



HONOLULU AUTHORITY for RAPID TRANSPORTATION

HART PROGRAM COST ESTIMATE & SCHEDULE ASSESSMENT

Part One: Cost Estimate Assessment Report
Part Two: Schedule Assessment Report
Part Three: Mauka Shift Assessment Report

PREPARED BY
Triunity, Inc.



December 3, 2021



HONOLULU AUTHORITY for RAPID TRANSPORTATION

PART ONE

COST ESTIMATE ASSESSMENT REPORT

TRIUNITY

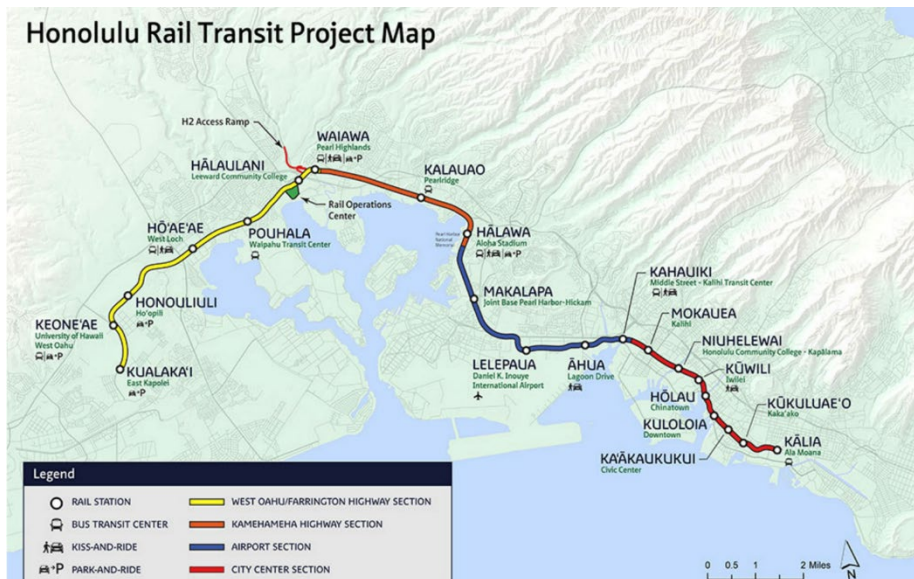
Report Issue Date: December 3, 2021

INTRODUCTION

As the Honolulu Authority for Rapid Transportation (HART) continues towards completion of its large capital program, the Project Team has recently refreshed the overall Estimate at Completion (EAC). This includes costs realized and progress achieved through the first three segments of the Program. The estimate to complete (ETC) primarily includes remaining testing activities in the first two segments, the West Oahu-Farrington Highway segment, and Kamehameha Highway segment. The ETC includes the yet to complete Pearl Highlands Garage, Bus Terminal, and H2 ramp (PHTG) in the first segment, as well as open claim issues being evaluated in the second segment. Approximately 10% of the Airport Section, segment three, is still underway. The majority of the work to complete is in segment four, the City Center. While the work remaining spans the entire Program, the focus of this assessment is the City Center segment.

The Assessment Team performed a top-down assessment on the individual project estimates that make up the remaining scope for the HART Program. The assessment has been conducted utilizing the Team’s Subject Matter Experts (SMEs) and organized according to the current reporting structure utilized by the HART Project Team. The goal of the assessment is to provide HART with an independent evaluation of the latest cost estimates and provide an opinion as to the level of appropriateness for the various projects. Since projects are currently at various levels of design and delivery, the assessment is broken into respective sections to capture the program in totality.

The largest effort was assessing the Program’s construction cost for reasonableness. The Assessment Team also briefly considered right-of-way and vehicles with the understanding that right-of-way is significantly advanced and vehicles have progressed through procurement and are contracted. The last portion considered was professional services with a major focus on program staffing levels and allocated/unallocated contingencies.



AGENCY

Honolulu Authority for Rapid Transportation
 1099 Alakea Street, 17th Floor
 Honolulu, Hawaii, 96813

ASSESSMENT TEAM

Triunity, Inc.
 633 17th Street, Suite 1500
 Denver, CO 80202

TABLE OF CONTENTS

TABLE OF CONTENTS..... 2

1.0 Executive Summary 3

 1.1 Guideway, Stations, Support Facilities, Systems and Vehicles 3

 1.2 Real Estate/Right of Way Acquisition..... 4

 1.3 Professional Services..... 4

 1.4 Unallocated Contingency 5

2.0 Approach to the Cost Assessment..... 6

3.0 Guideway, Stations, Support Facilities, Systems and Vehicles 7

 3.1 City Center Section Guideway and Station Group 7

 3.2 Pearl Highlands Garage, Bus Terminal (PHTG), + H2 Ramp 7

 3.3 City Center Utilities Relocation (CCUR)..... 8

 3.4 Core Systems Contract Design-Build-Operate-Maintain (CSC)..... 8

 3.5 Waipahu Makai Entrance 9

 3.6 Park-and-ride Lots Construction 9

 3.7 Volt Ampere Reactive Equipment 10

4.0 Real Estate and Art Elements 11

 4.1 Real Estate/Right of Way Acquisition..... 11

5.0 Professional Services and City and County Participating Departments..... 12

 5.1 Professional Services Overview..... 12

 5.2 Eastside CE&I Services 13

 5.3 Program Management Support Consultant..... 13

 5.4 General Engineering Consultant, Construction 14

 5.5 Core Systems Contract Oversight Consultant..... 14

 5.6 Honolulu Authority for Rapid Transit Labor, Expenses and Other Direct Costs 15

6.0 Conclusion..... 16

1.0 Executive Summary

The current EAC for the HART program consists of over 80 Contract Packaging Plans (CPPs) with multiple contracts in each for a total value of over \$11.37 billion. The Assessment Team prioritized efforts based on the contracts that hold the largest monetary value to be spent and the areas of the program that hold the greatest risk. The three major areas of the report are: (1) Guideway, Stations, Support Facilities, Systems and Vehicles, (2) Real Estate and Art Elements, and (3) Professional Services and City and County Participating Departments. Globally, the Assessment Team found HART's EAC to be complete and well managed. The Team also found areas of the EAC that present cost savings opportunities and these findings are summarized in Table 1.0 below and detailed throughout the report.

Group	HART's Current EAC			Assessment Team's Recommendation			Delta
	Base	Contingency	Total	Base	Contingency	Total	
Guideway, Stations, Support Facilities, Systems and Vehicles	\$6,677M	\$1,062M	\$7,740M	\$6,507M	\$836.7M	\$7,343M	\$396.3M
Real Estate and Art Elements	\$646.1M	\$146.6M	\$792.7M	\$646.1M	\$146.6M	\$792.7M	-
Professional Services and City and County Participating Departments	\$2,415M	\$201.5M	\$2,617M	\$2,169M	\$95.5M	\$2,264M	\$352.7M
Unallocated Contingency	-	\$221.7M	\$221.7M	-	\$221.7M	\$221.7M	-
Total	\$9,738M	\$1,632M	\$11,371M	\$9,321M	\$1,301M	\$10,622M	\$749.0M

Table 1.0

1.1 Guideway, Stations, Support Facilities, Systems and Vehicles

- a. **Overview:** The Guideway, Stations, Support Facilities, Systems and Vehicles is the group within the current EAC that holds all incurred and forecasted construction costs. The Assessment Team was provided the Independent Cost Estimate (ICE) for each particular scope of work (contract) to evaluate for reasonableness. This group of the assessment is made up of over 25 contracts, many of which are 100% complete and are summarized in Table 1.1 below in the row titled "All Other + Incurred."

Project	HART's Current EAC			Assessment Team's Recommendation			Delta
	Base	Contingency	Total	Base	Contingency	Total	
City Center Section Guideway and Station Group (CCGS)	\$1,570M	\$277.2M	\$1,848M	\$1,450M	\$217.5M	\$1,668M	\$180.0M
Pearl Highlands Garage, Bus Terminal (PHTG), + H2 Ramp	\$481.8M	\$206.5M	\$688.3M	\$443.0M	\$88.6M	\$531.6M	\$156.7M
City Center Utilities Relocation (CCUR)	\$631.3M	\$177.4M	\$808.7M	\$631.3M	\$177.4M	\$808.7M	-
Core Systems Contract Design-Build-Operate-Maintain (CSC)	\$825.4M	\$173.3M	\$998.7M	\$825.4M	\$173.3M	\$998.7M	-
Waipahu Makai Entrance	\$70.0M	\$30.0M	\$100.0M	\$70.0M	\$21.0M	\$91.0M	\$9.0M
Park-and-ride Lots Construction	\$55.0M	\$36.7M	\$91.7M	\$43.4M	\$13.0M	\$56.4M	\$35.3M

Volt Ampere Reactive Equipment	\$55.0M	\$23.6M	\$78.6M	\$55.0M	\$8.3M	\$63.3M	\$15.3M
All Other + Incurred	\$2,988M	\$137.6M	\$3,126M	\$2,988M	\$137.6M	\$3,126M	-
Total	\$6,677M	\$1,062M	\$7,740M	\$6,507M	\$836.7M	\$7,343M	\$396.3M

Table 1.1

- b. Findings:** Based on the Assessment Team's evaluation, the estimated amount of potential savings for the Guideway, Stations, Support Facilities, Systems and Vehicles group is estimated at \$396.3M. Of this amount, \$170.7M is accounted for in base cost and \$225.6M is accounted for in Allocated Contingency (AC). A detailed analysis of each individual project can be found in Section 3 of this report.

1.2 Real Estate/Right of Way Acquisition

- a. Overview:** Real Estate/Right of Way Acquisition is the section of the current EAC where property acquisition, relocations, and litigation reserves are held. The Assessment Team held interviews with the Project Team to gain knowledge of the system currently being used and to gather all information necessary to perform the assessment. These findings can be found in Table 1.2 below.

Description	Base	Contingency	Total
HART's Current EAC	\$345.3M	\$126.1M	\$471.4M
Assessment Team's Recommendation	\$345.3M	\$126.1M	\$471.4M

Table 1.2

- b. Findings:** Currently, HART is forecasting roughly \$345.3M for property acquisition, relocations, and litigation reserves. With much of the project footprint already identified through design, the risk of a ballooning number of new parcels being required appears negligible. Concurrently, the Real Property Group's formula approach to finding and reporting realistic property values appears appropriate and should mitigate the risk of any underestimation that could not be covered by AC. Further deep analysis could be performed if required at a later date, but at this time the Assessment Team is comfortable with HART's approach.

1.3 Professional Services

- a. Overview:** The Assessment Team evaluated staffing levels from two perspectives; the ability to properly manage owner tasks and risks, and the analysis of how HART staffing compares to other large transit programs. Since the new staffing plan is underway, we focused on that plan for this assessment. Table 1.3 below reflects the implementation of the new staffing plan and recommendations by the Assessment Team described in detail below.

Description	HART's Current EAC			Assessment Team's Recommendation			Delta
	Base	Contingency	Total	Base	Contingency	Total	
Eastside CE& I Services II	\$281.4M	\$31.3M	\$312.7M	\$218.2M	\$10.9M	\$229.1M	\$83.6M
Program Management Support Consultant III	\$206.7M	\$23.0M	\$229.7M	\$138.7M	\$6.9M	\$145.6M	\$84.1M
General Engineering Consultant, Construction (GEC-3)	\$322.9M	\$35.9M	\$358.8M	\$289.5M	\$14.5M	\$304.0M	\$54.8M
Core Systems Contract Oversight Consultant	\$187.3M	\$20.8M	\$208.1M	\$175.7M	\$8.8M	\$184.5M	\$23.6M
Honolulu Staffing, Expenses, & ODC's	\$532.2M	\$59.2M	\$591.4M	\$461.7M	\$23.1M	\$484.8M	\$106.6M
All Other Professional Services + Incurred	\$884.7M	\$31.3M	\$915.8M	\$884.7M	\$31.3M	\$915.8M	-
Total	\$2,415M	\$201.5M	\$2,617M	\$2,169M	\$95.5M	\$2,264M	\$352.7M

Table 1.3

- b. Findings:** The team found efficiencies with the new staffing plan and recommends forecasting the new values in their current EAC. In addition, the team also believes changing the computing formulas (consultant contracts forecasted at 160 hours/month vs. 175 hours/month) is an area that should be considered. Lastly, the AC currently being held at 10% could be reduced to 5% as an additional opportunity for cost savings. The Assessment Team estimates that implementing these three recommendations could save the agency \$352.7M over the span of the program.

1.4 Unallocated Contingency

- a. Overview:** Unallocated Contingency (UC) is typically used to address general project risks that could occur during the construction phase. These are unforeseen conditions such as hyperinflation or depressed workforce that could not have been forecasted. The appropriate UC should be determined by management based on overall project familiarity and risk profile. The Assessment Team’s evaluation can be found in Table 1.4 below.

<i>Description</i>	<i>Base</i>	<i>Contingency</i>	<i>Total</i>
HART’s Current Unallocated Contingency	-	\$221.7M	\$221.7M
Assessment Team’s Recommendation	-	\$221.7M	\$221.7M

Table 1.4

- b. Findings:** Currently, HART’s EAC is budgeting \$221.7M for UC. Based on review, the Assessment Team believes this to be appropriate for this stage of the program. A big reason for this is that HART’s current EAC has taken a targeted approach through identifying the risk profiles of individual projects and assigning appropriate levels of AC. Other metrics such as UC amounts versus percentage of remaining construction costs and general industry standards were also used in the Assessment Team’s evaluation.

2.0 Approach to the Cost Assessment

The Assessment Team performed a high level, top-down assessment on the individual project estimates that make up the remaining scope for the HART Program. The assessment is organized by the latest EAC currently being utilized by the HART Project Team. The goal of the assessment is to provide HART with an independent overall evaluation of the latest cost estimates and provide an opinion as to the level of appropriateness for the various projects. Since projects are currently at various levels of design and delivery, the assessment is broken into various segments as necessary with input from the HART Project Team. The Assessment Team utilized the latest Risk Register to help guide the review of the risk and contingency amounts currently being held for the program. Interviews with the various departments and Project Teams were held and the conclusions drawn from those meetings are presented in this report at various levels of detail.

The current EAC for the HART program consists of over 80 contracts for both costs incurred, and costs forecasted for a total value of over \$11.37 billion. The Assessment Team prioritized efforts based on the contracts that hold the largest monetary value to be spent and the areas of the program that hold the greatest risk. The three major groups of the report are: **(1) Guideway, Stations, Support Facilities, Systems and Vehicles, (2) Real Estate and Art Elements, and (3) Professional Services and City and County Participating Departments.** The Guideway, Stations, Support Facilities, Systems and Vehicles group is the area of the EAC that contains incurred construction costs to date as well as the forecasted capital cost to complete the remaining construction and testing. The Real Estate and Art Elements group contains prior and upcoming costs for property acquisition and relocations and is also where litigation reserves are held. Lastly, the Professional Services and City and County Participating Departments group is where both HART staff and consultant contracts are held. This report is all inclusive and spans across each major element of the program; however, since each major group contains many individual contracts, this report does not comment on each individual contract. Instead, only the contracts that hold significant value or contracts where the Assessment Team's findings significantly differ from what is currently being forecasted in the EAC, were reported.

This assessment is based on a smoothly functioning economic and construction environment, both nationally and locally. The pandemic has resulted in short term disruptions to the market and there is still the potential for unforeseen and longer-term impacts. It is difficult and not advisable to add large amounts of contingency for unknown, future pandemic impacts and HART staff should continue to closely monitor these trends. This assessment is valid only under the terms of a construction environment that could be reasonably forecasted. Such examples include: inflation percentages that can be realistically forecasted by published consumer price index (CPI) and/or producer price index (PPI) data; major scope changes to upcoming projects will be exempt or minimal; and projects will be executed in a competitive bid environment.

3.0 Guideway, Stations, Support Facilities, Systems and Vehicles

3.1 City Center Section Guideway and Station Group

- a. **Overview:** The HART City Center Section Guideway and Station Group (CCGS) is the last of three major segments to HART's capital program. This section consists of over 4 miles of double track beginning at Middle Street at the ewa side and terminating at the Ala Moana Station at the diamond side. Major scope elements include an aerial guideway with eight (8) elevated stations and various street improvements along the corridor. The areas the Assessment Team particularly targeted were construction costs, allowances, markups and other indirect costs, escalation, and contingency. The Assessment Team's evaluation can be found in Table 3.1 below.

Description	Base	Contingency	Total
City Center Section Guideway and Station Group (CCGS)	\$1,570M	\$277.2M	\$1,848M
Assessment Team's Recommendation	\$1,450M	\$217.5M	\$1,668M
Potential Savings	\$120.3M	\$59.7M	\$180.0M

Table 3.1

- b. **Accuracy of Estimate at Completion:** The Assessment Team reviewed the latest independent cost estimate dated July 23, 2020. The estimate included the most recent quantity and plan set takeoffs. HART refreshed the estimate and re-escalated for the revised EAC but the basis did not change from the July 2020 estimate. The Assessment Team believes that this approach was taken based on information related to the recent attempt at a public-private partnership (P3) procurement that resulted in greater than expected bid prices particularly in the areas of General Conditions and Engineering and Design. While partially merited due to the difficulties in the current procurement environment, the Assessment Team believes that the P3 procurement type used as a basis of the refresh should result in a higher cost in these areas than what should be reasonably forecasted for HART's most recent forecasted procurement type of design-build. Therefore, it is suggested that the current values in the base EAC could be reduced presenting a savings opportunity to the program estimated at \$120.3M.
- c. **Risk and Contingency Assessment:** The current amount of AC stands at \$277.2M or 15% of the total value of the contract. It's of the opinion of the Assessment Team that the base estimate, while realistic, also carries a substantial amount of the expected project risk. A reduction in AC from 15% of the total contract value to 15% of the base cost is recommended.

3.2 Pearl Highlands Garage, Bus Terminal (PHTG), + H2 Ramp

- a. **Overview:** The Pearl Highlands Garage, Bus Terminal, and H2 Ramp is a large transit center facility in Segment 1. Major scope elements include a 1,600-stall elevated parking structure, a bus transit center, and various ramps and street improvements. The Assessment Team's evaluation can be found in Table 3.2 below.

Description	Base	Contingency	Total
Pearl Highlands Garage, Bus Terminal (PHTG), + H2 Ramp	\$481.8M	\$206.5M	\$688.3M
Assessment Team's Recommendation	\$443.0M	\$88.6M	\$531.6M
Potential Savings	\$38.8M	\$117.9M	\$156.7M

Table 3.2

- b. **Accuracy of Estimate at Completion:** The current base estimate for this scope of work is \$481.8M. The Assessment Team reviewed the latest independent cost estimate dated July 23, 2020. The estimate included the most recent quantity and plan set takeoffs. HART refreshed the estimate and re-escalated for the revised EAC but the basis did not change from the July 2020 estimate. Once again, the Assessment Team believes that this approach was taken based on information related to the recent attempt at a procurement that resulted in greater than expected bid prices particularly in the areas of General Conditions and Engineering and Design. While partially merited, the amount currently being carried in HART's EAC surpasses the results from the procurement and appears to be a conservative increase to the unit cost particularly in the structural components of the Pearl Highlands Garage. The Assessment Team suggests the current values in the EAC could be reduced presenting a savings opportunity to the program estimated at \$38.8M.

- c. **Risk and Contingency Assessment:** The current AC for this scope of work is \$206.5M. This would account for 30% of the total contract value or 43% of base cost. The Assessment Team believes this is considerably high by both industry metrics and HART’s recent procurement efforts and would recommend lowering to 20% of the base cost. This would provide a savings opportunity of an estimated \$117.9M for the program.

3.3 City Center Utilities Relocation (CCUR)

- a. **Overview:** The CCUR project will relocate both wet and dry utilities as well as road improvements as required in advance of the CCGS contract. Major scope elements include wet utilities, dry utilities, roadway improvements, Kapalama utility bridges, traffic signals, street lighting, fiber optic and traffic signal interconnect, and a 138 kV relocation. The areas the Assessment Team particularly targeted were construction costs, allowances, markups and other indirect costs, and escalation. The Assessment Team’s evaluation can be found in Table 3.3 below.

Description	Base	Contingency	Total
City Center Utilities Relocation (CCUR)	\$631.3M	\$177.4M	\$808.7M
Assessment Team’s Recommendation	\$631.3M	\$177.4M	\$808.7M

Table 3.3

- b. **Accuracy of Estimate at Completion:** The Assessment Team reviewed the latest independent cost estimate dated May 7, 2020. The current estimate sits at \$631.3M without associated contingencies. This estimate has since been refreshed with adjustments to items such as overall project schedule, indirect costs, and general escalation. The Assessment Team believes this number to be derived from the high range of the ICE generated in Q2 of 2020, which was deemed to be thoroughly and sufficiently developed for the level of design detail produced to date.
- c. **Risk and Contingency Assessment:** The current AC being held in the EAC is \$177.4M. This by percentage accounts for 22% of the overall contract amount or 28% of base cost. While this looks conversative by most metrics, this area of the program also holds the most risk and the Assessment Team does not recommend reducing contingency at this time.

3.4 Core Systems Contract Design-Build-Operate-Maintain (CSC)

- a. **Overview:** The HART Core Systems Contract (CSC) is an overarching contract spanning the entire HART program for the supply and installation of the train control, communications, traction power, and station systems. The contract also supplies 80 trains and holds the operations and maintenance of the system for a 5-year period. The contractor is performing satisfactorily as the civil contractors open areas for the systems to progress. The evaluation of the CSC was centered around a review of the remaining risk to completion of the contract instead of a full project scope review. The Assessment Team held discussions with the CSC project management. The topics discussed ranged from contractor performance to the structure of the delay change order and the payment milestones. The Assessment Team’s evaluation can be found in Table 3.4 below.

Description	Base	Contingency	Total
Core Systems Contract Design-Build-Operate-Maintain (CSC)	\$825.4M	\$173.3M	\$998.7M
Assessment Team’s Recommendation	\$825.4M	\$173.3M	\$998.7M

Table 3.4

- b. **Accuracy of Estimate at Completion:** As the contract was signed in 2011 there have been significant delays to the overall project. To address the delays, a \$160M change order was executed in late 2018. Based on the information provided, the Assessment Team believes the current values carried in the EAC to be appropriate.
- c. **Risk and Contingency Assessment:** The future delay claims pose the largest risks remaining for the CSC. The HART staff’s approach to mitigating the delay claims is well reasoned considering the unusual challenges that the program delays present to this overarching systems contract. The allocated risk for delays to the systems contractor for Segment 2 is currently \$30M. The AC appears sufficient for the delays the systems contractor will experience from the civil contracts. The CSC is typical for major construction projects. Major changes are negotiated for scope and compensation. The onus of the change falls to the CSC project management to negotiate. The project management team has the responsibility to determine the best approach to manage the CSC contractor and the strategy to limit HART exposure for future delays.
- d. **Additional Comments:** Due to the delays of the program the segments will be opened in a different manner than originally planned. One effect this may produce is an increased cost to test and open Segment 2 while Segment 1 is operational. Systems testing is challenging under normal circumstances and when short windows, nights and weekends are added into

the mix, costs can climb quickly due to premium labor for craft and increased overheads to cover both day and night shifts. COVID-19 has introduced further uncertainty in terms of escalation and material procurement delays. Copper has risen significantly since COVID-19; however, it is historically very similar in price to when the CSC was executed. One large risk that has been mitigated is all the train control equipment is on site. The initial large change order that was executed with the CSC included payments for completed milestones in Segments 2 and 3. The CSC contractor is experiencing challenges of their own which may help HART to mitigate (concurrent) delay claims allegedly caused by the civil contracts.

3.5 Waipahu Makai Entrance

- a. **Overview:** The Assessment Team reviewed the Waipahu Makai Entrance contract which consists of three various scopes of work described below:
- **Waipahu Transit Center Makai Entrance Module & Stairs:** Construction of a fare gate entrance building to the Makai side of the Waipahu Station. The entrance building will be elevated to bring the entrance level to the same elevation as the elevator first floor level, giving the public access to the entrance module from the surrounding site grade.
 - **UHWO Station East Entrance Building:** Construction of a permanent east entrance building and an elevated pedestrian bridge on the east side of the guideway platform at the UHWO Station. The pedestrian bridge will be elevated at the concourse level to allow the public access to the guideway platform.
 - **Keone’ae Station at UHWO:** Construction of a 1,000-stall asphalt parking lot and bus transit center. The construction includes asphalt paving, pavement markings, landscaping, lighting and security, concrete bus parking, concrete curbs/sidewalks, and bus shelters.

The Assessment Team’s evaluation can be found in Table 3.5 below.

Description	Base	Contingency	Total
HART’s Waipahu Transit Center Makai Entrance Module & Stairs	\$10.8M	\$4.6M	\$15.4M
UHWO Station East Entrance Building	\$37.4M	\$16.0M	\$53.4M
Keone’ae Station at UHWO	\$21.4M	\$9.2M	\$30.6M
Waipahu Makai Entrance Total	\$70.0M¹	\$30.0M¹	\$100.0M¹
Assessment Team’s Recommendation	\$70.0M	\$21.0M	\$91.0M
Potential Savings	\$0M	\$9.0M	\$9.0M

1 – Total has been rounded and reflects the amount carried in the EAC.

Table 3.5

- b. **Accuracy of Estimate at Completion:** The three estimates making up this contract total \$70.0M. The Assessment Team reviewed the independent cost estimates for each of the three projects and believe them to be appropriate for this level of design.
- c. **Risk and Contingency Assessment:** The current contract holds a 30% AC based on overall contract value (43% of base cost) and is viewed by the Assessment Team as conservative. While the projects lack more than 15% design, each independent cost estimate already carries a design contingency in the base cost. The Assessment Team recommends lowering the AC to 30% of base cost resulting in a reduction of \$9.0M to the EAC.

3.6 Park-and-ride Lots Construction

- a. **Overview:** The Assessment Team reviewed the Park-and-Ride Lots Construction contract which consists of three various scopes of work described below:
- **Kualakai Station at East Kapolei:** Construction of an east entrance building and an elevated pedestrian bridge on the west side of the guideway platform at the Kualakai Station. The pedestrian bridge will be elevated at the concourse level to allow the public access to the guideway platform.
 - **East Kapolei Parking Lot:** Construction of a 958-stall parking lot at East Kapolei. The construction includes asphalt paving, pavement markings, landscaping, lighting and security, concrete curbs/sidewalks, bus shelters, access roads, and the Keahumoa Roadway Extension.
 - **Ho’opili Park-and-Ride Electrical:** Electrical work for the Ho’opili Park-and-Ride including installation of 11,200 feet of electrical underground conduit, 65 each handholes, extensions and connections to the station’s TCCR room.

The Assessment Team’s evaluation can be found in Table 3.6 below.

Description	Base	Contingency	Total
Kualakai Station at East Kapolei	\$23.1M	\$15.4M	\$38.5M
East Kapolei Parking Lot	\$14.5M	\$9.7M	\$24.2M
Ho’opili Park-and-Ride Electrical	\$0.84M	\$0.56M	\$1.4M
Park-and-ride Lots Construction Total	\$55.0M¹	\$36.7M¹	\$91.7M¹
Assessment Team’s Recommendation	\$43.4M	\$13.0M	\$56.4M
Potential Savings	\$11.6M	\$23.7M	\$35.3M

1 – Total reflects the amount carried in the EAC.

Table 3.6

- b. **Accuracy of Estimate at Completion:** The current estimate at completion is \$55.0M which exceeds the ICEs reviewed by the Assessment Team by the amount of \$16.6M. Based on previous conversation with HART staff, it is understood that \$5.0M was added to the EAC to account for the construction of the Ho’opili Park-and-Ride; however, there remains a gap of \$11.6M between the EAC and the ICEs provided. The Assessment Team believes that a more reasonable dollar amount for the base estimate should be around \$43.4M based on the information provided. This would account for a reduction of \$11.6M in base cost.
- c. **Risk and Contingency Assessment:** Currently carrying \$36.7M in AC which equates to 40% of the total contract value (67% of base cost) and is viewed as very conservative by the Assessment Team. It is recommended that the contingency percentage be reduced to 30% of base cost. Using the recommended base estimate of \$43.4M, the new AC is recommended at \$13.0M. This would account for an additional reduction of \$23.7M.
- d. **Recommendations:** Based on the information provided, the total potential savings is \$35.3M. However, this appears to be a “catch all” contract. It is recommended that the HART team clearly identify the scope of this contract and update the EAC as necessary.

3.7 Volt Ampere Reactive Equipment

- a. **Overview:** Electrified light rail systems typically power the traction power substations with a dedicated power feed. The HECO feeds for the substations are shared among multiple clients. HECO is required to maintain a level of power quality for all customers and traction power substations may cause the power to fluctuate outside of the established limits. The mitigation strategy is to provide equipment to keep the power feed within the established limits. The responsibility to mitigate these effects has been negotiated between HECO and HART over the years. The latest HART leadership team has agreed to install the equipment at HART’s expense. The Assessment Team’s evaluation can be found in Table 3.7 below.

Description	Base	Contingency	Total
HART’s Current EAC	\$55.0M	\$23.6M	\$78.6M
Assessment Team’s Recommendation	\$55.0M	\$8.3M	\$63.3M
Potential Savings	\$0M	\$15.3M	\$15.3M

Table 3.7

- b. **Accuracy of Estimate at Completion:** The HART engineering team has developed technical solutions with associated engineering estimates of \$55.0M. The procurement is planned to be a DBOM due to the unique nature of the equipment. The engineering estimate includes scope to design, build, operate and maintain the STATCOM VVO equipment and it also includes possible ROW acquisition and changes to the civil and CSC to integrate the new equipment. The estimates appear conservative but due to the nature of the work and the vaguely defined scope, the Assessment Team does not recommend changing the base cost at this time.
- c. **Risk and Contingency Assessment:** The current AC for this contract is \$23.6M. This accounts for 30% of total contract value and 43% of base cost. After reviewing the engineering estimates, it appears that a substantial amount of contingency is already built into the base cost. The Assessment Team recommends reducing the AC to 15% of base cost resulting in a potential savings of \$15.3M for the program.

4.0 Real Estate and Art Elements

4.1 Real Estate/Right of Way Acquisition

- a. **Overview:** The real property group at HART has processes and procedures that appear to be mature and complete. The HART team uses a combination of assessed values, adjustment factors for both full property takes and construction easements, and relocation expenses to forecast the expected budget for the program. The team’s attention to detail and flexibility of consistently updating their formulas should lead to an accurate estimate of forecasted cost. The overall approach to both acquiring real estate and mitigating damages is seen by the Assessment Team to be at or above industry standards.

The Assessment Team’s evaluation can be found in Table 4.1 below.

<i>Description</i>	<i>Base</i>	<i>Contingency</i>	<i>Total</i>
HART’s Current EAC	\$345.3M	\$126.1M	\$471.4M
Assessment Team’s Recommendation	\$345.3M	\$126.1M	\$471.4M

Table 4.1

- b. **Accuracy of Estimate at Completion:** Currently, HART is forecasting roughly \$345.3M for property acquisition, relocations, and litigation reserves. With much of the project footprint already identified through design, the risk of a ballooning number of new parcels being required appears negligible. Concurrently, the real property group’s formula approach to finding and reporting realistic property values appears appropriate and should mitigate the risk of any underestimation that could not be covered by the forecasted AC.
- c. **Risk and Contingency Assessment:** Currently, HART is carrying roughly \$126.1M in AC or 26% of the forecasted contract amount. Due to the nature and sensitivity of the real estate market, it has been found that this category of the estimate typically carries a higher percentage of contingency. Through interviews with right-of-way (ROW) staff, it was identified that the most recent appraisal was early 2020. This may account for the largest risk for this category as it is unclear how the effects of higher-than-expected economic volatility due to COVID-19 could impact real estate prices.
- d. **Recommendations:** The Assessment Team performed the ROW evaluation at a high level without the use of a local real estate expert and found no significant recommendations for this group. After interviews with staff, it’s clear that this group is well qualified to handle the upcoming needs in this category. Both base cost and AC appear to forecast reasonable expectations and appear appropriate for this stage of the program

5.0 Professional Services and City and County Participating Departments

5.1 Professional Services Overview

- a. Overview:** Large capital programs like HART typically see their Professional Services account for 20-40% of construction costs. Despite the magnitude of this dollar value, this category, which is critical to program delivery, can often be overlooked. For this report, the Assessment Team focused primarily on agency staffing and consultant contracts since it makes up the bulk of the remaining cost to the program. Rail transit programs have become very large and complex and the need for adequate management and staffing with the skills and experience to address these challenges cannot be underestimated. In addition, it is imperative to find the right balance for the program as too many personnel can lead to inefficiencies and unproductive activities.

The Assessment Team evaluated staffing levels from two perspectives; the ability to properly manage owner tasks and risks, and the analysis of how HART staffing compares to other large transit programs. Since the new staffing plan is underway, we focused on the new plan for this assessment. Table 5.1 reflects the implementation of the new staffing plan and other suggestions by the Assessment Team described in detail below.

Description	HART's Current EAC			Assessment Team's Recommendation			Delta
	Base	Contingency	Total	Base	Contingency	Total	
Eastside CE& I Services II	\$281.4M	\$31.3M	\$312.7M	\$218.2M	\$10.9M	\$229.1M	\$83.6M
Program Management Support Consultant III	\$206.7M	\$23.0M	\$229.7M	\$138.7M	\$6.9M	\$145.6M	\$84.1M
General Engineering Consultant, Construction (GEC-3)	\$322.9M	\$35.9M	\$358.8M	\$289.5M	\$14.5M	\$304.0M	\$54.8M
Core Systems Contract Oversight Consultant	\$187.3M	\$20.8M	\$208.1M	\$175.7M	\$8.8M	\$184.5M	\$23.6M
Honolulu Staffing, Expenses, & ODC's	\$532.2M	\$59.2M	\$591.4M	\$461.7M	\$23.1M	\$484.8M	\$106.6M
All Other Professional Services + Incurred	\$884.7M	\$31.3M	\$915.8M	\$884.7M	\$31.3M	\$915.8M	-
Total	\$2,415M	\$201.5M	\$2,617M	\$2,169M	\$95.5M	\$2,264M	\$352.7M

Table 5.1

The average full-time equivalents (FTE) through 2030 that were derived from this plan are as follows:

Previous Staffing Plan	
Year	FTE
2021	189
2022	169
2023	157
2024	124
2025	165
2026	166
2027	155
2028	138
2029	104
2030	104

New Staffing Plan	
Year	FTE
2021	162
2022	133
2023	122
2024	102
2025	132
2026	135
2027	129
2028	114
2029	91
2030	91

- b. Accuracy of Estimate at Completion:** The Assessment Team did not identify gaps or obvious deficiencies for any specific discipline in the new staffing plan. The overall staffing numbers, given the complexity of this program and the challenges of maintaining personnel in Hawaii, are consistent with other rail mega-projects of this scale including those for LA Metro. However, there is a gap between the new projected staffing numbers and what is currently being carried in the latest EAC. Further, in translating the overall detailed staffing projections into costs, certain elements of conservatism were observed. For example, the estimate uses 175 hours worked for each position and each month throughout the life of the contract. The FTA typically recommends 160 hours as more reflective of actual conditions. This has a significant cumulative impact over the life of the program, resulting in a savings of approximately \$246.7M if applied with the most recent staffing reduction plan.
- c. Risk and Contingency Assessment:** Each consulting contract is currently assigned a 10% AC in the EAC. Contingency is applied to address unforeseen conditions over the long timeframe of the program. In this estimate, most of the consultants are serving as an extension of staff with a detailed position by position projection. It is unlikely that the staff projections will need an order of magnitude increase, particularly given HART’s recent experience in successfully reducing and managing staffing levels. However, given the unpredictable nature of long-running mega-projects, some level of contingency is warranted. The Assessment Team recommends that HART reassess its 10% AC for consultant contracts and consider an AC of 5%. This reduction would provide an additional savings of \$106.0M, assuming all other recommendations are implemented.
- d. Recommendations:** The Assessment Team believes overall staffing levels that are planned and budgeted are sufficient to manage and oversee the program, and consistent with other large rail mega-projects. Strategies to reduce the overall length of the program should be vigorously pursued, where feasible, as a shorter schedule will bring a commensurate reduction in costs for professional services. In many cases, this reduction can help fund contractor acceleration strategies and agreements. HART should continue to work closely with the FTA in its ongoing Management Capacity and Capability assessments and respond appropriately in filling critical positions.

5.2 Eastside CE&I Services

<i>Description</i>	<i>Base</i>	<i>Contingency</i>	<i>Total</i>
HART’s Current EAC	\$281.4M	\$31.3M	\$312.7M
Assessment Team’s Recommendation	\$218.2M	\$10.9M	\$229.1M
Potential Savings	\$63.2M	\$20.4M	\$83.6M

Table 5.2

- a. Accuracy of Estimate at Completion** Currently, the EAC is valuing this contract at \$281.4M, which is a combination of both already incurred costs and the forecasted cost to complete. The Assessment Team views this as conservative and through conversations with the HART project team it’s now known that an overall reduction to this contract is currently underway in the forecasted amount of \$50.9M. In addition, while evaluating the staffing plan it was recognized that HART is currently budgeting full-time staff at 175 hours per month. The Assessment Team recommends reducing this to 160 hours a month which fall within industry standards. Applying this would reduce the EAC amount by an additional \$12.3M over the life of the contract.
- b. Risk and Contingency Assessment:** Currently, the AC amount of this contract stands at \$31.3M or 10% of the estimated total contract amount. The HART project team appears to have a great handle on their staffing needs and therefore the Assessment Team recommends reducing AC to 5% of the estimated base contract amount. Assuming all other recommendations are implemented, this would account for an additional \$20.4M savings to the program.

5.3 Program Management Support Consultant

<i>Description</i>	<i>Base</i>	<i>Contingency</i>	<i>Total</i>
HART’s Current EAC	\$206.7M	\$23.0M	\$229.7M
Assessment Team’s Recommendation	\$138.7M	\$6.9M	\$145.6M
Potential Savings	\$68.0M	\$16.1M	\$84.1M

Table 5.3

- a. Accuracy of Estimate at Completion:** Currently, the EAC is valuing this contract at \$206.7M, which is a combination of both already incurred costs and the forecasted cost to complete. The Assessment Team views this as conservative

and through conversations with the HART project team it's now known that an overall reduction to this contract is currently underway in the forecasted amount of \$59.5M. In addition, while evaluating the staffing plan it was recognized that HART is currently budgeting full-time staff at 175 hours per month. The Assessment Team recommends reducing this to 160 hours a month which fall within industry standards. Applying this would reduce the EAC amount by an additional \$8.5M over the life of the contract.

- b. **Risk and Contingency Assessment:** Currently, the AC amount of this contract stands at \$23.0M or 10% of the estimated total contract amount. The HART project team appears to have a great handle on their staffing needs and therefore the Assessment Team recommends reducing AC to 5% of the estimated base contract amount. Assuming all other recommendations are implemented, this would account for an additional \$16.1M savings to the program.

5.4 General Engineering Consultant, Construction

<i>Description</i>	<i>Base</i>	<i>Contingency</i>	<i>Total</i>
HART's Current EAC	\$322.9M	\$35.9M	\$358.8M
Assessment Team's Recommendation	\$289.5M	\$14.5M	\$304.0M
Potential Savings	\$33.4M	\$21.4M	\$54.8M

Table 5.4

- a. **Accuracy of Estimate at Completion:** Currently, the EAC is valuing this contract at \$322.9M, which is a combination of both already incurred costs and the forecasted cost to complete. The Assessment Team views this as conservative and through conversations with the HART project team it's now known that an overall reduction to this contract is currently underway in the forecasted amount of \$13.2M. In addition, while evaluating the staffing plan it was recognized that HART is currently budgeting full-time staff at 175 hours per month. The Assessment Team recommends reducing this to 160 hours a month which fall within industry standards. Applying this would reduce the EAC amount by an additional \$20.2M over the life of the contract.
- b. **Risk and Contingency Assessment:** Currently, the AC amount of this contract stands at \$35.9M or 10% of the estimated total contract amount. The HART project team appears to have a great handle on their staffing needs and therefore the Assessment Team recommends reducing AC to 5% of the estimated base contract amount. Assuming all other recommendations are implemented, this would account for an additional \$21.4M savings to the program.

5.5 Core Systems Contract Oversight Consultant

<i>Description</i>	<i>Base</i>	<i>Contingency</i>	<i>Total</i>
HART's Current EAC	\$187.3M	\$20.8M	\$208.1M
Assessment Team's Recommendation	\$175.7M	\$8.8M	\$184.5M
Potential Savings	\$11.6M	\$12.0M	\$23.6M

Table 5.5

- a. **Accuracy of Estimate at Completion:** Currently, the EAC is valuing this contract at \$187.3M, which is a combination of both already incurred costs and the forecasted cost to complete. The Assessment Team views this as conservative and through conversations with the HART project team it's now known that an overall reduction to this contract is currently underway in the forecasted amount of \$325K. In addition, while evaluating the staffing plan it was recognized that HART is currently budgeting full-time staff at 175 hours per month. The Assessment Team recommends reducing this to 160 hours a month which fall within industry standards. Applying this would reduce the EAC amount by an additional \$11.3M over the life of the contract.
- b. **Risk and Contingency Assessment:** Currently, the AC amount of this contract stands at \$20.8M or 10% of the estimated total contract amount. The HART project team appears to have a great handle on their staffing needs and therefore the Assessment Team recommends reducing AC to 5% of the estimated base contract amount. Assuming all other recommendations are implemented, this would account for an additional \$12.0M savings to the program.

5.6 Honolulu Authority for Rapid Transit Labor, Expenses and Other Direct Costs

<i>Description</i>	<i>Base</i>	<i>Contingency</i>	<i>Total</i>
HART's Current EAC	\$532.2M	\$59.2M	\$591.4M
Assessment Team's Recommendation	\$461.7M	\$23.1M	\$484.8M
Potential Savings	\$70.5M	\$36.1M	\$106.6M

Table 5.6

- a. **Accuracy of Estimate at Completion:** Currently, the EAC is valuing this contract at \$532.2M, which is a combination of both already incurred costs and the forecasted cost to complete. The Assessment Team views this as conservative and through conversations with the HART project team it's now known that an overall reduction to this contract is currently underway in the forecasted amount of \$70.5M. The Assessment Team recommends proceeding with the staffing plan reductions in progress.
- b. **Risk and Contingency Assessment:** Currently, the AC amount of this contract stands at \$59.2M or 10% of the estimated total contract amount. The HART project team appears to have a great handle on their staffing needs and therefore the Assessment Team recommends reducing AC to 5% of the estimated base contract amount. Assuming all other recommendations are implemented, this would account for an additional \$36.1M savings to the program.

6.0 Conclusion

The Assessment Team performed a high level, top-down assessment on the individual project estimates that make up the remaining scope for the HART Program. The most significant findings were opportunities for potential savings to the program, particularly in areas of forecasted construction costs and professional services. Globally, the HART program appears to be well managed, and any upcoming challenges are at the forefront, and are reflected in the current EAC. Examples of this are the targeted approach to AC and the management of the program's Risk Register. Many large programs rely too heavily on UC which by nature is less targeted and can lead to ballooning of program costs if not properly managed. The Assessment Team did find several areas within the various EAC groups that costs appear to be forecasted with conservatism. It is suggested that the Project Team investigate these findings and update the current EAC as necessary.

HART

HONOLULU AUTHORITY for RAPID TRANSPORTATION

PART TWO

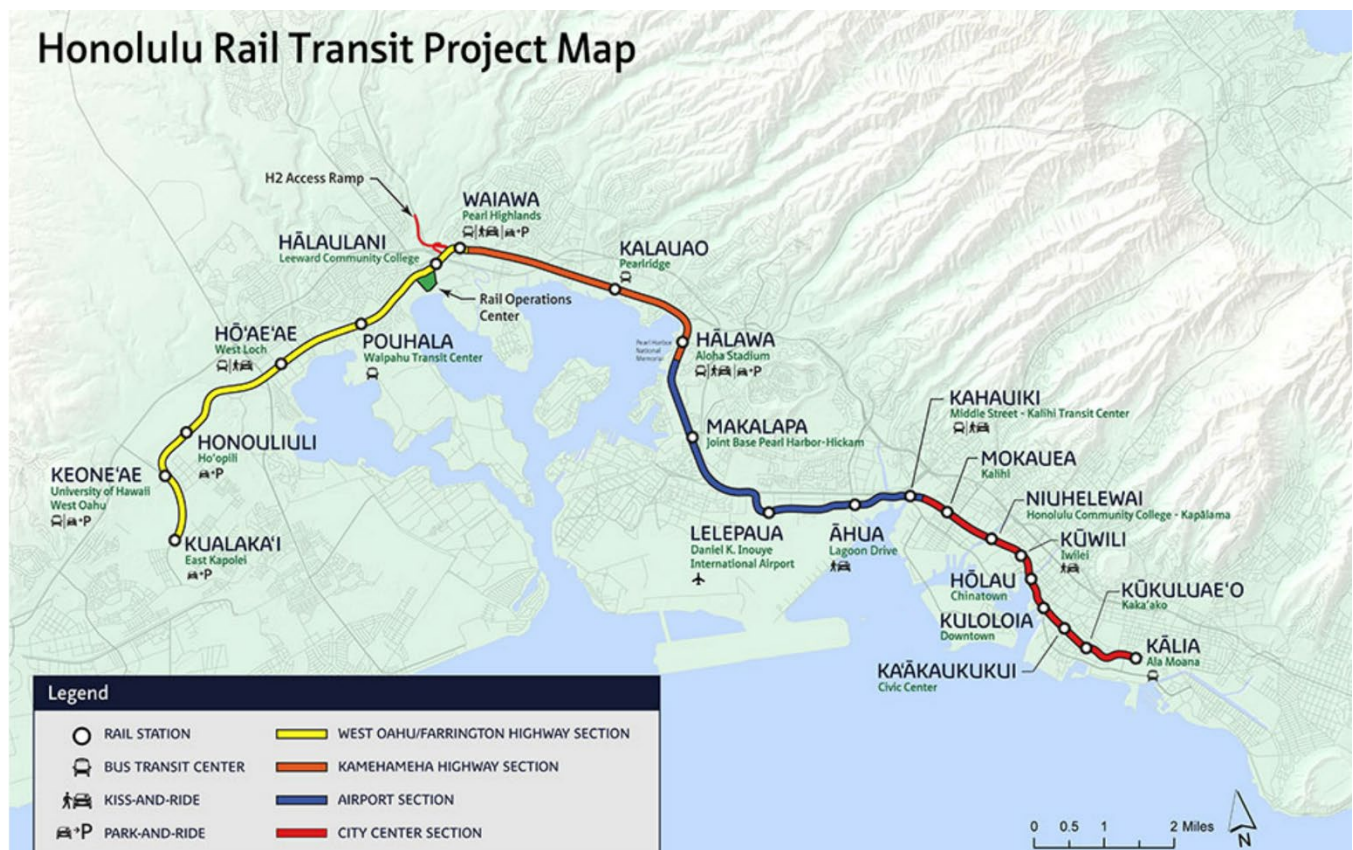
SCHEDULE ASSESSMENT REPORT

TRIUNITY

Report Issue Date: December 3, 2021

INTRODUCTION

As the Honolulu Authority Rapid Transportation (HART) Program (Program) continues towards completion, the Project Team has recently refreshed the overall Master Project Integrated Schedule (MPIS). This includes progress achieved through the first three segments of the Program. The schedule to complete primarily includes remaining core systems installation, testing and integration activities in the first two operating segments, the combined West Oahu-Farrington Highway section, plus the Kamehameha Highway section is now being considered Operational Segment 1 – Westside. The work remaining in the second segment, Operational Segment 2 – Airport, is the final stretch of guideway approaching and including the Kahauiki Station at Middle St. (last station at the east end of the segment), followed by the core systems installation, integrated testing, and commissioning. And the last operational segment, Segment 3 – City Center, has only begun some preliminary utility relocation work, with the bulk of the work remaining to be procured and constructed over the next 8-10 years. While there is work remaining in all 3 segments of the Program, the majority of focus for this assessment will be on Segment 3 – City Center, as it has the most exposure to remaining risks and uncertainty for schedule impacts and delays.



The Assessment Team assessed the program’s MPIS for reasonableness and performed a top-down assessment of the individual project/contract schedules that make up the remaining scope for the Program. The assessment has been conducted utilizing the Team’s subject matter experts (SME’s) and the goals of the assessment are to provide HART with an evaluation of the latest completion schedules and provide an opinion as to the level of appropriateness for the various projects. Since projects are currently at various levels of design and delivery, the assessment will be broken into the 3 operational segments being turned over to Honolulu Department of Transportation Services (DTS) in succession.

The Assessment Team will briefly consider right-of-way and vehicles procurement schedules with the understanding that right-of-way acquisitions are significantly advanced ahead of the need for construction, and vehicles have progressed through procurement and are contracted for delivery to support testing and operations. After the critical paths for design and construction are evaluated, the remaining schedule activities to be considered are for professional services only as a level of effort, and the allocated/unallocated risk contingency activities as they are represented within the critical path by a duration

placeholder activity only, or added at the end of each critical path to operational readiness. To perform this final step of the schedule assessment, the Team will concurrently be examining the program schedule, claims log, and risk registers for remaining projects.

Reviews of the cost Estimate-at-Complete or EAC (as it relates to the schedule), claims, and risk register will be performed at a high-level, targeted to assist in the overall schedule assessment. In-depth schedule analysis for existing claims and risk will not be performed at this time.

List of Acronyms:

AGS – Airport Guideway and Stations (contract)
CBS – Cost Breakdown Structure
CCC – Change Control Committee
CCGS – City Center Guideway and Stations (contract)
CCUR – City Center Utilities Relocation (contract)
CPM – Critical Path Method (schedule technique)
CSC – Core Systems Contract(or)
DTS – Department of Transportation Services (City and County of Honolulu)
EAC – Estimate-at-Complete (cost forecast technique)
EPS – Enterprise Project Structure (in Primavera P6)
HRH – Hitachi Rail Honolulu (Core Systems Contractor)
KHG – Kamehameha Highway Guideway section
MPIS – Master Project Integrated Schedule
OBS – Organization Breakdown Structure
PMP – Project Management Plan
P6 – Primavera Project Planner (Enterprise scheduling software)
STG – Shimmick/Traylor/Granite (Joint Venture Contractor)
WBS – Work Breakdown Structure
WOFH – West Oahu-Farrington Highway (guideway) section

TABLE OF CONTENTS

TABLE OF CONTENTS	3
1.0 Executive Summary	4
2.0 General Findings and Approach to Evaluating the Schedule	5
3.0 Critical Path	6
4.0 Structure of Schedule	8
4.1 Master Schedule Structure	8
4.2 Enterprise Project Structure (EPS)	9
4.3 WBS	9
5.0 Incorporation of Schedule Risk	10
6.0 Schedule Contingency	11
7.0 Schedule Specification	12
7.1 Additional Considerations:.....	12
8.0 Contractor/Consultant Schedules (Baseline and Progress Updates)	14
9.0 Pending Delay Claims	15
10.0 Staffing Evaluation	16
11.0 Production Rates	17
11.1 Hours and Major Unit quantities	17
12.0 Logic/Sequence	18
13.0 Resource/Cost Loading	19
14.0 Tracking	20
14.1 Earned Value Analysis	20
14.2 Progress Reporting.....	20
14.3 S-Curves.....	20

1.0 Executive Summary

Analyzing the trends of actual schedule progress against the original baseline “planned” schedule for the Airport Guideway and Stations (AGS) project, the HART Program has clearly encountered more schedule delay events and resourcing challenges than was ever anticipated by the early HART project management teams. The earned value and actual cost profile curves (see Section 14.3, S-Curves) indicate that the baseline production rates required to stay within the early/late (“on-schedule”) envelope were not ever achieved. However, analyzing the latest forecast curves, current CPM schedules used for forecasting the remaining contracts to complete, and a robust list of evaluated risks (either mitigated or managed), it is apparent the lessons learned and actual production rates proven thus far have been adequately modeled program wide for more realistic (probability of achievement) completion schedules to meet the following revised Operational Readiness Dates for Segments 1, 2 and 3. It should also be noted that Segment 1 will be the first experience of LRT operations for HART and DTS and we have not assessed the complexities of Operational turn-over from HART to DTS for revenue service.

Segment:	Operational Readiness Date:
1 - Westside	April 2022 (not risk adjusted)
2 - Airport	March 2024 (not risk adjusted)
3 - City Center	October 2029 (risk adjusted March 2031)

Table 1.0

The Assessment Team recommends HART coordinate with DTS to produce a detailed plan for transitioning the Segment 1 Operations from Operational Readiness (OR) into Revenue Service. We understand that a Revenue Service Operations date (open service to the public) has not yet been determined.

With only six months left to Segment 1 OR date, there are still risks concerning the weld modifications and wheel replacements; however, HART indicated that the system could operate safely while the wheel replacement modifications took place over the first 1-2 years of service.

The Assessment Team further recommends HART perform more in-depth and continuous analysis of resource requirements and achievable planned production rates, especially pertaining to critical path production activities such as guideway girder/station platform erection and systems integration testing. We also recommend adding interim event and hand-over milestones (payment milestones and incentives) built into the remaining contracts for completing significant phases of the work along the critical path(s) to OR.

2.0 General Findings and Approach to Evaluating the Schedule

The Assessment Team's general finding is that the CPM Master Schedule is completely modeled in a single Primavera P6 database, inclusive of all contractors' as-built schedules to date (completed or in-progress) as well as all planned schedules (HART fragnets) for any future contracts remaining to be procured. All schedules are cost-loaded to the extent that HART has developed or captured all available cost estimate-to-complete data. While most schedules are not resource-loaded, the major critical path items in the schedules are resource-driven using resource-sequencing logic, and are also quantity loaded with major production units. (For example: City Center Utility Relocation current schedule is quantity loaded for linear feet, sq ft, etc.) We also evaluated HART's schedules against the following [FTA Oversight Procedure OP34 -Project Schedule Review criteria](#) and found them to be in compliance:

- Completeness and reliability of the Sponsor's project schedule.
- Usefulness as a management tool.
- Extent to which the project schedule reflects the project scope, cost, management practices, and method of project delivery.
- Whether the Sponsor's schedule management and project schedule are sufficient to plan and control the project time at the programmatic and contract level and complement the management of scope, cost, and risk.

We reviewed the project control organization, schedule development, and control process and procedures and found them to be in accordance with best industry practices. HART's scheduling team has the experience and qualifications required to manage the remaining program (*see Section 10. Staffing Evaluation*). The Basis of Schedule is also adequate. It was last formally updated with the Airport Segment re-baseline effort and is currently being updated again along with the Program Management Plan (PMP) and City Center Segment revised schedule and procurement plan.

In addition to reviewing the current and baseline versions of all electronic CPM schedules in HART's Primavera (P6) database, the HART Project Controls staff also provided access to the HART Project GIS for planning and design as well as the following planning and analysis documents for our review:

- Critical Path reports for all 3 Segments
- MPS Cost-loaded Summary Schedules (for comparison with respective contracts and remaining cost estimates)
- P3 Bidders Schedule Comparisons
- Project Earned Value S-curves
- AGS Productivity Metrics
- CCUR Task Orders by Areas (for comparison with CCUR critical path schedule)
- AGS HECO and 3rd Party Utility Relocation TIAs

Our approach to evaluating the Master Schedule and constituent detailed schedules was to first assess the Work Breakdown Structure (WBS) structures against the major scope elements (guideway, stations, systems, etc.), locations (segments and areas), and lifecycle phases (design, procurement, construction, integration and testing). We evaluated the resource allocations, their assumed crews, and production rates which determined the durations and concurrency of the activities. Lastly, we assessed the critical path logic and durations for each segment required to reach OR. We also evaluated the contractual schedule specifications and HART's process for monitoring and planning schedule contingency based on risks.

3.0 Critical Path

Overall, the critical path is driven by the logical flow and availability of design and construction trade resources (see Section 11. Production Rates) beginning from the west end of Segment 1 and moving east through the Airport Segment 2 and ending with the City Center Segment 3. The critical sequence of major work activities follows a typical path of design/re-design, row acquisitions/access/permitting, utility relocations, sitework preparations, foundations, columns, guideway structure, stations, trackwork, core systems, integration, and OR testing.

Segment 1 (Westside)

Currently 95% complete with construction, the remaining critical path to OR is completion of weld modifications (resulting from rail/wheel interface design issue) to the DF Track and crossovers, followed by three months of trial operations and two weeks for final Safety and Security Certification transmittal to DTS. The OR date for Segment 1 is currently being forecast for April 2022. With only six months left to Segment 1 OR date, we would not expect any remaining float contingency, however there are still risks concerning the first HART segment to experience beginning service operations, and the transfer of Operations from HART to DTS.

Regarding the wheel replacements, HART indicated that the system could operate safely while those modifications happened over the first 1-2 years of service.

Master Project Integrated Schedule (MPIS)										2022											
#	Project ID	Activity ID	Activity Name	Orig Dur	Prev Mo. Dur	Start	Finish	Prev Month Start	Prev Month Finish	A	S	Oct	N	D	Jan	F	Mar	Apr	M	Jun	Jul
1	1																				
2	CSC1 2108	PR100	Supplier Proposal Due Date	37	31	11-Aug-21 A	16-Sep-21	11-Aug-21	10-Sep-21												
3	CSC1 2108	PR35	TTCI - Track Issues Report Findings	108	87	01-Jun-21 A	16-Sep-21	01-Jun-21	26-Aug-21												
4	CSC1 2108	PR70	Weld Modification Validation Complete	0	0		16-Sep-21		26-Aug-21												
5	CSC1 2108	PR110	HART Bid Evaluation	37	43	17-Sep-21	23-Oct-21	11-Sep-21	23-Oct-21												
6	CSC1 2108	PR120	Contract Award & NTP to Supplier	0	0	25-Oct-21		25-Oct-21													
7	CSC1 2108	PR130	Supplier Mobilization	21	21	25-Oct-21	14-Nov-21	25-Oct-21	14-Nov-21												
8	CSC1 2108	PR140	Weld Modification Implementation at DXOs in IO#1 Segment	56	56	15-Nov-21	09-Jan-22	15-Nov-21	09-Jan-22												
9	CSC1 2108	PR150	Segment 1 Weld Modifications Complete	0	0		09-Jan-22		09-Jan-22												
10	CSC1 2108	PR	System Trial Operations - Segment 1	90	90	10-Jan-22	09-Apr-22	10-Jan-22	09-Apr-22												
11	SS 2108	SSC0072	Prepare and Transmit SSCVR to DTS - Segment 1	14	14	10-Apr-22	23-Apr-22	10-Apr-22	23-Apr-22												
12	CSC1 2108	PR10	Operational Readiness - Segment 1 (Aloha Stadium)	0	0		23-Apr-22		23-Apr-22												

Sample of Segment 1 Critical Path Activities

Segment 2 (Airport)

Currently 75% complete, the remaining critical path to Operational Readiness is completion of aerial utility relocation, followed by completing the last column required to finish the guideway and the last station under construction near the east end (Ahua Station at Lagoon Drive), followed by 18 months of core systems installation, integration, and integrated testing, followed by 3 months of trial operations and concluding with 2 weeks for final Safety and Security Certification transmittal to DTS.

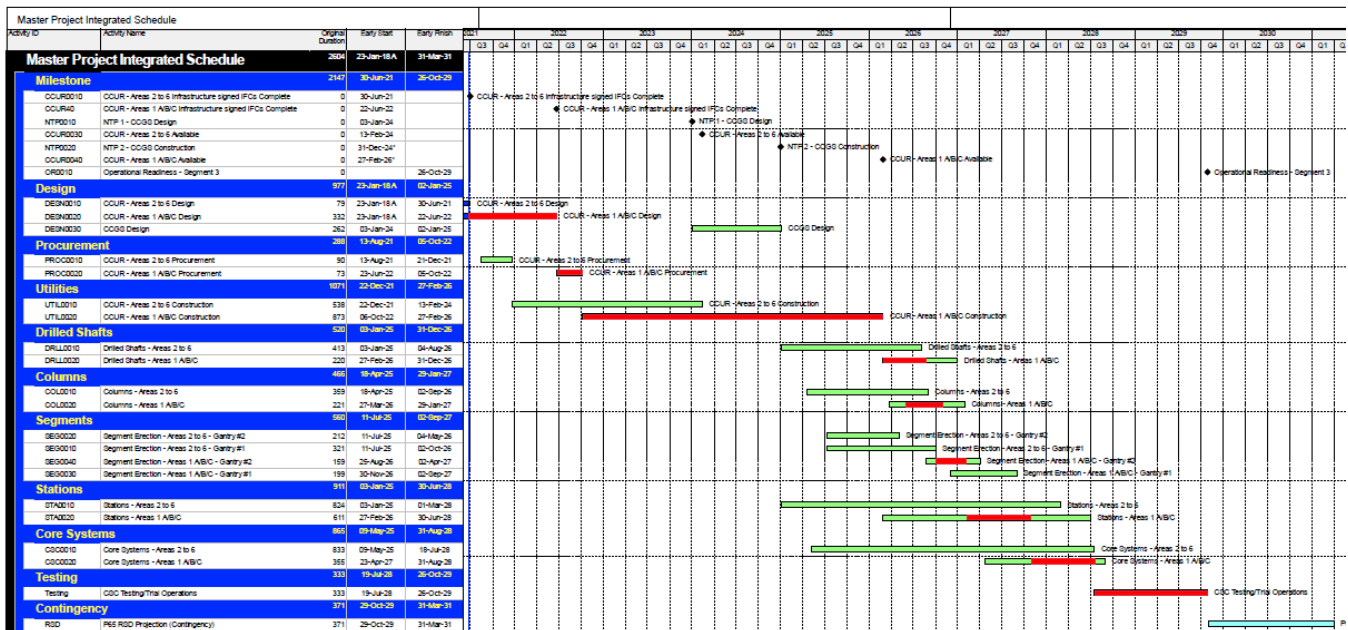
Concurrent parallel critical path to the utility relocation is mobilization of the falsework from Kahauiki Station at Middle Street Transit Center to Ahua Station at Lagoon Drive. The critical path to March 2024 is not currently risk adjusted (not reflecting any float for contingency). Our Assessment Team is recommending that HART consider adding a risk-adjusted contingency to the OR date, based on a P65 risk analysis, similar to the approach on Segment 3.

Master Project Integrated Schedule (MPIS)										2022												2023				2024			
#	Project ID	Activity ID	Activity Name	Orig Dur	Prev Mo. Dur	Start	Finish	Prev Month Start	Prev Month Finish	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2								
49	CSC2 2108	83460	Subsystems Integration -Airport Seg	63	63	16-Jun-23	13-Sep-23	02-Jun-23	30-Aug-23																				
50	CSC2 2108	69630	System Integration Test -Airport Seg	89	89	13-Sep-23	11-Dec-23	30-Aug-23	27-Nov-23																				
51	CSC2 2108	73710	Pre-Op SysDemonstration -Airport Seg	90	90	11-Dec-23	10-Mar-24	27-Nov-23	25-Feb-24																				
52	SS 2108	SSC2-0072	Prepare and Submit SSCVR to DTS - Segment 2	70	70	14-Jan-24	24-Mar-24	31-Dec-23	10-Mar-24																				
53	MPS 2107	RSD-MS-PR10	Operational Readiness - Segment 2 (Middle Street)	0	0		24-Mar-24*		10-Mar-24																				

Sample of Segment 2 Critical Path Activities

Segment 3 (City Center)

Currently 3% complete, the critical path to Operational Readiness begins with the final design of the HECO Aerial Utility Relocation (Undergrounding) throughout Area 1 (Dillingham Area), forecast to complete in June 2022, then HART can complete procurement and award of the CCUR Construction Contract (NTP October 2022). The critical path then flows through the CCUR relocations of Area 1, to the critical construction trades sequence described above in the overall critical path. The major critical path sequence is controlled by packaging the construction trades into separate sequential procurements for Utility Relocations (CCUR), then Guideway and Stations (CCGS), then Core Systems (CCSC), followed by 5 months of integrated testing and trial operations, forecasting an earliest OR for Segment 3 by end of October 2029. A contingency of 17 months has been added per the P65 risk analysis, for a conservative Operational Readiness of March 2031. There is currently underway, a risk mitigating design modification to the Area 1 alignment referred to as the “Mauka Shift” (toward the mountain side of the road), which will reduce the magnitude of the utilities to be relocated in that area. The assessment team is awaiting the results of the HART re-scheduling effort to incorporate the Mauka Shift, to see how it may reduce the critical path to Segment 3 OR date.



Sample of Segment 3 Critical Path Activities (Overall Summary)

4.0 Structure of Schedule

4.1 Master Schedule Structure

The HART Master Project Integrated Schedule (MPIS) is currently organized first by major LRT Segment, then by Procurement Contract. The procurements have been packaged by the major critical path construction trade elements (i.e., ROW parcels, utility relocations, guideway and stations, core systems, and construction engineering and inspection professional services.) for each Segment separately. Level 3 MPIS is the lowest level of integrated activities representing Control Accounts which are synchronized with the master budget and cost estimate at complete.

When updating the HART PMP, some clarification is needed for distinction between the Master Schedule levels of varying detail and their purposes for planning and controlling the work. The following are our Assessment Team's recommended definitions for Master Schedule levels which aligns with most common and best industry practices:

- Level 1 is the Executive Summary Schedule or highest-level management summary schedule for a Program of projects, or a Project with sub-projects, showing only their overall durations with start and finish milestones. The HART Project Level 1 Schedule might simply show the 3 major LRT Segments, MSF Operations facility, and Vehicles procurement as sub-projects.
- Level 2 is the Planning Schedule for procurement packaging level to plan and control primary delivery contracts and resource deployments in concert with the fundamental planning, development and delivery phases, their sponsor's funding availability, and financial authority decision milestones.

Master Project Integrated Schedule (MPIS)							Print Date/Time: 04-Oct-21/12:03																																
Activity Name	Start	Finish	Prev. Month Variance - Start	Prev. Month Variance - Finish	Prev. Month Variance - Duration	Activity Type	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050			
HONOLULU RAIL TRANSIT PROJECT MILESTONES																																							
Operational Readiness - Segment 1 (Ala Moana)	23-Apr-22	31-Mar-31	0	0	0	Station *																																	
Operational Readiness - Segment 2 (Middle Street)		23-Apr-22																																					
Operational Readiness - Segment 3 (Ala Moana)		30-Mar-24*	-6	-6	0	Operational Readiness - Segment 2 (Middle Street) *																																	
Operational Readiness - Segment 3 (Ala Moana)		31-Mar-31*	0	0	0	Operational Readiness - Segment 3 (Ala Moana) *																																	
WEST OAHU / FARRINGTON HIGHWAY - SECTION 4																																							
West Oahu / Farrington Highway (WOFH) Guideway & Utilities	03-Apr-09 A	30-Nov-27	0	0	0																																		
West Oahu Station Group (WOSG)	03-Apr-09 A	13-Dec-18 A	0	0	0																																		
Farrington Highway Station Group (FHSG)	14-Jun-10 A	30-Jan-20 A	0	0	0																																		
UH West Oahu Temporary Park & Ride and Campus Road "B"	10-Jun-13 A	09-Dec-20 A	0	0	0																																		
Hoopii Interim Park and Ride	01-May-17 A	21-Oct-19 A	0	0	0																																		
East Kapolei Permanent Park and Ride	01-Oct-20 A	23-Apr-22	0	-178	0																																		
UHWO Permanent Park and Ride	03-Jun-24	30-Nov-27	0	0	0																																		
KAMEHAMEHA HIGHWAY - SECTION 2	03-Jun-24	30-Nov-27	0	0	0																																		
Kamehameha Highway (KHG) & Utilities	19-Mar-10 A	09-Aug-29	0	20	0																																		
Kamehameha Highway Station Group (KHSG)	19-Mar-10 A	13-Dec-18 A	0	0	0																																		
Ramp H2R2	28-Jun-11 A	30-Dec-21	0	0	0																																		
Kamehameha Highway Resurfacing	30-Jan-15 A	16-Feb-18 A	0	0	0																																		
Pearl Highlands Garage, Transit Center and Ramp H2R1	15-May-18 A	28-Aug-20 A	0	0	0																																		
Kamehameha Highway 138kV Utilities Relocation	09-Dec-22	09-Aug-29	28	29	0																																		
Kamehameha Highway 138kV Utilities Relocation	07-Sep-18 A	17-Feb-29	0	-17	0																																		
AIRPORT - SECTION 3																																							
Airport Section Guideway 7 Pier	05-Jan-12 A	16-Sep-22	0	-6	0																																		
Airport Station Group Final Design	09-Jul-14 A	24-Apr-15 A	0	0	0																																		
Airport Section Utilities	30-Mar-12 A	01-Jul-15 A	0	0	0																																		
Airport Section Guideway and Utilities Final Design	17-Dec-13 A	07-Oct-16 A	0	0	0																																		
Airport Guideway & Stations (AGS)	05-Jan-12 A	30-Jun-17 A	0	0	0																																		
Airport Guideway & Stations (AGS)	06-Apr-15 A	16-Sep-22	0	-6	0																																		
CITY CENTER - SECTION 4																																							
City Center Section Guideway and Utilities Final Design & Support	19-Dec-11 A	07-Jun-29	0	0	0																																		
City Center Utility Relocation (CCUR)	16-Dec-11 A	03-Jun-22	0	0	0																																		
City Center Guideway and Stations (CCGS)	20-Dec-17 A	23-Feb-29	0	0	0																																		
City Center Guideway and Stations (CCGS)	28-Sep-18 A	07-Jun-29	0	0	0																																		
PROJECT WIDE																																							
Archaeological Inventory Survey (AIS) Suspension	24-Aug-12 A	16-Sep-13 A	0	0	0																																		
Maintenance and Storage Facility (MSF)	24-Jul-09 A	02-Jul-16 A	0	0	0																																		
Programmatic Agreement - Historic Preservation Committee	15-Mar-13 A	17-Jul-19 A	0	0	0																																		
LEED Commissioning Services for MSF	06-Oct-10 A	17-Nov-16 A	0	0	0																																		
HDOT Traffic and Design Coordination	27-Oct-10 A	31-Dec-24	0	0	0																																		
Construction Engineering and Inspection Services (CE&I) West	25-Jul-13 A	31-Dec-20 A	0	0	0																																		
Real Estate Consultant / ROW Acquisition	01-Apr-11 A	31-Dec-25	0	0	0																																		
Elevators / Escalators Manufacture & Install	18-Dec-12 A	08-Mar-29	0	0	0																																		
On-Call Contracts	23-Aug-12 A	07-Jun-29	0	0	0																																		
Archaeological and Cultural Monitoring	10-Sep-13 A	08-Apr-25	0	0	0																																		
Construction Engineering and Inspection Services (CE&I) East	26-Jul-13 A	07-Jun-29	0	0	0																																		
Core Systems	17-Aug-09 A	31-Mar-31	0	0	0																																		
Project Management and Specialty Consultant Agreements	03-Sep-09 A	31-Mar-31	0	0	0																																		
Fare Collection System	11-Aug-15 A	01-May-29	0	0	0																																		
Safety and Security	23-Oct-13 A	31-Mar-31	0	0	0																																		
Owner Controlled Insurance Program (OCIP)	31-Jan-12 A	31-Aug-29	0	0	0																																		
Backup Generators	12-Dec-16 A	23-Nov-21	0	-33	0																																		

Sample Level 1 and 2 Summary Schedule

- Level 3 is the Control Schedule or Control Account summary level for assigning delivery accountability to specific resources, and typically aligns with FTA's SCC level 2 deliverables and should also directly correlate with a summary of the Contractor's Schedule of Values (SOV) roll-up. Control Accounts are commonly created at the lowest defined levels of the Program/Project's Organizational Breakdown Structure (OBS), Work Breakdown Structure (WBS), and Cost Breakdown Structure (CBS).
- Level 4 Schedules are typically the Contractor's detailed CPM activities, and their sub-contractors' fabrication and 3-week look-ahead schedules are then considered Level 5 (summarized to Level 4 for updating the P6 schedule details).

4.2 Enterprise Project Structure (EPS)

The Enterprise Project Structure is the hierarchical organization view in Primavera P6, for all projects with the enterprise. HART's top-level EPS nodes are organized by Scheduler work areas to simplify controlling security access to the scheduling data. The Master Schedule node is first in the hierarchy, for the purpose of keeping all projects and sub-projects within the MPIS collectively and uniformly maintained, followed by the EPS nodes for Contractor's and HART Schedulers' development work areas for isolating their schedule updates and what-if scenarios that are in process. HART's EPS utilization reflects industry practice.

4.3 WBS

The Work Breakdown Structure (WBS) for the MPIS aligns with major project lifecycle phases and construction work types but is not ideally aligned with the FTA's Standard Cost Categories (SCC).

Even though not required by the FTA PMOC thus far on this project, the Assessment Team recommends aligning the formal MPIS WBS with the FTA SCCs as a means to simplify and streamline the rollup of Contractor's Earned Values for FTA progress reporting and payment applications, as well as assignment of allocated risk-based contingencies from the risk registers. HART is currently accommodating the FTA reporting requirements through the assignment of SCC activity codes in both the P6 Schedules and the Project Risk Register.

5.0 Incorporation of Schedule Risk

All Risks are managed using a centralized Risk Register, developed by HART, organized by FTA's 5 Risk Categories, and assigned to FTA's Level 2 SCCs. Risks which materialize and become contract scope are moved to the Change Log and are retired from the Risk Register. We understand that all remaining risks in the risk register pertain mostly to Segment 3, as Segments 1 and 2 have completed sufficient construction towards mitigation of their specific risks. As Segment 2 has more than 2 years remaining to complete, we'd recommend a risk-adjusted contingency be considered similar to Segment 3.

"Expected Values" of Risks are modeled by applying probabilities and cost/schedule ranges of low, most likely, and high, then using Monte Carlo methods to run multiple simulations/iterations and arrive at a 65% likelihood (P65) outcome to be used in forecasting Total Project EAC and Schedule Completion. The results for Segment 3 are summarized below:

- Construction – 49 risks, 19 on critical path, 27 months total cumulative expected impact
- Design – 8 risks, 3 on critical path, 6 months total cumulative expected impact
- Management Capability and Capacity – 4 risks, 1 on critical path, 0(zero) months total cumulative expected impact
- Market Conditions – 2 risks, 0(zero) on critical path, 0(zero) months total cumulative expected impact
- Requirements – 32 risks, 5 on critical path, 20 months total cumulative expected impact

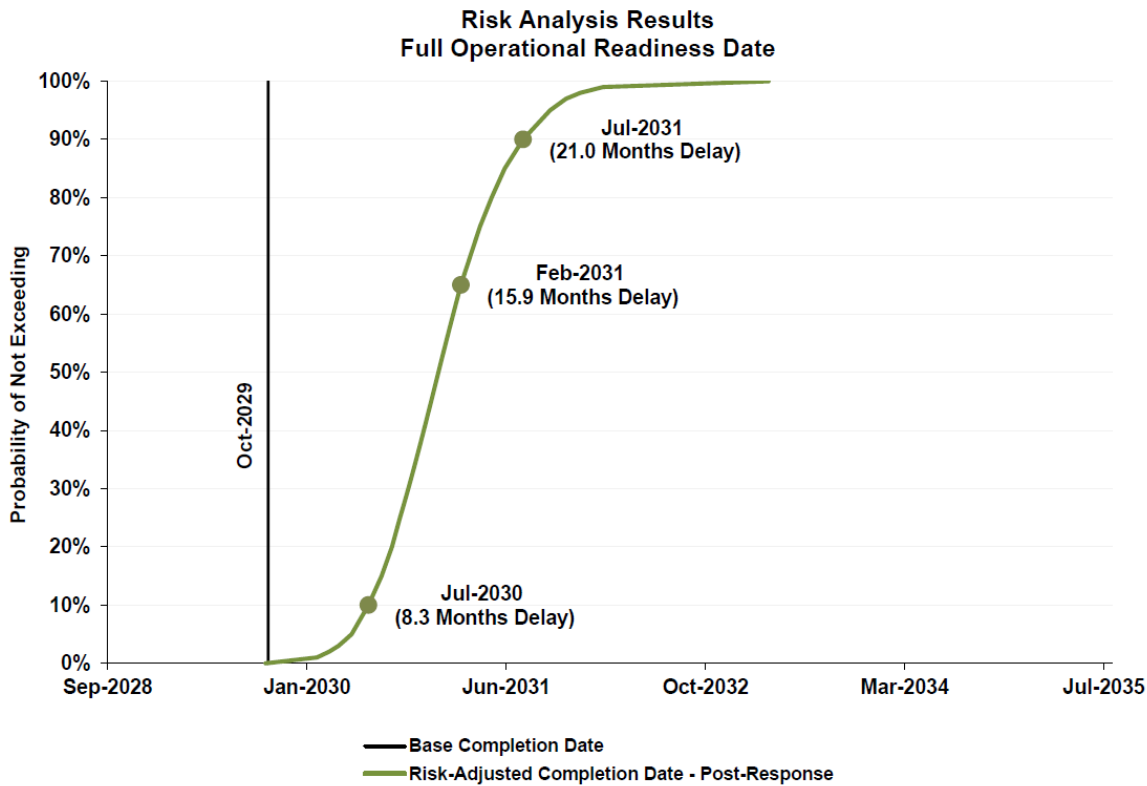
Note that the sum of "total cumulative expected impacts" for these risk categories is much higher than the risk-adjusted contingency 18-month duration added to the end of the critical path for Segment 3. That is because 1) not all expected impacts are assigned to critical path activities, and 2) the total cumulative risk-adjusted contingency duration is calculated by running a Monte Carlo risk analysis on the comprehensive CPM schedule including detailed activities and logic from all contract schedules and incorporating all risks.

- Most common High-Risk areas:
 - a. **ROW** – HART staff assured our Assessment Team they are way out ahead of the construction access needs for property acquisition activities. Most ROW has already been acquired in Segment 3, with the exception of the Ward Avenue and Queen Street properties around the Kukuluao Station, but that one has 1-2 years of float since not in Area 1 (Dillingham).
 - b. **Utilities** – Utilities are complete in Segment 1 (no longer a risk). Final Utility Relocation recently completed in Segment 2. All remaining utility risks are in Segment 3, with the most significant utility relocations in the Area 1 (Dillingham). HART staff have assured the Assessment Team that the utility relocations in the City Center are very thoroughly planned and AECOM has been coordinating with the utility owners for final designs to be completed by summer of 2022. Most conservative relocation durations have been assumed for the Segment 3 (CCUR) schedules.
 - c. **Third Party Approvals** – Even though Industry expert organizations such as The Eno Center for Transportation (Eno, <https://projectdelivery.enotrans.org/>) recommend Third Party Approvals as one of the highest risk areas to transit projects, HART project staff have assured our Assessment Team that they have been very proactive in public engagement activities in an effort to mitigate this risk, and have established positive working relationships with all Third Parties involved with the project, especially around the station area vicinities such as the University of Hawaii school campus buildings. Many of the station area stakeholders are anticipating to have the transit project completed and are committed to meeting review cycle timeframes spelled out in their agreements.

The remaining schedules appear to have adequate duration contingencies included to cover these high-risk areas, however they must be continuously monitored and managed to assure on-time completion.

6.0 Schedule Contingency

Overall Schedule Contingency is based on the Monte Carlo risk analysis outputs. Below is an excerpt from the Monte Carlo report. The Assessment Team noted that the analysis calculates a 65% probability (P65) of 16 months delay and a February 2031 OR date, but HART chose to include a 17-month contingency activity and March 2031 OR date in their risk-adjusted schedule forecast for Segment 3.



Sample provided by HART

7.0 Schedule Specification

The Assessment Team reviewed the most current Schedule Specifications included with the AGS contract. In general, the schedule specification meets with industry best practices. We've suggested the following improvements and questions for consideration:

- Section 7.6.1.a.5: Clarify that any milestones added to the schedule are not considered contractual milestones if not explicitly identified in the contract as a schedule requirement.
- Section 7.6.1.a.6: Does HART enforce the clause about withholding progress payments if schedules are not maintained per the spec? If not, why put in the spec and consider eliminating.
- Section 7.6.1.a.8: It is good to have the scheduler position qualifications listed. It would also be good to make sure this position is called out as a 'key' person in the request for proposals/bids.
- Section 7.6.1.a.9: Consider using "accepted" instead of "approved" in this section and all schedule spec language.
- Section 7.6.1.b: Is it achievable for a contractor to provide a compliant 'cost-loaded' Baseline Schedule 30 days after NTP? Consider modifying this to submit a 'Preliminary Baseline Schedule' within 30 calendar days to cover scope of the first 90 days. Then submit a full cost loaded schedule within 90 calendar days.
- Section 7.6.1.b: We are assuming the HART review times on submittals are defined elsewhere.
- Section 7.6.1.b.4: Consider adding the following clarification for lags – "Negative lags are prohibited. Lags should be kept to a minimum and should be substituted with activities. No lag within the schedule shall have a duration exceeding 20 working days or exceeding the duration of the successor activity."
- Section 7.6.1.b.7.F&G: Should clarify whether these are required codes or just milestones.
- Section 7.6.1.b.8.B: Assuming "As-Builts" activities would be cost-loaded. So that money is being withheld to do this task.
- Section 7.6.1.b.8.D: If a full Contract Data Requirements List (CDRL) is prepared for the project, that would be a good start for a milestone checklist for the baseline schedule.
- Section 7.6.1.b.8.L: The 25% limit of critical activities should be carried over to the monthly updated schedules. And when verified, if it isn't met in an updated schedule, the specification should also allow for HART to ask for a recovery schedule of some sorts. The schedule specification should also define what is a 'critical activity', such as "any activity with total float less than 20 days".
- Section 7.6.1.c: Suggest that HART have any major sub (5% of work or more, or if their work falls on the critical path) signs off on the submittal along with the prime on the baseline schedule and any monthly updates. This will give HART an indication if there are any problems between the subs and the prime.
- Section 7.6.1.d.3.B: What if the contractor is not working to these Time Periods. HART want them to use what they are assuming for days per week, hours per day and such. Their baseline narrative should have the same assumptions listed.
- Section 7.6.1.f.2: Consider using a tool like Acumen Fuse to show monthly deltas in the schedule. HART can require this of the contractor as well to use and submit reports. Ultimately is a good tool for them as well.
- Section 7.6.3: Identify what schedule is to be used for the TIA. "The date of the most recent Schedule update shall be a date prior to the date the change is given to the Contractor, the date the delay occurred or the date the Contractor submits a request for a Change. The event times used in the Time impact Analysis shall include the most recent Schedule update or as adjusted by mutual agreement".
- Section 7.6.6: Something to consider adding to this section- "The progress schedules will reasonably correlate with any 'field schedules' utilized by the contractor. Any 'field schedules' will be made available to HART at their request".

7.1 Additional Considerations:

- Consider requiring the schedule to include major quantities loaded as resources on activities (i.e., number of OCS foundations/poles, numbers of piers/girders, etc.). Graphs could then be developed to show planned installed quantities and how actuals are progressing. Valuable visual tool to see progress and if achieved installation rates are being met, and if the estimate to complete is realistic.
- Consider having the contractor work in HART's schedule database. This could alleviate any issues with importing XER's into HART's schedule database.
- When discussing cost-loading it would be helpful to restrict cost-loading of any level of effort activities. It has the potential to distort the S curves and earned value should be held at the lowest level for accuracy.

- Is there a “due date” for submitting the progress schedules? There is a specified data date (“status as of” date) of the last Friday of each month, but there is not a specified time period for how many days after that they have to get the schedule updated and submitted.
- There should be a definition of HART’s review process/duration/approval, etc. Will there be a draft, review and final for payment? Or is it just the one submittal?
- A clause that has been helpful in the past to look at the effects of a progressed only schedule (without any logic manipulation, duration changes, etc.) is “As requested by HART, the Contractor will prepare for review a Progress Only Schedule. This Schedule will accurately reflect progress through the previous month but will not modify logic or durations for activities not in progress. Therefore, showing only progress to date, identifying any potential impacts to the Schedule milestone completion dates prior to any Schedule mitigation efforts”.
- Consider adding this clause so review activities do not just get extended durations: “Any time there is a need for a resubmittal and additional review for any documents, whether to a Third Party or the HART representative, additional activities will be added to the Schedule to identify these additional submittals and reviews.”
- Costs should be loaded on an activity with a resource not an ‘Expense’, consider adding: “Expenses will not be used by the Contractor in lieu of a Resource. Any billable expense item cost should be built into a Resource rate or set up as a separate non-labor or material resource”.
- Consider adding definitions for seasonal weather conditions. Example: “Days shall be based on the average historical seasonal weather or climatic conditions for the preceding 10 years in the area as prepared by the National Oceanographic and Atmospheric Administration (NOAA). The Contractor shall submit the days for Approval by the HART representative.....”. And then keep track in the monthly report.

8.0 Contractor/Consultant Schedules (Baseline and Progress Updates)

- **Management of Baselines and Updates:** Schedules are reviewed by the Construction Engineering and Inspection (CE&I) teams and progress (start/finish dates and physical % complete) is verified by HART's field scheduling team. The contractors' P6 data is then used to update and integrate detailed and summary activity status within the MPIS.
- **Quality and accuracy of the Contractor/Consultant schedules:**
 - Shimmick, Traylor and Granite (STG's) Airport Guideway and Stations (AGS) schedule: Original baseline and updates are generally of good quality, realistic and accurate, however has been re-baselined twice. Updates, however, the need for the re-baselines were based on unplanned delays/impacts.
 - Hitachi Rail Honolulu (HRH's) Core Systems Contractor (CSC's) Segment 1 schedule: original baseline and progress updates were not planned in sufficient detail to assess actual production rates and durations for comparison with Segment 2 and 3 schedules. The remaining Segment 1 work is being coordinated in the field with only testing/commissioning activities left to track and complete.
 - HRH's CSC Segment 2 schedule: timing and sequence of activities are dependent on contractually negotiated AGS access/handoff dates. MSF Operations facility testing schedule could use better integration with the running line comms/systems install and test durations.
 - HRH's CSC Segment 3 schedule: is more detailed than previous segments. Logical sequencing of activities is valid, but durations for testing and integration activities are still lengthy and not based on any evident resource or unit production rates.
- **General:**
 - Workday and shift calendars are incorporated into the schedules. Based on a 5-day workweek requirement, and special calendars are used for holidays work around the airport.
 - HART has integrated the AGS and CSC detailed contractors' schedules into one combined P6 schedule within the MPIS to track critical path progress performance to completion.
 - HART continues to encourage and enforce the use of the primary baseline and progress reporting schedules in P6 as the contractors' planning tool for remaining work.
 - STG (AGS) is cooperating with using only one schedule for internal planning and external reporting.
 - HRH (CSC) is now also using 1 P6 schedule for internal use and reporting to HART.

9.0 Pending Delay Claims

Major pending delay claims: (will be confirmed against the Cost Estimate Evaluation)

- The Contract Access Milestone (CAM) dates from the AGS contractor (STG) is being incorporated into the updated CSC schedule for Segment 2. This may result in a delay claim from the Core System Contractor (HRH). Now that the commercial team has settled the original delay (219 calendar days) with STG, HART is continuing to work with them to mitigate and recover the critical path impacts, to reduce the durations of the 2 related potential further delay claims: one for an additional 111 calendar days, plus another for 163 additional calendar days, totaling 274 additional calendar days currently under Time Impact Analysis (TIA) review.
- General:
 - Lessons learned and delay claims avoidance strategies are being incorporated in schedules and specs. Example: updating the cost/resource loading specifications for remaining Segment 3 contracts, after TIA experience/lesson learned on Segment 2 - AGS.
 - Incorporating lessons learned from Segment 1 safety, quality non-conformance, and testing delays (i.e., does contractor need more contingency for safety and quality certification processes?)
 - Settled claims are reflected in the actual completed and past activities.
 - HART has also incorporated claims avoidance techniques into their schedule management process. Example: Baseline and Updated schedule reviews focus priority on assessing potential claims and mitigating the impacts.
 - HART has developed a change control committee (CCC) and time impact analysis (TIA) processes. The CCC meets weekly as needed. TIAs are requested from the contractors for each major contract change, and then evaluated as part of the Change Order negotiation process.

10.0 Staffing Evaluation

HART staffing is not currently based on resource-loaded agency review activities in the Master Schedule. Planning for Consultant/Contractor staff is based on Level-of-Effort (LOE) activities as % of design or construction. The following table compares current staffing vs peak staffing for Scheduling support staff:

	HART Project Controls	CE&I West	CE&I East	TOTAL
Previous Staff				
Lead Scheduler	1			1
Senior Scheduler	5.5	2	2	9.5
Scheduler	1	1		2
	7.5	3	2	12.5
Current Staff (2021)				
Lead Scheduler	1			1
Senior Scheduler	2		1	3
Scheduler	1		0.5	1.5
Jr. Scheduler	1			1
	5		1.5	6.5

Table 10.0 Max Scheduling Staff (2017-2018)

The current level of Scheduling support staff is adequate to complete the program. Of the 2 HART Sr Schedulers remaining, 1 is dedicated to primarily focus on Core Systems planning, which is based on lessons learned from Segments 1 & 2.

11.0 Production Rates

11.1 Hours and Major Unit Quantities

- The general assessment is that the production rates assumed for the remaining major construction activities are adequate, based on combination of HART's expert field observations, actual past performance by current and past contractors on the work completed thus far and on proposed schedules from the PLOs (PPP Developers).
- Critical path construction activity production rates (units per time period) by Type of Work:
 - Foundations (drilled shafts): CCGS is assuming 4 crews (7-8 days / drilled shaft/ crew) based on maximum production of 5-6 crews (7.5 days / drilled shaft / crew) in KHG, WOFH and AGS, and in the P3 proposal schedules.
 - Columns (each): CCGS is assuming 4 crews (6 days / column / crew) based on 6-8 crews with an average production of 6.5 days/column/crew in KHG, WOFH and AGS.
 - Precast Girders (spans):
 - Segment 1 (Kiewit) – maximum production rate of 2-3 days / span / gantry (using 3 gantries for 7.5 spans per week total)
 - Segment 2 (STG) – maximum production rate of 3 days / span (using 3 gantries, averaging 9 days / span / gantry including delays).
 - Segment 3 (planned forecast) – average 5 days/span/gantry (currently assuming 2 gantries). Production rate is more conservative than Segment 1 and 2 which seems warranted because of more restricted access for crews, cranes and material staging in the denser urban area of the City Center.
 - Stations (platforms): CCGS platform erection is based on the AGS baseline schedule and actual performance to date, assuming 2 sets/crews of station falsework.
 - Core Systems SITs (systems components installation and testing): No production rate data was provided or discovered for Core Systems installation and testing activities, however the durations for these activities in the MPIS have been based on Hitachi's and Lea & Elliot's past experiences in the field.

12.0 Logic/Sequence

The logic and sequence of work activities determines the overall duration of the project and can vary based on “means and methods” of the contractor or consultant performing the work. The logic and sequence of activities also affects the efficient and effective use of resources and the resulting overall cost performance for the project.

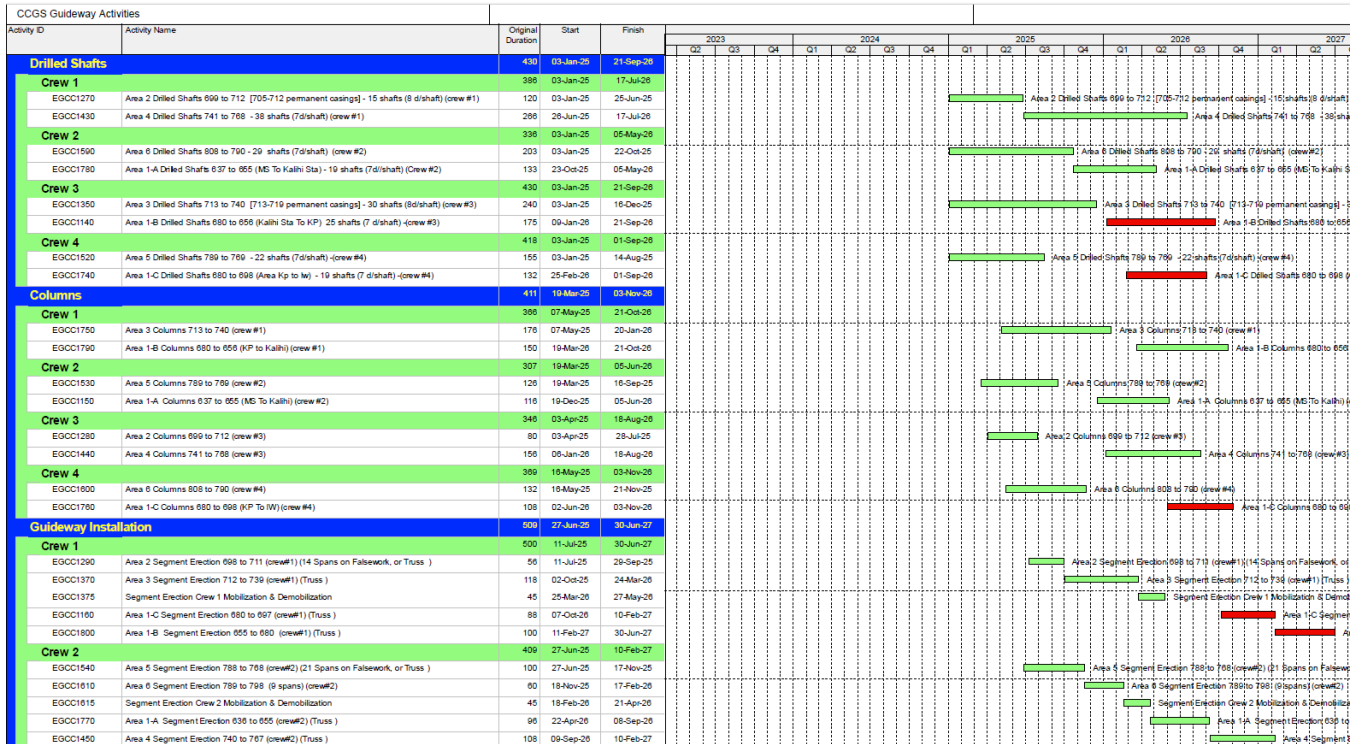
While adding more crews of the same trade allows for concurrent work of the same construction trade in multiple areas of the project, the critical sequence of all construction trades follows a typical path of 1) ROW Acquisitions/Access/Permitting; 2) Utility Relocations; 3) Sitework Preparations; 4) Foundations (Drilled Shafts); 5) Columns; 6) Guideway Structure (Precast Segmental Girders); 7a) Stations (Platforms); 7b) Track; 8) Systems; 9) Integration and Operational Readiness Testing. Trackwork and Stations work can be built concurrently in the same locations; however, Stations are typically on the longest (critical) path to completion, because the majority of the platform finishes, and equipment installations require unencumbered site access after all guideway work is completed.

A sample of the basic trade flow sequencing and critical path logic is shown in the summary of Segment 3 critical path activities (see *Section 3.0 Critical Path*).

13.0 Resource/Cost Loading

There are currently no requirements in existing contracts for loading major resource quantities on activities. However, while most schedules contained in the MPIS are not resource-loaded, the major critical path items in the schedules are resource-driven using preferential logic, and quantity loaded with major production units. (For ex: CCUR current schedule is quantity loaded for linear feet, sq ft, etc.)

Also, CCGS is sequenced specifically with crew availability in mind for construction, similar to AGS. This was verified when comparing to the bid schedules submitted by the P3 bidders in July 2020. A sample of the CCGS scheduled crew logic is shown below (highlighting the crews working in Area 1 as being on the critical path).



And the assessment team was assured that for future procurements, the contract language will require more detailed resource loading and moving away from Expenses.

The requirements for loading contract Schedule of Values (SOV) costs in the contractor's schedules are not in the P6 Schedule specifications, however, these cost-loading requirements are found in current contracts' Terms & Conditions for the purpose of measuring earned value progress payments on all activities performed to date. The contractors load costs on P6 activities using expense items. Contractor SOV total costs in their pay requests must match their schedule total costs by line item. If there is a discrepancy, it is flagged as a possible cause for rejection of the schedule or pay request, or both. This applies to BPS (Baseline Project Schedule) and progress schedules. The BCWS (Planned Values) and BCWP (Earned Values) are based on the SOV.

HART utilizes cost-loaded summary schedules for cashflow modeling of 'what-if' scenarios which is commensurate with industry best practices; however, we would also recommend resource-loading with labor hours and major material quantities which helps determine unit costs and productivities required to forecast accurate completion dates and costs at complete.

14.0 Tracking

14.1 Earned Value Analysis

Contractors report physical percentage (%) complete on all activities and multiply by their budget to calculate Budgeted Cost of Work Performed or Earned Value (BCWP or EV). Schedule of Values (SOV) cost-loading is assigned as expense items (SCC items) not on Resources in P6.

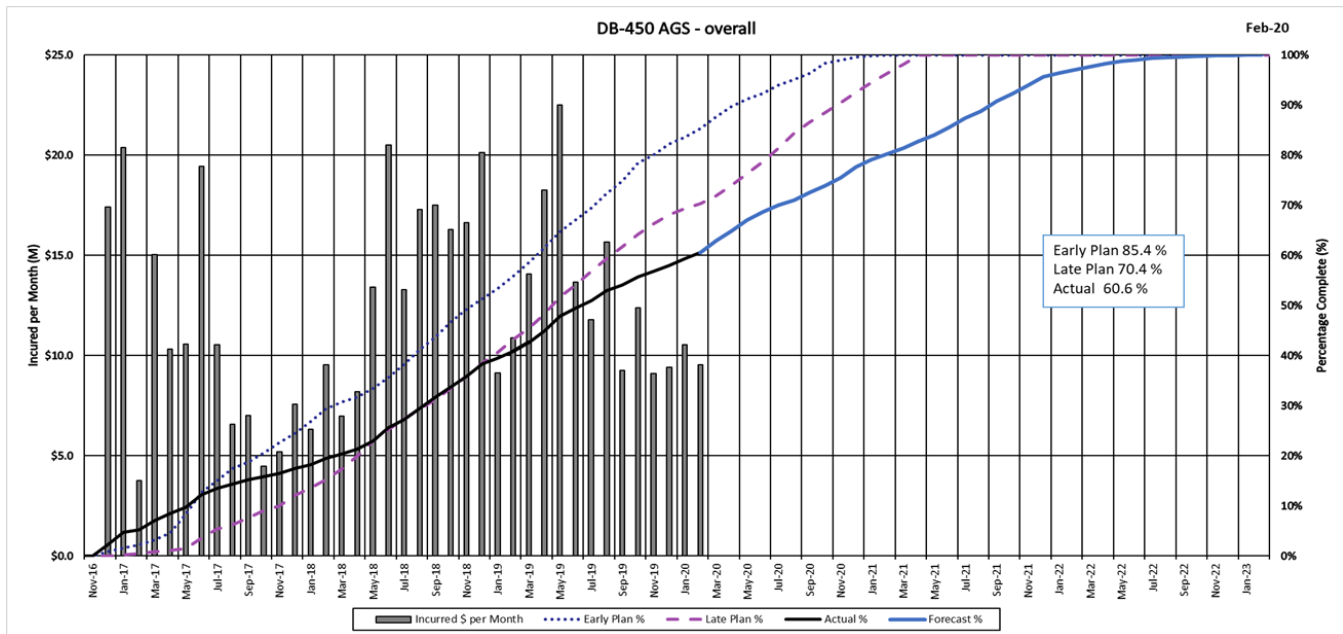
14.2 Progress Reporting

Progress reporting and payment for the work in the field is based on EV performance. Actual start and finish dates are updated monthly and verified with HART’s schedulers in the field. This is in line with best industry practice.

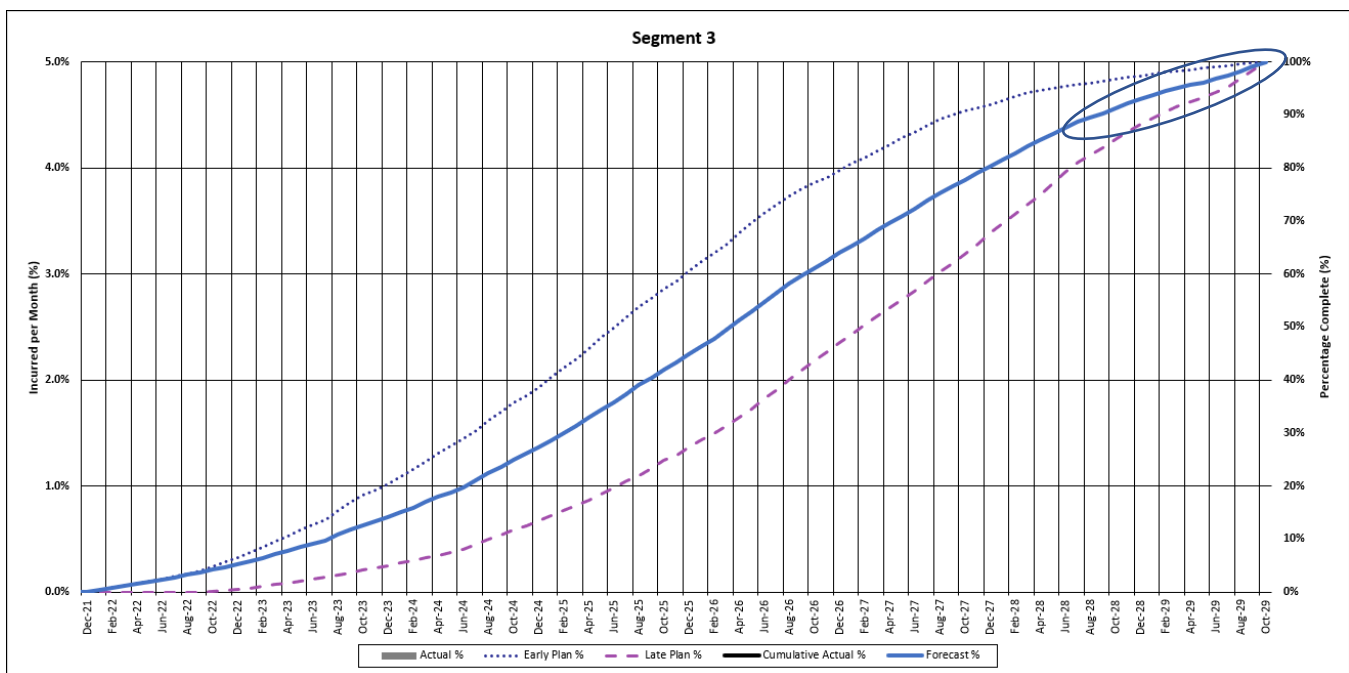
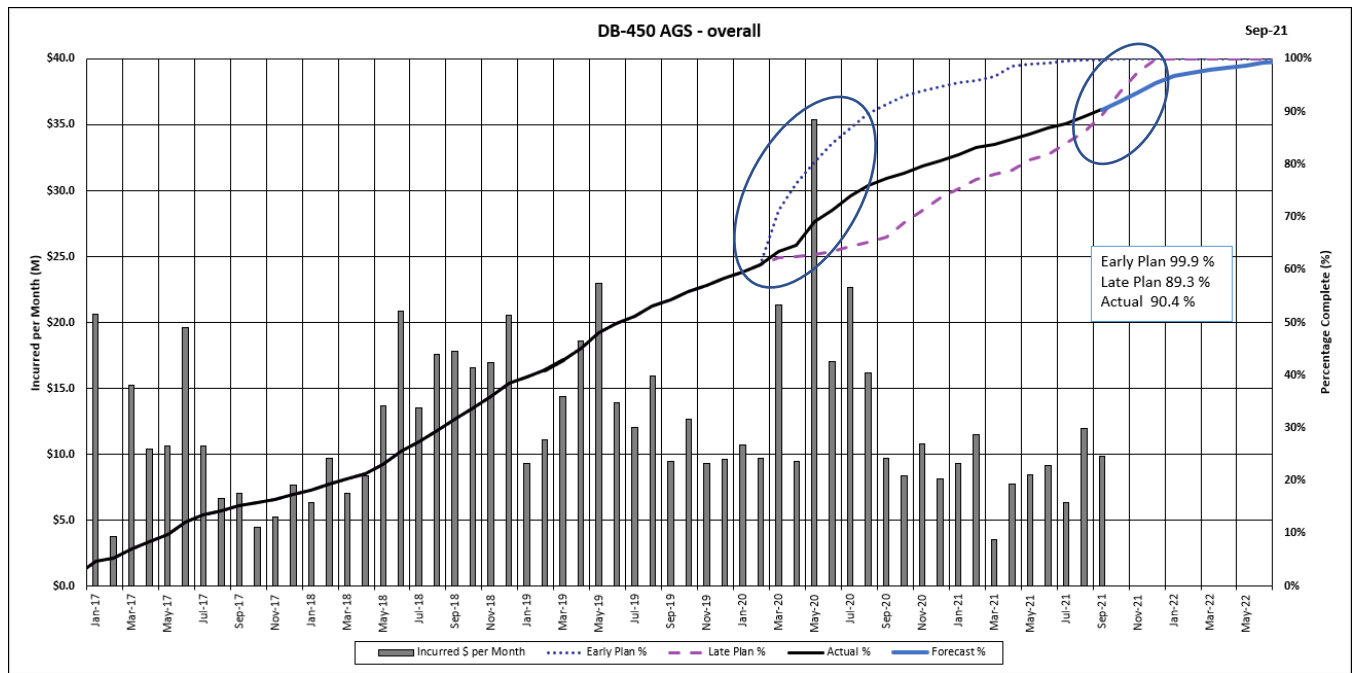
14.3 S-Curves

Shows Early and Late planned curves compared with Actual and Forecast curves. HART does not have data to produce S-curves from the Segment 1 Utilities, Guideway or Stations Contracts or the Core Systems Contracts for Segment 1 or 2. However, they have AGS curves, and all CC contracts are planned to be resource and cost-loaded to provide S-curves for EV analysis. See the following page for more information.

The overall S-Curve graphic below is for the Airport Segment Guideway and Stations contract and shows the actual progress as of February 2020 (just prior to COVID) and the forecast to complete curve in blue. This is a good depiction of how the production and performance of the AGS contractor never achieved the steepness of the baseline early and late curve envelope, meaning the original baseline was overly-optimistic as to planned production rates. This lesson learned is being carried into the planned schedule performance for the City Center Segment, which forecast production similar to the actual curve here.



Comparing the February 2020 version to the below September 2021 overall S-Curve (indicating a re-baseline in March of 2020), it is apparent that actual progress performance accelerated for a few months then resumed back to the previous average rate of production and schedule performance through the remainder of 2020 and 2021 (during COVID). This is evidence that the maximum achievable production shown in the original and revised baselines (see areas in ovals) was unrealistic. The Actual and Forecast curves reflect reality of the current possible production rates based on local resource, environmental and economical constraints.



When comparing the overall Forecast S-curve for Segment 3 City Center above (including Utility Relocations, Guideway, Stations and Core Systems) with the Segment 2 Actual/Forecast curves, the planned production appears to be very realistic and achievable given the same local resource, environmental and economical constraints.

The Assessment Team recommends looking at the final 8-12 months of Systems Testing and Integration to see if more production (crews) should be planned to stay closer to the Early Plan curve. Essentially making the current Forecast curve (see area in oval) become the Late Plan curve. This can be achieved by scheduling more detailed and discrete finish-start activities, based on assumed logical resource trade-flows, either through concurrent or parallel crew sequencing (linear scheduling technique), or resource loading and leveling analysis of the unconstrained P6 activities.



HONOLULU AUTHORITY for RAPID TRANSPORTATION

PART THREE

MAUKA SHIFT ASSESSMENT REPORT

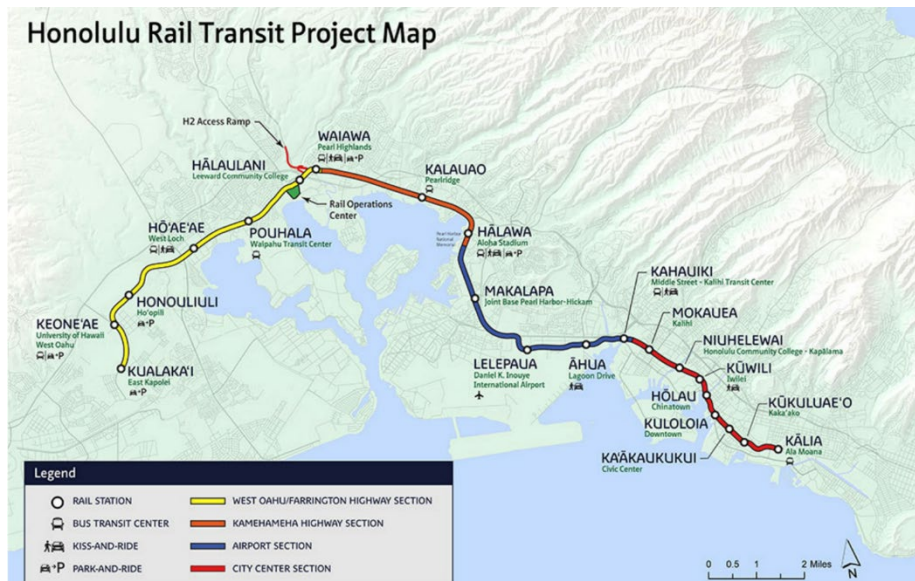
Report Issue Date: December 3, 2021

INTRODUCTION

The Assessment Team provided a cost assessment of the impact of the Mauka shift which eliminated a substantial amount of utilities that needed to be relocated in critical areas of Area 1C (Dillingham). Shifting the guideway to the Mauka side of the roadway allows the project to leave all Makai utilities in Area 1C overhead, in-place. The majority of the cost savings were found by elimination of work, easier construction methods, and a reduction of the overall project schedule. Since design is preliminary at this stage, the Assessment Team relied heavily on unit pricing already reviewed in the previous overall HART program evaluation for the cost assessment portion of this report. This cost assessment is broken into three sections:

1. Utility Relocations
2. Guideway Savings
3. Professional Services (soft costs)

Each group is detailed in the sections to follow.



The Assessment Team also noted the Segment 3 scheduled completion data now reflects the recent approval of the Mauka Shift design changes in the Dillingham Area, resulting in a 5-month earlier risk-adjusted Operational Readiness Date. This will be expanded on in greater detail in Section 6.0 of this report.

AGENCY

Honolulu Authority for Rapid Transportation
 1099 Alakea Street, 17th Floor
 Honolulu, Hawaii, 96813

ASSESSMENT TEAM

Triunity, Inc.
 633 17th Street, Suite 1500
 Denver, CO 80202

TABLE OF CONTENTS

TABLE OF CONTENTS	2
1.0 Overview	3
2.0 Utility Relocations	4
2.1 Utility Relocation Potential Savings.....	4
3.0 Guideway	5
3.1 Guideway Savings	5
4.0 Professional Services	6
4.1 Professional Services Savings	6
5.0 Schedule Assessment	7
6.0 Conclusion	8
6.1 Cost Assessment	8
6.2 Schedule Assessment.....	8

1.0 Overview

The current rough order of magnitude (ROM) estimate provided by the HART Project Team for the impact of the Mauka Shift accounts for a total estimated savings (or credit) of \$145M. The Assessment Team split this evaluation into three parts: 1) Utility Relocations, 2) Guideway, and 3) Professional Services as indicated in Table 1.0 below. Globally, the Assessment Team agrees with the potential cost savings opportunity presented by the Mauka Shift. The methodologies used by the HART Project Team appear well thought out and appropriate for the available information regarding the Mauka shift. The largest discrepancy found during this evaluation pertains to allocated contingency (AC) amounts being absent from the current potential savings forecast. Since base cost plus AC is currently being held in HART's Estimate at Completion (EAC), it is the position of the Assessment Team that these should also be included in potential savings (credited) work.

Description	HART's Current ROM			Assessment Team's Recommendation			Delta
	Base	Contingency	Total	Base	Contingency	Total	
Utility Relocations	(\$50.3M)	-	(\$50.3M)	(\$50.3M)	(\$14.1M)	(\$64.4M)	(\$14.1M)
Guideway	(\$20.6M)	-	(\$20.6M)	(\$20.6M)	(\$3.1M)	(\$23.7M)	(\$3.1M)
Professional Services	(\$74.1M)	-	(\$74.1M)	(\$74.1M)	-	(\$74.1M)	-
Total	(\$145.0M)	-	(\$145.0M)	(\$145.0M)	(\$20.9M)	(\$165.9M)	(\$17.2M)

Table 1.0

It should also be noted that Segment 3 schedule data now reflects the recent approval of the Mauka Shift design changes in the Dillingham Area, resulting in a 5-month earlier risk-adjusted Operational Readiness Date (from March 2031 to October 2030).

2.0 Utility Relocations

2.1 Utility Relocation Savings

- a. **Overview:** The Assessment Team evaluated a ROM estimate for the credit for the relocation of utilities for moving the guideway to the Mauka side of Dillingham Boulevard. The utilities involved include drainage, sewer, water, electrical, and gas. Other associated work includes roadway work, selective demolition, dewatering, jet grouting, erosion control, clear and grub, fencing, concrete flatwork, traffic control, pavement markings, and signage.

Description	HART's Current ROM			Assessment Team's Recommendation			Delta
	Base	Contingency	Total	Base	Contingency	Total	
Project General	(\$20.4M)	-	(\$20.4M)	(\$20.4M)	(\$5.7M)	(\$26.1M)	(\$5.7M)
Civil Underground	(\$47.5M)	-	(\$47.5M)	(\$47.5M)	(\$13.3M)	(\$60.8M)	(\$13.3M)
Electrical	(\$1.1M)	-	(\$1.1M)	(\$1.1M)	(\$0.3M)	(\$1.4M)	(\$0.3M)
Surface	(\$2.9M)	-	(\$2.9M)	(\$2.9M)	(\$0.8M)	(\$3.7M)	(\$0.8M)
Contingency for Unknown Impacts	\$21.6M	-	\$21.6M	\$21.6M	\$6.0M	\$27.6M	\$6.0M
Total	(\$50.3M)	-	(\$50.3M)	(\$50.3M)	(\$14.1M)	(\$64.4M)	(\$14.1M)

Table 2.1

- b. **Findings:** Currently, HART's ROM reflects \$50.3M of savings for the associated work. The Assessment Team found this to be appropriate for this level of detail about the effects of the shift but do believe a host of unknowns exist that could skew these findings. The largest two buckets of cost are Project General and Civil Underground. Project General includes items such as mobilization, traffic control, and allowances. This bucket appears to be appropriate and in line with previous estimates. Civil Underground includes the majority of the construction cost. The unit cost for the credit, particularly the electrical relocation savings, although slightly conservative compared to the original estimate still falls in line with expectations.

The contingency for unknown impacts is the largest area of uncertainty. Without more information on the impacts of the new alignment it is difficult to evaluate the true cost implications. Areas the Assessment Team are particularly concerned about are:

- a. New impacts to utilities on new alignment
- b. Mitigation efforts in areas such as environmental and acoustical
- c. Pedestrian access constraints
- d. Any other unknown constructability constraints

The HART Project Team has allotted \$21.6M to account for these uncertainties. Based on the limited information, it's the opinion of the Assessment Team that this is appropriate for this level of detail.

As mentioned in Section 1.0, the largest discrepancy found during this evaluation pertains to allocated contingency amounts being absent from this ROM estimate. The Assessment Team recommends applying the same Allocated Contingency percentage used in HART's EAC in the amount of (\$14.1M) or 28% of base cost.

3.0 Guideway

3.1 Guideway Savings

- a. **Overview:** The Assessment Team evaluated the effect of the Mauka Shift on guideway costs. The shift eliminates 8 straddle bents along with their associated drilled shafts, in exchange for more center piers throughout alignment, particularly at Piers 671-699. The estimated savings from the HART Project Team can be found in the table below.

Description	HART's Current ROM			Assessment Team's Recommendation			Delta
	Base	Contingency	Total	Base	Contingency	Total	
Centerline Column Bent	\$1.6M	-	\$1.6M	\$1.6M	\$0.2M	\$1.8M	\$0.2M
Straddle Bent	(\$12.2M)	-	(\$12.2M)	(\$12.2M)	(\$1.8M)	(\$14.0M)	(\$1.8M)
Hammer Head Bent	\$4.6M	-	\$4.6M	\$4.6M	\$0.7M	\$5.3M	\$0.7M
Drilled Shaft Foundation	(\$8.9M)	-	(\$8.9M)	(\$8.9M)	(\$1.3M)	(\$10.2M)	(\$1.3M)
Indirects, Bond, Insurance, GET	(\$5.8M)		(\$5.8M)	(\$5.8M)	(\$0.9M)	(\$6.7M)	(\$0.9M)
Total	(\$20.7M)	-	(\$20.7M)	(\$20.7M)	(\$3.1M)	(\$23.8M)	(\$3.1M)

Table 3.1

- b. **Findings:** Currently, HART's ROM is forecasting a savings of \$20.7M for guideway costs. The Assessment Team reviewed the Bid Items provided by the Project Team and found that they were appropriate for this level of detail. Indirects, bond & insurance, and GET were also evaluated and appear consistent with expectations and industry standards. The Assessment Team recommends applying the same Allocated Contingency used in HART's EAC in the amount of (\$3.1M) or 15% of base cost.

4.0 Professional Services

4.1 Professional Services Savings

- a. **Overview:** The Assessment Team evaluated the impacts of professional services related costs for shortening the schedule by 5 months due to the Mauka Shift. The HART Project Team performed their cost savings exercise based on the new methodology recommended in the Part One Cost Estimate Assessment Report.

Description	HART's Current ROM			Assessment Team's Recommendation			Delta
	Base	Contingency	Total	Base	Contingency	Total	
Eastside CE& I Services II	(\$10.9M)	-	(\$10.9M)	(\$10.9M)	-	(\$10.9M)	-
Program Management Support Consultant III	(\$6.9M)	-	(\$6.9M)	(\$6.9M)	-	(\$6.9M)	-
General Engineering Consultant, Construction (GEC-3)	(\$14.5M)	-	(\$14.5M)	(\$14.5M)	-	(\$14.5M)	-
Core Systems Contract Oversight Consultant	(\$8.8M)	-	(\$8.8M)	(\$8.8M)	-	(\$8.8M)	-
Honolulu Staffing, Expenses, & ODC's	(\$24.2M)	-	(\$24.2M)	(\$24.2M)	-	(\$24.2M)	-
All Other Professional Services	(\$8.8M)	-	(\$8.8M)	(\$8.8M)	-	(\$8.8M)	-
Total	(\$74.1M)	-	(\$74.1M)	(\$74.1M)	-	(\$74.1M)	-

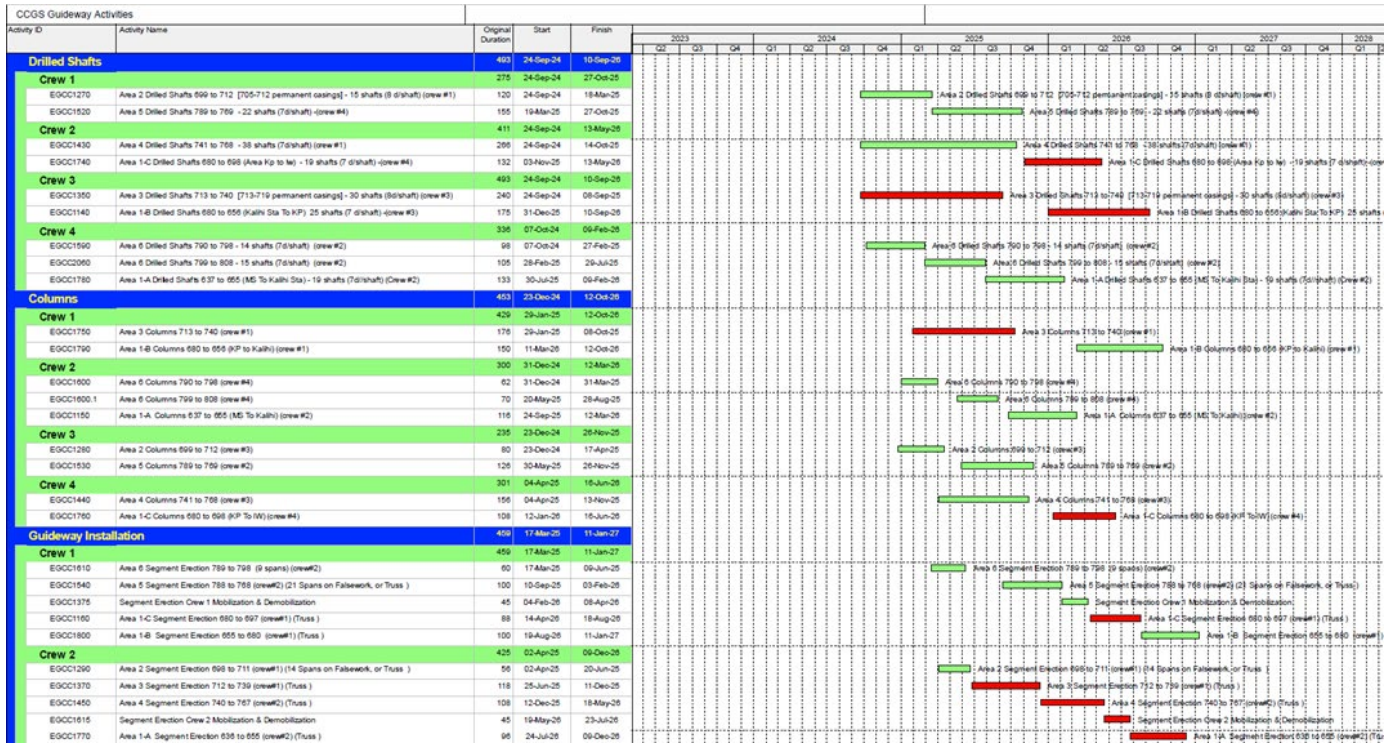
Table 4.1

- b. **Findings:** Currently, HART's ROM is forecasting a savings of \$74.1M for guideway costs. The Assessment Team reviewed the calculations provided by the Project Team and found that they were appropriate for this level of detail. Since HART's cost savings exercise for the Mauka Shift used the same methodology recommended in the Part One Cost Estimate Assessment Report, the savings appears appropriate and no further revisions are suggested at this time.

5.0 Schedule Assessment

The Assessment Team evaluated the effect of the Mauka Shift on the critical path schedule to Segment 3 Operational Readiness. The shift essentially allows the CCUR procurement and construction to begin on the utility relocations in the Dillingham area 2.5 months sooner and shortens the overall duration of CCUR construction an additional 2.5 months for a total time savings of 5 months.

The logic flow of the Segment 3 critical path activities is unchanged by the Mauka Shift; however, the reduced duration of Area 1 construction has brought crew production in other areas onto a parallel critical path. Reduced float in the other Segment 3 areas may increase risk of impacts to timely critical resource allocation and availability. See the revised CCGS scheduled crew-logic graphic below which incorporates the Mauka Shift adjustments to the critical path schedule.



6.0 Conclusion

6.1 Cost Assessment

The Assessment Team performed a high level, top-down assessment on the impact of the Mauka Shift. The largest discrepancy found during this evaluation pertains to allocated contingency amounts being absent from the current potential savings forecast. Since base cost plus allocated contingency is currently being held in HART's EAC, it is the position of the Assessment Team that these should also be included in potential savings (credited) work. Another area of concern that cannot be precisely assessed is the contingency for unknown impacts in the 2.0 Utility Relocation section of this report. Without more information on the impacts of the new alignment it is difficult to evaluate the true cost implications. However, the HART Project Team has allotted \$21.6M to account for these uncertainties. Based on the limited information, it's the opinion of the Assessment Team that this is appropriate for this level of detail.

6.2 Schedule Assessment

The Assessment Team evaluated the effect of the Mauka Shift on the critical path schedule to Segment 3 Operational Readiness. The shift essentially allows the CCUR procurement and construction to begin on the utility relocations in the Dillingham area 2.5 months sooner and shortens the overall duration of CCUR construction an additional 2.5 months for a total time savings of 5 months. The assessment team concurs with the incorporated Mauka Shift adjustments to the Segment 3 schedule, which now reflects a forecast (early) Operational Readiness date of May 2029 (Risk-adjusted Operational Readiness date is now October 2030).