

**METROPOLITAN TRANSPORTATION AUTHORITY**

**METRO RED LINE SEGMENT 3  
EAST SIDE EXTENSION**

**PRELIMINARY ENGINEERING  
DESIGN REPORT**



**March 31, 1994**

**Prepared By**

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**TABLE OF CONTENTS**

**EXECUTIVE SUMMARY** ..... 1

**SECTION 1: STATION DESIGN AND ARCHITECTURE** ..... 1

    1.1 INTRODUCTION ..... 1

    1.2 STATION DESIGN ..... 1

    1.3 STATION ARCHITECTURE ..... 3

    1.4 STATION ENTRANCES ..... 4

    1.5 STATION LOCATION AND ENTRIES ..... 4

        1.5.1 Little Tokyo Station ..... 4

        1.5.2 First/Boyle Station ..... 5

        1.5.3 Brooklyn/Soto Station ..... 6

        1.5.4 First/Lorena Station ..... 6

        1.5.5 Whittier/Rowan Station ..... 6

        1.5.6 Whittier/Arizona Station ..... 7

        1.5.7 Whittier/Atlantic Station ..... 7

**SECTION 2: CIVIL DESIGN** ..... 8

    2.1 INTRODUCTION ..... 8

    2.2 LINE SECTION: UNION STATION LITTLE TOKYO STATION ..... 8

        2.2.1 Station: Little Tokyo ..... 9

    2.3 LINE SECTION: LITTLE TOKYO STATION TO FIRST/BOYLE STATION . 10

        2.3.1 Station: First/Boyle ..... 11

    2.4 LINE SECTION: FIRST/BOYLE STATION TO BROOKLYN/SOTO STATION ..... 11

        2.4.1 Station: Brooklyn/Soto ..... 12

    2.5 LINE SECTION: BROOKLYN/SOTO STATION TO FIRST/LORENA .... 12

        2.5.1 Station: First/Lorena ..... 12

    2.6 LINE SECTION: FIRST/LORENA STATION TO WHITTIER/ROWAN .... 12

        2.6.1 Station: Whittier/Rowan ..... 13

    2.7 LINE SECTION: WHITTIER/ROWAN STATION TO WHITTIER/ARIZONA STATION ..... 13

        2.7.1 Station: Whittier/Arizona ..... 13

    2.8 LINE SECTION: WHITTIER/ARIZONA TO WHITTIER/ATLANTIC ..... 14

        2.8.1 Station: Whittier/Atlantic ..... 14

**SECTION 3: ELECTRICAL** ..... 15

    3.1 INTRODUCTION ..... 15

    3.2 SPECIFIC FEATURES AT EACH STATION ..... 16

**SECTION 4: MECHANICAL SYSTEMS** ..... 17

- 4.1 INTRODUCTION ..... 17
- 4.2 SYSTEMWIDE EQUIPMENT ..... 17
- 4.3 VENTILATION ANALYSIS ..... 19

**SECTION 5: OPERATIONS AND MAINTENANCE PLANNING** ..... 21

- 5.1 INTRODUCTION ..... 21
- 5.2 SERVICE PLAN ..... 21
- 5.3 TRAVEL TIMES ..... 23
- 5.4 FLEET SIZE ..... 24
- 5.5 CROSSOVERS ..... 27
- 5.6 TAIL TRACKS ..... 28
- 5.7 YARD ACCESS ..... 28
- 5.8 UNION STATION YARD LEADS FOR TURNBACK ..... 29
- 5.9 TRANSPORTATION FACILITIES ..... 29

**SECTION 6: RIGHT-OF-WAY** ..... 31

- 6.1 INTRODUCTION ..... 31
- 6.2 LITTLE TOKYO STATION ..... 31
- 6.3 FIRST/BOYLE STATION ..... 32
- 6.4 BROOKLYN/SOTO STATION ..... 32
- 6.5 FIRST/LORENA STATION ..... 32
- 6.6 WHITTIER/ROWAN STATION ..... 33
- 6.7 WHITTIER/ARIZONA STATION ..... 33
- 6.8 WHITTIER/ATLANTIC STATION ..... 33

**SECTION 7: TUNNELING** ..... 34

- 7.1 INTRODUCTION ..... 34
- 7.2 STUDIES AND INVESTIGATIONS PERFORMED ..... 34

**SECTION 8: TRACKWORK** ..... 37

- 8.1 INTRODUCTION ..... 37
- 8.2 TRACK MATERIAL ..... 37
  - 8.2.1 Running Rail ..... 37
  - 8.2.2 Rail Fastening Systems ..... 38
  - 8.2.3 Special Trackwork ..... 38
  - 8.2.4 Bumping Posts ..... 39

**SECTION 9: UTILITIES AND POTHOLING** ..... 40

- 9.1 INTRODUCTION ..... 40
- 9.2 UNIQUE UTILITY DESIGN CASES ..... 41
  - 9.2.1 Little Tokyo Station ..... 41
  - 9.2.2 First/Boyle Station ..... 41

9.2.3 First/Lorena Station .....	41
<b>SECTION 10: STRUCTURAL .....</b>	<b>42</b>
10.1 INTRODUCTION .....	42
10.2 STRUCTURAL DESIGN DEFINITION .....	42
10.3 STRUCTURAL CODES AND CRITERIA .....	43
10.3.1 Codes and Criteria .....	43
10.3.2 Material Properties .....	43
10.4 LOADS .....	43
<b>SECTION 11: SYSTEM INTEGRATION .....</b>	<b>45</b>
<b>SECTION 12: SYSTEMS .....</b>	<b>46</b>
12.1 INTRODUCTION .....	46
12.2 TRACTION POWER .....	47
12.2.1 Train Characteristics .....	51
12.3 TRAIN CONTROL .....	51
12.4 COMMUNICATIONS .....	53
<b>SECTION 13: VALUE ENGINEERING .....</b>	<b>56</b>
13.1 INTRODUCTION .....	56
13.2 610-FOOT STATION BOX .....	56
13.3 ALIGNMENT STUDIES .....	57
13.4 FIRST/LORENA STATION .....	57
13.5 LITTLE TOKYO STATION .....	58
<b>SECTION 14: DELIVERABLES .....</b>	<b>60</b>
14.1 INTRODUCTION .....	60
14.2 GEOTECHNICAL .....	60
14.3 OPERATIONS AND MAINTENANCE .....	60
14.4 RIGHT-OF-WAY .....	60
14.5 SYSTEMS INTEGRATION .....	61
14.6 SYSTEMS .....	61
<b>APPENDIX: PRELIMINARY ENGINEERING SPECIFICATIONS - TABLE OF CONTENTS</b>	

**EXECUTIVE SUMMARY**

The Metro Red Line Segment 3 East Side Extension, undertaken by the Los Angeles County Metropolitan Transportation Authority, will have a significant impact on the future development of the East Los Angeles area. The area residents and business community will all benefit from the addition of an efficient, safe and economical underground transit system being located in the heart of their community and will directly connect it to the Los Angeles Central Business District.

The East Side Extension will run from Union Station to East Los Angeles and is being planned to have approximately 6.8 miles of track and seven stations. The entire system will be an underground system consisting of two mined tunnels between each of the stations that will be cut-and-cover structures.

The seven stations will be located at approximately one mile intervals along the alignment with the first one being the Little Tokyo Station located under Santa Fe Avenue. Subsequent stations will be located at First Street and Boyle Avenue, Brooklyn Avenue and Soto Street, First Street and Lorena Street, Whittier Boulevard and Rowan Avenue, Whittier Boulevard and Arizona Avenue, with the final terminal station being located at Whittier Boulevard and Atlantic Avenue.

This report marks the completion of the 30% level Preliminary Engineering (PE) design effort. The report is organized by the various design disciplines that developed the PE design package. Each section defines what the design was based on and then describes in detail what work was accomplished.

The following is a summary of the work described in each section of this report:

1. **Architecture Station Design and Architecture**

The physical and design characteristics of the stations have been defined. Six of the stations are designed to be the new 610-foot modular design with a single mezzanine and with one entrance. These stations will also have one knock-out panel to allow for a second future entrance to be developed on the opposite side of the station. Only the Whittier/Atlantic Station is a standard full modular with two end mezzanines and three additional knock-out panels to accommodate future entrances.

2. **Civil Design**

The alignment has been developed to increase all curve radii to the greatest extent possible in order to increase the civil design speed to the greatest extent possible. The best alignment will permit only 45 mph.

3. **Electrical**

The design is based on systemwide design criteria and follows all applicable standards and directives. As the greater portion of the electrical design will not take place until the final design, the PE only covers power distribution, electrical equipment, room sizes, mechanical systems, traction power systems, communication and signal systems, lighting systems and UPS systems requirements in the manner of a generalized overview.

4. **Mechanical Systems**

The design is based on the same technology as has been used for Metro Red Line Segments 2 and 3. Again, as with Electrical, the greater portion of the design work will be accomplished during final design. The

PE effort was directed toward confirming vent shaft sizes and equipment procurement option clauses appropriate to this project.

5. **Operations and Maintenance Planning**

The PE effort describes the plan for operating service on the line, associated fleet requirements and facilities and equipment requirements, for supporting operations and maintenance.

6. **Right-of-Way**

The PE chosen alignment has 344 impacted parcels. Of these parcels, 284 are subsurface areas, fifty are full take parcels, one parcel is a partial take, eight are temporary construction and subsurface area parcels, and one parcel is a combination partial take and temporary construction area.

7. **Tunneling**

The tunneling PE work was incorporated with the structural and civil PE work. The main effort was to support structural and civil design in required clearances and the feasibility of construction along with reviewing tunnel machine and liner requirements.

8. **Trackwork**

Based on the track alignment developed (underground tunnels and cut-and-cover boxes), the most appropriate and recommended type of track construction is direct fixation.

9. **Utilities and Potholing**

For PE, Utilities developed a composite of existing utilities from the City and County of Los Angeles, utility companies and other agencies. Utilities then developed plans showing recommendations for relocation,

abandonment, temporary support or other disposition of affected utilities.

**10. Structural**

As the PE Geotechnical Report is not due until February 14, 1994, Structural based its design on a worst case scenario derived from past experience on Segments 1, 2 and 3 work. All of the structural work is shown on the architectural drawings. For final design, Structural will have its own set of drawings.

**11. Systems Integration**

The only systems integration work that was completed for the PE package was for corrosion control and noise and vibration analysis, both of which have resulted in reports with recommendations that will be used for the final design work. See Section 14, Deliverables for a listing of deliverables.

**12. Systems**

TBD

**13. Value Engineering**

There was a consistent effort throughout the entire PE effort to reduce the overall costs of the East Side Extension. These efforts examined the stations, the alignment, the utilities and the right-of-way. The station size, location and depth were analyzed. The alignment curves, radii, gradients and design speeds were studied to improve train speed, reduce wheel wear and shorten the overall length of tunnel required. Existing utilities were researched to determine whether they had to be relocated, avoided or abandoned. Four of the many items examined produced the greatest benefits:

- Shorten station box to 610-foot length (\$50 million ±)
- Locate Little Tokyo Station underground (\$40 million ±)
- Raise elevation of the First/Lorena Station (\$10 million ±)
- Change alignment between Little Tokyo Station and Brooklyn/Soto Station (\$6.5 million ±)

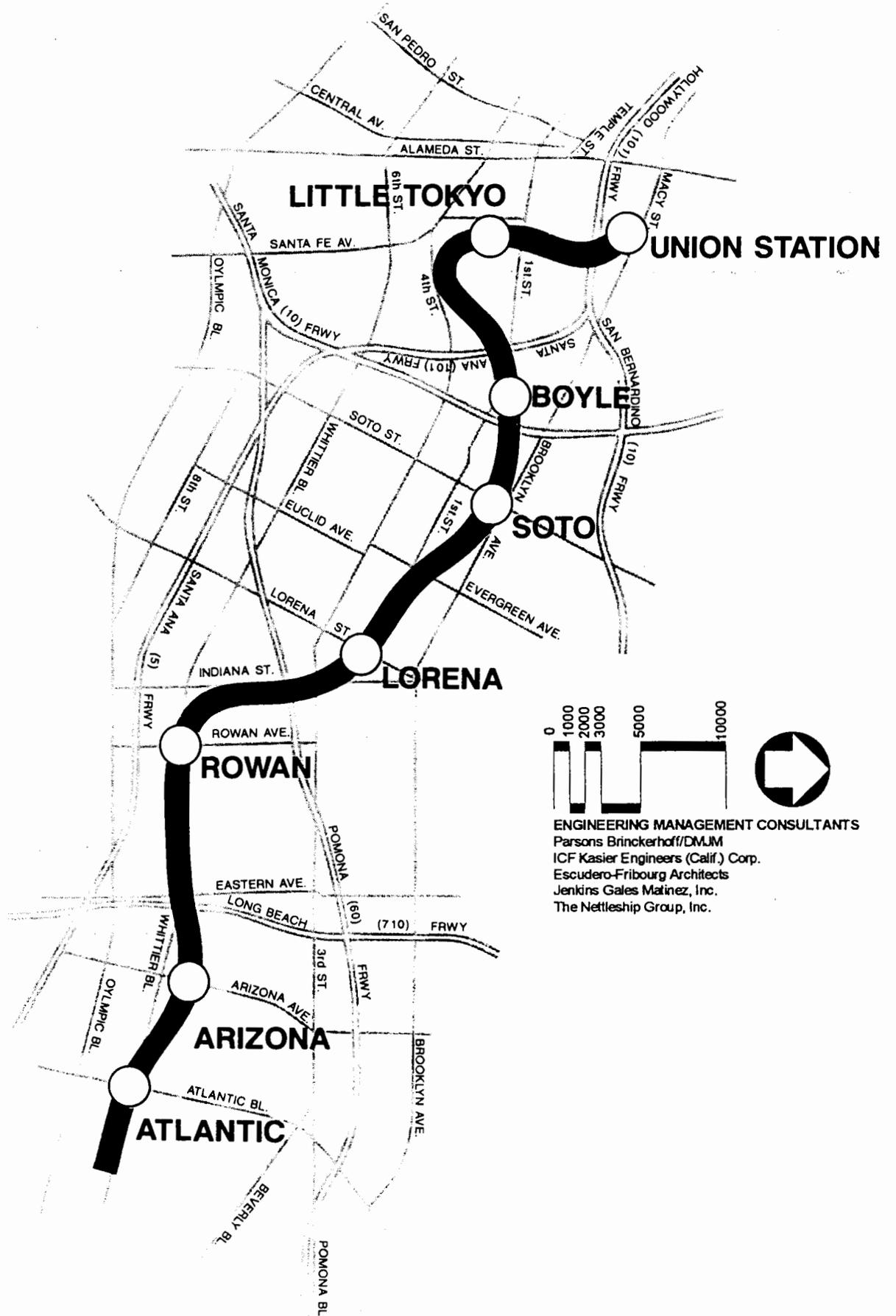
It should be pointed out that this last change also will yield a cost savings to overall cost, as the underground solution avoids taking some very expensive industrial properties and has to deal with the AT&SF, Union Pacific and the Corps of Engineers.

#### 14. Deliverables

This section provides a list of reports. While these deliverables are not included in this report, they are available for review.



# METRO RED LINE - EAST SIDE EXTENSION



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 Parsons Brinckerhoff/DMJM  
 ICF Kasier Engineers (Calif.) Corp.  
 Escudero-Fribourg Architects  
 Jenkins Gales Matinez, Inc.  
 The Nettleship Group, Inc.

**SECTION 1: STATION DESIGN AND ARCHITECTURE****1.1 INTRODUCTION**

The East Line Extension, which will run from Union Station to East Los Angeles, is currently planned to consist of approximately 7 miles of track and seven below-grade stations. The alignment will begin approximately 130 feet east of the existing Union Station platform, turn off the AR/AL tracks prior to entering the Red Line Yard Lead tracks, run alongside the existing Red Line storage yard, cross the Los Angeles River and travel into East Los Angeles.

Seven stations, which utilize standard modular station designs, are as follows:

- Little Tokyo
- First/Boyle
- Brooklyn/Soto
- First/Lorena
- Whittier/Rowan
- Whittier/Arizona
- Whittier/Atlantic

The service frequencies (headways) of 4 minutes have been assumed for all rail stations. Maximum operating speed is 70 mph, and station dwell time is assumed to be 20 seconds.

**1.2 STATION DESIGN**

The physical and design characteristics of the East Side facilities are consistent with the existing Red Line modular design. All facilities generally consist of cut-and-cover underground stations connected by tunnel line sections that are usually located within a public street right-of-way.

The Design Criteria and Standards used for the East Side Corridor stations are consistent with the latest MTA/RCC Metro Red Line System Design Criteria and Standards documents. A standard modular double-end and single-end mezzanine subway station, with double-height public space over the platform, has been developed for use on the East Side Corridor. Provisions for knock-out panels located at the mezzanine level have been included, three for the Whittier/Atlantic Station and one for all of the others.

The modular design elements are described as follows:

- Type A - 2-level ancillary, 122 feet in length
- Type B - 2-level platform mezzanine, 450 feet in length
- Type C - 2-level crossover/ancillary with TPS and DWP, 372 feet in length
- Type H - 2-level ancillary/extended mezzanine with TPS and C, 80 feet in length
- Type J - 2-level platform/single mezzanine (public area) 450 feet in length
- Type K - 2-level ancillary with extended mezzanine 80 feet in length

Each station provides a site-specific approach to the disposition of the modular station design elements. The design elements associated with each of the stations of the East Line Extension are shown in Table 1-1.

**Table 1-1. Modular Design Elements**

STATION	MODULES
Little Tokyo	H, J, K
First/Boyle	C, J, K
Brooklyn/Soto	H, J, K
First/Lorena*	C, J, K
Whittier/Arizona	H, J, K
Whittier/Atlantic*	C, B, A

\*Note: The First/Lorena and Whittier/Atlantic Stations are designed as terminal stations due to their operational significance.

Materials and finishes for each station will be determined in the next stage of design following PE. Each station designer will pick from a palette of choices to ensure quality, high durability and maintenance within a pre-established budget.

**1.3 STATION ARCHITECTURE**

The program objective has been to provide latitude for section designers to create an image which is unique to a specific station, within a framework of minimizing costs and impacts to schedule. It is expected that each station design will respond to its neighborhood characteristics, culture and adjacent architecture. At the same time, standard station elements of continuity have been established to maintain cost savings and reduced maintenance costs.

These station elements have been developed as directives to the section designers. These elements include elevators, escalators, ticket vending

machines, and signage. All above-ground station components (entry portals, elevator housings, plazas, landscaping and lighting) are elements of variability that provide the section designers the latitude to be fully responsive to the section designers' creative talents.

#### **1.4 STATION ENTRANCES**

Plaza-type entrances and entrances within existing or planned developments are preferred.

#### **1.5 STATION LOCATION AND ENTRIES**

The Locally Preferred Alternative (LPA) adopted by MTA follows generally the Draft Environmental Impact Statement/Draft Environmental Impact Report alternatives 9B and 6A. Station locations are as indicated, with the exception of those stations moved to avoid impact on major cross streets or major utilities.

The station entry locations are those presently completed to be publicly funded. Their final orientation is subject to conclusive negotiations with landowners and developers once funding for construction has been obtained. The general location of all other structures which impact station areas, such as vent shafts, fresh air intakes, and emergency exit stair hatches has been established during the PE phase.

##### **1.5.1 Little Tokyo Station**

The station design development began with the implementation of an aerial station inside of the MTA Red Line Maintenance property (as shown in the LPA). This station was located approximately 600 feet

east of Santa Fe Avenue and approximately 300 feet south of the First Street Bridge. Two aerial station alternatives were studied, a center platform configuration and a side platform configuration. Both of these alternatives presented several impacts to the maintenance facilities:

- The loss of approximately one-third of the yard storage track area
- A pedestrian bridge access of approximately 500 feet in length impacting the current vehicular access circulation to the Maintenance-of-Way Building

Due to the significant number of impacts on the Metro Red Line Maintenance Facility, the LPA aerial station alternative was eliminated. The new station alternative is located under Santa Fe Avenue and partially on yard property (west of the Maintenance-of-Way Building and south of Second Street, to avoid a major storm drain).

This station reflects the module design developed for the Mid City Stations value engineering (610-foot) total station length.

### 1.5.2 First/Boyle Station

The station location, as reflected in the LPA, was modified in order to accommodate alignment changes. Most of the station is located under private property. No major utility impacts were identified in this area.

For the design development of the station entrance, two alternatives were presented. These alternatives were developed to accommodate the future implementation of the Mariachi Plaza at the intersection of the station. The station entrance design comprises two groups of vertical

circulation elements, with an intermediate landing. A design featuring a single group of vertical circulation was also studied, but this alternative was eliminated since it can be used only with the proposed Mariachi Plaza.

### 1.5.3 Brooklyn/Soto Station

This station is located approximately 200 feet south of Brooklyn Avenue, running parallel to Brooklyn Avenue. The main entrance is located under an existing abandoned one-story structure. Minimum property take is required. All proposed structures, shafts, emergency stairs, fresh-air intakes, etc., are located at the perimeter of each lot, leaving an abundance of land suitable for future development of mixed use. A tunnel access shaft was added to the eastern end of the station. The "King Taco" is being preserved by locating the station entrance south of this fast food outlet.

### 1.5.4 First/Lorena Station

In general, this station concurred with the locally preferred alternative, with the exception of the moving of the station eastward to bypass an existing driveway entrance to the adjacent cemetery. The station maintains a crossover located west of the entrance. Operationally, the First/Lorena Station is a terminal station. The station's vertical alignment is set to avoid a major storm drain located in Lorena Street. The entrance is located north of First Street and provides access to a single-end mezzanine containing two knock-out panels.

### 1.5.5 Whittier/Rowan Station

In general, this station concurred with the LPA, with the exception of the

station entrance. The station entrance is located south of Whittier Boulevard. This modification was made based on property takes.

Two alternatives in the design of the station surface penetrations were studied. The first alternative located the shafts on top of the station box. This alternative required lowering the top of the rail elevation approximately 7 additional feet. The second alternative did not require lowering the top elevation and maintained the station top of structure at only 10 to 12 feet below existing ground. This alternative located all the shafts of the south side of the station box. In addition, sidewalk gratings will be located at the south side of Whittier Boulevard. The width of this sidewalk was increased 10 feet, setting the property line 18 feet from the existing curb.

#### 1.5.6 Whittier/Arizona Station

This station is located about 80 feet north of Whittier Boulevard.

#### 1.5.7 Whittier/Atlantic Station

This station location was modified in order to accommodate alignment changes. The Whittier/Atlantic Station is a crossover station. It utilizes Modules A, B and C. The station entrance is located at the south side of Whittier Boulevard between Woods and Atlantic Boulevard. The Golden Gate Theater is a historical landmark. A 30,600 sq. ft. commercial center is proposed for the site adjacent to the entrance. A park and ride lot containing 1100 spaces is proposed for this site. A future entrance is proposed for the northeast corner of Atlantic and Whittier Boulevards. This site (F2) spans two blocks between Atlantic Boulevard, Amalia and Hillview Avenue.

**SECTION 2: CIVIL DESIGN****2.1 INTRODUCTION**

The project begins in the existing crossover structure south of Union Station. Currently, the structure contains tracks for Yard Leads YL and YR, which connect to existing mainline tracks AR and AL. The structure was originally designed to accommodate No. 10 equilateral and lateral turnouts, on tracks AR and AL, respectively, to allow trains travelling to the south toward East Los Angeles to either continue on the mainline or diverge toward the center into Yard Leads YL and YR. Presently, YL and YR connect to AL and AR directly via simple curves; the proposed turnouts were not installed. The tunnel structure, however, contains stubs for the future East Side Extension tracks.

The conventions on MOS-1 and Segment 2 were to consider that in travel from Union Station toward the North Hollywood, the right-hand track was named AR (for Route "A", track right), and likewise for AL. Route "A" stationing runs from Union Station to North Hollywood, and Route "B" stationing runs from Wilshire/Vermont to Wilshire/Western. Route "C" stationing, then, runs from Union Station to East Los Angeles. Therefore, in leaving Union Station toward East Los Angeles, the right-hand track, formerly AL, becomes CR. A similar standard was adopted for track CL.

**2.2 LINE SECTION: UNION STATION LITTLE TOKYO STATION**

Beginning at the future points of switch at the proposed No. 10 turnouts, tracks AL and AR are renamed CR and CL, respectively. Upon leaving the existing crossover structure, the tracks begin running in separate, mined tunnels, passing beneath the U.S. 101 Hollywood and I-5 Golden State Freeways. Track CR bears right with a 2000 foot radius simple curve, as shown in

previous construction plans; this curve will require further study in order to determine the best alignment to increase operating speed. The tunnel then turns quickly to the right to avoid mining in potentially contaminant-laden soil beneath petroleum storage tanks located at Center and Commercial Streets. It continues under private property to South Santa Fe Avenue ( at Banning Street), passing beneath the First Street Viaduct to Little Tokyo Station.

Track CL, after leaving the crossover structure, passes beneath the Santa Ana Freeway, and continues southeasterly under private property. It then travels under the existing Yard Lead two-cell box tunnel structure, and continues under private property to South Santa Fe Avenue, passing beneath the First Street Viaduct, to Little Tokyo Station.

Due to the large separation between tunnels, cross passages between the two cannot be provided. In order to meet Fire/Life Safety requirements for emergency exiting, four emergency exits to the surface, two along each track, are provided. In addition, sag vertical curves require the construction of sump pumps in both tunnels. The sump on track CR has been combined with an emergency exit, eliminating the need for a separate shaft.

### **2.2.1 Station: Little Tokyo**

Little Tokyo Station is located in Santa Fe Avenue at East Third Street, directly opposite the existing MTA Rail Maintenance-of-Way Building. It is a cut-and-cover end-mezzanine station, with the entrance located at the northwest corner of Santa Fe and Third. It was positioned as far north along Santa Fe as possible without interfering with an existing 13 foot high concrete arch tunnel storm drain. Pushing the station further north would have necessitated lowering the station at least 15 feet or more, and supporting the immense drain structure in place. The station,

as shown in the Environmental Impact Report (EIR), was originally planned as an aerial station along the east side of the Red Line Yard. But further study showed this station to be less cost-effective, disruptive to yard operations and less accessible to patrons than a Santa Fe Avenue subway alternative; so the subway alternate was subsequently adopted.

### **2.3 LINE SECTION: LITTLE TOKYO STATION TO FIRST/BOYLE STATION**

After leaving Little Tokyo Station, the twin mined tunnels begin a long left-hand curve, passing beneath the Metro Red Line shop building and yard storage tracks, and running beneath the Los Angeles River, just north of the Fourth Street Viaduct. The low point in the profile, however, occurs not at the river, but beneath Mission Road, where the tunnels must avoid existing and proposed sanitary sewer interceptors.

The alignment from this point varies slightly from that which appeared in the EIR. The original alignment brought the tunnels northerly beneath private property, then curving to the east, bringing the tracks into East First Street and the First/Boyle Station. In that scheme, the station was located entirely within First Street in an east/west direction. The curves required to produce this reverse curve alignment, however, limited the running speed to 35 mph. EMC reoriented the alignment, leaving the river area in a northeasterly direction, and similarly oriented the station along this new tangent. This eliminates the reverse curve and increases the operating speed to 45 mph. The realignment also reduces the amount of street opening required for station construction by placing more of the 910 foot station box on private property, the air right of which can be reclaimed following construction.

The route from the river also follows along under private property, passing beneath the U.S. 101 Hollywood and I-5 Golden State Freeways. At this point, the ground profile rises nearly 40 feet.

### **2.3.1 Station: First/Boyle**

The First/Boyle Station is located just east of the U.S. 101 Hollywood Freeway. At first glance, it might appear that the station is excessively deep. This, in fact, is due to the sharp increase in ground profile elevation. The station has actually been designed as shallow as possible to allow the adjacent running tunnels approaching west of the freeway to be built with minimum cover.

The station features a double crossover on the westerly end, located under private property (to be acquired) and under a portion of Boyle Avenue. The platform extends diagonally across the present First/Boyle intersection, crosses private property, and crosses Pennsylvania Avenue at the north end, just prior to entering the White Memorial Hospital parking lot.

The entrance to the station is located at the northeast corner of First and Bailey Streets.

## **2.4 LINE SECTION: FIRST/BOYLE STATION TO BROOKLYN/SOTO STATION**

After leaving the First/Boyle Station, the route turns easterly, passing below the White Memorial Hospital complex and the depressed I-5 Golden State Freeway. The tunnels then run parallel to Brooklyn Avenue approximately midway between Brooklyn Avenue and New Jersey Street.

**2.4.1 Station: Brooklyn/Soto**

After the route crosses Soto Street, the Brooklyn/Soto Station begins. It runs across private property (to be acquired) for approximately 1 ½ blocks. The station entrance is located at the northwest corner of Brooklyn Avenue and North Mathews Street.

**2.5 LINE SECTION: BROOKLYN/SOTO STATION TO FIRST/LORENA**

After leaving the Brooklyn/Soto Station, the alignment immediately turns southeasterly into a reverse curve to bring it onto East First Street. Sharp curves are required in order to avoid entering Evergreen Cemetery property and to avoid impacting the location of Brooklyn/Soto Station. The curves, as designed, maintain a 45 mph speed. The alignment proceeds along East First Street to the First/Lorena Station and crossover at Lorena Avenue.

**2.5.1 Station: First/Lorena**

A combination of hilly terrain along First Street and deep sewers forces the station to be fairly deep, as much as 85 feet below grade at the east end. In fact, in order to keep the station from being any deeper, a notch is designed into the roof to allow the sewers to remain in operation and in place. The station entrance is located at the northeast corner of East First Street and North Lorena Street, adjacent to the "Mercado" shop building.

**2.6 LINE SECTION: FIRST/LORENA STATION TO WHITTIER/ROWAN**

Upon leaving the First/Lorena Station, the alignment begins a long sweeping set of reverse curves to bring the tracks onto South Indiana Street. The reverse

curves are necessary because the First/Lorena Station is too close to Indiana Street to allow development of adequate single curves onto Indiana. The first curve is designed to avoid travelling beneath Ramona High School, instead passing behind it east of Alma Avenue.

The line then runs southwesterly, crossing under the Route 60 Pomona Freeway and then joining Indiana Street. After passing Princeton Street, it turns easterly under private property onto Whittier Boulevard and into the Whittier/Rowan Station and crossover.

#### **2.6.1 Station: Whittier/Rowan**

The Whittier/Rowan Station and crossover are located in Whittier Boulevard between Townsend Avenue and Gage Avenue, with the station entrance at the southeast corner of Whittier and Rowan.

### **2.7 LINE SECTION: WHITTIER/ROWAN STATION TO WHITTIER/ARIZONA STATION**

After leaving this station, the line continues down Whittier, past the New Calvary Cemetery. Just west of the I-710 Long Beach Freeway, Whittier Boulevard takes a turn southeasterly into East Los Angeles. But the tunnel alignment continues on a tangent, passing under I-710, before turning to run parallel to Whittier Boulevard, to approach the Whittier/Arizona Station.

#### **2.7.1 Station: Whittier/Arizona**

This station is located in the first alley north of Whittier Boulevard, centered around South McDonnell Avenue and South Arizona Avenue, with the entrance at the northwest corner of Whittier and Arizona. In

order to avoid a small church near the west end of the station box, the station was moved easterly, with the east end crossing Arizona Avenue. Several large utilities will need to be supported in place in Arizona Avenue, including a 66" storm drain.

## 2.8 LINE SECTION: WHITTIER/ARIZONA TO WHITTIER/ATLANTIC

Leaving the Whittier/Arizona Station, the alignment swings back via a pair of reverse curves under private property to Whittier Boulevard. The line continues east to the Whittier/Atlantic Station and crossover.

### 2.8.1 Station: Whittier/Atlantic

The crossover begins near Vancouver Avenue, with the station nearly centered about South Atlantic Boulevard, and ends at Amalia Avenue. The entrance is located on the Southwest corner of Whittier Boulevard and Atlantic Avenue in front of an historic theater.

Beyond the station is provided approximately 650 feet of twin-bore tail-track, ending with a cut-and-cover emergency exit and vent shaft structure.

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**SECTION 3: ELECTRICAL****3.1 INTRODUCTION**

- A. The electrical design conforms to the following documents:
- Systemwide Design Criteria, Section 7, Electrical
  - Electrical Standards and Directives, as applicable
  - Modular Design of Station Areas
  - Systemwide Specifications
- B. All drawings are prepared on CADD.
- C. Power Distribution will be provided from auxiliary power transformers at 480 volts with further transformation down to lower voltages as required for equipment provided.
- D. In public areas, all conduit, outlet boxes and fittings will be concealed from view.
- E. Electrical equipment rooms, such as auxiliary power rooms, have been laid out on the basis of dimensions provided by manufacturers for similar equipment.
- F. Mechanical systems, traction power systems and communications and signal systems follow the established designs already provided for Metro Red Line Segments 1 and 2.

- G. Lighting systems will be designed using the revised fixture and lamp types recommended by the lighting consultant and implemented in the electrical standard drawings. Platforms will continue to be provided with edge lighting as manufactured by Ledalite.
  
- H. UPS systems will be provided to support emergency lighting in the stations, tunnel lighting and signal and communication systems throughout the stations.

### **3.2 SPECIFIC FEATURES AT EACH STATION**

Electrical design at each station will follow the general features listed above.

**SECTION 4: MECHANICAL SYSTEMS****4.1 INTRODUCTION**

Mechanical system design is based on the existing Metro Red Line criteria. Final design will be in accordance with MTA Systemwide Criteria, Section 8, Mechanical.

**4.2 SYSTEMWIDE EQUIPMENT**

Emergency ventilation and certain air handling equipment will be provided by option clause in the following systemwide contracts:

- B740, Ventilating Equipment
- B745, Air Handling Equipment
- Contracts B740 and B745 are procurement and installation contracts

The following equipment is included in B740, Ventilation Equipment Option:

- emergency fan motor units
- mid-tunnel ventilation fan motor units
- subway ventilation booster fan motor units
- underplatform fan motor units
- smoke exhaust fan motors units

- emergency fan dampers
- mid-tunnel fan dampers
- track dampers
- bypass dampers
- sound attenuators for the first five items above

The following equipment is included in Contract B745, Air Handling Equipment Option:

- station air supply units with air filters and fan dampers
- traction power substation supply fans with air filters and fan dampers

Equipment quantities and capacities in the option are preliminary and will be finalized during final design.

The East Side Extension option, included in each of the procurement and installation contracts, was based on an alignment which included only four stations. The present East Side Extension alignment includes seven stations. Therefore, additional equipment will be required for the present seven-station alignment. The option is valid until August 26, 1997 for both Contracts B740 and B745. In accordance with the option, the delivery of the equipment shall be completed prior to December 1998, and installation shall be completed by December 2000.

The systemwide equipment procured and installed under Contract B740 is specified to operate continuously for a minimum of one hour in an ambient temperature of 300°F as was mandated by NFPA Standard 130 - Fixed Guideway Transit Systems. In May 1993, NFPA changed the temperature requirement from 300°F to 482°F. In June 1993, Fire/Life Safety Committee adopted this change and mandated that all future contracts include options in present contracts to follow the 482°F requirement. This change is estimated to increase the cost of ventilation equipment by approximately 10% and the cost of dampers by approximately 275%. Rebidding of ventilation equipment and air handling equipment should be considered for the following reasons:

- Additional equipment is required for the new alignment. Equipment duty may change as the design progresses;
- Increased cost of Contract B740 equipment due to the change in NFPA Standard 130; and
- Bid prices for Contract B745 were lower than engineer's estimate and change notices were issued at considerable cost.

#### 4.3 VENTILATION ANALYSIS

Ventilation analysis is not included in the PE design. Ventilation analysis will be prepared prior to or during final design to include the following:

- Ventilation analysis during emergency operations
  - Determine emergency ventilation equipment capacities
  - Develop emergency ventilation operations matrix

- **Ventilation analysis during normal operations**
  - **Analysis of air velocities resulting from train piston action**
  - **Determine blast relief shaft aerodynamic performance requirements, review in-progress designs at 30%, 60% 90% and 100%; re-evaluate as required to support design alternatives**
  - **Evaluate station temperatures during initial years of operation (4-minute headway); determine future cooling loads for full build-out**
  
- **Soil gas (methane) purge, if any**
  - **Determine fan requirements background (night) ventilation of tunnels**
  - **Develop methane ventilation operations matrix for background (night) and emergency ventilation**

**SECTION 5: OPERATIONS AND MAINTENANCE PLANNING****5.1 INTRODUCTION**

This section summarizes the plan for operating service on the East Side Extension, associated fleet requirements, and facilities and equipment requirements for supporting operations and maintenance.

At MTA direction, the service described for preliminary engineering is consistent with that identified in the Draft Environmental Impact Statement/Environmental Impact Report (DEIS/DEIR). It also reflects the possibility that the line may be constructed and opened in two stages. If necessitated by funding constraints, the four westernmost stations may be constructed and opened first, with the remaining three stations to follow. (Note: the DEIS/DEIR identifies additional construction staging scenarios which were not including in the scope of the Preliminary Engineering work.)

**5.2 SERVICE PLAN**

As described in the DEIS/DEIR, three service routes would be operated on the Metro Red Line in the Year 2010. One route would run from Pico/San Vicente in Mid-City through Union Station to Whittier/Atlantic on the East Side. A second route would run between North Hollywood and Whittier/Atlantic. The third service route would originate at Oxnard/Sepulveda station on the planned East/West San Fernando Valley Extension (three stations west of North Hollywood) and terminate at Union Station.

Service is planned as shown in Table 5-1:

**TABLE 5-1. Metro Red Line Service Levels**

	HEADWAYS		CARS/TRAIN	
	PEAK	OFF-PK	PEAK	OFF-PK
WHITTIER/ATLANTIC TO PICO/SAN VICENTE	4 MIN.	6 MIN.	4 CARS	4 CARS
WHITTIER/ATLANTIC TO NORTH HOLLYWOOD	8 MIN.	12 MIN.	4 CARS	4 CARS
UNION STATION TO OXNARD/SEPULVEDA	8 MIN.	12 MIN.	4 CARS	4 CARS

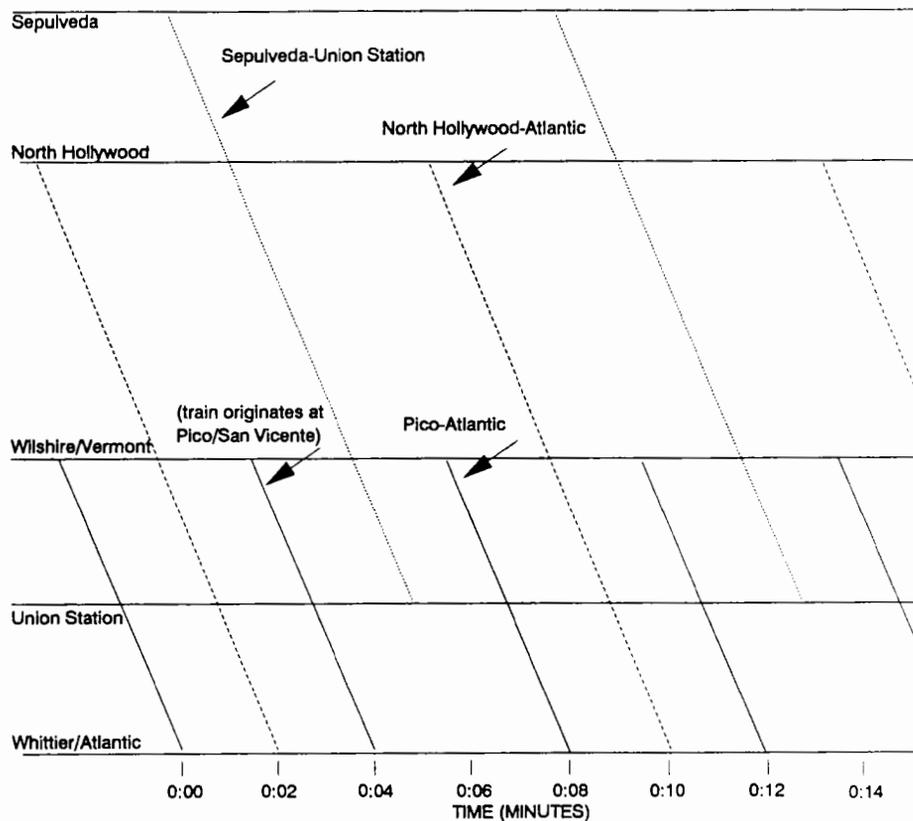
Service will be operated seven days per week, 20 hours per day, although nothing will preclude operating service 24 hours each day. Weekday service will be operated as follows:

- 5:00 AM - 6:00 AM Off-Peak
- 6:00 AM - 9:00 AM PEAK
- 9:00 AM - 3:00 PM Off-Peak
- 3:00 PM - 6:00 PM PEAK
- 6:00 PM - 1:00 PM Off-Peak

If service opens initially to First/Lorena station, the operating pattern will be the same as the service plan described above. Trains dispatched from Pico/San Vicente and North Hollywood will operate to First/Lorena, while trains from Oxnard/Sepulveda will turnback at Union Station.

The planned service levels described above will result in an operating headway (time between train arrivals) on the East Side that alternates between two and four minutes, as illustrated in Figure 5-1 below:

FIGURE 5-1. DIES/DEIR Peak Period Service Plan



Thus, the prescribed service levels require that the line be designed and constructed to support two-minute service headways.

**5.3 TRAVEL TIMES**

Travel times were determined for the adopted route by computer simulation. (Travel times for trains between Oxnard/Sepulveda and North Hollywood stations were estimated.) The simulation utilizes the performance characteristics of Red Line trains (propulsion, braking, train control) and the civil characteristics of the line (speeds, grades, station and interlocking locations) to calculate and track train movement along the line. A 20-second dwell time at each station is assumed. The resulting one-way and round trip travel times for each service route are summarized in Table 5-2 below:

**TABLE 5-2. Service Route Travel Times**

SERVICE	1-WAY TRAVEL TIMES	TERMINAL TIMES		ROUND TRIP TIMES
		EAST-TERM.	WEST-TERM.	
WHITTIER/ATLANTIC TO PICO/SAN VICENTE	31 MIN.	2½ MIN.	2½ MIN.	67 MIN.
WHITTIER/ATLANTIC TO NORTH HOLLYWOOD	43 MIN.	2½ MIN.	2½ MIN.	91 MIN.
UNION STATION TO OXNARD/SEPULVEDA	37 MIN.	2½ MIN.	2½ MIN.	79 MIN.
FIRST/LORENA TO PICO/SAN VICENTE	25 MIN.	2½ MIN.	2½ MIN.	55 MIN.
FIRST/LORENA TO NORTH HOLLYWOOD	37 MIN.	2½ MIN.	2½ MIN.	79 MIN.

**5.4 FLEET SIZE**

In order to provide the planned service described in Table 5-1 with the calculated round trip times shown in Table 5-2, seventeen trains will be required for the Whittier/Atlantic-Pico/San Vicente service, twelve trains will be required for the Whittier/Atlantic-North Hollywood service, and ten trains will be required for Union Station-Oxnard/Sepulveda service. Adding two four-car standby consists to press into service during either service disruptions or equipment failures, and a 20-percent margin of spare vehicles to account for vehicles either needing repair or scheduled for maintenance brings the total fleet size requirement to 196 cars, as summarized in Table 5-3 below:

**TABLE 5-3. Fleet Size Projections**

SERVICE	PEAK TRAINS	CARS/ TRAIN	CARS REQUIREMENTS			
			REVENUE	STANDBY	SPARES	TOTAL
WHITTIER/ATLANTIC - PICO/SAN VICENTE	17 TRAINS	4 CARS	68 CARS	4 CARS	14 CARS	86 CARS
WHITTIER/ATLANTIC - NORTH HOLLYWOOD	12 TRAINS	4 CARS	48 CARS	0 CARS	10 CARS	58 CARS
UNION STATION - OXNARD/SEPULVEDA	10 TRAINS	4 CARS	40 CARS	4 CARS	8 CARS	52 CARS
TOTAL CARS:						196 CARS

The maximum number of cars that the downtown Red Line Yard can accommodate is 180 cars. Trains can also be stored overnight at terminal stations properly equipped with tail tracks of sufficient length. At Whittier/Atlantic, three trains can be stored overnight: one in each tail track and a third train on one platform track (the remaining platform track would be left clear for turnback during non-revenue periods, when testing and maintenance may be underway). Additional trains could also be stored at Oxnard/Sepulveda if so designed. (Note: Storage at outlying terminals such as Whittier/Atlantic also reduces carmiles during the morning pullout and evening pullin.)

Table 5-4 summarizes fleet size requirements for various operating conditions:

**TABLE 5-4. Fleet Size Summary**

	CARS/TRAIN	PEAK TRAINS	TOTAL CARS
SERVICE TO WHITTIER/ATLANTIC	4 CARS	39 TRAINS	196 CARS
	6 CARS	39 TRAINS	296 CARS
SERVICE TO FIRST/LORENA	4 CARS	34 TRAINS	172 CARS
	6 CARS	34 TRAINS	260 CARS

(NOTE: PEAK TRAINS AND TOTAL CARS REFERS TO THE TOTAL REQUIREMENT FOR ALL METRO RED LINE SERVICE (PICO/SAN VICENTE-EAST SIDE; NORTH HOLLYWOOD-EAST SIDE; OXNARD/SEPULVEDA-UNION STATION))

(NOTE: TOTAL CARS INCLUDES CARS FOR REVENUE SERVICE, STANDBY TRAINS AND CARS HELD OUT OF SERVICE FOR MAINTENANCE.)

**5.5 CROSSOVERS**

Operating criteria requires a minimum 10-minute single-tracking headway be achievable anywhere along the line. The Rail Transit Simulator model was used to determine the achievable single-tracking headway achievable between each pair of crossovers. In order to achieve this capability and to expedite terminal operations at Whittier/Atlantic and First/Lorena, crossovers are required at the locations indicated in Table 5-5 below:

**TABLE 5-5. Crossover Requirements**

STATION	CROSSOVER LOCATION	PURPOSE
UNION STATION	WEST END	CONSTRUCTED AS PART OF SEGMENT 1
LITTLE TOKYO	none	
FIRST/BOYLE	WEST END	SINGLE TRACKING HEADWAY: 10 MIN.
BROOKLYN/SOTO	none	
FIRST/LORENA	WEST END	REQUIRED FOR TERMINAL OPERATIONS; SINGLE TRACKING HEADWAY: 9 MIN.
WHITTIER/ROWEN	WEST END	SINGLE TRACKING HEADWAY: 6 MIN.
WHITTIER/ARIZONA	none	
WHITTIER/ATLANTIC	WEST END	REQUIRED FOR TERMINAL OPERATIONS; SINGLE TRACKING HEADWAY: 9 MIN.

## 5.6 TAIL TRACKS

Tail tracks are lengths of track that lie beyond the terminal station. They can serve two purposes. First, tail tracks provide "safe braking distance" enabling trains to enter a terminal station at reasonable speeds. Depending upon the grade of the right-of-way, a 300-400 foot tail track will enable a train on the Red Line to enter a station at 25 mph. The second function of tail tracks is to enable the storage of trains. This can become critical when a disabled train must be removed from service to keep from severely disrupting service. Overnight storage can also expedite the start of service in the morning from outlying areas.

At Whittier/Atlantic terminal, a 750-foot tail track is planned at the end of each mainline track. This will provide 300 feet for safe braking distance and 450 feet for storage of 6-car trains. The RCC has directed that tail tracks at First/Lorena be limited to 80 feet, if that station is operated as a temporary terminal. (EMC recommended 500-foot tail tracks at the station.) The 80 feet of track will enable trains to enter the station at 9 mph in the Automatic Train Operation (ATO) train operating mode. (A shorter tail track would require that the train come to a full stop in advance of the station and then enter in Restricted Manual Operation (RMO) operating mode.)

## 5.7 YARD ACCESS

As currently configured, all trains entering and leaving the Red Line Yard are routed into Union Station. Trains will service the East Side in one of the following ways:

- Trains will enter the AL platform track at Union Station from the yard, reverse direction, and be routed to the East Side; or
- Trains will be dispatched into service first to the west side from the yard, and on the return trip, be routed through Union Station to the East Side.

For operation of service at close headway, either a satellite yard will be required on the East Side from which to dispatch trains, or a new yard lead will be required to dispatch trains from the downtown yard directly to the eastern mainline, bypassing Union Station. Without either the new yard or the direct yard lead, trains will continue to be turned at Union Station, which at close headway will be disruptive to revenue operations, particularly during the buildup for afternoon peak service. Recovery of disabled trains to the yard from the East Side will also be disruptive to peak period operations if these trains must be routed through Union Station.

A direct yard lead must accommodate dispatch of 6-car trains through the yard transfer point to either eastern mainline track.

#### **5.8 UNION STATION YARD LEADS FOR TURNBACK**

Trains operating between North Hollywood and Union Station will first platform on the AL Track at Union Station to unload passengers, pull forward to the YR yard lead, reverse direction, and at the scheduled time pull forward to the AR platform track to begin its run to North Hollywood. Use of the crossovers and yard leads east of Union Station to turnback North Hollywood trains will avoid movement conflict between these and the trains operating to/from the East Side.

**5.9 TRANSPORTATION FACILITIES**

Crew facilities are required for train operators reporting for duty, and laying over between runs. The following facilities are provided on the East Side:

- **Terminal Facilities at Whittier/Atlantic:** Satellite Transportation facilities will accommodate both train operator reporting and layover, with the following:
  - TOS-Line Supervisors booth, located at the west-end of the platform; glass-enclosed, with radio and telephone communications, a writing surface and secure file drawers.
  - Track- or platform-level toilet for operator use during layover.
  - Locker Room/Crew Room, with adjacent toilets/changing rooms (2 minimum)
  
- **Temporary Terminal Facilities at First/Lorena:** Satellite Transportation facilities will accommodate partial opening of the line to this station, with the following:
  - TOS-Line Supervisors booth, removable.
  - Track- or platform-level toilet for operator use during layover.

## **SECTION 6: RIGHT-OF-WAY**

### **6.1 INTRODUCTION**

The East Side Extension required the identification of 567 total parcels for right-of-way consideration. The chosen alignment has 344 impacted parcels. Of these parcels, 284 are subsurface areas, fifty are full take parcels, one parcel is a partial take, eight are temporary construction and subsurface area parcels, and one parcel is a combination partial take and temporary construction area.

The two largest areas of the 223 parcels identified but not impacted were the following:

- The study of two alignments from Union Station to Brooklyn/Soto - eighty-six identified but not impacted
- The shifting of the alignment at First and Indiana to not impact Ramona High School - twenty-one identified but not impacted

Right-of-way requirements per station follows below (refer to Property Identification Plans dated January 31, 1994).

### **6.2 LITTLE TOKYO STATION**

Two parcels are identified as permanent areas. Parcel E-B24 would be a full take, whereas Parcel E-B27 would require only a partial take of an area approximately 100 feet by 200 feet. The station entrance would be located on one of the two parcels and only one purchase would be required.

A temporary construction area would be required on Parcel E-B27. The size of the area would be approximately 200 feet by 500 feet.

**6.3 FIRST/BOYLE STATION**

Eight parcels are identified as permanent areas and all would be full take parcels. The parcels are E-D24, E-D25, E-D30, E-D31, E-D32, E-D34, E-D35 and E-D92. Parcel E-D30 is a triangular-shaped parcel that may be acquired as part of the creation of Mariachi Plaza.

Eight parcels would be required for temporary construction areas. The parcels are E-D21, E-D22, E-D23, E-D26, E-D27, E-D29, E-D33 and E-D91. A Victorian house is built on Parcel E-D26 and is close to the location of the station box. After further studies, it may be determined that the Victorian house will have to be moved or demolished. This parcel may be changed from a construction area to a permanent area (full take).

**6.4 BROOKLYN/SOTO STATION**

Seven parcels are identified as permanent areas and six would be full take parcels. The six parcels are E-E73, E-E74, E-E76, E-E77, E-E80 and E-E81. Parcel E-E72 is a partial take.

The existing "Johnson Market" parking lot, which is Parcel E-E74, is divided into two parcels. The southerly 80 feet of the parking lot is not identified as an impacted parcel but may need to be acquired for construction.

**6.5 FIRST/LORENA STATION**

Parcel E-G09 is the only parcel identified as a permanent area and would be a full take parcel.

**6.6 WHITTIER/ROWAN STATION**

Sixteen parcels are identified as permanent areas and are full take parcels. The parcels are E-J15 through E-J19, E-J21 through E-J24, E-J26, and E-J31 through E-J36.

Two parcels (E-J20 and EJ-25) were not needed for construction but may be added as permanent areas at a later date.

**6.7 WHITTIER/ARIZONA STATION**

Twelve parcels are identified as permanent areas and would be full take parcels. The parcels are E-L26 through E-L37.

If the station box was shifted west to clear Arizona, three parcels would not be required as permanent parcels. Three parcels would be E-L35, E-L36, and E-L37. An additional five parcels would be required for the construction of the station. These parcels would be E-L21 through E-L25. It may also require the acquisition of two other parcels (E-L19 and E-L20) for construction traffic circulation.

**6.8 WHITTIER/ATLANTIC STATION**

Four parcels are identified as permanent and are full take parcels. These parcels are E-M03 through E-M06.

Two additional parcels, identified as permanent areas, would be for vehicle rail access. Only one of the two parcels (E-M21 and E-M22) would be required, the preference being E-M21.

## SECTION 7: TUNNELING

### 7.1 INTRODUCTION

The tunneling PE work was incorporated with the structural and civil PE work. The main effort was to support structural and civil design in required clearances and the feasibility of construction along with reviewing tunnel machine and liner requirements.

### 7.2 STUDIES AND INVESTIGATIONS PERFORMED

Tunnel to Union Station structure connection: Station clearance check to enlarge the 2000 foot radius of the existing design. We are maintaining the 2000 foot radius until further checking.

- Feasibility of a temporary pit to retrieve the shield machines

Underpinning the busway bridge: It was performed in a preliminary design for the transfer beam and piles.

- Checking of the clearances to the existing and future structures

Passing of the CL tunnels under the existing Yard Leads cut-and-cover structures.

- Plan, profile and sections were elaborated to set the profile 20 feet below the existing structures

Passing under the Third Street Bridge: Check of bridge foundation. Spread footings. No settlement due to tunnel construction.

Passing under storm drainpipes. Very important because it establishes Little Tokyo Station profile. Sections were drawn indicating the amount of grouting needed.

Little Tokyo Station: The station location was reviewed; some modifications are suggested. Construction site to locate the mucking operations for four tunnels.

Tunnel under the river: The horizontal and vertical alignments were studied using preliminary geotechnical information to establish the type of machine and liner to use, and water level above crown.

Crosspassages: Crosspassages were located following fire life/safety regulations. Vertical emergency exits were considered as an alternative to the typical horizontal crosspassages due to the soil characteristics and the groundwater elevation under the river.

Sump Pump Structures: Alternatives were studied for the different alignments, and soil conditions and cost comparisons were made.

The available building foundations were reviewed to find potential problems. Further investigation is needed.

Freeway bridges were studied for possible conflicts. Some of them too close to the tunnels need to be protected by grounding, as indicated on the plans for the 710 Freeway.

Tunnel machines and liners were reviewed; cast-in-place and precast to be used in the different segments of the line. Precast one-pass liners were drawn and included in the set.

The stations' sites were studied to find out the potential conflicts with the shield starting pits, mucking and storage areas. Need further studies with right-of-way and CALTRANS.

The sequence and directions of the tunnel machines were studied. More discussions and studies are needed for the final tunnel driving schemes and contract partition. The contracts may change to make the shield machines used compatible with the type of soil. Closed face machines are expensive, therefore, when needed, they must be within the same contract.

**SECTION 8: TRACKWORK****8.1 INTRODUCTION**

Based on the track alignment developed (underground tunnels and cut-and-cover boxes), the most appropriate and recommended type of track construction is direct fixation. Direct fixation track requires shallower section (17 inches) compared to ballasted track (approximately 26 1/2 inches) and, therefore, will also require smaller tunnel diameter. Direct fixation track is also preferred in underground construction because it does not require frequent maintenance (tamping and lining) compared to ballasted track.

Direct fixation track consists of 115 RE running rail which is fastened onto the concrete second pour by a certain type of rail fastening system. This fastening system is made of elastomeric material which is capable of supporting the vehicle loadings. It also dampens the noise and vibration from the passing vehicle and prevents stray currents from the running rail to the ground.

**8.2 TRACK MATERIAL****8.2.1 Running Rail**

The running rail shall be 115 RE rail manufactured in accordance with the American Railway Engineering Association (AREA) specifications. Based on the present alignment, approximately 3000 tons (78,000 track feet) of rail is needed. Running rail for the Segment 3 East Side Extension is being procured under Contract B611, Running

**Rail Procurement.****8.2.2 Rail Fastening Systems**

Rail fastening systems shall consist of elastomeric pads, elastic rail clips and rail anchorage assembly. There are two types of rail fastening systems. They are as follows:

**A. Standard Direct Fixation Rail Fasteners**

This type shall be used in most areas where the main purpose is to carry the vehicle loadings, and the expected noise and vibration transmission to the adjacent areas is within the allowable limit. Approximately 64,000 pieces of standard direct fixation rail fasteners are needed. This amount will have to be procured under a separate contract.

**B. Special Direct Fixation Rail Fasteners**

This type shall be used in areas where the expected noise and vibration transmission using the standard fasteners will exceed the allowable limit. Preliminary indication is that there are several areas along the alignment that will need this type of fastener. Approximately 2,500 pieces of special direct fixation rail fasteners for the Segment 3 Eastside Extension are being procured under

Contract B616, Special Direct Fixation Rail  
Fastener Procurement.

### 8.2.3 Special Trackwork

As indicated on the alignment, the following special trackwork shall be used and shall be procured under a separate contract:

- four 645-foot-radius double-crossover, 38'-10" track centers, direct fixation
- one No. 10 lateral turnout, direct fixation
- one No. 10 equilateral turnout, direct fixation.

The double crossover at Whittier/Atlantic Station will be used more often than the others, because this station will be a terminus station for some time. This crossover will require more frequent maintenance and replacements. Considerations must be made to use larger turnouts to reduce the need for maintenance which could impact the operations.

### 8.2.4 Bumping Posts

Two bumping posts shall be used at the end of the line, past the Whittier/Atlantic Station. These bumping posts shall be the energy absorbing hydraulic type and could be procured by the contractor.

**SECTION 9: UTILITIES AND POTHOLING****9.1 INTRODUCTION**

Several items control the utility work design. They are:

- **Gravity lines:** usually the deepest utilities which eventually control the top of the station. Sanitary sewer and storm drain are in this category.
  - **Sanitary Sewer:** During station construction, polyvinyl chloride (PVC) pipe is utilized temporarily. Permanent vitrified clay pipe (VCP) is installed during restoration phase.
  - **Storm drain:** During station construction, temporary lines are installed. Permanent reinforced concrete pipe (RCP) is constructed during restoration phase.
- **Telephone:** Generally, it is preferable to save telephone cables. During station construction support, existing telephone duct bank in place. If the telephone duct bank is shallow, then breaking existing ducts is required; lower and support in order to clear the decking structure. During restoration phase, encase telephone duct in concrete.
- **Power Lines:**
  - **Overhead power lines** impacted by construction to be relocated or new underground cables to be installed as another alternative.

- **Underground:** During station construction electrical ducts to be supported in place. If the electrical duct bank is shallow, it requires lowering and supporting to clear the decking structure.
- **Water:** Existing water lines are usually cast iron which have weak joints. During station construction, new steel water lines to be constructed above excavation and to be supported from the decking structure.
- **Gas:** New steel gas lines to be installed above excavation and to be supported from the decking structure.

## 9.2 UNIQUE UTILITY DESIGN CASES

### 9.2.1 Little Tokyo Station

The station was shifted southerly to avoid the 12 foot reinforced concrete arch storm drain.

### 9.2.2 First/Boyle Station

A large telephone duct bank runs under the westerly sidewalk of Boyle Avenue. The shafts on that sidewalk were shifted to avoid relocating the telephone duct bank.

### 9.2.3 First/Lorena Station

Due to the existing topography, Lorena Street is the lowest point. A 72" RCP storm drain and 10" VCP sanitary sewer run under Lorena Street. A notch in top of station is

designed to avoid the aforementioned utilities. Moreover, a sanitary sewer line was diverted outside the soldier corridor to avoid top of station.

**SECTION 10: STRUCTURAL****10.1 INTRODUCTION**

The East Side Extension project begins at the east side of the existing Union Station, crosses below the Los Angeles River and through the commercial and residential east side Los Angeles, and ends at Whittier Boulevard and South Ford Oak Drive.

This project consisted of approximately 6.8 miles of twin underground tunnels, seven underground stations, two cut-and-cover tunnel access shafts and one cut and cover vent shaft. There are four stations; First and Boyle, First and Lorena, Whittier and Rowan and Whittier & Atlantic which have crossovers.

**10.2 STRUCTURAL DESIGN DEFINITION**

Preliminary structure design definition includes:

- A preliminary structural analysis and design for the seven underground stations in coordination with the architectural and the developed modular concepts
- A tunnel line analysis, in coordination with the civil department, includes the location of the crosspassages and the emergency exits. A tunnel drive sequence was developed per RCC direction; and
- With the limited information available for the existing structures along the alignment, the underpinning for one existing bent at the

Bus way Bridge, on the east side of Union Station, and special grouting around the existing piles of one of the wing walls at the 710 Freeway, were identified.

### **10.3 STRUCTURAL CODES AND CRITERIA**

For the preliminary structural design of the underground stations, the following codes and criteria, material properties and loads were used:

#### **10.3.1 Codes and Criteria**

- A. RCC Metro Red Line System Design Criteria, Volume 2**
- B. Seismological Investigation and Design Criteria by Converse Consultants, dated May 1983**
- C. Supplementary Criteria for Seismic Design of Underground Structures by MRTC, dated June 1983**
- D. American Concrete Institute, ACI 318-89**

#### **10.3.2 Material Properties**

- A. Concrete: Compressive Strength 4000 psi at 28 days**
- B. Reinforcement: ASTM A-615 Grade 60**

**10.4 LOADS****A. Dead and Live Load**

1. Dead and live load per RCC Metro Red Line System Criteria, Volume 2. No additional load for future joint venture construction was considered.
  
2. Lateral soil pressure: No geotechnical recommendations were available at this time. The following assumptions were made
  - a) Long-term lateral soil pressure
    - 1) Above water table 55 psf
    - 2) Below water table 30 psf
  
  - b) Short-term lateral soil pressure
    - 1) Above water table 35 psf
    - 2) Below water table 20 psf
  
  - c) Water table was assumed to be 20 feet below the finish grade, except at the First and Boyle Station where it was assumed to be 40 feet below finish grade.
  
  - d) Modules of Subgrade Reaction: Vertical 75 kcf and Horizontal 50 kcf

- B. Dynamic load: Per criteria B and C in 10.3.1 above

The final design will have to address site-specific geotechnical recommendations. Four volumes of analysis and design calculations are available for future use.

**SECTION 11: SYSTEM INTEGRATION**

The only Systems Integration work that was completed for the PE package was for corrosion control and noise and vibration analysis, both of which have resulted in reports with recommendations that will be used for the final design work. See Section 14, Deliverables for a listing of deliverables not included in this Report, but available for review.

**SECTION 12. SYSTEMS****12.1 INTRODUCTION**

Systems has provided three separate reports which provide the detail PE for traction power, train control and communications.

The traction power PE report includes a computer simulation report which considered several potential outage scenarios. The simulations are based on six-car trains at 4-minute headways. In the event the East Side Extension is continued beyond Whittier/Atlantic or a branch is established, then 2-minute headways may be required. Sufficient floor space for any additional equipment requirements has been considered.

The Train Control block design and train run simulations were generated by using the equipment designs provided by the awarded Segment 2 contractor. It is based on 90-second headways which yield a 2-minute service. It is not planned to purchase or install equipment to provide a 2-minute headway until it is needed.

Because extensive use is made of the modular station design, accurate quantities of the communications equipment have been provided. Extensive use of awarded contract values was considered. Room sizes and equipments placement for all the station modules have been considered and verified.

Equipment lists were developed and given to Estimating for traction power, train control, contact rail and coverboard, communications and emergency equipment.

## 12.2 TRACTION POWER

The principle area of study completed for traction power design in support of the PE is the Traction Power System Computer Simulation Report.

This study determines required Traction Power Substation (TPSS) locations and ratings, and required numbers and sizes of DC positive and negative feeder cables for the Metro Rail Red Line Segment 3 Extension project.

Design analysis done by this study is based on the following:

- six-car trains, fully loaded (AW-2), operate in both directions
- 4-minute headways on branch lines (all Segment 3 Line sections are considered branch lines), and 2-minute headways on the trunk line (between Union Station and Wilshire/Vermont). The headway criteria has been furnished by the Operations and Maintenance Group.
- ability of two fully loaded trains to start simultaneously (one in each direction) at peak acceleration performance from station platforms
- ability of two fully loaded trains to start simultaneously (one in each direction) at reduced acceleration performance midway between passenger stations

No provision has been made for the expansion of these capabilities.

Should future operation plans require facilities or equipment for line capacity expansion, these will have to be added at a later date. The information passed to the civil designers includes space for this added equipment.

To provide the above level of service, East Side Extension of Segment 3 TPSS ratings and locations are:

First/Boyle Station	3 MW TPSS
Brooklyn/Soto Station	3 MW TPSS
Indiana/First Station (near First/Lorena)	3 MW TPSS
Whittier/Rowan Station	3 MW TPSS
Whittier/Atlantic Station	3 MW TPSS

River Yard (Little Tokyo) and Whittier/Arizona require no TPSS.

This study finds that current design practice of including six 1000-MCM positive feeder cables connecting each TPSS DC feeder breaker with the positive contact rail accommodates DC current loads at each Segment 3 TPSS. Further studies for detailed design may show that the number of feeder cables may be reduced at some of the more lightly loaded TPSS DC switchgear units.

At most Segment 3 TPSS locations, expected negative return current, based on TPSS RMS loading and positive DC feeder current loads, is well

within the RMS current rating for the standard number of negative DC feeder cables used by present Red Line TPSS designs (six 1000-MCM DC negative feeders connecting PS/S negative bus box with each track). Negative return feeder current loadings at these TPSSs will be further explored during detail design.

MTA Metro Rail Red Line Traction Power System Design Criteria are:

- Rating of equipment must be able to support the ultimate operating scenarios. Six-car trains operating at 2-minute headway on the trunk line and at 3-minute headway on the branch lines;

(This study simulates operation of two routes running at 4-minute headways whose trains are interleaved on the trunk line. Consequently, the simulations use 2-minute headways on the trunk line and 4-minute headways on the branch lines.)

- Allow simultaneous starting and accelerating at full performance of two six-car trains from any passenger station; and
- Allow starting at reduced performance of two six-car trains at any point between stations.

The East Extension Alternative 9B, upon which this study is based, proceeds southeast from Union Station to an at-grade station adjacent to the Yard. It crosses above the Los Angeles River and descends back into tunnels before reaching the second station at First/Boyle. The line then runs along Brooklyn Avenue, along Indiana Avenue and Whittier Boulevard to the last station at Whittier/Atlantic.

The details of the Alternative 9B alignment differ somewhat from the presently planned East Extension alignment. Little Tokyo (River Yard) Station has been relocated underground, and the Indiana/First station has been moved to First/Lorena. The overall alignment length has not significantly changed, and the distances between stations are similar to the earlier Alternative 9B. Since the newer alignment is totally underground, it does not have the steep grades required by the Alternative 9B aerial structure crossing the Los Angeles River. Use of Alternative 9B by these simulations consequently results in slightly more conservative results than would use of the present planned alignment; and as the latest option available at the time of the simulations, Alternative 9B is retained as the basis for this study.

These simulations are based upon advice by the Operations and Maintenance Group of two operational routes for the Metro Red Line, representing the most dense traffic anticipated over Segments 1, 2 and 3:

- Trains run in both directions from Union Station to North Hollywood on 4-minute headways
- Trains run in both directions from Whittier/Atlantic to Pico/San Vicente on 4-minute headways

The above routes are interleaved on the mainline trunk section running between Union Station and Wilshire/Vermont, resulting in 2-minute headways on this section of the alignment.

**12.2.1 Train Characteristics**

Vehicle characteristics used are those for the present Breda stainless steel body Metro Red Line trains, with trains consisting of six vehicles.

The Metro Red Line vehicles are powered by four ABB chopper-controlled motors per vehicle.

Given the above computer simulation results, the traction power system suggested by this report will be able to provide a minimum operating headway of less than 4 minutes for six-car trains on the East and Mid-City Extensions during single TPSS AC outage scenarios. However, it is unlikely that the traction power system proposed by this study could support operation on any Segment 3 extension of six-car trains at 2-minute headways (as on the trunk line).

**12.3 TRAIN CONTROL**

The Train Control report is based on and is an extension of Contract B620 which has been awarded to General Railway Signalling (GRS).

The Automatic Train Control (ATC) system to be utilized on the East Line Extension is expected to be designed, installed and tested under Automatic Train Control Contract B620 which was awarded on July 28, 1993.

The design, based on an alignment which will run from Union Station to East Los Angeles, is currently planned to consist of approximately 7

miles of track and seven below-grade stations. The alignment will begin approximately 130 feet east of the existing Union Station platform, turn off the AR/AL tracks prior to entering the Red Line Yard Lead tracks, run alongside the existing Red Line storage yard, cross under the Los Angeles River and travel into East Los Angeles.

Diamond crossovers will be installed in front of First/Boyle, First/Lorena and Whittier/Atlantic Stations, with a tail track behind the terminal station at Whittier/Atlantic. A diamond crossover will also be installed behind Whittier/Rowan Station.

The equipment and design elements to be utilized on the East Line Extension ATC system will be as specified in the B620 contract documents, barring obsolescence or other unforeseen reasons for changes, and will be fully interchangeable and compatible with the ATC system utilized in Segments 2 and 3, as well as with Segment 1, which is currently in service. All product submittals and approvals, including test procedures, systems assurance, quality assurance, etc., for Segment 2 work will apply to the East Line Extension with the exception of supplemental site specific submittals where required.

The preliminary track plan layout drawings were created from a preliminary block design based on the current alignment. Even though the Operations and Maintenance planning calls for a 4-minute operational headway, the preliminary train control system design is based on a 90-second design headway. This 90-second design headway will provide future operational flexibility for the East Line Extension with a branch line, or a closer headway operation of the East Line with four-car train turning back at either Union Station or Pico/San Vicente Station. A midline turnback will require a precise control of arrival and departure of

trains at the junction. Such precise control of arrival/departure of trains in either direction can be achieved through station dwell time adjustment via software application at Central Control.

Cable plans for the East Line Extension were provided in Contract B620 and still apply, with the exception of TC&C location C2 since no single crossover and turnout now exist. The cable requirements provided for the diamond crossover at TC&C location C4 can be utilized for the new terminus at TC&C location C7. The same diamond crossover cable requirements, less the trip stops, bumper post signals, and future PSS equipment can be utilized for all other diamond crossovers.

#### **12.4 COMMUNICATIONS**

The communications systems to be utilized on the East Line Extension are of the same technologies as those designed for Segments 2 and 3 and will be designed and procured by exercise of the Option Clause in each of the existing staged, multi-year procurement Red Line communications contracts (with the exception of B648, Communications Installation) as follows:

- B641 Radio
- B642 Public Address
- B643 Closed-Circuit Television
- B644 Fiber Optic and Cable Transmission System

- B645 TRACS
  
- B646 Fire and Emergency Management
  
- B647 Gas and Seismic Monitoring -  
NOTE - This contract was incorporated into B648A
  
- P0060 Variable Message Signs
  
- 4239 Telephones - Supplied by MTA Operations
  
- B648A Communications Installation

The equipment and design elements to be utilized on the East Line Extension communications systems will be as specified in the contract documents, barring obsolescence or other unforeseen reasons for changes, and will be fully interchangeable and compatible with the communications systems utilized in Segments 2 and 3, as well as with Segment 1, which is currently in service. All product submittals and approvals, including test procedures, systems assurance, quality assurance, etc., for Segment 2 work will apply to the East Line Extension.

As with TC&C rooms in Segments 2 and 3, the following Authority-furnished equipment will be provided in each TC&C room:

- duct bank/conduit access
  
- cable tray system
  
- room lighting

- battery room access - conduit access from TC&C room will be provided
- equipment ground plate - an equipment ground connection plate will be provided in each TC&C room for using in grounding both the ATC and communications system grounding

The B648D contractor shall install and test all equipment necessary to complete the communications systems. The communications systems in the existing Union Station TC&C room will be expanded and modified to allow for the addition of the East Line as required.

Rolf Jensen & Associates have used the January 31, 1994 drawings and the patronage data figures marked "for station analysis only" dated February 10, 1994 as a basis for the preliminary exiting calculations.

Because of time constraints, Rolf Jensen & Associates used the standard figures for area deductions used in calculations for the Segment 3 stations. The widths of the various exit elements were scaled off the reduced set of drawings because dimensions were not provided. Based on the requirements of the 1991 UBC, the stations do not have sufficient exit width. Approximately 12 to 24 inches of additional exit width would be needed at each station. However, since they did not deduct for fixed station furniture or the additional area, which could be made inaccessible with the under-stair railing, the stations will probably have sufficient exit width to meet the UBC requirements when the final design features are incorporated into the design.

Rolf Jensen & Associates looked at the patronage data which was supplied. The numbers appear to be similar to or lower than those from Segment 2. These figures would also tend to support the premise that the stations will have sufficient exit width at final design.



**SECTION 13: VALUE ENGINEERING****13.1 INTRODUCTION**

During the development of the PE work, a number of the elements of the East Side Extension project was evaluated with the objective to reduce the overall construction cost. Some of these exercises were true, value engineering studies conducted in a classical value engineering format. Others were the result of an improved alignment resulting in shorter tunnel length or relocating a station box to avoid having to move major underground utilities.

The most complex analysis entailed finding the overall, lowest cost solution for the location of the Little Tokyo Station. This study considered a number of different locations and determined all of the impacts that would have to be addressed in order to construct a station in that particular location.

The following is a brief description of four of the major studies that resulted in a reduction of the PE construction cost estimate by some 6% under the conceptual budget estimate, while taking into account the addition of two new crossovers and vent/emergency exit cut-and-cover shafts at the end of the tail track beyond the Whittier/Atlantic Station and two permanent construction shafts at Brooklyn/Soto and Whittier Arizona Stations.

**13.2 610-FOOT STATION BOX**

The development of the 610-foot Modular Station Box was a direct result of the Value Engineering Study conducted by the EMC Design Team on the Olympic/Crenshaw Station. The results were reviewed and approved by the Fluor Daniel Group who is responsible for the Metro Value Engineering effort.

The 610-foot Modular Station was utilized for six of the seven stations on the East Side Extension. With an estimated savings of between \$6 and \$9 million per station, the Study resulted in a substantial cost reduction for the project.

### **13.3 ALIGNMENT STUDIES**

The selected LPA alignment between the Little Tokyo Station and the First/Boyle Station was proposed to be part above-grade and part underground which produced 4% grade changes. Due to the north/south orientation of the Little Tokyo Station and the east/west orientation of the First/Boyle Station, a double "S" curve section was created. The radii for these two curves were the minimum allowable 750 foot radius which resulted in a 23 mph civil design speed that would have forced a 22.5 mph maximum train speed.

After looking at several alternatives, it was realized that if the First/Boyle Station was to be rotated from its east/west orientation to a northeast/southwest orientation, a considerably easier curve could be achieved (1150 foot radius) which would permit a 45 mph civil design speed. This alignment would also shorten the alignment by approximately 500 feet with a construction cost savings of approximately \$6.5 million.

### **13.4 FIRST/LORENA STATION**

Due to the topography at this station, it is the deepest station in the East Side Extension. There is also a deep 30" gravity storm water sewer running under Lorena Street which forced the station box to be even deeper. By positioning the station so that the sewer line could pass through a notch in the station box top it was possible to raise the elevation of the box by ten feet. Due to the fact that this is a station plug, a crossover saved over \$10 million in construction costs for this station.

**13.5 LITTLE TOKYO STATION**

The most extensively studied station in the entire East Side Extension was the Little Tokyo Station. The reason for this was that during the early PE design effort, there was a number of significant impacts identified that would have to be overcome in order to build this station.

The LPA, adopted by the MTA, located this station above grade along the eastern edge of the existing MTA Yard. The track alignment started underground in the portal just south of Union Station, came up to grade just north of the First Street Bridge, passed under the bridge, and began an incline in order to achieve enough height to cross over the AT&SF Yard, the Los Angeles River and the Union Pacific Railroad. The alignment then went through an industrial area on the east side of the Los Angeles River and back underground to the First/Boyle Station.

All of these considerations impacted civil, structural, trackwork, right-of-way, architectural, operations and maintenance, systems and Fire/Life Safety design effects. One main concern was to find the most cost-effective solution. Therefore, it became necessary to look at all the costs from Union Station to the First/Boyle Station and not just compare the cost difference between an at-grade station to an underground station.

Many alternatives were examined along with their plans and profile impacts. ICF Kaiser Engineers was even asked by the Area Team to look independently at the problem in order to obtain a second opinion. The end result of all this effort was the confirmation that the underground solution along Santa Fe Avenue was in fact the most cost-effective scheme. The scheme, when looked at from Union Station to First/Boyle Station, used \$38 million less just for construction costs. This dollar figure did not take into account the cost of the

real estate takes in the industrial area that were not required for the under Santa Fe scheme.

**SECTION 14: DELIVERABLES****14.1 INTRODUCTION**

The following is a list of PE Reports that are not part of this submission, but are available for review. Please contact Mr. Jim Hays at (213) 312-3239 to review these documents or for more information.

**14.2 GEOTECHNICAL**

- Draft Preliminary Geotechnical
- Final Preliminary Geotechnical
- Stage I Environmental Site Assessment
- Stage II Environmental Site Assessment

**14.3 OPERATIONS AND MAINTENANCE**

- Operating Requirements

**14.4 RIGHT-OF-WAY**

- Blue Line aerial topography maps <sup>\*</sup>(1" = 40') 25 sheets 39" x 58"
- Aerial photographs
  - Photo scale at 1" = 250' - 9" x 9" color contact prints (62)
  - Photo scale at 1' = 400' - 9" x 9" color contact prints (43)
  - Black and white photo index for the 1" = 250' contact prints (1" - 850')
  - Black and white photo index for the 1" = 400' contact prints (1" = 160')

<sup>\*</sup>Half-size aerial topography maps are also available.

**14.5 SYSTEMS INTEGRATION**

- Noise and Vibration
- Corrosion Control Report

**14.6 SYSTEMS**

- Automatic Train Control (ATC)
- Systems Communications
- Traction Power System Computer Simulation

# **APPENDIX**

## **PRELIMINARY ENGINEERING SPECIFICATIONS**

### **TABLE OF CONTENTS**

LOS ANGELES METROPOLITAN TRANSPORTATION AUTHORITY  
METRO RED LINE RAIL TRANSIT PROJECT

PART A - SPECIFICATIONS  
TABLE OF CONTENTS

NEW SYSTEMWIDE BASELINE

(EAST SIDE EXTENSION PRELIMINARY ENGINEERING)

<u>Section Number</u>	<u>Section Title</u>	<u>Number of Pages</u>
<b>DIVISION 1 - GENERAL REQUIREMENTS</b>		
01010	SUMMARY OF THE WORK	4
01018	INSTALLATION OF AUTHORITY-FURNISHED EQUIPMENT	4
01042	ARTWORK COORDINATION	1
01046	ELEVATOR INTERFACE	3
01048	ESCALATOR INTERFACE	3
01050	GRADES, LINES AND LEVELS	2
01056	GEOTECHNICAL INSTRUMENTATION - CUT-AND-COVER	16
01057	GEOTECHNICAL INSTRUMENTATION - TUNNELS	11
01105	AUTHORITY-DIRECTED STOPPAGES	4
01170	ARCHAEOLOGICAL AND PALEONTOLOGICAL COORDINATION	2
01175	HAZARDOUS WASTE OPERATIONS EARTHWORK	3
01200	CONTRACT MEETINGS	4
01300	SUBMITTALS	9
01310	COST/SCHEDULE INTEGRATION SYSTEM	11
01311	BAR CHART SCHEDULE	4
01312	BAR GRAPH SCHEDULE	5
01380	CONSTRUCTION PHOTOGRAPHS	2
01455	QUALITY ASSURANCE FOR PROCUREMENT	5

<u>Section Number</u>	<u>Section Title</u>	<u>Number of Pages</u>
01460	CONTRACTOR CONSTRUCTION CONTROL REQUIREMENTS	5
01500	TEMPORARY FACILITIES	6
01505	MOBILIZATION	2
01518	TEMPORARY AND POST CONSTRUCTION VENTILATION	3
01522	TEMPORARY DECKING SYSTEMS	5
01530	TEMPORARY BARRIERS	2
01535	CONSTRUCTION FENCING (WOOD)	
01536	CONSTRUCTION FENCING (CHAIN LINK)	2
01537	SHRUB AND TREE PROTECTION	4
01545	WORKSITE SAFETY REQUIREMENTS	4
01546	FIRST AID FACILITIES	1
01550	TEMPORARY ACCESS ROADS AND PARKING AREAS	2
01563	TEMPORARY EROSION AND SEDIMENTATION CONTROLS	3
01566	POLLUTION CONTROLS	9
01568	HAZARDOUS WASTE OPERATIONS SAFETY AND HEALTH PROGRAM	4
01576	CONTROLLING TRAFFIC (AUTHORITY-FURNISHED WTCP)	5
01577	CONTROLLING TRAFFIC (CONTRACTOR FURNISHED TLR)	4
01578	CONTROLLING TRAFFIC	4
01580	TEMPORARY SIGNS	3
01590	FIELD OFFICE	4
01620	STORAGE AND PROTECTION	2
01710	CLEANING	2
01720	AS-BUILT DRAWINGS AND CURRENT STATUS DOCUMENTS	5
01730	OPERATION AND MAINTENANCE DATA	3
01740	WARRANTIES AND BONDS	1
01750	SPARE PARTS AND REPLACEMENT MATERIALS	1

	<u>Section Number</u>	<u>Section Title</u>	<u>Number of Pages</u>
<b>DIVISION 2 - SITE WORK</b>			
***	02050	DEMOLITION, REMOVAL, AND REPLACEMENT	5
***	02090	ARTIFACTS	6
	02110	SITE CLEARING	3
	02117	TREE PRUNING	2
	02140	DEWATERING	5
	02145	DEWATERING FLUID TREATMENT (DFT)	7
	02154	CHEMICAL GROUTING, PROTECTION AND RESTORATION OF STRUCTURES	7
	02155	COMPACTION GROUTING, PROTECTION, AND RESTORATION OF STRUCTURES	13
	02156	UNDERPINNING, SUPPORT AND RESTORATION OF STRUCTURES	4
	02160	EXCAVATION SUPPORT SYSTEMS	11
	02162	TIEBACK ANCHORS	8
	02200	EARTHWORK	9
	02232	CRUSHED AGGREGATE BASE	1
	02271	EARTH RETAINING SYSTEM	8
***	02311	SHIELD DRIVEN TUNNELS	14
	02312	MINED CROSSPASSAGES	7
	02322	PRECAST CONCRETE ONE-PASS TUNNEL LINERS	17
	02324	FABRICATED STEEL SEGMENTED TUNNEL LINERS	15
***	02330	TUNNEL GROUTING	4
	02344	DIRECT INITIAL STEEL TUNNEL SUPPORT	7
***	02345	DIRECT INITIAL TUNNEL SUPPORT SYSTEM	12
	02351	DRILLED CAISSONS	4
	02352	DRILLED PILES	5
	02355	DRILLED SHAFT FOUNDATIONS	8

<u>Section Number</u>	<u>Section Title</u>	<u>Number of Pages</u>	
02356	STEEL SHEET PILING	6	
02362	CAST-IN-PLACE CONCRETE PILES	4	
02374	OCS POLE FOUNDATION AND GUY ANCHOR PIER SHAFTS	3	
02376	OCS POLE FOUNDATION PIER CONSTRUCTION	4	
02378	OCS GUY ANCHOR PIER CONSTRUCTION	3	
02379	OCS POLE ANCHOR BOLT PEDESTAL CONSTRUCTION	4	
02387	CAST-IN-DRILLED-HOLE PILES	9	
02450	GENERAL TRACK CONSTRUCTION	20	
02451	DIRECT FIXATION TRACK CONSTRUCTION	10	
02453	SPECIAL TRACKWORK CONSTRUCTION - DIRECT FIXATION	8	
02455	RUNNING RAIL		
02456	STANDARD DIRECT FIXATION RAIL FASTENERS	37	
02459	SPECIAL DIRECT FIXATION RAIL FASTENERS	38	
02467	RAIL WELDING	9	
02512	ASPHALT CONCRETE PAVEMENT	3	
02514	PORTLAND CEMENT CONCRETE PAVEMENT	3	
02528	CONCRETE CURBS, GUTTERS AND SIDEWALKS	3	
02580	PAVEMENT STRIPING AND MARKING	2	
02600	PIPED UTILITIES	22	
02601	MAINTENANCE AND SUPPORT OF UTILITIES	7	
02605	MANHOLE FRAMES AND COVERS	2	
02660	WATER DISTRIBUTION SYSTEM	13	
02661	CATHODIC PROTECTION FOR WATER DISTRIBUTION FACILITIES	4	
02666	GAS DISTRIBUTION SYSTEM REARRANGEMENTS	5	
***	02667	WATER SERVICE	6
***	02712	FOUNDATION DRAINAGE SYSTEM	2

<u>Section Number</u>	<u>Section Title</u>	<u>Number of Pages</u>
02720	STORM DRAINAGE SYSTEMS	7
***	02725 UNDERDRAINS AND GEOTEXTILE FABRICS	3
02730	SANITARY SEWERS	7
02753	GAS SUPPLY SYSTEM	2
02788	UNDERGROUND ELECTRICAL DISTRIBUTION SYSTEM AND STRUCTURES	8
02790	STREET LIGHTING	6
02791	TRAFFIC SIGNALS	2
02795	UNDERGROUND TELEPHONE, TELEGRAPH AND CITY COMMUNICATIONS	4
02796	UNDERGROUND TELEPHONE, TELEGRAPH AND CITY COMMUNICATIONS AND ATSAC, FACILITIES	
02798	UNDERGROUND CABLE TELEVISION AND ATSAC FACILITIES	3
02810	IRRIGATION SYSTEM	9
02831	CHAIN LINK FENCING	6
***	02846 ROADSIDE SIGNS	4
***	02872 TRASH RECEPTACLES	2
***	02873 TREE GRATES AND FRAMES	2
02875	TREE WELLS	1
02910	TREE STORAGE AND REPLANTING	4
02950	LANDSCAPE PLANTING	8
02951	LANDSCAPE MAINTENANCE AND PLANT ESTABLISHMENT	6
<b>DIVISION 3 - CONCRETE</b>		<b>16</b>
03100	CONCRETE FORMWORK	9
03200	CONCRETE REINFORCEMENT	9
03253	WATERSTOPS	3
03300	CAST-IN-PLACE CONCRETE	20

<u>Section Number</u>	<u>Section Title</u>	<u>Number of Pages</u>
03301	PORTLAND CEMENT CONCRETE	
03338	ARCHITECTURAL CONCRETE PAVING	10
03345	CONCRETE DUSTPROOFING	3
03346	UNFORMED CONCRETE FINISHES	8
03347	EXPOSED FINISH CONCRETE	6
03361	CAST-IN-PLACE CONCRETE TUNNEL LINERS	8
03363	SHOTCRETE	6
03365	FLOATING SLABS	8
03366	CAST-IN-PLACE FLOATING SLABS	12
03402	PRECAST PRESTRESSED PANELS	4
03403	PRECAST PRESTRESSED PLANKS	4
***	03400 PRECAST CONCRETE	16
	03412 TEMPORARY PRECAST CONCRETE DECK	2
	03450 ARCHITECTURAL PRECAST CONCRETE	6
	03500 EMERGENCY STAIRWAYS	2
	03600 GROUT	4
	<b>DIVISION 4 - MASONRY</b>	4
***	04010 DUCTS AT DIRECT FIXATION TRACK	3
***	04020 CONDUITS AT DIRECT FIXATION TRACK	2
	04100 MORTAR	3
	04150 MASONRY ACCESSORIES	2
	04220 CONCRETE UNIT MASONRY	6
***	04410 COMPOSITE GRANITE PAVERS	8
	04465 GRANITE	9

**DIVISION 5 - METALS**

<u>Section Number</u>	<u>Section Title</u>	<u>Number of Pages</u>
05040	GALVANIZING	4
05055	BASIC WELDING REQUIREMENTS	5
05120	STRUCTURAL STEEL (STANDARD)	9
05415	NON-BEARING STEEL STUD WALLS	3
05500	METAL FABRICATIONS	10
05505	TELEPHONE BOOTHS	6
05510	METAL STAIRS	4
05511	STAINLESS STEEL ASSEMBLIES	9
***	05512 STAINLESS STEEL FILLER PANEL SYSTEM	4
***	05581 CUSTOM SHEET METAL	7
***	05700 ORNAMENTAL METAL WORK	8
	05810 SEISMIC EXPANSION JOINT ASSEMBLIES	3
<b>DIVISION 6 - WOOD AND PLASTIC</b>		
06100	ROUGH CARPENTRY	4
<b>DIVISION 7 - THERMAL AND MOISTURE PROTECTION</b>		
07100	THREE-PLY MEMBRANE WATERPROOFING	4
07101	HYDROCARBON-RESISTANT MEMBRANE FOR CAST-IN-PLACE CONCRETE	6
07102	ADHERED WATERPROOFING	
07103	HYDROCARBON-RESISTANT ELEVATOR CASING	4
07110	FLUID APPLIED WATERPROOFING	5
07121	HYDROCARBON-RESISTANT COATING	4
07150	DAMPPROOFING	3
07210	BUILDING INSULATION	3
07211	DIELECTRIC INSULATION	3

	<u>Section Number</u>	<u>Section Title</u>	<u>Number of Pages</u>
***	07810	SKYLIGHTS	6
***	07820	METAL FRAMED SKYLIGHTS	5
***	07901	SEALING LEAKS	5
	07910	JOINT FILLERS AND GASKETS	4
	07920	SEALANTS	7
<b>DIVISION 8 - DOORS AND WINDOWS</b>			
	08100	HOLLOW METAL DOORS AND FRAMES	9
***	08304	EMERGENCY EXIT DOORS	3
	08305	ACCESS DOORS	5
	08315	PRESSURE RESISTANT DOORS AND FRAMES FOR TUNNELS AND CROSS PASSAGES	7
	08331	OVERHEAD COILING DOORS - ELECTRIC	5
***	08343	OVERHEAD COILING STAINLESS STEEL GRILLES, ELECTRIC	4
	08710	FINISH HARDWARE	19
	08800	GLASS AND GLAZING	4
<b>DIVISION 9 - FINISHES</b>			
	09260	GYPSUM BOARD	5
	09330	FLOOR AND WALL TILE	6
***	09412	TERRAZZO REMOVAL, STORAGE AND REINSTALLATION	7
	09510	ACOUSTICAL PANEL CEILINGS	4
***	09512	ACOUSTICAL CELLULAR GLASS PANELS	6
***	09513	ACOUSTICAL ALUMINUM PANELS	4
***	09515	METAL CEILING SYSTEMS	7
***	09516	STAINLESS STEEL FORMED CLADDING	5
***	09549	PREFORMED METAL PANELS	4
	09650	RESILIENT FLOORING	3

	<u>Section Number</u>	<u>Section Title</u>	<u>Number of Pages</u>
***	09782	DETECTABLE DIRECTIONAL TILES	3
***	09802	COAL-TAR EPOXY COATING SYSTEM	5
***	09818	ACID-RESISTANT APPLIED COATING	3
***	09853	FLUOROPOLYMER COATING	4
***	09860	ANTI-GRAFFITI COATING	3
***	09861	CONCRETE AND MASONRY SEALER	3
	09900	PAINTING	12
<b>DIVISION 10 - SPECIALTIES</b>			
	10200	LOUVERS	3
	10210	ALUMINUM LOUVERS	2
	10400	INSTALLATION OF SIGNS	2
	10430	INSTALLATION OF SIGNING AND EDGE LIGHT	4
	10440	SITE AND OPERATION SIGNS	9
	10522	FIREHOSE AND STAINLESS STEEL CABINETS	4
	10670	STORAGE RACK SYSTEM	3
	10800	TOILET ACCESSORIES	4
<b>DIVISION 11 - EQUIPMENT (NOT USED)</b>			
<b>DIVISION 12 - FURNISHINGS</b>			
	12100	INSTALLATION OF FOIC ARTWORK	10
<b>DIVISION 13 - SPECIAL CONSTRUCTION (NOT USED)</b>			
<b>DIVISION 14 - CONVEYING SYSTEMS (NOT USED)</b>			
	14200	HYDRAULIC ELEVATORS	21
	14241	FIBERGLASS ELEVATOR JACK-HOLE CASING	3

<u>Section Number</u>	<u>Section Title</u>	<u>Number of Pages</u>
14300	JIB CRANES - FLOOR MOUNTED	6
14310	ESCALATORS	19
<b>DIVISION 15 - MECHANICAL</b>		
15001	MECHANICAL DEMOLITION	3
15005	ELECTRICAL REQUIREMENTS OF MECHANICAL WORK	2
15010	BASIC MECHANICAL REQUIREMENTS	30
15142	PIPE SLEEVES, SUPPORTS, GUIDES AND ANCHORAGE	7
15162	WATER CIRCULATING PUMPS	3
15165	SUMP PUMPS	6
15190	MECHANICAL IDENTIFICATION	2
15242	VIBRATION ISOLATION DEVICES	6
15252	INSULATION	7
15253	DUCT LINING	2
15333	FIRE PROTECTION SYSTEMS	7
15377	FIRE PUMPS	3
15405	WATER SUPPLY SYSTEM	7
15432	SANITARY SEWER SYSTEM	9
15434	STORM DRAINAGE SYSTEM	7
15436	SAND AND GREASE INTERCEPTOR	3
15440	PLUMBING FIXTURES	4
15454	DOMESTIC WATER HEATERS	4
15482	COMPRESSED AIR SYSTEM	10
15484	VACUUM CLEANING SYSTEM	2
15486	NATURAL GAS SYSTEM	4
15500	HEATING, VENTILATING AND AIR CONDITIONING UNITS	7
15504	HEATING, VENTILATING AND AIR CONDITIONING EQUIPMENT	16

<u>Section Number</u>	<u>Section Title</u>	<u>Number of Pages</u>
15510	HEATING HOT WATER SYSTEM	5
15520	BOILERS	3
15530	REFRIGERANT PIPING SYSTEM	4
15532	CHILLED AND CONDENSER WATER PIPING SYSTEM	7
15671	AIR COOLED CONDENSING UNIT	3
15852	AIR HANDLING APPARATUS - HVAC	9
15888	AIR DISTRIBUTION AND DUCT SYSTEM	9
15920	SOUND ATTENUATORS	3
15952	CONTROLS AND INSTRUMENTATION	6
15990	TESTING, ADJUSTING AND BALANCING	7

**DIVISION 16 - ELECTRICAL**

16001	ELECTRICAL DEMOLITION	4
16050	BASIC ELECTRICAL MATERIALS AND METHODS	23
16051	MOTORS	5
16052	CABLEWAYS FOR TUNNEL	5
16110	MISCELLANEOUS SYSTEMS RACEWAYS FOR INSIDE PASSENGER STATIONS	4
16119	UNDERGROUND ELECTRICAL DISTRIBUTION SYSTEM AND STRUCTURES	5
16120	INSULATED WIRES AND CABLES	6
16426	480-VOLT SWITCHBOARD	9
16455	GROUNDING AND BONDING	4
16460	AUXILIARY POWER TRANSFORMERS, DRY-TYPE	7
16464	DRY-TYPE TRANSFORMERS	3
16471	ENCLOSED CIRCUIT BREAKERS AND PANELBOARDS	4
16472	AUTOMATIC TRANSFER SWITCH (ATS)	5
16482	MOTOR CONTROL CENTERS	7

<u>Section Number</u>	<u>Section Title</u>	<u>Number of Pages</u>	
16483	MOTOR STARTERS AND CONTACTORS	5	
16484	LOCAL CONTROL STATIONS, AUXILIARY CONTROL PANELS, COMMUNICATION INTERFACE CABINETS, PUMP CONTROL PANEL AND AIR CONDITION CONTR	3	
16500	LIGHTING	11	
16510	TUNNEL LIGHTING	4	
16610	UNINTERRUPTIBLE POWER SUPPLY	3	
16645	CATHODIC PROTECTION SYSTEMS	4	
16760	SCADA		
16761	TRACS		
16770	PUBLIC ADDRESS SYSTEM		
16780	TELEVISION SYSTEM		
16792	WIRE LINE DATA TRANSMISSION		
16794	COAXIAL CABLE DATA TRANSMISSION		
16795	FIBER OPTICS DATA TRANSMISSION SYSTEM		
16798	RADIO DATA TRANSMISSION SYSTEMS		
***	16944	CONTROLS AND INSTRUMENTATION	6
	16955	TEST SUPPORT	3

END OF TABLE OF CONTENTS