GENERAL DESCRIPTION

Of

RAPID TRANSIT SYSTEM

BACKBONE ROUTE

For

LOS ANGELES METROPOLITAN TRANSIT AUTHORITY

July, 1961

KAISER INDUSTRIES CORPORATION

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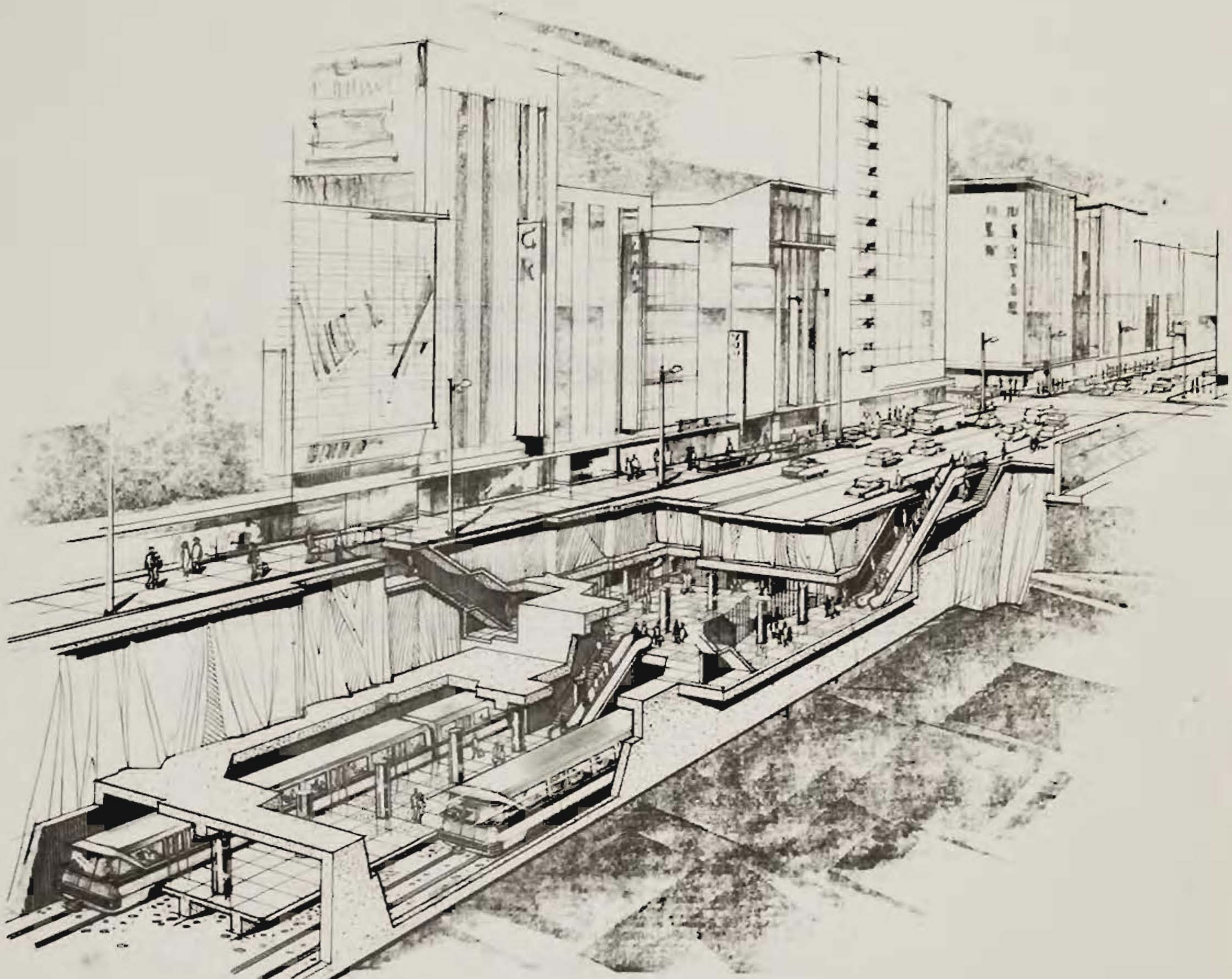

SIXTH AND BROADWAY STATION

GENERAL DESCRIPTION

OF

RAPID TRANSIT SYSTEM

BACKBONE ROUTE

FOR

LOS ANGELES METROPOLITAN TRANSIT AUTHORITY

July, 1961

Kaiser Industries Corporation

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I. INTRODUCTION

Kaiser Industries has been following with active interest the planning for a rapid transit system in Los Angeles with its vital impact on the growth of the central city and adjoining areas.

Kaiser Industries has had extensive experience in large scale operations for both commercial and governmental interests. This experience which includes the complete execution of a project starting with the basic planning through detailed engineering design, construction and installation has been utilized in preparing this submission.

Kaiser Industries has reviewed all aspects relating to the early construction of the mass rapid transit system. As a result of this preliminary review, Kaiser Industries findings consisting of the following conclusions were presented to LAMTA in April, 1961.

A. Kaiser Industries engineering studies to reduce capital costs indicate that savings in the magnitude of $100 million can be realized in the full 75-mile system, using the routing and alignment recommended to the Authority by its consulting engineers. This would be accomplished by the use of advanced but more conventional concepts of rolling equipment and improved engineering features as they apply to the system structures.

B. Our preliminary review also indicated that the 75-mile system could be placed into operation within 3 to 4 years after all major decisions have been made with respect to the system itself and all rights-of-way have been firmly secured.

C. If adequate financing could not be secured for the full system, Kaiser Industries proposed that consideration be given to a stage construction program.

The Los Angeles Metropolitan Transit Authority staff embarked on a traffic, revenue and financing study based on a first stage referred to as the "backbone route" which consisted of approximately 22.7 miles of system, of which 12 miles in the downtown area and Wilshire Boulevard were in subways. Kaiser Industries furnished construction costs for this system. As a result of this study the following conclusions were drawn by LAMTA:

That the construction of the backbone route could be financed by a low interest loan from system revenue.

That by employing steel wheel, steel rail concept, the construction of the backbone route is possible within the next four years.

This presentation deals with the development of criteria leading to the general system description which accompanies the LAMTA basic report on traffic and revenue. In this presentation, Kaiser Industries has analyzed the major technical and construction challenges for this program.

The information presented in this report is sufficient to form the basis of a general specification upon which the project could proceed immediately.

II. SUMMARY

Kaiser Industries objectives in this report are to select and present a mass rapid transit system having the following characteristics:

1. Lowest possible first cost within the performance criteria established for the recommended system.

2. Proven reliability and safety without embarking on an extensive and costly research and development program.

This study led to the investigation of rolling equipment and transit system concepts other than the systems presented in detail to LAMTA by their consulting engineers.

Results of this investigation led to the conclusion that an ultra-modern steel wheel, steel rail system employing improved light weight cars should be used for the transit system. The reasons for this conclusion are as follows:

1. Substantially lower system first cost.

2. Reliability and safety, in that the elements making up the steel wheel, steel rail system have been proved in service.

3. Lower operating and maintenance costs in favor of the steel wheel, steel rail system.

4. The rolling equipment can be designed with a pleasing interior and exterior appearance, smooth riding qualities and with an acceptable noise level both inside and outside. Interior and exterior concepts of the proposed rolling equipment are shown at the end of this summary.

The system alignment dictated by the criteria indicates a backbone route 22.7 miles long with approximately 12 miles in subway in the downtown Los Angeles area and out the Wilshire Corridor. The balance of the system is located at grade adjoining and in the median strip of the San Bernardino Freeway.

The system will be operated completely by automatic controls with provision for manual override.

Section III of this report outlines the general technical considerations involved in the selection of the specific alignment and equipment. Table I, page II-4, lists the principal characteristics of the system. Figure I indicates the general routing of the backbone system in relation to the full 75-mile system.

Due to the extensive use of subways, a preliminary geologic and soils study was conducted to determine underground construction methods and costs. The results of this study indicated the following:

1. The proposed underground route is geologically feasible. Proper precautions can be taken in the design stage to provide adequate support for the ground so that settlement does not occur in adjacent and overlying buildings.

2. An extensive soils boring program along the proposed route will be required to determine specific soils conditions before underground design can be completed.

Based on the findings in the geological study, tunnel sections taking into consideration the general nature of soils encountered were developed and served as the design basis in this report. Tunneling will be carried out from the east and west portals and from two intermediate adits located off of Wilshire Boulevard so the tunneling distances will be approximately equal. By employing tunneling methods between stations, and by virtue of the soils characteristics, the following advantages over a "cut-and-cover" type of operation will result:

1. Minimum surface construction

2. Immediate ground support

3. Minimum traffic disturbance

4. Minimum utility relocation

Station construction will be based on staged cut-and-cover type of operations. The method for accomplishing this has been selected with emphasis on project and public safety. For example, no systematic or heavy blasting is contemplated. Piles, where required, will be set in bored holes rather than being driven. Pedestrian traffic will be maintained. Except for relatively short periods, street traffic will be maintained. Utility service will be maintained throughout the construction period.

The project schedule for the backbone increment of the mass rapid transit system covers a 42-month period from initiation of the project to the date of initial operation. This schedule is predicated on the resolution of all major decisions with respect to the system itself and the availability of all rights-of-way. It is planned to initiate the orders for the major equipment items in the early stages of design and to start construction prior to completion of design engineering.

General arrangement and outline drawings have been prepared to supplement the facility description for the proposed backbone system. Section IV of this report presents facility descriptions and concept drawings.

TABLE I

SUMMARY OF RAPID TRANSIT SYSTEM DATA

BACKBONE ROUTE

1. SYSTEM LENGTHS - Miles

Underground	12.0 Miles
At Grade	10.7 Miles
Total	22.7 Miles

2. STATIONS

	Number	Locations	
Underground	16	Beverly	Century City
		Normandie	Western
		Crenshaw	La Brea
		Masselin	Fairfax
		Robertson	Union Station
		1st Street	6th Street
		Hope	Lucas
		Alvarado	Vermont
At Grade	8	Fremont	Eastern
		State	Hoyt
		Rosemead	San Gabriel
		New	Atlantic
Total	24		

3. POWER SUBSTATIONS

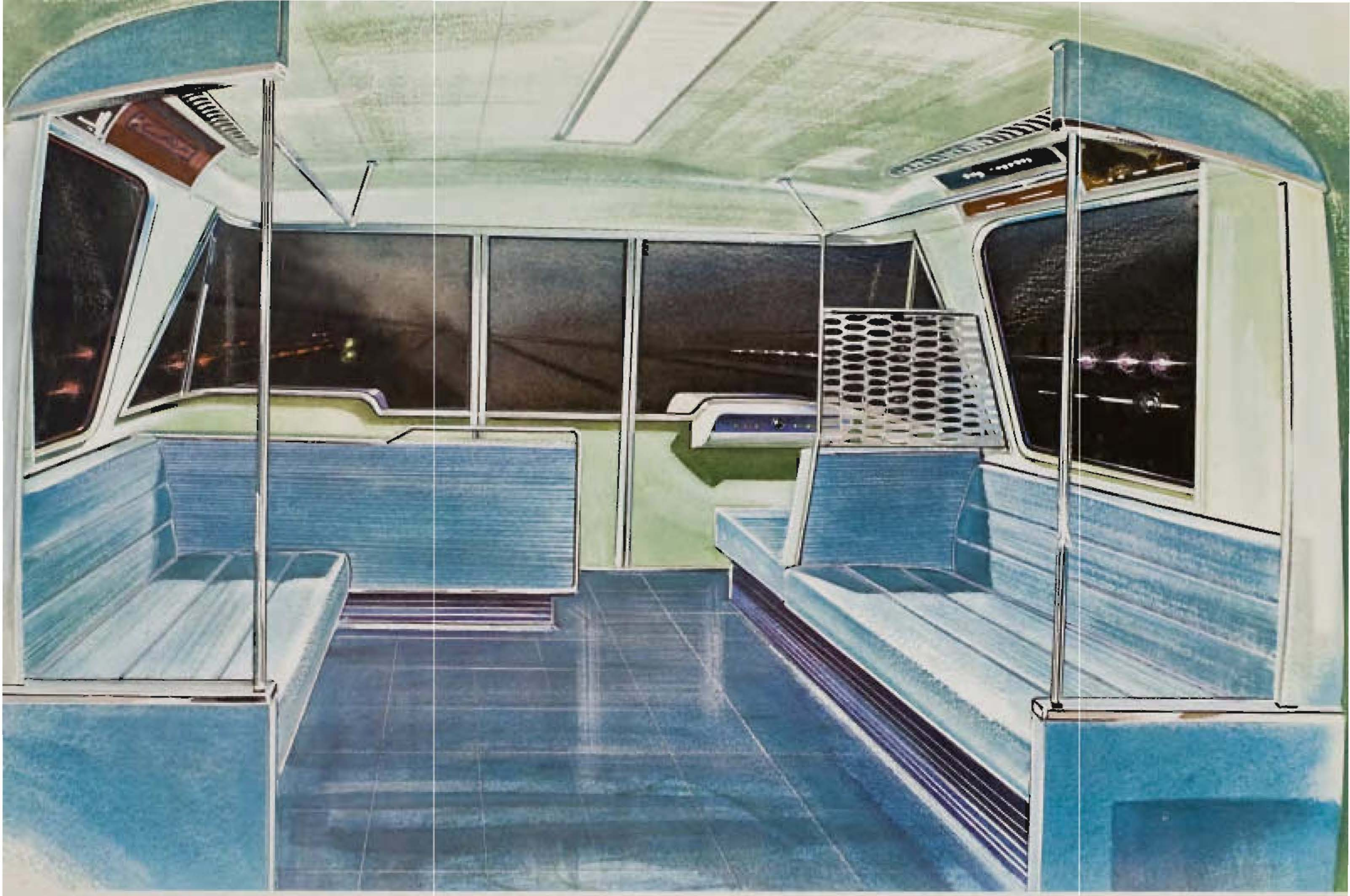
Number	15
Traction Power Supply	600 Volts d-c

4. ROLLING STOCK

Number of cars	120
Car length	75 ft - 78 ft
Seated passengers	85-88
Standees (maximum)	112
Total Passengers	200

5. NUMBER OF DAILY RIDERS — 86, 000 (first year)


CEN. CITY



PROPOSED INTERIOR VIEW (FRONT SECTION)

BACKBONE ROUTE
FOR
LOS ANGELES METROPOLITAN TRANSIT AUTHORITY

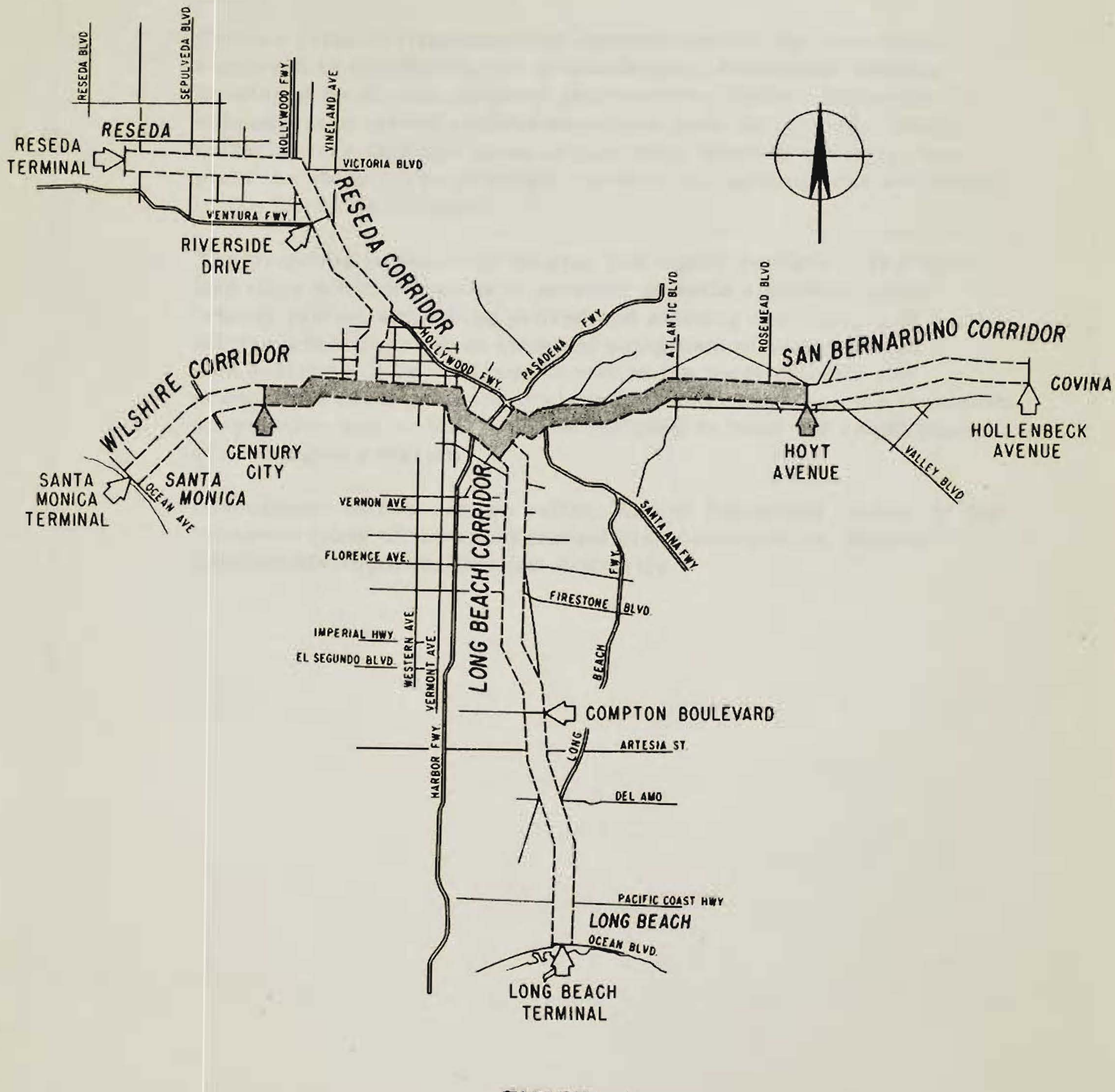


FIGURE 1

III. GENERAL CONSIDERATIONS

A. Scope

Certain criteria from previous reports and studies have been employed in developing this presentation. Additional criteria developed by the Los Angeles Metropolitan Transit Authority subsequent to issued reports also have been designated. Where criteria were lacking, assumptions were made in order to complete the study. The principal criteria and assumptions are listed in the following sections.

The proposed system will be safe and highly reliable. The specified time schedule makes it possible to build a modern rapid transit system employing proved and existing services, and off-the-shelf or in-place items of equipment of latest design. The system will be designed to utilize the most reliable and economical arrangements now available. In addition, the maximum adaptability and mobility will be included to meet the requirements of a changing program.

Discussions in this section reflect Kaiser Industries concept of the backbone route of the rapid transit plan developed by the Los Angeles Metropolitan Transit Authority.

B. Criteria and Assumptions

1. Transit System

a. Safety

Safety of transit passengers and operating personnel is of primary importance. All equipment and structures shall be designed and selected to achieve this criteria.

b. Passenger Traffic

The initial backbone route shall be capable of transporting passengers in accordance with the following rates per hour over one track at an average speed of 35 miles per hour.

	2-Minute Headways		90-Second Headways	
	Seated	Seated & Standees	Seated	Seated & Standees
No. of Passengers	15,300	36,000	20,400	48,000

To accomplish this, a transit car of the following dimensions has been assumed:

Length	75 ft to 78 ft
Seated Passengers	85 to 88

The ultimate system shall be capable of transporting passengers in accordance with the following rates:

	2-Minute Headways		90-Second Headways	
	Seated	Seated & Standees	Seated	Seated & Standees
No. of Passengers	20,400	48,000	27,200	64,000

Provision will be made in the initial design for the ultimate system requirements without incurring the construction cost in the initial phase.

c. Corridors

The four broad corridors developed by Coverdale and Colpitts as part ot the ultimate eight-corridor system shall be used in establishing the alignment. The corridors used for this report shall be the Wilshire and San Bernardino Corridors.

d. Subway Alignment

The alignment established by Daniel, Mann, Johnson, and Mendenhall for the subway routing in the downtown area and the Wilshire Corridor shall be used, including station stops with the following exceptions made by the LAMTA staff:

Broadway in lieu of Main Street in the downtown area. This was done to provide more direct access and to obviate a secondary distribution system at this time.

The Soto Street Station in the San Bernardino Corridor was combined with the State Street Station.

The Masselin Avenue Station was added in the Wilshire Corridor.

e. Pacific Electric Right-of-Way

It is assumed that the Pacific Electric right-of-way can be shared in the San Bernardino Corridor. Provisions have been made to retain one Pacific Electric track in addition to two new rapid transit tracks.

f. Steel Wheel, Steel Rail Equipment

The use of steel wheel, steel rail equipment is to be considered in addition to the rubber tire equipment recommended by Daniel, Mann, Johnson, and Mendenhall.

g. Car Speeds

The following acceleration and deceleration rates have been selected. These rates are within the performance characteristics of equipment being presently built.

Acceleration	3 mph/sec
Deceleration	3 mph/sec

Due to the average distance between stations (1 mile) a top speed of 70 mph is adequate to produce an average speed of 35 mph.

h. Track Alignment

The following criteria will prevail for the alignment selected:

(1) Horizontal curves to be provided with spiral easement and superelevation for top speeds of 70 mph. Where curves are limited to fit alignment, speed restrictions shall be applied.

(2) Superelevation is based on speed at 3 in. unbalanced elevation where $E = 0.00066\,DV^2 - 3$

Where

E = Difference in elevation between inner and outer rail
D = Degree of curvature
V = Velocity in mph

(3) The radius of curvature for horizontal curves employed is listed as follows:

Main Line - unrestricted speed of 70 mph at 7 in. superelevation = 1,855 ft minimum

Main Line - restricted speed of 40 mph at 7 in. superelevation = 600 ft minimum

(4) The maximum slope employed in the alignment is 3 per cent.

(5) Vertical curves shall be 300-ft minimum.

i. Power Supply and Distribution

(1) High voltage power supply will be obtained from two switching stations located near San Vicente Boulevard and at Soto Street. This supply will be at 16.5 kv a-c.

(2) Traction power will be converted from 16.5 kv a-c to 600 volts by means of transformers and rectifiers in 15 substations spaced approximately 1-1/2 miles apart.

j. Stations

(1) General

Stations are to be planned to provide swift and unimpeded passenger flow through the stations and along the train platforms. During peak hours, large volumes of passenger traffic will be moving in opposite directions. Therefore, it will be necessary to avoid sharp angular turns into cross traffic.

(2) Station Finish

Durable functional materials will be required for the station interiors. Wall materials are to be durable, smooth and are to require a minimum of maintenance. Consideration should be given to glazed hollow tile structural wall units.

The edges of loading platforms are to be conspicuously emphasized by means of contrasting strips of non-slip tile. Floors are to be finished with wear-resistant, non-slip type of surfaces.

k. Tunnel and Station Ventilation

Ventilation normally will be provided by the piston action of the moving trains. However, to minimize the air blast as a result of the piston action, intermediate ventilation shafts between stations will be required. These shafts will also serve as emergency exits. The ventilation system should have the flexibility and controls to maintain safe and comfortable conditions on the subway under a wide range of operating and weather conditions. The system should meet the following requirements:

(1) Fresh Air

Air changes of five times per hour minimum under normal conditions will be required.

(2) Temperature Control

Considerable heat will be generated by the car motors and this must be removed to maintain comfortable temperatures within the subway and stations.

(3) Dew Point Control

The temperature in the subway or station should not drop below the dew point as the resultant condensation will be a nuisance and may result in the deterioration of electrical and mechanical equipment.

(4) Passenger Protection

Passengers should be protected from strong blasts of air on the station platform, escalators and stairways.

(5) Pedestrian Protection

Pedestrians passing over the vent shaft grills should be protected from high velocity air currents.

1. Control and Communications System

Design of the Control and Communications System will be based on the following criteria:

(1) Safety of people is of primary importance.

(2) The "building block" technique shall be employed so the system can be expanded, other automated functions added, or the degree of automation changed without major effect on the basic system.

(3) The development of a malfunction in one portion of the system shall not prevent continuation of remaining operations subject to compliance with all safety requirements.

(4) The manual control of any operation shall not affect other operations except for possible reduction in system performance.

(5) The system must provide optimum utilization of manpower and facilities without compromise of passenger safety, convenience and comfort.

2. Geologic and Soils Criteria

a. Geology

(1) Introduction

A geologic field reconnaissance was made of the proposed underground transit route from Beverly Hills along Wilshire Boulevard to downtown Los Angeles, thence along Broadway to Macy and then easterly under the Los Angeles River terminating just beyond Mission Road. Also, available geologic publications and maps on the area were reviewed.

The route traversed by the proposed 12-mile underground transit line lies at the northern end of the Los Angeles Basin just south of the Santa Monica Mountains. Topographically it follows the relatively flat basin skirting the southern and eastern edge of the low hills in downtown Los Angeles.

(2) General Geology

The Los Angeles Basin was a deep marine trough during Miocene and early Pliocene time and has been successively filled with sediments characteristic of shallower and shallower water until upper Pliocene and Pleistocene time when fresh water continental sediments were deposited. In Pleistocene and Recent times alluvial fan deposits have covered most of the area.

The basin is divided structurally into blocks primarily by major fault zones. The Newport-Inglewood Fault zone separates a raised "West Side" block and the "Central Deep" block that underlies the low basin area. The eastern shelf is split by the Whittier Fault zone into the northern or "Puente Hills" block and a southern "Anaheim-Santa Ana" block. The "Central Deep" block lies just west of the eastern shelf and east of the Newport-Inglewood Fault zone.

Elevation of the coastal area in late Pleistocene time is suggested by wave cut marine terraces and recent uplift inland is indicated by fluviatile terraces. Survey work indicates that movement is continuing at the present time by subsidence of the central portion of the basin and the raising of the margins.

(3) Faulting

The Los Angeles Basin area is one of string seismic disturbances which generally emanate from the many faults in the area. Although the Newport-Inglewood fault is an old fault and movement on it is believed to be waning, it was responsible for the destructive 1933 Long Beach earthquake and is the most likely local source is disturbance on the proposed route. This fault projects through the tunnel alignment and could conceivably rupture the bore. While the post-Pliocene Whittier Fault does not extend through the alignment, earth vibrations emanating from this zone would affect the tunnel area. Two minor faults, which although poorly defined, are believed to project through the alignment in the vicinity of Vermont Avenue. No movement along these fault lines is anticipated.

(4) Local Geology

The attached geologic plan and profile of the proposed route depicts the geologic formations to be encountered as well as the general ground water conditions. The legend shows the relative geologic age of the formations and the general nature of the sediments.

The Puente formation of upper Miocene age underlies the entire route at depth and outcrops along the alignment in the hills of downtown Los Angeles. This marine formation has been subdivided into several members, two of which outcrop in this general area. The Soquel sandstone member is comprised of massive coarse feldspathic sandstone and is followed stratigraphically by the Yorba member, which is comprised of thin-bedded grey siltstone, diatomaceous silty shale and locally thin beds of sandstone and conglomerate. In the area of the tunnel these beds strike to the west and dip about 30^{o} to the south. Some oil has been derived from this formation.

The marine sediments of the Repetto formation of lower Pliocene age lie conformably over the Puente formation. The Repetto formation is comprised mostly of siltstone with a few layers of sandstone and conglomerate. Locally it contains many shell beds. This formation provides the principal source for petroleum in the area.

The Pico formation of upper Pliocene or lower Pleistocene age lies conformably above the Repetto and is a moderately well indurated, greenish-grey, micaceous siltstone with some gradations to silty clay and fine sandstone.

The older alluvium and terrace deposits of the Pleistocene are deposited unconformably over the older formations. This older alluvium is a continental plain built from the merging alluvial cones from the Santa Monica Mountains to the north. It has been uplifted subsequently nearly 250 feet. It is now being eroded by the present streams and overlain in part by recent alluvium. The older alluvium is generally a dark reddish-brown poorly sorted sediment containing silt, clay, sand and angular rock fragments. It is moderately well bedded and indurated and is characterized by medium shear strengths. It is well exposed in high bluffs along the Pacific Palisades that have stood nearly vertically without slumping for many years.

The younger alluvium of recent geologic age lies unconformably over all the older formations. Its composition varies but it is chiefly poorly sorted sandy to gravelly material with a sand-silt-clay matrix. It is commonly poorly bedded and only slightly indurated. It may have a high permeability laterally but generally has a low vertical permeability. It is characterized by low shear strengths.

(5) Ground Water

Although the 1960 ground water table is well below the proposed tunnel grade over most of the route, drill holes and open excavations examined indicate that at various elevations above the water table water flows in perched stream channels. These perched channels are probably fed from the Santa Monica Mountains to the north. Perched water has only been indicated on the profile where existing holes indicate its presence. However, it seems likely that many other perched bodies of water exist that have not been disclosed by exploration to date. Although a ground water table is indicated in the Puente bedrock, it is believed that this formation will generally be fairly tight and will produce only small seepages of water.

(6) Conclusions

(a) The suggested route is geologically feasible for the proposed tunnel if adequate support and drainage is provided in the weak semi-pervious alluvial deposits through which most of the bore will be driven.

(b) The area is subject to strong seismic vibrations so that the proposed tunnel as well as surface structures must be designed to withstand severe earthquake forces.

(c) Oil, tar and gas will be encountered in the vicinity of the La Brea tar pits and may be found along other portions of the tunnel line. Oil and gas occur primarily in the Repetto formation but are also found in the Puente formation. Seeps from the upturned edges of the oil-bearing strata of the parent rock may work up through the pervious overlying alluvium producing conditions such as found at the tar pits.

(d) Although the 1960 ground water level is below the tunnel grade over most of the line, perched water will be encountered at tunnel grade and above and provisions for drainage must be provided to take care of this water as well as higher ground water tables which have occurred in the past and may recur in the future. A raise in the tunnel grade between Main Street and the Los Angeles River might be worth consideration to avoid the high permanent ground water table in this area.

(e) The principal problem in tunnel driving will be to provide adequate support for the ground so that settlement does not occur in adjacent and overlying buildings. Some of the dry cohesionless sands in the alluvium will run into open excavations, and where ground water is encountered much of the silty and sandy material will flow into open faces. However, no squeezing or swelling ground is anticipated. Liner plate and breast boarding will be necessary in most of the recent alluvium.

It is estimated that about 20% of the tunnel will be in the soft consolidated and stratified sediments of the Puente, Repetto or Pico formations and will require only moderate support considering the large diameter of the tunnel.

The moderately consolidated older alluvium will comprise nearly 50% of the proposed tunnel. It will require moderate to fairly heavy support where dry (estimated at 25% of the total tunnel) and fairly heavy support where wet (estimated at 25% of the total tunnel).

In the unconsolidated recent alluvium which will comprise about 30% of the proposed tunnel fairly heavy support will be required where dry (estimated at 10% of the total tunnel) and heavy support will be required where it is wet (estimated at 20% of the total tunnel).

(f) Because of large boulders found in some of the recent alluvium, the driving of piles at stations and the use of a mole in tunnelling this type of ground will be difficult.

(g) Pile driving in the alluvial materials may tend to consolidate surrounding materials and produce minor settlement in adjacent structures. Drilling out the holes where possible prior to placing the piles will avoid much of this difficulty.

(7) Recommendations

(a) The entire line should be explored by drilling to determine more accurately local foundation conditions and strata carrying perched ground water.

(b) Exploratory holes should be sampled and tested to determine possible consolidation by vibration both from driving piles and from the proposed use of the tunnel by heavy trains.

b. Soils Criteria

(1) General

Boring data has been gathered in the vicinity of Los Angeles Municipal Transit Authority's proposed subway from the Los Angeles River crossing, along Wilshire Boulevard, to the intersection with Santa Monica Boulevard. Organizations which have cooperated in furnishing the results of their test borings are the City of Los Angeles, Storm Drain Department; Corps of Engineers, Los Angeles District; and Raymond Concrete Pile Company.

In general, the permanent water table will be encountered in the vicinity of the Los Angeles River and along upper Broadway. Water indicated in other areas is considered as perched water and may exist only seasonally and in small areas.

Following is a general description of the material expected to be encountered, some of the problems to be expected, and possible solutions.

Los Angeles River Crossing

The proposed crossing of the Los Angeles River will be mostly in sand and gravel with the bottom probably resting on soft shale. According to the 1941 record of the Corps of Engineers, about one-half to three-quarters of the tunnel will be under water, depending upon the season in which the work is undertaken. A comparison of the proposed profile of the tunnel with the river borings made by the Corps of Engineers indicates that the proposed tunnel will create a cut-off wall across the river basin, thereby raising the water table on the upstream side of the tunnel. Raising of the ground water will create uplift on the river channel paving and probably other structures upstream of the tunnel. It is the practice of the Corps of Engineers to intercept all ground water by drains under the slab and not to provide weep holes to relieve uplift. The Corps of Engineers has indicated that this section of the channel is scheduled for repaving within the next five years, and it is possible that this section of the design tunnel could be combined with the river pavement in a manner suitable to them, thereby faciliting the construction of the tunnel.

It will be difficult to balance the water pressure with air pressure if tunneling methods are used because of the pervious nature of the granular materials. If it is possible to combine the tunnel and pavement design for the tunnel area only, then the excavation could be made by open cut using well points to intercept the water. This work could be done during the period the river is dry.

Los Angeles River to Broadway

At the right bank of the river the first 16 feet of depth is composed of debris of the nature of large blocks of concrete, boulders, and metal. Shale was encountered at 18 feet. During excavation for the storm drain on Second Street over to Broadway, shale was encountered 30 to 35 feet from the surface. The overburden is sand and gravel. It appears that this section of the tunnel will be in shale and below the water table.

First Street to Seventh Street on Broadway and Broadway to Figueroa on Seventh Street

The tunnel will be in shale at First Street and Broadway. At about Third Street or Fourth Street, it will enter the sand and gravel overburden with the crown of the tunnel.

Borings were available for a storm drain on Eights Street between Broadway and Figueroa. These indicate that the tunnel will be completely in sand and gravel at Seventh and Broadway.

The tunnel will remain in sand and gravel until it reaches the Statler Hotel at Seventh Street and Figueroa Street. At this point, it will be about one-half in sand and gravel and the lower portion will be in silts and clays. Shale will be about 9 feet under the tunnel.

The sand and gravel in this section has a low cohesion value and caves readily. The blow-count for driving a sampler varied between 19 and 30 blows per foot which indicates a sand of medium compaction. Densities in-place vary between 113 pcf and 120 pcf dry weight with a moisture content varying between 4 and 6 per cent of the dry weight. A friction angle could be assumed at 35 degrees for the sand and gravel.

A possible hazard will exist to building footings as a result of tunneling operations. The degree of danger depends on the location of the footing relative to the tunnel in the event the sand and gravel runs into the tunnel heading. Water was not encountered in any of the borings on Eighth Street.

If it is indicated in future borings that the sand will run, or there is an indication that the footings of nearby buildings will be in jeopardy, consideration should be given to chemical stabilization which can develop 400 psi compressive strength.

If a shield is used in the sand and gravel, skin friction could be as high as 210 pounds per square foot.

Figueroa Street to Vermont Avenue

A boring on Seventh Street and Figueroa Street, at the Statler Hotel, indicates sand and gravel overlying silt and clay with shale about 46 feet from the surface. Water was encountered about 22 feet from the surface of Seventh Street. Towards the northwest corner of the Statler Hotel site the sand becomes a sandy clay.

Between Seventh and Figueroa Streets and Vermont Avenue only one boring was available at Sunset Place and Wilshire Place. Black siltstone was encountered between 28 and 40 feet from the surface. No water was observed at this location. The siltstone was medium hard. A tunnel would be expected to encounter shale intermittently along a line from Figueroa Street to Vermont Avenue. The Raymond Concrete Pile Company indicated that there is a debris fill in this area which has required them to spud piles to a maximum depth of 30 feet. The debris was of a nature that made driving of cast-in-place shells difficult to drive.

On Wilshire Boulevard from Vermont Avenue to End of Line

Much of the line west of Vermont is composed of sandy to silty lean clay which is quite stiff. Much of the lean clay is overlain by sands and gravels which could be encountered by the roof of a shallow tunnel.

(2) Design Criteria for Soils and Foundations

Criteria for foundations and the effect of earth on tunnels has been determined from available borings and soil tests made by the City of Los Angeles for the Storm Drain Department. The values given are preliminary and would need to be revised on the basis of tests made for the design phase of the work.

Design constants:

Sand - 100 pcf dry weight, natural moisture 12%, friction angle 35°, cohesion 0.

Clays - 90 pcf dry weight, natural moisture 30%, friction angle 0, cohesion 750 psf.

Shale - 125 pcf.

<u>Loads on Tunnel</u>

The design should be based on the following loading conditions. The values used are expected to be conservative and exploration work done specifically for the tunneling operation should indicate a reduction in the assumed values used at this time.

B = width of tunnel
H = height of tunnel

Loads acting on tunnel:

(a) Shale - 0.5 (B+H) vertical, 1/3 x vertical = lateral

(b) Clay - 1.6 (B+H) = vertical load but not more than that computed from a rectangle over the width of the tunnel and to the surface of the ground. 0.8 vertical = lateral.

(c) Sand - above water table 0.5 (B+H) = vertical load. For lateral load use Rankine plus 500 psf surcharge.

Below water table 1.0 (B+H) = vertical load. Lateral load same as dry sand (bouyant) plus hydrostatic pressure.

The above loads should not exceed that computed as a rectangle from the surface of the ground to the tunnel and equal to the width of the tunnel.

Effects on Footings in Adjacent Areas

Footings adjacent to the tunnel will distribute stresses at an angle of approximately 30 degrees with a vertical from the near edge of the footing. Any tunnel operation within this area laterally and less than 1-1/2 times the width of the footing below the footing will cause settlement. In areas where the tunnel operation is within the influence of adjacent footings, some form of underpinning will be necessary.

(3) Drilling Program

For this presentation, borings have been assumed at intervals of 100 feet to a depth of 10 feet below the tunnel invert. The exact location of borings would depend on the field conditions disclosed by the borings.

Sampling

Continuous through tunnel depth and two feet in each five feet above and below the tunnel.

Logs

The logs should contain field classification by the Unified Soil Classification System, water table when encountered, blow-count for driving the sampler, and any other pertinent data encountered while drilling.

Testing

Routine testing on a project of this magnitude should be accomplished in a field laboratory. The field laboratory would perform the following tests:

(a) Determine field density and moisture content.

(b) Unconfined compression.

(c) Establish compaction curves for various types of material.

(d) Control compaction of backfill.

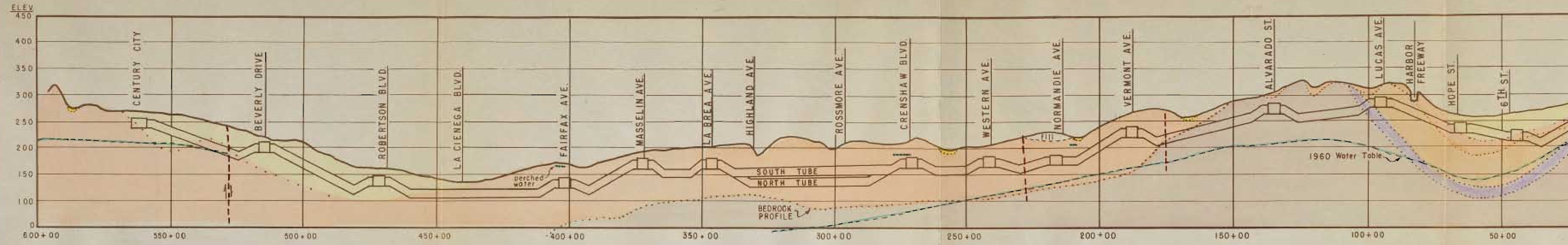
(e) Atterburg limits.

Special Tests

Special tests such as consolidation, triaxial shear, and vibrations should be sent to a commercial soils laboratory. These tests should be made on representative samples of various types of material as selected by the field personnel.

The prime purpose of the field tests would be the classification of soild into types, and the compilation of data which would assist in the tunneling operation.

Moisture content and unconfined compression will be very important in determining how much the tunnel can be advanced ahead of the placing of sets. The special tests would provide data for design and for the protection of existing structures and pavements.



SECTION

Scale - 1" = 2000' Hor.
1" = 100' Vert.

PLAN

Scale - 1" = 2000'

LEGEND

QUATERNARY	RECENT	Qal	Recent Alluvium; Sand, silt, clay and gravel.
QUATERNARY	PLEISTOCENE	Qt	Terrace deposits; Sands and gravels.
QUATERNARY	PLEISTOCENE	Qpu	Older Alluvium; Upper Pleistocene sand, silt, clay, and gravel.
TERTIARY	PLIOCENE	TQ	Pico marine sediments; Micaceous siltstone & fine sand
TERTIARY	PLIOCENE	Tr	Repetto marine sediments Siltstone with minor beds of sandstone & congl.
TERTIARY	MIOCENE	Tpy	Puente-Yorba member; Diatomaceous siltstone, sandstone, and conglomerate
TERTIARY	MIOCENE	Tpsq	Puente-Soquel member; Massive sandstone, some conglomerate.

- - - - Approximate fault

. . . . Concealed fault

GEOLOGIC PLAN & SECTION
PROPOSED TUNNEL FOR BACKBONE ROUTE

LOS ANGELES METROPOLITAN TRANSIT AUTHORITY

BURTON H. MARLIAVE — JUNE 12, 1961

3. Factors Effecting Cost Estimates

a. Assumptions

The factors discussed in this section have been selected for their influence on the cost of construction.

(1) Extent of System Design

Major elements of the system have been tentatively designed including horizontal and vertical route alignment, tunnel cross sections, station locations and dimensions, rolling stock, control and communication systems, electrification and trackage. System descriptions are based on these preliminary drawings.

(2) Structures and Roadbeds

Certain portions of the design, particularly tunnels and stations, are dependent on the geological conditions which can be determined only by a systematic subsurface exploration program. In the absence of such a program, information for this report has been obtained from a review of previous geological exploration data, inspection of surface geology and consultation with engineers and contractors in the Los Angeles area.

(3) Stations

Station excavations are based on preliminary geological data which indicates that full sheeting and bracing will be required and that ground water will be encountered.

(4) Utility Relocation and Underpinnings

Utility relocations are based on the assumptions that most existing utilities may be relocated within the excavations where required by suspending them from decking and supporting.

Excavations will be located to bypass major drainage structures.

It has been assumed that some utilities will require complete replacement to withstand handling during relocation and because of damage during construction.

Underpinning concepts are based on two assumptions:

(a) That footings located closer than 15 feet from cuts will require preliminary support and underpinnings. In these cases grillages will be used to provide temporary support and columns will be underpinned using concrete-filled approach pits.

(b) That footings located farther than 15 feet from cuts can be held with protection walls provided by H-pile soldiers and timber sheeting. Where the influence line of footing falls within a cut, soil will be stabilized at the affected level by chemical injections. Each building adjacent to excavation will require analysis and treatment when work is being performed. Costs for individual buildings will vary widely. However, the assumed approach should be adequate in all but the most exceptional situations.

(5) Land Acquisition and Rights-of-Way

Costs for acquiring rights-of-way have been supplied by LAMTA. It has been assumed that LAMTA and other public agencies will afford full cooperation in obtaining access, yards and other facilities required for construction.

(6) Labor, Supplies, Materials and Administration

Costs of labor, supplies and materials are based upon wages and costs prevailing in the Los Angeles area during 1961.

(a) Methods used for determining construction, labor and supply costs are described under Section III. E. These are based on experience in similar work with adjustments made for special conditions anticipated on the project.

Construction plant and equipment costs are based on procurement of those items necessary to perform the work as outlined in Section III.E. and within a 3-year construction period.

(7) Administration and engineering indirect costs for general and administrative labor are based on the completion of the project within the 3-year construction period. Estimated general and administrative costs include taxes, insurance, office and engineering supplies, consulting and engineering legal fees, employment and other miscellaneous expenses.

C. Routing and Alignment

1. General

The routing of a rapid transit system to serve the transportation needs of communities in and around Los Angeles was broadly established by studies of Cloverdale and Colpitts, Consulting Engineers, submitted in May, 1959 and further refined in the report submitted by Daniel, Mann, Johnson and Mendenhall in August, 1960 to the Los Angeles Metropolitan Transit Authority.

These studies established the needs of four main transit corridors:

1. Wilshire - Central Business District to Santa Monica
2. San Bernardino - Central Business District to Covina
3. Reseda - Central Business District via Wilshire and Cahuenga Pass to Reseda
4. Long Beach - Central Business District to Long Beach

Kaiser Industries, employing the alignment criteria, made comprehensive studies of the first phase of a rapid transit system which would become the backbone for future development and expansion to the ultimate system.

This backbone, composed of portions of the Wilshire and San Bernardino Corridors, will stretch roughly west to east from Century City along Wilshire Boulevard to the Central Business District and out the San Bernardino Freeway median strip to El Monte.

With the selection of line length for the backbone system, the next determination was that of a profile relative to the surface. Along Wilshire and in the Central Business District, it was decided by the Authority that transit lines would be placed in a subway for community acceptance and the preclusion of structures above grade not in keeping with the aesthetic values of the corridor. Along the San Bernardino Freeway, the tracks will be placed at grade in conjunction with the existing Pacific Electric right-of-way. This right-of-way lends itself to fast dependable transit because of grade separations provided by present freeway structures and interchanges.

2. Subway Considerations

The subway portion, consisting of approximately 12 miles of twin tubes, begins at the western terminal of the backbone at Century City on the Beverly Hills-Santa Monica city limit line. The station at Century City is situated on Santa Monica Boulevard for the future extension to Santa Monica. Proceeding east, the subway swings to Wilshire Boulevard at the intersection with Santa Monica Boulevard, to a station at Beverly Drive, thence along Wilshire with stations, determined by the Authority from traffic studies, at Robertson, Fairfax, Masselin, La Brea, Crenshaw, Western, Normandie, Vermont; off Wilshire Boulevard to 6th Street near MacArthur Park to a station at Alvarado; then over to Ingraham Street to a station at Lucas; then over to Seventh Street under the Harbor Freeway to a station at Hope; then off Seventh Street to Broadway with stations at Sixth Street and First Street; then under the Hollywood Freeway, over to Macy Street to a station at Union Station; then along Macy Street under the Los Angeles River and up to the surface with a portal at the Macy Street maintenance and repair yards, and a junction with the San Bernardino Corridor line.

Generally, the subway profile has been determined by investigation of large underground storm drains, sanitary sewers and utility lines buried in the street. Stations were located as close to the surface as underground conditions have permitted. The subway tubes approaching stations have been provided with descending and ascending grades to facilitate the acceleration and deceleration of cars without excessive use of power and mechanical braking. The extent of these grades and grades in between, not dictated by terrain and substructures, will be determined in a computer program on profile optimization discussed later in this section.

At the Century City terminal, a crossover and 450 ft of tail track will be provided from the north tube to the south tube to permit the reversal of trains. This crossover will be made through a box structure between tubes.

Between La Brea and Crenshaw, the tubes will be separated vertically to provide for a future interchange of turnouts for the line to Reseda. This will permit grade separation at the junction of subway tubes, and eliminate any conflict of tracks in opposite directions.

Between Vermont Avenue and Lucas Avenue, the alignment has been established along the north side of the lake at MacArthur Park to place the subway in an area of more suitable soil conditions and to facilitate tunnel construction. Should extensive soil exploration along the south side prove favorable, an alternative route along Seventh Street to Wilshire Boulevard should be seriously considered. The Seventh Street alternative between Lucas and Vermont would minimize the subsurface easement under private lands and provide a more direct route between these two points. At this time, soil information available makes the present alignment satisfactory from a construction standpoint.

At Normandie Avenue, two large flood control drainage structures required a shift in station location in order to minimize construction problems. Access to Normandie Avenue and Wilshire Boulevard is provided from the east end of the station by means of escalators to the surface.

The alignment of subway from Seventh Street to Broadway will be a long radius curve of approximately 700 feet, and will require subsurface easement under a large commercial establishment. Extensive research and engineering of underpinning will be required to facilitate construction of the subway in this area.

The depth of the Sixth Street station was controlled by a large sanitary sewer outfall along Broadway. The First Street station depth was established by track grade passing under a large storm drain at Second Street. The location of the Union Station station was influenced by a convergence of several large storm drains and depth determined by a large relief sewer at the intersection of Alameda and Macy Streets.

The subway near its eastern portal will pass under the Los Angeles River Channel. The subway must pass in close proximity to the bottom of the channel to enable the subway, by maximum grade, to surface at its east portal at the beginning of the Macy Street storage, maintenance and repair yards and to junction with the San Bernardino surface tracks.

The Macy Street yards will contain storage tracks for approximately 150 car units in conjunction with repair and maintenance facilities. Storage yards will be arranged to provide an orderly procedure in train dispatching and retirement caused by fluctuations in traffic.

3. Surface Transit Considerations

The surface portion of the backbone route consists of approximately 11 miles of double track along the San Bernardino Freeway, from the subway portal at Macy Street yards to the eastern terminal at Hoyt Avenue in El Monte. The Pacific Electric right-of-way will be utilized for the twin tracks of the rapid transit system and a possible third track to be retained for Pacific Electric use. This right-of-way provides an existing grade separated route suitable for fast uninterrupted service. The right-of-way parallels the north side of the freeway to Fremont Avenue, then crosses the north lanes into the median strip. The right-of-way remains in the median strip until Baldwin Avenue where a grade-separated structure carries the freeway away to the southeast and the right-of-way continues on into El Monte over the Rio Hondo channel. From Hoyt Avenue, a future extension along the Pacific Electric right-of-way will carry the rapid transit system to Covina.

Stations will be provided east from the subway portal at Soto-State Streets, Eastern Avenue, Fremont Avenue, Atlantic Boulevard, New Avenue, San Gabriel Boulevard, Rosemead Boulevard, and Hoyt Avenue.

Stations will consist of loading platforms placed between the tracks on the right-of-way and connected to passenger stations and parking areas adjacent to the freeway by pedestrian overpasses.

The rapid transit track profile will parallel that of the existing track grade which is within the allowable grade of 3% maximum.

Existing bridge structures at grade separations are capable of carrying two tracks at present. With the possibility of a third track retained by Pacific Electric, such structures will be widened and modified to meet this requirement. At Baldwin

Avenue, a box structure under the freeway would be provided with an additional bay. At the Rio Hondo channel, a single track bridge will be supplemented with a new double track bridge.

Hoyt Avenue terminal will be provided with a crossover from the south track to the north track to permit the reversal of trains.

4. Subway Profile Optimization

The subway portion of the system profile will be optimized in the final detail design for lowest total cost for both operating power and maintenance.

The profile optimization problem will be formulated and programed for computer solution. In the formulation, the following factors are considered constant:

Maximum allowable speed

Maximum allowable acceleration rate

Maximum allowable braking rate

Train weight

Cost of electrical power (rate schedule as resolved with the power supplier)

The following factors are considered variable:

Track grades

Length of sloped portions of profile

Acceleration rates (variable up to the maximum)

Highest speed between stations (variable up to the maximum)

Train resistance

Grade resistance

Acceleration resistance

Effect of rise and fall on maintenance expense

Cost of stations, emergency exits and vents as influenced by depth

Drive horsepower

Gear ratio

Motor characteristics

A range of possible profiles between each pair of stations will be examined and the optimum combination of profiles for the entire subway portion of the system will be determined from the computer results. The influence of skip stop operation and operation in two directions will be considered.

The maximum profile elevations are established by existing physical features, utilities, and major subsurface structures, such as the Los Angeles River and Harbor Freeway undercrossings and large storm drains. The profile is to be optimized below these maximum elevations.

The cost of operation at maximum practicable speeds will also be examined.

The horizontal alignment of the subway and horizontal and vertical alignment of the surface portions of the system are not subject to optimization. That is, the horizontal alignment of the subway is fixed by the station locations and the economic desirability of routing under city streets. The location of the surface portion of the system is fixed by the configuration of the Pacific Electric right-of-way and the median strip of the San Bernardino Freeway.

D. Type of Equipment Selected

1. Control and Communications

The purpose of the Control and Communication System is to provide a high performance and completely automatic train control system designed for maximum safety of operation, passenger convenience and comfort, optimum utilization of facilities, and minimum operating cost.

System design, as conceived and presented by General Electric Company, is based on a decentralized approach combining several operations into a homogeneous automatic process or system. Each operation in the automated process is automatically performed relatively independent of other operations. However, related operations in the process are interconnected to ensure desirable and safe sequence of operation.

General Description of System Operation

Present plans for operation of the system are as follows:

a. Each train will be assembled in an initiating yard prior to entering service.

b. The assembled train ready to enter service will be placed on a "ready track" at the yard exit. At this point an identifying number will be assigned automatically to the train to actuate local functions.

c. The train will be dispatched automatically from the ready track by a central stored program.

d. The train will proceed automatically to the first station stop on its route.

e. The train will make station stops and will proceed from station to station, under programed local automatic control.

f. The flow of trains along the route will be controlled on a "time interval" basis. After automatic dispatch from the initiating yard ready track, the time interval between trains will be maintained according to a predetermined value. Direct "timetable control" will not be employed.

g. At each end of the line, the trains will be reversed automatically and will re-enter the system on a programed basis. Following a predetermined operating schedule, individual trains will be withdrawn automatically from the system.

Control of the operation will use automation techniques to a greater degree than generally is the case in the rapid transit industry today. This control will be applied both on a local basis and on a centralized system basis.

In accordance with accepted transportation industry practice, those functions essential to the reliable and safe operation of trains will be handled principally at the local level. The automatic running of trains from station to station and the protection of trains are examples of such local control functions. Conversely, optimizing of the operation through the Line Supervision Subsystem is an example of a centralized function.

Primary Subsystems

The Control and Communication System consists of three primary subsystems:

a. Line Supervision Subsystem

The purpose of this subsystem is to increase the capability of the system dispatcher in making more effective and efficient use of the transportation facilities under his direction.

b. Automatic Train Running Subsystem

The purpose of this subsystem is to provide more uniform and predictable operation of trains than would otherwise be possible on this high-performance system. Also, an attendant on the train will be able to operate the train manually in emergency situations.

c. Train Protection Subsystem

This subsystem will provide protection against train-to-train collision and other potential hazards that are now provided by standard railway block signal systems.

Communication and information-handling functions associated with each of these subsystems are regarded as part of the subsystems.

Each subsystem is explained in the remaining portion of this section. However, the Line Supervision Subsystem and the Automatic Train Running Subsystem include functions which are novel in the transportation industry in this country. Therefore, these two subsystems are discussed in considerable detail.

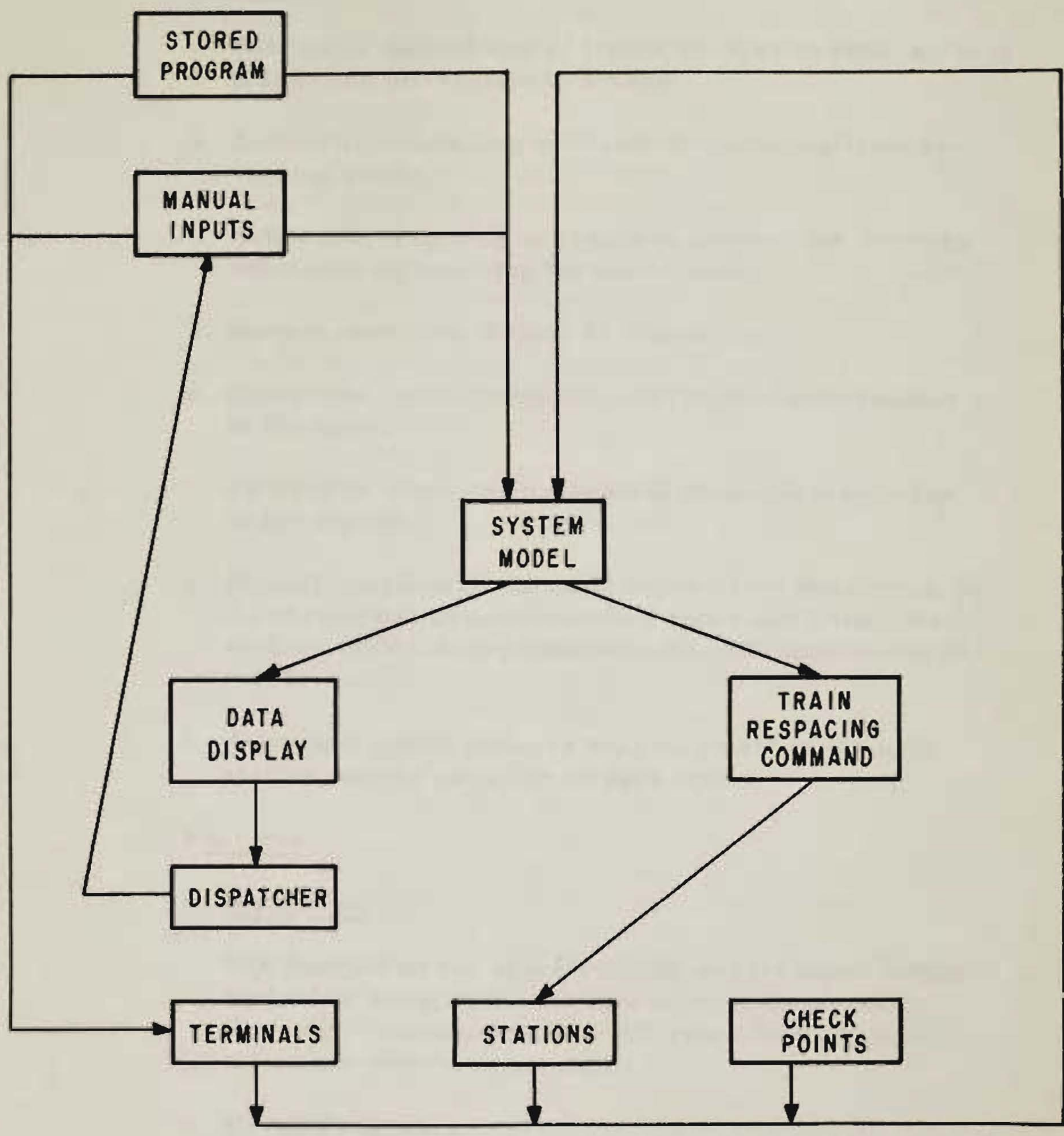
Line Supervision Subsystem

General Description

The Line Supervision Subsystem will both monitor and control the transit operation. Principal functions will be to dispatch trains automatically from the ready track; provide the system dispatcher with information concerning the operation of trains and with other data necessary to direct over-all operation; and to control the transit process through automatic respacing of trains.

Figure 2, page III-30, shows the block diagram for this subsystem. The Stored Program block represents operating management's plan for handling anticipated passenger movement during a particular period of time. It may, however, be changed by the System Dispatcher as required by real-time traffic developments.

The other portions of the Line Supervision Subsystem are concerned principally with the execution of the stored program in an optimum manner. The System Model is the focal point for this part of the subsystem. It receives information concerning operation of trains, and provides useful output to the Data Display for the dispatcher's guidance, and control information for automatic Train Respacing.



BLOCK DIAGRAM FOR LINE SUPERVISION SUBSTATION

FIGURE 2

Functions

a. Automatic dispatching of trains on-system from a ready track, and off-system to a yard.

b. Automatic scheduling of trains at the end-of-line reversing points.

c. Automatic respacing of trains to correct for headway unbalance or bunching between trains.

d. System operation display to dispatcher.

e. Party-line voice communication from the dispatcher to the train.

f. Party-line voice communication from the dispatcher to the station.

g. Manual override of the Line Supervision Subsystem by the dispatcher to accommodate abnormal situations such as right-of-way maintenance, off-hour travel demand, etc.

h. Automatic public address announcement of the next station stop on each car of each train.

Features

a. System Model

The function of the system model and its input-output control is to optimize the operation of the system. However, individual trains will run safely on local automatic control at all times.

b. Stored Programs

Programed information stored on a suitable medium, such as magnetic tape, will be provided for operations originating at each end of the line and from the storage yard.

All program readers will be controlled by a master clock. There will be provision for manually retarding each individual program, to adjust the program to localized or general changes in the operation.

Each stored program will provide a train-departure signal at the time of each scheduled train departure from its associated terminal point.

Each stored program will provide train identification of each train before leaving a terminal point.

There will be provision for manual introduction of train departure data and identification data at each terminal point.

There will be provision for manual nullification of a scheduled train departure.

c. Operations Recorder

Data will be provided for later off-line analysis of operations.

d. Data Display

Purposes of the Data Display are:

(1) To provide the system dispatcher with information on the location of each train on the system.

(2) To identify each train on the system.

(3) To indicate that a train is ready to be dispatched onto the main line.

(4) To indicate off-normal operating situations.

(5) To indicate where an excessive headway and/or bunching has developed on the system.

e. Automatic Respacing of Trains

The Line Supervision Subsystem will continually monitor the transportation process. Should excessive headway or bunching of trains develop, the control subsystem will determine and initiate necessary corrective action.

f. Train Location Identification

Check points are provided to inform the dispatcher of the location of each train on the system from stations, terminal points, the yard "ready track", and at spaced intervals throughout the system.

Train Running Subsystem

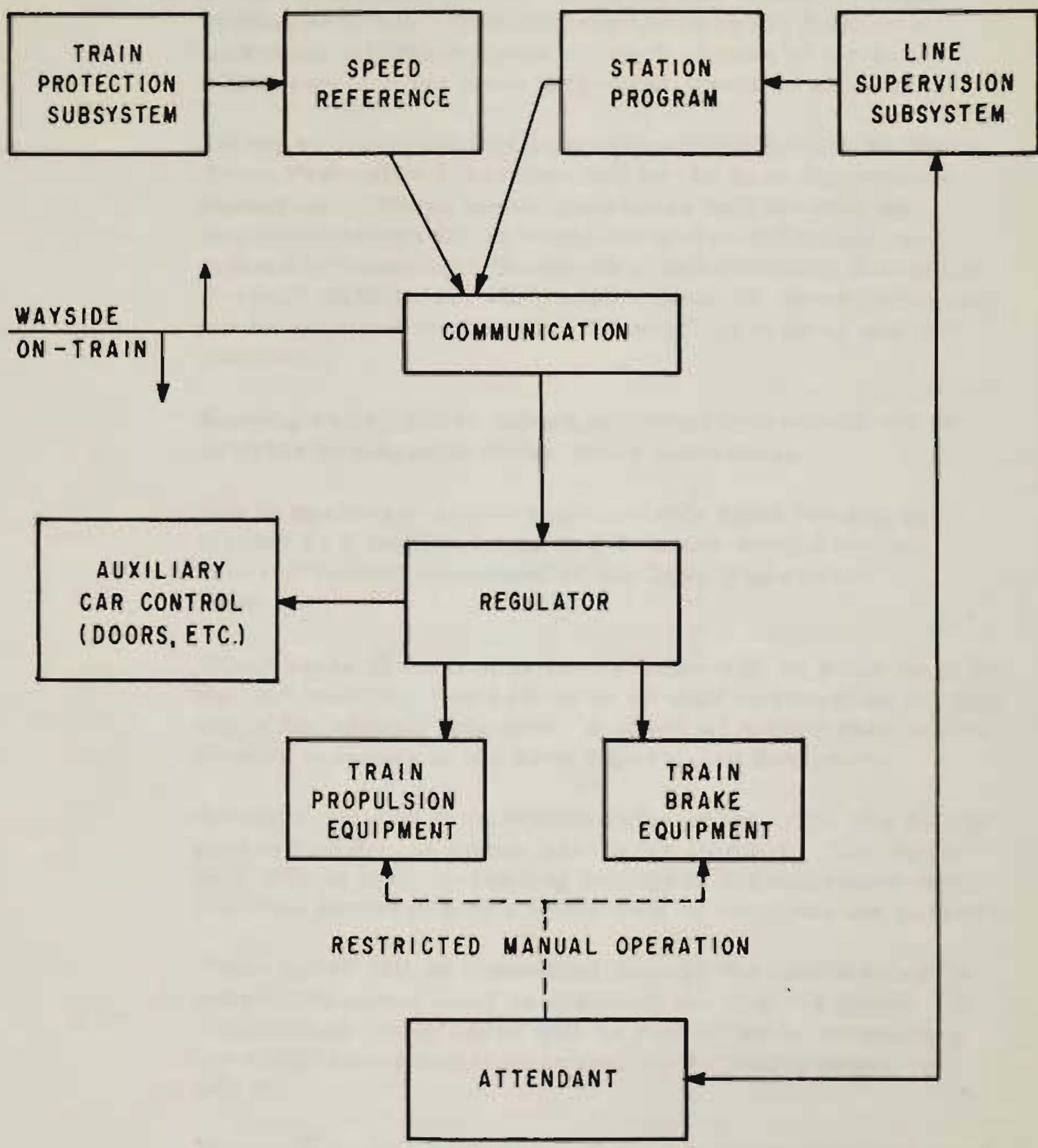
General Description

The Train Running Subsystem will be capable of providing higher train performance with safety than has been possible to date. High train performance as used here means train speed of 80 miles per hour within traffic densities which result in 90-second train spacings.

Figure 3, page III-34, shows the block diagram for this subsystem. The Train Running Subsystem is to be "fail safe for persons and property". "Fail safe" as used here means that the failure of any component must result in a more restrictive mode of operation than would have been the case had the failure not occurred. In general, this will mean that the train will be required to stop, although some exceptions are possible.

Control of train running is accomplished by means of a closed-circuit regulating system in the car control.

Portions of the Train Running Subsystem which do not affect passenger safety will be highly reliable. In this case redundancy will be used to improve materially the degree of continuity of operation.



BLOCK DIAGRAM FOR TRAIN RUNNING SUBSYSTEM

FIGURE 3

Wayside information is made available to the train as the proper reference for the control of car speed for each section of track. This information is in the form of a maximum allowable speed for each section of track, taking into account track alignment, track profile, etc.

All speed references will be subject to reduction by the Train Protection Subsystem and by the Line Supervision Subsystem. These speed references will provide the functional equipment of "Continuous Train Control" as defined in "American Standards - Definitions of Electrical Terms" (AIEE) item 42.51.065. Should a speed reference not be received by the train, emergency braking will be instituted.

Running rails, power cables or contact wires will not be used for propagation of the speed references.

Due to passenger safety requirements train running is treated as a local function and does not depend on centralized control equipment of the Line Supervision Subsystem.

Three rates of maximum acceleration will be programed in the car control. One rate is to be used in operating according to the normal schedule. A lower or higher rate will be used in response to the Line Supervision Subsystem.

Acceleration and deceleration rates of the train will be preprogramed for maximum passenger comfort. The initial rate will be low, increasing rapidly to the maximum rate and then decreasing to a lower rate to complete the process.

Train speed will be controlled through the selection of the propulsion power level to maintain the desired speed. In this method, train speed will be controlled by modulating the propulsion power rather than by switching power on and off.

Should the train reach a speed above a predetermined maximum, propulsion power will be removed and emergency braking applied.

Trains will be stopped in an optimum manner; that is, in the shortest possible time and distance consistent with passenger comfort.

The final stop at a station platform will be within ±2 feet of a predetermined point which is dependent on train length.

Train doors will open automatically only after the train has come to an absolute stop within the stop limits. The train doors will remain open for a predetermined time interval. The door open time will be pre-programed, but subject to modification by the Line Supervision Subsystem.

Manual operation at reduced train speed will be possible for yard movements or in the event of an automatic control malfunction during scheduled operation.

Functions

a. Automatic starting of train from stations.

b. Automatic acceleration of train at a predetermined rate.

c. Automatic control of train speed in observance of wayside speed references.

d. Automatic deceleration of train to make optimum-performance stop at stations.

e. Positioned stop of train at predetermined station berth with an accuracy of ±2 feet.

f. Automatic opening of train doors for a predetermined time interval.

g. Automatic reversing of trains at terminal points. (Re-entry of train to system remains under automatic scheduling of Line Supervision Subsystem.)

h. Manually controlled reduced speed operation for yard movements and in event of automatic train running control malfunction.

Features

a. Car Control

Automatic regulating control located on each train and receiving continuous reference from the wayside will ensure uniform optimum performance of each train over the system.

Under normal operating conditions, train doors cannot open until the train has come to a complete stop at a predetermined station platform location. Under manual operating conditions, the train attendant can open train doors after the train has come to a complete stop.

Trains cannot start until all doors are fully closed. Malfunctioning of the door closure will be indicated on each train.

b. Station Control

At each station a controlled unit will provide the following sequence of operations:

(1) Checks the proper platform location of each arriving train.

(2) Initiates the opening of train doors adjacent to the platform.

(3) Holds train at station platform for a predetermined time interval.

(4) Initiates door closing after receiving an indication that it is safe for the train to proceed.

(5) Initiates train departure.

Station stop time will be subject to modification by the Line Supervision Subsystem to meet current operating conditions.

c. Wayside Control

Wayside control will provide to each train the continuous maximum allowable speed reference for each section of track. All speed references are subject to reduction by the overriding Train Protection Subsystem.

A malfunction in the speed reference equipment, or in the Train Protection Subsystem, will be recognized in the fail-safe manner.

Train Protection Subsystem

General Description

The Train Protection Subsystem will be based on the concept that safety is a local condition.

Proper train spacing interval will be maintained between all trains. When some are operated manually, proper space interval for trailing trains will be maintained.

The Train Protection Subsystem will perform a redundancy in preventing automatic trains from "running away".

Design of the Train Protection Subsystem will be based on the closed circuit principle which is defined in ICC Regulation 136.786 as follows:

> "The principle of circuit design where a normally energized electric circuit which, on being interrupted or de-energized will cause the control function to assume its most restrictive condition."

The Train Protection Subsystem will impose speed limits under all conditions on both automatically and manually controlled trains, commensurate with safe operation of the system.

The Train Protection Subsystem will position track switches automatically and will prevent train movement over switches improperly positioned.

The Train Protection Subsystem will be interconnected with the Train Running Subsystem so that a failure in the Train Protection Subsystem will cause the loss of a speed reference, thereby initiating emergency braking action.

The Train Protection Subsystem will be designed for train speeds of 80 miles per hour and train spacing intervals of 90 seconds.

Hazards Protection

The Train Protection Subsystem will provide protection against train-to-train collision under all foreseeable conditions, and also against other potential hazards as normally provided by railway block signal systems. The following is a non-inclusive list of potential hazards for which protection will be provided:

a. A malfunction in Line Supervision, Train Running, or Train Protection Subsystems.

b. Failures of normal control channels in whole or in part.

c. Failures of the power supply to any subsystem.

d. Collision with train stopped on account of traction power failure, application of emergency brakes, or from any other cause.

e. Operation of automatic and manual trains on the same track.

f. Failure of automatic train control to respond to normal train speed reference, such as a train "running away", but with brake control in good operating condition and ready to respond to a wayside safety device.

2. Rolling Stock

a. General

The selection of the type of rolling equipment required an analysis based on the following factors:

(1) Reliability

(2) Passenger Comfort

(3) Economics

The choice of vehicle has been narrowed down to a light weight rubber tired car proposed for this system and light weight steel wheel equipment. The following paragraphs outline the major considerations as they apply to the dominant factors outlined above.

b. Reliability

Reliability, and passenger safety as a result of reliability, must be given careful consideration. At the present time, experience in this country with a rapid transit system of the type considered in this report employing rubber tires is practically nonexistent. To employ this type of system ready for operation within the next four years would require an extensive research and development program to prove the same degree of reliability achieved with the steel wheel cars. Of interest in such a development program would be the effect of the failures on the car of both vertical and side stabilizing tires at the high speeds required.

The steel wheel train, on the other hand, has been developed and tested under actual service conditions and has been proven extremely reliable and safe at the required operating speeds.

c. Passenger Comfort

The transit equipment should have the capability of providing comfortable seating and access, low internal noise levels, adequate ventilation and temperature control, and architecturally pleasing interiors. The outward appearance of the car must be aesthetically appealing to the surrounding community and an effort must be made to reduce external noise generation produced on the running surfaces.

Noise reduction from external sources within the car can be accomplished by the following:

(1) Application of sound deadening material in the construction of the floor.

(2) The use of air type suspension in the trucks.

(3) The use of rubber type isolation mounts for the drive equipment.

(4) The use of sound absorbent panels within the interior of the car.

(5) The isolation of auxiliary equipment from the car body and frame by means of shock and sound absorbent material.

(6) Careful detail design involving the sealing with accoustical material of all penetrations into the car.

For reduction of noise emanating from the running surfaces, the following construction methods can be employed:

(1) The use of continuously welded rail mounted on sound deadening pads.

(2) The use of rubber in the truck and wheel construction to damp vibrations.

In general, the items above apply primarily to the steel wheel car; however, the rubber tired train will generate noise from the running surfaces. It has been concluded from published material and other reports (1) on the subject that with the proper design, noise generated by both types of systems can be controlled to approximately the same level.

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(1) Convair Report 2P-298, March, 1960

d. Economics

Investigations were made of the characteristics and preliminary car costs of proposed light weight rubber tire and steel wheel cars. For comparison purposes, costs of conventional steel wheel transit cars with approximately the same operating characteristics were developed. A tabulation of this data is shown on Table III, page III-47.

The results of this study indicate the following:

(1) That of the cars studied, the lighter weight cars employed air frame construction techniques. This method of construction provided reduction in weight but added significantly to the initial car cost.

(2) That the rubber tired cars were slightly higher in first costs due to a more complicated bogie which required steel wheels inboard of the rubber tires in the event of tire blowout and for switching purposes.

(3) From an operational standpoint with cars of equal weight, one employing steel wheels and one employing rubber tires, the power costs for operating the rubber tired vehicle is approximately 20 per cent greater.

(4) From a maintenance standpoint the more frequent replacement of the rubber tires will contribute to higher maintenance costs.

(5) That the rubber tired car bogie will require a considerable research development and testing program at the speeds required for the system before it can be used. In this regard, the running track will require careful design to produce a smooth surface.

(6) For trains of equivalent passenger capacity, the costs for light weight steel wheel trains, when compared with rubber tire trains, produce cost savings in the magnitude of 1-1/2 to 1.

e. System Costs

When considering car costs, the effect of the system structure costs must also be evaluated to determine the over-all savings in first costs. For example, the running track installation at grade for the rubber tire train is approximately three times the cost of the steel wheel train track installation. Total system costs are sensitive to the weight of the cars. This is particularly true for the overhead structures. The range of weights used in the study varied from 400 pounds per lineal foot empty to 1,000 pounds per lineal foot empty. Design investigations indicated that significant savings in beam costs could be made by reducing car weights from 1,100 pounds per foot to approximately 800 pounds per foot. The bar graph, Figure 4, page III-48, represents the combined costs of cars and structures for the proposed full 75-mile system.

f. Car Development

As a result of the foregoing investigation, the steel wheel type of car has been selected for the following reasons.

(1) Available information indicates that this type of car can be built and put into operation within the next three to four years by employing components of advanced but proven design characteristics.

(2) Employment of careful and thorough design in regard to noise generation will produce a quiet and comfortable operating car.

(3) From an economic standpoint and employing the car criteria established, the steel wheel car will provide lower first costs and lower operating and maintenance costs than the rubber tired car.

Once the type of car had been established, further design effort was directed toward styling the exterior and interior of the car to provide an aesthetically attractive car to the passengers. In this phase of the work aluminum was used extensively in the car body and underframe. The most current information to date indicates that the extensive use of aluminum produces economy, weight savings and lower maintenance costs.

3. Traction Power Voltage and Equipment

a. Traction Power Voltage Selection

(1) The high acceleration rates which are required to maintain high schedule speeds in rapid transit service with frequent stops led to the selection of direct-current traction motors of the series-field type as the type of motors most suited for this service.

(2) The trucks under modern rapid transit cars designed for mass transportation use afford limited space for mounting traction motors. Therefore, the motors must be small-diameter, and consequently must have high armature speeds, in order to deliver the requisite power to the axles. Such motors have limited clearance for insulation, requiring an applied voltage less than 750 volts d-c. Since 600 volts is a standard voltage with the manufacturers, this voltage was selected as the applied voltage.

(3) Light-weight cars and high acceleration rates require all of the train weight on the driving wheels to prevent the driving wheels from slipping. Therefore, one motor must be applied to each axle, with four motors per car. The selection of series-parallel control naturally followed, with the incidental but important advantage of electrodynamic braking adding to the merits of the system.

(4) The selection of low d-c voltage traction motors requires one of three possible current collection schemes to apply power to the moving trains from stationary conductors:

(a) Low d-c voltage (600 volts) on an overhead trolley wire or catenary.

(b) Low d-c voltage (600 volts) on a low-elevation contact rail close to each track.

(c) High a-c voltage (assume 11, 000 volts single-phase) on an overhead catenary over each track, with a transformer-rectifier on each car to convert to 600 volts d-c.

An economic comparison of Schemes (a) and (b) showed that Scheme (b) with contact rails is preferable on a completely grade separated right-of-way, since overhead trolley wires require additional supporting structure on tracks at grade or on structure, and also require larger subway tunnels and higher cross-over bridges with consequent greater cost of excavation and construction. Also, the unsightliness of the overhead catenary and the pantographs on the cars helped to influence the decision.

Scheme (c) was rejected for economic reasons because the capacity of the conversion equipment on the cars would be much higher in total than the capacity required for stationary substations along the track which would result in higher costs. More power is required to accelerate and move the heavier cars. Also, the power companies object to the unbalanced load of single-phase catenary sections on their 3-phase systems.

b. High-Voltage Power Distribution System

The 600-volt d-c contact rails along the tracks will be supplied with power from 15 traction substations located at intervals of less than two miles. These substations can be located in separate rooms of those passenger station structures which will be situated in desired substation localities.

These traction substations must be supplied with a-c power with can be obtained from the local power utility at their standard 3-phase 60-cycle voltage. If power is purchased directly at each of the 15 new traction substations, the cost per kilowatt-hour would be higher than if the Transit Authority purchased the power at one or two central points and then distributed the high-voltage power along the tracks to the traction substations.

An economic study was made which showed that the preferred method would be for LAMTA to purchase the rapid transit power at two points and to own and operate its own high-voltage distribution system. Since a power contract now exists for purchasing power, it was assumed that this contract can be extended to the rapid transit system. Also, LAMTA now owns and operates a high-voltage distribution system which feeds its existing traction substations now supplying power to trolley buses and street cars, and also feeds its repair shops. It was found that part of this distribution system and two of the existing traction substations could be utilized for the rapid transit system without interfering with present operations.

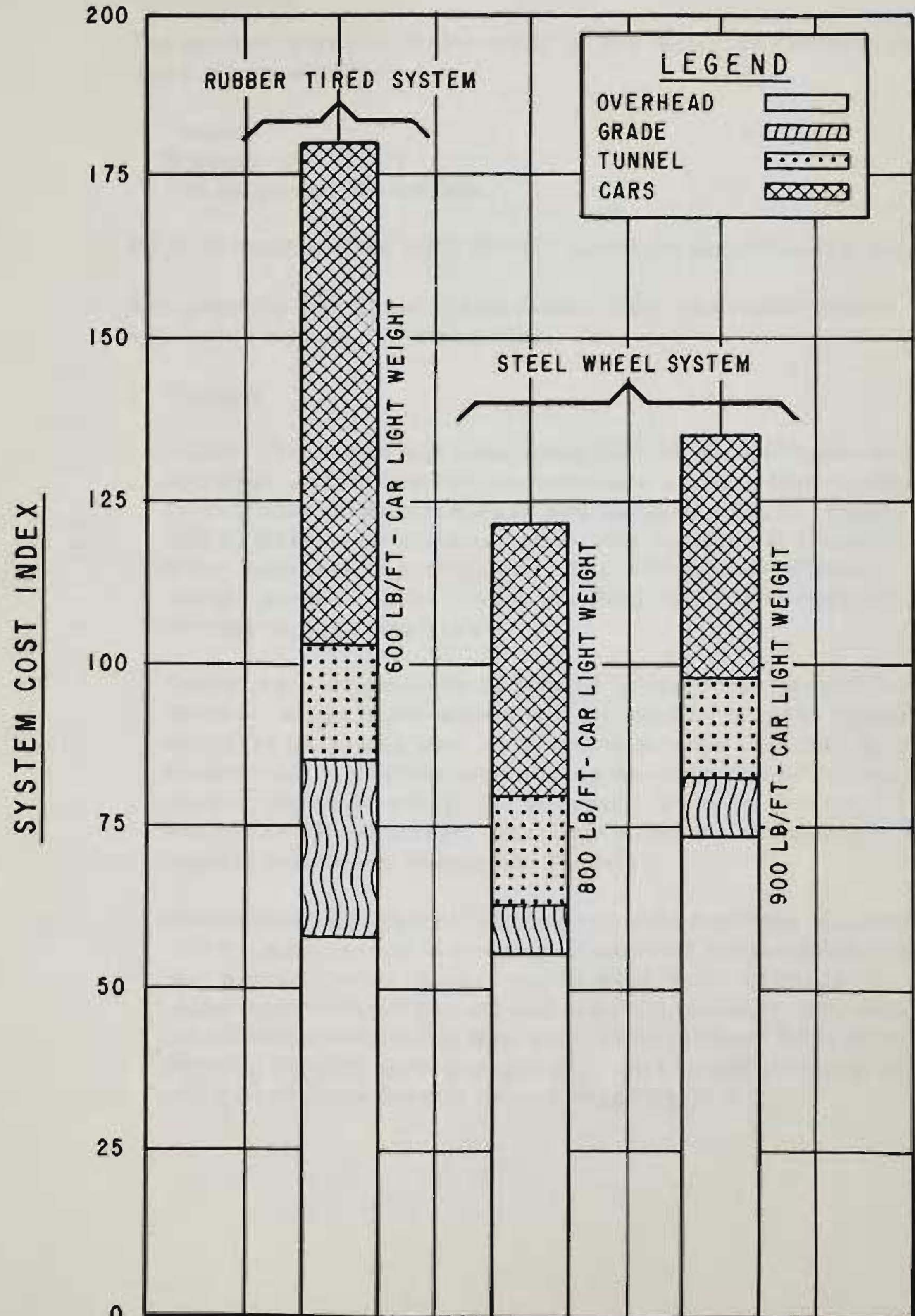
The bulk of the high-voltage power for rapid transit use will be distributed through new high-voltage cables along the tracks and looped into each new traction substation. Each substation will have a normal and emergency connection to these cables, so that if one high-voltage cable should be out of service, the other one would be adequate to maintain normal train service until the normal supply is returned to operation.

TABLE III

CAR COMPARISON TABULATION

	Car A	Car B	Car C	Car D	Car E	Car F	Car G	Car H	Car I
Length, ft	55'-4"	57'-0"	67'-3"	53'-8"	58'-0"	58'-0"	56'-7½"	67'-0"	75'-0"
Max. Width, ft	9'-0"	10'-4"	10'-5"	10'-0"	10'-5"	10'-5"	10'-4"	10'-5"	10'-3"
Seated Passengers	60	62	76	52	70	70	61	76	85
Car Weight Empty, lb	50,000	50,956	60,800	30,000	32,700	41,000	60,000	53,600	64,000
Total Car Weight, lb	59,000	60,256	72,200	37,800	43,200	51,500	69,150	65,000	76,700
Weight/Lineal Foot (Empty) lb/ft	904	894	904	559	564	707	1,060	800	855
Weight/Seated Passenger (Empty) lb/pass.	833	822	800	577	467	586	984	700	750
Wheel and Rail Type	Stl-Stl	Stl-Stl	Stl-Stl	Rubber-Conc	Rubber-Conc	Stl-Stl	Stl-Stl	Stl-Stl	Stl-Stl
Car Costs, $	90,370	90,921	120,000	166,500	175,000	170,000	113,000	135,000	120,000
$/Passenger	1,500	1,460	1,580	3,200	2,500	2,420	1,852	1,760	1,410
$/Lb	1.81	1.78	1.97	5.55	5.35	4.15	1.85	2.05	1.87
$/Ft	1,634	1,595	1,784	3,103	3,020	2,920	1,995	2,050	1,600

COMPARISON
OF
STRUCTURES AND CAR COSTS



E. Construction Considerations

1. General Plan

The general plan for construction of the facilities encompasses three major efforts:

Tunnels
Stations
Trackage and Equipment

Each of these will be discussed in order on the following pages.

A supporting functional organization chart and construction schedule conclude the discussion.

a. Tunnels

Tunnel excavation and concreting will be worked from east and west portals and two intermediate access adits located in vicinities of Hancock Park and Lafayette Park. Adits will be permanently decked open cuts located off street. Plant facilities at portals and adits will include offices, change houses, shops, muck handling facilities, compressors, storage and parking areas.

Tunnel excavation methods will be governed by ground conditions. A hydraulic shield will be used in alluvial deposits which lie generally west of Vermont Avenue and east of Hope Street. A continuous mining electric "mole" will be used in the shale which lies generally between Vermont Avenue and Hope Street. Steel rib supports and timber lagging will be set throughout tunnels.

Preliminary geological information indicates that alluvium will be encountered in varying degrees of consolidation and that perched water tables may be expected. Sections of highly consolidated ground and isolated boulders will slow the rate of advance and may require occasional light blasting. Running ground, both wet and dry, will be encountered locally and will require careful breast boarding at face.

(1) Shield

An open-faced horseshoe section shield will be jacked through the ground by hydraulic jacks bearing against collar braces set between steel ribs. Timber lagging will be set skin tight over steel ribs within the tail of the shield. As the shield is jacked, a cement grout mixture will be pumped into tail void of shield to prevent ground subsidence.

An electric-hydraulic shovel will excavate the face and feed a conveyor for loading mine cars. Muck trains will be hauled by diesel locomotives to portals or adits. Muck will be dumped to inclined conveyor feeders and conveyed to truck loading bins. Truck-trailers will haul muck to disposal areas.

After completion of tunnel excavation, construction track will be removed, invert cleaned and the tunnel retimbered where required.

(2) "Mole"

An electric continuous mining "mole" will excavate a circular section through shale and soft rock. Cutters on counter-rotating heads will score and break down the tunnel face. Buckets on the outer rotating head will pick up mined material and deposit it on a belt conveyor for loading mine cars. Full round steel ring beams will be set immediately behind "mole" cutterhead and blocked and lagged as required.

Muck disposal will be as described for shield tunneling.

(3) Emergency Access Shafts

Shafts will be bored to required diameter using earth drill. Reinforced concrete casings will be set into shafts and annular rings grouted. In loose ground casings will be set as shafts are drilled. After casings are set breakthroughs will be made from shafts to tunnel. Ribs will be burned through and blockouts set for forming entrances in arch concrete.

(4) Tunnel Concrete

Tunnel concreting operations will be worked in three sections. An invert-arch-walkway cleanup sequence will be used.

Centrally mixed concrete will be hauled to stations, emergency shafts or other access points in truck agitators and delivered to the tunnel through downpipes. Rail mounted agitator cars will haul concrete to headings.

(a) Invert Concrete

Invert concrete will be poured from a belt conveyor carried on a bridge over previously completed pour. Conveyor bridge will ride on roller brackets clamped to tunnel ribs. Concrete will be formed by a screed traveling on the conveyor bridge.

(b) Arch Concrete

Arch concrete will be poured continuously using air operated placer and telescoping steel forms carried on rail mounted traveler.

(c) Walkway Concrete

Walkway concrete will be poured directly from agitator cars to steel forms using an inclined belt conveyor and side chutes.

(d) Final Cleanup

After concrete is poured and other auxiliary work completed, construction rail, temporary pipes, lines and other construction facilities will be removed and con-concrete cleaned and patched as required.

(5) Permanent Drainage

Sumps will be formed in invert concrete at low points of profile. Automatic electric pumps will discharge to pipe header. Water will be pumped to surface at stations for discharge to storm drains.

b. Stations

Stations will be constructed in temporarily decked open cuts. Construction normally will not begin until passage of tunnels. Exceptions are made in those stations which will serve as access shafts for removing tunnel equipment. These stations--Robertson, Crenshaw and Hope--will be excavated prior to approach of tunnels.

Wilshire and Central Business District Stations will be excavated in the following steps:

(1) Pavement will be broken and initial cuts made to expose utilities and shallow building footings at mezzanine or lobby sections.

(2) Steel H-piles will be driven into bored holes around perimeter of excavation for main station sections.

(3) Precast decking will be set on H-piles and cantilevered over sidewalk, mezzanine and lobby areas.

(4) Buildings will be underpinned at lobby and mezzanine sections as required.

(5) Stations will be excavated under decking from end to end in a series of 8 ft to 10 ft cuts using rubber tired tractor-shovels to excavate and haul material to skip tower for hoisting through hatch in decking. Self dumping skips will discharge to truck loading bins.

(6) Utility mains and building services will be suspended from deck and supported as excavation progresses.

(7) Timber lagging will be set between H-piles as excavation progresses.

(8) Steel tunnel ribs will be removed as excavation approaches final grade.

(9) After completion of station concrete and waterproofing, excavation will be backfilled, piles pulled, utilities restored and sidewalks and streets repaved.

Approximately seven months will be required to excavate each Central Business District Station and three months each Wilshire Corridor Station.

Reinforcing steel and forms for station concrete will be set under decking. Concrete will be pumped into forms from surface with Pumpcrete machine.

Approximately two months will be required to concrete each Central Business District Station and Wilshire Corridor Station.

c. Trackage and Equipment

Trackage, mechanical and electrical installations will be made concurrently with tunnel and station concrete pouring and as necessary preliminary work is completed.

Inserts for track bolts will be set into invert concrete. Permanent rails will be set after removal of construction rails by crews working from diesel trucks.

2. Critical Path Scheduling

A feature of the general plan for construction is the contemplated use of critical path scheduling. The critical path method, utilizing electronci computers already in use within Kaiser Industries, provides management with a highly sensitive tool for recognizing planning and scheduling problems as they occur. Of equal importance to problem recognition is the ability to take remedial action through immediate reassignment of project talent to the critical areas as they occur.

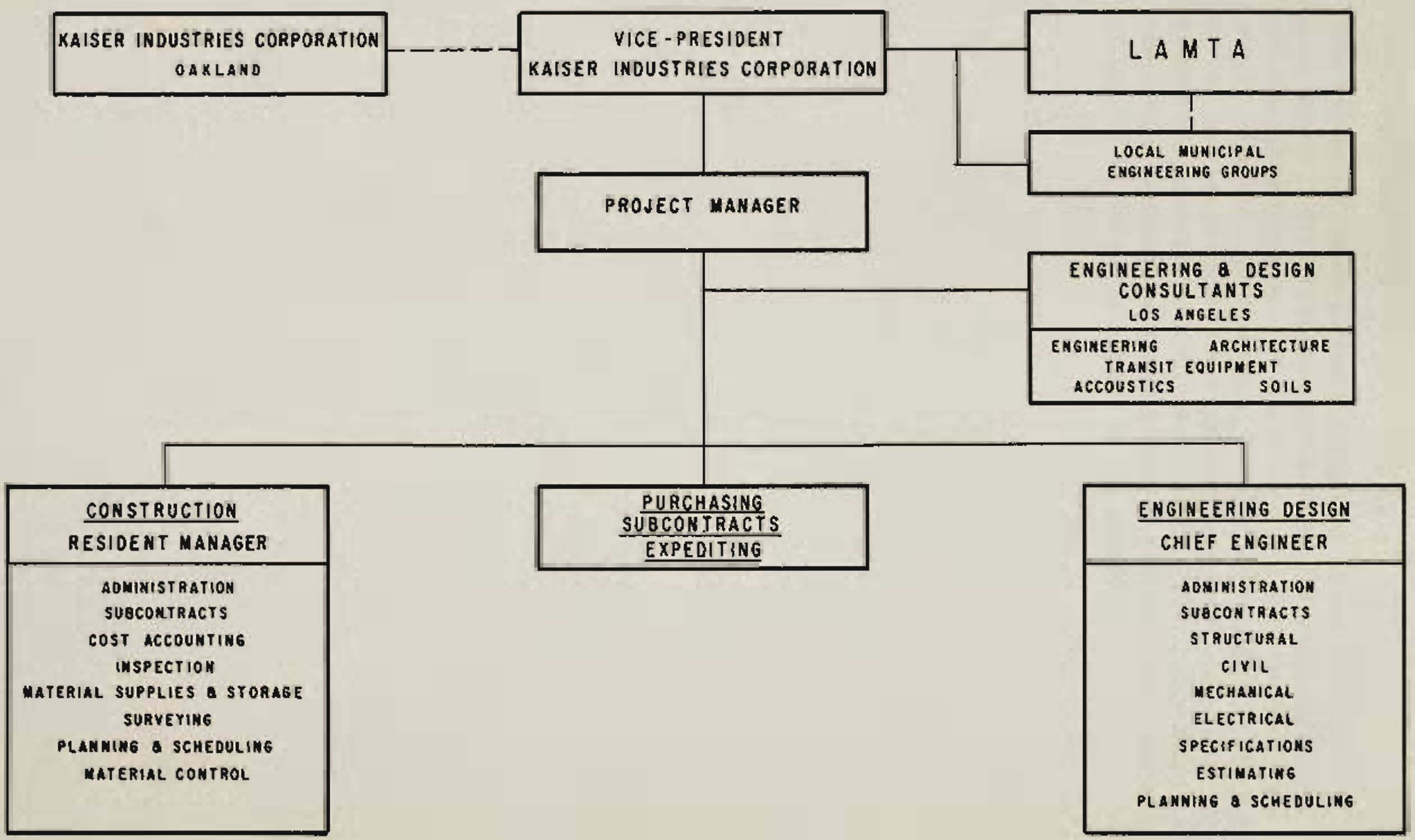
This technique has been previously utilized within Kaiser Industries and is a part of regular engineering activities.

3. Organization on a Project Basis

Since experience with other assignments performed in an extremely short period of time has shown the advantages of the autonomous project method of management, a new organization would be established for the design and construction of the backbone system. This organization would have the authority and quick reaction needed to complete this extensive complicated system on time. This project group would be under the direction of a vice president of the company and would make its headquarters in Los Angeles. Figure 5, page III-55 depicts the project organization on a functional basis.

FIGURE 5

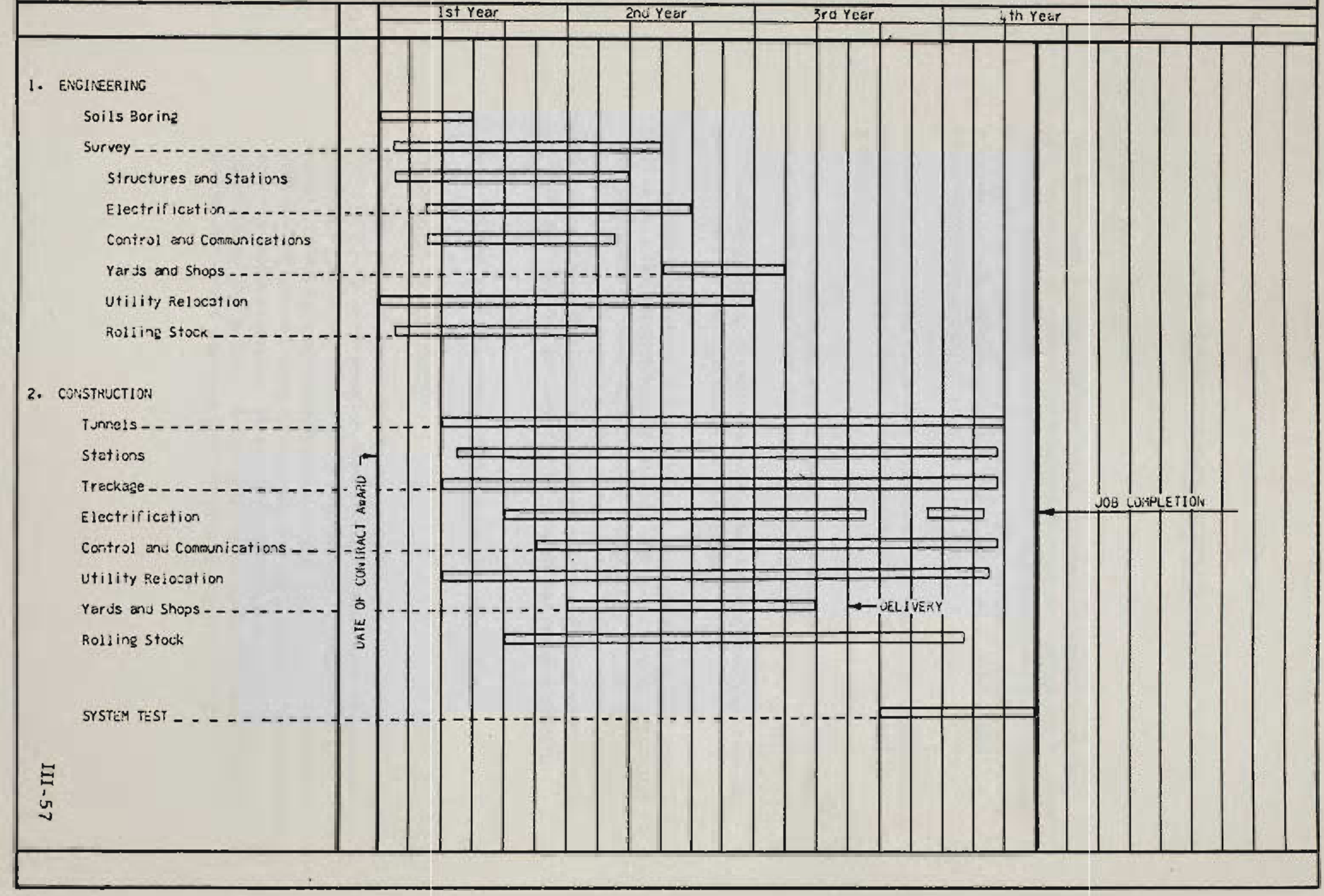
PROPOSED FUNCTIONAL PROJECT ORGANIZATION CHART



4. Construction Schedule

The proposed construction schedule is shown on Figure 6, page III-57. This schedule is based on job completion 42 months after the award of the design and construction as a single contract. Certain major decisions regarding the type of car and securing of the rights-of-way will have to be resolved before the contract award. Engineering and construction will proceed simultaneously and orders for major equipment would be placed in the early stages of the project.

FIGURE 6
PROPOSED PROJECT SCHEDULE
BACKBONE ROUTE



IV. FACILITY DESCRIPTION

A. General Description

The backbone system, as designed, consists of approximately 22.7 miles of an electrified dual track system. Of the 22.7 miles, 12 miles of the system is in subway in the downtown Los Angeles area and out the Wilshire Corridor. The balance of the system is located at grade adjoining and in the median strip of the San Bernardino Freeway.

A total of 24 station stops are provided. Of these, 16 stations are located underground in the subway system and 8 are located at grade.

The system is equipped with a ventilation system which provides temperature control for the underground portion of the system.

An automatic train control system is provided which assures high performance as well as safety of operation.

High voltage a-c power is furnished to 15 substations along the route where the transformation to 600 volt d-c traction power is made by means of transformers and rectifiers.

Modern light weight aluminum cars employing speeds of 70 miles per hour and capable of carrying 85 seated passengers will be used.

Specific items are described in the following sections:

1. Structures and Roadbeds

Tunnels between stations will be constructed either by a circular mole or a horseshoe shaped shield. Steel ribs and wood lagging suitable for loads encountered will be placed in the bore. Grouting and reinforced concrete will be placed to provide the structural integrity for the tunnel section in accordance with the soils criteria. Sumps will be formed in the invert concrete at low points. Small automatic pumps located at low points and at the stations will discharge water to grade.

Trackage at grade will consist of two parallel sets of tracks running in the Pacific Electric right-of-way. Trackage will consist of ballast, ties, 100-lb ARA continuously welded running rails, except for insulated joints which form the blocks for signal operation, placed at standard gauge complete with all hardware. Special track pads of a resilient material will be placed on the ties. The power rail is a special section weighing 150 lb/yd and of lower electrical resistance than the standard track rail.

Trackage in the tunnels will be similar except that concrete inserts will be installed in the tunnel invert concrete. Concrete pads and grouting will be installed beneath the resilient track pads.

A portion of the existing Pacific Electric track in the San Bernardino Freeway will have to be relocated approximately 14 ft north of its present location in the San Bernardino median strip. This is necessary to provide for the two new rapid transit tracks.

2. Stations

The 13 underground stations in the Wilshire corridor will have a station platform length of 300 ft. These stations will have outboard platforms and each track will be located in a separately conctructed box section connected by a pedestrian tunnel.

The 3 underground downtown stations will be constructed with a platform length of 450 ft. These stations will have a center island type boarding platform.

Underground substations have been consolidated with certain of the underground stations. These combined substations and stations are located as follows:

Beverly	Vermont
Masselin	Lucas
Crenshaw	Union Station

Station floors and platforms are to be of wear resistant composition floor finish with nonslip floor surfaces. The edges of loading platforms will be furnished with a contrasting band of nonslip tile which will extend the entire length of each loading platform. All service floor areas are to be colored concrete. Toilet room floors are to be finished with ceramic tile.

Glazed structural tile units will be used for the walls. These units will have a high reflecting value and will provide easy maintenance.

Stair treads are to be fitted with abrasive strips embedded in the finish to prevent slipping.

Doors and their frames shall be of steel with baked on enamel finish. Handrails shall be of aluminum. Signs shall be provided indicating the location of various facilities, such as stairs, telephones, train stops, etc.

Escalators are to be of the modern heavy duty type with all stainless steel trim. Escalators leading up to the street shall be weatherproofed. The arrangement and number of escalators are to be as shown on the station arrangement drawings.

Lighting is provided for mezzanines, platform lobbies and stairways. The following table of light intensities has been used as a guide.

Downtown and Stations

Mezzanine	35 foot candles
Platforms	35 foot candles
Stairways	30 foot candles
Lobbies	35 foot candles

Substations

General Lighting	75 foot candles

Eight at-grade stations will be provided and located in the San Bernardino Corridor. Station platforms will be located in the Pacific Electric right-of-way. In most cases, the lobby which will house the ticketing equipment will be separated and located on a frontage road area adjacent to the freeway. Connection will be by means of a pedestrian overpass. Six substations are combined with the stations in the following locations:

Hoyt	Rosemead
New	Fremont
Eastern	State

3. Emergency Exits and Station Vents

The following ventilation facilities will be provided:

a. Air vent shafts of approximately 90 sq ft of area extending from the subway to the surface and located at 900 to 1,000 ft spacing along the subway between stations. These air vents also serve as emergency exits.

b. Blast vent shafts located near the inbound entrance to each station to reduce strong wind blasts caused by arriving trains.

c. An emergency vent fan of approximately 60,000 cfm capacity installed midway between all stations. These fans will provide ventilation in case of emergency due to fire or train power failure. They may also be used to ventilate the subway during extended train shutdowns.

d. Ventilation fans of approximately 25,000 cfm capacity installed in each downtown station.

e. The air vent shafts and blast vent shafts will be equipped with dampers which may be closed during emergency conditions so that the emergency vent fan will pull air from the stations to the vent point midway between stations. Likewise, these dampers will be adjustable to maintain temperature in the stations at a comfortable level during cold weather or above dew point during periods of high humidity.

f. The air and blast vent shafts which discharge through grills on sidewalks or other travel areas will have a grill area at least 50 per cent larger than the area of the vent shaft.

4. Electrification

High voltage 16.5 kv power will be supplied from two switching stations. This power will be fed to 15 traction substations where it will be transformed and converted to 600 volts d-c. The traction substations will be located at intervals of less than two miles.

The 600 volt d-c will be fed to the contact rail with a negative return to the substation through the running rails.

Circuit breakers will be provided with overload and automatic releasing features. The breakers can be controlled manually or remotely by means of the supervisory control system.

5. Control and Communications

The control and communications system will be based on standard centralized traffic control with a modified form of block signalling system. Trackage is to be electrically sectionalized to provide positive indications of train occupancy within each section and to limit track section occupancy to one train. The system will provide positive identification of any train in the transit system with relation to other trains at any given time. Transit operation will be continuously monitored with fully automatic train protection. Manual override for emergency operation will be provided.

Principal equipment for the line supervision subsystem will be included in a central control building, located at Mason Street. Major components will include the necessary control equipment, a system display board, a taped program dispatching unit and auxiliary control equipment.

Associated wiring will consist of twin wire connections between each station and the central office, as well as suitable power supply.

Vehicle-borne equipment would be placed on 64 cars to provide automatic train control from wayside check points. Cars equipped with automatic control devices would be placed as the leading and trailing car of each operating train.

Wayside control equipment would be placed at each station for each direction of train movement.

Control components would also be placed at approximately 200 check points along the trackage. Ancillary equipment would consist of twin lead cables installed throughout the track right-of-way and a power supply of 110 volts a-c for both station and check point equipment.

The train protection subsystem would include block signalling type of automatic control. All train running equipment would be constructed to accept train protection signals on an override basis, utilizing normal train running circuits and equipment.

6. Yards and Shops

The existing Macy Street facility will be utilized as a storage and maintenance area. Sufficient trackage for storage of 120 cars will be provided.

A central control building consisting of 15,000 sq ft of floor space to house all communication and control equipment will be provided.

7. Land Acquisition and Right-of-Way

Land acquisition and right-of-way costs have been furnished by LAMTA and are based on the following:

a. San Bernardino Corridor

Real estate costs in the San Bernardino Corridor will consist of right-of-way for twin tracks and platforms in the Pacific Electric right-of-way, and acquisition of private lands for passenger stations and parking areas. Track right-of-way assumed at 27.5 ft wide, with platform area as 450 ft x 13 ft additional, station area at 200 ft x 50 ft, parking area of 300 sq ft per car for 200 cars typical, and 1,600 for cars at Hoyt Avenue for a total of 3,000 cars.

Type Facility	Type Property	Area Required		
		Track Sq Ft	Station Sq Ft	Parking Area Sq Ft
Tracks & Platforms	P.E. R/W	1,650,000		
Passenger Stations	Private Lands			
Soto-State			10,000	60,000
Eastern			10,000	60,000
Fremont			10,000	60,000
Atlantic			10,000	60,000
New			10,000	60,000
San Gabriel			10,000	60,000
Rosemead			10,000	60,000
Hoyt			10,000	480,000
Total		1,650,000	80,000	900,000

b. Wilshire Corridor and Central Business District

Real estate costs in the Wilshire Corridor and central business district will consist of sub-surface easements under private lands, and surface area for an electrical switching station at Wilshire and San Vicente Boulevard. The sub-surface easement is assumed at 50 ft wide for twin tubes. The electrical switching station is assumed as an area 30 ft x 30 ft.

(1) Sub-Surface Easement

Station	to Station	Sub-Surface Easement Sq Ft
Portal	to Union	108,500
Union	to First	14,500
Sixth	to Hope	25,000
Hope	to Lucas	37,000
Lucas	to Alvarado	75,000
Alvarado	to Vermont	40,000
Total		300,000

(2) Surface Area

Electrical switching station at Wilshire and San Vicente - 900 sq ft.

8. Rolling Stock

Cars are to be electrically powered, light weight, high-speed aluminum vehicles designed to offer attractive appearance and comfortable ride. Cars will be air-conditioned and equipped for fully automatic external operation. They will ride on steel wheels running on steel rails. Cars and right-of-way will be designed to provide low and entirely acceptable noise level inside and outside.

Basic body structure will be of aluminum alloys with underframe of steel and aluminum. Fabrication methods are completely at discretion of builder. In both fully loaded and light conditions, car must be capable of withstanding 200,000 lb static buffing load applied at coupler locations without taking permanent set. Suitable anti-climbers and collision posts must be incorporated at both free and joined ends of all cars. Anti-climbers shall be satin-anodized aluminum plate.

Interior of passenger compartment should be approximately 10 ft 6 in. wide and 7 ft 0 in. clear height in standee areas. Dimensions over seats can be revised as appropriate to finished contour.

Car length shall be approximately 79 ft as shown in these specifications. Alternate lengths will be considered if shown to offer advantage in weight and cost per foot of length, and where the alternate length is consistent, with efficient operation in off-peak service, with performance within limits of available propulsion equipment and within clearance and curvature limits set by right-of-way.

Objective is car weight of 800 lb/ft complete ready-to-run.

Body structure shall be of aluminum with specific alloys and tempers appropriate to the design. Underframe members shall be aluminum or steel, or judicious combination thereof, to obtain minimum weight consistent with cost. Truck parts shall be commonly used steel alloys but with provision for service testing on individual cars of alternate materials that offer reduced weight or maintenance. Aluminum items either employed structurally or exposed continually to the elements shall be of alloys 5083 for sheet items and either 5083 or 6061 for structural shapes. Unpainted exterior aluminum surfaces should be anodized where appearance is important.

Car shall have pleasing and modern appearance, with exterior surfaces that require minimum maintenance. Only painted surfaces are to be car top and sides. Exterior design shall also have the objective of minimizing both exterior and interior noise levels. Front and rear end trim is to be fluted satin finish anodized aluminum extrusions or rolled sections. Header sash and trim along side of car is to be polished anodized aluminum sheet. Headlight bezels are to be of stamped bright finish anodized aluminum. Wheel skirts are to be bright anodized fluted rolled aluminum sections. Air conditioning grilles in roof are to be bright finish anodized aluminum extrusions.

In recognition of high degree of highway competition, comfort, appearance and noise levels within these cars must be of much higher standard than on many existing utilitarian-type transit vehicles. Layout must provide for maximum number of seats consistent with rapid entry and exit. To permit rapid acceleration with passenger safety, grab railing must be easily accessible to all standees, and to all passengers traversing between doors and seat. All such assist rails and poles are to be extruded aluminum tubing, satin finish anodized, or stainless steel tubing as alternate. Materials used on inside shall be paint-free and maintenance-free. Joints shall be rounded for easy cleaning. Side walls are to be vinyl laminated aluminum sheet. Attractive roll formed aluminum placards shall be installed for advertising cards. Inside ceiling shall be perforated vinyl laminated aluminum sheet or perforated porcelainized aluminum sheet. Air conditioning grilles are to be expanded aluminum extrusions. Baseboards are to be rolled stainless steel.

An air conditioning-ventilation system shall be incorporated. Air conditioning capacity shall be suitable to keep standing car comfortable. Ventilation system will supplement while car is in motion, and will include blowers plus front and ceiling louvres to take in fresh air. Provision shall be made for air duct work and wiring for air conditioning system of sufficient capacity to handle entire load.

Doors will be twin-unit light weight aluminum side doors, at least one opening per side for each 20 ft of car length. These doors to be operable from one central point in any length train, and interlocked with train controls to prevent opening while train is in motion. Side doors may be staggered or opposite each other whichever fits best into overall interior arrangement. Emergency doors are required on each end of each car.

Seats will be light weight, walk-over or fixed, with easily cleaned seat and back. Framing shall be satin finish anodized aluminum tubing or stainless steel tubing, and it shall provide hand hold for standees. Seat sides shall be vinyl laminated aluminum sheet. Seat backs shall be embossed aluminum. Seat trim is to be aluminum, either extruded or roll formed with painted grooves and polished ribs. An alternate method of seat construction is to support the seats by aluminum forgings cantilevered from the side wall supporting the free end from the ceiling structure through the grab rail, thus eliminating the seat base trim, and affording maximum ease of cleaning and maintenance. Seat cushions and backs will be vinyl covered.

Windows will be fixed sash, rounded corners, tinted safety glass in bright anodized aluminum window frame. A minimum of three windows per car side must be of the type that can be pushed out for emergency exit. Glass area to be minimum consistent with visibility and appearance.

High-intensity fluorescent lighting will be required, supplied by aluminum wiring in overhead troughs of white gloss coated aluminum with smooth translucent white plastic diffusers.

Insulation will be adequate for both temperature control and interior noise reduction.

A minimum cost and weight heating system will be required to maintain 60^{o} inside with 40^{o} ambient.

The floor will have a light weight aluminum sub-floor with skid-resistant vinyl covering.

Each car will contain public address system for station announcements and emergency messages.

Trucks will be of conventional type with four steel wheels and inboard-mounted roller bearings. Air springs automatically keeping car body height approximately constant at all passenger loads. Supplemental coil springs and shock absorbers are at car-builder's discretion.

The motor and controls will be a combination of motor capacity, gearing and controls and must be capable of accelerating fully loaded car at 3 mphps up to 30 mph with minimum top speed of 70 mph. Service braking to be 3.0 mphps and emergency braking 4.0 mphps. Retardation is to be by dynamic braking down to 5 mph maximum. Complete air brake system is to be installed for braking below 5 mph and as emergency system at all speeds, and so installed as to take over braking function automatically in event dynamic braking is inoperative from any cause.

Composition shoes or disc brakes to be used.

Controls to permit operation of trains up to 20 cars in length with operation either by operator in cab or by external means. Control panel is to be embossed aluminum sheet with an extruded aluminum roll away cover which can be locked in closed position when not in use. Screen in back of control panel is to be perforated anodized aluminum sheet.

Where possible, bus bar and cable shall be aluminum to reduce weight and cost.

B. Concept Drawings

The following design drawings illustrate the concept and configuration of the principal elements of the backbone route.

Drawing No.	Title
101-LC	Wilshire Corridor - Plan and Profile
102-LC	Wilshire Corridor - Plan and Profile
103-LC	San Bernardino Corridor - Plan and Profile
104-LC	San Bernardino Corridor - Plan and Profile
105-LC	First and Broadway Station - Plan and Profile of Station and Utilities
106-LC	Sixth and Broadway Station - Plan and Profile of Station and Utilities
107-LC	Seventh and Hope Station - Plan and Profile of Station and Utilities
108-LC	Union Station - Plan and Profile of Station and Utilities
101-LA	Sixth and Broadway Station - Perspective
102-LA	Sixth and Broadway Station - General Arrangement
103-LA	First and Broadway Station - General Arrangement
104-LA	Wilshire Subway Stations - Deep Type Arrangement
105-LA	Wilshire Subway Stations - Shallow Type Arrangement
106-LA	San Bernardino Stations - Surface Type Arrangement
101-LE	Electrification System - Diagrams
--	Proposed Los Angeles Metropolitan Rapid Transit Car

NO.	DATE	REVISION	BY	APP.	APP.	REFERENCE DRAWINGS	NUMBER

NOTES

1" = 1000'

1" = 50'

DESCRIPTION — COST ACCOUNT

CONSTRUCTION APPROVAL

APPROVAL — DATE

PROJECT ENGINEER

CHIEF ENGINEER

KAISER ENGINEERS

DRAWN BY R.B. RASMUSSEN

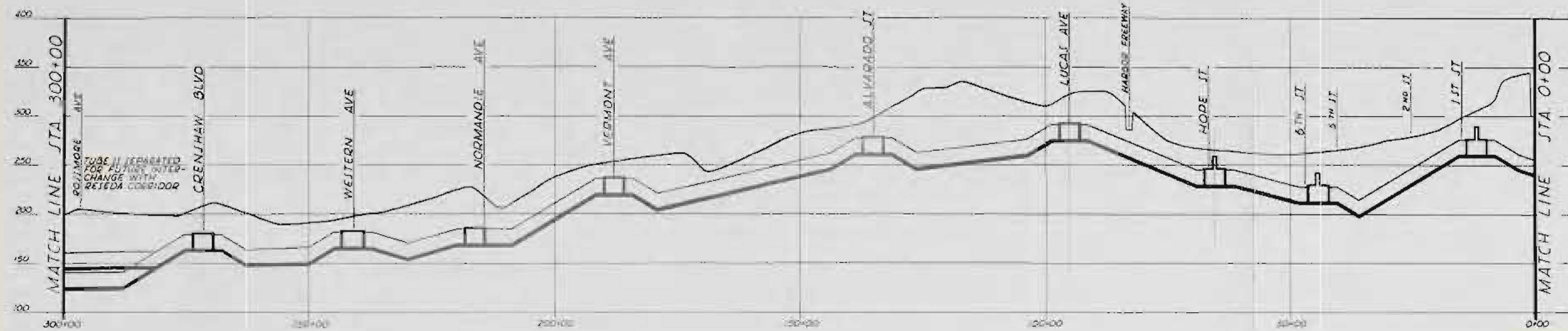
CHECKED BY W.C. THAYER

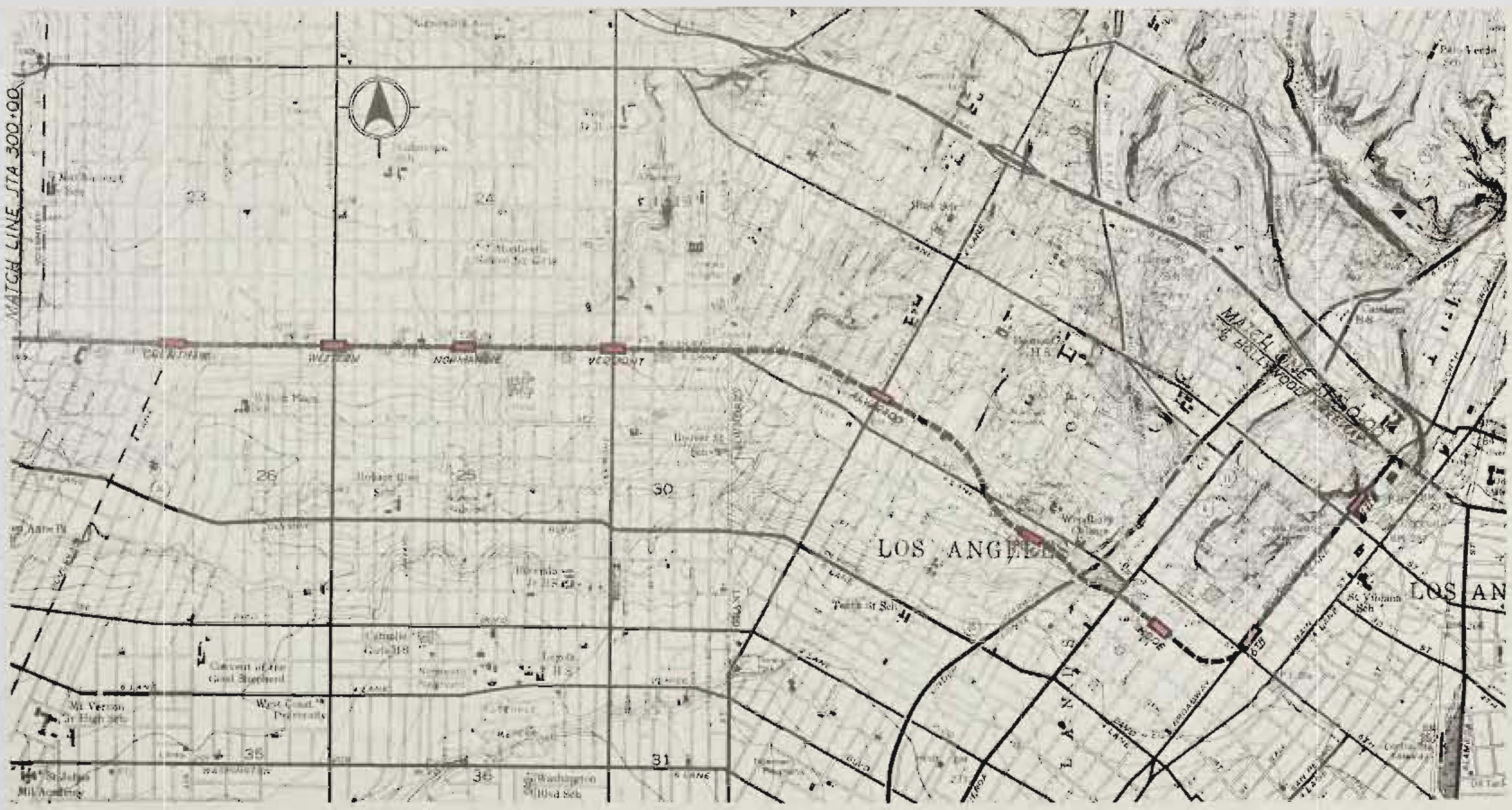
FOR: METROPOLITAN TRANSIT AUTHORITY

LOCATION: LOS ANGELES, CALIFORNIA

RAPID TRANSIT SYSTEM
WILSHIRE CORRIDOR
PLAN & PROFILE

JOB NO. 6005-596 | DWG. NO. 101-LC | R-





NO.	DATE	REVISION	BY	APP.	APP.	REFERENCE DRAWINGS	NUMBER

NOTES

1. FOR LEGEND SEE DWG Nº 101-LC

1" = 1000'

1" = 50'

DESCRIPTION — COST ACCOUNT

CONSTRUCTION APPROVAL

APPROVAL	DATE
PROJECT ENGINEER R. S. Tamm	
CHIEF ENGINEER	

KAISER ENGINEERS

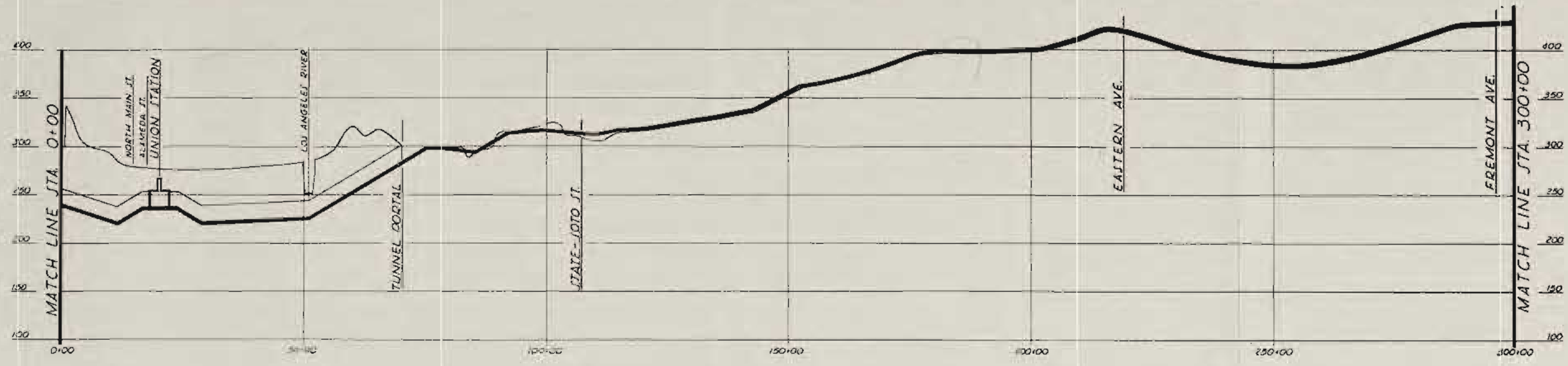
SCALE	HORZ. 1" = 1000' VERT. 1" = 50'	DATE
DRAWN BY	R. S. RASMUSSEN	
CHECKED BY	THAYER	
APPROVED BY		
CHIEF ENGINEER		

FOR: METROPOLITAN TRANSIT AUTHORITY

LOCATION: LOS ANGELES, CALIFORNIA

RAPID TRANSIT SYSTEM
WILSHIRE CORRIDOR
PLAN & PROFILE

JOB NO 6005-596 — DWG. NO 102-LC — REVISION R-



1. FOR LEGEND SEE DWG Nº 101-LC

1" = 1000' — 1000 0 1000 2000
1" = 50' — 50 0 50 100

NO.	DATE	REVISION	BY	APP.	APP.	REFERENCE DRAWINGS	NUMBER

NOTES

DESCRIPTION — COST ACCOUNT

CONSTRUCTION APPROVAL

APPROVAL — DATE

KAISER ENGINEERS

SCALE: HORZ. 1" = 1000' VERT. 1" = 50'

DRAWN BY: R. D. RASMUSSEN 7-6-61

CHECKED BY: H. E. THAYER 7-7-61

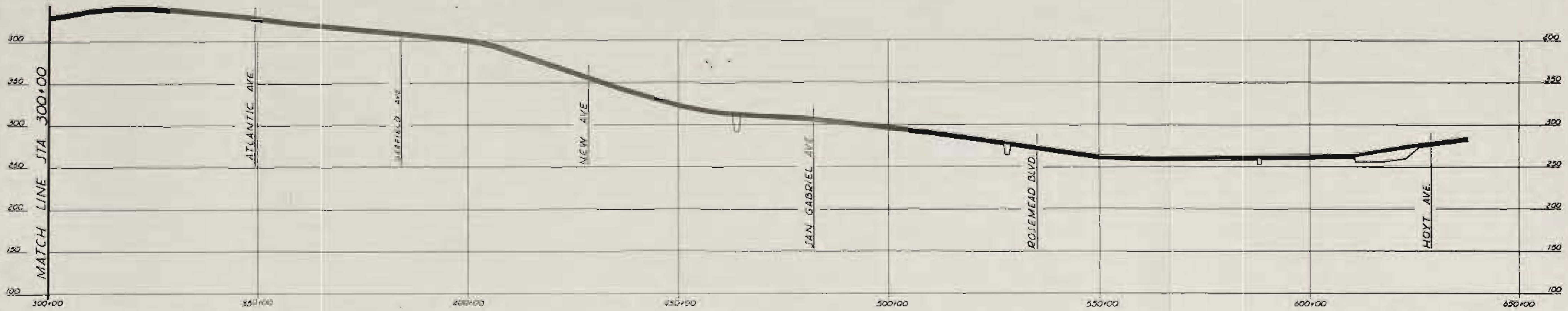
APPROVED BY: J. V. Ellis 7-10-61

FOR: METROPOLITAN TRANSIT AUTHORITY

LOCATION: LOS ANGELES, CALIFORNIA

RAPID TRANSIT SYSTEM
SAN BERNARDINO CORRIDOR
PLAN & PROFILE

JOB NO. 6005-596 — DWG. NO. 103-LC — REVISION R-



1. FOR LEGEND SEE DWG Nº 101-LC

1" = 1000' 1000 0 1000 2000

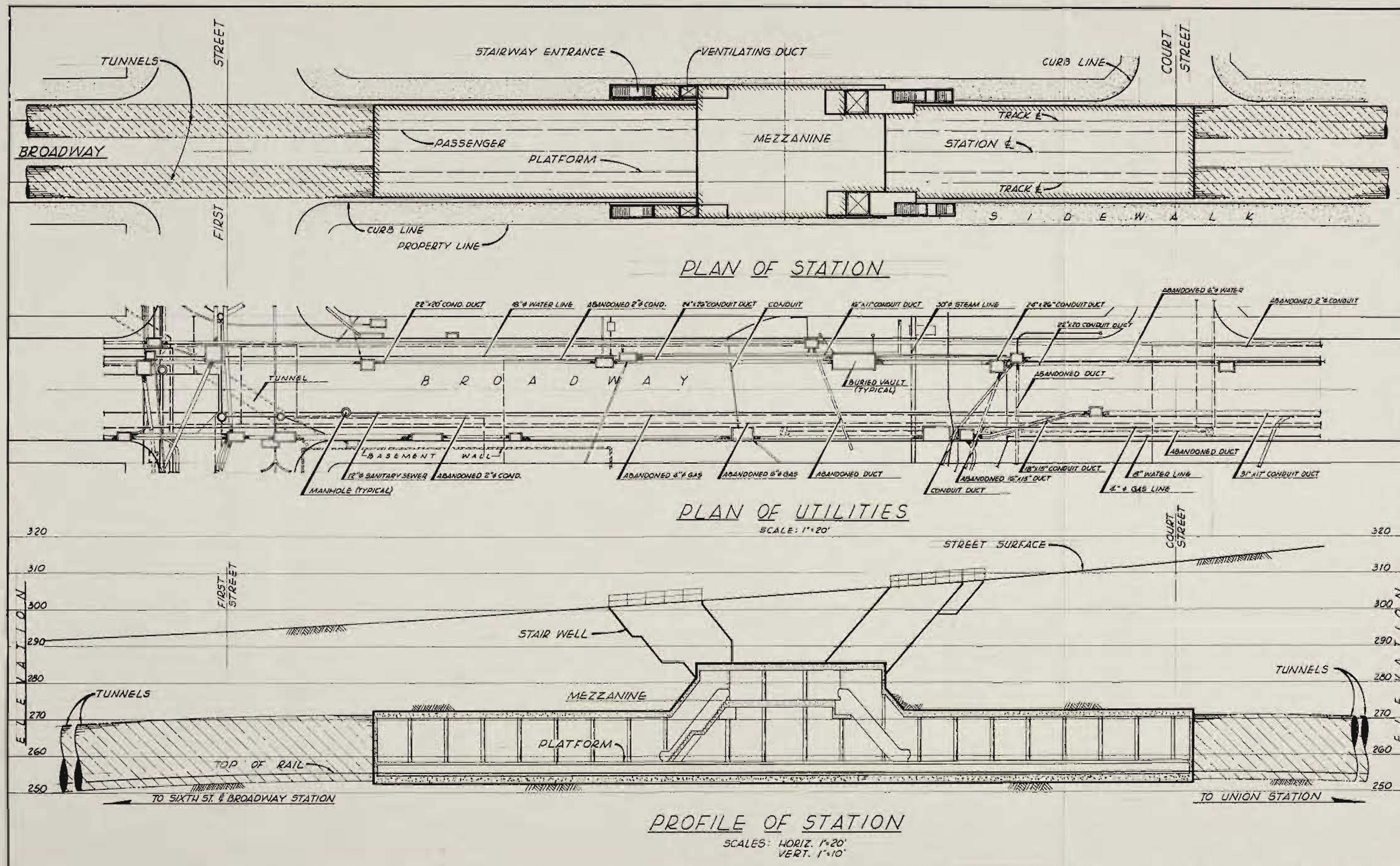
1" = 50' 50 0 50 100

NO.	DATE	REVISION	BY	APP.	APP.
REFERENCE DRAWINGS	NUMBER	NOTES

APPROVAL	DATE	
PROJECT ENGINEER	P lam	7/10/61
CONSTRUCTION APPROVAL		

KAISER ENGINEERS

SCALE HORIZ 1"=1000' VERT 1"=50'		FOR METROPOLITAN TRANSIT AUTHORITY
DRAWN BY R. B. RASMUSSEN	7-6-61	LOCATION LOS ANGELES, CALIFORNIA
CHECKED BY H. E. THAYER	7-7-61	RAPID TRANSIT SYSTEM SAN BERNARDINO CORRIDOR PLAN & PROFILE
APPROVED BY J V Ellen	7-10-61	
JOB NO. 6005-596	DWG. NO. 104-LC	REVISION R-



NO.	DATE	REVISION	BY	APP.	APP.	REFERENCE DRAWINGS	NUMBER

GRAPHIC SCALES
1"=20' 20 0 20 40 60
1"=10' 10 0 10 20 30

NOTES

DESCRIPTION | COST ACCOUNT

CONSTRUCTION APPROVAL

APPROVAL	DATE
PROJECT ENGINEER	
CHIEF ENGINEER	

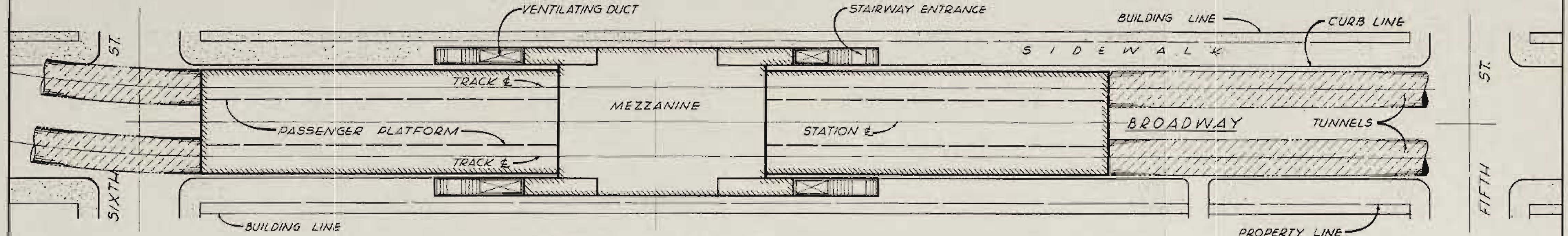
KAISER ENGINEERS — Division of Henry J. Kaiser Company, Oakland, California

		DATE
SCALE	AS NOTED	
DRAWN BY	J. V SNYDER	7-2-61
CHECKED BY	H. E THAYER	7-7-61
APPROVED BY	J. V. Ell	7-10-61
CHIEF DESIGN ENGINEER		

FOR METROPOLITAN TRANSIT AUTHORITY
LOCATION LOS ANGELES, CALIFORNIA

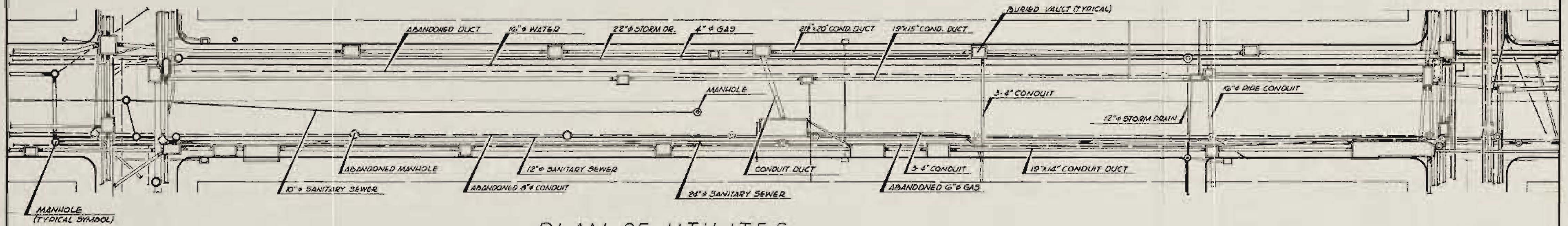
RAPID TRANSIT SYSTEM
FIRST & BROADWAY STATION
PLAN & PROFILE OF STATION & UTILITIES

JOB NO. 6005-596 | DWG. NO. 105-LC | REVISION R-



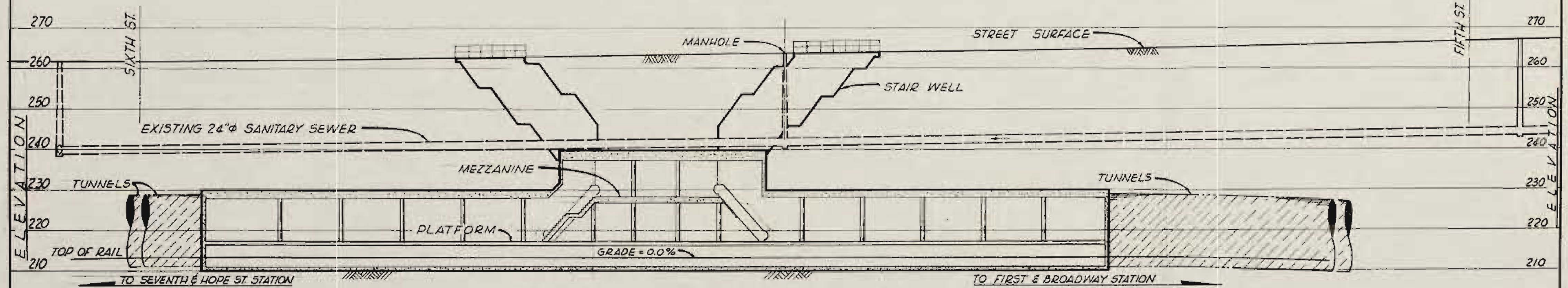
PLAN OF STATION

SCALE: 1" = 20'



PLAN OF UTILITES

SCALE: 1" = 20'



PROFILE OF STATION

SCALES: HORIZ 1" = 20'
VERT. 1" = 10'

GRAPHIC SCALES:

1" = 20': 20, 0, 20, 40, 60
1" = 10': 10, 0, 10, 20, 30

NO.	DATE	REVISION	BY	APP.	APP.	REFERENCE DRAWINGS	NUMBER	NOTES

DESCRIPTION — COST ACCOUNT

CONSTRUCTION APPROVAL

APPROVAL	DATE
PROJECT ENGINEER: (signature)	7/10/61
CHIEF ENGINEER	

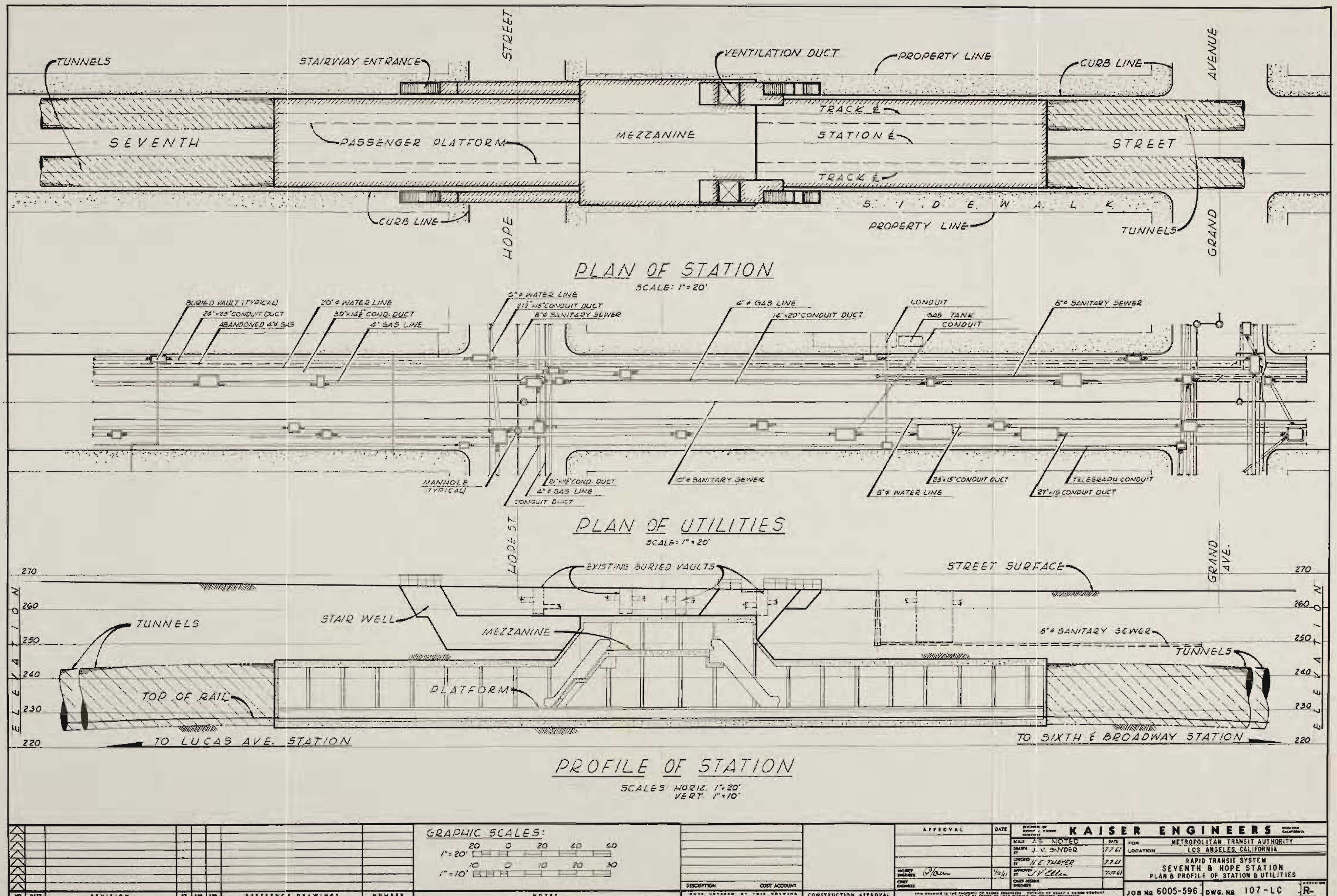
KAISER ENGINEERS — DIVISION OF HENRY J. KAISER COMPANY — OAKLAND, CALIFORNIA

		DATE
SCALE		
DRAWN BY		
CHECKED BY	H. E. THAYER	7-7-61
APPROVED BY	J. V. Ellis	7-10-61
CHIEF DESIGN ENGINEER		

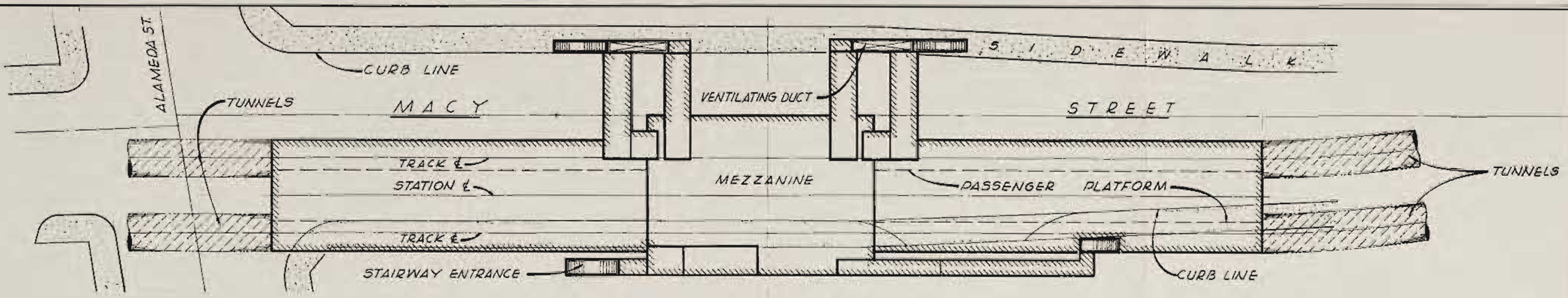
FOR: METROPOLITAN TRANSIT AUTHORITY
LOCATION: LOS ANGELES, CALIFORNIA

RAPID TRANSIT SYSTEM
SIXTH & BROADWAY STATION
PLAN & PROFILE OF STATION & UTILITIES

JOB NO. 6005-596 | DWG. NO. 106-LC | REVISION R-

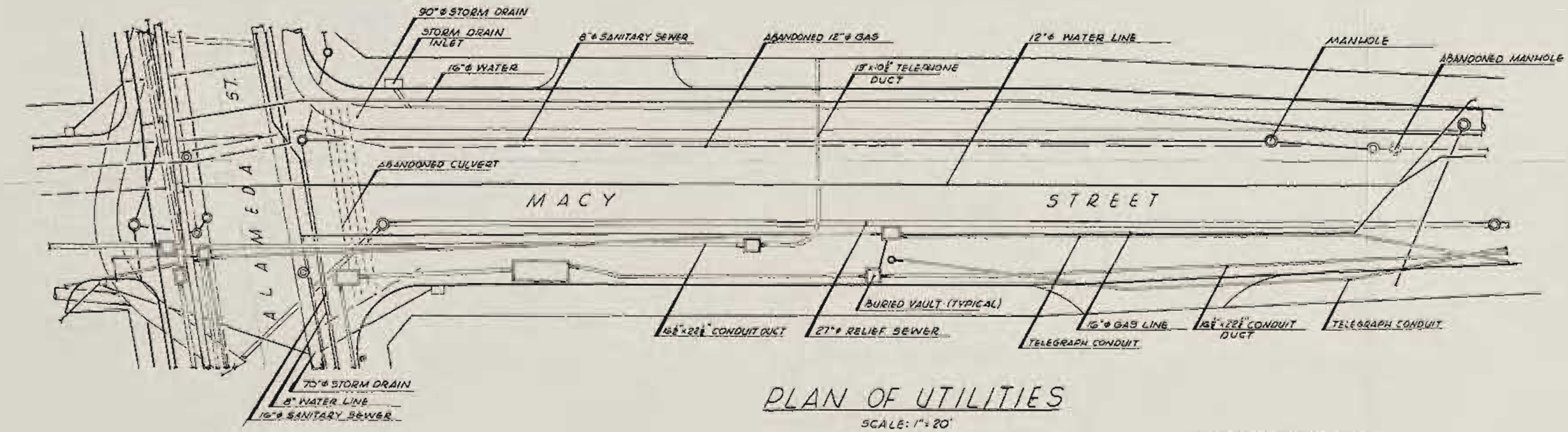


PLAN OF STATION
SCALE: 1" = 20'
TUNNELS
STAIRWAY ENTRANCE
STREET
HOPE
VENTILATION DUCT
PROPERTY LINE
CURB LINE
AVENUE
GRAND
SEVENTH
PASSENGER PLATFORM
MEZZANINE
TRACK ℄
STATION ℄
STREET
S I D E W A L K
CURB LINE
PROPERTY LINE
TUNNELS
PLAN OF UTILITIES
SCALE: 1" = 20'
BURIED VAULT (TYPICAL)
24"x25" CONDUIT DUCT
ABANDONED 4"ø GAS
20"ø WATER LINE
39"x14½" COND. DUCT
4" GAS LINE
6"ø WATER LINE
21"x15" CONDUIT DUCT
8"ø SANITARY SEWER
4"ø GAS LINE
14"x20" CONDUIT DUCT
CONDUIT
GAS TANK
CONDUIT
8"ø SANITARY SEWER
MANHOLE (TYPICAL)
21"x15" COND. DUCT
4"ø GAS LINE
CONDUIT DUCT
10"ø SANITARY SEWER
8"ø WATER LINE
28"x15" CONDUIT DUCT
27"x15 CONDUIT DUCT
TELEGRAPH CONDUIT
PROFILE OF STATION
SCALES: HORIZ. 1" = 20' VERT. 1" = 10'
HOPE ST.
GRAND AVE.
EXISTING BURIED VAULTS
STREET SURFACE
STAIR WELL
MEZZANINE
8"ø SANITARY SEWER
TUNNELS
TUNNELS
TOP OF RAIL
PLATFORM
ELEVATION
270
260
250
240
230
220
TO LUCAS AVE. STATION
TO SIXTH & BROADWAY STATION
GRAPHIC SCALES:
1" = 20' 20 0 20 40 60
1" = 10' 10 0 10 20 30
NO. DATE REVISION BY APP. APP.
REFERENCE DRAWINGS NUMBER
NOTES
DESCRIPTION COST ACCOUNT
CONSTRUCTION APPROVAL
APPROVAL DATE
PROJECT ENGINEER
CHIEF ENGINEER
KAISER ENGINEERS
SCALE AS NOTED
DRAWN BY J. V. SNYDER 7.7.61
CHECKED BY H. E. THAYER 7.7.61
APPROVED BY 7.10.61
CHIEF DESIGN ENGINEER
FOR METROPOLITAN TRANSIT AUTHORITY
LOCATION LOS ANGELES, CALIFORNIA
RAPID TRANSIT SYSTEM
SEVENTH & HOPE STATION
PLAN & PROFILE OF STATION & UTILITIES
JOB NO. 6005-596
DWG. NO. 107-LC
REVISION R-



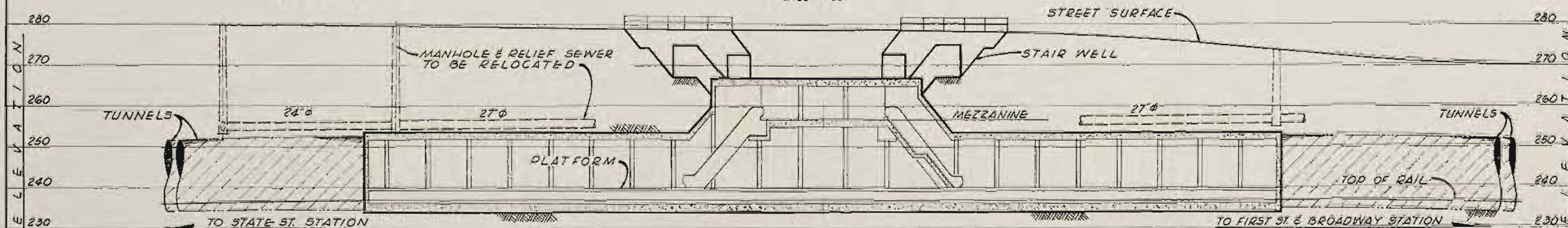
PLAN OF STATION

SCALE: 1" = 20'



PLAN OF UTILITIES

SCALE: 1" = 20'



PROFILE OF STATION

SCALES: HORIZ. 1" = 20'
VERT. 1" = 10'

NO.	DATE	REVISION	BY	APP.	APP.	REFERENCE DRAWINGS	NUMBER	NOTES

GRAPHIC SCALES:

1" = 20' — 20, 0, 20, 40, 60

1" = 10' — 10, 0, 10, 20, 30

DESCRIPTION — COST ACCOUNT

CONSTRUCTION APPROVAL

APPROVAL — DATE

PROJECT ENGINEER: [signature] — 7/10/61

CHIEF ENGINEER

KAISER ENGINEERS — DIVISION OF HENRY J. KAISER COMPANY — OAKLAND, CALIFORNIA

SCALE

DRAWN BY

CHECKED BY H. E. THAYER — 7-7-61

APPROVED BY J. V. Ellison — 7-10-61

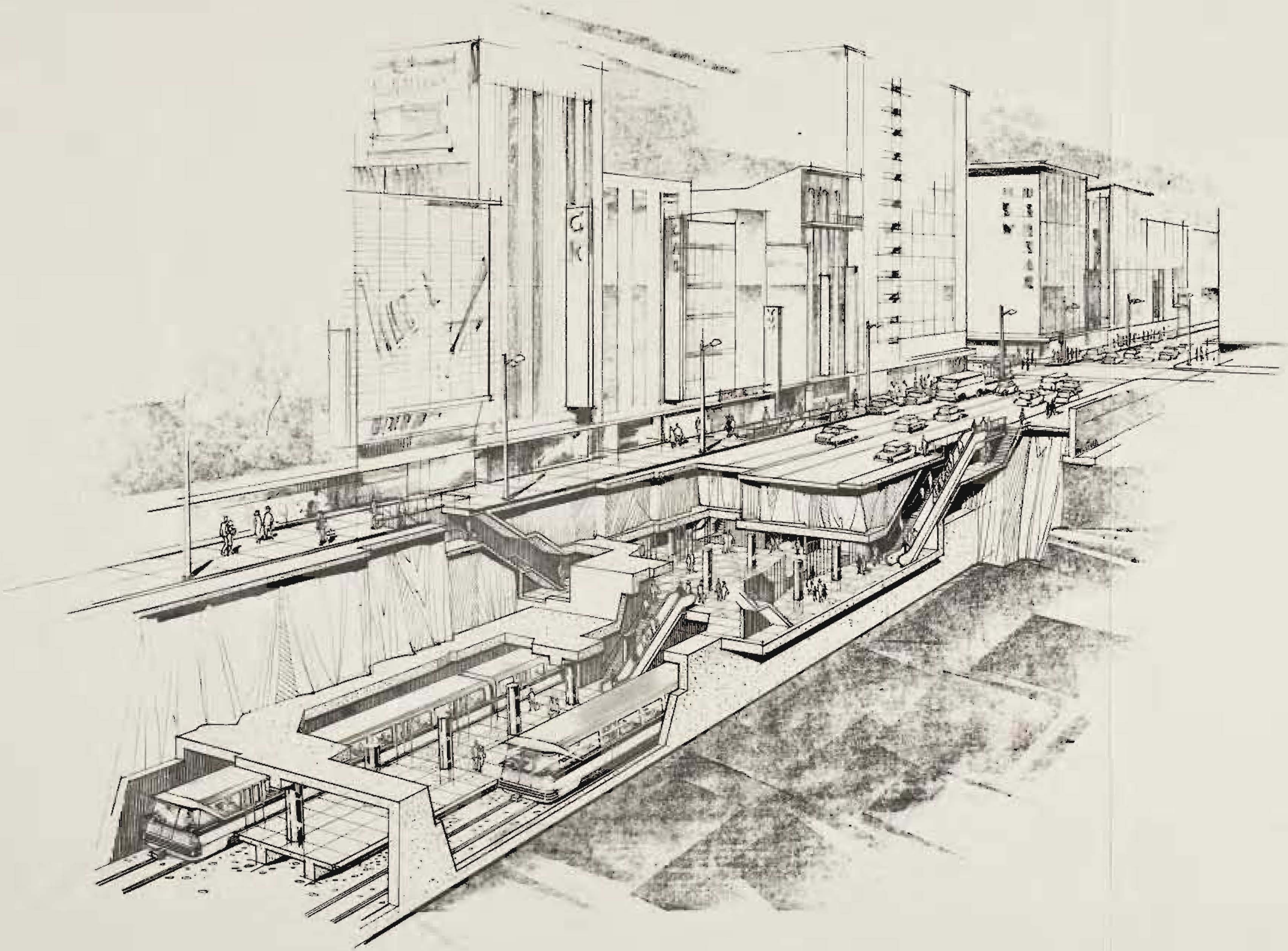
CHIEF DESIGN ENGINEER

FOR: METROPOLITAN TRANSIT AUTHORITY

LOCATION: LOS ANGELES, CALIFORNIA

RAPID TRANSIT SYSTEM
UNION STATION
PLAN & PROFILE OF STATION & UTILITIES

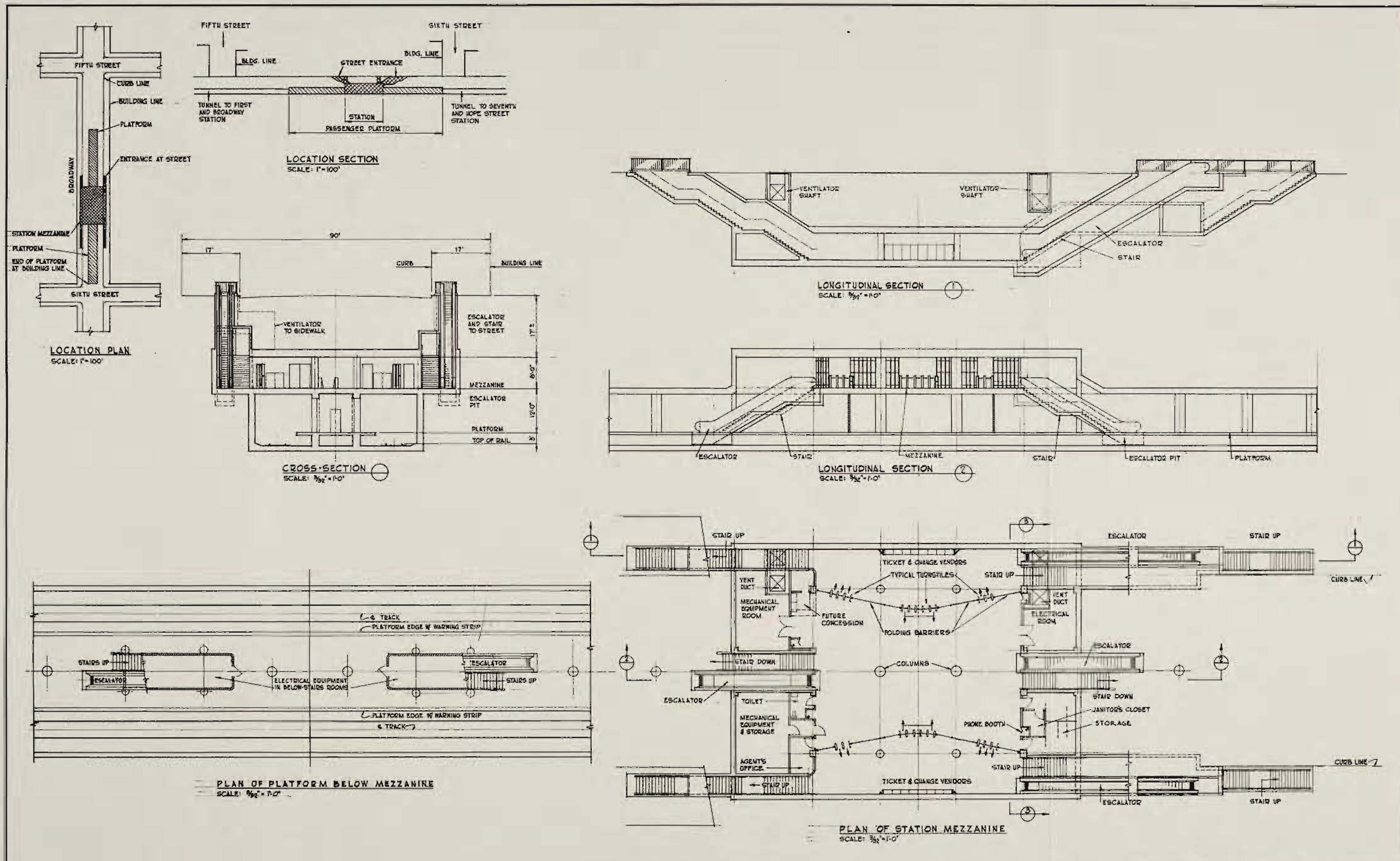
JOB NO 6005-596 — DWG. NO 108-LC — REVISION R-



APPROVAL	DATE	DIVISION OF HENRY J. KAISER COMPANY	KAISER ENGINEERS		OAKLAND CALIFORNIA
		SCALE	DATE	FOR	METROPOLITAN TRANSIT AUTHORITY
		DRAWN BY R. PAARO	7-6-61	LOCATION	LOS ANGELES, CALIFORNIA
		CHECKED BY R. WILSON			RAPID TRANSIT SYSTEM SIXTH & BROADWAY STATION PERSPECTIVE
PROJECT ENGINEER		APPROVED BY			
CHIEF ENGINEER		CHIEF DESIGN ENGINEER			

THIS DRAWING IS THE PROPERTY OF KAISER ENGINEERS, DIVISION OF HENRY J. KAISER COMPANY AND IS NOT TO BE COPIED OR USED WITHOUT ITS WRITTEN PERMISSION

JOB NO. 6005-596 DWG. NO. 101-LA REVISION R-



NO.	DATE	REVISION	BY	APP.	APP.	REFERENCE DRAWINGS	NUMBER	NOTES

DESCRIPTION — COST ACCOUNT — CONSTRUCTION APPROVAL

APPROVAL	DATE
PROJECT ENGINEER [signature]	7/10/61
CHIEF ENGINEER	

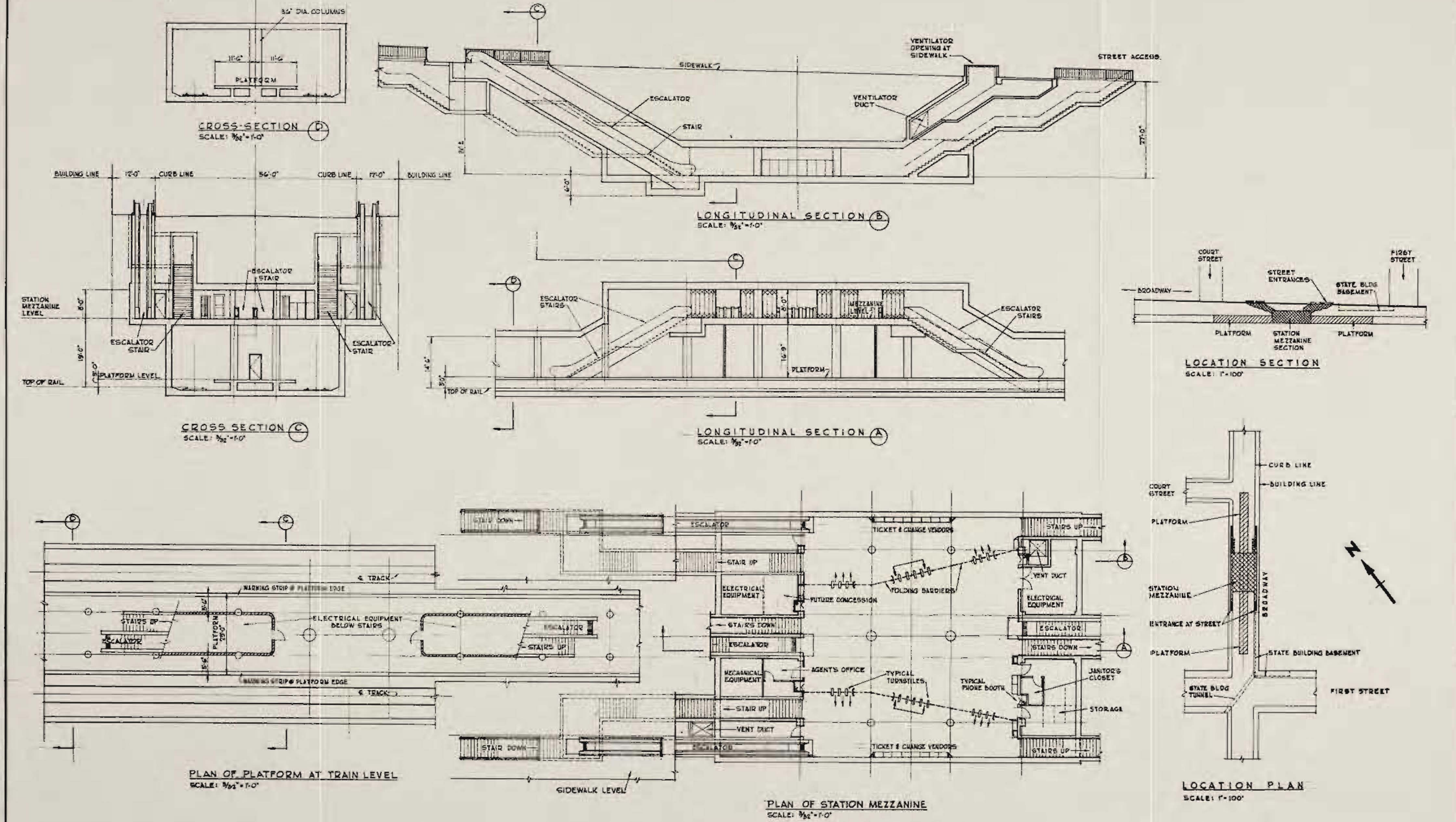
KAISER ENGINEERS — Division of Henry J. Kaiser Company — Oakland, California

		DATE
SCALE	AS NOTED	
DRAWN BY	E. WHYBONG	7-6-61
CHECKED BY	R. WILSON	7-7-61
APPROVED BY	[signature]	7-10-61
CHIEF DESIGN ENGINEER		

FOR: METROPOLITAN TRANSIT AUTHORITY
LOCATION: LOS ANGELES, CALIFORNIA

RAPID TRANSIT SYSTEM
SIXTH & BROADWAY STATION
GENERAL ARRANGEMENT

JOB NO. 6005-596 — DWG. NO. 102-LA — REVISION R-



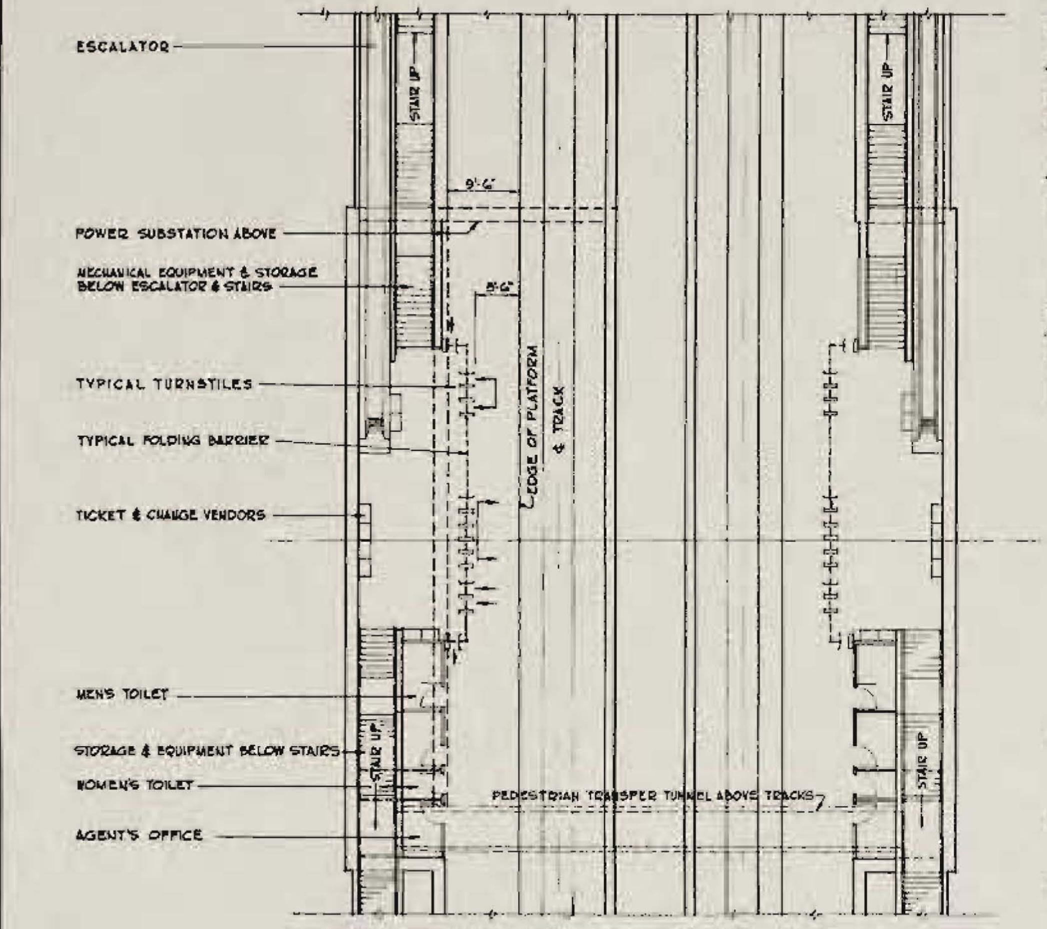
APPROVAL	DATE	KAISER ENGINEERS	
PROJECT ENGINEER		SCALE AS NOTED	
		DRAWN BY E. WHYBONG	7-6-61
		CHECKED BY R. WILSON	7-7-61
		APPROVED BY J.V. Ellis	7-10-61

FOR METROPOLITAN TRANSIT AUTHORITY
LOCATION LOS ANGELES, CALIFORNIA

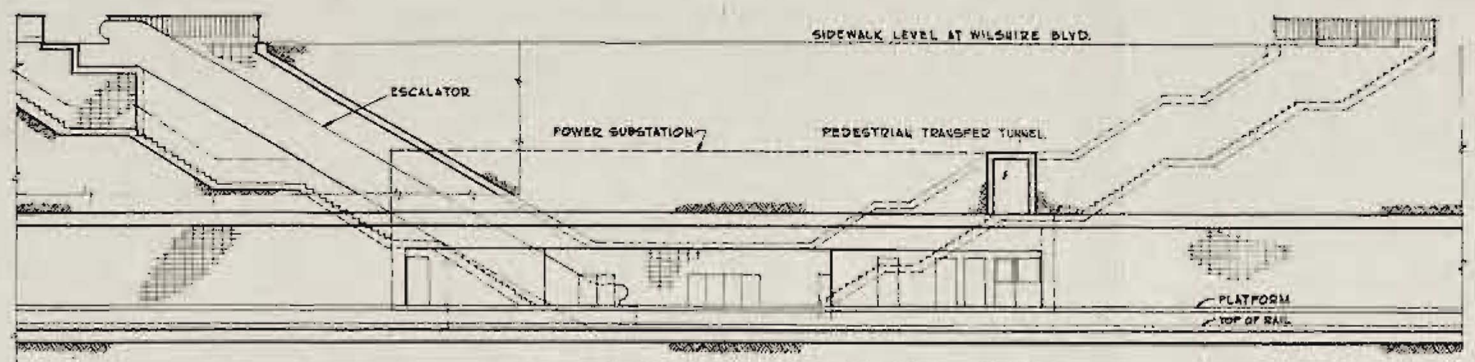
RAPID TRANSIT SYSTEM
FIRST & BROADWAY STATION
GENERAL ARRANGEMENT

JOB No 6005-596 DWG. No 103-LA REVISION R-

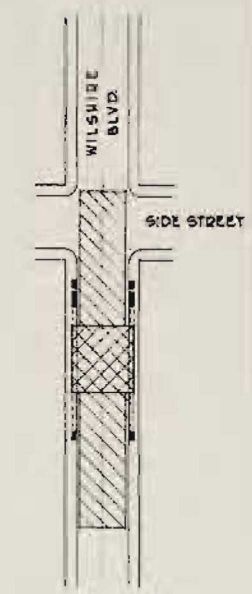
REVISION | BY | APP. | APP. | REFERENCE DRAWINGS | NUMBER | NOTES | DESCRIPTION | COST ACCOUNT | CONSTRUCTION APPROVAL



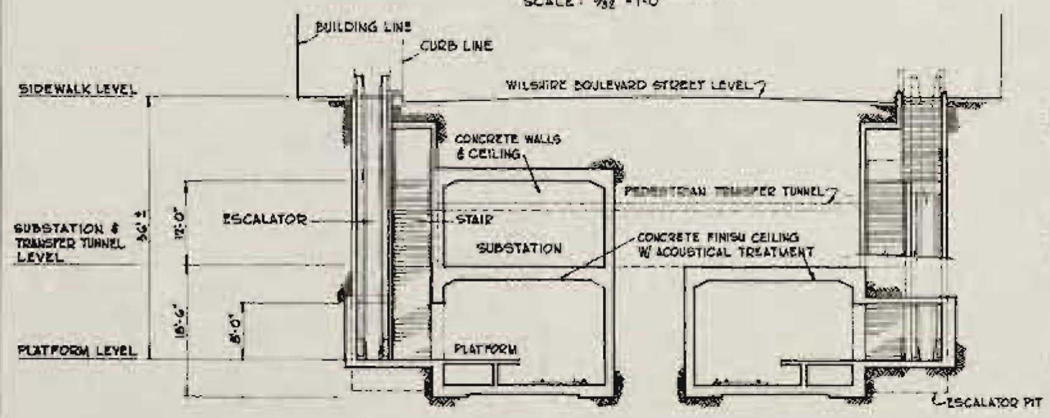
STATION PLAN
SCALE: 3/32" = 1'-0"



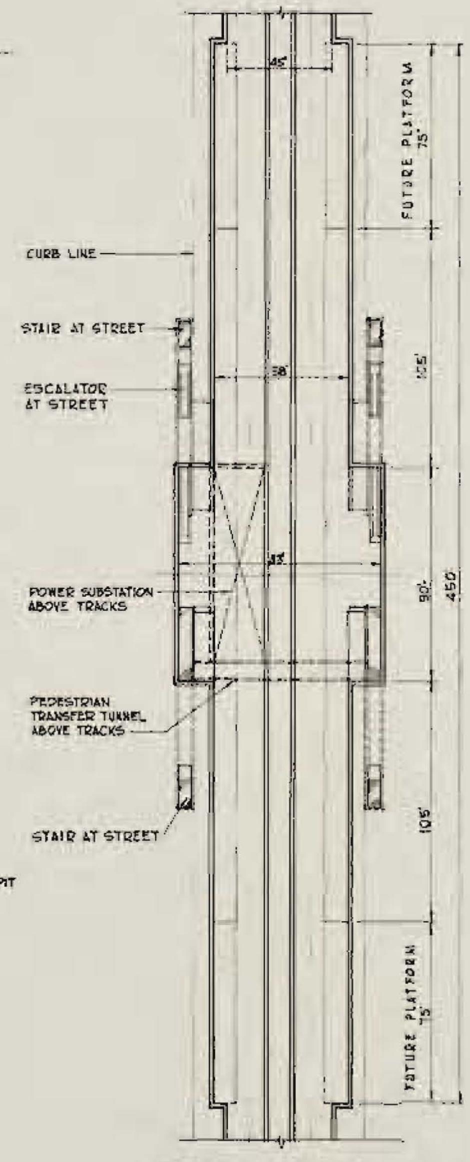
STATION · TYPICAL LONGITUDINAL SECTION
SCALE: 3/32" = 1'-0"



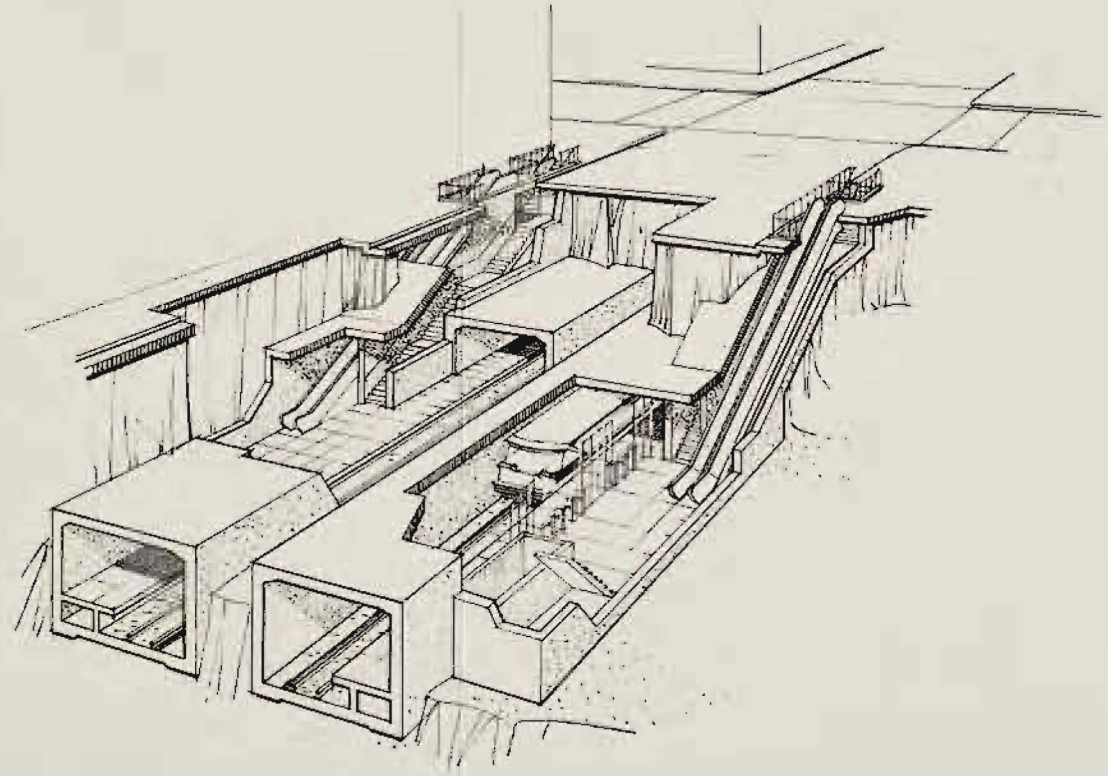
LOCATION PLAN
SCALE: 1" = 100'



STATION CROSS SECTION
SCALE: 3/32" = 1'-0"



PLATFORM PLAN
SCALE: 1/32" = 1'-0"



NO.	DATE	REVISION	BY	APP.	APP.	REFERENCE DRAWINGS	NUMBER	NOTES	DESCRIPTION	COST ACCOUNT	CONSTRUCTION APPROVAL

APPROVAL	DATE
PROJECT ENGINEER [signature]	7/10/61
CHIEF ENGINEER	

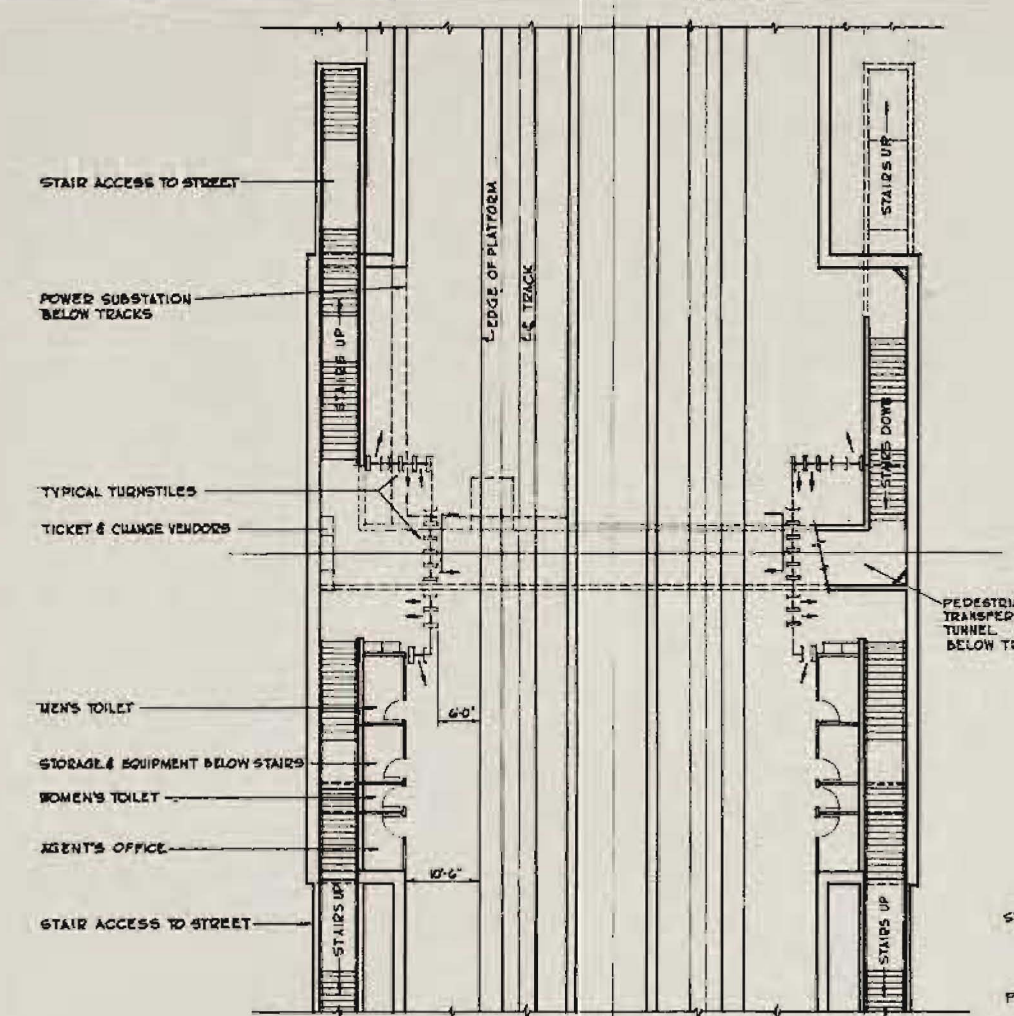
KAISER ENGINEERS — DIVISION OF HENRY J. KAISER COMPANY — OAKLAND, CALIFORNIA

		DATE
SCALE	AS NOTED	
DRAWN BY	E. WHYSONG	7-6-61
CHECKED BY	R. WILSON	7-7-61
APPROVED BY	[signature]	7-10-61
CHIEF DESIGN ENGINEER		

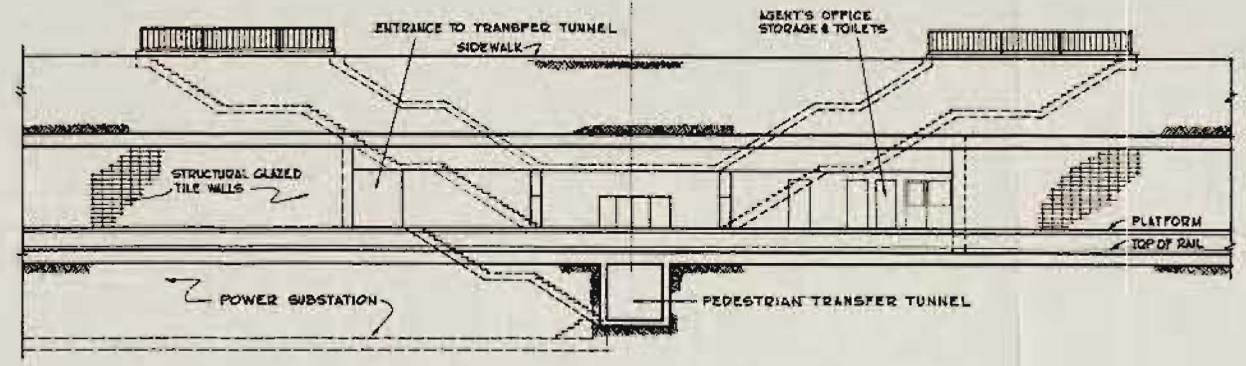
FOR: METROPOLITAN TRANSIT AUTHORITY
LOCATION: LOS ANGELES, CALIFORNIA

RAPID TRANSIT SYSTEM
WILSHIRE SUBWAY STATIONS
DEEP TYPE ARRANGEMENT

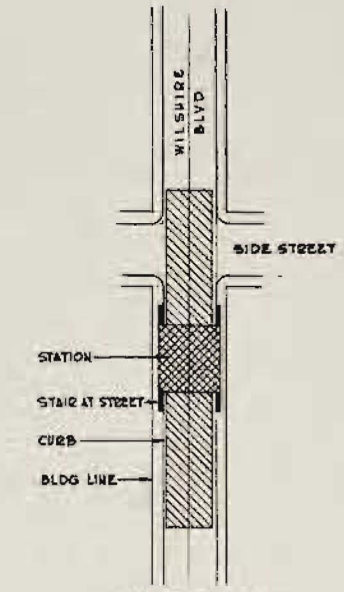
JOB № 6005-596 DWG. № 104-LA REVISION R-



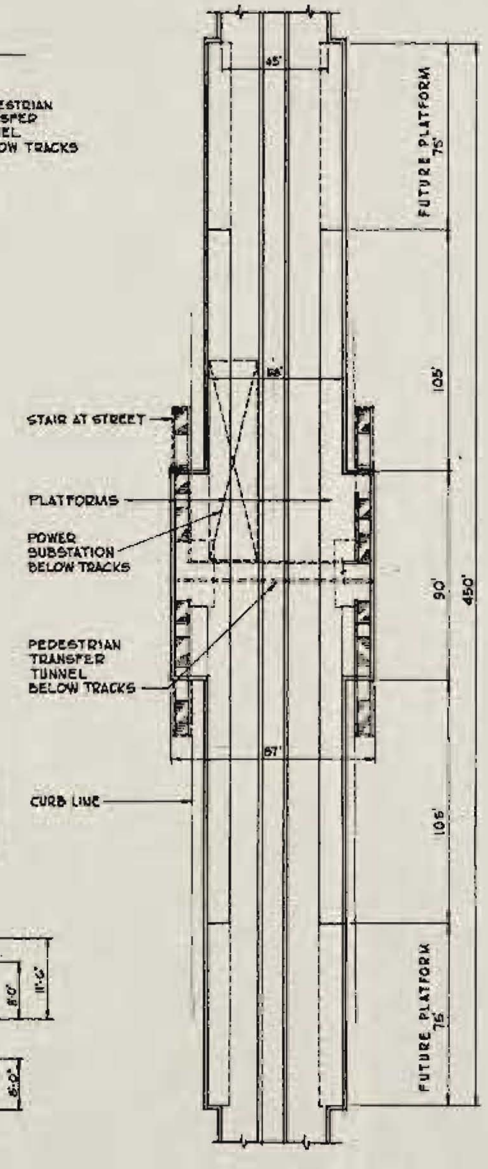
STATION PLAN
SCALE: 3/32" = 1'-0"



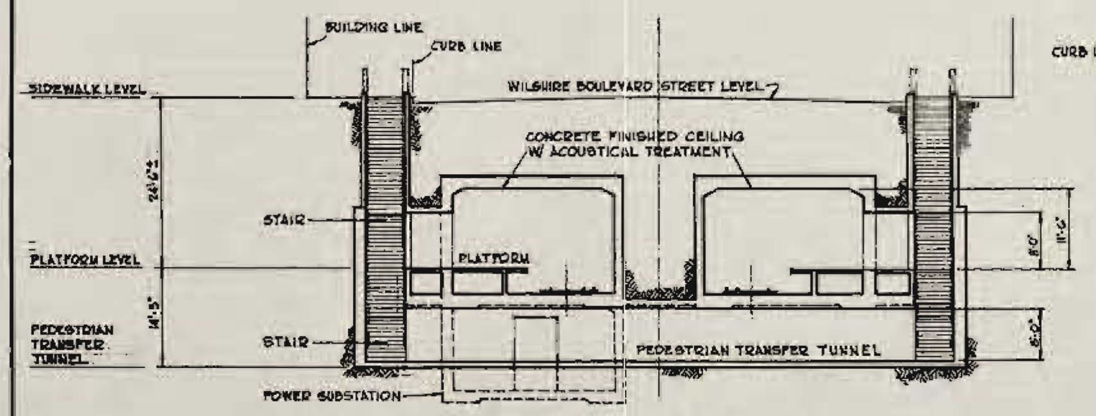
STATION - TYPICAL LONGITUDINAL SECTION
SCALE: 3/32" = 1'-0"



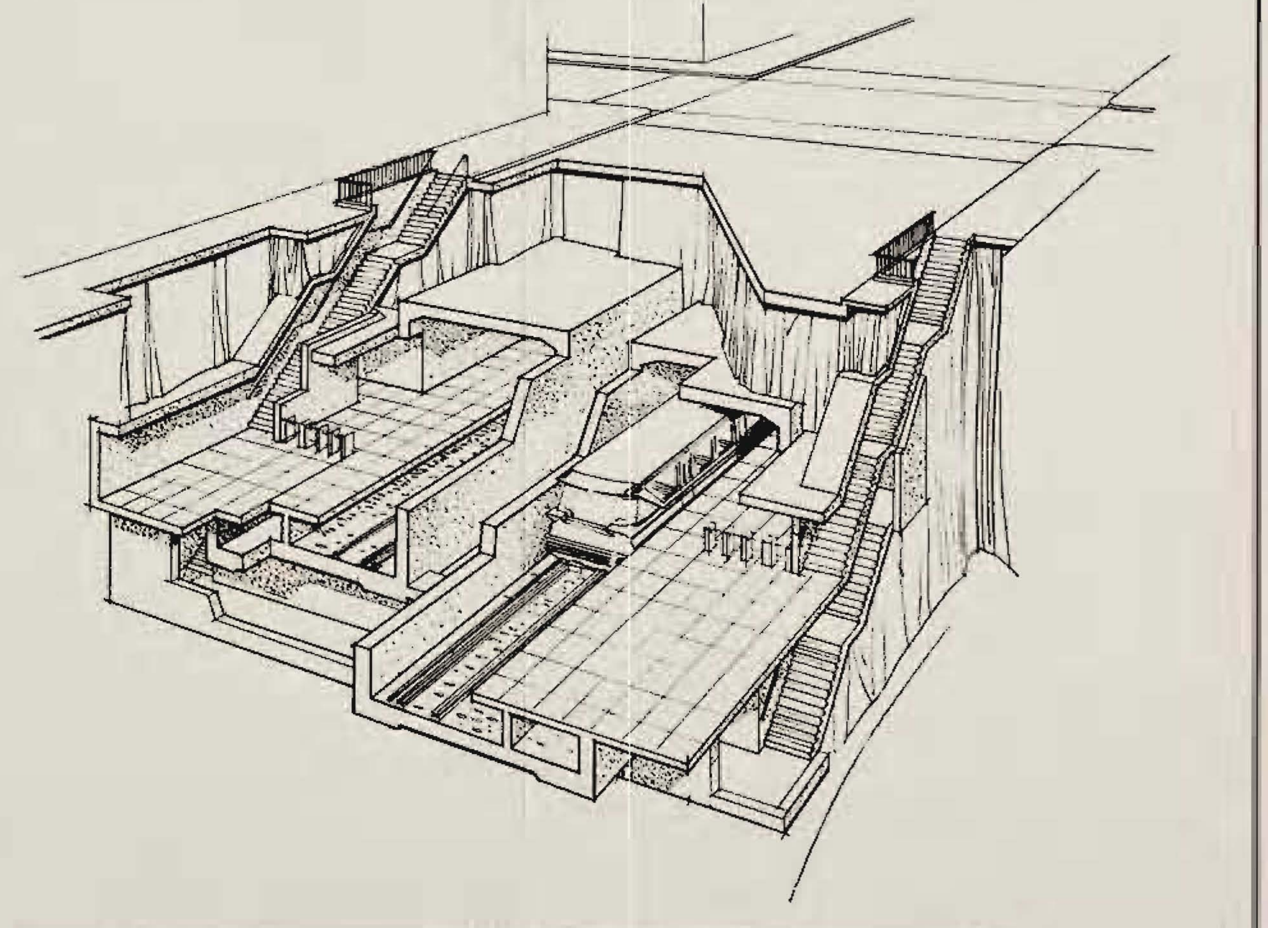
LOCATION PLAN
SCALE: 1" = 100'



PLATFORM PLAN
SCALE: 1/32" = 1'-0"



STATION CROSS SECTION
SCALE: 3/32" = 1'-0"



NO.	DATE	REVISION	BY	APP.	APP.	REFERENCE DRAWINGS	NUMBER	NOTES

DESCRIPTION	COST ACCOUNT

CONSTRUCTION APPROVAL

APPROVAL	DATE
PROJECT ENGINEER (signature)	7/10/61
CHIEF ENGINEER	

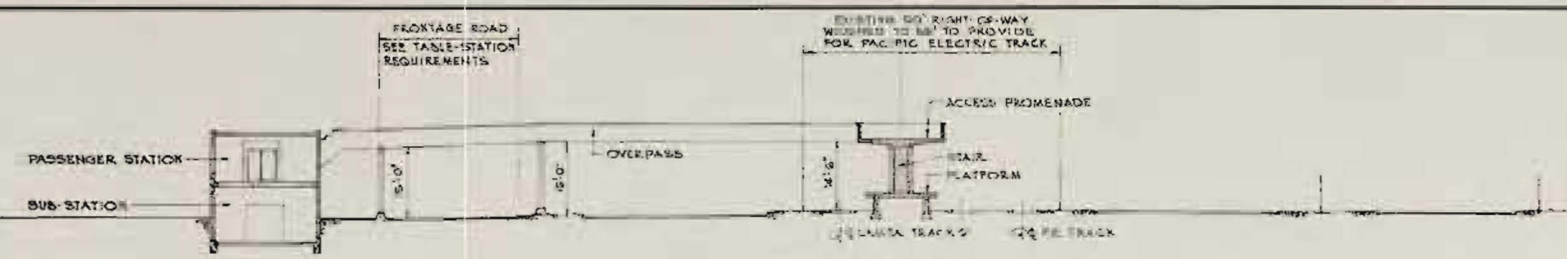
KAISER ENGINEERS — DIVISION OF HENRY J. KAISER COMPANY — OAKLAND CALIFORNIA

		DATE
SCALE	AS NOTED	
DRAWN BY	E. WHYBONG	7-6-61
CHECKED BY	R. WILSON	7-7-61
APPROVED BY	J. Ellis	7-10-61
CHIEF DESIGN ENGINEER		

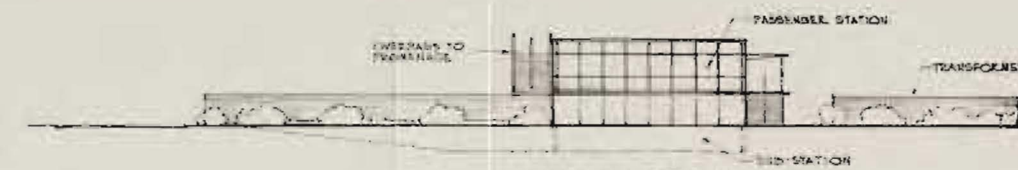
FOR METROPOLITAN TRANSIT AUTHORITY
LOCATION LOS ANGELES, CALIFORNIA

RAPID TRANSIT SYSTEM
WILSHIRE SUBWAY STATIONS
SHALLOW TYPE ARRANGEMENT

JOB NO. 6005-596 DWG. NO. 105-LA REVISION R-

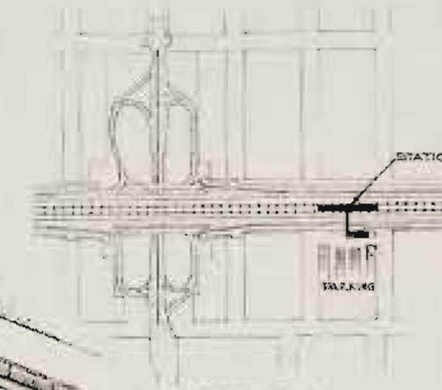


CROSS SECTION

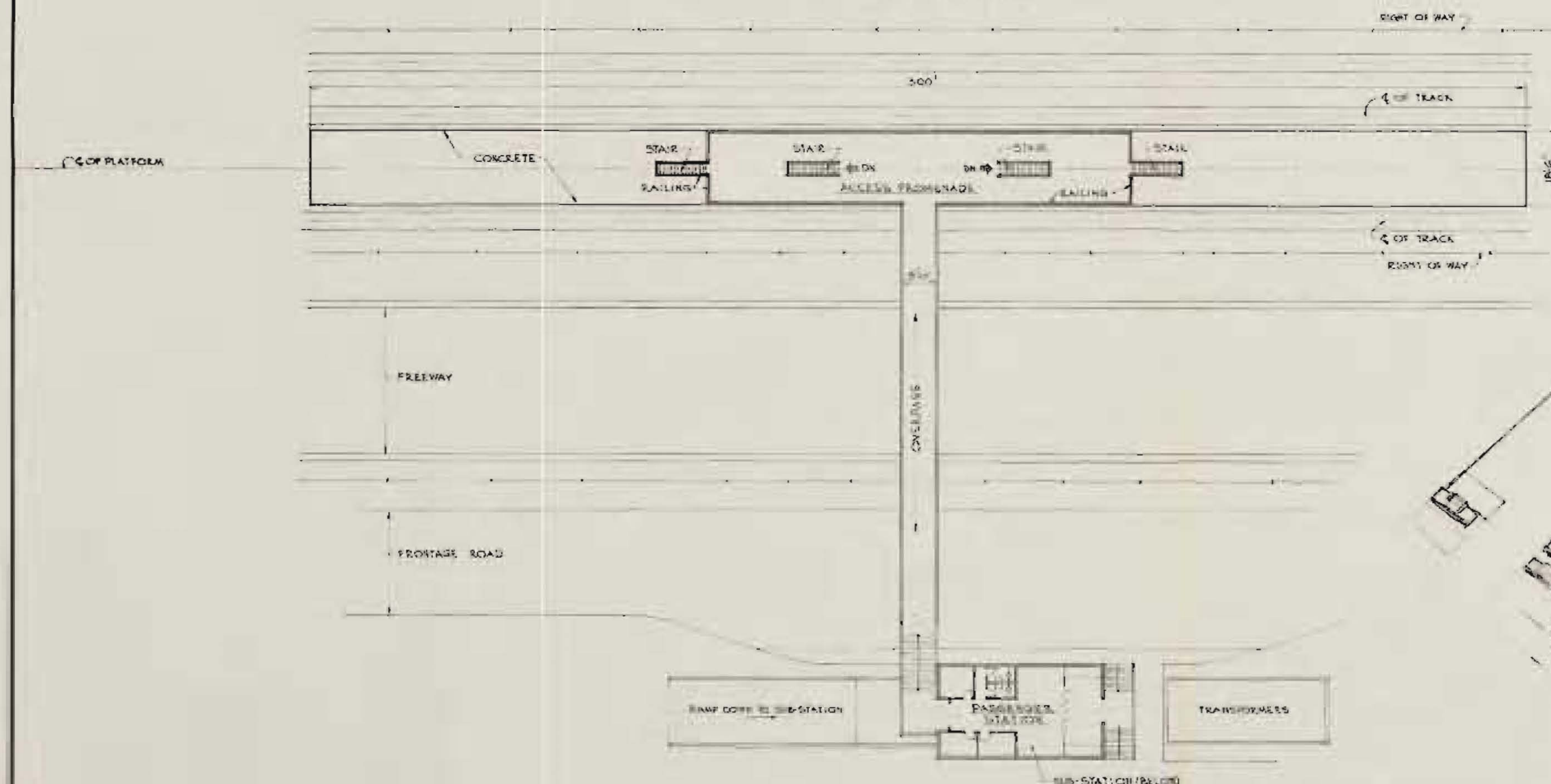


ELEVATION

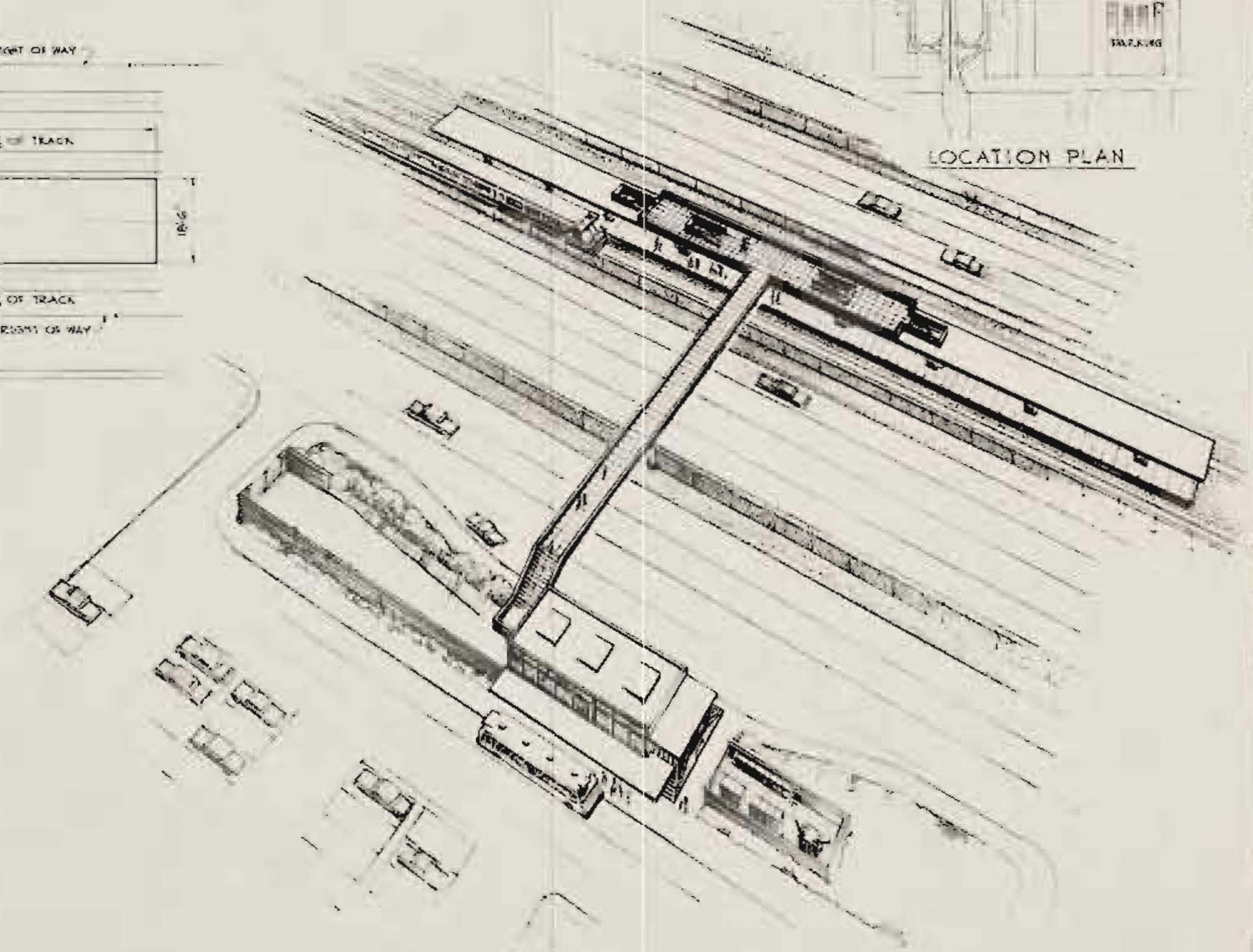
PLAN OF PLATFORM



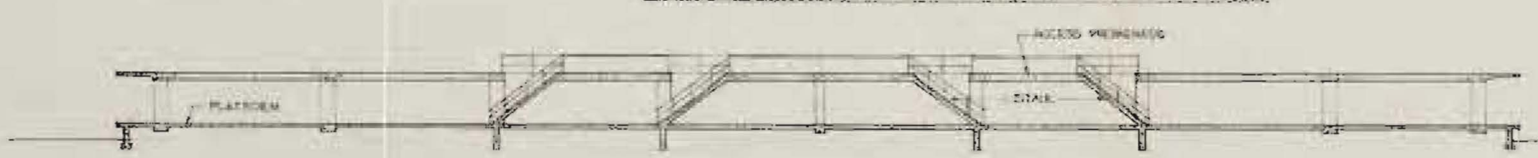
LOCATION PLAN



PLAN OF PASSENGER STATION & ACCESS PROMENADE



PERSPECTIVE



LONGITUDINAL SECTION THROUGH PLATFORM

FREEWAY MEDIAN STATIONS					
OUTSIDE FREEWAY MEDIAN		ON FRONTAGE ROADS		NON FRONTAGE ROADS	
EASTERN	(NORTH SIDE)	ROSEMEAD	(NORTH SIDE)	SAN GABRIEL	(SOUTH SIDE)
SOTO-STATE	(NORTH SIDE)	ATLANTIC	(SOUTH SIDE)	NEW	(SOUTH SIDE)
HOYT	(NORTH SIDE)	FREMONT	(SOUTH SIDE)		

NO.	DATE	REVISION	BY	APP.	APP.	REFERENCE DRAWINGS	NUMBER	NOTES	DESCRIPTION	COST ACCOUNT

WHEN COVERED BY THIS DRAWING CHARGED TO COST ACCOUNT ABOVE

CONSTRUCTION APPROVAL

APPROVAL	DATE
PROJECT ENGINEER	
CHIEF ENGINEER	

KAISER ENGINEERS — DIVISION OF HENRY J. KAISER COMPANY — OAKLAND, CALIFORNIA

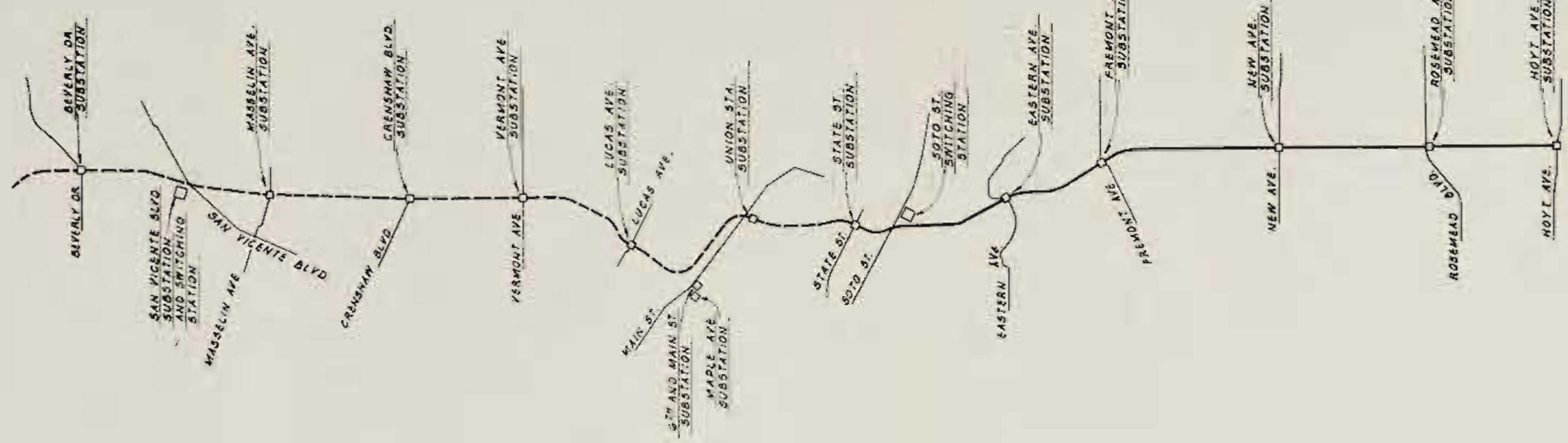
		DATE
SCALE		
DRAWN BY	C. APPLANCE	7-6-61
CHECKED BY	R. NILSEN	7-7-61
APPROVED BY		
CHIEF DESIGN ENGINEER		

FOR: METROPOLITAN TRANSIT AUTHORITY

LOCATION: LOS ANGELES, CALIFORNIA

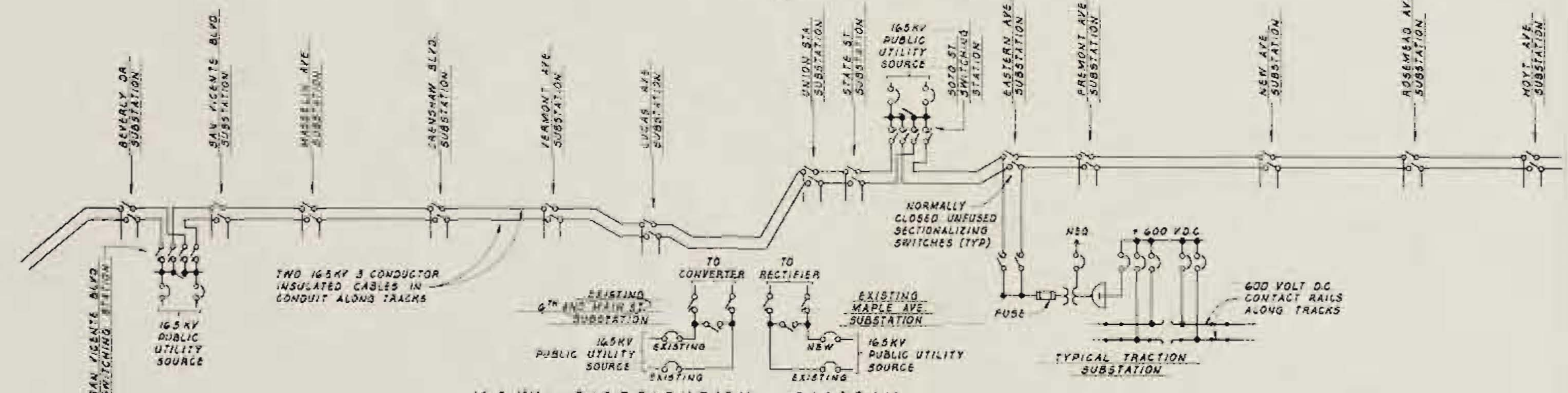
RAPID TRANSIT SYSTEM
SAN BERNARDINO STATIONS
SURFACE TYPE ARRANGEMENT

JOB NO. 6005-596 | DWG. NO. 106-LA | REVISION R-

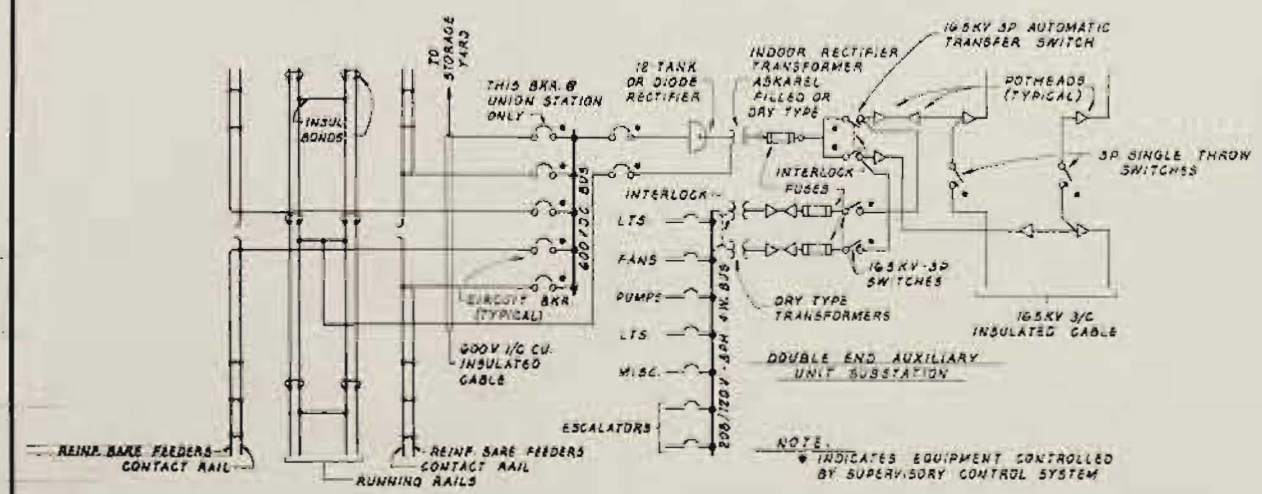


KEY PLAN
N.T.S.

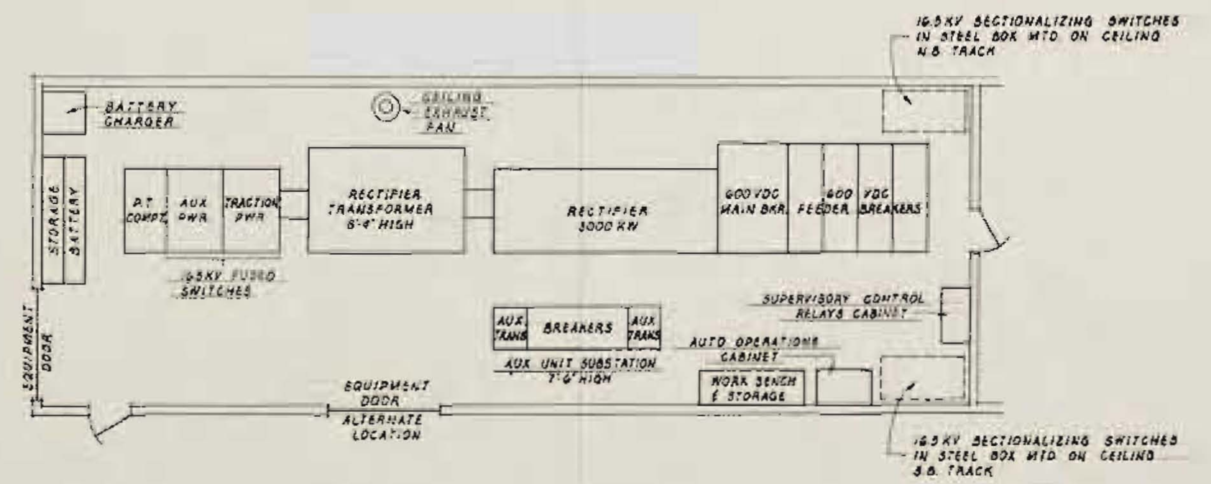
LEGEND
- L.B. FUSED SWITCH (EXCEPT AS INDICATED)
- CIRCUIT BREAKER
- SUBWAY
- AT GRADE



16.5 KV DISTRIBUTION DIAGRAM



TRACTION SUBSTATION LINE DIAGRAM



SUBSTATION ARRANGEMENT

NO.	DATE	REVISION	BY	APP.	APP.	REFERENCE DRAWINGS	NUMBER	NOTES

DESCRIPTION — COST ACCOUNT — CONSTRUCTION APPROVAL

APPROVAL — DATE

KAISER ENGINEERS

SCALE NONE
DRAWN BY W. EDDY — DATE 6-28-61
CHECKED BY A.S.H. — 6-29-61
APPROVED BY J.V. Ellen — 7-10-61
PROJECT ENGINEER — 7-10-61
CHIEF ENGINEER

FOR METROPOLITAN TRANSIT AUTHORITY
LOCATION LOS ANGELES, CALIFORNIA

RAPID TRANSIT SYSTEM
ELECTRIFICATION SYSTEM
DIAGRAMS

JOB NO. 6005-596 — DWG. NO. 101-LE — REVISION R-