HOLLYWOOD BOWL CONNECTOR STUDY

Technical Memorandum

Submitted to

SOUTHERN CALIFORNIA RAPID TRANSIT DISTRICT

Submitted by

PARSONS BRINCKERHOFF QUADE & DOUGLAS, INC.

MARCH 15, 1988

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TECHNICAL MEMORANDUM

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SUMMARY

This report focused upon alternative connection that directly link the Hollywood Bowl and the Metro Rail station located at the intersection of Hollywood Boulevard and Highland Avenue. The technologies examined include moving walkways and people movers. Both technologies were analyzed in elevated and underground alignments. Furthmore the people mover alternatives considered systems manufactured by Westinghouse Electric Corporation and Universal Mobility, Incorporated.

The connector alternatives with the greatest system capacities are the moving walkway alternatives. These alternatives can provide a capacity of 16,600 passengers per hour. Exiting time for 4,000 people who attend an event at the Bowl would be 14 minutes. The quickest travel time between the Hollywood Bowl station and the Metro Rail station for the moving walkway would be attained by the underground system, at a time of 23.5 minutes. A comparative summary of the alternative connectors is presented in Table S-1.

The alternatives with the next highest system capacities are the Westinghouse people mover systems with capacities of 9,700 and 9,100 passengers per hour for the underground and elevated alternatives, respectively. Both Westinghouse alternatives could exit 4,000 people from a Bowl event in around 25 minutes, and could transport a person between Metro Rail and the Bowl in less than 11 minutes.

The performance of the Universal Mobility people mover varies only slightly between the elevated and underground alternatives. Its system capacity is between 5,800 and 6,000 passengers per hour. The higher capacity can be attained by the underground connector. The Universal Mobility system could deliver an end-to-end trip in about 11 minutes which is only seconds slower than the Westinghouse people mover.

The most significant impact to traffic operations on Highland Avenue would occur with the elevated alternatives, due to support piers being placed within the street. Even with street widening, the elevated guideway would result in a reduction in the level of traffic service along this segment.

TABLE S-1

SYSTEM CHARACTERISTICS OF ALTERNATIVES

	Elevated Moving Walkway	Underground Moving Walkway	Universal Elevated People Mover	Universal Underground People Mover	Westinghouse Elevated People Mover	Westinghouse Underground People Mover
1. Approx. Capital Costs (In millions, 1988 $)	33	40	25	69	45	74
2. Event Exiting Time (In minutes; assuming 4,000 passengers)	14	14	41	40	26	25
3. Travel Time (Hollywood/Highland Station to Hollywood Bowl Station	27	24	11	10	11	10
4. Average Speed (Mph)	1.7	1.7	20	20	24	24

Traffic circulation impacts associated with the underground alternatives would be temporary and limited. During construction of the underground connector, circulation would be affected in the vicinity of the cut-and-cover site. Most of the underground system would be constructed using bored tunnels. However, the cut-and-cover construction method would be used near Hollywood/Highland to provide the excavation portal for the tunnel operation and to construct the subsurface interface with Metro Rail.

The vibration associated with the aerial or underground connector would not have an appreciable impact upon the surroundings. Also, the noise attributable to the moving walkway and people mover alternatives would not be noticeably perceptible over the existing vehicular traffic noise. It is anticipated that the electrically powered, rubber-tired people mover and moving walkway would produce noise levels less audibly perceptible than the noise generated by vehicular traffic on Highland Avenue.

The visual impacts associated with the underground connector alternatives will be limited to the Hollywood Bowl station. An elevated connector, however, would introduce a new and distinctive element into the visual environment along the entire length of the alignment.

The moving walkway will present the largest physical impact to the streetscape. This alternative would add an elevated and continuous enclosed structure along Highland Avenue. Above the roadway the enclosed structure will measure approximately 20 feet square with the highest point located roughly 35 feet above the street.

The people mover alternatives would be less visually intrusive compared to the moving walkway concept since their primary visual impact is associated with the aerial guideway. The Universal Mobility system consists of two monorail guideways supported on "hammerhead" shaped piers. The Westinghouse guideway would be slightly larger and consist of a single deck connected to "T" shaped piers.

Each of these elevated alternatives would introduce a new and significant impact to the visual environment of Highland Avenue. These impacts can only be partially mitigated by the use of aesthetically pleasing design and landscaping. The elevated connector would be visible from Highland Avenue, as well as some surrounding hillside areas.

The historic properties located within the alignment are on the westside of Highland Avenue. The underground alternative would exclusively impact the Hollywood Bowl with the presence of a station located on the premises.

The elevated connectors would be significantly more intrusive upon these historic properties. The elevated alternatives create a continuous visual element which would inhibit the view of these sites from the eastside of Highland Avenue. The determination of whether these effects upon the historic properties are adverse will be made in conjunction with the State Historic Preservation Officer.

Land acquisition and displacements would not be required with the underground alternatives; however, underground easements beneath fifteen parcels would need to be obtained. These easements would be necessary where the alignment deviates from the Highland Avenue alignment. It is anticipated that these easements could be acquired for approximately $300,000.

The elevated alternatives would require the acquisition of two parcels presently occupied by a Burger King restaurant, commercial parking lot, and keymaking shop located on the eastside of Highland Avenue. The properties would be required for the construction of the elevated guideway transfer station to the underground connection to Metro Rail. The cost to acquire these parcels is estimated to approximate $3.7 million.

Many undefined variables could affect the ultimate cost of a system; however, based upon preliminary analysis, it is evident that the most expensive systems are the underground alternatives. The Westinghouse underground people mover would be the most expensive connection to the Hollywood Bowl at around $74 million. Among the least costly connector options, the Universal Mobility elevated people mover would be even less expensive than the moving walkway. The estimated cost of this alternatives is $26 million.

In conclusion, the connector impacts would be significantly greater for the elevated alternatives in terms of their impacts to circulation, construction, aesthetics, and historic properties. However, the underground alternatives are substantially more expensive to construct. The moving walkway alternatives would provide the greatest capacity, yet the people mover options would provide the shortest travel times between the Hollywood Bowl and the Metro Rail station.

I. PURPOSE AND NEED FOR THE CONNECTOR

PROJECT BACKGROUND

The Hollywood Bowl is a world famous 18,000 seat amphitheater located in the Santa Monica Mountains north of the proposed Hollywood Boulevard/Highland Avenue Metro Rail station. The Hollywood Bowl hosts approximately 80 major annual events which attract nearly 800,000 patrons per year. Additionally, the Bowl is a major tourist attraction generating another 1.5 million annual visitors. Consequently, community leaders have expressed the desire to provide rail transit service to the Hollywood Bowl as part of the Metro Rail MOS-2.

Since a direct Metro Rail connection to the Hollywood Bowl is not possible with the presently preferred MOS-2, Candidate Alignment 6, alternative means of connecting the Hollywood Bowl to the Hollywood Boulevard/Highland Avenue Station have been analyzed. In the vicinity of the Hollywood Bowl, Candidate Alignment 6 is proposed as a subway alignment beneath Hollywood Boulevard with a station located at the intersection of Hollywood Boulevard and Highland Avenue. The distance between this station and the Hollywood Bowl is approximately 4,000 feet, as measured along Highland Avenue.

Providing transit service to persons attending performances at the Hollywood Bowl is the primary purpose of the Hollywood Bowl Connector, since this will not only enhance accessibility for the Bowl but improve the off-peak use of Metro Rail as well. Additionally, the Connector would enable the Hollywood Bowl's parking lots to be used by Metro Rail park-and-ride patrons, when they are not being used for event parking.

PROJECT ALTERNATIVES

Several alternative technologies were examined to determine their ability to serve as a transit connector between the Hollywood Bowl and Metro Rail. The technologies examined include moving walkways and people movers. The moving walkway concepts which were analyzed are an elevated configuration and an underground configuration using a system manufactured by Westmont Industries. The people mover alternatives also include elevated and underground alignments, as well as an examination of two separate people mover systems. The systems considered are manufactured by Westinghouse Electric Corporation and Universal Mobility, Incorporated.

II. HOLLYWOOD BOWL MOVING WALKWAY ALTERNATIVES

MOVING WALKWAY ALTERNATIVES

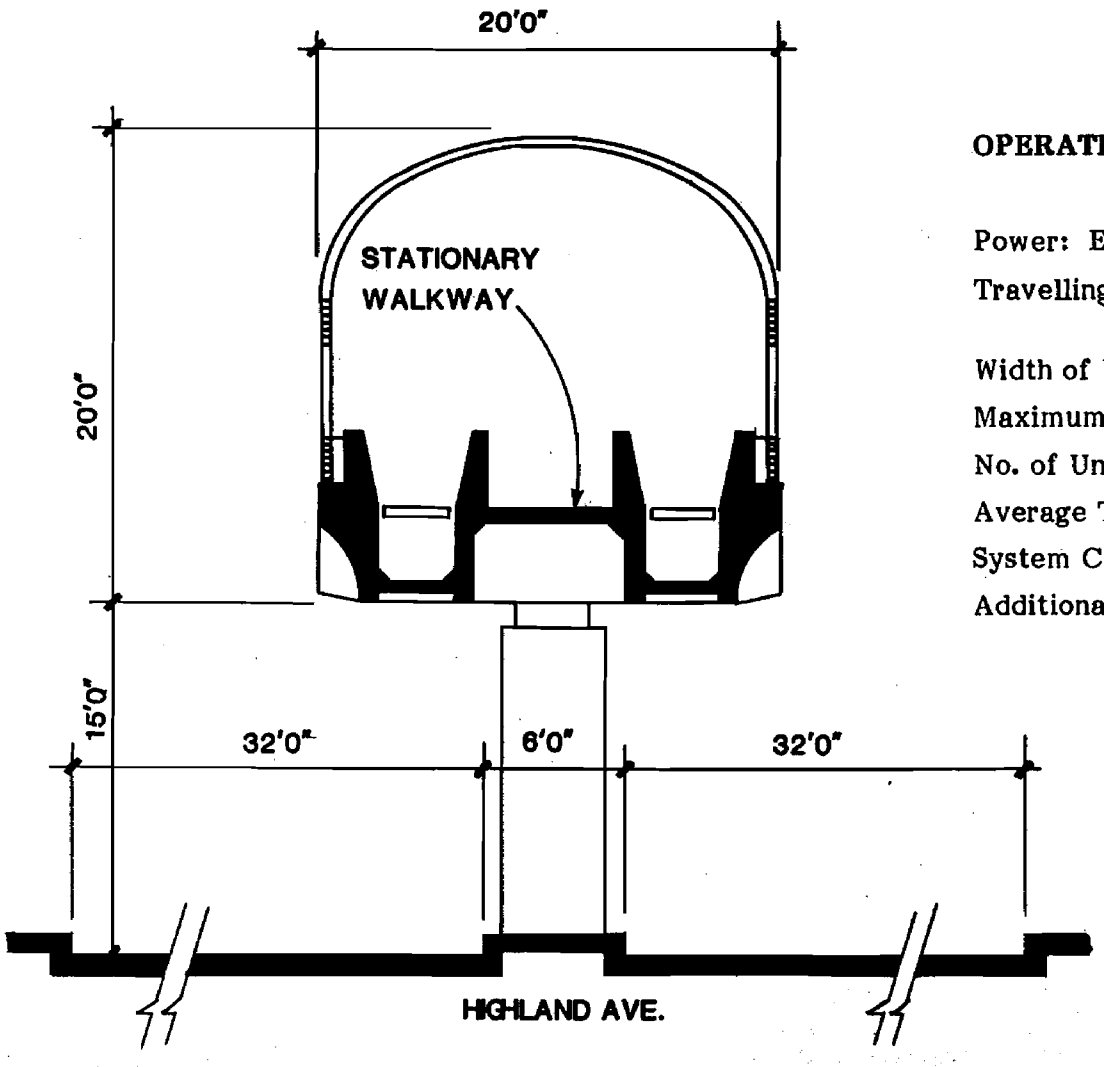
Description

The moving walkway alternatives consist of elevated and underground options. Both options would be fully enclosed and grade separated from vehicular traffic.

The Connector would consist of a series of linear moving walkway segments with stationary walkway segments between the moving belts. The moving walkway segments would utilize two parallel moving belts with a stationary walking path in the middle. The moving walkways would be fully reversible allowing for single direction or bidirectional operation. Segments of moving walkway would range from a minimum length of 80 feet to a maximum of 700 feet. Stationary walkway segments between the belts would range from 140 to 440 feet.

Both the elevated and underground facilities would be enclosed in a guideway envelope of approximately 20 feet in width and height. The two alternatives are illustrated in typical section in Figures 1 and 2, for the elevated and underground systems, respectively. The elevated facility would be constructed on columns in the center of Highland Avenue with a minimum vertical clearance of 15 feet. The underground system would be enclosed in a bored tunnel of 20 feet diameter.

The moving walkway technology assumed in this analysis is manufactured by Westmont Industries and is called "speedwalk". The system consists of a series of self-contained power belt assemblies. Utilizing a belt-pulley principle, each unit has a support structure, drive machinery, an unbroken headway riding on ball bearing rollers and moving handrails with balustrades. In addition, each unit is fitted with a controller and safety devices. The speedwalk units operate from a standard three phase, 460 volt, 60 Hz source.



TYP. SECTION

OPERATION CHARACTERISTICS

Power: Electric

Travelling Unit: Motor-driven, continuous loop belt, with reversible direction travel

Width of Unit: 39" (inside clear)

Maximum Length of Unit: 700'-0"

No. of Units: 6

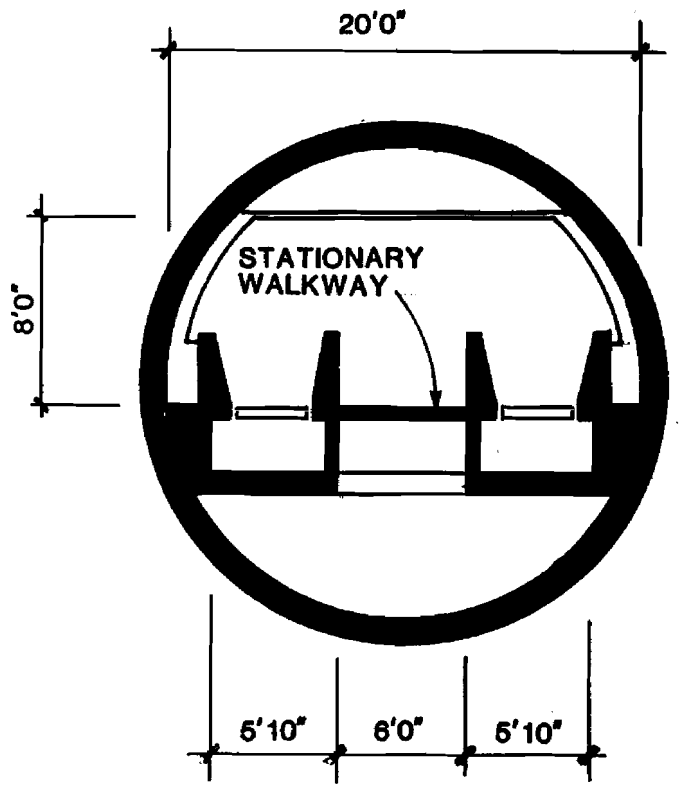
Average Travel Speed: 150 fpm

System Capacity: 16,590 passengers/hour

Additional: Moving Walkway Units are broken by walkable variable length (440' max.) long landings

Parsons Brinckerhoff

Figure 1
Elevated Moving Walkway



TYP. SECTION
THRU BORED TUNNEL

OPERATION CHARACTERISTICS

Power: Electric

Travelling Unit: Motor-driven, continuous loop belt, with reversible direction travel

Width of Unit: 39" (inside clear)

Maximum Length of Unit: 700'-0"

No. of Units: 4

Average Travel Speed: 150 fpm

System Capacity: 16,590 passengers/hour

Additional: Moving Walkway Units are broken by walkable 170' - 0" long landings

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Figure 2
Underground Moving Walkway

Other System Characteristics

Width of Unit

- actual tread width	39"
- width at 27" above tread	52"
- handrail centerline-to-centerline	53"

Speed of Unit

- standard	120 feet per minute (fpm)
- maximum allowable	140 fpm

Capacity

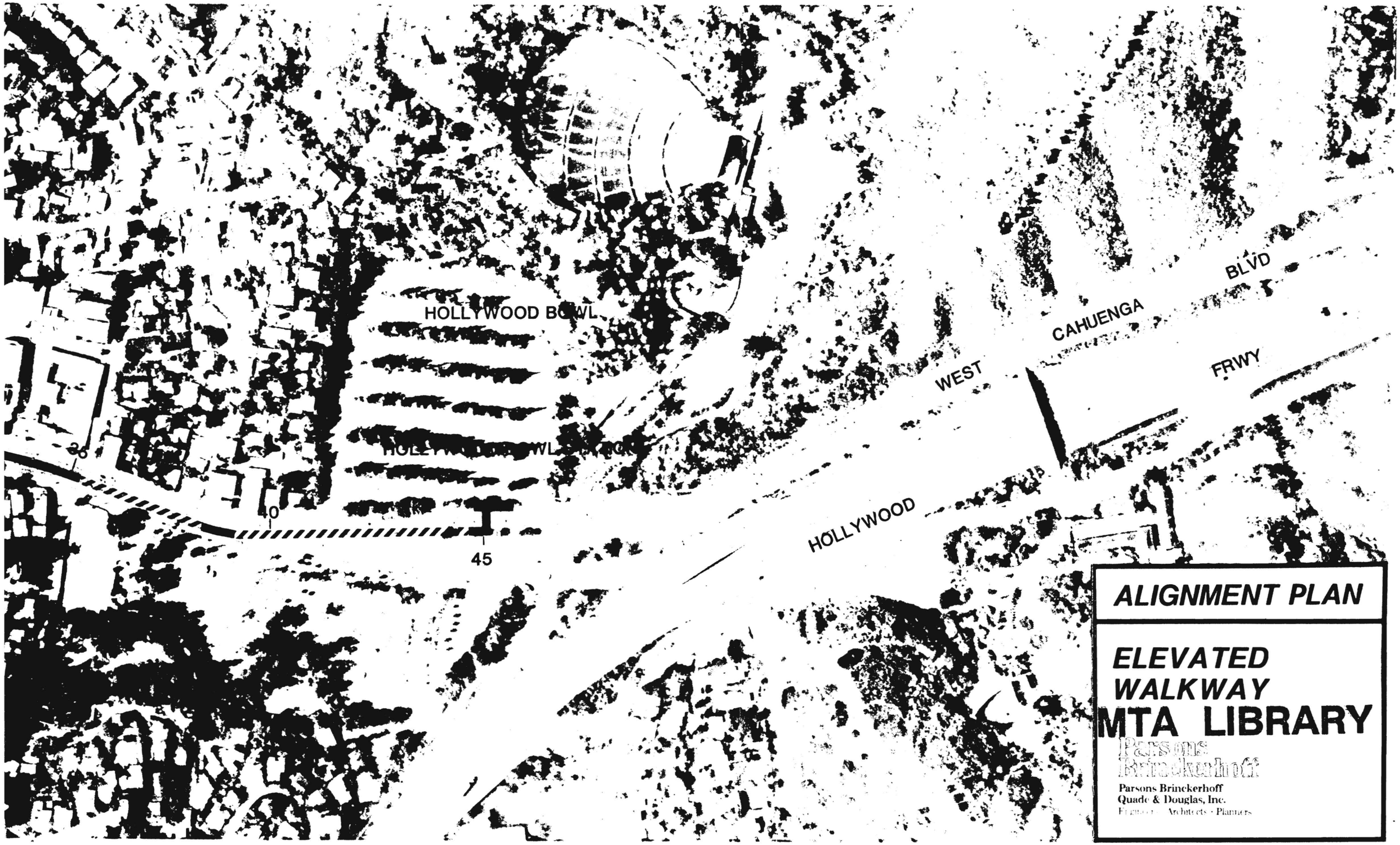
- maximum	10,000 people per hour (p/h)

The elevated structure alignment shown in Figure 3, primarily follows the centerline of Highland Avenue from the Hollywood Boulevard Metro Rail station to the Hollywood Bowl for a length of approximately 3,660 feet. The facility extends from the mezzanine level of the Metro Rail station for approximately 250 feet underground then rises through a transfer station with escalators (and elevators for the handicapped) to the elevated alignment. The profile is illustrated in Figure 4. This system would utilize six segments of moving walkway with individual units ranging from 80 to 700 feet in length. Since the moving walkways are limited to linear applications and can't be used on curves, the amount of moving walkway is constrained by the street's geometrics.

The underground alignment also extends along Highland Avenue to Franklin Avenue (south) and since it is not constrained to the street alignment it would continue in a more direct alignment to the Hollywood Bowl station as shown in Figure 5. This alternative utilizes four segments of maximum 700 feet length with landing intervals of approximately 170 feet. Beginning at the Metro Rail mezzanine level at approximately 27 feet below grade, the facility extends in a cut-and-cover section to a cover depth of approximately 40 feet. The bored tunnel then continues at a depth of 40 feet and approximate grade of 3% until the Hollywood Bowl station. This profile is illustrated in Figure 4.


BLVD
FRANKLIN AVE (SOUTH)
HOLLYWOOD
METRO
HIGHLAND
STATION
TRANSFER STATION
20
30
AVE
HIGHLAND
LAS PALMAS
YUCCA
AVE
FRANKLIN AVE (SOUTH)
MTA LIBRARY
NORTH
1"=200'
200
0
20
scale
feet

Figure 3



ALIGNMENT PLAN

ELEVATED WALKWAY MTA LIBRARY

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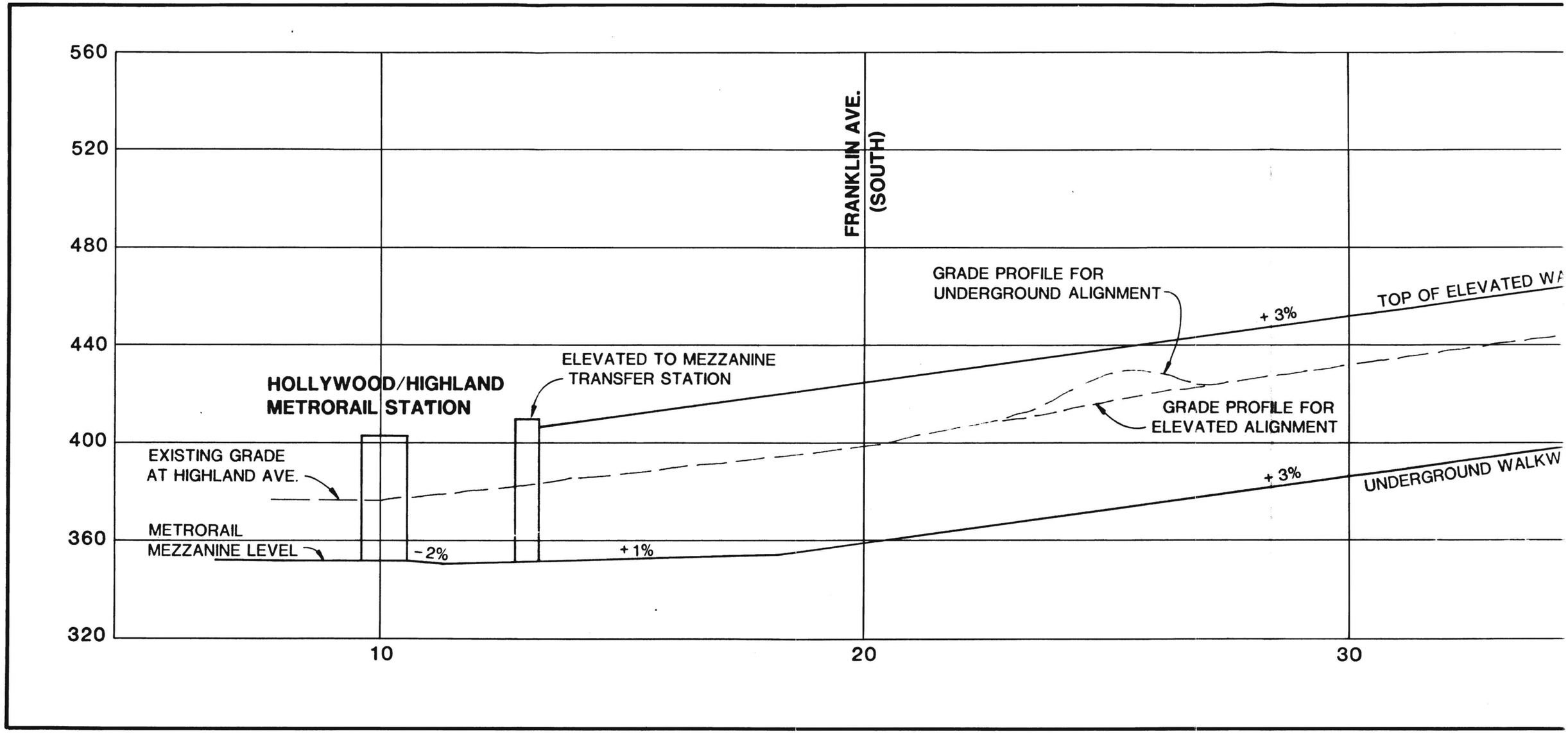
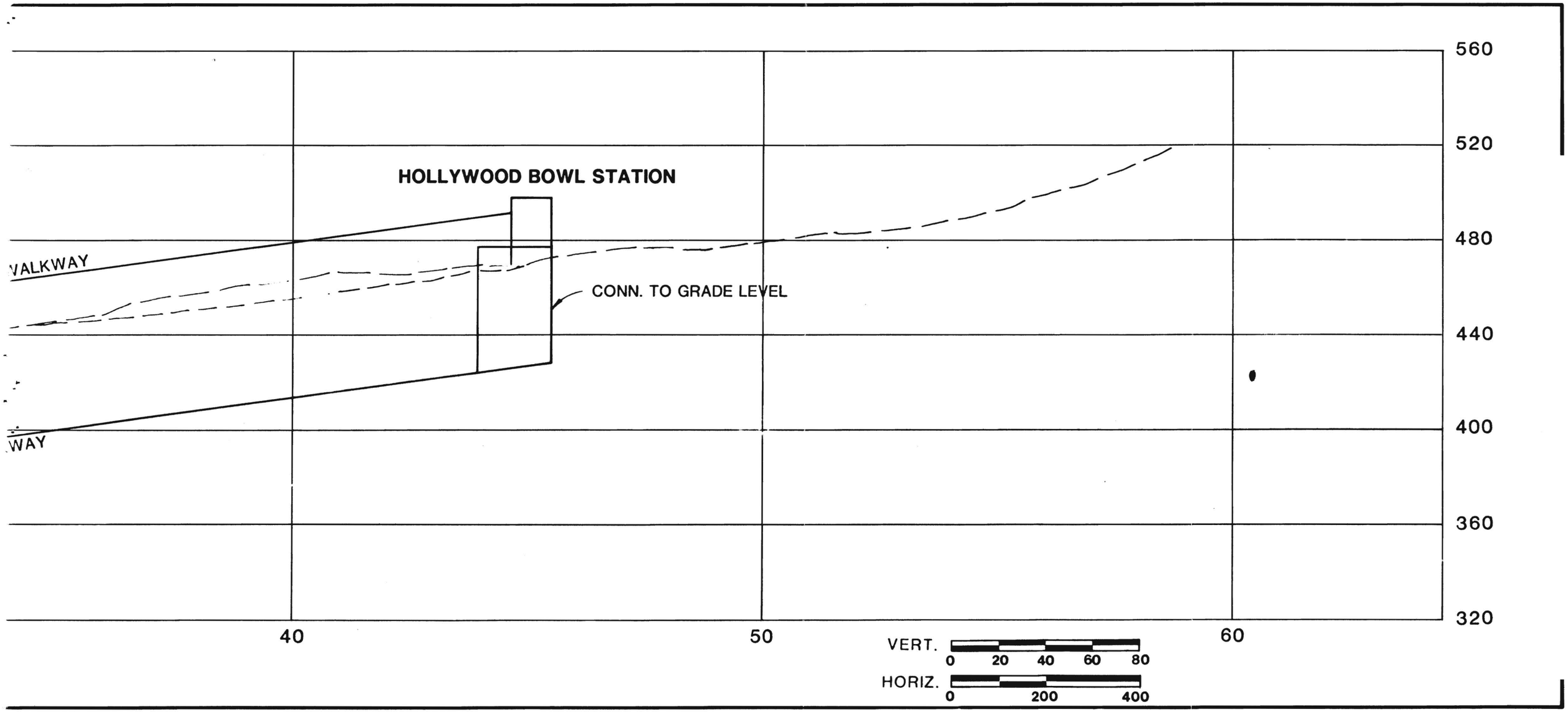
Engineers · Architects · Planners

MOVING WALKWAY

STATIONARY WALKWAY



MOVING WALKWAY



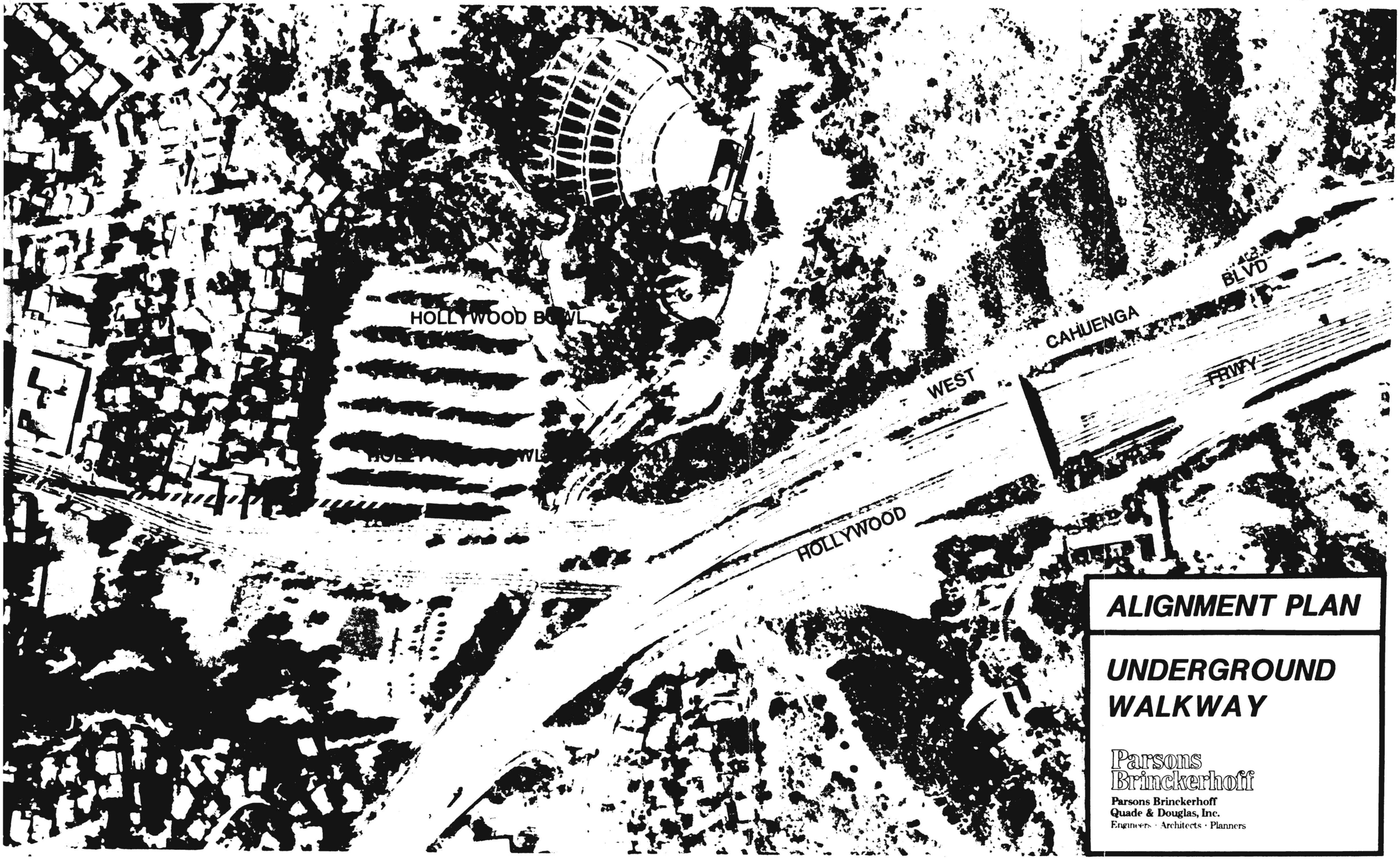
Y ALTERNATIVES

PROFILE PLAN

Figure 4


HIGHLAND
HIGHLAND AVE (SOUTH)
30TH AVE
HIGHLAND
AVE
LAS PALMAS
YUCCA
NORTH
MTA LIBRAR
1"=200'
200 0 20
scale feet

Figure 5


HOLLYWOOD BOWL
CAHUENGA
BLVD
FRWY
WEST
HOLLYWOOD
ALIGNMENT PLAN
UNDERGROUND WALKWAY
Parsons Brinckerhoff
Parsons Brinckerhoff Quade & Douglas, Inc.
Engineers · Architects · Planners
MOVING WALKWAY
STATIONARY WALKWAY

Emergency power and lighting would be provided with both systems. The elevated facility would be equipped with blue light stations connected to emergency power at 800 feet intervals. The stations would also allow for emergency power disconnect and provide telephone connections to a central facility. Emergency access from the elevated guideway to ground level would be provided at one of the stationary walkway sections approximately 2,500 feet along the structure. The underground facility would provide emergency access to ground level through stair towers at the stations and at the three stationary walkway sections. Additionally, these landings allow people to cross over within the tunnel.

Operations

The two moving walkway tracks will provide single direction usage for performances at the Hollywood Bowl. Prior to events, for example, the walkway system will convey people solely from the Metro Rail station to the Hollywood Bowl. At these times, one track will be assigned purely for standing on the belt, while the other track will be assigned for walking on the belt, allowing more efficient separation of the pedestrian flow. During non-event operations, the walkways can operate in separate directions to enable free flow between the two stations. Both systems allow usage of the middle stationary walkway for additional capacity (see rendering illustrated in Figure 6). Metro Rail connections with both alternatives are shown in Figures 7 and 8. The Metro Rail and Hollywood Bowl station layouts for the elevated and underground alternatives are illustrated in Figures 9, 10, 11 and 12, respectively.

People exiting the Metro Rail can connect with the moving walkway system, in both alternatives, at mezzanine level and access a moving walkway segment after a 75 foot landing. With the elevated option people would then transfer to the above grade guideway at a transition station via an escalator or elevator. At the Hollywood Bowl station people would access the walkways via the escalators from a refuge area immediately after crossing Arbor Drive.

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Figure 6

Underground Moving Walkway

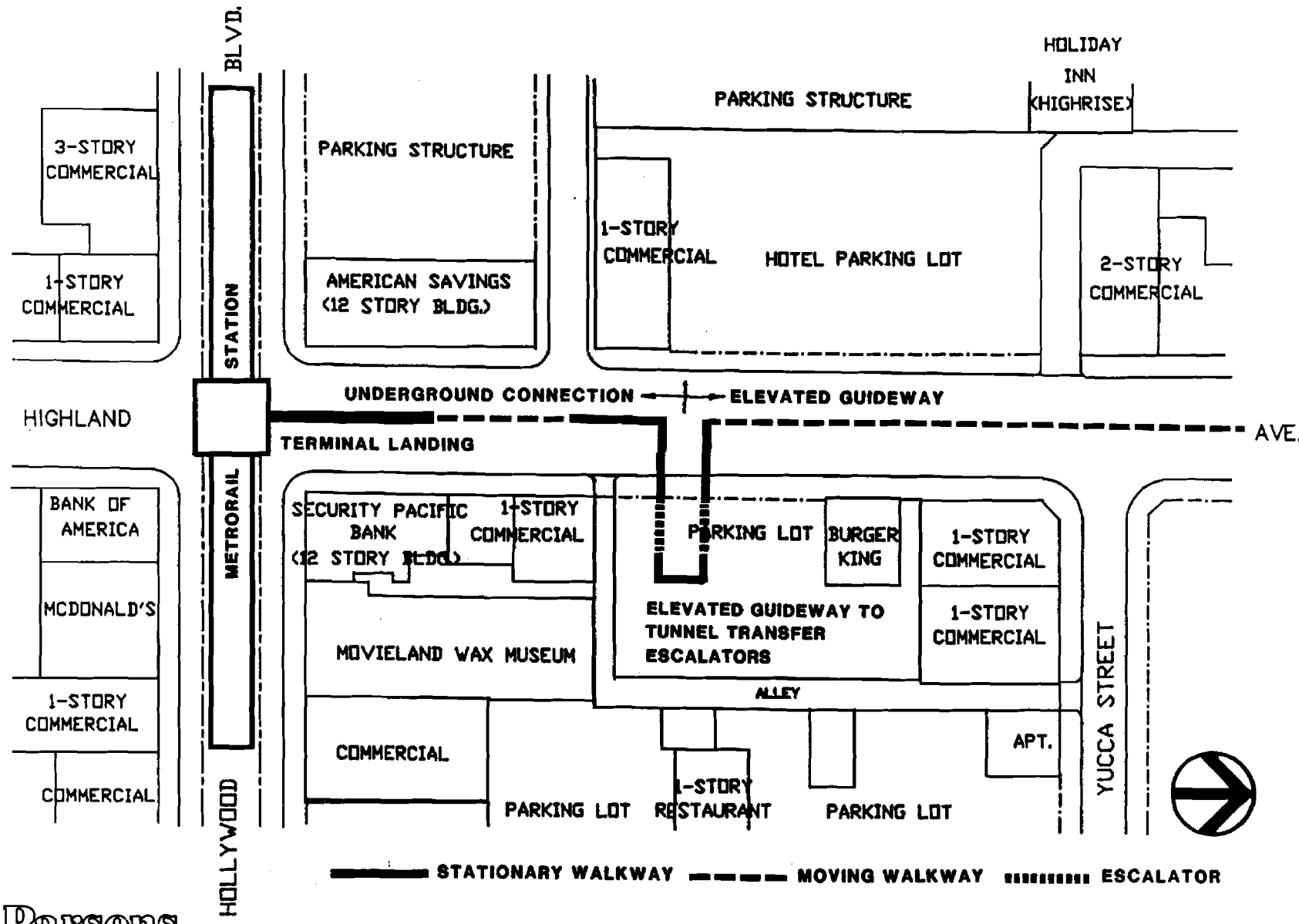

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Figure 7
Elevated Alternative

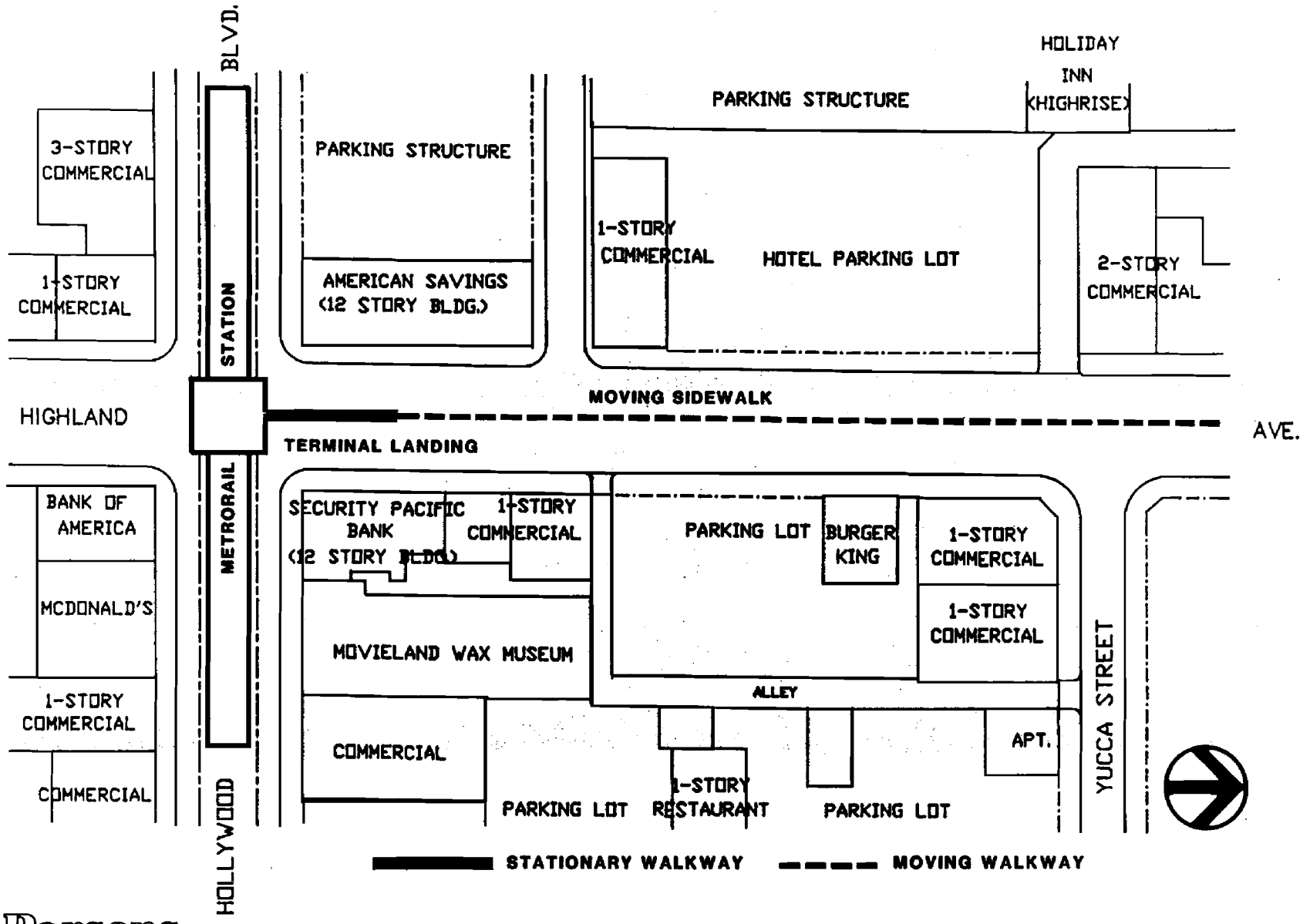

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Figure 8
Underground Alternative

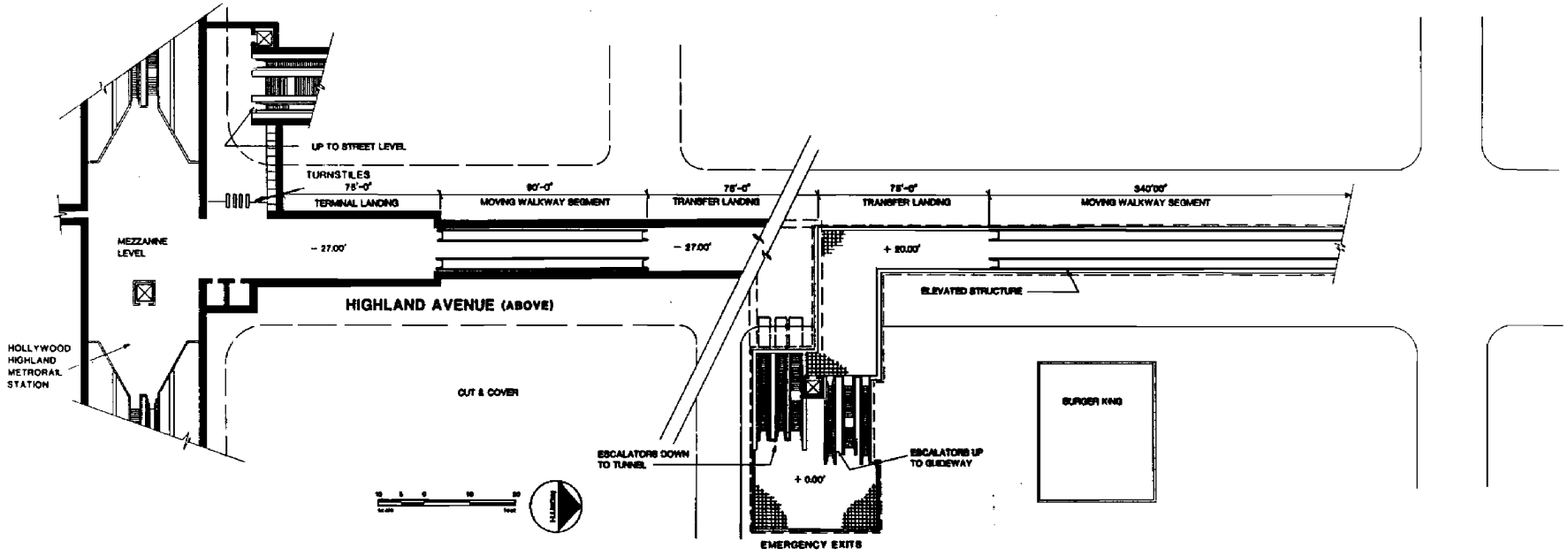

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Figure 9

Metrorail Station Elevated Moving Walkway

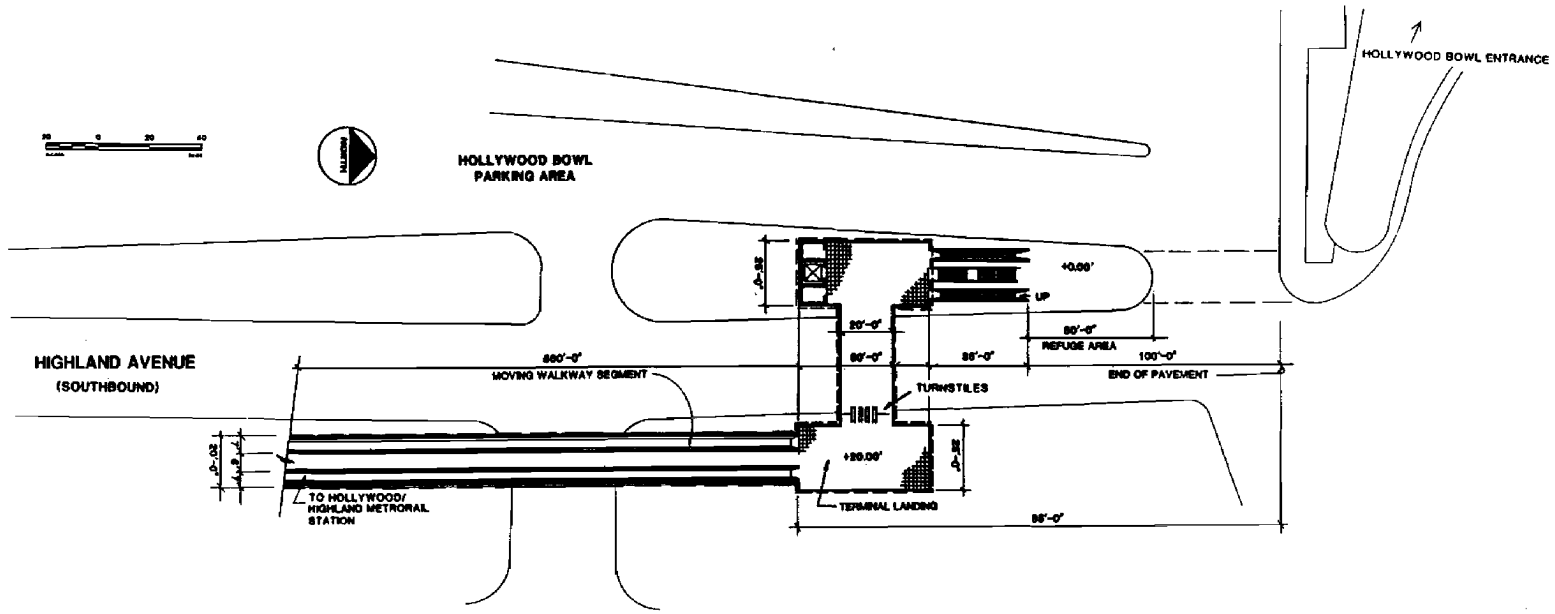

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Figure 10

Hollywood Bowl Station Elevated Moving Walkway

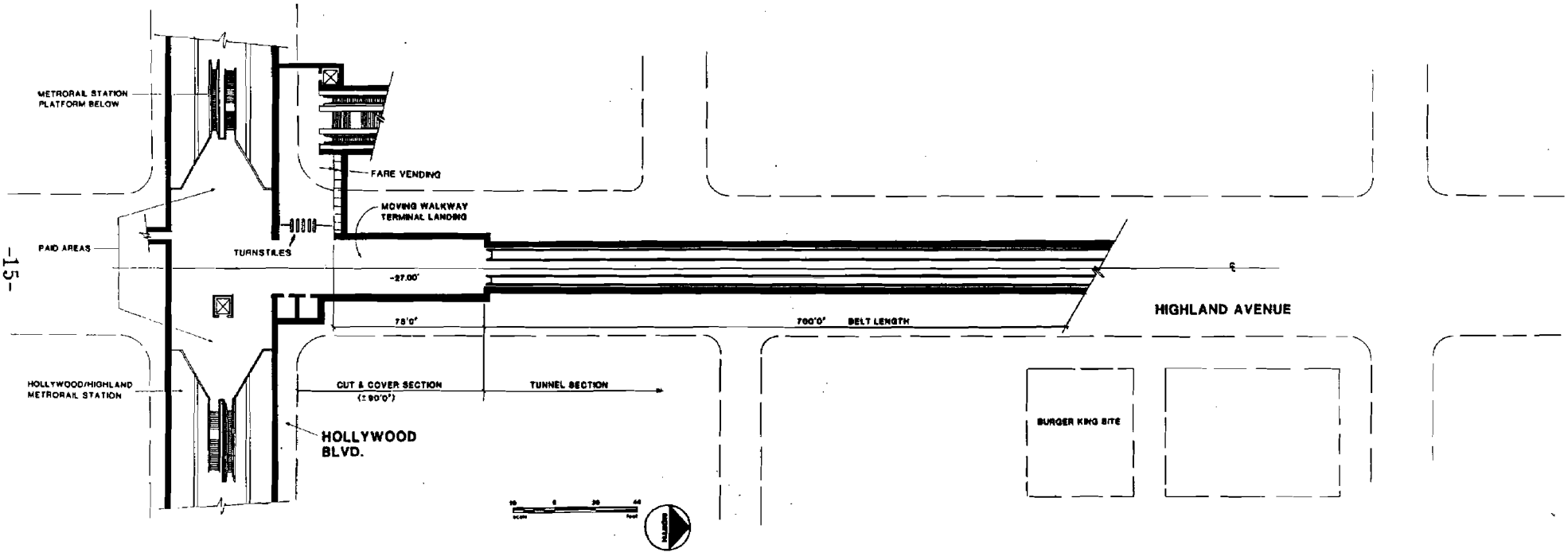

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Figure 11

Metrorail Station Underground Moving Walkway

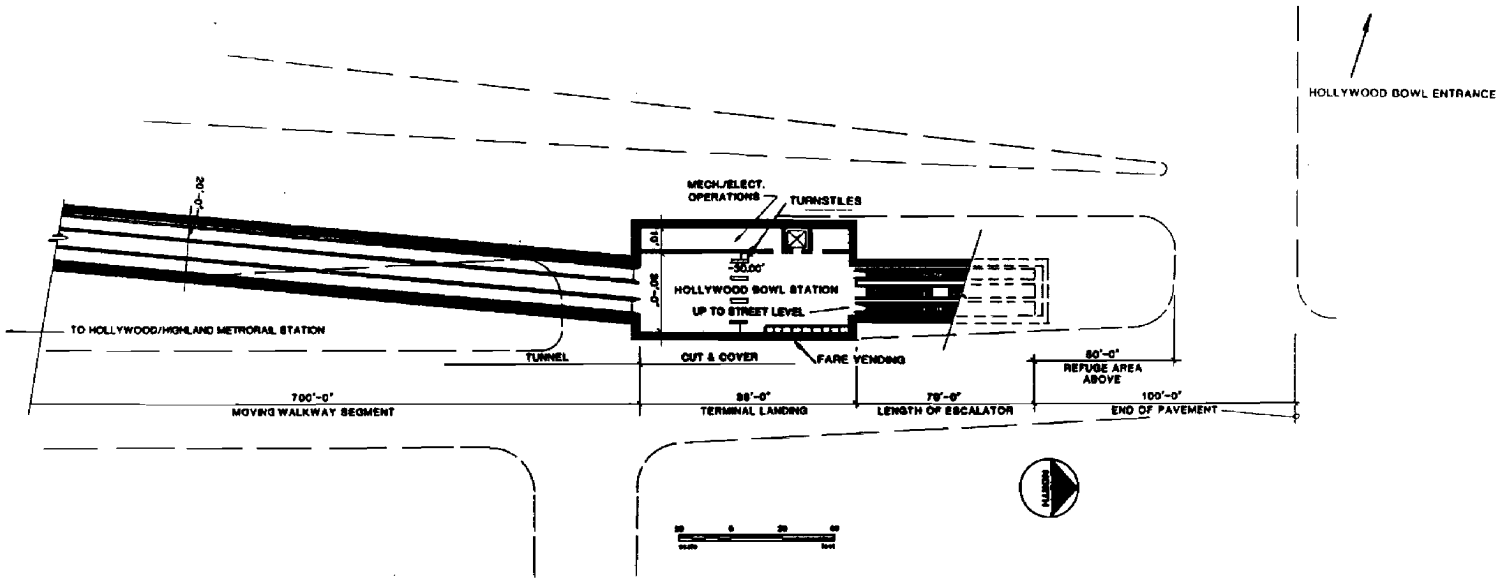

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Figure 12

Hollywood Bowl Station Underground Moving Walkway

Performance

The two alternative moving walkway systems both provide a total system capacity of approximately 16,600 p/h during single direction event operation. The 'stand only' track provides a capacity of 10,000 p/h at a system speed of 120 fpm. The 'walk only' moving walkway track can convey a walking person at a combined speed of 270 fpm providing a system capacity of 6,600 p/h. A comparison of cost and performance data for the two systems are presented in Table 1.

TABLE 1

MOVING WALKWAY PERFORMANCE CHARACTERISTICS

	Total Approximate Cost ($ Million)	Total Distance (LF)	Average Station-to-Station Time (Min.)	Average Speed (fpm)	Event Exiting Time (Min.)*	Percent Travel On Moving System
Elevated	33	3,920	26.5	150	14.5	53
Underground	40	3,590	23.5	153	14.5	80

*Assuming 4,000 people.

The maximum demand on the systems will occur as people exit the Hollywood Bowl at the conclusion of an event. Both moving walkway alternatives could exit approximately 90% of the total Hollywood Bowl capacity in one hour. However, since a significant percent of Hollywood Bowl patrons utilize the park-and-ride system and private vehicles to travel to events, the connector system will not be called on to serve anywhere near such a high percentage. For evaluation purposes, the systems ability to serve 4,000 patrons is analyzed.

The walkway systems can accommodate this demand in 14.5 minutes. The underground system allows a slightly shorter travel time from station-to-station than the elevated

alternative, 23.5 minutes as compared to 26.5 minutes, respectively. The total length of the elevated system is greater than the underground system due to the less direct alignment and the additional transfer between grades connecting to the Metro Rail station. The underground system also provides a greater percentage of moving walkway service, 80% as compared to 53%, respectively. This difference in percent of moving walkway to total system length for each system is due to the greater number and length of walk sections necessary for the elevated alignment around horizontal curvatures. The estimated system cost for the underground alternative is approximately $40 million compared to $34 million for the elevated facility.

III. PEOPLE MOVER ALTERNATIVES

The People Mover alternatives for the Hollywood Bowl connection are based on Automated Guideway Transit (AGT) technologies. AGT systems consist of driverless vehicles which travel along exclusive grade separated guideways. These systems provide full Automatic Train Control (ATC) to manage the operation of the system including controlling the vehicle speeds, headways, stops, and door openings at the stations.

The Hollywood Bowl Connector analysis is focused on people mover systems produced by two manufacturers; Westinghouse Electric Corporation and Universal Mobility, Inc. Selected system characteristics are shown in Table 2. The characteristics of these systems vary considerably, including the areas of vehicles, guideways, operations, and systems costs. The following discussion provides an overview of these two people mover technologies.

UNIVERSAL MOBILITY, INCORPORATED

Universal Mobility, Incorporated (UMI) has specialized in the design and development of AGT systems since 1956. Currently, UMI has designed and installed nine people mover systems in the United States, including 355 vehicles and 14 miles of guideway. The primary application of UMI people movers has been at amusement parks.

The UMI people mover operates on a monorail guideway which can be configured in a single or double guideway and is capable of bidirectional operation.

Vehicle

The Universal Mobility people mover vehicle is smaller than the typical Westinghouse vehicle. Each vehicle can accommodate a design capacity of 37 persons or a crush capacity of 74 persons. This system is designed to operate in individual units or in multi-unit trains.

The UMI vehicle features a body constructed of lightweight fiber reinforced plastics. This construction enables the Universal Mobility vehicles to be lighter and more

TABLE 2

PEOPLE MOVER CHARACTERISTICS

Characteristics	Westinghouse Electric	Universal Mobility
Overall Length	39' 0"	15' 8"
Overall Width	9' 4"	7' 6"
Overall Height	11' 1"	9' 7"
Empty Weight	25,600 lbs.	9,900 lbs.
Total Passenger Area	270 Sq. Ft.	93 Sq. Ft.
Vehicle Design Capacity	108	37
Vehicle Crush Capacity	216	74
Maximum Speed	26 mph	23 mph
Acceleration Rate	3.54 ft/sec^2	3.54 ft/sec^2
Deceleration Rate	3.54 ft/sec^2	3.54 ft/sec^2
Maximum Grade	10%	10%
Station Boarding	Level	Level
Noise for Maximum Speed as measured 50' from centerline	77 dBA	75 dBA

energy efficient than many other systems. The empty weight of a single Universal vehicle is 9,900 pounds.

As shown in Figure 13, a four car train is assumed for comparison purposes.

Guideway

The Universal people mover employs monorail guideway. In the single guideway configuration, the monorail guideway offers a compact spatial envelope to minimize visual intrusion. The guideway provides the horizontal and vertical running surface for train operations and allows attachment of power and control rails in a protected envelope. The guideway is made of structural steel and comprised of straight linear and curved sections. This guideway can accommodate a minimum horizontal radius of 100 feet and minimum vertical radius of 300 feet.

Since the weight of the Universal Mobility vehicle is lighter than most people mover vehicles the guideway can be narrower. Additionally, the guideway's support piers are generally slimmer compared to other systems. Steel or concrete columns can be used to support the guideway with standard spans of up to 75 feet. The use of the all-steel guideway structure facilitates the speed of construction. The guideway can be fabricated off-site and shipped to the project site to be secured to the support piers.

WESTINGHOUSE ELECTRIC CORPORATION

Westinghouse Electric Corporation is a recognized leader in people mover technology and implemented the world's first totally automated guideway transit system. Currently, eleven Westinghouse people mover systems are in operation within the United States and England. The Westinghouse systems have been primarily implemented to provide transit service at airports. Figure 14 shows the Westinghouse system at Miami International Airport.

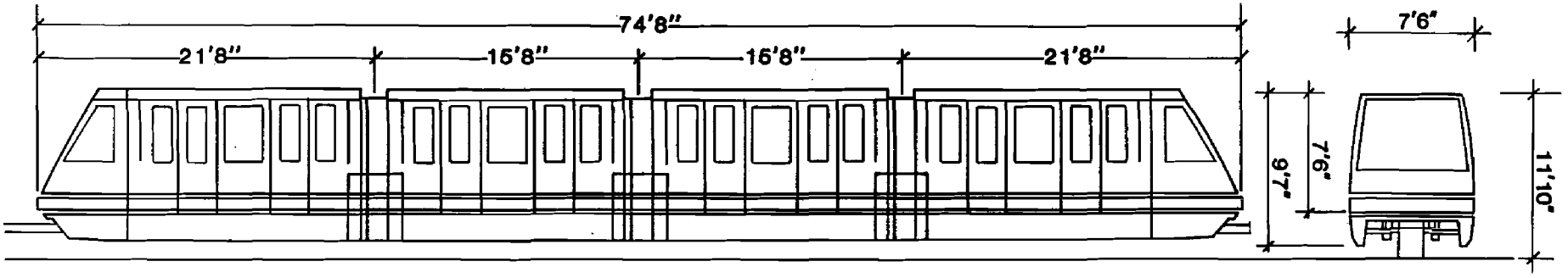

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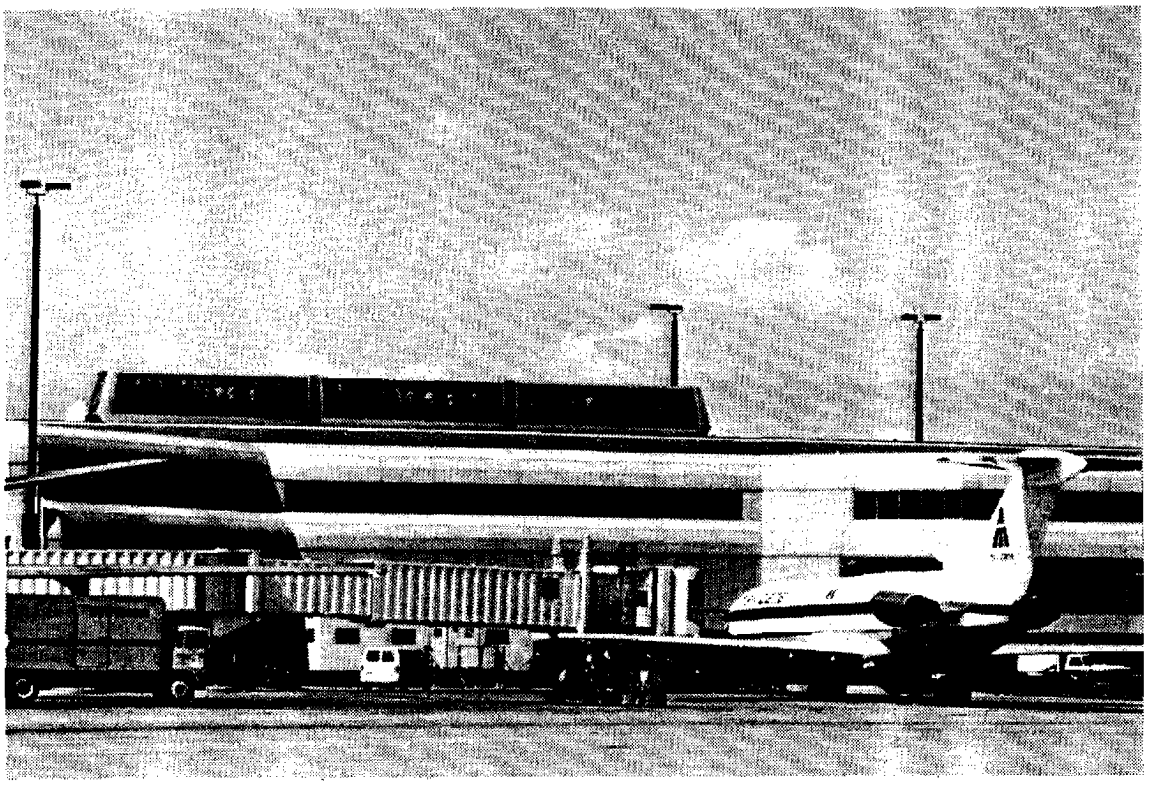
Figure 13

Universal People Mover



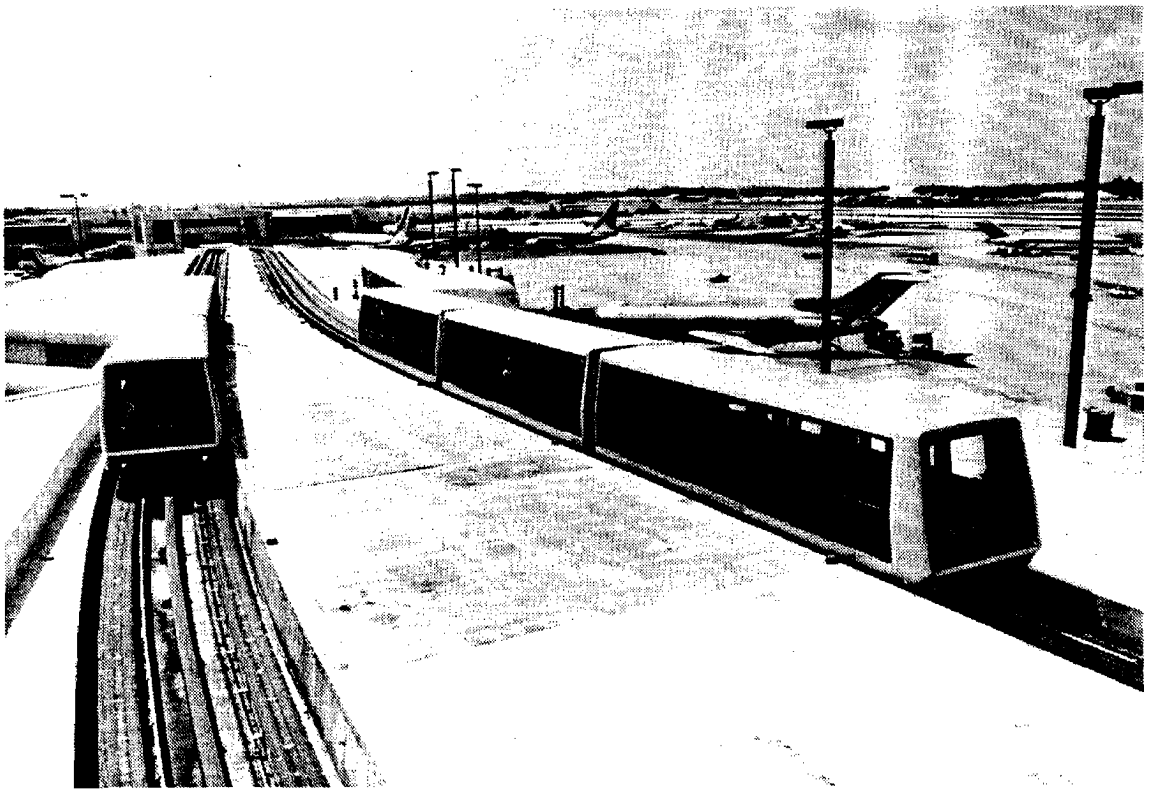


Figure 14

WESTINGHOUSE PEOPLE MOVER

Miami International Airport

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Vehicle

The Westinghouse standard size C-100 people mover vehicle is used for this analysis. This vehicle is more than twice the length of the Universal Mobility vehicle. The design capacity of the Westinghouse C-100 vehicle is 108 persons. The crush capacity is 216 persons.

The Westinghouse vehicle is primarily made of aluminum to minimize weight and resist corrosion. The empty weight of the C-100 vehicle is 25,600 pounds.

To provide transit service for the Hollywood Bowl connection, the Westinghouse people mover would be operated in two-car trains, as shown in Figure 15.

Guideway

The guideway consists of the support structure, a steel guide beam, the concrete running surface, and the power distribution system. The Westinghouse system affords a wide variety of guideway support structures which may be used to achieve the desired architectural treatment. Elevated guideway structures can be designed using concrete or steel beams and columns.

ELEVATED PEOPLE MOVER ALTERNATIVES

Description

The elevated people mover alternative for the Hollywood Bowl connector would be accommodated within the right-of-way of Highland Avenue. The elevated guideway would be placed within the street and generally follow the centerline alignment of Highland Avenue. Figure 16 shows the typical sections of the Westinghouse Electric and Universal Mobility elevated double tracked guideways.

Since the Universal Mobility people mover is smaller and lighter than the Westinghouse system, its guideway and physical requirements are less pronounced. Both guideways would provide a minimum 15 foot vertical clearance over the roadway. The guideway elevation for the Universal and Westinghouse people movers would be minimally 19'3"

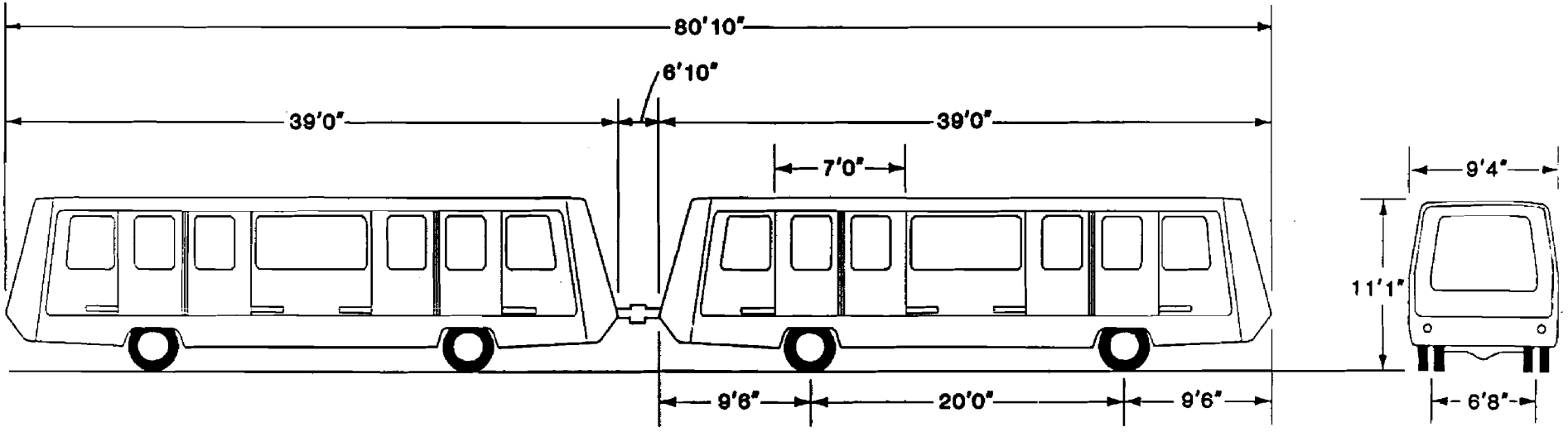

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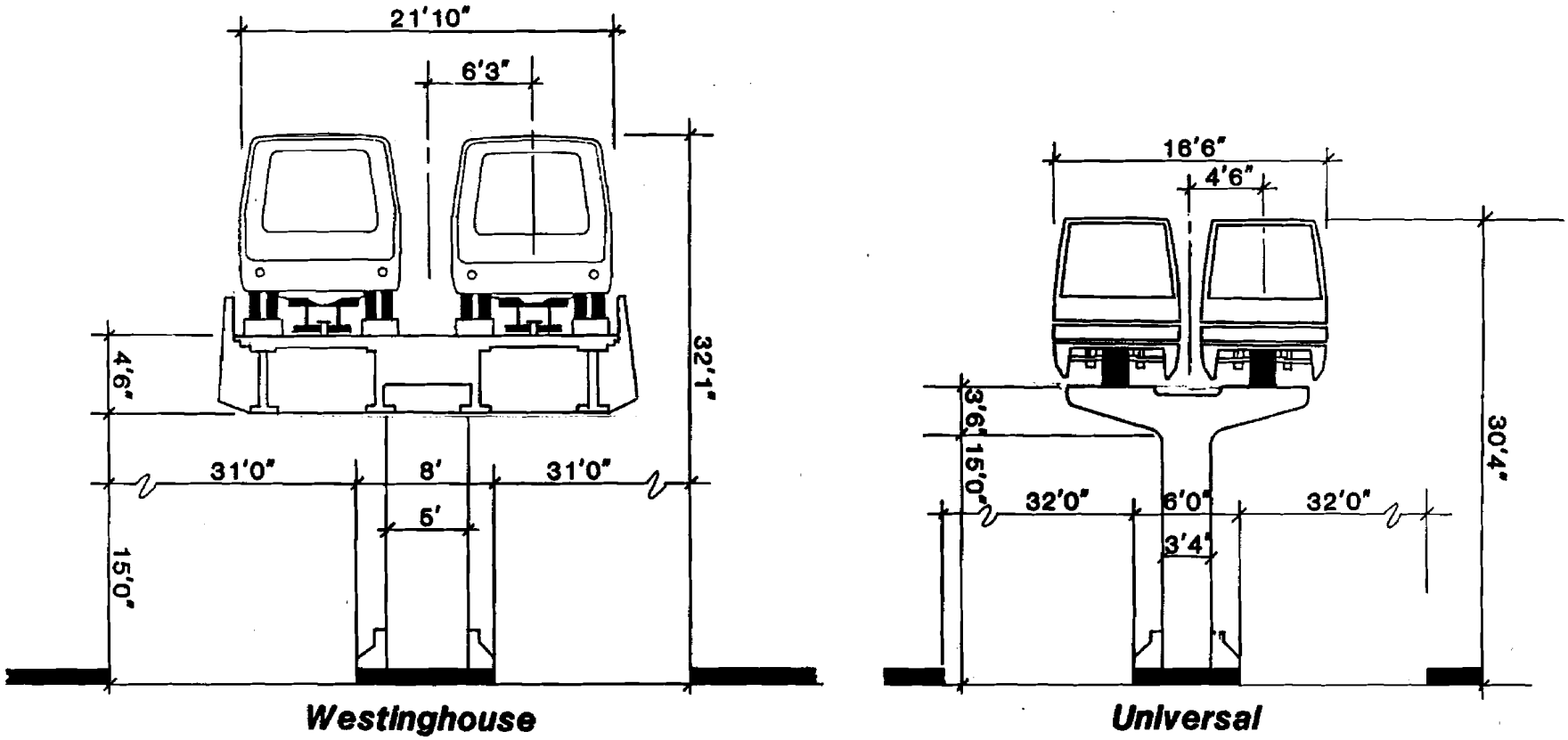
Figure 15

Westinghouse People Mover



HIGHLAND AVENUE
TYPICAL SECTION

Parsons Brinckerhoff

Figure 16
Elevated People Mover

and 21', respectively, above street grade. Renderings are provided to illustrate these elevated guideway options as shown in Figures 17 and 18.

The alignment and profile of the elevated connector is shown in Figures 19 and 20. To reduce right-of-way requirements of a loop, the system utilizes a "pinched loop" concept which provides a switch at each end to allow the trains to change direction for the return trip. Figure 21 illustrates the operation of the pinched loop.

As the train approaches the station travelling south on the western guideway, the people mover will transition from the double guideway into a single guideway. From this point, the train pulls into the station to allow passenger boarding or alighting. The people mover leaves the station by reversing direction and proceeds north along the same track. At the switch, the people mover transfers to the eastern guideway of the double guideway segment proceeding north to the Hollywood Bowl. The switch operation is performed in the same manner as the northern end.

Near the southern station is a second switch located in the single guideway segment. This switch directs the people movers into the station or into the spur segment of the guideway. In normal operation, the switch will be positioned to direct the trains into the station. However, should a train become disabled, the spur would be used for the temporary storage of the vehicle while operations on the line continue uninterrupted.

At the northern end of the system beyond the station, a maintenance/operations facility is conceptually located within the confines of the Hollywood Bowl's parking area. This facility would be an integral element in the successful operation of the people mover. This site can support the maintenance shop, the control center for the operation of automated train control systems, and the traction power systems.

Conceptually, this maintenance facility should be designed to accommodate the following functions: scheduled maintenance, corrective maintenance, component testing and repair, parts storage, and vehicle cleaning. To support these functions, the maintenance facility would have working pits that can handle the entire length of a train, electrical and machine shops, storage areas, and personnel and office spaces.

Other system requirements include auxiliary power and lighting, communications, and elevators at stations to meet accessibility requirements. Emergency facilities include the provision of "blue light" stations, emergency access, and tunnel crossovers. A blue

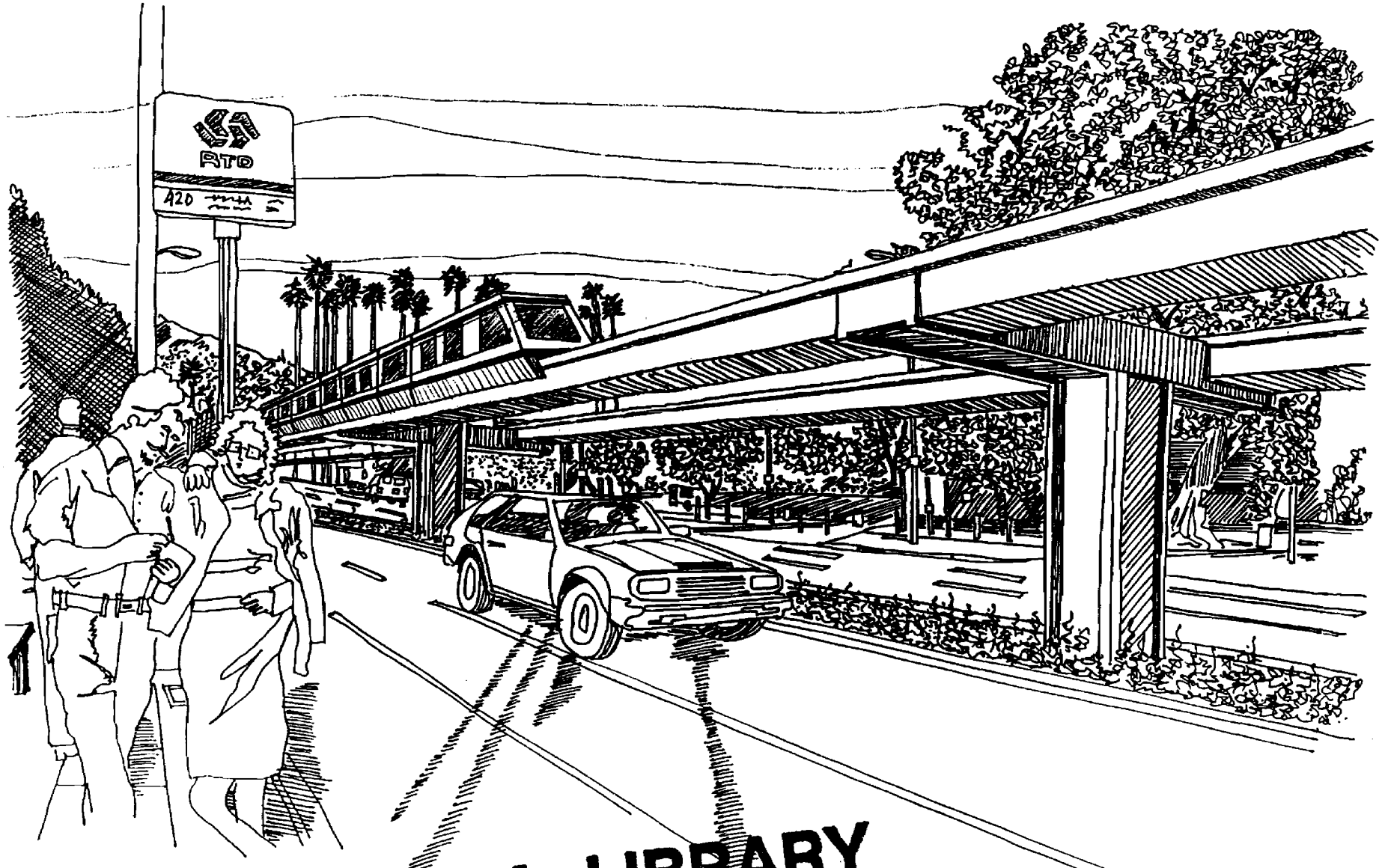


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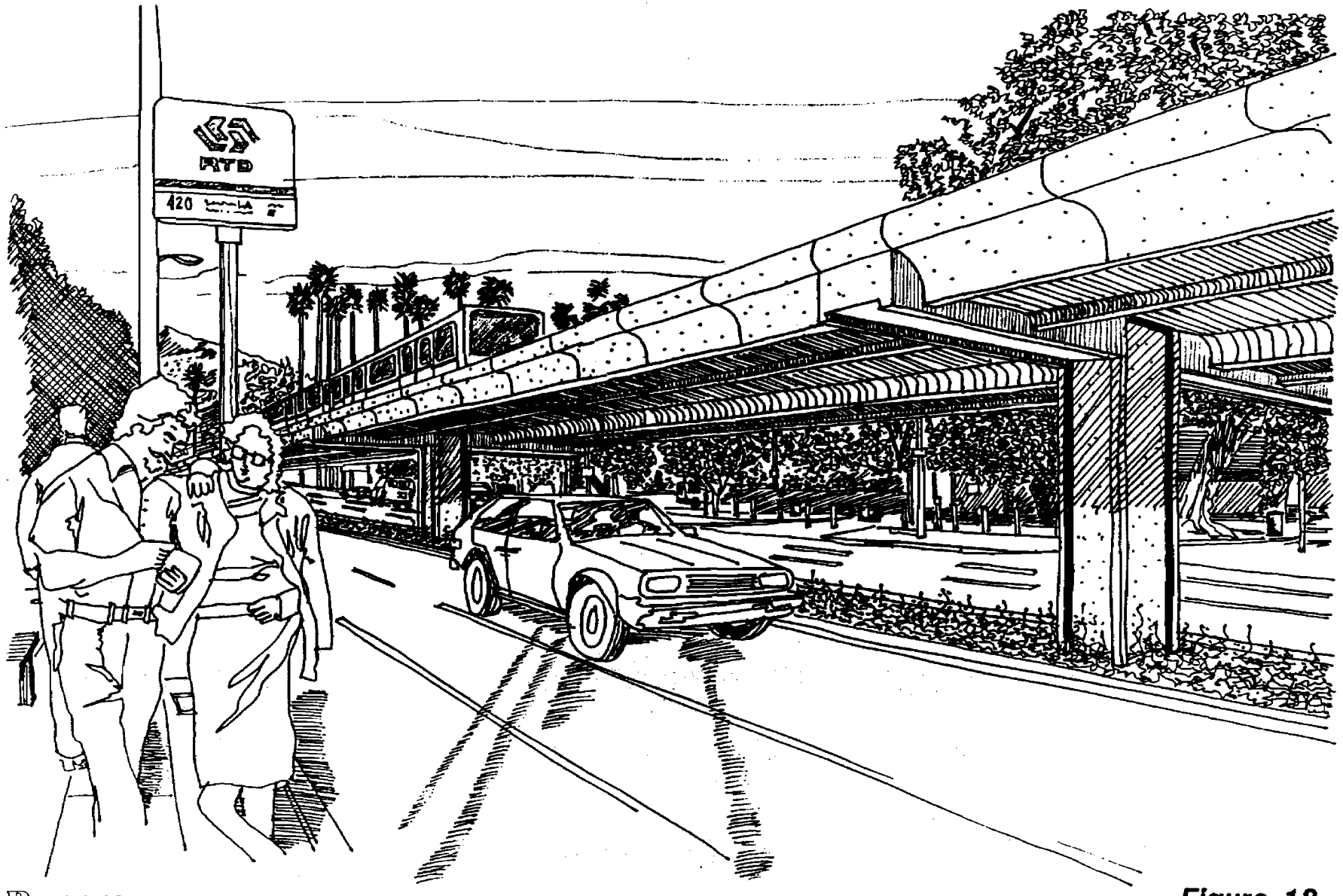
Figure 17

Universal Elevated People Mover



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Brinckerhoff

Figure 18

Westinghouse Elevated People Mover

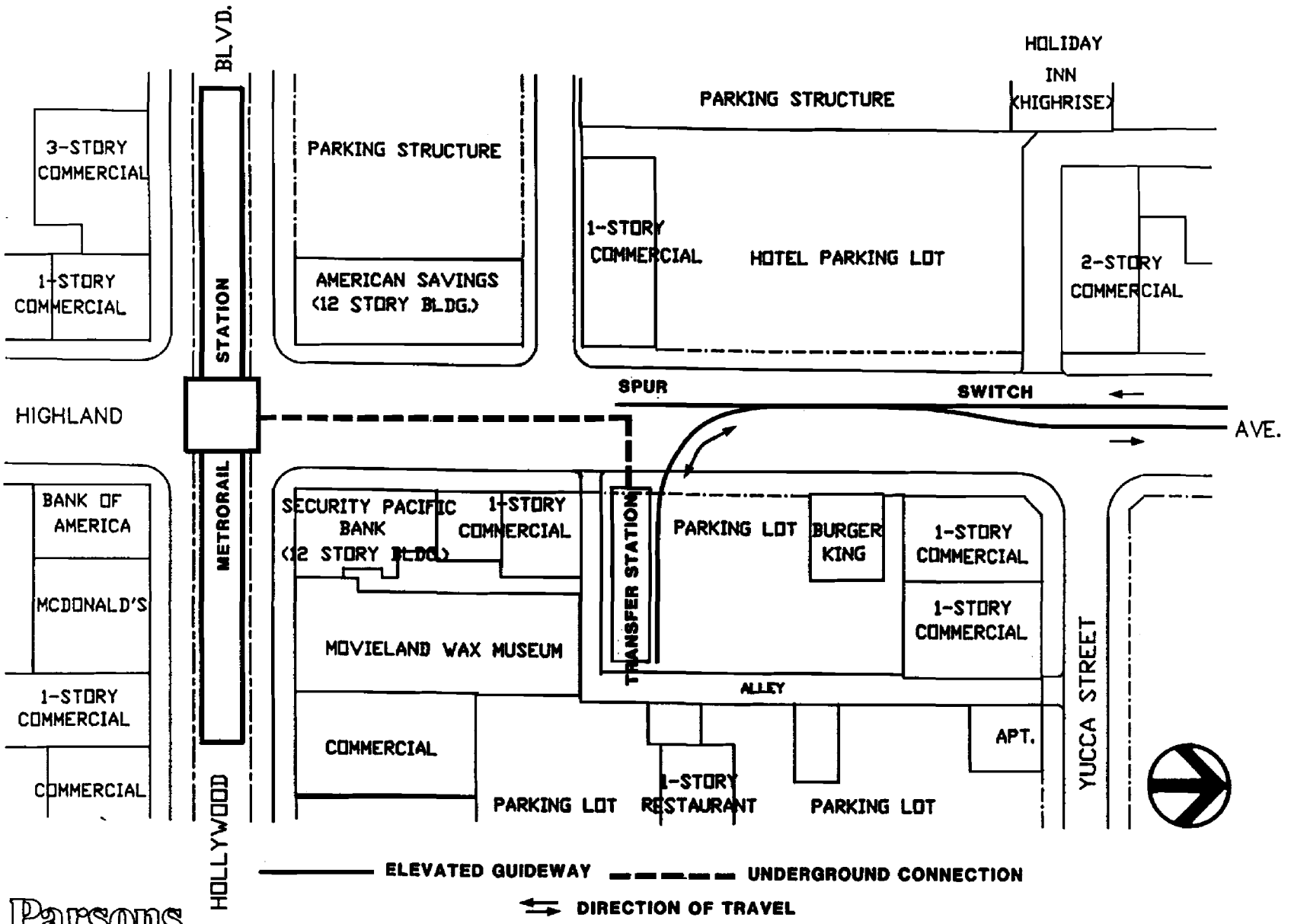

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Figure 21
Elevated People Mover

light station is a emergency facility equipped with a telephone connected to the operation center, a traction power emergency disconnect device, and information which identifies the route and location of access points. The blue light identifies this facility as an emergency station.

On elevated guideways, "blue light" stations should be provided at 800 foot intervals. For the underground people mover, emergency access to ground level should be spaced so that the distance to an emergency exit does not exceed 1,250 feet. A blue light station shall be provided at each emergency exit. Also, crossovers to parallel tunnels should be provided at 800 foot intervals.

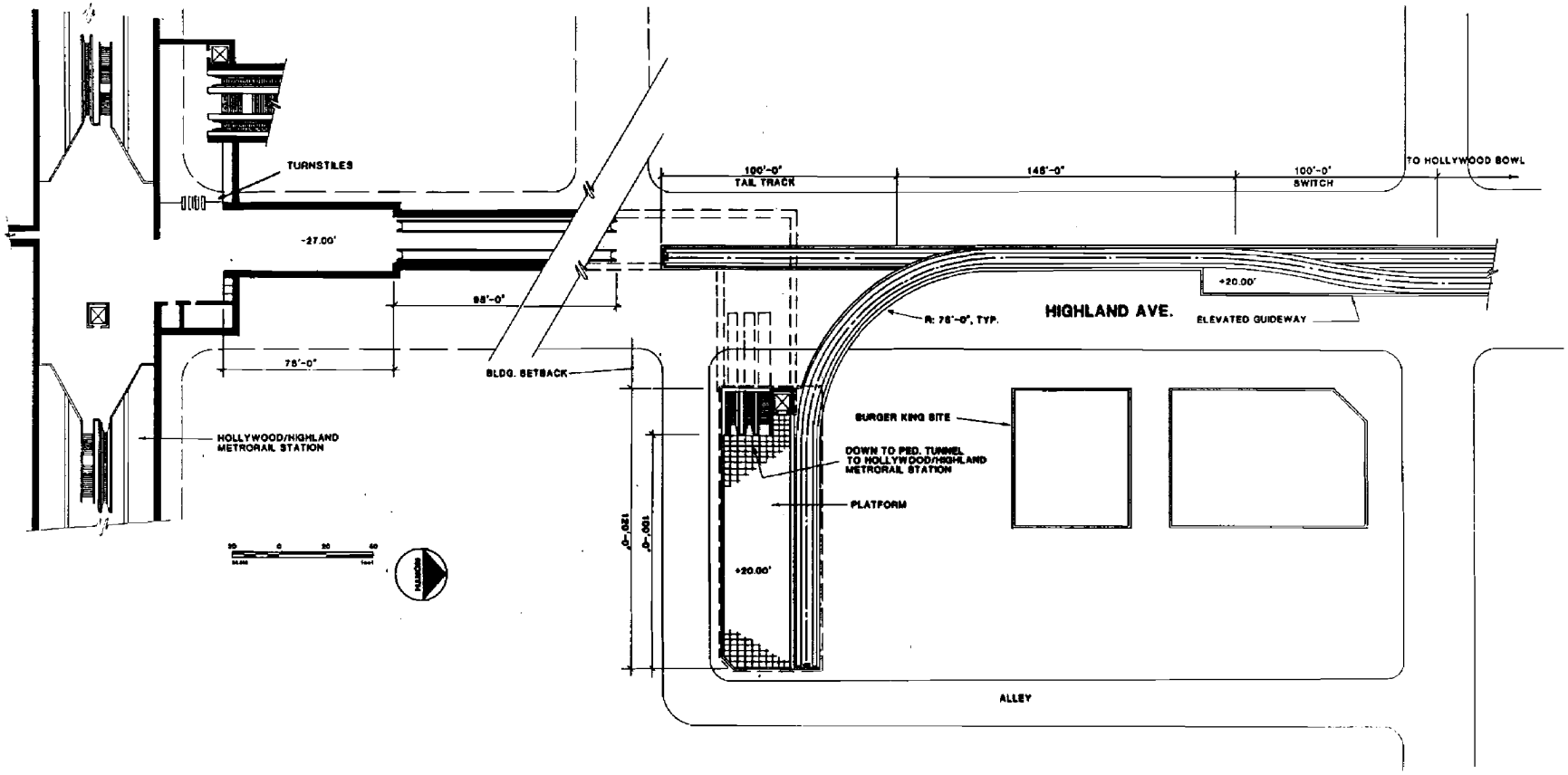
Operations

Patrons attending a performance at the Bowl would use this system directly from the Hollywood/Highland Metro Rail station as shown in Figure 22. An underground connection between Metro Rail and the elevated guideway transfer station is provided. At the transfer station, the patrons would transition from the underground level to the elevated platform level. From this location, the people mover would transport passengers to the Hollywood Bowl station which is located near the entrance to the pedestrian undercrossing as indicated by Figure 23. Descending the station platform, the passengers arrive at the Hollywood Bowl Entrance. The reverse operation would be used to return to the Metro Rail station.

Performance

The Westinghouse alternative for the elevated people mover connection would utilize three two-car trains to provide service to the Hollywood Bowl. The minimum headway for this three train system is 2 minutes 10 seconds, which provides a theoretical capacity of 9,100 passenger per hour based upon two-car trains. The average system speed is 24 miles per hour and the time required to complete a single round trip is less than 6.5 minutes.

The Universal Mobility system would utilize three four-car trains to service this connection. The operating speed of this system is slightly less than the Westinghouse system with an average system speed of 20 miles per hour. This yields a minimum



Parsons Brinckerhoff

Figure 22

Metrorail Station Elevated People Mover

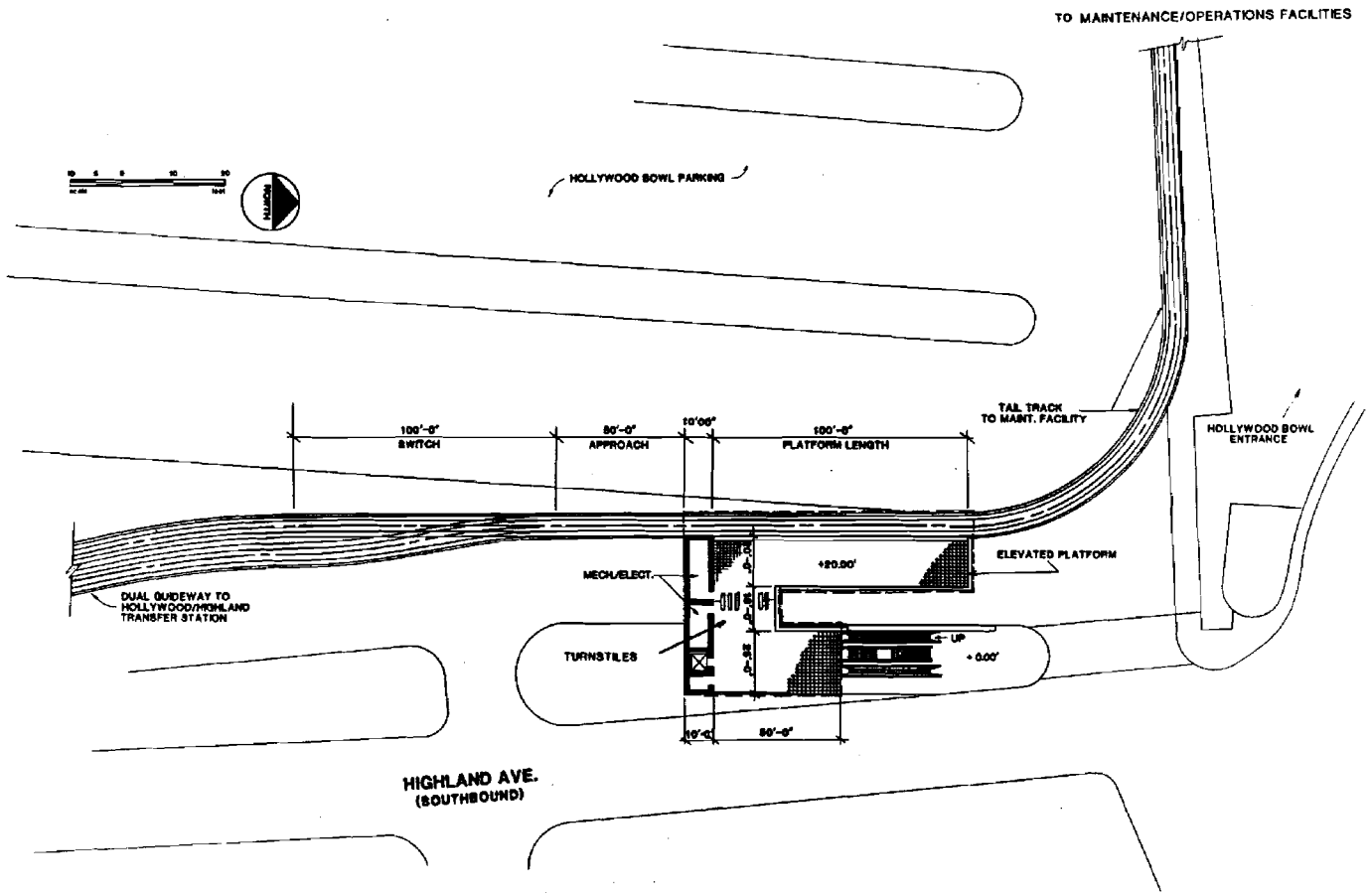


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Figure 23

Hollywood Bowl Station Elevated People Mover

headway of 2 minutes 20 seconds and a system capacity of 5,800 passengers per hour. A single round trip would require nearly 7 minutes to complete.

Based upon these system characteristics, the Westinghouse people mover system could accommodate 51% of the Bowl's capacity in one hour. The Universal Mobility system would be able to transport 32% of the Bowl's capacity during the same period. The travel time between the Hollywood Bowl people mover station and the Hollywood/ Highland Metro Rail station would be 10 minutes 34 seconds for the Westinghouse system and 10 minutes 58 seconds for the Universal system.

For evaluation purposes, each system's ability to provide service to 4,000 patrons has been compared. The heaviest demand will occur at the conclusion of an event when the majority of the persons desiring to use the system arrives within a short interval. The Westinghouse people mover can clear the 4,000 person demand from the Bowl in 26.4 minutes. With the lower system capacity of the Universal system, the time to clear the demand at the Bowl would be 41.4 minutes.

The cost of these elevated people mover systems was estimated to be $26 million and $47 million for the Universal Mobility and Westinghouse systems, respectively. The Universal system could be significantly less expensive, compared to the Westinghouse people mover. Since the Universal vehicles are smaller and lighter, its aerial guideway can be very compact and can utilize an all-steel construction. Also guideway can be fabricated at a remote location and shipped to the site for installation. However, the Universal people mover does not have the equivalent capacity of the Westinghouse system in this operating configuration. An additional car could be added to each train to increase the capacity and the system would still be significantly less expensive than the Westinghouse system.

A summary of the performance characteristics for the elevated people mover connectors is provided in Table 3.

UNDERGROUND PEOPLE MOVER ALTERNATIVES

Description

The underground alignment would be constructed primarily using tunnel technology. The system would be composed of two standard Metro Rail 18 foot diameter bored

TABLE 3

ELEVATED PEOPLE MOVER
PERFORMANCE CHARACTERISTICS

System Performance	Westinghouse Electric	Universal Mobility
Theoretical Capacity	9,100 pass/hr	5,800 pass/hr
Theoretical Headway	2 min 10 sec	2 min 20 sec
Traveling Unit	2-car train	4-car train
Number of Trains	3	3
Theoretical System Speed	24 mph	20 mph
Round Trip Time	6 min 22 sec	6 min 56 sec
% of Bowl Capacity Served in 1 Hour	51%	32%
Event Exiting Time (Assuming 4,000 pass.)	26 min 22 sec	41 min 23 sec
Travel Time (Metro Rail Station to Hollywood Bowl Station)	10 min 34 sec	10 min 58 sec
Costs ($ Millions)	47	26

tunnels, as shown in Figure 24. At the stations, cut-and-cover construction would be utilized (Figure 25 depicts the typical underground station configuration).

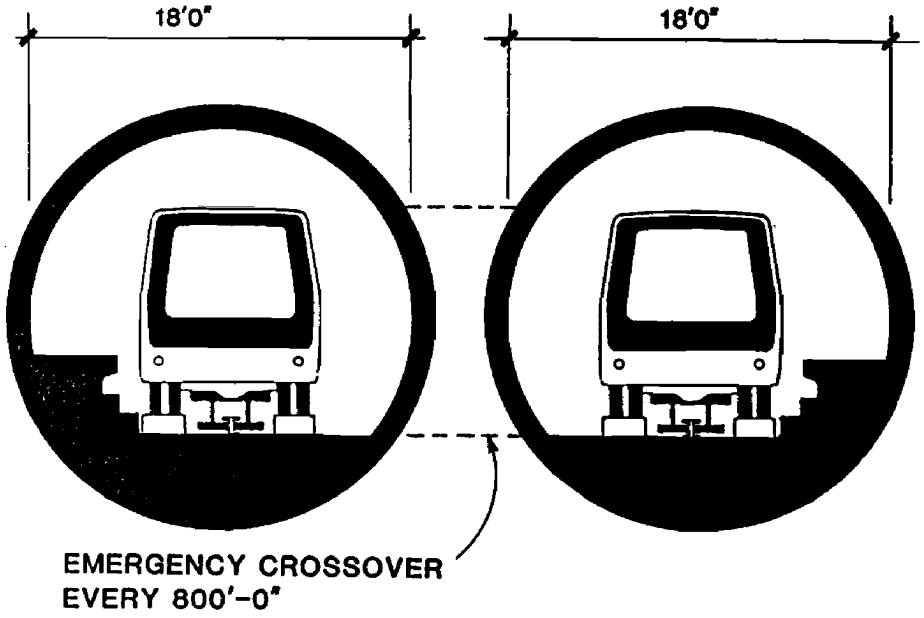
Since an underground alignment is not confined to the street right-of-way, the system was laid out to maximize the efficiency of the system. Generally, the system is laid out in two reversing curves as shown in Figure 26. The underground alignment allows the people mover station to be located closer to the Metro Rail station. (The underground profile is presented in Figure 20.)

At the southern end, the platform elevation of the people mover coincides with the platform elevation of the Metro Rail system. The floor elevation of the tunnels are minimally 40 feet below street grade. Additional depth is shown provided above the system as the alignment veers out of the street alignment and below private structures. Near the system's midpoint, the alignment returns to the street right-of-way and the profile grade is increased to minimize the depth below the Hollywood Bowl at the station.

Special consideration was given to the maintenance facility for the underground alternative. Ideally, a maintenance facility should be located at grade to provide convenient access to vehicles. However, in this case, it would not be practical or economical to construct the maintenance facility at the surface. Consequently, the maintenance/operations facility for the underground alignment would be located below grade. The service bays and shop areas would be located at track elevation, while other functions can be located on the level(s) above. This subterranean maintenance facility concept is used within the Seattle-Tacoma International Airport and the Atlanta Hartsfield International Airport and is depicted in Figure 27.

Deliveries are lowered to the facility using a ten foot square industrial elevator. Larger commodities are lowered or removed by crane from the site through an access vault which is normally covered by detachable concrete plates.

For public safety, tunnel crossovers would be provided at intervals of approximately 800 feet to allow emergency passage into the adjoining tunnel. Additionally, emergency access to the surface would be provided at 1,250 foot intervals. Therefore, in addition to the stations, it will be necessary to provide two emergency access stair shafts within this underground system.



TYP. SECTION
THRU BORED TUNNELS

UNIVERSAL
OPERATION CHARACTERISTICS

Power: Electric
Travelling Unit: 4-car Train
Vehicle Design Capacity: 37
Vehicle Crush Capacity: 74
System Capacity: 6,000 passengers/hour
No. of Trains: 3
Headway: 2 Minutes
Average System Speed: 20 mph

WESTINGHOUSE
OPERATION CHARACTERISTICS

Power: Electric
Travelling Unit: 2-car Train
Vehicle Design Capacity: 108
Vehicle Crush Capacity: 216
System Capacity: 9,700 passengers/hour
No. of Trains: 3
Headway: 2 Minutes
Average System Speed: 24 mph

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Figure 24

Underground People Mover

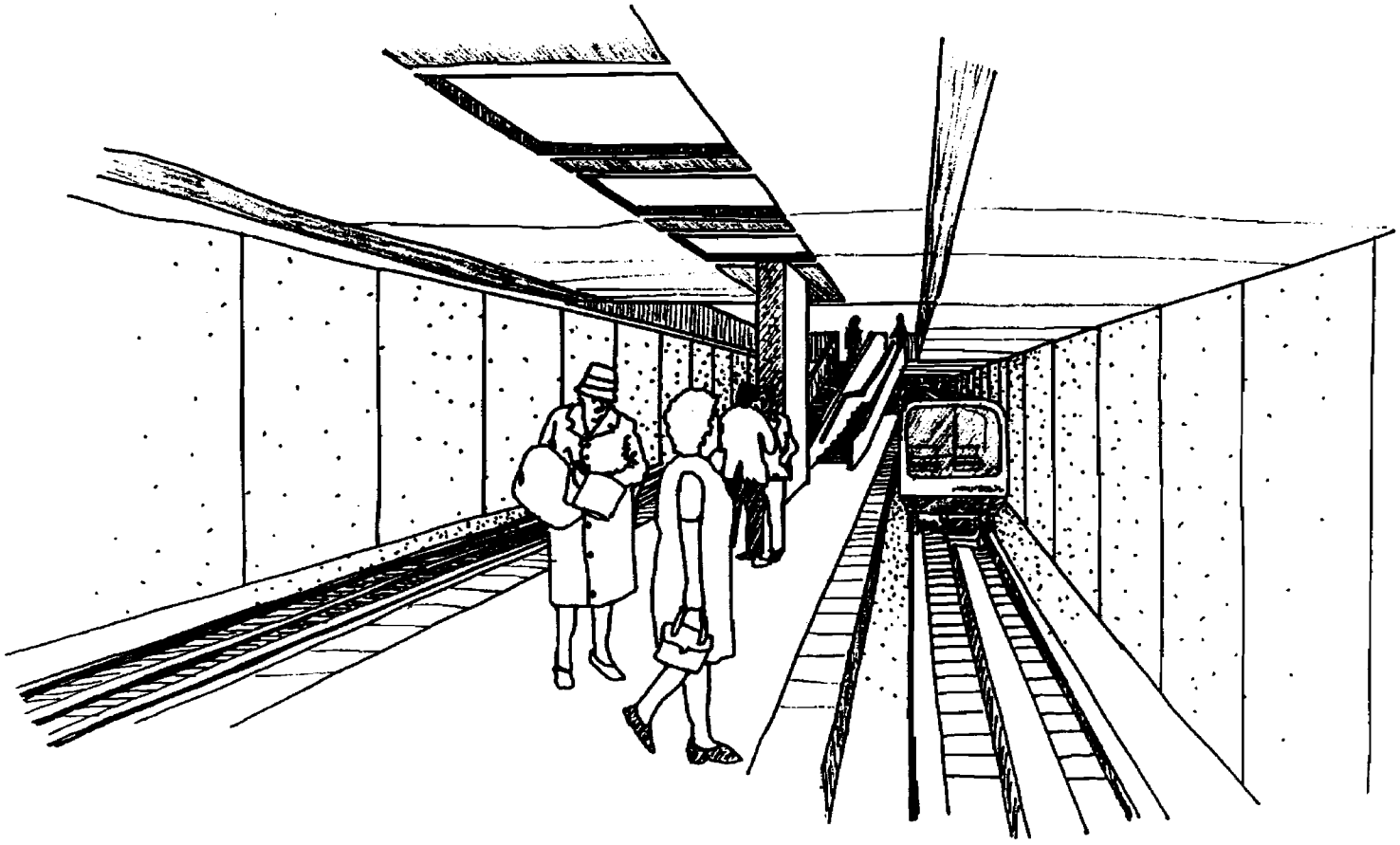

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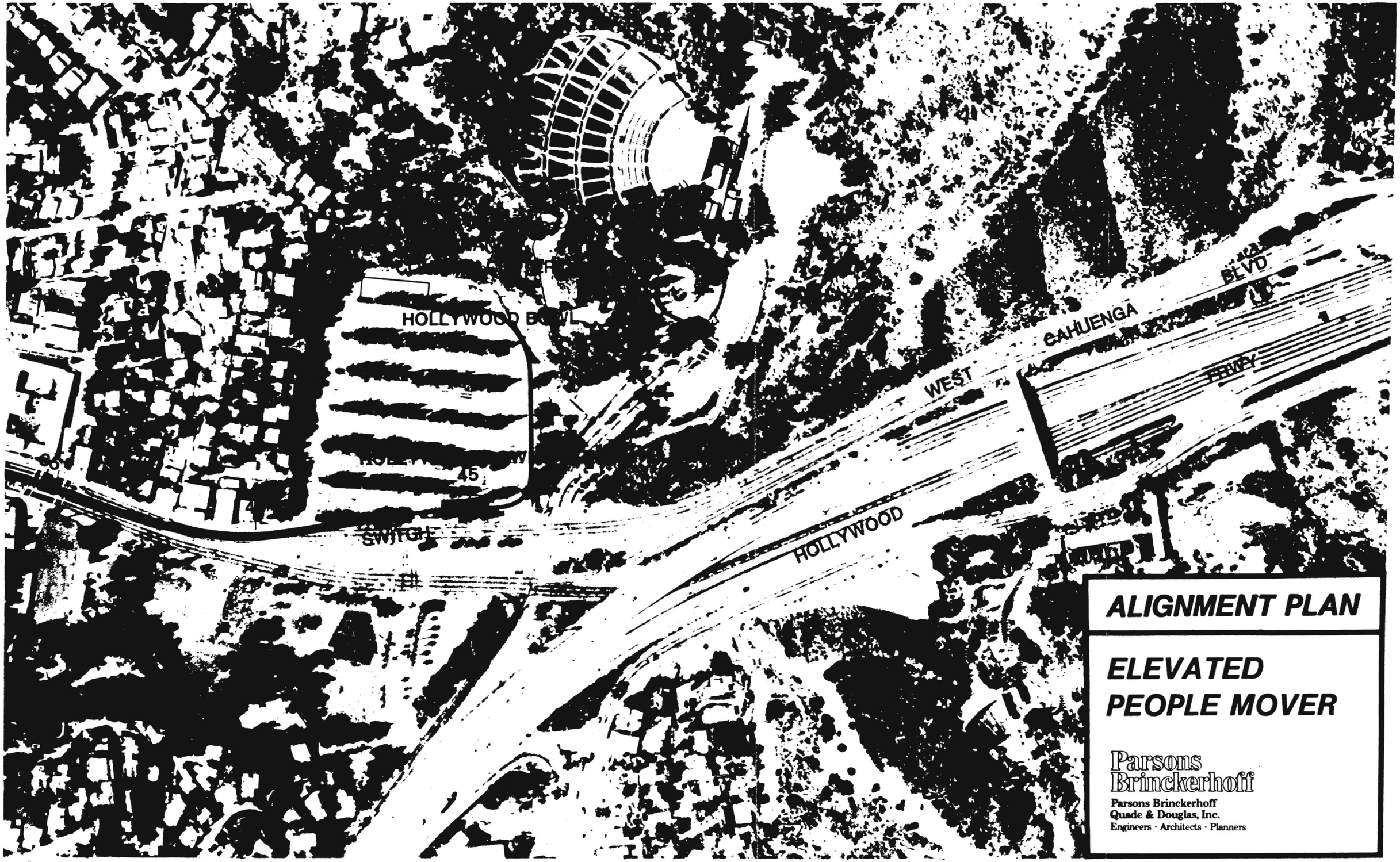
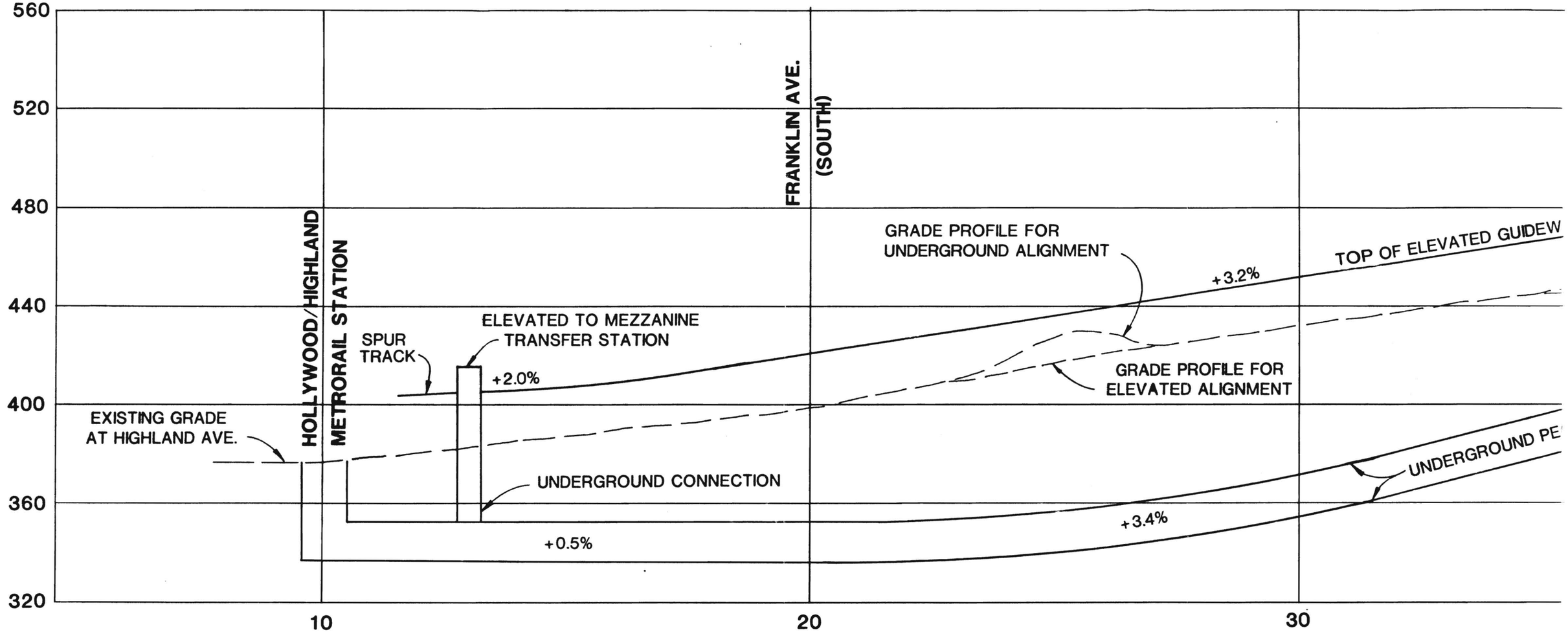
Figure 25
Underground People Mover


MTA LIBRARY
HIGHLAND
SPUR
SWITCH
15
20
30
AVE
LAS PALMAS
AVE
NORTH
1"=200'
200
0
20
scale
feet

Figure 19


HOLLYWOOD BOWL
CAHUENGA
BLVD
FRWY
WEST
HOLLYWOOD
45
SWITCH
ALIGNMENT PLAN
ELEVATED
PEOPLE MOVER
Parsons
Brinckerhoff
Parsons Brinckerhoff
Quade & Douglas, Inc.
Engineers · Architects · Planners



PEOPLE MOVER

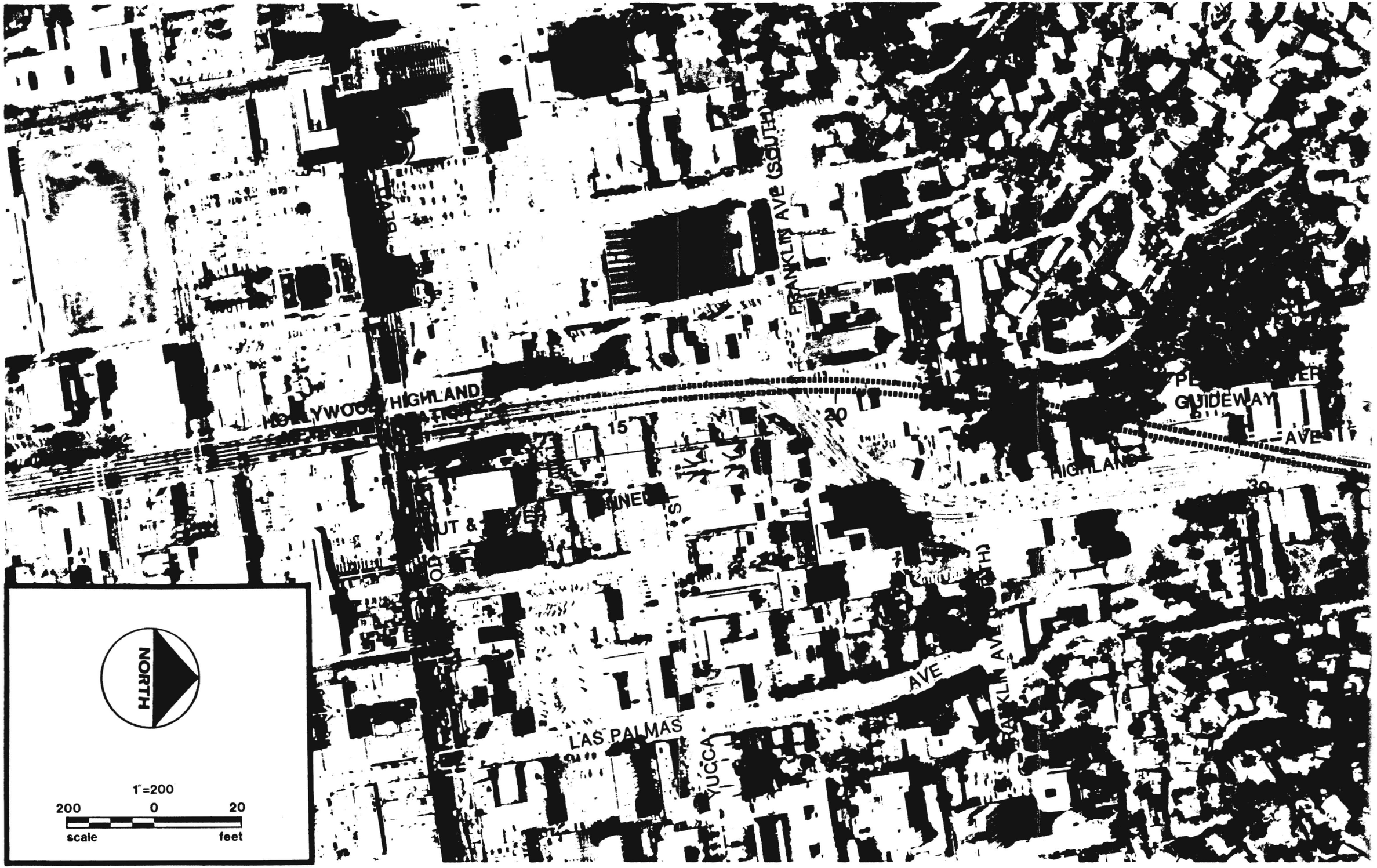
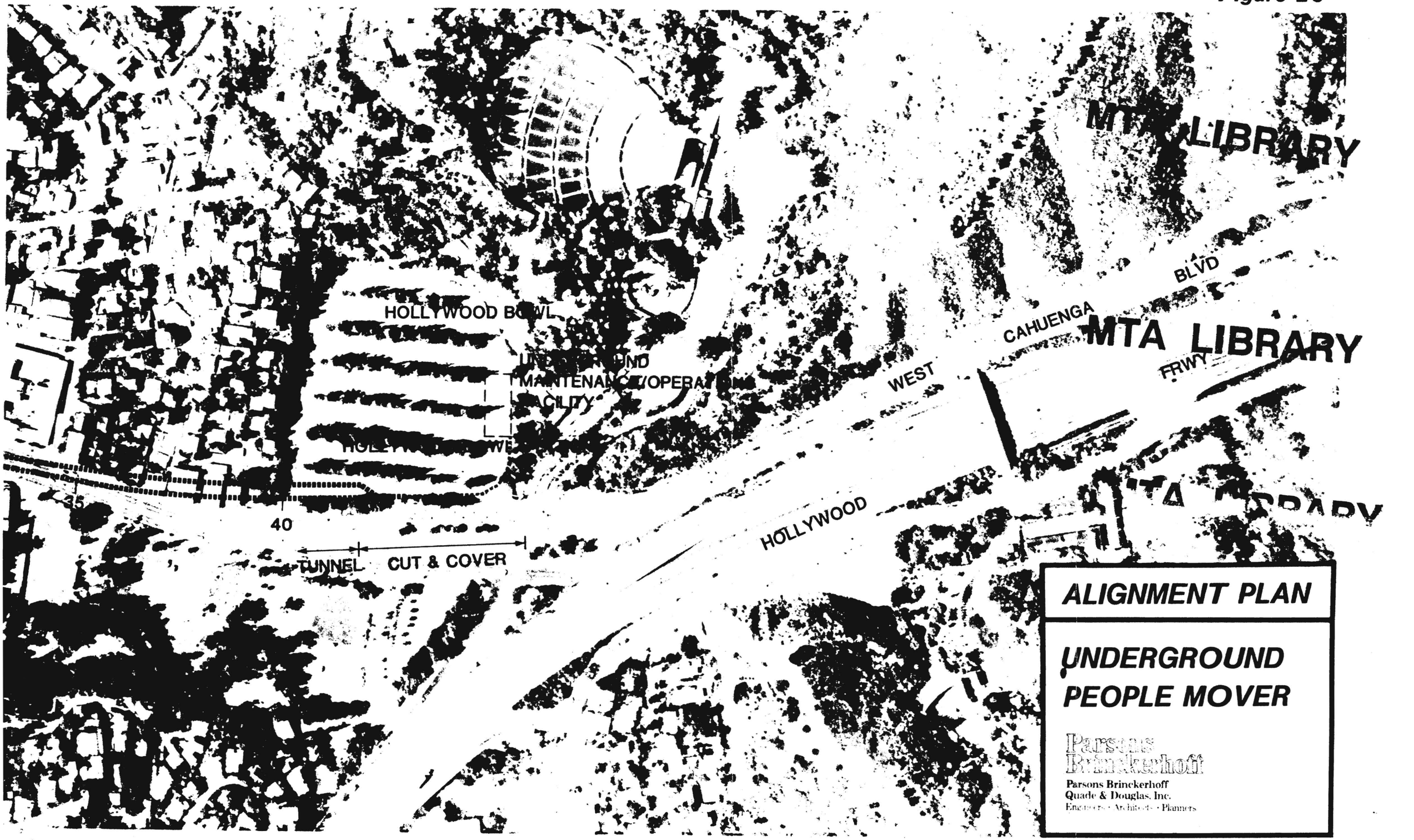

HOLLYWOOD
HIGHLAND
FRANKLIN AVE (SOUTH)
HIGHLAND AVE
GUIDEWAY
LAS PALMAS
YUCCA
AVE
15
20
30
NORTH
1"=200
200
0
20
scale
feet

Figure 26



ALIGNMENT PLAN

UNDERGROUND PEOPLE MOVER

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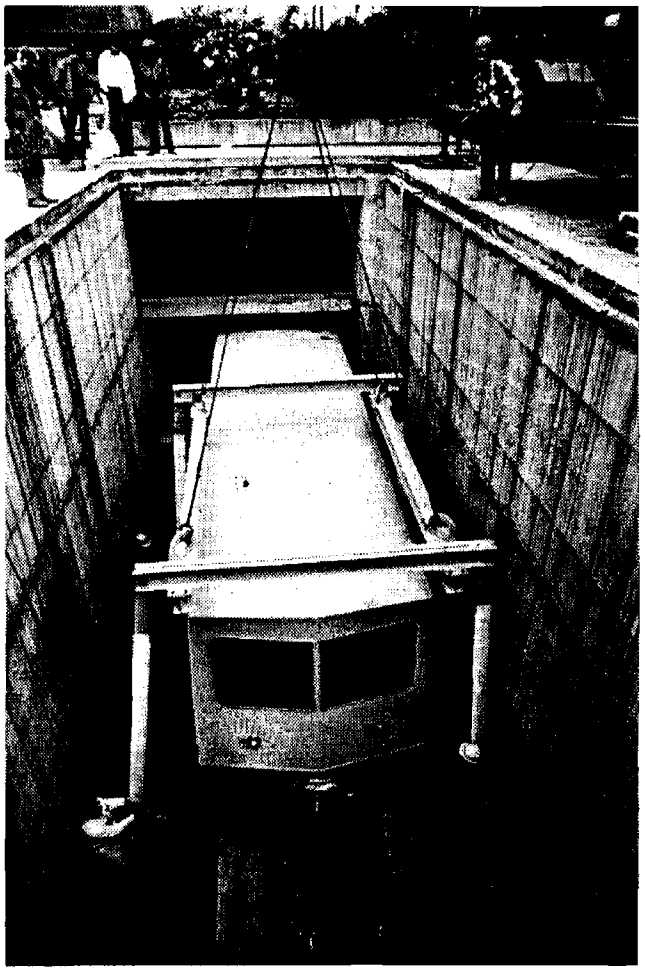

Figure 27

Parsons Brinckerhoff

UNDERGROUND MAINTENANCE FACILITY
Seattle-Tacoma International Airport

Operations

The people mover trains will operate in a loop between the two stations utilizing the same "pinched" loop concept as the aerial alternative to reduce the right-of-way and construction impacts. The switching maneuver would occur near the stations and is shown on Figure 28.

The operation of the underground alternative would be similar to the elevated people mover system. The people mover's interface at the Metro Rail station is represented in Figure 29. As patrons arrive on Metro Rail, they would proceed directly through the underground connection located on the mezzanine level and descend to the platform level of the people mover. From this location, patrons would board the people mover trains and be transported to the Hollywood Bowl station. Persons can take the escalators or stairs from the station's platform level to the surface to arrive at the entrance of the Hollywood Bowl. The return trip to the Metro Rail station would be similar.

Performance

The operation of the underground alternative would be the same as the elevated alternative, in terms of trains in operation and average people mover speeds. The underground alternative performance characteristics are summarized in Table 4. As a result of the system layout, the Westinghouse alternative can operate with a theoretical headway of 2 minutes which provides a system capacity of 9,700 passengers per hour.

The Universal Mobility system would provide a theoretical headway of 2 minutes 13 seconds which can accommodate a capacity of 6,000 persons per hour. This system would be able to provide transit service to 33% of the Bowl's capacity within one hour compared to Westinghouse's ability to service 54%. The travel times for the underground alternatives are shorter than those of the elevated alternatives. The time required to travel between the Hollywood Bowl and the Metro Rail station is 9 minutes 44 seconds and 10 minutes 18 seconds for the Westinghouse and Universal systems, respectively.

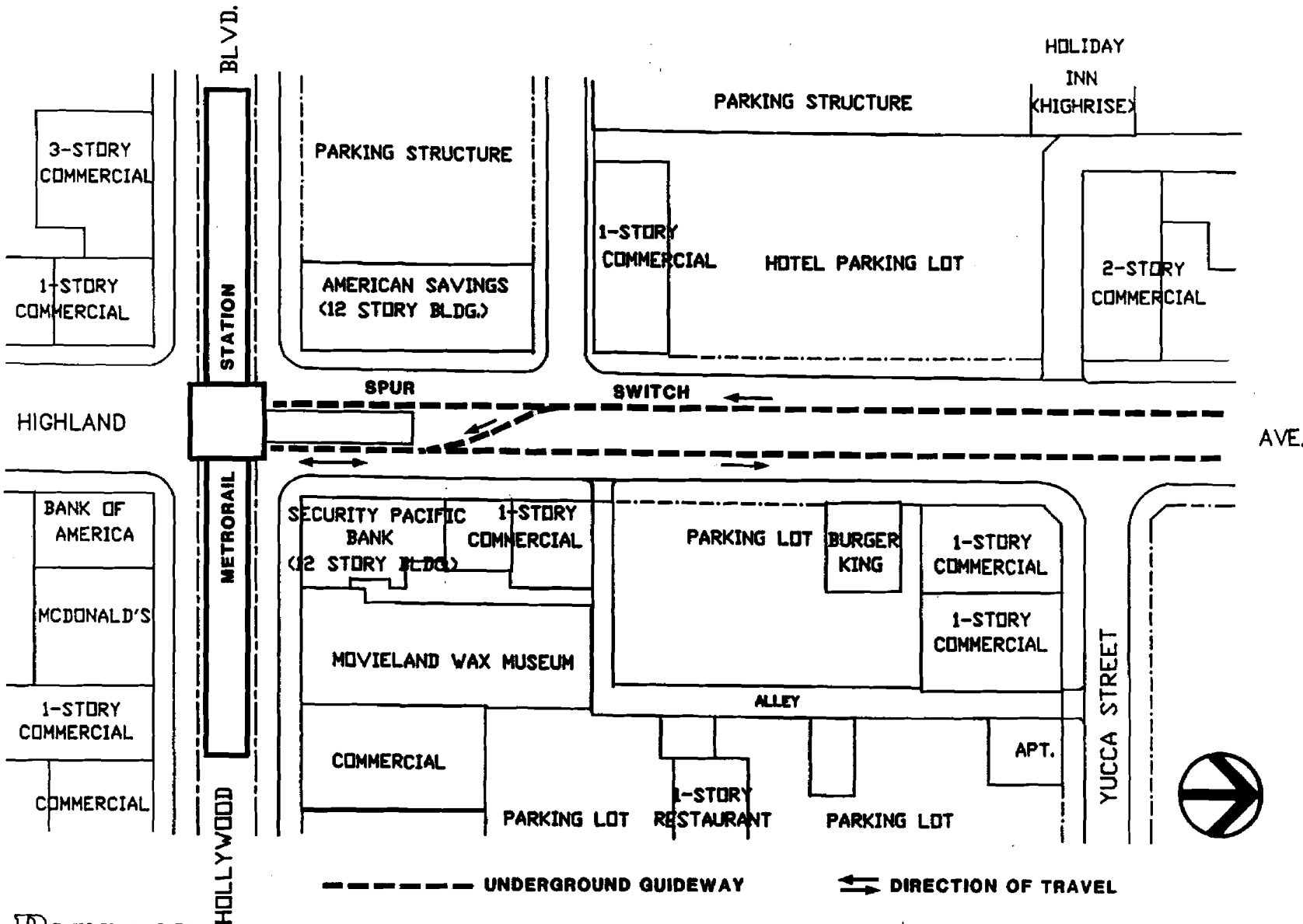

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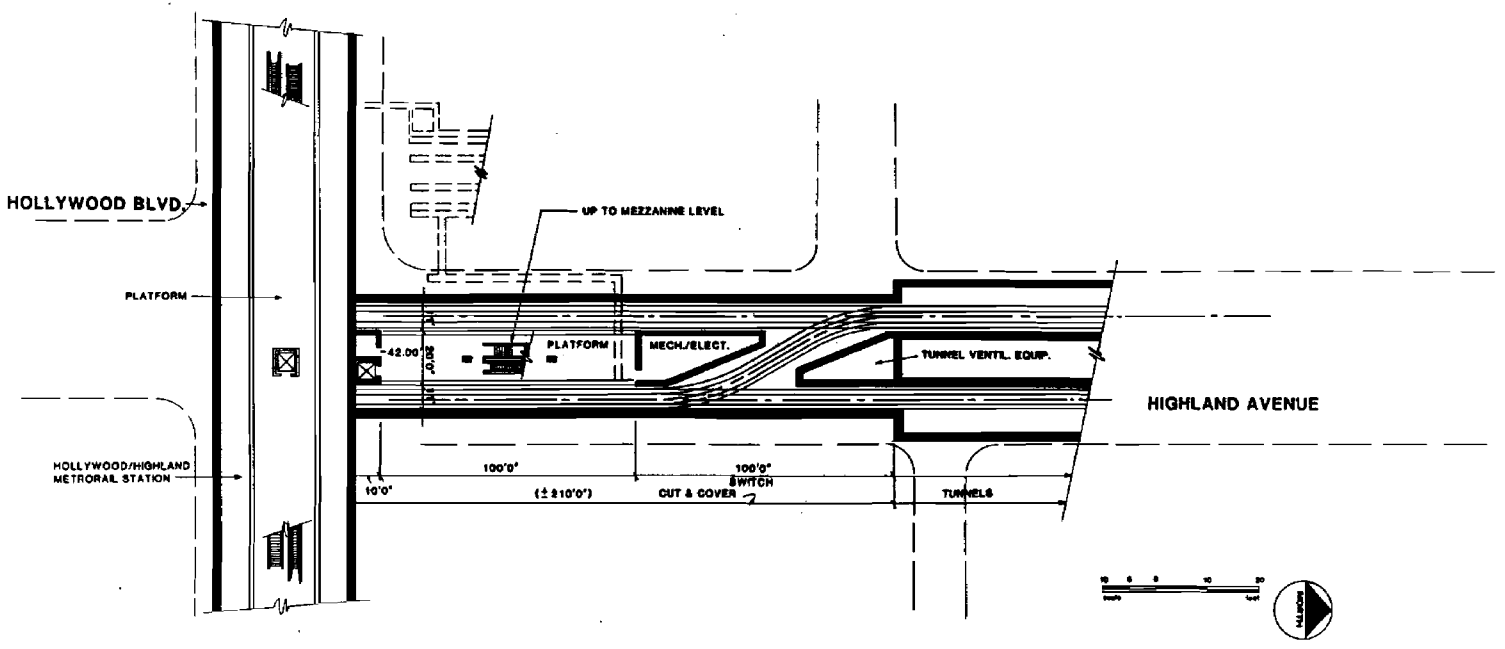
Figure 28
Underground People Mover



Parsons Brinckerhoff

Figure 29

Metrorail Station Underground People Mover

TABLE 4

UNDERGROUND PEOPLE MOVER PERFORMANCE CHARACTERISTICS

System Performance	Westinghouse Electric	Universal Mobility
Theoretical Capacity	9,700	6,000
Theoretical Headway	2 min	2 min 13 sec
Traveling Unit	2-car train	4-car train
Number of Trains	3	3
Theoretical System Speed	24 mph	20 mph
Round Trip Time	5 min 54 sec	6 min 28 sec
% of Bowl Capacity Served in 1 Hour	54%	33%
Event Exiting Time (Assuming 4,000 pass.)	24 min 45 sec	40 min
Travel Time (Metro Rail Station to Hollywood Bowl Station)	9 min 44 sec	10 min 18 sec
Costs ($ Million)	74	69

Round Trip Time is travel time + dwell at ends for people mover.

Travel time includes passenger time from enter escalator in Metro Rail Station to step off escalator or out of H B Tunnel.

To exit 4,000 persons from the Bowl would require about 25 minutes for the Westinghouse people mover compared to the 40 minutes needed by the Universal Mobility alternative.

The system costs associated with these alternatives is estimated to be $74 million for the Westinghouse system and $69 million for the Universal Mobility people mover. The major cost of the underground system is attributable to the tunnel construction. Accordingly, the Universal system does not have a significant cost advantage with a subsurface scenario.

IV. COMPARISON OF ALTERNATIVES

IMPACTS OF ALTERNATIVES

Circulation

A preliminary traffic analysis was performed to assess the impacts to traffic operations along Highland Avenue associated with the elevated guideway alternatives. Highland Avenue is part of the state highway system and is designated as State Route 170 between Santa Monica Boulevard and the Hollywood Freeway. Highland Avenue is classified as a major arterial by Caltrans. The City of Los Angeles is responsible for the operation and maintenance of this roadway.

Recent traffic counts (1987) collected from the City of Los Angeles indicate that Highland Avenue is carrying approximately 80,000 vehicles per day along the section where the guideway is proposed. Within this segment Highland Avenue is predominantly a seven-lane facility providing four southbound lanes and three northbound lanes. However, due to the heavy weekday northbound demand in the PM peak period, the Number 1 southbound lane becomes a reversible lane providing four travel lanes northbound between 3:00 PM and 7:00 PM. The reversible lane, formed by manually placing traffic cones at designated locations along the street each day, begins at Leland Way and terminates at Odin Street.

The elevated guideway will be supported by piers, spaced at 75-foot maximum intervals, located along the centerline of Highland Avenue. Special attention will be provided to the placement of guideway piers so that impacts to sight distances are minimized.

For analysis purposes, it is assumed that these piers will be contained within a 10-foot median. The installation of this median, assuming no mitigation measures, will require removing one travel lane from Highland Avenue. To ascertain the impact this will have on existing traffic operation, Level of Service (LOS) calculations were performed at the affected signalized intersections. Along the proposed elevated guideway alignment, traffic signals are located along Highland Avenue at Franklin Avenue/ Franklin Place (south), Franklin Avenue (north), and Camrose/Milner. Peak hour LOS

calculations of these signalized intersections, for both the existing and median guideway condition, are shown below:

Intersection	Existing		Median Guideway (no mitigation)	
	AM	PM	AM	PM
Franklin (south)	D	E	F	F
Franklin (north	C	D	E	F
Camrose/Milner	B	B	D	D

The above information indicates that if no mitigation measures are implemented, the affected signalized intersections will operate at a reduced LOS. Removing one travel lane on Highland Avenue will impact traffic flow in both directions because of the reversible lane operation that is currently employed. This removal of AM southbound capacity and PM northbound capacity will result in significant congestion causing traffic to back-up north of Camrose/Milner in the AM peak period and south of Hollywood Boulevard in the PM peak period.

If the elevated guideway is installed, the same number of travel lanes that exist today could be supplied by widening Highland Avenue. However, this widening would preclude any future City widening plans and would not result in the same amount of capacity that is currently provided. This capacity reduction, primarily due to the guideway median, would occur for several reasons. First, to maintain continued operation of the reversible lane, traffic cones would have to be manually installed to convert the Number 1 southbound lane (nearest the median) to a northbound lane between the hours of 3:00 PM and 7:00 PM. Hence, when the lane is reversed it would be separated from the other three northbound lanes by the guideway median. With this configuration, northbound traffic using the reversible lane would have lateral obstructions on each side. On the left would be traffic travelling in the opposite direction (southbound) and on the right would be the median. Drivers tend to compensate for these lateral obstructions by maintaining longer spacing between vehicles, and/or avoiding the lane entirely which results in a reduction in lane distribution, and therefore capacity.

Second, with the above configuration, tapers/transitions are necessary at each end of the median to direct vehicles in and out of the reversible lane. This transition can be accommodated on the north end by using the broad median on Highland Avenue just south of Odin Street. To accommodate this transition on the south end will be

difficult due to the proximity of Hollywood Boulevard. The distance between the northern cross walk at Hollywood Boulevard and the first column of the proposed elevated guideway will be approximately 210 feet. Preliminary studies indicate that the minimum distance required to safely transition vehicles around the median is 250 feet. Thus, reduced design standards may be necessary to accommodate the southern transition.

Third, separating the northbound reversible lane from the other three northbound lanes effectively forces traffic to travel the entire guideway median section without any option of turning right at Yucca Street, Franklin Place, Franklin Avenue, or Camrose/ Milner.

Fourth, from an operational standpoint, requiring traffic using the reversible lane to transition around a median, face southbound traffic, and transition at the terminus is undesirable simply because drivers will tend to use the other three northbound lanes where they will not have to worry about oncoming traffic or transitioning their vehicle.

The median installation will result in some left turn restrictions along Highland Avenue. Currently, during the peak when the reversible lane is in operation, left turns are prohibited at all intersections except at Camrose/Milner. Based on conversations with City staff, left turns will probably be prohibited at this location during reversible lane operation in the near future. These same turning restrictions will be maintained under the median guideway scenario. The potential off-peak left turn impacts of the median guideway scenario are discussed below.

Highland at Hollywood - The southbound approach provides three through lanes and one left turn lane. The design configuration of the transition necessary to accommodate continued operation of the northbound reversible lane may potentially restrict southbound left turns.

Highland at Yucca - Yucca meets Highland as an unsignalized "T" intersection from the east. Currently, there are minimal left turn movements at this location. Consequently, a continuous median through this intersection will have minor impacts.

Highland at Franklin (south) - Left turns are restricted on Highland at all times so there will be no impacts at this location. To accommodate left turn movements from the west leg of Franklin, special design treatments for the elevated guideway will be necessary to span a distance in excess of 75 feet.

Highland at Franklin (north) - Franklin north meets Highland as a "T" intersection from the east. Left turns are prohibited from southbound Highland so there will be no impacts at this location.

Highland at Camrose/Milner - Left turns are currently allowed at this intersection to serve the local residential neighborhoods, however, left turn pockets are not provided. If left turn pockets are desired, longer guideway spans could be employed to accommodate the necessary left turn storage lengths.

Another impact of the median guideway will be to the mid-block driveways of the various businesses along Highland. Left turns will no longer be possible to or from these driveways due to the guideway median.

Upon preliminary review, it appears difficult to maintain the reversible lane operation with a guideway located in the street. Left turn movements are already severely restricted; however, left turn access to local driveways will be additionally impacted by an aerial structure. Consequently, the elevated guideway would adversely impact the circulation and traffic operation of Highland Avenue.

The underground connector would not have any permanent adverse impact upon circulation. The impacts to circulation associated with the underground alternatives would be restricted to their initial implementation, as discussed in the next section.

Construction

Implementation of any of the alternatives will result in some temporary construction impacts to vehicular circulation, pedestrian movement, and local access. The impacts related to the construction of the underground alternatives would be less extensive than the elevated concepts. The primary construction technique used would be the

bored tunnel. The surface impacts would be limited to the areas in the immediate vicinity of the cut-and-cover operations proposed for the connector station located near Hollywood/Highland. At this location, circulation and capacity would be limited for the duration in which the subsurface construction is exposed. The cut-and-cover operation would have the most significant impact upon subsurface utilities. The tunnel operation would utilize the cut-and-cover site as its excavation portal. The impact related to this operation would be the presence of haul vehicles circulating on Highland Avenue.

The people mover underground alternatives would have a more significant impact upon circulation than the moving walkway alternative. Since the people movers utilize a double tunnel compared to the single tunnel of the moving walkway, the cut-and-cover site will have more extensive surface impacts. The people mover alternative could result in greater restriction of through traffic during construction.

For the construction of an elevated guideway, the number of traffic lanes on Highland Avenue would be restricted to permit construction of the median guideway. The impacts related to the Universal Mobility people mover would be relatively minor since its implementation utilizes pre-fabricated components. Once the support piers are set in their foundations, the pre-fabricated all-steel guideways can be set and secured to the piers. This technique facilitates an accelerated construction schedule to minimize the construction impacts. Using pre-cast piers and pre-fabricated sections, the elevated Westinghouse people mover or moving walkway can be similarly constructed. The elevated alternatives would use cut-and-cover construction to build the underground connection between the elevated transfer station and Metro Rail. These cut-and-cover impacts would be as described above.

Noise and Vibration

The alternative elevated and underground systems presented will not provide any significant noise or vibration impacts. The underground guideway systems, in particular, will not impact the surface environment. The only impact from below grade operations would be temporary from the cut-and-cover operation. All systems would

be designed to minimize any adverse impact of the system operation upon the surrounding environment by minimizing the creation and transmission of noise and vibration levels.

The elevated moving walkway system would only emit a low level continuous noise without any significant vibration. It is anticipated this passenger conveyor system would not be perceptible against the background street noise levels.

Although no field measurements were undertaken, manufacturer specifications provide noise information on the alternative people mover systems. At the maximum operating speeds, the noise levels that would be measurable at a distance 50 feet from guideway centerline are 77 dBA for the Westinghouse system, and 75 dBA for the Universal Mobility system. The noise impact due to the people mover systems would be no greater than that of one of the numerous buses, including the Hollywood Bowl park-and-ride buses, that currently travel on Highland Avenue. It is also expected that people mover systems on the aerial guideway would not produce any objectionable impact due to vibration.

Aesthetics

The underground guideway systems would only impact the visual environment at the stations; whereas the elevated guideway systems would have significant visual impact along the entire Highland Avenue alignment. All impacts could be partially mitigated by aesthetically pleasing design and with appropriate landscaping.

The enclosed moving walkway will present the greatest visual impact of the elevated alternatives. The moving walkways provide a continuous structure elevated above Highland Avenue. The aerial structure is approximately 20 feet square and would create a physical barrier to the present visibility.

The visual impacts related to the people mover alternatives are less intrusive primarily attributable to the guideway. The Universal elevated guideway consists of the two steel guideways supported on hammerhead shaped piers, resulting in a slim and tapered appearance. The Westinghouse guideway is larger and consists of a single 22 foot-wide deck supported by "T-shaped" piers.

Each of these alternatives clearly introduces a new and distinctive element into the streetscape which will significantly impact the visual environment along Highland Avenue. Additionally, the adjacent properties and some surrounding residential hillside areas will be visually impacted by the elevated connector.

A major visual impact would be the view of the historic properties as seen from the east side of Highland Avenue. Each elevated connector will present a physical barrier obscuring the cross-street view of these sites.

Historic Properties

Six properties located on the westside of Highland Avenue have been identified as having potential historic significance in the vicinity of the alternative connector alignments. Four of these properties have been determined by the State Historic Preservation Officer (SHPO) to be potentially eligible for the National Register of Historic Places. These locations are as follows:

The First Methodist Church, 6807 Franklin Avenue
American Legion Hollywood Post, 2305 Highland Avenue
Highland/Camrose Bungalow Village, 6809-19 Camrose/2103-2115½ Highland Avenue
Hollywood Bowl

The other two properties of potential merit are:

Dekeyser Duplex, 1911 Highland Avenue
Dekeyser Residence, 1913 Highland Avenue

The Hollywood Bowl would obviously be impacted by all alternative systems; however, all alternatives could be designed to complement this landmark. The elevated guideway systems will clearly impact the historic properties fronting Highland Avenue in the same way as determined for other adjacent properties.

The elevated connector would be significantly more intrusive upon these historic properties, especially upon the Hollywood Bowl, since a portion of the connector would be built on the premises. Each of the alternatives will have an effect upon the historic properties. The majority of the properties have direct visual exposure to the guideway, and the connector will reduce the visibility of these properties from the eastside of Highland Avenue. The determination of whether these effects on the historic sites are adverse will be made in conjunction with the State Historic Preservation Officer.

The underground connector will have a less intrusive impact upon these properties. However, the Hollywood Bowl would be impacted by the presence of a connector station located near the entrance to the facility.

Land Acquisition and Displacement

No land acquisition or displacements would be associated with the underground moving walkway or people mover alternatives. However, based on the preliminary alignments, it would be necessary to obtain underground easements beneath fifteen parcels. These parcels are all located on the western side of Highland Avenue between Franklin Avenue and Camrose Drive. It is anticipated that these parcels will not be impacted by noise or vibration generated by the underground connector. Therefore the cost of the underground easements are assumed to be $20,000 per parcel for an aggregate easement cost of $300,000.

Land acquisition would be necessary for both the elevated moving walkway and people mover alternatives. The preliminary location of the elevated guideway transfer station affects two parcels. The first parcel is occupied by a commercial parking lot and a key making shop and the second parcel is the site of a Burger King restaurant.

The proposed elevated station is contained within the first parcel, however, the City's building setback requirements will require the acquisition of additional right-of-way from the second parcel. Since this will adversely impact the available restaurant parking, it is assumed both parcels will be required for the elevated connector

alternatives. The cost of the acquisition of these parcels is estimated to be approximately $3.7 million.

For this evaluation, it was assumed that right-of-way at the Hollywood Bowl for the station or maintenance facility would not have to be purchased.

Costs

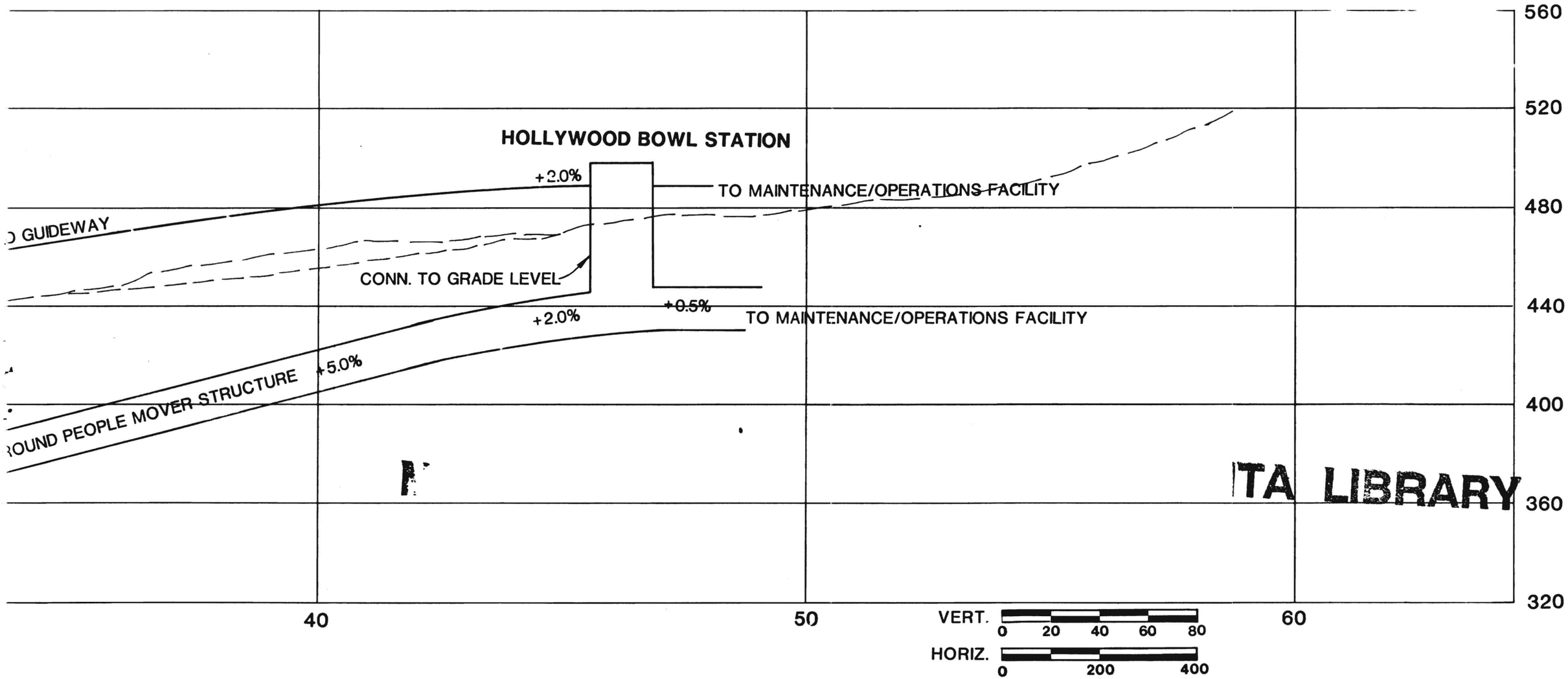
Many undefined variables could affect the ultimate cost of a system; however, based upon preliminary analysis, we have concluded that the underground connector would be the most expensive. The estimated cost for these underground connections to the Hollywood Bowl ranged from approximately $40 to $74 million. The Westinghouse underground people mover would be the most expensive connection.

The elevated alternatives would be the least costly connector options. The estimated cost for these systems ranged between $20 and $47 million. The Universal Mobility elevated people mover alternative would be the least expensive connection to the Hollywood Bowl. The cost for each connector is summarized in Table 5.

TABLE 5

CAPITAL COSTS:
HOLLYWOOD BOWL CONNECTOR ALTERNATIVES
(Millions of 1988 Dollars)

Alternative	Construction and Procurement	Contingency Design and Construction Management	Right-of-Way	Insurance and Agency	Total
Elevated Moving Walkway	17	7	4	6	34
Underground Moving Walkway	22	10	.3	8	40
Universal Elevated People Mover	13	6	4	3	26
Universal Underground People Mover	42	18	.3	9	69
Westinghouse Elevated People Mover	26	11	4	6	47
Westinghouse Underground People Mover	45	19	.3	10	74



VER ALTERNATIVES

PROFILE PLAN

Parsons Brinckerhoff

Figure 20