted for Sept. 2011. Probability increased to 90% due to delay being an additional 6	5	5	2	17.5	10.5
68	40.04	West Oahu/Farrington Highway	Geotech/Early Const	Extensive rain could, because of potential flooding of the work site, affect construction schedule at the Pearl Highlands Station area.		2	2	1	3	3
69	40.04	West Oahu/Farrington Highway Guideway	Design	Natural drainage at Ho'opili Station may need to be addressed by project if DR Horton development does not do it, which would result in additional costs to the project.		5	1	0	2.5	2.5

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7	20.02	Project Wide	Design	Additional costs may arise through simple stations and guideway integration.		1	2	2	2	2
70	20.02	West Oahu/Farrington Highway Guideway	Design	East Kapolei Station design could change, based on hydraulic and geotech study, and additional costs may be incurred.		2	3	1	4	4
71	20.02	West Oahu/Farrington Highway	Design	Waipahu Station is located in the floodplain and the design has yet to be approved by DPP, which could result in a delay due to redesign.		5	2	1	7.5	7.5
72	20.02	West Oahu/Farrington Highway	Design	UH West Oahu Station design could change, based on hydraulic and geotech study, and additional costs may be incurred.		2	3	1	4	4
73	10.04	West Oahu/Farrington Highway	Geotech/Early Const	Lateral deflection of shafts at top is an added requirement: specified as not to exceed 1 inch under Service I loading combination.		5	2	0	5	5
74	20.02	Kamehameha Highway Stations	Construction	With guideway previously constructed at Pearl Highlands Station, constructability issues could arise for Bus Transit Center and Parking Garage.		3	2	2	6	6
75	20.02	West Oahu/Farrington Highway Guideway	Requirements	Project may be required to build a 1-mile paved street at Ho'opili Station (final decision to be made by Toru).		1	5	0	2.5	2.5
76	80.05	West Oahu/Farrington Highway Guideway	Market	Insurance amount in budget may be insufficient to cover change from OCIP to a CCIP.	RFC will be submitted to Kiewit for a full term quote for their self insurance for life of contract. Kiewit's change order for CCIP coverage through Dec. 2011 is for $4 million.	3	4	0	6	6

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77	10.04	West Oahu/Farrington Highway Guideway	Design	Traffic studies at intersection near West Oahu Station may require changes to column locations and result in redesign and additional costs to guideway and station.		2	2	1	3	3
78	90	West Oahu/Farrington Highway Guideway	Construction	Strike by local labor may cause delays to WOFH Contract.		1	3	2	2.5	2.5
79	10.09	Maintenance & Storage Facility Contract	Market	Delayed NTP of MSF may increase costs associated with rail, building steel fasteners etc. (Substantial completion to be about 6 months later than currently assumed.)	NTP1 was given July 25, 2011.	2	3	0	3	3
7d	20.02	Airport Guideway	Design	Additional construction costs may arise through simple stations and guideway integration.		2	2	2	4	
8	20.02	Project Wide	Design	Additional costs may arise through complicated stations and guideway integration.		2	3	3	6	6
80	30.03	Maintenance & Storage Facility Contract	Start-up	Equipment supplied by MSF contract may not meet performance criteria agreed with Core Systems Contractor.	MSF did meet the specs in their bid, however CSC could still come back and need additional changes. MSF must receive approval from CSC before they purchase equipment.	2	3	2	5	5
81	40.02	Maintenance & Storage Facility Contract	Construction	The utility connections required for the MSF facility may be greater than expected and/or the layout of the final facility required by the Core System contractor may impact the Utility scope and costs.		1	1	2	1.5	1.5

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82	40.03	Maintenance & Storage Facility Contract	Geotech/Early Const	The Navy may not have cleared all contaminated material from the Navy Drum Site.	Navy has said that contaminated soil has,been removed. If it is later found that contamination remains, then the Project will work with DHHL to resolve.	2	2	2	4	4
83	60.01	Right of Way	Requirements	Approvals by Navy for the MSF drainage (storm drain) easement that goes through Navy property may take longer than expected and delay construction.	Navy has all the documentation and is in the process of approving.	1	2	0	1	1
84	30.03	Maintenance & Storage Facility Contract	Design	Reconfiguration of yard and building layout during design results in additional costs to contract.	The Final Designer will flip the one building but the cost impact should be minimal.	4	2	0	4	4
85	80.04	Maintenance & Storage Facility Contract	Requirements	Field office space may increase in size over current contract requirements.	Contractor specs are to supply space for 6 employees of City and GEC. More spaces will be needed. Cost reduced due to City input which said that any cost over $250,000 will be denied by the City.	5	1	0	2.5	5
86	60.01	Right of Way	Design	DHHL (Dept. of Hawaiian Home Lands) owns the MSF property and City needs to get right to occupy and construct.	August 15th is DHHL's Board Meeting and will grant access for construction for MSF and WOFH Guideway. Will then work on license agreement or property exchange.	2	2	2	4	4
87	40.04	Right of Way	Construction	Inability to obtain property access in a timely manner to undertake further environmental studies delays project.	Received concurrence from FTA Aug. 9 and will make an offer by August 23rd. They will then have 30 days to respond. By the end of Sept. will know what is going on.	2	2	2	4	4
88	40.02	Kamehameha Highway Guideway	Requirements	Relocation of 10 inch fuel line and 16 inch gas line along Kamehameha Highway may be more difficult than expected due to possible time frames for outages, etc.		2	1	3	4	4

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89	20.02	Right of Way	Construction	Property issues associated with Aloha Stadium Authority could result in scope changes and additional costs.	Have a pre-construction agreement with Aloha Stadium. Currently working to obtain agreement for construction.	2	2	1	3	3
8d	20.02	Airport Guideway	Design	Additional costs may arise through complicated stations and guideway integration.		2	3	3	6	
8e	20.02	City Center Guideway	Design	Additional costs may arise through complicated stations and guideway integration.	More complicated stations in City Center so probability is higher than in other sections.	3	4	2	9	
9	20.02	Project Wide	Requirements	Bus shelters may be added to scope and increase project cost.		5	3	0	7.5	7.5
91	50.01	Core Systems Contract	Market	If there is a legal protest to the award of Core Systems it could cause delays to NTP resulting in additional costs and schedule delays.	NTP was supposed to occur in April 2011. Contract hopes to be signed by mid -Sept. 2011. Mitigating delays by supplying current designers with information that they need from CSC but cannot obtain since contractor is not on board.	5	4	3	17.5	17.5
92	50.07	Core Systems Contract	Design	Back-up OCC proposed to be integrated with City Traffic Management Center may be underestimated.		1	2	0	1	1
93	40.02	Core Systems Contract	Design	Utility costs and scope to provide power to TPSS may be more than estimated. (ex. need to extend a medium voltage transmission line -12 kV)		2	4	0	4	4

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94	50.01	Core Systems Contract	Construction	Equipment, structures, etc. supplied by other contractors may not meet criteria required by Core Systems Contractor. (Systems Integration)		2	3	2	5	5
95	50.01	Core Systems Contract	Construction	Changes suggested by other contractors may result in change orders with Core Systems.		3	2	2	6	6
96	50.01	Core Systems Contract	Construction	Testing/ Demo/ Safety and Security Certification process may be more complicated than assumed.		2	2	2	4	4
98	50.01	Core Systems Contract	Construction	Construction sequencing is disrupted by fixed facility performance which causes inefficiencies and additional costs due to remobilization (or even double shifting because there are 2 locations at once).	The longer CSC is delayed the more likely that fixed facilities are available in time.	2	3	0	3	3
99	50.01	Core Systems Contract	Construction	Resource management may be limited during oversight of both operations of specific sections and construction/installation/testing of other sections.		2	2	2	4	4
9d	20.02	Airport Guideway	Requirements	Bus shelters may be added to scope and increase project cost.		5	2	0	5	
9e	20.02	City Center Guideway	Requirements	Bus shelters may be added to scope and increase project cost.	More shelters in City Center than other sections so cost is higher.	5	3	0	7.5	
PMOC16	10.04	City Center Guideway	Design	Estimates for remaining guideway contracts may be low due to adjustments using pricing from WOFH Bid.		3	4	0	6	6

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PMOC35	10.04	City Center Guideway	Construction	Underground obstruction delays pier/bent installation		1	4	2	3	3
PMOC8e	10.04	Core Systems Contract	Construction	Breakdown of specialty equipment/replacements not available locally		2	1	3	4	4
PMOC36	30.01	Maintenance & Storage Facility Contract	Construction	CSC could dictate changes to the Administration Building to accommodate its latest projections of staff needs.		2	2	1	3	3
PMOC11	60.01	Right of Way	Construction	Real Estate market could rebound before purchase of all needed properties, greatly increasing cost of property and delaying construction if legal actions are pursued.		2	5	0	5	5
PMOC50	50.01	Core Systems Contract	Requirements	Location of manholes, duct banks and conduits may require changes once systems design is finalized. (If installation of system wide duct banks is in the Civil packages.)		2	4	1	5	5
PMOC4	20.02	Project Wide Stations	Construction	Community pressure or transit-oriented development causes need for additional infill stations.		1	5	4	4.5	4.5
PMOC32	70.01	Maintenance & Storage Facility Contract	Design	Current layout in MSF for inspection pit design may not be conformed with selected vehicles.	MSF has looked at selected vehicles by CSC and there does not seem to be much impact to the current layout.	3	1	1	3	3
PMOC51	50.02	Core Systems Contract	Design	CSC electrical sub has limited transit systems construction experience. Likely cost & schedule impact. Will require more extensive monitoring by RTD.		2	1	1	2	2

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PMOC6	30.04	Maintenance & Storage Facility Contract	Design	Maintenance of Way (MOW) employees, once hired, may make requests for changes to MOW facility.		1	2	2	2	2
PMOC17	90	Project wide	Market	Project Labor Agreement does not cover utility companies. Schedule could be impacted if they experience labor dispute.		2	3	2	5	5
PMOC7	80.04	Core Systems Contract	Requirements	The outlined interface management plan (IMP) must function comprehensively and correctly. CSC proposal recognizes the importance of this process and lists it as a critical success factor. May require more staffing.		2	3	1	4	4
PMOC52	70.01	Core Systems Contract	Construction	Vehicle delivery may be delayed, as has been experienced in prior transit projects.	Project is at least 3 years out from needing a vehicle.	2	1	3	4	4
PMOC20	80.08	Core Systems Contract	Construction	Additional costs and delays may result due to the possible need for progressive changes to the design to accommodate staged working, along with operational and non-operational transitions.		2	2	2	4	4
PMOC8c	10.04	Airport Guideway	Construction	Breakdown of specialty equipment/replacements not available locally		2	1	3	4	4
PMOC44	30.03	Maintenance & Storage Facility Contract	Design	Schedule of coordination of yard and shop space versus vehicle delivery and acquisition of real estate.	ROW is currently working on agreement. ROW access for construction will not become critical until November since they already have the ability to access for testing and design.	1	2	2	2	2

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PMOC8d	10.04	City Center Guideway	Construction	Breakdown of specialty equipment/replacements not available locally		2	1	3	4	4
PMOC8f	10.04	Maintenance & Storage Facility Contract	Construction	Breakdown of specialty equipment/replacements not available locally.		2	1	1	2	2
PMOC12	20.02	Project Wide Stations	Construction	Separate procurement and installation of conveyance devices may create coordination problems in field resulting in schedule impact.		1	1	1	1	1
PMOC13	20.02	Project Wide Stations	Requirements	Costs are not allocated in station cost estimates for Art Program.		5	4	0	10	10
PMOC2c	10.09	Airport Guideway	Construction	Lower than expected production rate for track construction.		1	2	2	2	2
PMOC2d	10.09	City Center Guideway	Construction	Lower than expected production rate for track construction.		1	2	2	2	2
PMOC2a	10.09	West Oahu/Farrington Highway Guideway	Construction	Lower than expected production rate for track construction delays interim opening.		1	2	2	2	2
PMOC2b	10.09	Kamehameha Highway Guideway	Construction	Lower than expected production rate for track construction.		1	2	2	2	2

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PMOC8a	10.04	West Oahu/Farrington Highway Guideway	Construction	Breakdown of specialty equipment/replacements not available locally		2	1	3	4	4
PMOC26	20.02	Project Wide Stations	Design	Consideration of design changes to reduce station length and platform width may impact guideway structure design / construction.		1	2	2	2	2
PMOC31	20.07	Project Wide	Requirements	Elevators and escalators are a separate contract which may result in coordination issues with other contracts and cause delays.		2	2	2	4	4
PMOC8b	10.04	Kamehameha Highway Guideway	Construction	Breakdown of specialty equipment/replacements not available locally		2	1	1	2	2
PMOC22	50.01	Core Systems Contract	Market	Damage may occur to parts during long haul shipping and delay openings.		1	0	3	1.5	1.5
PMOC30	80.03	Project wide	Requirements	Grantee has not awarded contracts for the Cultural Resources (Kako'o) and a Job Order Contractor for Misc Construction Work. The Contract Packaging Plan states this work will be funded with contingency but needs to be part of contract packaging plan.		2	3	3	6	6
PMOC8	10.04	Project wide	Construction	Breakdown of specialty equipment/replacements not available locally		2	1	3	4	4

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PMOC19	50.05	Core Systems Contract	Design	Managing technology advances in sub-system components throughout the eight-year construction and 10-year O&M program will be difficult.		2	1	1	2	2
PMOC5	20.02	Project Wide Stations	Design	Comprehensive station design reveals need for increased number or size of guideway piers in station areas.		1	5	1	3	3
PMOC2	10.09	Project wide	Construction	Lower than expected production rate for track construction.		1	2	2	2	2