REPORT

TO

THE LOS ANGELES METROPOLITAN TRANSIT AUTHORITY

ON

MONORAIL RAPID TRANSIT

FOR

LOS ANGELES

PART III

MONORAIL SYSTEM DESIGN
ESTIMATES OF CONSTRUCTION COSTS
AND OF OPERATING EXPENSES

December 31, 1953

GIBBS & HILL, INC.
ENGINEERS - CONSTRUCTORS
NEW YORK - LOS ANGELES

GIBBS & HILL, INC.
CONSULTING ENGINEERS
DESIGNERS - CONSTRUCTORS

510 WEST SIXTH STREET
LOS ANGELES 14, CAL.

PENNSYLVANIA STATION
NEW YORK 1, N. Y.

December 31, 1953

Coverdale & Colpitts
120 Wall Street
New York 5, New York

Gentlemen:

Transmitted herewith is our report on preliminary design as required for estimating purposes, estimates of construction cost and of maintenance and operating expenses of a monorail rapid-transit installation over both the longer and shorter routes in Los Angeles specified by you.

Attention is called to the fact that unit costs of operation and maintenance are favorable due to the high intensity of use resulting from the schedules proposed. High scheduled speed combined with dense train service over a long main line run results in low costs per train mile and per track mile. The figures given in the report have been derived from the records of similar and successful rapid transit operation adjusted for inherent differences in the two services.

While some structural modifications should be considered in case final design is undertaken the first cost figures based upon the preliminary design are adequate for the present economic study.

A few of the preliminary drawings have been included in the report for illustrative purposes and to indicate the care with which the estimates were prepared. The entire file of drawings is available to you at any time you wish.

We wish to express our appreciation of the wholehearted cooperation received from all members of your staff and the officials of the Metropolitan Transit Authority.

Very truly yours,

GIBBS & HILL, Inc.

J B Saxe

J. B. Saxe
Vice President and
Chief Engineer

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SCOPE

Under a contract consummated April 15, 1953 Gibbs & Hill, Inc. has prepared the following estimates of a Monorail installation to provide mass rapid transit in Los Angeles, California:

1. The estimated cost of construction of a Monorail line along a route location furnished by Coverdale & Colpitts;
2. The estimated cost of equipment and appurtenances, stations, shops and inspection facilities, yards, power supply, power transmission and distribution system, signals and cars;
3. The estimated cost of maintaining and operating the system based on desired overall speeds, frequency of service and passenger loads from information furnished by Coverdale & Colpitts.

SUMMARY

The study required has developed the following First Cost and Annual Maintenance and Operating Cost figures:

1. For full length of line, Panorama to Long Beach:

a.	Estimated First Cost of Line	$82,904,175
b.	Estimated First Cost of Equipment, etc.	44,262,290
c.	Contingency	10,000,000
d.	Estimated Annual Cost of Maintenance and Operation involving 23,750,000 car miles/year	8,021,000

2. For the shorter line, North Hollywood to Compton:

a.	Estimated First Cost of Line	65,146,855
b.	Estimated First Cost of Equipment, etc.	36,170,677
c.	Contingency	10,000,000
d.	Estimated Annual Cost of Maintenance and Operation involving 17,540,000 car miles/year	5,928,520

INTRODUCTION

Monorail rapid transit was devised as a promising answer to the need, evident in many communities, of providing mass rapid transit in face of existing surface-traffic congestion and of the high costs of alternate forms of rapid transit, notably the subway. In most instances, high speed movement of true mass-transportation vehicles on the surface is impossible because of interference from other traffic using the same arteries. The cost usually involved for suitable private rights-of-way on the surface would be prohibitive. A subway, of course, provides the private right-of-way and eliminates the hindrance of movement from competing traffic. It is, therefore, an admirable solution in all respects, except that of cost. Very few, if any communities can support this burden even when the population served is very dense and riding relatively uniform throughout a large part of the day.

When both surface and sub-surface solutions are unavailable, the only resort is to go above the surface. In the past this has involved the "elevated", an air-less, light-less, near-tunnel over a street cluttered by two or more rows of supporting structures and surrounded by a din of noise. The elevated did provide the desired private right-of-way and as a form of transportation could be satisfactory. Its cost was, relative to the subway, a step in the right direction.

Starting from the elevated, the problem is to strip away its objectionable features and improve its better ones with the aid of modern technical progress. Monorail is the resulting answer.

The more or less conventional roadbed of the elevated, its ties, and rails, are reduced to a single longitudinal supporting member of strength and stiffness adequate to support the equipment, and within this limitation, of the smallest dimensions possible. This member, being placed above the car, the normal clearance above the ground surface is increased ten or twelve feet. This relationship in combination with the small amount of light cut off, even by a "two track" line, restores the space below it to the out-of-doors without increasing appreciably the usual street noise. Both the single and double track arrangements of members require only a single row of columns presenting a limited surface obstruction. In fact, whatever obstruction is involved becomes almost negligible when columns are placed in the center division provided in most important new highways.

GENERAL DESCRIPTION OF LOS ANGELES PROJECT

The route for which cost studies have been prepared extends approximately 45 miles from a terminal station at the north end of Van Nuys Boulevard near Roscoe Boulevard to a similar station at the southern end on American Boulevard at Broadway in Long Beach. Short turn-around, loop facilities extend beyond both terminal stations. The entire operation is above ground except for a short tunnel, slightly over two miles in length, under Hill Street in downtown Los Angeles. Turn-around facilities are also provided at either end of the tunnel section, and adjacent to North Hollywood and Compton.

Along Van Nuys Boulevard, the structures occupy the center of the wide thoroughfare, from which a turn is made onto private right-of-way in the center of Chandler Boulevard. Leaving the latter boulevard, the line runs along Vineland Avenue to a second section of private right-of-way in the center of Cahuenga Pass Freeway. It leaves this right-of-way at a point where freeway construction interferes and passes via Highland Avenue to Sunset Boulevard. Located along the previous two track street car route, the line follows Sunset Boulevard to the vicinity of the old Hill Street intersection. At this point the route swings across the Hollywood Freeway and into a tunnel extending under Hill Street to Washington Boulevard. Thence it cuts across to Broadway, running eventually into Main Street which is followed until the route turns onto Florence Avenue, across which it runs east to Pacific Boulevard. Running south on this thoroughfare, the line moves over to Long Beach Boulevard, which together with American Avenue provides the route into Long Beach.

STRUCTURES

The structure is, in general, supported by a single row of columns located in the center of private right-of-way where available or alternately in the middle of streets. Each column, resting on a concrete foundation adequate to withstand the overturning moments imposed upon it, terminates at the upper end in a transverse double bracket member, supporting two longitudinal girders. Each longitudinal girder, provided with expansion joints at suitable intervals, forms a continuous rail support from one end of the line to the other.

A single running rail, for the form of monorail used as the basis for cost estimates, is fastened on top of the longitudinal girder, resting upon a resilient, sound-deadening material. At expansion joints in the supporting girder, mitre-joints in the rail are provided to preserve a smooth-running surface, free of usual rail-joint clicking. When actual design is undertaken certain alternate forms of construction should be examined. One of these, constituting a change in physical form, is to arrange the trucks and supporting girders so that the truck runs inside the girder, possibly on pneumatic tires. While this arrangement would probably increase the cost of supporting structures and girders approximately 15 per cent, it presents offsetting advantages in cost of subway installation and more convenient switching. Further investigation of the feasibility and economy of pre-stressed concrete structures is also warranted.

Each of the two trucks supporting each car is provided with two double-flanged wheels. All propulsion motors and equipment are mounted in the trucks, which ride above the running rail surface. The car body runs below the supporting girder and is supported by a hanger-arm from each truck in such a way that the center of gravity of the unit of rolling stock is directly below the rail.

Side clearances are provided to permit sway of the car body in passing around curves or due to transverse wind-loading. In the former case, the car assumes a position of equilibrium between centrifugal and gravitational forces leading to the easiest passage around curves and to greater passenger comfort. The maximum sway provided for, results from the extreme condition of a steady transverse wind loading on the side of the car equivalent to a sustained wind velocity of 70 miles per hour. Under this condition, the displacement of the car is 12° 40' from the vertical. Speed restrictions on curves are established, and enforced by automatic speed control, to keep the sway on curves within this same limit of displacement.

All parts of the structure are designed to withstand earthquake shock of an acceleration equal to 0.2g, or 20 per cent of the rate of acceleration due to gravity.

Due to the presence of the hanger arms between trucks and car bodies, track switches necessarily differ from conventional rail-line switches. For straight-through movement space between the tangent girder and that for the turn-off, must be provided for passage of the hanger arms. This is very simply accomplished by arranging a length of the girder support as a 180 degree rotating block turning around a longitudinal axis. In one position it places a tangent rail in alignment with adjacent straight-through rails. When rotated over, a curved rail on the opposite surface matches with one adjacent tangent rail and with the curved turnout rail, so bridging the gap between stationary supporting members. Movement is provided by dual motor driving mechanisms, so allowing for remote control analogous to conventional switch machines.

The vertical dimensions of the supporting structure provide 16 feet clear between the bottom of cars and the surface of streets or ground below. The under surface of the supporting girders are approximately ten and a half feet above the 16 foot clearance line or slightly over 26 feet above a road surface. Being at such height and of relatively small dimensions, the girders cannot approach the effect of a nearly solid roadbed at a sixteen foot clear height in obstructing air and light above the street and in reflecting traffic noises, nor do they come nearly as close to structures on abutting property.

A number of varying station arrangements are possible, some of them making use of property adjacent to the street. Such solutions are, however, special cases, generally applicable in only a few locations. Since the line runs in general down the center of a street or private right-of-way, the least complication is involved by placing the stations in the same location.

Each station must provide space for a change booth, turnstiles and other general facilities, with convenient access to and from the street level and the train platform. In the case of ten stations, the latter is placed between the inbound and outbound routes by somewhat spreading the space between supporting girders. The fare collecting facilities are placed below the platform level as this arrangement avoids restricting space for free passenger movement on the platform and permits access to the platform by stairways leading outward toward the ends of the platform so resulting in convenient passenger distribution. This mezzanine level can be supported on the same row of columns as the main structure, by increasing the usual girder height sufficiently to preserve the standard 16 foot clearance from the mezzanine to the street.

It appears undesirable to provide access to the mezzanine level from the center of the street due to the traffic hazard of concentrating pedestrian travel to and from sidewalks in the vicinity of stations. Instead, foot-bridges across the street at both ends of the mezzanine level and four stairways to sidewalk level are provided. Two of these stairways are equipped with moving stairs.

It is considered that both the profile and downtown traffic conditions, under which even a single row of supporting columns would be undesirable, indicate a tunnel under approximately two miles of Hill Street. This tunnel section includes two stations, one serving the Civic Center and one at Seventh Street. In these stations passenger platforms are provided outside the two-track area in order to facilitate convenient stairways to the surface without forcing the construction deeper into the ground as would be required by a mezzanine level.

Adjacent to all except downtown stations, parking lot facilities are provided for the convenience of patrons using their own cars, rather than feeder buses or walking to reach the station.

Storage yards and shops for inspection and maintenance are provided at two locations, on the northern end just off Chandler Boulevard near Woodman Avenue and on the southern end just off Long Beach Boulevard between Compton Boulevard and San Antonio Drive. For the 45 mile installation each storage yard has ten tracks each capable of storing 10 cars. Three additional tracks of thirteen car capacity are provided for car cleaning and light inspection. All of these tracks are at a lower height than on the main line so providing easy access to car interiors from ground level. Each yard is provided with an automatic car washer through which cars will pass between cleaning and light inspection tracks and the storage area. For the shorter installation, between North Hollywood and Compton the number of storage tracks and yard capacity are reduced in proportion to the number of cars required.

Both inspection and maintenance shops are provided with covered tracks long enough for three car trains. The southern shop, designated to handle periodic and heavy repairs has two tracks for such work and two more for heavy inspection and lubrication. These two tracks can also be used for heavy repairs if required. The northern shop is designed with two tracks for heavy inspection and one for light repairs. Both shops have office and repair shop areas for brake, drive, and control equipment repairs and for motor overhaul if this latter work is not handled on a contract basis by an outside service shop.

Entrance to and departure from the yards is provided to or from both inbound and outbound directions on the line. Track facilities required for this feature may also be used for turning trains short of the terminal stations when riding does not justify the full run.

CAR EQUIPMENTS

The cars are to be lightweight, double truck units, approximately 50 feet long and seating approximately 67 persons depending on the arrangement of seats finally adopted. The body, of semi-monocoque construction will have two large sliding doors on each side, near the quarterpoints of the car, to facilitate rapid loading and unloading. Inter-communicating doors for emergency use are provided in the ends of the car. All cars are identical except that a proportion of the total number, to be used as lead cars, will have a streamlined nose and be equipped with a control position for train operation and the necessary automatic speed control apparatus. Trailing cars will be equipped with a modified control station for handling in yards and switching to make up trains.

Trains consisting of one lead car and one to seven trailing units can be operated. If consistent with estimates of riding, semi-permanent coupling of cars in pairs is advantageous.

Each of the two trucks per car will have two 30-inch double-flanged wheels mounted singly on each of the two axles. The axles will also carry a right angle gear box and a disc type brake and will run in roller bearings supporting the lightweight welded truck frame.

Each truck frame will carry two propulsion motor assemblies, driving through double universal joint propeller shafts, brake and control equipment and current collection devices. No propulsion power circuits or apparatus are located in the car body in the interest of maintaining simplicity and to avoid any increase in vertical dimensions which would in turn require proportionately higher supporting structures throughout the installation.

Each of the four propulsion motor assemblies per car consists of a 100 horsepower three phase, alternating current squirrel-cage induction type motor, to which is rigidly bolted a hydraulic torque-converter. This combination permits the induction motor to come up to speed very rapidly because the converter does not exert its maximum drag on the motor until the latter reaches a speed within its desirable operating range, approximately 87.5 per cent of synchronous speed and well above the point of breakdown torque. The net result of the combined characteristics is to provide an extremely smooth, high rate of acceleration in vehicle speed practically up to vehicle balancing speed. It permits use of the very rugged squirrel-cage type of motor and complete elimination of alternating-to direct-current roadside conversion equipment and its corresponding investment.

The motor winding is arranged for full and half speed connections by means of a cam type group switch, which together with a main switch constitutes all the control equipment required. The half speed connection is used only for reduced speed running. Normal accelerations are made in the single high speed connection, thus eliminating "transitions" during acceleration. Because the lower, half-speed, shaft input speed to the converter also reduces the latter's torque multiplication factor, the resulting acceleration is also suitable for yard and switching movements.

Reverse movement, also at a reduced rate of acceleration, is obtained without gearing by reversal of the driving motor direction of rotation.

POWER SUPPLY SYSTEM

Three-phase, 60-cycle, alternating current at 2300 volts is delivered to the cars by using a dual wire contact system and the running rail as the three phase conductors. Energy is supplied this distribution system from simple, stationary transformer unit-substations located in parking lots adjacent to passenger stations. To insure continuity of supply, each substation is fed over two independent supply lines by the utility in whose area the substation is located. The substation itself is provided with two step-down transformers. In case of outage of a supply line or a transformer, the remaining unit, with assistance from adjacent substations, can carry the load with auxiliary radiator cooling.

Within areas permitted by the configuration of utility supply sources, varying from two to five consecutive substations, the distribution system is in effect a secondary, line network with all the advantages of such a scheme. Although, within networks, sectionalizing of the distribution system is supplied where needed, a large part of the sectionalizing is provided by the breaks in continuity required by unmatched energy supply conditions existing in the utility systems. A total of 15 substations is supplied by the Los Angeles Department of Water and Power and 7 by Southern California Edison.

SIGNAL SYSTEM

A very complete and modern signal and automatic speed control system is provided to insure safety of operation on a minimum headway of 90 seconds. To avoid possible confusion between wayside signal aspects and background colored lighting, cab signal indications are provided in each train operating position. Any change of signal aspect to a more restrictive indication, that is, for example, one showing closer approach to a preceding train, requires acknowledgment by appropriate action on the part of the following operator or braking will be automatically initiated. Closing-up movements involving passing of a stop signal can be made, at slow speed only, following acknowledgment of the signal aspect by the operator first bringing the train to a full stop.

In areas where speed restrictions are established, the speed control feature will operate to reduce train speed to the allowable maximum if the operator does not do so. On longer radius curves, only a service brake application is involved; on curves of moderate radius, power is cut off and braking initiated. In the case of sharp curves, such as exist on terminal loops, the motor control will be prevented from operating the motors in any but the lower speed connection, supplementary to braking action if required.

It is considered that the signal and speed control system provides maximum safety of operation, especially as it requires only features already proven in actual service.

SCHEDULE PERFORMANCE

The car equipments will have a scheduled speed, that is overall average speed including stop time at sixteen intermediate stations and reduced speed operation on severe curves, of 41 miles per hour. The running time from terminal to terminal over the 45 mile route is 66 minutes. The scheduled speed depends principally on the rates of acceleration and braking, which are the maximum consistent with available adhesion at the rail, and passenger comfort; and on the balancing, or free-running speed, in this case, 60 miles per hour. With station stops averaging 2.8 miles apart, a substantially higher balancing speed would be less economical as it would barely be attained before braking for the next station stop would commence. A lower balancing speed would probably be an adverse psychological factor in view of prevalent speeds on freeways.

TIME OF CONSTRUCTION

The construction schedule for the entire system is a function of several factors, the most important of which would be the time required for determination of concept, design, supply and fabrication of the steel shapes and plate and the construction of the subway section. It is felt that a period of six months will be required after award of contract to study the final routing, and crystallize the design precepts. The actual design development would be accomplished in the ensuing year but mill orders for both Monorail and subway steel could be placed in the interim so that construction might be started at the end of this period. Because higher speeds are contemplated for Los Angeles than experienced in any previous similar installation it is recommended an initial section one or one and a half miles long be installed for advance testing purposes before all details for the entire project are released for construction.

It is estimated that the construction of the subway section will require thirty months and that all work involved in the construction of the remainder of the Monorail system can be completed within this time. Construction would be performed simultaneously in the several sections in order to reduce the overall time requirements. It is anticipated that the entire system could be completed within four years after award of contract.

MAINTENANCE AND OPERATING COSTS

The unit costs of maintenance, operating and power costs tabulated below, were estimated after careful comparison of the proposed service with an efficient, comparable operation. They are based upon an annual car mileage for the full length of the system of 23,750,000, indicated by others, as required for the expected riding. It should be noted that the intensity of use of the proposed service is high, that is the miles per car per year, the annual car-miles per track mile and the cars per hour per track mile all are high. Such figures are inherent in a fast and frequent service over a straight-away main line of considerable length.

Respectfully submitted,

GIBBS & HILL, Inc.

E. H. Anson
Vice President

EXHIBITS

MAINTENANCE AND OPERATING UNIT COSTS

Maintenance Way & Structures - Annual Cost	$ 1,220,000.
Per Car Mile	5.14¢
Maintenance Equipment - Annual Cost	$ 1,750,000.
Per Car Mile	7.37¢
Operating Expense - Annual Cost	$ 2,426,000.
Per Car Mile	10.22¢
General Administrative Cost - Annual	$ 875,000.
Per Car Mile	3.68¢
Power	$ 1,750,000.
Per Car Mile	7.36¢
Total Maintenance, Operating, Power & Administrative Costs - Annual	$ 8,021,000.
Per Car Mile	33.8¢

FULL LENGTH OF LINE

Panorama to Long Beach

1. Estimated Cost of Construction

a.	Supporting Structures including girders and rail for Main Route, Turn Arounds and Terminal Loops (exclusive of Line Switches, Tunnel Section, Storage Yard Access Trackage and Storage Yards)	$40,988,710.
b.	Foundations and Anchor Bolts	14,078,653.
c.	Special Foundations for Freeway and River Channel Crossings	61,000.
d.	Retaining Walls, Drainage, Fencing, etc. for Turnaround at Washington Blvd.	262,500.
e.	Subway Section, Supporting Structures, Girders and Addition for Foundations - "Monorail Facilities ONLY"	1,423,569.
f.	Line Switches with Supporting Structures and Foundations	736,405.
g.	Painting	864,478.
h.	Traffic Islands in Streets for protection of columns	1,837,410.
i.	Elimination of Overhead Interferences	512,600.
j.	Elimination of Underground Interferences	124,850.
k.	Sub-soil Investigations	214,000.
l.	Subway Structure	21,800,000.
	Total	$82,904,175.

FULL LENGTH OF LINE

Panorama to Long Beach

2. Estimated Cost of Equipment and Appurtenances, Stations, Shops and Inspection Facilities, Yards, Power Supply, Power Transmission and Distribution Systems, Signals and Cars

a.	Passenger Stations (except subway)	$ 3,898,980.
b.	Subway Stations (tunnel structure not included)	450,000.
c.	Scheduled Repair Shop	802,000.
d.	Running Repair Shop	450,000.
e.	Parking Lots at Stations	427,250.
f.	Land Acquisition for Parking Lots, Storage Yards (no provision for R/W property)	2,833,780.
g.	Southern Storage Yard	2,499,666.
h.	Northern Storage Yard	2,329,345.
i.	Power Supply	2,534,520.
j.	Electric System	1,772,730.
k.	Signals and Intercommunication Systems	5,174,019.
l.	Cars 131 @ $80,000. each	10,480,000.
m.	Maintenance Equipment	110,000.
n.	Model Testing and Development	250,000.
o.	Engineering	3,500,000.
p.	Supervision during construction) Field Engineers and Inspectors) Field Survey Crews) Procurement of material and equipment)	5,000,000.
q.	Insurance during construction	1,000,000.
r.	Expenses for procuring property	400,000.
s.	Furnishings and equipment for Authority's general and administration offices	100,000.
t.	Placing equipment in operation and training personnel	250,000.
	Total	$44,262,290.

FULL LENGTH OF LINE

Panorama to Long Beach

3. Contingencies, (NOT including Escalation protection, Value of R/W property, Property Taxes during construction, Legal expenses, Expense of Authority's personnel during construction)	$10,000,000.
4. Basis of Estimate: Labor and material estimates are based upon prices as of December 1953 and the former on the basis of a 40 hour week at straight-time. As far as can be determined no royalties are payable on any part of the basic concept of the monorail	
Total Estimated First Cost	$137,166,465.

SHORTER LENGTH OF LINE

North Hollywood to Compton

1. Estimated Cost of Construction

a.	Supporting Structures including Girders and Rail for Main Route, Turn Arounds and Terminal Loops (exclusive of Line Switches, Tunnel Section, Storage Yard Access Trackage and Storage Yards)	$28,782,669.
b.	Foundations and Anchor Bolts	9,908,851.
c.	Special Foundations for Freeway and River Channel Crossings	49,000.
d.	Retaining Walls, Drainage, Fencing, etc. for Turn-around at Washington Blvd.	262,500.
e.	Subway Section, Supporting Structures, Girders and Addition for Foundations - "Monorail Facilities ONLY"	1,467,044.
f.	Line Switches with Supporting Structures and Foundations	371,694.
g.	Painting	595,627.
h.	Traffic Islands in Streets for Protection of Columns	1,269,470.
i.	Elimination of Overhead Interferences	415,050.
j.	Elimination of Underground Interferences	85,950.
k.	Sub-soil Investigations	139,000.
l.	Subway Structure	21,800,000.
	Total	$65,146,855.

SHORTER LENGTH OF LINE

North Hollywood to Compton

2. Estimated Cost of Equipment and Appurtenances, Stations, Shops and Inspection Facilities, Yards, Power Supply, Power Transmission and Distribution Systems, Signals and Cars

a.	Passenger Stations (except subway)	$ 2,243,200.
b.	Subway Stations (tunnel structure not included)	450,000.
c.	Scheduled Repair Shop	802,000.
d.	Running Repair Shop	450,000.
e.	Parking Lots at Stations	262,000.
f.	Land Acquisition for Parking Lots, Storage Yards and Sub Stations (no provision for R/W property)	2,046,900.
g.	Southern Storage Yard	2,457,666.
h.	Northern Storage Yard	2,009,345.
i.	Power Supply	1,818,900.
j.	Electric System	1,327,566.
k.	Signals and Intercommunication Systems	4,183,100.
l.	Cars 117 @ $80,000. each	9,360,000.
m.	Maintenance Equipment	110,000.
n.	Model Testing and Development	250,000.
o.	Engineering	3,000,000.
p.	Supervision during construction Field Engineers and Inspectors Field Survey Crews Procurement of material and equipment	4,000,000.
q.	Insurance during construction	750,000.
r.	Expenses for procuring property	300,000.
s.	Furnishings and equipment for Authority's general and administration offices	100,000.
t.	Placing equipment in operation and training personnel	250,000.
	Total	$36,170,677.

SHORTER LENGTH OF LINE

North Hollywood to Compton

3. Contingencies (Not including Escalation protection, Value of R/W property, Property taxes during construction, Legal expenses, Expense of Authority's personnel during construction.) $ 10,000,000.

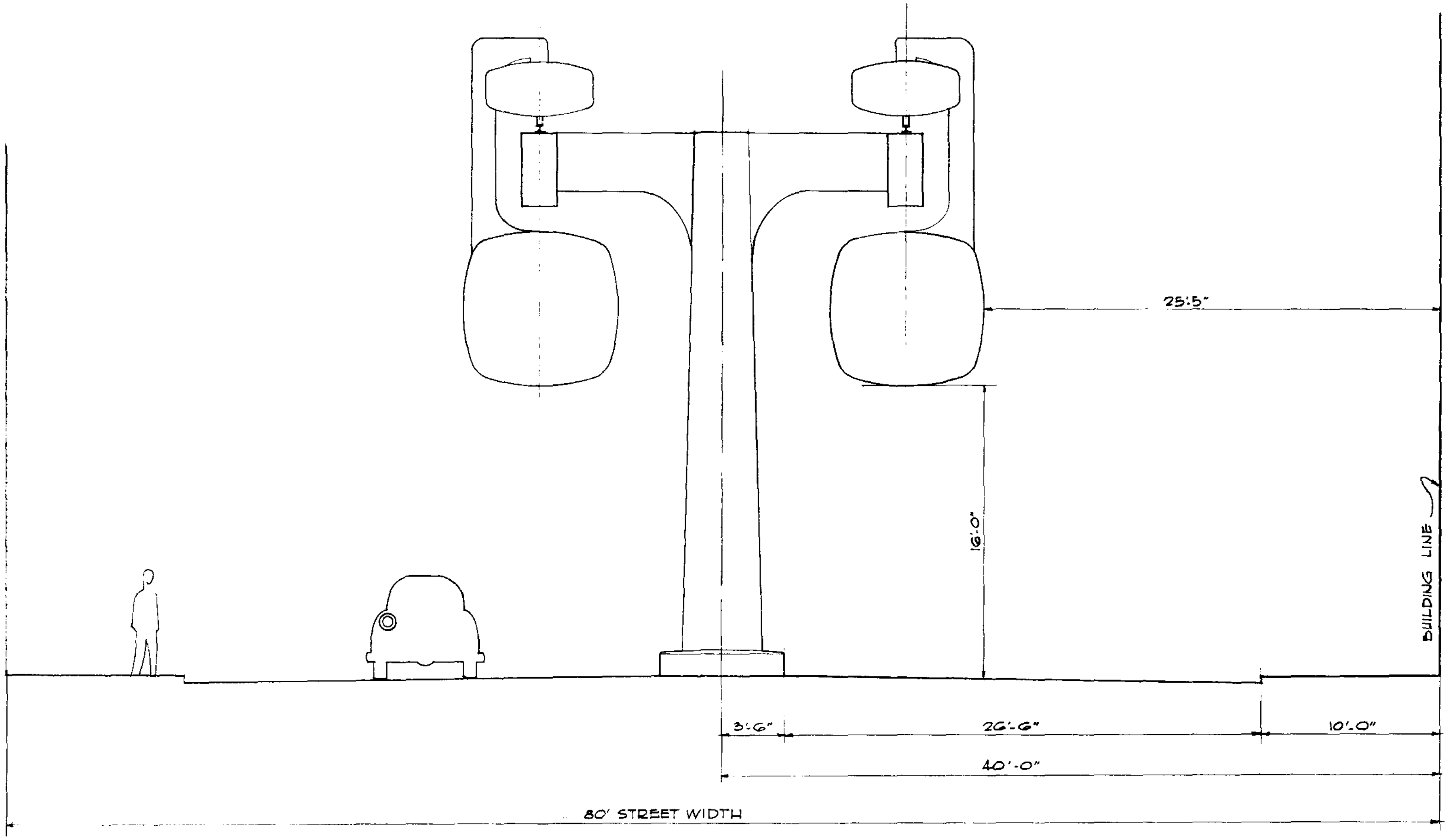
4. Basis of Estimate: Labor and material estimates are based upon prices as of December 1953 and the former on the basis of a 40-hour week at straight time. As far as can be determined no royalties are payable on the basic concept of the Monorail.

Total Estimated First Cost $111,317,532.

CONDENSED PROFILE

SCHEMATIC ARRANGEMENT OF LINE

CROSS-SECTION OF MINIMUM WIDTH STREET



12-15-53

LOS ANGELES METROPOLITAN TRANSIT AUTHORITY
MONORAIL STUDY - LOS ANGELES, CALIFORNIA

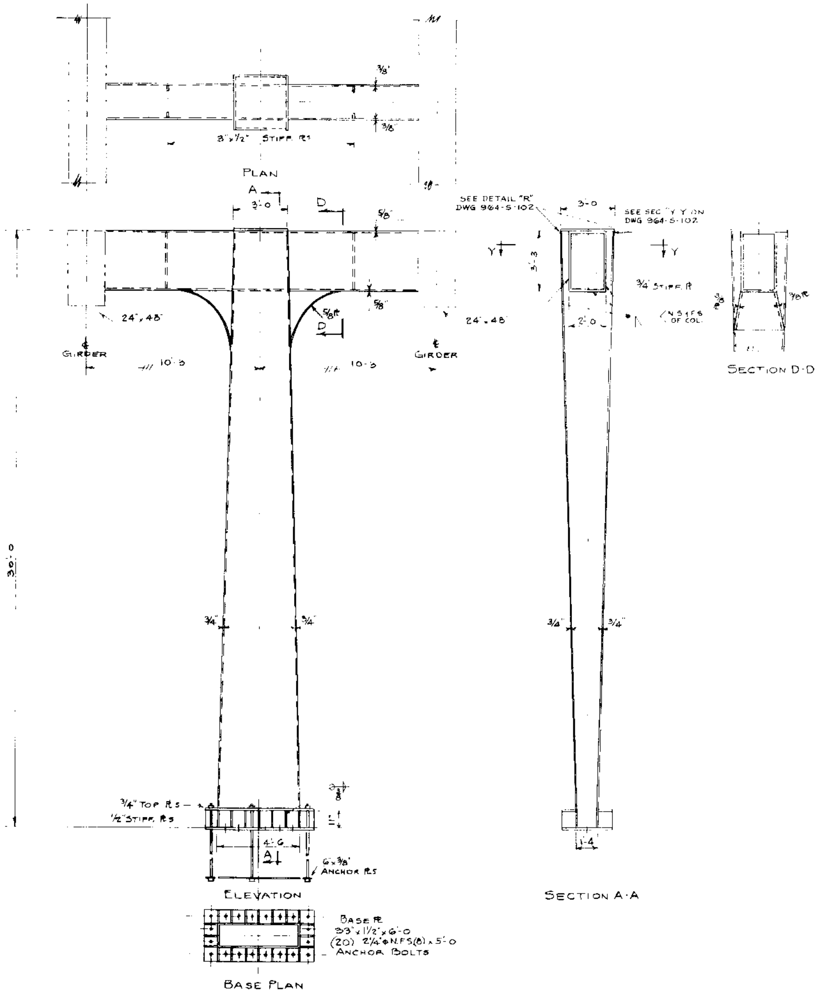
CROSS SECTION
80' STREET

GIBBS & HILL Inc.
ENGINEERS - CONSTRUCTORS
NEW YORK - LOS ANGELES

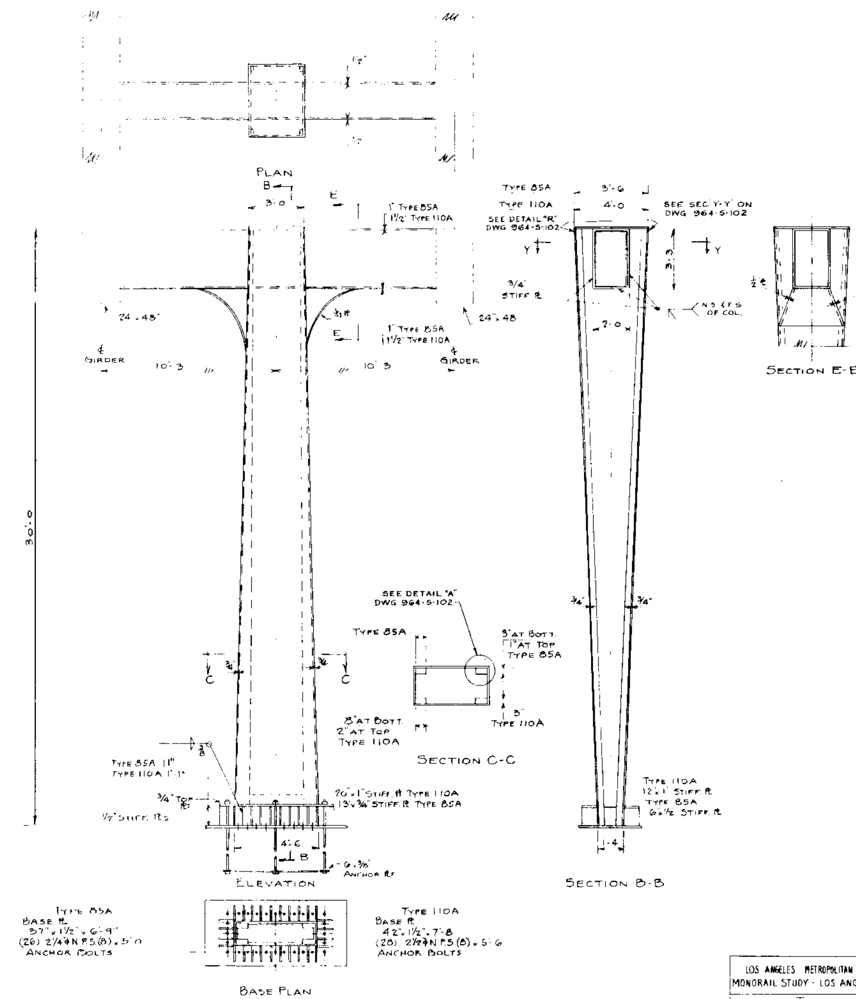
SCALE 1/4"=1'-0"

964-A-5

TYPICAL STRUCTURAL SUPPORT



Structure Type 60A



Structure Type 85A, Type 110A

Dec. 1, 1953

LOS ANGELES METROPOLITAN TRANSIT AUTHORITY
MONORAIL STUDY - LOS ANGELES, CALIFORNIA

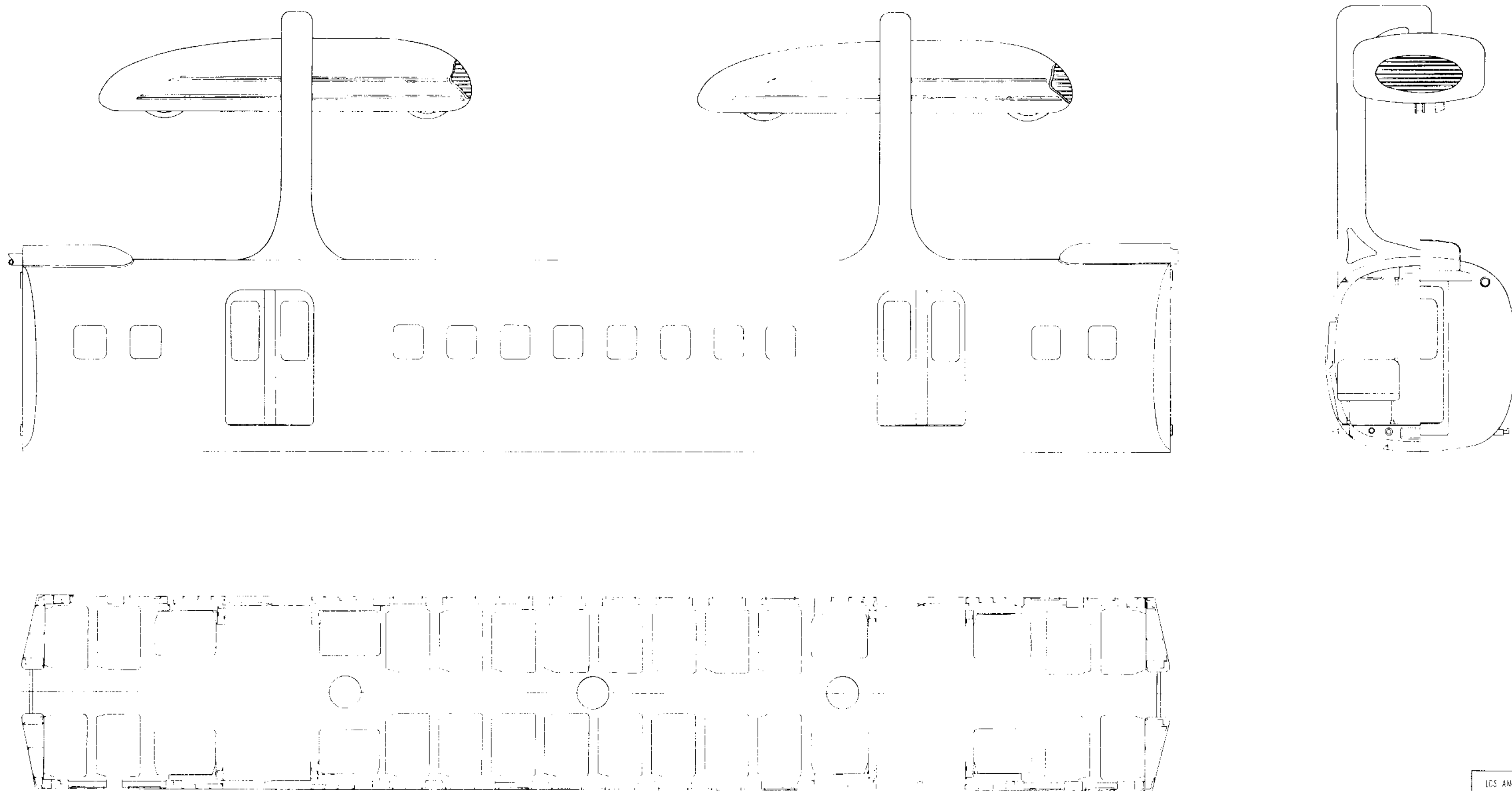
TYPICAL
SUPPORT STRUCTURES
16' CLEARANCE

GIBBS & HILL, INC.
ENGINEERS CONSTRUCTORS
NEW YORK · LOS ANGELES

SCALE:

964-S101

GENERAL ARRANGEMENT OF MONORAIL CAR



Dec 1, 1953

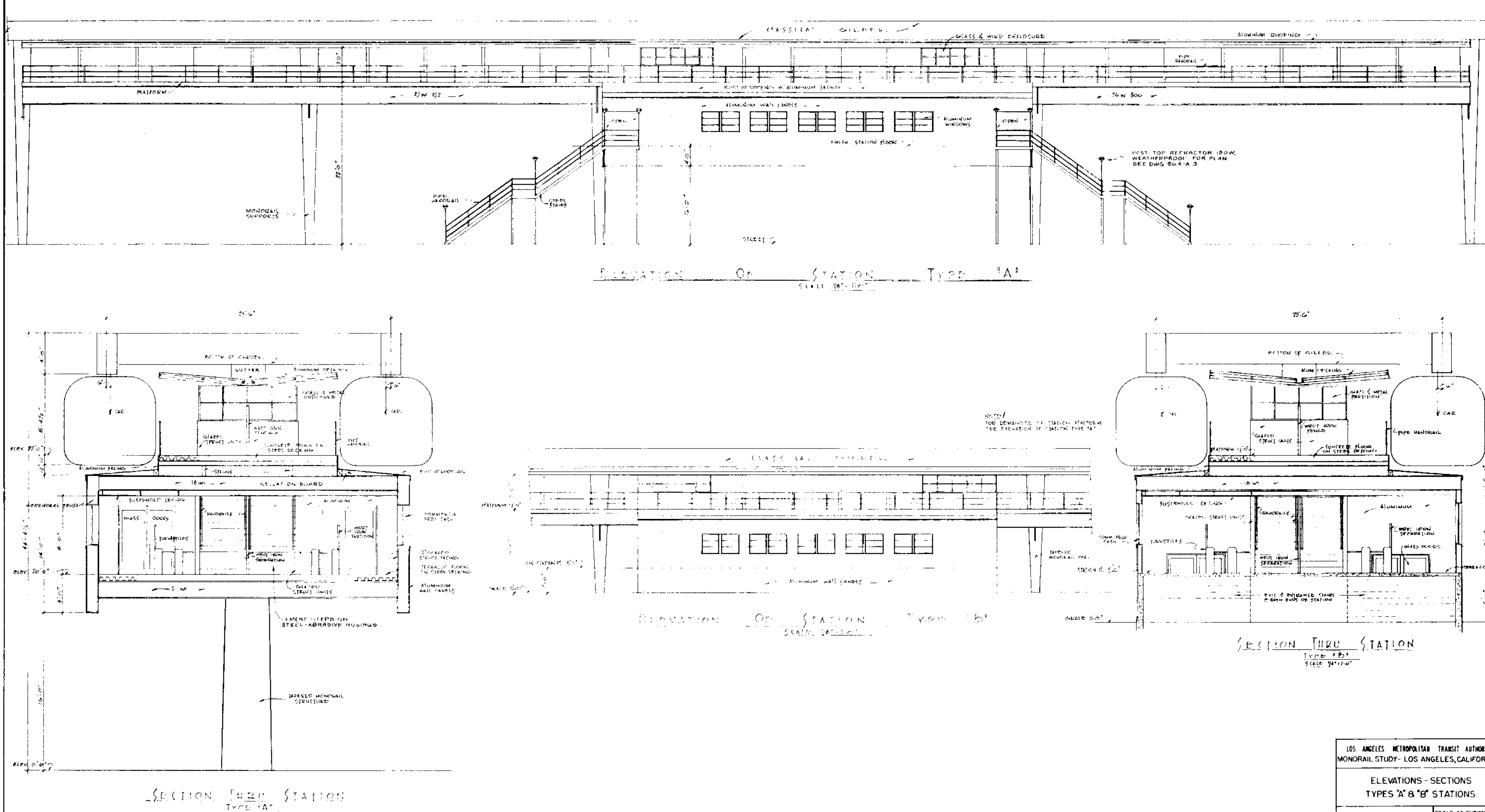
LOS ANGELES METROPOLITAN TRANSIT AUTHORITY
MONORAIL STUDY LOS ANGELES, CALIFORNIA

GENERAL ARRANGEMENT
MONORAIL CAR

GIBBS & HILL, Inc
ENGINEERS · CONSTRUCTORS
NEW YORK LOS ANGELES

964-M1

STATION ELEVATION AND SECTIONS



Elevation of Station Type "A"

Scale 1/8" = 1'-0"

Section Thru Station Type "A"

Elevation of Station Type "B"

Section Thru Station Type "B"

Scale 1/4" = 1'-0"

Dec 1, 1953

LOS ANGELES METROPOLITAN TRANSIT AUTHORITY
MONORAIL STUDY - LOS ANGELES, CALIFORNIA

ELEVATIONS - SECTIONS
TYPES "A" & "B" STATIONS

GIBBS & HILL, INC.
ENGINEERS - CONSTRUCTORS
NEW YORK - LOS ANGELES

SCALE AS SHOWN

964-A-2

STATION PLANS AND ARRANGEMENT

NOTES:

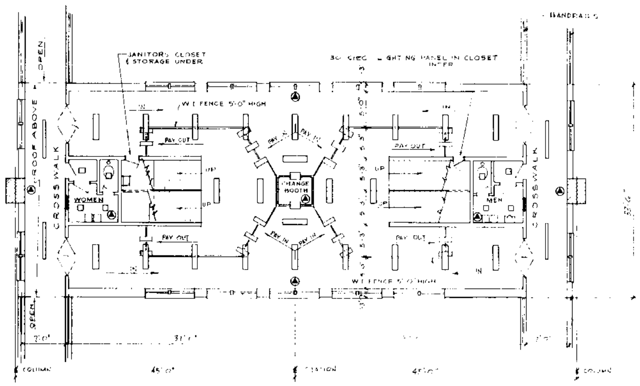
TYPE "A-1" ON STREET STATIONS W/DIVIDING BARRIER FOR STATION & PLATFORMS

TYPE "A-2" ON STREET STATIONS W/O BARRIERS

TYPE "B-1" OFF STREET STATIONS W/DIVIDING BARRIERS

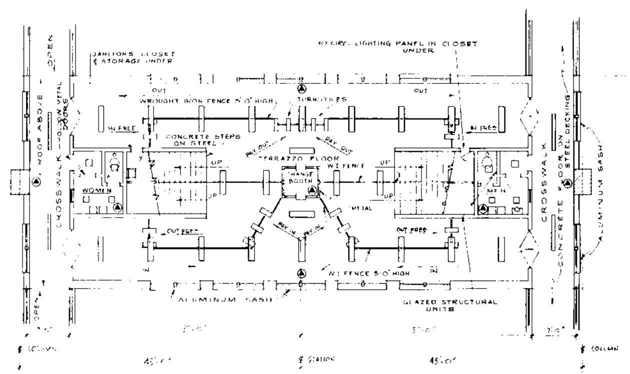
TYPE "B-2" OFF STREET STATIONS W/O BARRIERS

TYPE "C" SUBWAY STATIONS



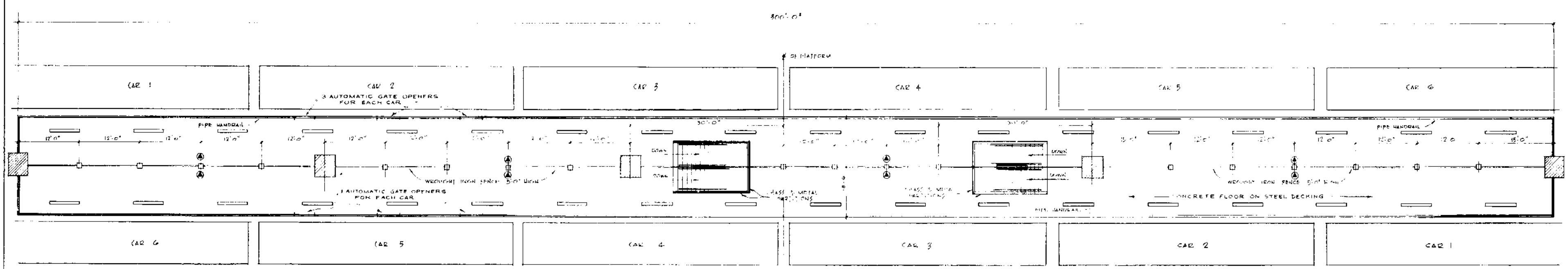
STATION LAYOUT - ZONE "B"
SCALE: 1/8" = 1'-0"

NOTE:
NOTES SHOWN ON PLAN OF ZONE "C" APPLY TO ZONES "A" & "B" EXCEPT AS NOTED AND SHOWN ON GROUND LEVEL STATION



STATION LAYOUT - ZONE "C"
REVERSE LAYOUT FOR ZONE "A"
SCALE: 1/8" = 1'-0"

NOTE:
SEE SHEET No. 964-A-3 FOR PLAN OF GROUND LEVEL STATION "B"



STATION PLATFORM

LIGHTING SYMBOLS

- SLIMLINE FIXTURE 1-72" 430MA LAMP, WEATHERPROOF, SURFACE MOUNTING
- FLUORESCENT FIXTURE-2-40 WATT LAMPS, WITH ALBALITE DIFFUSING PANEL, FLUSH MOUNTING.
- INCANDESCENT FIXTURE - 150 WATT, WITH ALBALITE DIFFUSING PANEL, FLUSH MOUNTING
- TWISTLOCK RECEPTACLE - 15AMP, 125VOLT, 3WIRE (ONE POLE GROUNDED), WITH CAST IRON PLATE WITH LIFT COVER

Dec 1, 1953

LOS ANGELES METROPOLITAN TRANSIT AUTHORITY MONORAIL STUDY - LOS ANGELES, CALIFORNIA	
PLANS & LIGHTING LAYOUT STATION "A"	
GIBBS & HILL, INC. ENGINEERS - CONSTRUCTORS NEW YORK - LOS ANGELES	SCALE: AS SHOWN 964-A-1

P L A T E S

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