

Airport Metro Connector

Technical Refinement Study of Alternatives - Final

October 2013



Metro

Airport Metro Connector

Phase I – AA/DEIS/DEIR

Technical Refinement Study of Alternatives Final

October 14, 2013



In Association with:

**Hatch Mott MacDonald
Lea+Elliott
Fehr & Peers
Leighton
Terry A. Hayes Associates Inc.
Epic Land Solutions**

**Ted Tanaka
VCA Engineers, Inc.
D'Leon Consulting Engineers
Coast Surveying
Cityworks Design**

TABLE OF CONTENTS

1. Introduction	1
1.1. Alternatives Analysis (AA) Report Summary and Recommendations	2
1.1.1. Purpose and Need	3
1.1.2. Definition of Alternatives	4
1.1.3. Alternative Screening	6
1.1.4. Recommendations	6
2. Definition of Alternatives	9
2.1. Alternative A: Aviation/Century Connection	11
2.1.1. Light Rail Alignment	11
2.1.2. Automated People Mover Alignment	11
2.1.3. Connections	12
2.1.4. Operations	12
2.2. Alternative B: ITF Connection	12
2.2.1. Light Rail Alignment	13
2.2.2. Automated People Mover Alignment	13
2.2.3. Connections	14
2.2.4. Operations	14
2.3. Alternative C: Central Terminal Area (CTA) Connection	14
2.3.1. Alternative C1: LRT Branch, 1 CTA Station	14
2.3.2. Alternative C2: LRT Branch, 2 CTA Stations	17
2.3.3. Alternative C3: Through LRT, 1 Station	19
2.3.4. Alternative C4: Through LRT, 2 CTA Stations	20
3. Performance Measures	22
3.1. Passenger Convenience and Travel Time	24
3.2. Environmental Factors	27
3.2.1. Construction Impacts	28
3.2.2. Land Acquisition	29
3.2.3. Historic Preservation	29
3.2.4. Noise and Vibration	30
3.3. Compatibility with Other Projects	30
3.3.1. Airport	31
3.3.2. Transit	31
3.3.3. Land Use	32
3.4. Engineering and Physical Feasibility	32
3.4.1. Parking Structures and Foundations	32
3.4.2. Roadway Columns and Foundations	33
3.4.3. Utilities	33
3.4.4. LAWA Identified Risk Areas	34
3.4.5. Geotechnical, Soils and Hazardous Materials	34
3.4.6. Airspace/Runway Protection Zone	34
3.4.7. Operability	35
3.5. Cost and Financial Feasibility	37

3.5.1. Capital Costs	37
3.5.2. Operating Costs	40
4. Summary and Next Steps	42

FIGURES

Figure 1-1: Project Development Process	3
Figure 1-2: Project Study Area.....	4
Figure 1-3: Off-Airport Routing Options	6
Figure 1-4: On-Airport Routing Options	6
Figure 1-5: Direct Alternative	7
Figure 1-6: Circulator Alternative.....	7
Figure 1-7: Through Alternative	8
Figure 2-1: Alternative A.....	11
Figure 2-2: Alternative B.....	13
Figure 2-3: Alternative C1	15
Figure 2-4: Alternative C2.....	17
Figure 2-5: Alternative C3.....	19
Figure 2-6: Alternative C4.....	20
Figure 3-1: Passenger Convenience.....	24
Figure 3-2: Travel Time Savings.....	25
Figure 3-3: Travel Time Added for Non-Airport Passengers	26
Figure 3-4: LRT Profile by Alternative	29
Figure 3-5: Estimated Capital Costs	39
Figure 3-6: Estimated Operating Costs (annual)	41
Figure 4-1: Summary of Findings	43

TABLES

Table 2-1: Key Alternative Characteristics	10
Table 2-2: Alternative A Operating Plan	12
Table 2-3: Alternative B Operating Plan	14
Table 2-4: Alternative C1 10-Minute Operating Plan	16
Table 2-5: Alternative C1 5-Minute Operating Plan	17
Table 2-6: Alternative C2 Operating Plan	18
Table 2-7: Alternative C3 Operating Plan	20
Table 2-8: Alternative C4 Operating Plan	21
Table 3-1: Evaluation Criteria and Performance Measures	23
Table 3-2: Environmental Factors Summary.....	28
Table 3-3: AMC Compatibility with Other Project.....	31
Table 3-4: Maximum Headways	36
Table 3-5: Engineering/Physical Feasibility Summary	37

APPENDICES

Appendix A Engineering Maps

Appendix B Capital Cost Estimate Memorandum

Appendix C Geotechnical Feasibility Evaluation Memorandum

Appendix D Flow Chart of Alternatives Considered

ABBREVIATIONS / ACRONYMS

AA.....	Alternatives Analysis
AMC	Airport Metro Connector
APM	Automated People Mover
BRT.....	Bus Rapid Transit
Caltrans.....	California Department of Transportation
ConRAC.....	Consolidated Rental Car Facility
CTA.....	Central Terminal Area
EIR.....	Environmental Impact Report
EIS.....	Environmental Impact Statement
FAA.....	Federal Aviation Administration
ITF	Intermodal Transportation Facility
LAWA	Los Angeles World Airports
LAX.....	Los Angeles International Airport
LRT	Light Rail Transit
LRTP.....	Long Range Transportation Plan
Metro	Los Angeles County Metropolitan Transportation Authority
NRHP.....	National Register of Historic Places
ROW.....	Right-of-Way
SCAG.....	Southern California Association Governments
SPAS.....	Specific Plan Amendment Study
TBIT.....	Tom Bradley International Terminal
TBM	Tunnel Boring Machine
TSM.....	Transportation Systems Management

1. INTRODUCTION

The Los Angeles County Metropolitan Transportation Authority (Metro) is working in collaboration with Los Angeles World Airports (LAWA) to identify a reliable and convenient connection for passengers and employees traveling between the Los Angeles International Airport (LAX) and the regional transit system. This connection would facilitate the movement of airport bound passengers from the Metro Crenshaw/LAX Line, under construction, and the existing Metro Green Line. In April 2012, the Metro Board received the Metro Green Line to LAX Alternatives Analysis (AA) Report and approved changing the name of the Project to the Airport Metro Connector. In addition to the No Build and Transportation System Management (TSM) alternatives, the 2012 AA Report recommended the following three Build Alternatives for further evaluation in the Draft Environmental Impact Statement (EIS)/Environmental Impact Report (EIR):

- Direct Light Rail Transit Branch
- Modified Light Rail Transit Trunk (Through LAX)
- Circulator(Automated People Mover)

As a result of several meetings with the Federal Aviation Administration (FAA) and the Federal Transit Administration (FTA), Metro was advised by the FAA that the federal environmental clearance process for the Airport Metro Connector could not begin until LAWA proposed a project for inclusion on the LAX Airport Layout Plan. In subsequent discussion, LAWA indicated that such a proposal would need to follow the completion of their Specific Plan Amendment Study (SPAS). The SPAS involved the identification and evaluation of potential alternatives to improve air and ground transportation operations at the airport. The ground transportation element in SPAS highlights an Automated People Mover (APM) system that would connect the airport terminals with a future Intermodal Transportation Facility (ITF), Consolidated Rental Car Facility (ConRAC) and the Metro Rail system.

With the completion of the SPAS not anticipated until the spring of 2013, Metro began this Technical Refinement Study, in cooperation with LAWA, to further evaluate the opportunities and constraints associated with the three build alternatives listed above. Although LAWA previously requested a Bus Rapid Transit (BRT) alternative be evaluated in the Draft EIS/EIR, it was not included in this study. The Technical Refinement Study focuses on the alternatives recommended in the 2012 AA Report.

In June 2013, the Metro Board awarded a Design/Build contract for the Metro Crenshaw/LAX project with an opening date expected in 2020. The alternatives evaluated in this report assume the Metro Crenshaw/LAX project as an integral component of the transportation network within the Project Study Area. As such, most of the alternatives either extend from or connect to the Metro Crenshaw/LAX station near the intersection of Aviation and Century Boulevards. Also in June 2013, the Metro Board approved studying a Metro Rail connection

at LAWA’s ITF (“Through ITF” alternative) during the environmental review process. A preliminary evaluation of that alternative is also provided in this report.

The Airport Metro Connector project has \$200 million (2008 dollars) in Measure R funds reserved in the constrained element of Metro’s 2009 Long Range Transportation Plan (LRTP) with a revenue service date of 2028. The opening date is contingent upon a financial contribution by LAWA.

This Technical Refinement Study builds upon the 2012 AA Report with input and data provided by LAWA and the SPAS EIR. This report is intended to advance the analysis of alternatives in order to better inform the public, Metro and LAWA and ultimately help expedite the subsequent environmental review process. This report is accompanied by an Advanced Conceptual Engineering (ACE) level design effort to characterize costs, design issues and environmental impacts in greater detail. Since the “Through ITF” alternative was introduced near the completion of this study, it was not able to be brought up to the same level of design as the other alternatives. It will need ACE level design in subsequent work.

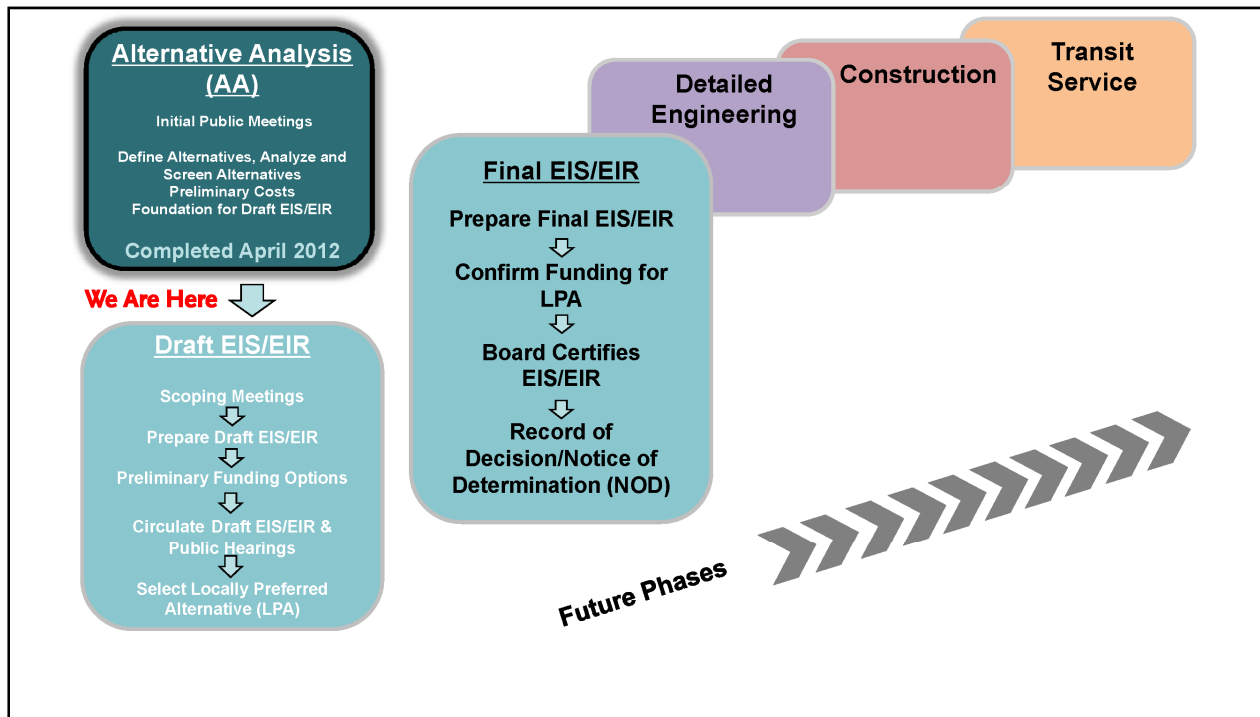
1.1. ALTERNATIVES ANALYSIS (AA) REPORT SUMMARY AND RECOMMENDATIONS

The AA is the first step in the planning, environmental assessment, design and construction of a large-scale transit project. Figure 1-1 illustrates the project development process for the AMC project. The focus of this study is to plan, design and environmentally assess a fixed guideway transit connection between Metro’s regional rail system and LAX. Such a connection has been the subject of study by Metro, Los Angeles World Airports (LAWA), and other agencies, with recent efforts including the LAX/Metro Green Line Interagency Task Force (2008), the LAX Master Plan (2004) and the Metro Green Line Northern Extension Supplemental EIR (1994).

The Project Study Area, shown in Figure 1-2, is bounded by Manchester Avenue to the north, La Cienega Boulevard to the east, 120th Street to the south and the LAX air cargo area to the west, and includes portions of the Cities of Los Angeles, Inglewood and El Segundo.

This Technical Refinement Study of Alternatives is an addendum to the AA for the AMC project, which was presented to the Metro Board of Directors in April 2012. Therefore, it does not “screen” alternatives, but rather provides more technical detail and analysis of those recommended to move forward in the 2012 AA Report. The following sections present the alternatives considered and resulting recommendations from the 2012 AA Report, which are the foundation for this Technical Refinement Study.

Figure 1-1. Project Development Process



Source: Metro, 2013

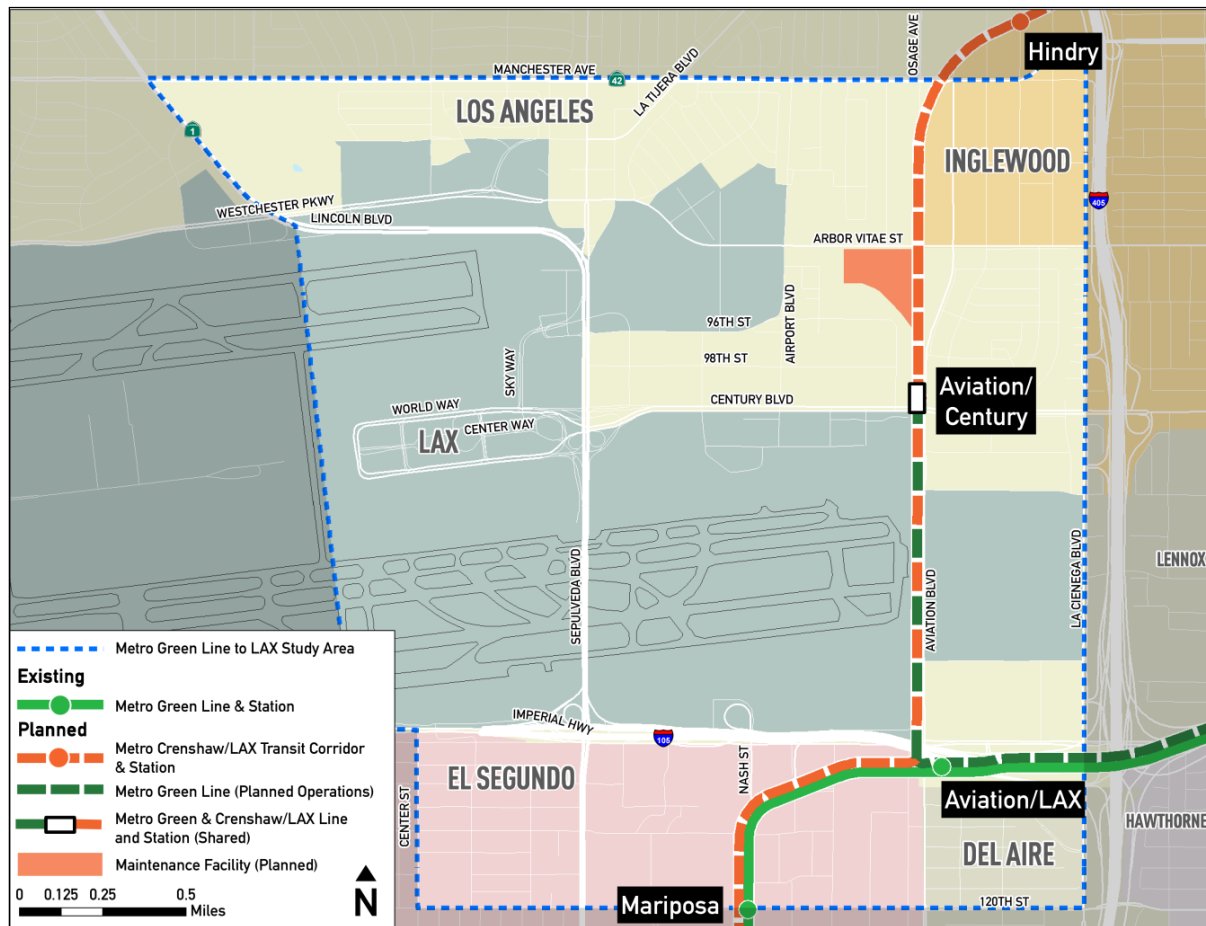
1.1.1. Purpose and Need

The 2012 AA Report included a Purpose and Need discussion, which analyzed the travel markets and existing transportation conditions within the Project Study Area and detailed a range of project objectives designed to address specific mobility problems. The 2012 AA Report identified four project objectives:

1. Provide a reliable, fast, and convenient connection for passengers traveling between LAX area and the regional transit system.
2. Integrate with existing and future transit connections and airport facilities.
3. Increase the share of transit trips to and from LAX, and reduce air pollution with minimal impact on airport facilities and surrounding communities.
4. Serve the surface transportation and travel demands of the high volume of passengers connecting to LAX.

These four project objectives served as the basis for evaluating the Build Alternatives in the 2012 AA Report. For details on the project objectives and baseline conditions, refer to the 2012 AA Report.

Figure 1-2: Project Study Area



Source: ConnectLAX, 2012

1.1.2. Definition of Alternatives

The 2012 AA Report considered a range of alternatives, including various modes and alignments. The alternatives included:

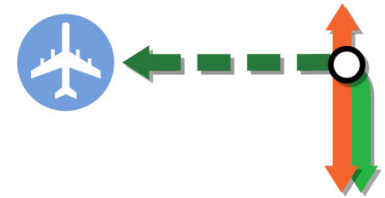
1. **No Build** – represents the Project Study Area in 2035, if the AMC project was not built, and includes funded major transportation improvements specified in the Southern California Association of Government’s (SCAG) 2008 Regional Transportation Plan and the constrained element of Metro’s 2009 Long Range Transportation Plan (LRTP).
2. **Transportation System Management (TSM)** - consists of operational improvements to current transit facilities and services, with minimal capital expenditure. These include: intersection improvements, minor roadway widening, bus route restructuring, expanded use of high-capacity buses, and traffic signalization improvements.

3. Build Alternatives

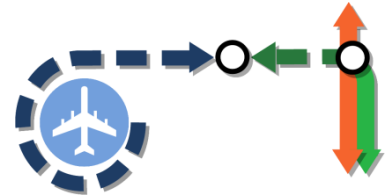
- a. **Circulator** – consists of a new system connecting the Central Terminal Area (CTA) to the Crenshaw/LAX line’s Aviation/ Century Station. The system would operate separately from the existing Metro Rail System, and it could be developed as rail (Automated People Mover (APM)) or bus (BRT).



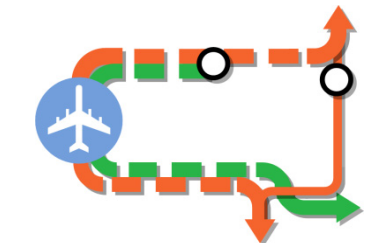
- b. **Direct Light Rail Transit (LRT) Branch** - extends the Metro light rail system (Metro Green Line and/or Metro Crenshaw/LAX Transit Corridor) into the CTA.



- c. **Intermediate LRT and Circulator** - combines elements from the Direct LRT Branch and Circulator Alternatives.



- d. **Modified LRT Trunk** - consists of a LRT alignment west of the Metro Crenshaw/LAX Line, with a single station in the airport.



For each build alternative, the 2012 AA Report considered the following modes:

- **Bus Rapid Transit (BRT)** - BRT was considered for the Circulator, Intermediate LRT and Circulator and the Modified LRT Trunk Alternatives.
- **Light Rail Transit (LRT)** - LRT was considered for three of the four Build Alternatives (Direct, Intermediate LRT, Circulator and Modified LRT Trunk).
- **Automated People Mover (APM)** – An APM system was considered for circulator elements as part of the Circulator, Intermediate LRT and Circulator, and Modified LRT Trunk with Circulator alternatives.

Various alignments for the Build Alternatives were considered, including: off-airport alignments (outside of the CTA) and on-airport alignments (within the CTA) shown in Figure 1-3 and Figure 1-4, respectively.

Figure 1-3: Off-Airport Routing Options



Source: ConnectLAX, 2012

Figure 1-4: On-Airport Routing Options



Source: ConnectLAX, 2012

1.1.3. Alternative Screening

The 2012 AA Report divided the screening process into two stages. Stage I consisted of a comparative evaluation of the modes, and on and off-airport options for each of the Build Alternatives against significant issue criteria, which emphasizes feasibility of the modes and routes for options within each of the four Build Alternatives Alignments. Based on the results of the Stage I screening, 27 packaged alternatives were carried forward to be evaluated further in Stage II.

As part of the Stage II analysis, several performance measures were developed to assess the pros and cons of each alternative. These measures include ridership, capital cost, travel time, passenger convenience, compatibility with other plans/facilities, and constructability. In addition to these performance measures, community acceptability was also considered based on comments received at the public meetings held in February/March 2012. The performance of each of the 27 packaged alternatives, as characterized by the Stage II quantitative performance measures are provided in Table 4.15 of the 2012 AA Report.

1.1.4. Recommendations

Based on the two-stage screening process and input received at public meetings, the following alternatives were recommended for study in the Draft EIR/EIS:

1. **No Build** – Existing transit and highway plans that are programmed through the year 2035 and open for operation.

2. **Transportation System Management (TSM)** – Lower cost capital and operational improvements designed to improve bus speeds along existing roadways from the Aviation/Century Station to LAX.

3. **Direct LRT Branch Alternative** – As shown in Figure 1-5, this alternative would directly connect the Metro Green Line and Metro Crenshaw/LAX passengers to the CTA from the Metro Rail extension along Aviation Boulevard. Lot C and the CTA are two areas where optional station configurations will require additional study. This alternative was selected because it offered a good balance between cost and passenger convenience, and was well-received by the public during the winter 2012 public outreach activities.

Figure 1-5: Direct Alternative



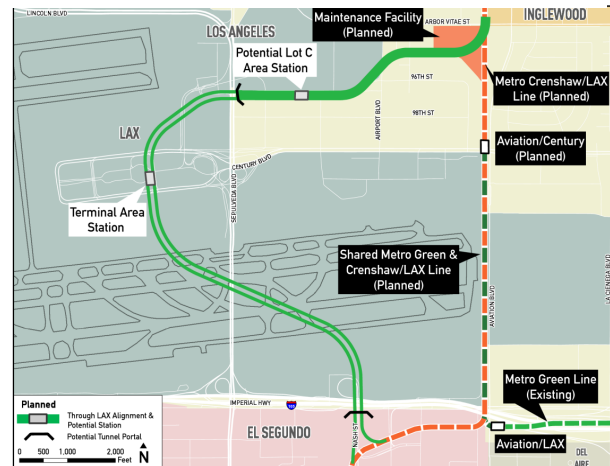
4. **Circulator Alternative** – As shown in Figure 1-6, this alternative is an airport APM that connects airport facilities with Metro Rail at the Aviation/Century Station. There are two station configuration options inside the CTA that will require additional study. This alternative was carried forward because it offers the operational flexibility needed to allow service and vehicles to be tailored to meet the unique needs of the airport environment, and was well-received by the public during the Winter 2012 public outreach activities.

Figure 1-6: Circulator Alternative



- Through LAX Alternative** – As shown in Figure 1-7, this alternative routes Metro Rail under the airport with one centrally located station, which will connect both the Metro Green and Crenshaw/LAX Lines directly to the airport. This alternative was carried forward for further consideration in the Draft EIS/EIR because it results in the fastest travel times and highest ridership to the airport of all the alternatives, and was well-received by the public during the winter 2012 public outreach activities.

Figure 1-7: Through Alternative



Before an EIS/EIR was initiated, LAWA released their SPAS report, which supported an airport connection to the regional rail system via an APM. In an effort to expedite the construction of a regional rail connection to the airport, Metro and LAWA have been working collaboratively together over the past year to further refine the definition of alternatives to be carried forward into the Draft EIS/EIR. These refined alternatives are presented in Section 2 and the performance measures are presented in Section 3.

2. DEFINITION OF ALTERNATIVES

The concepts considered in the Technical Refinement Study refine alternatives from the 2012 AA Report. Based on the input from LAWA, the various scenarios are organized into three main categories based on their interface point between the Metro Rail system and LAX facilities:

- **Alternative A: Aviation/Century Connection** – the Metro Crenshaw/LAX and Metro Green Lines connect to a LAWA-operated APM at the Aviation/Century Station.
- **Alternative B: ITF Connection** - the Metro Crenshaw/LAX and Metro Green Lines “shift” to the west to connect to a LAWA-operated APM at the ITF near Airport Boulevard.
- **Alternative C: Central Terminal Area (CTA) Connection** – the Metro Crenshaw/LAX and Metro Green Lines extend into the CTA to provide direct rail service to the LAX terminals. Within the CTA Connection category, there are several different configurations:
 - **Alternative C1: LRT Branch, 1 Station in the CTA** – the Metro Crenshaw/LAX and Metro Green Lines branch off to serve stations at the ITF and the eastern CTA. Metro Rail would connect to a LAWA-operated APM at these two stations. Two operating scenarios are under consideration – one with 10-minute headways and one with 5-minute headways. Two operating scenarios were considered due to the operating constraints associated with a stub-end terminal.
 - **Alternative C2: LRT Branch, 2 Stations in the CTA** – the Metro Crenshaw/LAX and Metro Green Lines branch off to serve stations at the ITF, the eastern CTA and the western CTA. This alternative is designed to test performance without an APM. However, the existing LAWA Shuttle A bus would remain in service and provide connections to each terminal within the CTA.
 - **Alternative C3: Through LRT, 1 Station in the CTA** – the Metro Crenshaw/LAX and Metro Green Lines branch to go through the LAX area to reconnect to the Metro rail system south of LAX. This alternative would serve stations at the ITF, the western CTA and Sepulveda Boulevard. This alternative is designed to test performance without an APM. However, the existing LAWA Shuttle A bus would remain in service and provide connections to each terminal within the CTA.
 - **Alternative C4: Through LRT, 2 Stations in the CTA** – the Metro Crenshaw/LAX and Metro Green Lines branch to go through the LAX area to reconnect to the Metro rail system south of LAX. This alternative would serve stations at the ITF, the eastern CTA, the western CTA and Sepulveda Boulevard. This alternative is designed to test performance without an APM. However, the existing LAWA Shuttle A bus would remain in service and provide connections to each terminal within the CTA.

The following sections describe each of the alternatives in detail. Each of the alternatives include an assumption about light rail and an assumption about an APM. Table 2-1 presents the key characteristics for each alternative. Appendix D illustrates how each of these alternatives evolved from the recommended AA alternatives.

Table 2-1: Key Alternative Characteristics

	Alternatives Connecting at Aviation/Century	Alternatives Connecting at the ITF	Alternatives Connecting within the Terminal Area			
Alternative Name	Aviation Century Connection	Intermodal Transportation Facility (ITF) Connection	Terminal Connection – LRT Branch (1 Station)	Terminal Connection – LRT Branch (2 Stations)	Terminal Connection – Through LRT (1 Station)	Terminal Connection – Through LRT (2 Stations)
Alternative Number	A	B	C1	C2	C3	C4
APM						
<i>Number of New Stations</i>	5	5	6	n/a	n/a	n/a
<i>Alignment Length (miles)</i>	2.9	2.0	1.9	n/a	n/a	n/a
LRT						
<i>Number of New Stations</i>	n/a	1	2	3	2	3
<i>Alignment Length (miles)</i>	n/a	1.4	2.4	4.1	5.1	5.5

2.1. ALTERNATIVE A: AVIATION/CENTURY CONNECTION

This alternative is a refinement of the Circulator alternative recommended from the 2012 AA Report. In this alternative, the APM would connect the Aviation/Century Station as shown in Figure 2-1.

2.1.1. Light Rail Alignment

For Alternative A, light rail follows an alignment along Aviation Boulevard and includes a station one mile east of the CTA at Aviation/Century. This alignment is under construction as part of the Crenshaw/LAX Line.

Two services operate along this alignment – a Crenshaw/LAX service from the Exposition Line to the South Bay via Aviation/Century and a revised Metro Green Line, which extends from Norwalk on the east to terminate at

Aviation/Century on the west, where travelers destined to LAX can transfer to an APM. The Metro Green Line, instead of turning south to Redondo Beach at Aviation/LAX as it does currently, would terminate at the Aviation/Century Station.

Figure 2-1: Alternative A



2.1.2. Automated People Mover Alignment

A LAWA-sponsored APM would connect passengers from the nearby Aviation/Century light-rail station to LAX terminals. Construction and operation of the APM would be independent of Metro light-rail service and would be operated by LAWA. The entirely aerial APM alignment would run from Manchester Square to the CTA with intermediate stops at a consolidated rent-a-car facility (ConRAC), the Metro Rail station and the ITF.

The APM alternative would make a counterclockwise loop around the CTA. There would be two APM stations on the north side to serve CTA terminals 0 (planned), 1, 2, and 3, one at the west end with connections to the Midfield Satellite Concourse and Tom Bradley International Terminal (TBIT), and two APM stations on the south side of the CTA to serve terminals 4, 5, 6, and 7/8.

2.1.3. Connections

Regional transit passengers on the Metro Crenshaw/LAX Line or the Metro Green Line could connect to LAX terminals by transferring at Aviation/Century to the LAWA-sponsored APM. To make this transfer, passengers would disembark their light-rail vehicle and walk to the APM station.

2.1.4. Operations

Based in LAWA operations plans, the APM would run at 2.5-minute peak headways. The Metro Crenshaw/LAX and Metro Green Lines would each run at five-minute peak headways. This alternative would allow the airport system to operate at more frequent headways during peak airport travel times, which often differs from peak Metro rail travel times. The differing peaks at LAX are due to the variable nature of flight scheduling.

The Aviation/Century Station would be served by the Metro Crenshaw/LAX Line and the Metro Green Line, which would both operate at 5-minute headway for a combined 2.5-minute peak headways between both light-rail trains. The chart below displays peak headways for the Metro rail lines and stations, as well as the APM.

Table 2-2: Alternative A Operating Plan

Destinations	Line Name	Peak Headways
Expo/Crenshaw ← → Aviation/Century ← → Redondo Beach	Metro Crenshaw/ LAX Line	5 min.
Norwalk ← → Aviation/Century	Metro Green Line	5 min.
Manchester Square ← → Aviation/Century ← → CTA	APM	2.5 min.

2.2. ALTERNATIVE B: ITF CONNECTION

The ITF Connection is a variation on the Intermediate Alternative. While it was not recommended in the 2012 AA Report, it is included in this report because it was directed to be analyzed by the Metro Board in June 2013. It has not been taken to the same level of analysis as the alternatives recommended in the 2012 AA Report. In this alternative, the Metro Green and Crenshaw/LAX Lines would be realigned slightly to the west to meet the APM closer to the ITF as shown in Figure 2-2.

2.2.1. Light Rail Alignment

In Alternative B, the Metro Crenshaw/LAX Line would operate trains between Expo/Crenshaw Station and Redondo Beach in the South Bay as planned in the No Build alternative. The major change would be that rather than servicing the Aviation/Century Station, the alignment would enter a tunnel and would go west under the planned maintenance facility at Arbor Vitae Street and travel below grade to Airport Boulevard where it would turn south and continue below-grade to a station adjacent to the planned ITF. From the ITF station, the Metro Crenshaw/LAX Line would continue south in a shared Metro Green Line tunnel before traveling east below Century Boulevard and rejoining the Metro Crenshaw/LAX alignment to the South Bay.

Figure 2-2: Alternative B



The Metro Green Line would operate trains between Norwalk and a station at the planned ITF. From the I-105, the Metro Green Line would head north on a shared Metro Green Line and Metro Crenshaw/LAX Line right-of-way along Aviation Boulevard. At Century Boulevard, the alignment would go west below-grade and then north to the planned ITF station, which would be the western terminus of the Metro Green Line.

2.2.2. Automated People Mover Alignment

A LAWA-sponsored APM would connect passengers from the ITF light-rail station to LAX terminals. The APM would also extend east of the ITF to Manchester Square and the ConRAC. LAWA would construct and operate the APM, independent of Metro light-rail service. The entirely aerial APM alignment would run from the ITF to the CTA. The APM would connect to the Metro Green Line and Metro Crenshaw/LAX Line station at the ITF.

The APM would make a counterclockwise loop around the CTA. There would be two APM station on the north side to serve CTA terminals 0 (planned), 1, 2, and 3, one at the west end with connections to the MSC and TBIT, and two APM stations on the south side of the CTA to serve terminals 4, 5, 6, and 7/8.

2.2.3. Connections

Regional transit passengers on the Metro Crenshaw/LAX Line or the Metro Green Line could connect to LAX terminals by transferring at the ITF station to the LAWA-sponsored APM. To make this transfer, passengers would disembark their light-rail vehicle and walk to the APM station at the ITF.

2.2.4. Operations

The Metro Crenshaw/LAX Line and the Metro Green Line would run with five-minute peak headways. The APM would have 2.5 minute peak headways. The headways are summarized in the table below.

Table 2-3: Alternative B Operating Plan

Destinations	Line Name	Peak Headways
Expo/Crenshaw ← → ITF ← → Redondo Beach	Metro Crenshaw/ LAX Line	5 min.
Norwalk ← → ITF	Metro Green Line	5 min.
ITF ← → CTA	APM	2.5 min.

2.3. ALTERNATIVE C: CENTRAL TERMINAL AREA (CTA) CONNECTION

There are four CTA Connection alternatives under consideration. C1 and C2 are variations of the Direct Alternative and C3 and C4 are variations of the Through Alternative recommended in the 2012 AA Report. For each concept, an alternative with one LRT station and two LRT stations in the CTA was considered. For Alternative C1, two different headway scenarios are also under consideration. For Alternative C1, an APM is assumed to facilitate connections to the terminals. For Alternatives C2, C3 and C4, passengers are either within walking distance of all terminals or take a local circulator bus (LAWA shuttle Bus A). LAWA requested that all LRT alternatives be underground in the CTA in order to leave clearance for the proposed APM.

2.3.1. Alternative C1: LRT Branch, 1 CTA Station

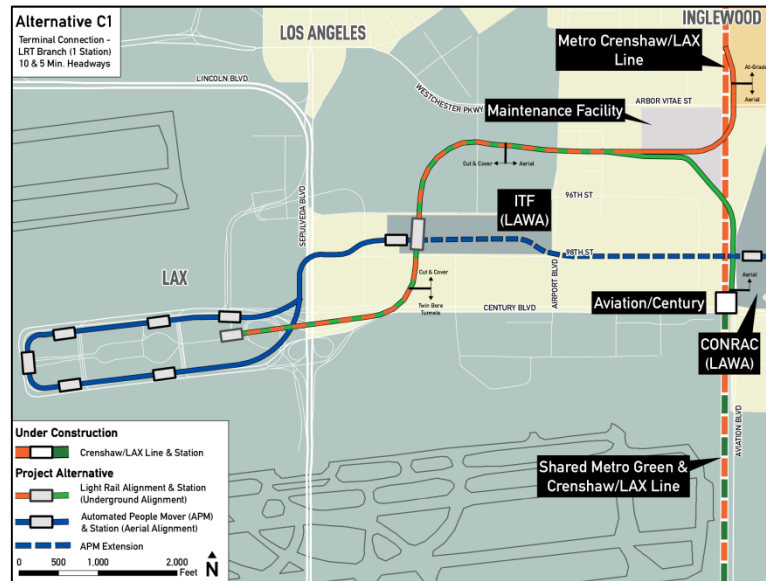
2.3.1.1. Light Rail Alignment

Alternative C1 includes one light-rail station under the eastern CTA serving Metro Crenshaw/LAX and Metro Green Line passengers as shown in Figure 2-3. The light rail alignment follows the south edge of the maintenance facility, turning south through the ITF and ending within the CTA. In this alternative, Metro Crenshaw/LAX and Metro Green Line trains can operate at five or ten-minute headways. The five-minute headway option would require additional infrastructure at the terminals to support the more frequent headways.

2.3.1.2. Automated People Mover Alignment

To facilitate travel between the airport terminals, an APM would be necessary under this alternative. The proposed APM would have an aerial alignment with six stations within the CTA and one at the ITF. The APM alignment in this alternative would extend to the ITF, but would not reach Aviation/Century Station. The APM station at the eastern end of the CTA would be near the LRT CTA east station.

Figure 2-3: Alternative C1



2.3.1.3. Connections

Passengers transferring from the APM to the light-rail CTA station would walk to make the connection.

2.3.1.4. Operations

Under this alternative, the APM would be constructed and operated by LAWA separately from Metro light-rail service. The APM would have 2.5-minute headways.

Ten-minute Light-Rail Headways

The ten minute headway scenario is the baseline for this alternative. With ten-minute headways, the Metro Crenshaw/LAX and Metro Green Lines each have one operating pattern that enters the terminal area and one that bypasses it and heads directly to the South Bay. The Metro Crenshaw/LAX trains that bypass the CTA would run as currently planned between Expo/Crenshaw Station and Redondo Beach. Metro Green Line trains bypassing the CTA would run between Norwalk and terminate at the Aviation/Century Station. Metro Crenshaw/LAX trains serving the CTA would travel west over Arbor Vitae Street and the maintenance facility (alternatively, this portion of the right-of-way could be below-grade under the maintenance facility and Arbor Vitae Street). West of the maintenance facility, the Metro Crenshaw/LAX Line would enter a shared right-of-way with the Metro Green Line. The right-of-way would go below-grade and turn south, stopping at an ITF light rail station before turning west to a station under the eastern CTA. An APM would be co-located at the ITF and could act as an additional transfer point between the LRT and APM systems.

The underground CTA light rail terminal station would be comprised of two tracks and one platform, which is sufficient to turn the trains at ten minute headways. The CTA station, which is currently planned to be located under the Administrative East building, could also be

located farther south under the current Parking Garage 7. However, this would require demolition of the parking garage. Another option would be to locate the light-rail station farther north, below the current Park One parking lot and future Terminal 0. To pursue the Park One option, the light-rail station must be built before the construction of Terminal 0.

Metro Green Line CTA-bound trains would turn north at Aviation/LAX to Aviation/Century Station. The line would then enter the Metro Crenshaw/LAX-Green Line shared right-of-way described above, and continue to the ITF station and eastern CTA station.

Five-Minute Light-Rail Headways

Under this operating scenario, Metro Crenshaw/LAX trains would travel between Expo/Crenshaw Station and the eastern CTA Station, and the eastern CTA Station and Redondo Beach Station at five-minute headways. Metro Green Line trains would travel between Norwalk and the eastern CTA Station at five-minute headways.

For Alternative C1 to accommodate five-minute headways, there must be at a minimum two platforms and a minimum three tracks in the underground CTA light rail terminal station. The alignment for the five and ten-minute headway options would be identical from the shared right-of-way west of the maintenance facility to the ITF station. West of the ITF station, however, light-rail trains would enter twin-bore tunnels leading to the eastern CTA, where the Metro Crenshaw/LAX and Metro Green Lines would split between two platforms and three tracks. From the eastern CTA station, southbound Metro Crenshaw/LAX trains would travel east in the same twin-bore tunnels, stop at the ITF station, and then to Aviation/Century Station. The Crenshaw/LAX Line would then continue south.

The following chart summarizes combined headways of relevant line portions under the ten-minute peak headways option.

Table 2-4: Alternative C1 10-Minute Operating Plan

Destinations	Line Name	Peak Headways
Expo/Crenshaw ← → ITF ← → CTA	Metro Crenshaw/LAX Line	10 min.
Expo/Crenshaw ← → Redondo Beach		10 min.
Norwalk ← → ITF ← → CTA	Metro Green Line	10 min.
Norwalk ← → Redondo Beach		10 min.
ITF ← → CTA	APM	2.5 min.

The following chart summarizes combined headways of relevant line portions under the five-minute peak headways option.

Table 2-5: Alternative C1 5-Minute Operating Plan

Destinations	Line Name	Peak Headways
Expo/Crenshaw ← → ITF ← → CTA	Metro Crenshaw/LAX Line	5 min.
Redondo Beach ← → ITF ← → CTA		5 min.
Norwalk ← → ITF ← → CTA	Metro Green Line	5 min.
ITF ← → CTA	APM	2.5 min.

2.3.2. Alternative C2: LRT Branch, 2 CTA Stations

2.3.2.1. Light Rail Alignment

Alternative C2 would provide passengers with the option of riding the Metro Green Line and the Metro Crenshaw/LAX Line directly to the Airport CTA. Every other Metro Crenshaw/LAX and Metro Green Line trains would be rerouted from the baseline alignment to serve the Airport CTA. There is no APM in this alternative.

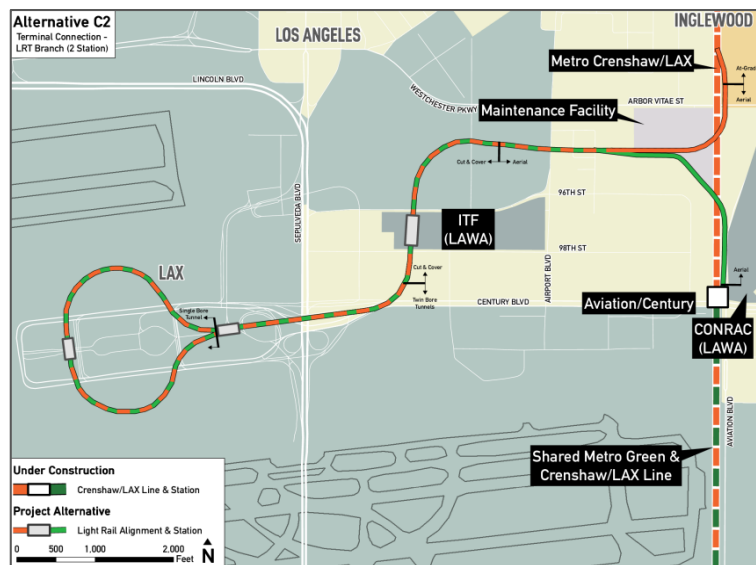
Airport CTA-bound Metro Crenshaw/LAX trains would turn west from Aviation Boulevard and follow an aerial alignment over the rail maintenance facility at Arbor Vitae Street and Aviation Boulevard. Alternatively, this portion of the alignment could run below grade under Arbor Vitae Street and the maintenance facility.

West of the rail maintenance facility at Arbor Vitae Street and Aviation Boulevard, the alignment would enter a cut and cover tunnel before turning south and arriving at the ITF station. Just south of the ITF, the alignment would enter a twin-bored tunnel and turn west toward the CTA. Under the CTA, light-rail trains would travel counterclockwise in a single-bored, one-way tunnel. One station at the west end of the CTA would serve terminals 2, 3, TBIT, 4, and 5 and another at the east end would serve terminals 0, 1, 6, and 7/8.

2.3.2.2. Automated People Mover Alignment

Alternative C2 would not include an APM because transit passengers on the Metro Crenshaw/LAX and Metro Green Lines would be able to directly connect to the Airport CTA.

Figure 2-4: Alternative C2



2.3.2.3. Connections

No connections between an APM and the LRT system would be necessary. This alternative connects the Airport CTA to Metro Crenshaw/LAX and Metro Green Lines directly. After passengers arrive at the LRT stations under the CTA, they would have to walk to their respective terminals, or take the LAWA shuttle that would continue to operate within the CTA.

2.3.2.4. Operations

In this alternative, the Metro Crenshaw/LAX line would be split into two separate lines, Metro Crenshaw/LAX Line A and B. On Metro Crenshaw/LAX Line A, regional transit passengers would have the option of riding the Metro Crenshaw/LAX Line and bypassing the CTA. Metro Crenshaw/LAX Line A would run between Expo/Crenshaw Station and Redondo Beach Station with 10 minute peak headways. Metro Crenshaw/LAX Line B would run between Expo/Crenshaw Station and the CTA with 10 minute peak headways. This would result in combined five-minute peak headways between Expo/Crenshaw and Aviation/Manchester.

Currently, the existing Metro Green Line travels south to Redondo Beach after Aviation/LAX station. In this alternative, the Green Line would also be split into two separate lines, Metro Green Line A and B. On Metro Green Line A, regional transit passengers would have the option of riding the Metro Green Line and bypassing the CTA. Metro Green Line A would run between Norwalk Station and Redondo Beach Station with 10 minute peak headways. Metro Green Line B would run between Norwalk Station and the CTA with 10 minute peak headways. This would result in combined five-minute peak headways between Norwalk and Aviation/LAX.

These Metro Crenshaw/LAX and Green Lines will result in combined five-minute peak headways at any given station along the system, but with different destinations for each train.

Table 2-6: Alternative C2 Operating Plan

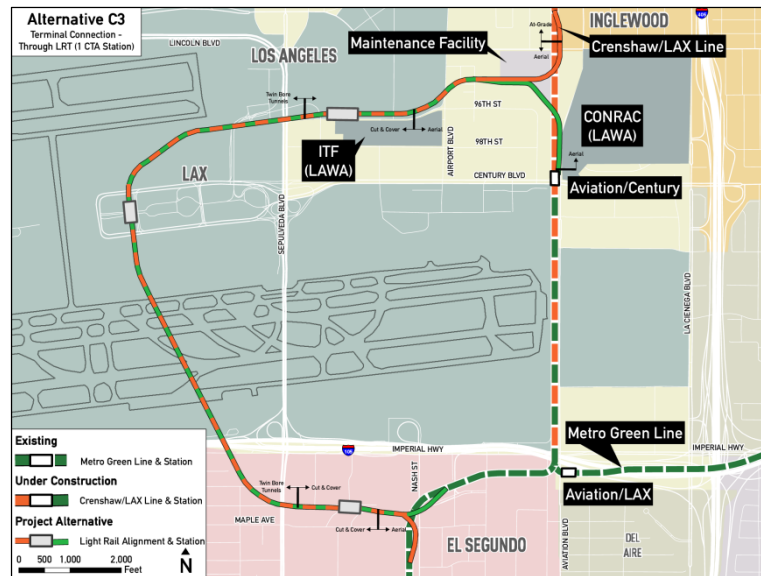
Destinations	Line Name	Peak Headways
Expo/Crenshaw ← → ITF ← → CTA	Metro Crenshaw/LAX Line	10 min.
Expo/Crenshaw ← → Redondo Beach		10 min.
Norwalk ← → ITF ← → CTA	Metro Green Line	10 min.
Norwalk ← → Redondo Beach		10 min.
ITF ← → CTA	Combined Lines	5 min.

2.3.3. Alternative C3: Through LRT, 1 Station

Figure 2-5: Alternative C3

2.3.3.1. Light Rail Alignment

This alternative is classified as a *Through LRT*, meaning that the planned Metro Crenshaw/LAX line and existing Metro Green Line would be rerouted through the CTA. From the north, the baseline Metro Crenshaw/LAX alignment would head west over Arbor Vitae Street and the maintenance facility.



Alternatively, the alignment could also be below grade under Arbor Vitae Street and the maintenance facility. The route would head west into a shared right-of-way with the Metro Green Line underground just east of Jenny Avenue. In this alternative, the LRT station at the ITF would be underground and oriented east-west to accommodate the *Through LRT* alignment. Just west of the ITF station, the shared right-of-way would enter twin-bore tunnels under Sepulveda Boulevard.

The alignment would remain below-grade as it turns south and enters the station below West Way at the west end of the CTA. The twin-bored tunnel would then continue south under the south runways, the I-105 freeway, and head east under Sepulveda Boulevard. The line would then enter the Sepulveda station adjacent to the Maple Avenue. The alignment would then become aerial west of Nash Street and then connect to the existing Metro Green Line aerial structure.

From Aviation/Century Station, the Metro Green line would go west parallel to the maintenance facility. Just west of the maintenance facility, the Metro Green Line would meet the Metro Crenshaw/LAX Line in the previously described shared right of way. The lines split south of the I-105 freeway where the Metro Green line heads east back to Aviation/LAX and ultimately Norwalk, and the Crenshaw/LAX Line turns south to Redondo Beach.

2.3.3.2. Automated People Mover Alignment

Alternative C3 would not include an APM because in this option transit passengers on the Metro Crenshaw/LAX and Metro Green Lines could directly connect to the Airport CTA without transferring. The station within the CTA would be within walking distance of two-thirds of the terminal. The other could be reached with LAWA shuttle A bus.

2.3.3.3. Connections

No connections between an APM and the LRT system would be necessary because this alternative connects the Airport CTA to Metro Crenshaw/LAX and Metro Green Lines directly.

2.3.3.4. Operations

In this alternative, the Metro Crenshaw/LAX Line and the Metro Green Line would both run with five-minute peak headways. As a result, stations along the shared right-of-way—the ITF, CTA, and Sepulveda stations—would have 2.5 minute peak headways. This is summarized in the following table.

Table 2-7: Alternative C3 Operating Plan

Destinations	Line Name	Peak Headways
Expo/Crenshaw ← → CTA ← → Redondo Beach	Metro Crenshaw/LAX Line	5 min.
Norwalk ← → CTA ← → Aviation/Century	Metro Green Line	5 min.
ITF ← → CTA	Combined Lines	2.5 min.

2.3.4. Alternative C4: Through LRT, 2 CTA Stations

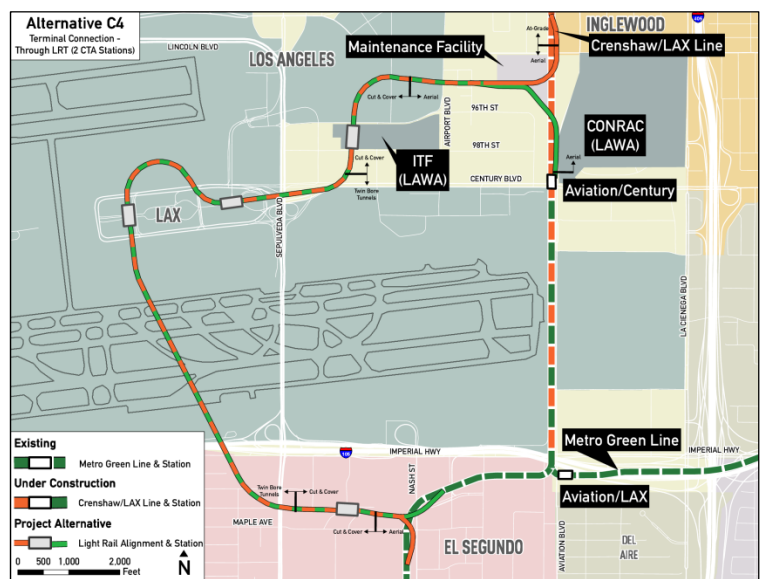
2.3.4.1. Light Rail Alignment

Alternative C4 has two light-rail stations in the CTA: one to the west and one to the east.

To accommodate a station at either end of the CTA, the alignment must be slightly adjusted from Alternative C3. From the north, the Metro Crenshaw/LAX Line baseline alignment would head west over the proposed maintenance facility.

This portion of the alignment could also be underground below the maintenance facility and Arbor Vitae Street. The line would then enter the below-grade shared right-of-way before heading south into a north-south oriented ITF station. Light-rail trains would then turn west and enter twin-bore tunnels under Century Boulevard and Sepulveda Boulevard and arrive at the east-west oriented station under the eastside of the

Figure 2-6: Alternative C4



CTA. The alignment would then proceed north under the northern terminals and loop back south to the western CTA station. The alignment would continue south under the southern runways and the I-105 Freeway and head east to the Sepulveda station. The Metro Crenshaw/LAX Line would then travel south on an aerial alignment to Redondo Beach.

In Alternative C4, the Metro Green Line would follow a loop under the CTA with one stop at either end of the terminal area. The Metro Green Line would share the right-of-way with the Metro Crenshaw/LAX Line from the Sepulveda station, under the CTA, to just east of the ITF station. After the ITF station, the Metro Green Line would complete the Airport loop and travel south to Aviation/LAX Station. However, the LAWA shuttle A bus would continue to operate.

2.3.4.2. Automated People Mover Alignment

Alternative C4 would not include an APM because in this option transit passengers on the Metro Crenshaw/LAX and Metro Green Lines could directly connect to the Airport CTA without transferring.

2.3.4.3. Connections

No connections between an APM and the LRT system would be necessary because this alternative connects the Airport CTA to the Metro Crenshaw/LAX and Metro Green Lines directly.

2.3.4.4. Operations

In Alternative C4, the Metro Green Line and Metro Crenshaw/LAX Line both operate with five-minute peak headways. As a result, in the shared right-of-way under the airport, between the ITF and Sepulveda stations, passengers could expect 2.5-minute peak headways. This is summarized in the following table.

Table 2-8: Alternative C4 Operating Plan

Destinations	Line Name	Peak Headways
Expo/Crenshaw ← → CTA ← → Redondo Beach	Metro Crenshaw/LAX Line	5 min.
Norwalk ← → CTA ← → Aviation/Century	Metro Green Line	5 min.
ITF ← → CTA	Combined Lines	2.5 min.

3. PERFORMANCE MEASURES

The Technical Refinement Study utilizes performance measures similar to those presented in the 2012 AA Report. Table 3-1 summarizes the detailed performance measures for the following evaluation criteria:

- **Passenger Convenience and Travel Time** – Transfers and vertical changes inform an understanding of the quality of the Metro passenger experience. This is supplemented by an assessment of systemwide travel times, which strongly influence the overall attractiveness of transit compared to other modes.
- **Environmental Factors** – An initial environmental screening will identify the potential short-term construction impacts and long-term operational impacts associated with each alternative.
- **Compatibility with Other Projects** – Integration with future transit and airport plans is paramount in ensuring the project is compatible with future Metro and LAWA goals.
- **Engineering/Physical Feasibility** – The physical constructability of each alternative will be determined to ensure that the alternatives fit within acceptable parameters for utility and construction disruption, and airport constraints.
- **Cost and Financial Feasibility** – Capital construction costs for each alternative, which will include the construction of the guideway, stations, vehicles, and supporting facilities, determine the potential fiscal impacts of each alternative. As noted previously, the AMC project only has approximately \$200 million allocated as part of Measure R. This project is a cooperative effort with LAWA. It is anticipated they will be a funding partner.

Additional performance measures, such as ridership, are still being refined and will be presented in a future report.

Table 3-1: Evaluation Criteria and Performance Measures

Evaluation Criteria	Performance Measures
Passenger Convenience and Travel Time	<ul style="list-style-type: none"> • Number of transfers • Number of level changes • Regional travel time to LAX • Travel time to terminals from ITF • Travel time for non-airport destined passengers
Environmental Factors	<ul style="list-style-type: none"> • Construction Impacts • Historic Resources • Land Acquisition
Compatibility with Other Projects	<ul style="list-style-type: none"> • Airport's current and future projects • Metro's current and future projects • Adjacent cities/specific plan areas
Engineering/Physical Feasibility	<ul style="list-style-type: none"> • Parking garage foundations • Roadway columns and foundations • Utilities • Geotechnical, hazardous materials and soils • Air spaces/Runway Projection Zones • Operability
Cost and Financial Feasibility	<ul style="list-style-type: none"> • Total capital cost of APM • Total capital cost of LRT • Total operating cost of APM • Total operating cost of LRT

3.1. PASSENGER CONVENIENCE AND TRAVEL TIME

Passenger convenience is an important determinant influencing how a passenger decides to travel to LAX. Passenger convenience is measured by comparing the number of transfers, number or level changes and changes in travel times. Figure 3-1 through Figure 3-3 provide a comparison of the alternatives based on these performance measures. Other factors, including the specific travel mode(s) to the airport and trip origin may also contribute to overall passenger convenience.

Figure 3-1: Passenger Convenience






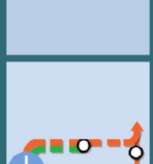
Alternative Connection Types				
			Transfers	Level Changes
A		Aviation Century Connection	1	3
B		ITF Connection	1	3
C1		Terminal Connection – LRT Branch	0-1	2 - 3
C2			0	2
C3		Terminal Connection – Through LRT	0-1	2
C4			0	2

Figure 3-2: Travel Time Savings

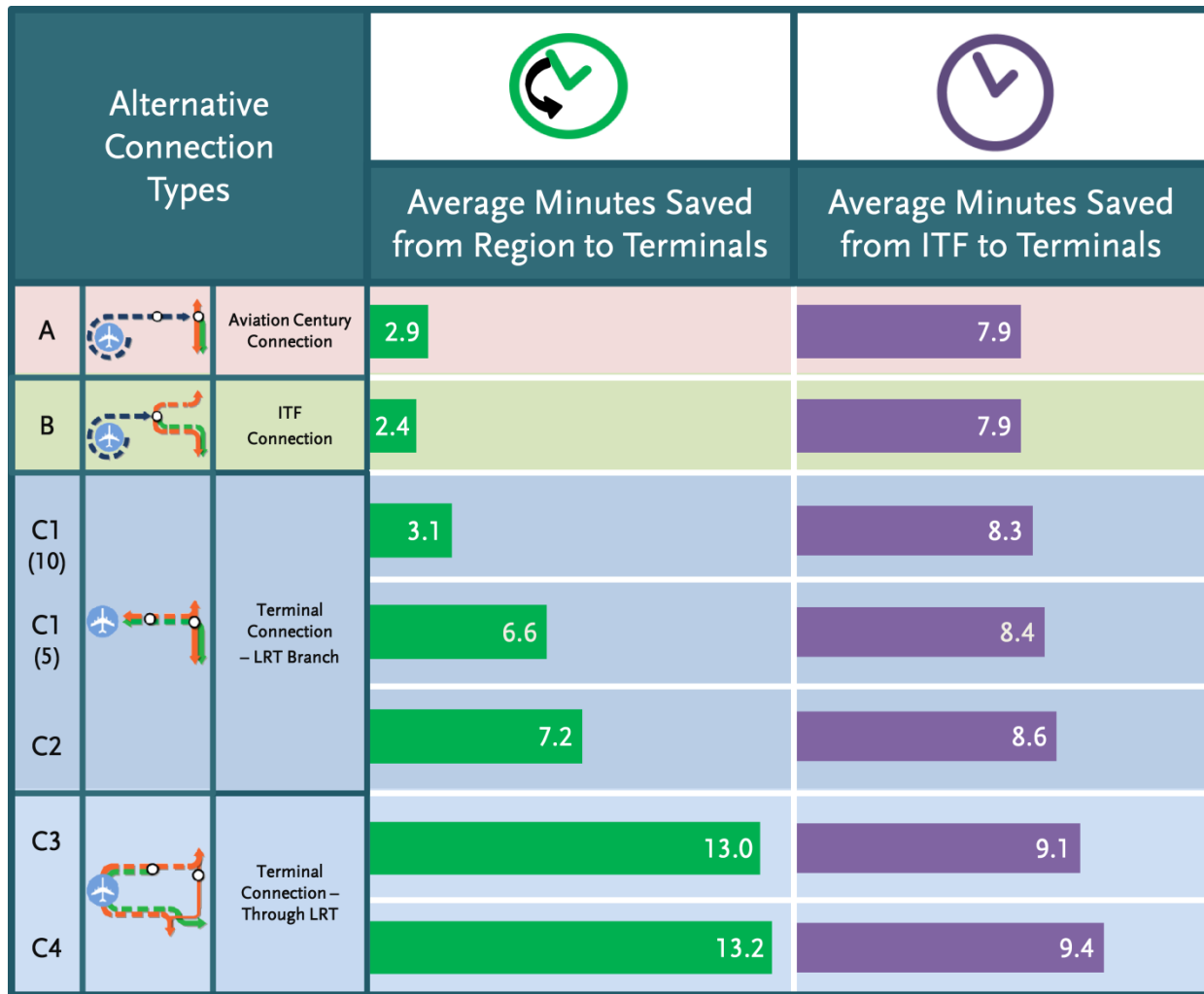
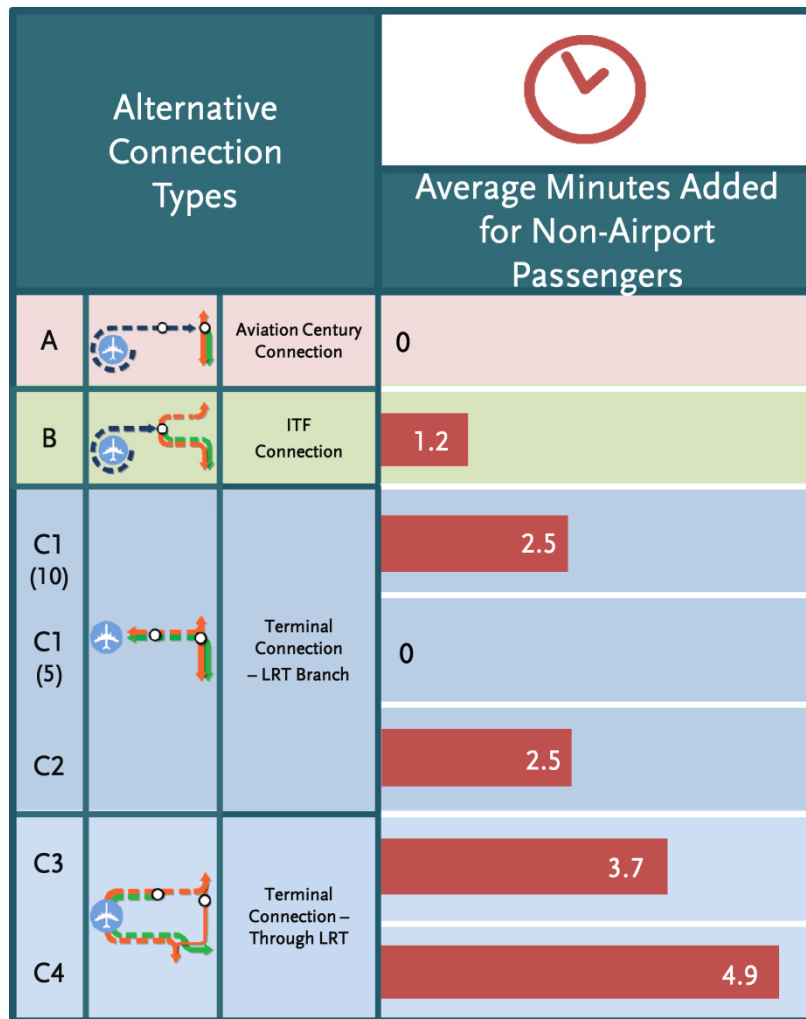


Figure 3-3: Travel Time Added for Non-Airport Passengers



In comparing the alternatives, the following conclusions related to passenger convenience can be drawn:

- Alternative C4 (Through LRT, 2-Station) provides the highest level of overall passenger convenience based on having no transfers, the second shortest walk distance to the terminals and the greatest travel time savings of all alternatives.
- Having fewer transfers and shorter walking times and distances also contributes to increased passenger convenience to the airport. Additionally, having a LRT station in the CTA contributes to higher overall passenger convenience but having two LRT stations in the CTA enhances passenger convenience even more.
- Alternatives A and B provide the lowest level of passenger convenience. Both alternatives have the highest number of level changes, transfers and the lowest travel time savings from ITF to the terminals.
- Alternatives that reroute or branch the Metro Crenshaw/LAX and Green Lines inconvenience non-airport bound passengers by increasing their travel time due to less

frequent service or longer alignments. Alternatives C3 and C4 increase travel time for through passengers the most.

- Travel time savings reflects many of the passenger convenience metrics and strongly influences travel behavior and ridership potential. Transfers and long walking distances contribute to longer travel times. The through alternatives provide the greatest overall travel time savings, especially from a regional standpoint, which will influence the likelihood of passengers to take the Metro Rail system to the airport. However, they do increase the travel time for those passengers traveling through, but not to, the airport.

3.2. ENVIRONMENTAL FACTORS





The goal of environmental considerations is to develop solutions which protect environmental resources and communities within the Study Area.

Objectives for environmental considerations include:

- Minimize construction impacts, especially to airport operations
- Minimize impacts on sensitive and protected environmental resources
- Minimize impacts to the traffic and circulation system
- Minimize land acquisition and impacts to the community
- Avoid hazardous materials and hazardous geologic conditions
- Reduce, not add to, tailpipe emissions/non-renewable fuel consumption
- Minimize noise and vibration impacts to surrounding uses

Table 3-2 provides a preliminary comparison of the alternatives based on a number of environmental factors. All environmental impacts will be clearly identified in the EIS/EIR and mitigation measures when necessary, will be identified for each significant impact. The purpose of this discussion is to consider the environmental implications of each alternative in relation to each other and identify potential significant impacts that will need to be further addressed in the EIS/EIR. Overall, the longer the alternative, the greater the potential for significant impacts.

Table 3-2: Environmental Factors Summary

Alternative Connection Types			● Most Promising ○ Least Promising							
			Construction Impacts	Land Acquisition	Traffic (Truck Trips)	Air Quality	Hazardous Materials/ Geology	Historic Preservation	Noise/ Vibration (Operations)	Overall
A		Aviation Century Connection	●	●	●	●	●	●	●	●
B		ITF Connection	●	●	●	●	●	●	●	●
C1		Terminal Connection – LRT Branch	●	●	●	●	●	●	●	●
C2			○	●	●	●	●	●	●	●
C3		Terminal Connection – Through LRT	○	○	○	●	○	●	○	○
C4			○	○	○	●	○	●	○	○

3.2.1. Construction Impacts

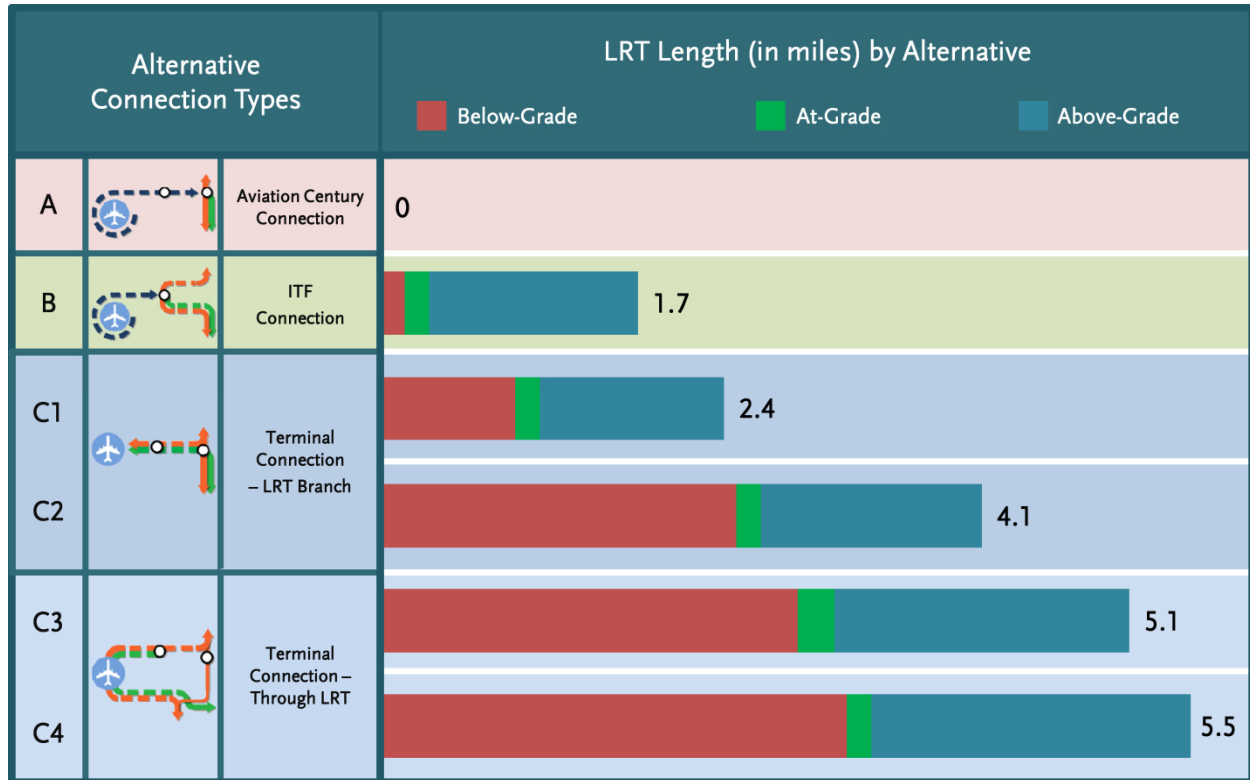
The magnitude of many of the potential construction impacts is related to the length of the alignment, particularly for tunnel alternatives. Tunnels will be constructed via tunnel boring machines (TBMs) and stations within the CTA will be trenched and mined. A single tunnel will be used for Alternative C2 and the rest of the tunnel alternatives will utilize twin-bore tunnels. This construction method will minimize construction impacts within the highly-constrained CTA. The majority of construction impacts will be at the TBM launch sites and stations, where the excavated materials will be removed and loaded on trucks for disposal. The length of each LRT alignment and the portion below grade is illustrated in Figure 3-4. This does not include the length of the APM, which is entirely aerial and will not require any tunneling activity.

Longer tunnels and a higher number of underground stations will require more extensive excavation, resulting in more truck trips, which in turn could potentially result in greater emissions and traffic impacts during construction. Extensive excavation also increases the likelihood of encountering hazardous materials or geological conditions. Therefore, Alternatives C2 through C4 have the greatest potential for construction impacts because they

involve the longest tunnel alignments. Refer to Section 3.4.5 for a more detailed discussion of the geological conditions.

Alternatives A and B do not involve any tunneling activity and therefore construction impacts will likely be less intensive than those alternatives that do involve tunneling. However, all alternatives with an APM do require at-grade construction activities within the CTA, which has the potential to affect traffic and airport operations.

Figure 3-4: LRT Profile by Alternative



3.2.2. Land Acquisition

Most of the land needed for construction of the alternatives is LAWA-owned property. However, all alternatives do require easements or acquisitions near the maintenance facility and along public rights of way. However, Alternatives C3 and C4 do necessitate additional land acquisition south of the airport property in El Segundo, located in active industrial and commercial areas.

3.2.3. Historic Preservation

The Airport Theme building has been determined eligible for the National Register of Historic Places (NRHP) and is also a City of Los Angeles Historic-Cultural Monument (HCM) (No.

570). The construction and operation of the alternatives pose two potential impacts to the Airport Theme building – vibration and visual.

The first is the potential for vibration impacts during construction and operation for the tunnel alternatives (C1 through C4). In alternatives C2 and C4, the tunnels pass within 200 feet of the Airport Theme Building, which is the closest of any of the alternatives. Further vibration analysis will be conducted during the preparation of the EIR/EIS to determine whether the construction or operation of the alternatives would create vibration impacts to the Airport Theme Building.

The second is the potential for visual impacts for the APM alternatives (Alternatives A, B and C1) due to the aerial structure. This aerial structure has the potential to alter the visual character of the Airport Theme Building. Further analysis will be conducted during the preparation of the EIR/EIS.

The 1961 Old Control Tower at the East Administrative complex is not individually eligible for listing in the NRHP because it has been extensively modified. While it does contribute to the Theme Building's setting, the Theme Building is already a NRHP-eligible resource and does not depend on the tower. Per LAWA's request, the tower has been regarded as a structure that would require special considerations during demolition, including hand-demolishing of the tower, offering building materials to historic building materials collectors or dealers, and properly photographing the building in context to memorialize it.





3.2.4. Noise and Vibration

The alternatives that include an APM component have a slightly greater potential to produce noise and vibration impacts during operation due to the proximity of the APM alignment to the hotels along Century Boulevard. The LRT alignments are mostly below-grade and the above-grade portions are not in close proximity to sensitive land uses. Further noise and vibration analysis will be conducted during the preparation of the EIR/EIS.

3.3. COMPATIBILITY WITH OTHER PROJECTS

For the most part, the proposed alternatives are compatible with projects and plans in the Study Area, including airport, transit, and land use projects. However, Alternative B is incompatible with the Metro Crenshaw/LAX line, which is in the construction phase. Table 3-3 summarizes the compatibility of AMC Alternatives with Study Area Projects and plans.

Table 3-3: AMC Compatibility with Other Project

Alternative Connection Types			LAX Master Plan 2004		Metro’s Long Range Transportation Plan				LAX Community Plan
			APM Systems	ITF	South Bay Metro Green Line Extension	Crenshaw/LAX Line\	Exposition (Expo) Line	Sepulveda Pass Project	Land Use Element
A		Aviation Century Connection	✓	✓	✓	✓	✓	✓	✓
B		ITF Connection	✓	✓	✓		✓	✓	✓
C1		Terminal Connection – LRT Branch	✓	✓	✓	✓	✓	✓	✓
C2			✓	✓	✓	✓	✓	✓	✓
C3		Terminal Connection – Through LRT	✓	✓	✓	✓	✓	✓	✓
C4			✓	✓	✓	✓	✓	✓	✓

3.3.1. Airport

The 2004 LAX Master Plan included a series of projects intended to modernize the airport. The most relevant to the AMC Project are two APM systems that could connect the airport to the Metro Rail system. The APM system is included as an alternative in this report.

LAWA recently completed its SPAS process which updates the 2004 Master Plan. The Preferred Alternative from SPAS includes an APM connecting the terminals, ITF, Metro Rail and Manchester Square. APM alternatives included in this document are consistent with these plans. LRT alternatives do not preclude a future APM system. All alternatives provide service to the ITF and are therefore consistent with LAWA’s intent to build the ITF and provide a location for facilitated transportation connection.

3.3.2. Transit

Several Metro Rail projects in the constrained element of Metro’s Long Range Transportation Plan (LRTP) are proposed in proximity of LAX, including:

- Exposition (Expo) Line: the Expo Transit Corridor is a 25.2 mile two phase project connecting the 7th Street/Metro Center Station in downtown Los Angeles to Santa Monica. The second phase of the Expo project is under construction. The Expo project would connect to the Crenshaw/LAX Line at the Expo/Crenshaw Station.
- Crenshaw/LAX Line: This transit project, currently under construction, is an 8.5 mile light rail line that extends from the Expo Line to the Metro Green Line, and terminates in Redondo Beach. This line will provide a Metro Rail station at the intersection of Aviation and Century Boulevards. This station is a potential transfer point to the APM. Additionally, several AMC alternatives consider branches or extensions directly off the Crenshaw Line into the airport. In most cases this would involve additional infrastructure added to the Crenshaw/LAX line. Alternative B would require realigning the Crenshaw/LRT line and changes to connections to the underground trench along Aviation Boulevard adjacent to LAX south runway, which presents a risk in terms of schedule and federal funding requirements.
- South Bay Metro Green Line Extension: This transit project will extend the Metro Green Line from the existing Marine Station south into the South Bay. The Metro Green Line currently includes a station that is located approximately 2.5 miles from LAX.
- Sepulveda Pass Project: all alternatives would allow for interface with the Sepulveda Pass project, which is exploring connections between the San Fernando Valley and the Westside with potential extensions as far south as LAX.

These transit projects are expected to improve transit access to the Project Study Area, and have been identified as compatible with the AMC Project.

3.3.3. Land Use

The AMC Project is compatible with the City of Los Angeles's Land Use element of the LAX Community Plan, in particular the Airport Landside area. This general area contains the CTA, Ground Transportation Center, ConRAC, and Intermodal Transportation Center (now referred to as the ITF), which are considered in this analysis.

3.4. ENGINEERING AND PHYSICAL FEASIBILITY

The engineering and physical feasibility analysis considers design challenges and identifies issues with the proposed alternatives that render it infeasible. The aerial APM and the tunnel LRT alternatives each present a unique set of design challenges, particularly in the highly constrained CTA.

3.4.1. Parking Structures and Foundations

The existing parking structures and foundations present a constraint for the aerial APM. The APM would encounter major conflicts with all existing parking structures (P1, P2A, P2, P3, P4, P5, P6 and P7) as the foundations would conflict with the columns for the elevated guideway.

The LRT alternatives that tunnel into the CTA would cross underneath the foundations for several of the garages. Alternative C1, which is the shortest tunnel, would be in close proximity to the foundations for parking structures P1 and P7, but would be designed to avoid parking structure piles. Alternative C2 would cross underneath parking structure P1 and P7 and would be in close proximity to parking structures P3 and P4. Alternative C3 would be in close proximity to parking structures P2, P3, P4 and P5 along West Way. Alternative C4 would cross underneath P1 at East Way and in close proximity to P2, P3, P4 and P5 along West Way.

3.4.2. Roadway Columns and Foundations

The aerial APM will impact second level deck foundations in Alternatives A, B and C1.

In Alternative C1, the tunnel will clear the deep second level deck piles, Control Tower foundation and the Century/Sepulveda overcrossing. The alignment will also cross underneath the Administration East Building. In Alternative C2, the single-bore tunnel will be designed at a depth to clear the second level deck foundations supporting World Way North and World Way South and the twin-bore tunnels will be designed to clear the second level deck pile foundations for the CTA return ramps at the Century Boulevard/Sepulveda Boulevard overcrossing. In Alternative C3, the tunnel will cross underneath World Way North, World Way South and in close proximity to the West Way second deck level. In Alternative C4, the tunnel will cross underneath World Way North, World Way South and underneath West Way and East Way second level deck.

3.4.3. Utilities

Utility as-builts were reviewed along the tunnel alignment to identify potential conflicts. There are no utility conflicts with the LRT tunnel segments for all alternatives provided adequate depth of cover. Along the tunnel alignment in the CTA, the majority of utilities are located within five feet of the surface. The deepest is the Central Outfall Sewer with the bottom of the pipe averaging 15 to 20 feet below the surface. The new CUP hot and chilled water supply and return lines average 30 feet below the surface. Any tunnel in the CTA associated with the LRT alternatives C1, C2, C3, and C4 are proposed with the top of the tunnel at a depth of 40 to 50 feet.

The major utility conflicts will occur at the proposed stations during the trenching construction. To construct both the West and East CTA Stations, locations of existing utilities will have to be well documented when constructing the station exterior walls. The majority of the existing utilities will have to be exposed and protected in-place by hanging underneath a temporary decking system, and kept in service during the entire construction phase. LAWA requested that all LRT alternatives be underground in the CTA in order to leave clearance for the proposed APM.

3.4.4. LAWA Identified Risk Areas

LAWA has identified three areas that they believe to be higher risk for tunneling due to vital airport operations. These areas include: the runways, World Way and terminals. LAWA is concerned that tunneling underneath these vital components of airport operations carry additional risk, which should be considered. Current tunneling technology reduces these risks and the soil conditions in the Study Area (including West Sepulveda) are similar to other locations where tunneling has been successfully completed with no noticeable settlement. Alternatives C2, C3 and C4 will require tunneling under risk areas as defined by LAWA. Further discussions with LAWA regarding risk areas will need to take place.

3.4.5. Geotechnical, Soils and Hazardous Materials

Alternatives B and C1 through C4 all require a portion of the alignment to be underground (Figure 3-4). The general depth of the tunnel is anticipated to be 40 to 50 feet below existing utilities. The potential underground segment includes twin-bored tunnels, cut and cover tunnels, portal and station excavations, cross-passages, and sump structures. Alternatives C1 and C2 do not pass beneath the runways, and alternative C3 and C4 pass beneath the south runways.

Preliminary geotechnical investigations conclude the following:

- Soils along the underground segment of the proposed alternatives consist of either older dune sand or alluvium. Groundwater is expected to be encountered below tunnel and station inverts. Perched groundwater may be encountered in excavations.
- Tunneled alternatives are deemed feasible from a geotechnical perspective.
- The presence of existing structures that are sensitive to ground deformation will dictate that earth pressure balance (EPB) and/or slurry shield tunnel boring machines (TBMs) are used for tunneling.
- Gasketed tunnel liners and safety systems at stations will be required to mitigate hazardous soil gas conditions, which will increase the cost of constructing and operating the project.
- EPB or slurry shield TBMs are well suited for the subsurface conditions along the proposed underground segments. Older dune sands, anticipated along most of the underground segments, will likely facilitate tunneling due to its predominantly uniform nature and lack of cobbles and boulders.

Refer to Appendix C for detailed geotechnical and tunneling feasibility information.

3.4.6. Airspace/Runway Protection Zone

The dedicated guideway or stations for a transit system are subject to regulations and policies established by Federal Aviation Administration (FAA) to protect the safety of runway

operations and minimize interference with air traffic control systems. In particular, off-airport routing options that encroach into areas designated as Runway Protection Zones (RPZs) may result in significant issues. All alternatives under consideration avoid the RPZ.

3.4.7. Operability

With the exception of Alternative A, all of the alternatives under consideration involve branching and merging the Crenshaw/LAX, which is under construction, and the existing Green Line LRT lines, creating potentially complex operating conditions. The analysis of the operations feasibility focused on three key issues:

- Terminal Capacity
- Junction Operations
- Yard Access

Provided the infrastructure requirements at the junctions and yard leads are met, all alternatives can feasibly operate as proposed. Alternative C1 with five minute headways would require additional infrastructure investment at the LAX terminal to accommodate the frequent headways.

3.4.7.1. Terminal Capacity

The operating analysis began by determining the terminal capacity for three LRT operating configurations:

- Stub-End (Alternative C1)
- Loop (Alternative C2)
- Through (Alternatives C3 and C4)

Alternatives A and B do not involve terminal stations in the CTA area, and therefore were not part of the terminal capacity analysis.

Table 3-4 presents the maximum headways that could be supported along each of the three branches (Green Line Norwalk-LAX, Crenshaw Redondo Beach-LAX and Crenshaw Expo-LAX) with each of these four terminal configurations. The loop and through alternatives can accommodate five minute headways on each branch (Crenshaw/LAX and Green Line) because the configurations of these two scenarios allow the CTA station(s) to act like a mainline station, rather than a traditional terminal in which a train must reverse direction to proceed back to the other end of the line.

With tail and pocket tracks, a two-track stub-end configuration can accommodate a maximum eight-minute headway on each of the three branches. In order to accommodate five-minute headways on each of the branches, a minimum of three terminal tracks is required (four tracks are recommended to allow for sufficient dwell times). Due to unique passenger requirements at an airport station, it is recommended that there be platforms on both sides of the track to allow passengers with luggage adequate time to alight and board trains.

In order to provide five-minute service on each of the three branches, the minimum configuration is three tracks and four platforms, which results in a station dimension of approximately 183 feet by 1412 feet, which is significantly more space to excavate within the CTA than would be required under the ten minute headway scenario, adding to costs and construction impacts.

Table 3-4: Maximum Headways

Terminal Configuration	Practical Headway on Each Branch
Stub-End no tail tracks	11.25 min
Stub-End with tail tracks and pocket tracks	>8.18 min
Loop	5 min
Through	5 min

3.4.7.2. Junction Operations

There are two critical junctions in the AMC operating system – AMC to Crenshaw/LAX and Crenshaw/LAX to Green Line. To determine whether the alternatives could feasibly operate through these two junctions, two operating simulations were run. An operations simulation was run for the alternatives that best represented the operations challenges posed across the alternatives. These scenarios are Alternative C1 with ten minute headways and Alternative C1 with five minute headways and a three-track terminal. Because these alternatives require a stub-end configuration, they present the most limiting operations scenarios. The operations simulation shows that both of these scenarios could feasibly operate through the junctions, although the five minute scenario has very little leeway and any small shift in the schedule would have a cascading effect on all operations through the junctions and would therefore require upgrades to the junction.

3.4.7.3. Yard Access

The third operations issue is yard access – moving trains in and out of the yard at the beginning and end of the day. The same operations simulations were run to determine the operability of yard access without a western lead – meaning all trains would be forced to enter and exit the yard through the Crenshaw/LAX line. The operations analysis concluded that the yard access lead could feasibly operate under either scenario, but again the five minute scenario could quickly experience a lot of conflict/delays, if there are any slight changes in the schedule and would therefore require upgrades to the yard lead.

Table 3-5: Engineering/Physical Feasibility Summary

Alternative Connection Types			● Most Promising ○ Least Promising								
			Parking Structure Foundation	Roadway Columns and Foundations	Utilities	Geotechnical and Soils	Hazardous Materials	Construction Tolerances/ Soil Settlement	Air spaces/ Runway Projection Zones	Operability	Overall
A		Aviation Century Connection	○	○	◐	●	●	●	●	●	●
B		ITF Connection	○	○	◐	●	●	●	●	◐	●
C1		Terminal Connection – LRT Branch	◐	○	◐	◐	◐	◐	●	◐	◐
C2			○	○	◐	◐	○	◐	●	◐	◐
C3		Terminal Connection – Through LRT	◐	○	◐	○	○	○	●	◐	○
C4			○	○	◐	○	○	○	●	◐	○

3.5. COST AND FINANCIAL FEASIBILITY

3.5.1. Capital Costs

Figure 3-5 presents the capital cost estimates for the alternatives and identifies the amounts attributed to the APM and the LRT portions of the project. Because all alternatives exceed the \$200 million allocated to the Project in Measure R, additional sources of funding will be needed for all alternatives. Alternative A would be funded by LAWA.

The cost of the stand-alone APM connecting at Aviation/Century in Alternative A is approximately \$1.1 billion and ranks as the lowest costing alternative. Alternatives B and C1 combine a LRT route in addition to an APM route. However, the APM cost in these alternatives is slightly reduced (\$.8 billion) because it terminates at the ITF instead of extending to the ConRAC.

For the LRT alignment, the costs are largely driven by how much would have to be in a tunnel since longer tunnels result in higher costs. Therefore, Alternative C4 has one of the highest costs at \$3.6 billion. However, although not the longest tunnel, Alternative C1 with five-minute headways has the highest overall cost at \$4 billion due to the additional terminal station infrastructure required within the CTA to accommodate the frequent headways.

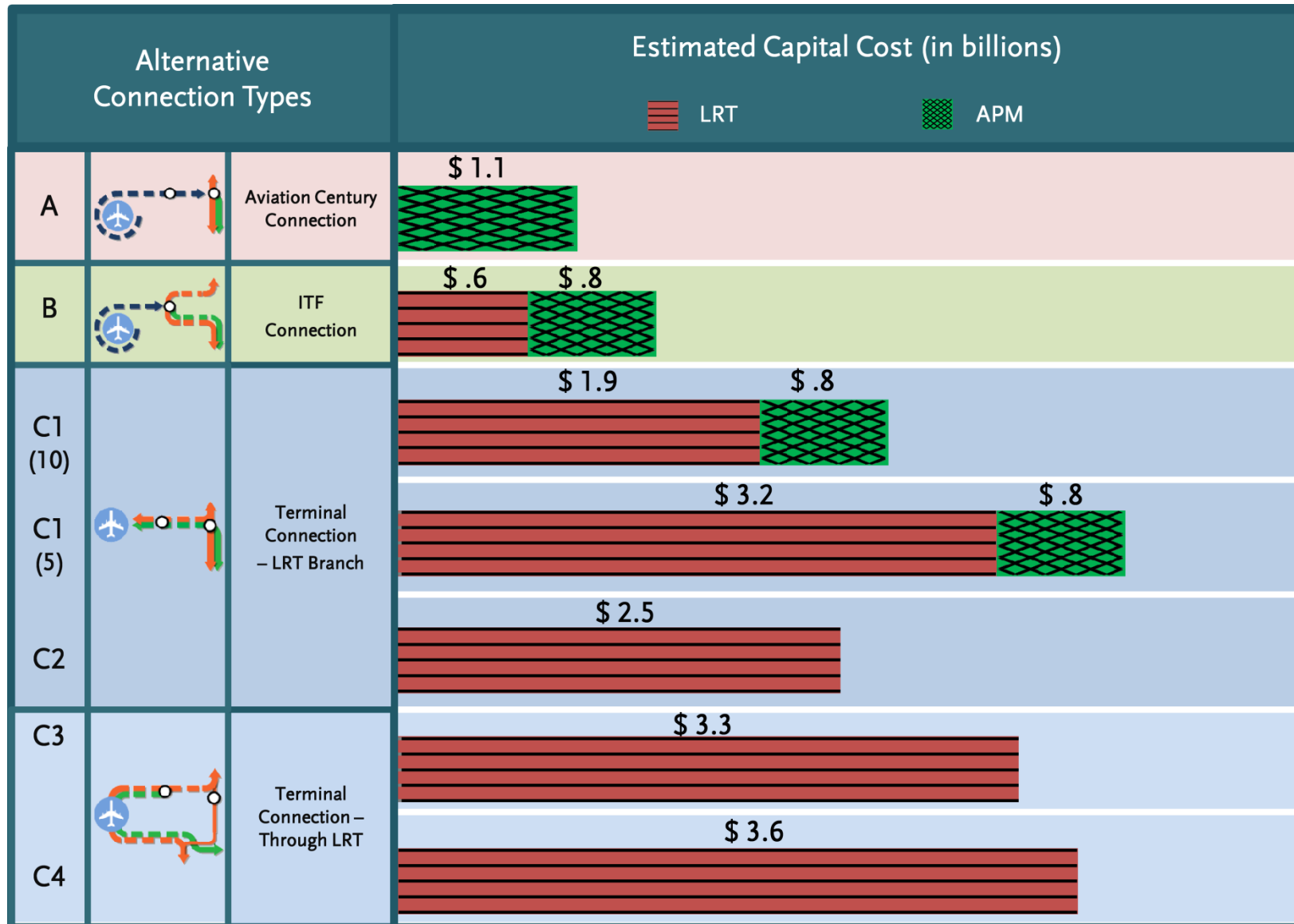
The detailed capital cost estimates are available in Appendix B. Each LRT alternative has been broken into On-CTA and Off-CTA segments to allow for easier estimation of quantities and to account for design options. Costs for some alternatives have been presented as ranges because multiple segments may apply to the overall alternative. For example, an alternative may connect through the Southwestern Yard either underneath via a trench or above via an aerial structure.

This capital cost estimate utilizes the most current unit cost data available locally and is priced in 2013 US dollars. Several other similar cost estimates have been examined to provide further validation of the unit costs used in this estimate. These projects include the 2010 Charlotte Area Transit System's LYNX Blue Line Extension, the 20 Riverside County Transportation Commission's Perris Valley Line Commuter Rail and the 2012 Caltrans Contract Cost Data from Districts 7 and 12 which reflect recent bid experience.

These were supplemented with other sources and studies to confirm accuracy of costs or to provide specific cost information. Additional sources include the 2008 Bay Area Rapid Transit's Silicon Valley Rapid Transit Project P0504 Western Yard & Shops 65 Percent, the 2010 Metro planning-level estimates for the Crenshaw/LAX Transit Corridor and Regional Connector Transit Corridor projects, San Francisco Muni China Town Station estimates, 2011 Westside Subway Extension Wilshire/Western to Wilshire/La Brea cost estimates, Seattle Northgate LRT Link bid results, as well as other sources such as local vendors and historical data.

Contingencies have been applied to the cost estimates. These include individual contingencies, as well as an overall unallocated contingency for the project. Contingency percentages have been calculated using recent cost estimating experience as a guide: Allocated contingencies, aka design allowances range from 15 percent for vehicles and 25 percent for maintenance facilities to 40 percent for utility relocation. The contingencies for most items fall within 30 percent and 35 percent.

Figure 3-5: Estimated Capital Costs



Changes in the cost estimate since the 2012 AA Report include:

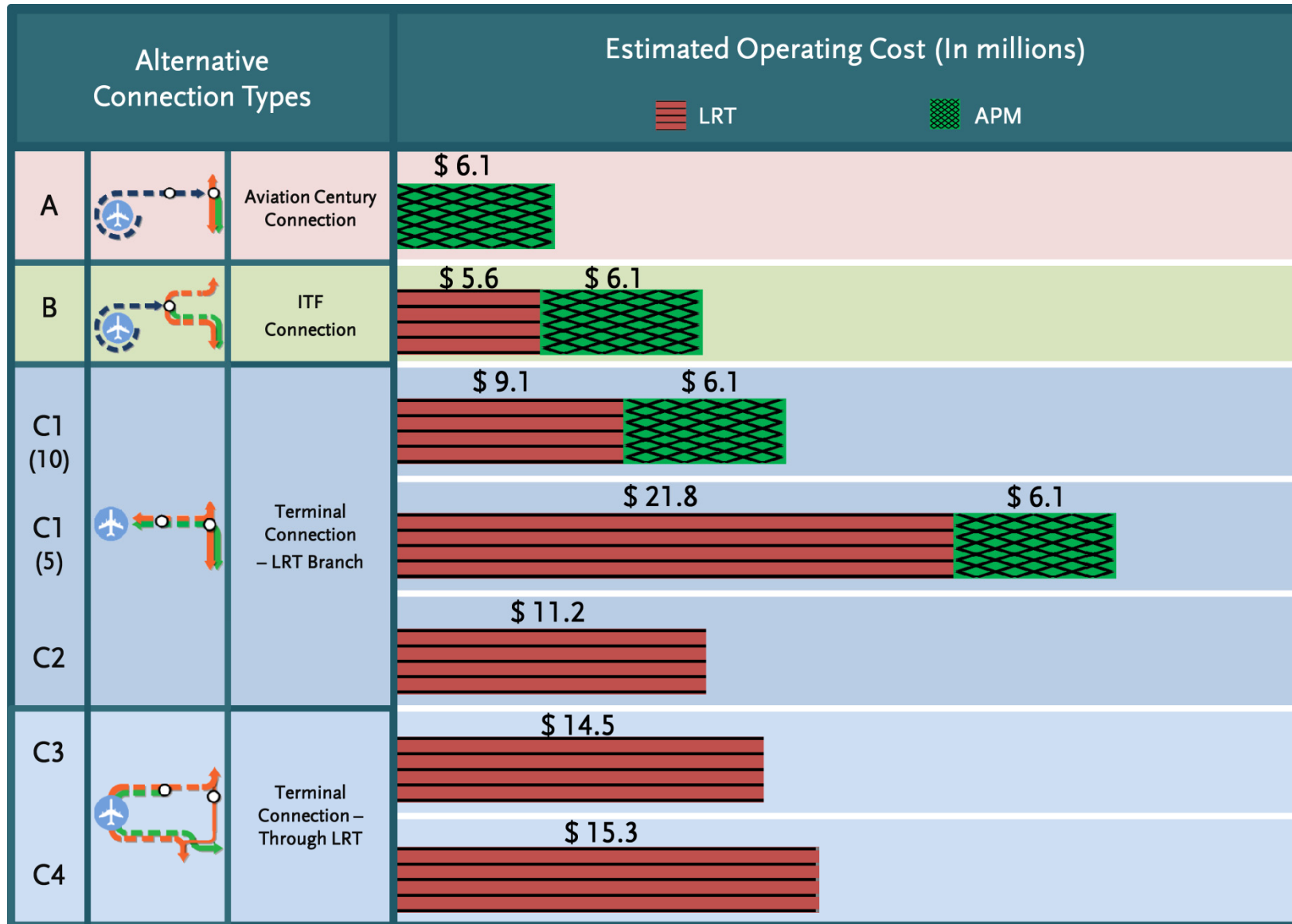
- Addition of a rail connection to the Crenshaw/LAX line to the north through the Southwestern Yard
- Addition of a stub end alignment in the eastern portion of the CTA (for Alternative C1)
- Through station and associated alignment shifted from East Way to West Way (for Alternative C3)
- Alternatives with two CTA stations were shifted to accommodate minimum turning radii of tunnel boring machines and to avoid placing east-west station underneath deep roadway foundations near TBIT
- CTA stations will be partially trenched and partially mined instead of completely trenched and will be deeper in order to bore tunnels deep enough
- Grade separation at Airport Boulevard in place of an at-grade crossing
- Addition of right-of-way costs
- More specific unit costs for aerial structures
- Extended Crenshaw/LAX tail track

Refer to Appendix B for detailed cost estimate explanations.

3.5.2. Operating Costs

The estimated operating costs for the alternatives are presented in Figure 3-6. The operating costs were calculated off the operating plan parameters (headway, etc.), not a precise operating plan. In general, longer alignments and more frequent headways result in higher operating costs. Alternative C1 with five minute headways has the highest overall operating cost due to the frequent LRT headways as well as layering the APM on top of the LRT. The two through alternatives, Alternatives C3 and C4, also have relatively higher incremental operating costs due to their length. Most LRT alternatives are more expensive to operate than the APM alternatives because the APM is automated, reducing labor costs. Since the alternatives that branch Metro Rail into the airport would build on existing transit service, the operating cost is the incremental increase compared to the No Build or “No Project” scenario.

Figure 3-6: Estimated Operating Costs (annual)



4. SUMMARY AND NEXT STEPS

All of the proposed alternatives meet the Project's Purpose and Need as stated in. However, the alternatives do vary in terms performance the ability to address program goals (Figure 4-1). Alternatives that provide a direct LRT connection into the CTA provide faster regional transit travel time and more convenient regional connections to LAX more than alternatives that force a transfer but may also involve slight increases in travel time for non-airport bound passengers. Conversely, the APM alternatives best serve the travel needs of passengers and employees getting around within the airport area.

The alternatives that best serve the regional travel needs of air passengers and employees are also the most expensive and require tunneling within the CTA. These longer tunnel alignments also pose greater potential for environmental impacts and design challenges.

Of the alternatives that do not tunnel into the CTA, Alternative A is less expensive than Alternative B. Alternative B involves the additional connection junctions off the Crenshaw/LAX line and underground construction (cut-and-cover and possible deep bore tunneling). These may add cost and schedule to the line, which is currently going into construction. Furthermore, Alternative B inconveniences through transit riders (non-airport bound passengers) by adding travel time to non-CTA bound trips. Metro will work closely with LAWA and the Crenshaw/LAX Construction Team during the environmental phase to refine the design of all the alternatives under consideration.

Metro will continue to work closely with LAWA to identify a transit connection to LAX that best serves Metro Rail passengers and LAWA's need to connect several transportation facilities identified in the SPAS.

Figure 4-1: Summary of Findings

Alternative Connection Types			● Highest Performing ○ Lowest Performing				
			Passenger Convenience and Travel Time	Environmental Factors	Compatibility with Other Projects	Engineering/Physical Feasibility	Cost and Financial Feasibility
A		Aviation Century Connection	●	●	●	●	●
B		ITF Connection	●	●	●	●	●
C1		Terminal Connection – LRT Branch	●	●	●	●	○
C2			●	●	●	●	○
C3		Terminal Connection – Through LRT	●	○	●	○	○
C4			●	○	●	○	○

APPENDICES

APPENDIX A

Engineering Drawings

APPENDIX B

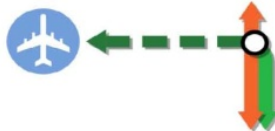

Capital Cost Estimate Memorandum

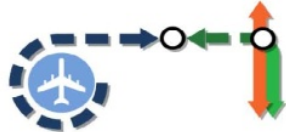
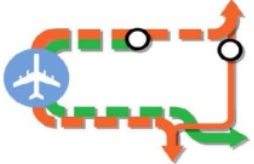
APPENDIX C

Geotechnical Feasibility Evaluation Memorandum

APPENDIX D

Flow Chart of Alternatives Considered

Alternatives Identified for Initial Screening	Stage I Screening	Promising Packed Alternatives	Stage II Screening	Alternatives Recommended From AA for Further Study	Interim Step	Technical Refinement Alternatives
No Build				No Build		No Build
TSM				TSM		
Direct LRT Branch				Direct LRT Branch		Direct LRT Branch
OFF-Airport Century Blvd 1994 SEIR Alternative 98th Street 98th Street North 96th Street 96th Street North		Century Blvd 98th Street North		98th Street North		
ON-Airport Center Way – 1 Station Aerial Center Way – 1 Station Tunnel Through LAX – 1 Station Tunnel Center Way – 2 Station Aerial Center Way – 2 Station Tunnel Loop – 3 Station Aerial Loop – 3 Station Tunnel Loop – 4 Station Aerial Loop – 5 Station Aerial Loop – 8 Station Aerial		Center Way – 2 Station Aerial Center Way – 2 Station Tunnel Loop – 3 Station Aerial		Center Way – 2 Station Aerial Center Way – 2 Station Tunnel Loop – 3 Station Aerial		Alt C1: Terminal Connection – LRT Branch (1 Station) Alt C2: Terminal Connection – LRT Branch (2 Stations)
Circulator				Circulator		Circulator
OFF-Airport 98th Street North Century Blvd 98th Street 96th Street 96th Street North		Century Blvd 98th Street North		APM- 98th Street North		
ON-Airport Center Way – 1 Station Aerial Center Way – 1 Station Tunnel Through LAX – 1 Station Tunnel Center Way – 2 Station Aerial Center Way – 2 Station Tunnel Loop – 3 Station Aerial Loop – 3 Station Tunnel Loop – 4 Station Aerial Loop – 5 Station Aerial Loop – 8 Station At-Grade		Center Way – 2 Station Aerial Center Way – 2 Station Tunnel Loop – 3 Station Aerial Loop – 8 Station At-Grade		Center Way – 2 Station Aerial Center Way – 2 Station Tunnel Loop – 3 Station Aerial Loop – 8 Station At-Grade		Alt A: Aviation Century Connection

Alternatives Identified for Initial Screening	Stage I Screening	Promising Packed Alternatives	Stage II Screening	Alternatives Recommended From AA for Further Study	Interim Step	Technical Refinement Alternatives
Intermediate LRT and Circulator						Intermediate LRT and Circulator
OFF-Airport Century Blvd 98th Street 1994 SEIR Alternative 98th Street North 96th Street 96th Street North	○ ○ ● ○ ○ ○	1994 SEIR Alt 98th Street North	○ ○			 <p>Alt B: Intermodal Transportation Facility (ITF) Connection</p>
ON-Airport Center Way – 1 Station Aerial Center Way – 1 Station Tunnel Through LAX – 1 Station Tunnel Center Way – 2 Station Aerial Center Way – 2 Station Tunnel Loop – 3 Station Aerial Loop – 3 Station Tunnel Loop – 4 Station Aerial Loop – 5 Station Aerial Loop – 8 Station At-Grade	○ ○ ○ ● ● ○ ○ ○ ○ ○	Center Way – 2 Station Aerial Center Way – 2 Station Tunnel Loop – 3 Station Aerial Loop – 8 Station At-Grade	○ ○ ○ ○			
Modified LRT Trunk						Modified LRT Trunk
OFF-Airport Century Blvd 1994 SEIR Alternative 98th Street Through LAX Airport Blvd 96th Street North 98th Street North 96th Street	○ ○ ○ ● ● ○ ○ ○	Airport Blvd Through LAX	○ ●	Through LAX	○	 <p>Alt C3: Terminal Connection – Through LRT (1 Station) Alt C4: Terminal Connection – Through LRT (2 Stations)</p>
ON-Airport Center Way – 1 Station Aerial Center Way – 1 Station Tunnel Through LAX – 1 Station Tunnel Center Way – 2 Station Aerial Center Way – 2 Station Tunnel Loop – 3 Station Aerial Loop – 3 Station Tunnel Loop – 4 Station Aerial Loop – 5 Station Aerial Loop – 8 Station At-Grade	○ ○ ● ● ○ ○ ○ ○ ○	Through LAX – 1 Station Tunnel Center Way – 2 Station Aerial Center Way – 2 Station Tunnel Loop – 3 Station Aerial Loop – 8 Station At-Grade	● ○ ○ ○	Through LAX – 1 Station Tunnel	●	