

EVALUATION OF SUNSET COAST LINE PROPOSAL
EXECUTIVE SUMMARY

PREPARED FOR
THE SOUTHERN CALIFORNIA RAPID TRANSIT DISTRICT

DE LEUW, CATHER & COMPANY
GRUEN ASSOCIATES
MOBILITY SYSTEMS
STANFORD RESEARCH INSTITUTE

MARCH 12, 1976

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12 March 1976

Mr. Ralph de la Cruz
Southern California Rapid Transit District
425 South Main Street
Los Angeles, California 90013

Subject: Evaluation of the Sunset Coast Line Proposal

Dear Mr. de la Cruz:

I am pleased to transmit forty copies of the Executive Summary Report incorporating tests provided by Gruen Associates, Mobility Systems, Stanford Research Institute and the SCRTD staff.

Sincerely yours,

DE LEUW, CATHER & COMPANY



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Staff Vice President

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TABLE OF CONTENTS

	<u>PAGE</u>
INTRODUCTION	1-1
ABSTRACT OF THE SUNSET COAST LINE PROPOSAL	2-1
DE LEUW, CATHER & COMPANY.....	3-1
GRUEN ASSOCIATES INCORPORATED.....	4-1
MOBILITY SYSTEMS & EQUIPMENT COMPANY.....	5-1
STANFORD RESEARCH INSTITUTE.....	6-1
SOUTHERN CALIFORNIA RAPID TRANSIT DISTRICT STAFF	7-1

INTRODUCTION

On January 28, 1976 Supervisor Baxter Ward, Chairman of the Board of Supervisors, Los Angeles County, presented to the Board of Directors of the Southern California Rapid Transit District the Sunset Coast Line proposal for a countywide rail rapid transit system. The Board of Directors subsequently retained four firms to evaluate certain features of the proposal and advise the Board of their findings by March 10, 1976. The date was set to allow the Board time to reach a decision regarding the placement of the proposal on the ballot.

A preliminary report of findings was presented to the Board at a Special Meeting on March 4, 1976. The evaluations were completed a few days later and the final reports were presented to the Board on March 12, 1976.

This report is an executive summary of the key findings and conclusions resulting from the evaluation of the Sunset Coast Line proposal. It incorporates:

- a) Findings regarding technological and engineering feasibility, capital and operating costs, and bus feeder systems produced by De Leuw, Cather and Company.
- b) Findings regarding environmental considerations and economic and social impacts produced by Gruen Associates.
- c) Findings regarding construction aspects, hardware availability, energy and shops and yards produced by Mobility Systems and Equipment Company.
- d) Findings regarding the financial program produced by Stanford Research Institute.

In addition, the staff of the Southern California Rapid Transit District prepared an evaluation of the District's bus system present and projected status and financial needs. Key findings of this evaluation are also included in this executive summary.

While this report has been prepared as a comprehensive summary of all key findings and conclusions it is expected that needed clarification and further exposition of its material will be found in the supporting final reports prepared by the four firms. The Preliminary Report prepared jointly by the firms on February 25, 1976 listing the primary issues to be the subject of this evaluation may also provide supplementary information to aid the reading of this document.

The consultants wish to reiterate that the guiding principle of this evaluation was the objective assessment of the Sunset Coast Line proposal's feasibility and the reasonableness of the assumptions made and conclusions drawn. No attempt was made to redesign the system or to comment on the principles which guided its development. However, within the limits of the resources and time available to the evaluation, the consultants have drawn attention to certain alternative considerations which could improve the system's operability, reduce its costs, alleviate its impacts or positively affect the financing feasibility. All alternatives have been reviewed in timely fashion with the District staff and with the Rapid Transit Committee of the Southern California Rapid Transit District Board of Directors. Important suggestions regarding the evaluation of certain alternatives were made by the Committee and were included in this assessment.

Due to the severe limitations of time devoted to this evaluation, the numerical findings reported in this document, and in the supporting final report, include uncertainties which can only be resolved by further analysis and design. The reported findings reflect to a considerable degree the consultants' professional expertise and judgement; they should not be regarded as having the accuracy and preciseness of the far more detailed analytical work that would ultimately be necessary to fully design the County's transit system.

ABSTRACT OF THE SUNSET COAST LINE PROPOSAL

The Sunset Coast Line, (SCL), is the designation for a countywide transit system providing direct heavy rail transit to 43 cities in Los Angeles County below the San Gabriel Mountains. Twenty-two additional cities are located within 1 1/2 mile distance from a heavy rail transit line and 12 cities are served by feeder lines interconnected with the network of mainlines. The SCL network provides direct connection with future transit in Orange County and in San Bernardino County. It includes as special projects the Wilshire - La Brea Corridor and the Los Angeles CBD Distribution System. Certain segments of the SCL network overlap the Starter Line.

The proposal locates the transit lines primarily in freeway rights-of-way. There are approximately 89 miles of aerial structure and approximately 94 miles of at-grade structure within freeway rights-of-way. Approximately 35 miles of the network are located on aerial structure within railroad or flood channel right-of-ways. The plan envisions 89 stations provided on the mainline with the cities having the prime responsibility for their location. Provisions for approximately 52 miles of feeder line transit to be located along alignments to be decided by the cities are also included. One hundred and two stations are provided in the feeder line proposal.

The SCL system consists of a network of mainlines supplemented by a network of guideway feeders and ancillary bus services. On the mainline there is local service, interurban service, and a special airporter service. Provisions are also included for special design cars to be used for recreational purposes. On the mainline the equipment would be designed to operate at a maximum speed of 85 miles per hour. With station spacing at approximately 2 1/2 miles apart the proposal estimates an average speed on the line ranging from 55 to 60 mph.

The fixed guideway feeder services are provided along five routes using light rail technology and along ten routes using advanced automated group rapid transit operating in simple loop networks.

While no precise estimates of transit demand have been made in preparing this proposal, the document infers that the system would have a theoretical daily capacity of 5 million passengers.

The SCL system is centered around the existing Union Station which is envisioned to become the hub of the system and to lend its architectural style to many of the stations to be built. Environmentally the proposal foresees no particular problems with the deployment of the system. It assumes that negative visual impacts will be kept at a minimum and that noise abatement procedures attained through the use of noise barriers, resilient wheels and other sound absorbing construction techniques would maintain the transit generated noise level at or below that found today as a result of normal automobile operation on the freeways. Major impacts in terms of land use would be encountered at stations which would, however, be under the control of the cities. The impact due to construction is assumed to be minimum through the location of lines essentially along the freeways and other public right-of-ways. To minimize the potential impact of construction on freeways, various techniques for fast construction during non-peak hours on medians or shoulders of the freeway have been proposed and accounted for in the cost estimates.

The plan proposes to finance the construction of the system and to subsidize the operation of the system with revenues received from a one cent sales tax. During its first year the sales tax is estimated to produce \$283 million. The financial plan assumes a 6.4 percent annual increase in the revenues produced by the sales tax. It has also been assumed that \$500 million per year would be available from bonds during each of the 15 years of the construction of the system.

The total cost for construction is estimated at over four billion dollars in 1976 dollars. This has been escalated to \$7,152 million at the completion of the project.

The plan makes an allowance for \$149 million in 1975 dollars with provisions for inflation during the time of construction for the Wilshire Corridor. Additional funds are provided for the La Brea Corridor extending south from the Hollywood Bowl.

By 1987, a full one half percent of the sales tax would be available for the operating cost of the system. This will amount to \$263,750,000.

The SCL proposal states that the Rapid Transit District will have the responsibility for operating the system and that the County of Los Angeles, through a newly established Transit Development Department, will be empowered to serve the RTD as project manager and prime contractor for the development of this system.

TECHNICAL EVALUATION SYSTEM DESCRIPTION

Evaluation Prepared by De Leuw, Cather and Company

The SCL is defined as a 281 mile system including 230 miles of mainline guideway and 51 miles of feeder guideway. There are 34.5 miles of mainline aerial guideway on railroad, flood channel and arterial right-of-way. On freeways, there are 89.4 miles of aerial and 94 miles of at-grade guideway. Only 7.2 guideway miles are in subway. The SCL system calls for 89 stations on the mainline and 102 stations on the feeder system. Union Station is the hub of the system and provides the architectural motif to other stations.

The mainline guideways would be located on freeway medians or on shoulders. Some freeway widening is proposed and some lane taking but for the most part the proposal assumes that emplacement within the freeway right-of-way will cause little loss of freeway capacity. Interline interchanges are located in the general area of the freeway interchanges and some stations are proposed at the same locations. Feeder lines would be located on arterials or railroad right-of-way but no locational details are given.

FINDINGS

- The proposed at-grade and aerial configuration of the mainline network on freeways conforms almost entirely with locational opportunities as defined by the Caltrans analysis and De Leuw, Cather & Company's independent field survey. Minor adjustments are recommended to fit the integration of the transit service with the layout of the Los Angeles International airport facilities and on other segments as dictated by the freeway configuration.
- Several small segments on the Valley/Long Beach and Cross-Country lines could be converted to at-grade feeder service without impairing the proposal's concept of service.
- The description of the fifteen fixed guideway feeder systems is incomplete insofar as location and other physical or performance parameters are concerned.

- The service characteristics of the proposed interurban trains cannot be realized on the system as described. Parallel trackage or offline stations are required to permit the interurban trains to bypass local trains and thereby gain the desired enhancement in travel time.
- The location of stations on lines constructed within freeway right-of-way creates special passenger, automobile and bus access problems.
- Guideway interchanges required to provide access from one line to another are complex multi-tiered structures. Colocation of guideway interchanges with freeway interchanges will result in structures of great complexity, large costs and considerable environmental and community impact. A preliminary analysis of the SCL operations suggests that some simplification in the number and geometry of the proposed interchanges is possible without impairing the basic intra county accessibility stipulated by the proposal. At some points alternate interchange designs might locate the structure on adjacent right-of-way or at some distance from the freeway interchange with attendant simplification in structural complexity and reductions in cost. Further design is required to resolve the interchange configuration problem.
- While the SCL contains a number of locations where construction of the guideway would be particularly difficult - as indicated above for the guideway interchanges - most of the proposed network can be constructed within the designated freeway right-of-way without much freeway widening.
- Freeway widening and permanent lane taking is proposed only where the corresponding freeway segments are under utilized or where ample right of way is available for the expansion. Elsewhere, at-grade or aerial guideway structures can be constructed with temporary lane taking. During the construction period the existing freeway lanes would be relocated and narrowed thereby reducing automobile speeds to the 30 mph range. This is likely to be one of the large impacts of the proposed construction program. Additional degradation in freeway operations can be expected where construction on shoulders or provision of access to the construction site might cause temporary relocation of freeway access or exit lanes.

- Construction of the guideway will require precast, cast-in-place or steel structures depending on the physical constraints of each particular site.
- Location of guideways at-grade in freeway medians will require removal of that part of the existing pavement that will be replaced by the guideway structure.
- Aerial guideways in freeway medians will cause permanent degradation of shoulder space and line of sight at the location of the columns.
- A project time table of sixteen years is more realistic than the proposal's twelve years . This schedule allows five years for preliminary design, twelve years for final design and thirteen years for construction. Partial operation could begin in the eight year and full operation in the seventeenth year. This time table assumes no financing limitations, full availability of all required resources and no undue litigation or jurisdictional delays.
- It does not appear desirable nor practical to utilize different vehicle technologies and designs for the local airporter and special purpose cars. An adaptation of existing rail rapid transit vehicle designs, as represented by New York R-46 car, should be considered for use on all proposed transit services. Suitable interior design modifications should be considered to accommodate airporter and recreational type service. The use of hybrid gas turbine/electric vehicles will entail unwarranted additional costs in technological complexity.
- The specification of a simple block type signal control and manual operation of the trains with automatic train protection backup is insufficient to assure the smooth and safe flow of traffic through interchanges and under adverse operating conditions. A form of control automation is required to process the movements of the high speed, low headway trains at interchanges and other critical points of the network.
- The specification of fifteen different, unconnected feeder systems would lead to unnecessary replication of service facilities, operating and maintenance staffs with different skills and limitations of service reliability.

- The specification of automated GRT mode for ten of the fifteen feeders anticipates the availability of a proven and safe technology; currently these technologies are not available for urban transit. Deferring the specification of the automated technology until late in this decade might make available currently projected GRT technological enhancements.
- Opportunities for deployment of light rail feeder systems will depend on opportunities for transit interface with surface street traffic at at-grade crossings of arterials.
- As suggested by the Rapid Transit Committee of the Board of Directors, certain simplifications in the proposed SCL design are possible which would not significantly impair the anticipated service. These included simplifications in interchange design, conversion of peripheral lines into feeder segments and temporary deployment of bus high-speed transit along lightly travelled corridors.

CONCLUSIONS

- The construction of the proposed SCL network along freeways and other public rights-of-way is physically feasible but requires the resolution of complex and difficult engineering problems. Guideway interchanges and the construction of the transit guideway in the fully developed and utilized right-of-way of most of the well established freeways in the County create large engineering design problems. Further detailed study and evaluation of alternative structural configurations within the envelope of the stipulated right-of-way are required to resolve these engineering issues.
- Construction of the network's guideways located in freeway right-of-way will not require permanent lane taking except in areas of low traffic density where the lane restriction will not adversely affect available freeway capacity. Elsewhere, the construction will cause temporary freeway disruption and inconvenience to motorists because of lane relocation and lane narrowing.

- The multiplicity of vehicular configurations for the mainline and the feeder systems can and should be avoided. Mainline vehicle configuration based on a single design is preferable. On the feeder lines, temporary de-emphasis of the GRT specifications will mitigate the reliance on a technology not as yet fully proven for urban transit.
- Incremental sophistication in the control system is required to assure the safety and reliability of the proposed transit service.
- The design and construction schedule of at least sixteen years will be required to complete the project under near ideal conditions.

CAPITAL COSTS

Evaluation Prepared by De Leuw, Cather and Company

The SCL proposal estimated the capital costs at \$7,152 million in escalated costs. In 1976 dollars, the cost is approximately \$4,470 million. The proposal provides \$362 million for the feeder system and \$253 million for the Wilshire/La Brea corridor and the central business district distributor. The proposal provides for the cost of 1,060 rail cars at a cost of \$541 million in 1976 dollars.

FINDINGS

- Most of the proposal's quoted unit costs fall within the range of current bid prices. Significant discrepancies were found in the cost of at-grade construction on freeways and for the cost of interchanges. More appropriate at-grade construction costs are estimated between \$2 and \$4.2 million per mile depending on the complexity of design, the presence of freeway overpasses and other factors. Interchange costs range from \$5 to \$90 million depending on the complexity of the structure. The multi-tiered configuration of the interchanges requires that high guideway structure be built as far as one half mile away from the intersection. This accounts, in part, for the high cost of the interchanges.
- The proposed fifteen percent contingency factor is considered to be low at this stage of conceptualization of the project. A larger factor, 25 percent, is required to provide for uncertainties in design, alternative location of the facilities and other cost increments not anticipated in the proposal.
- Vehicle costs have been slightly underestimated. Current unit costs are projected between \$500,000 and \$750,000. A large order of several hundred vehicles could result in costs in the range of \$600,000 per unit.
- Line costs for the proposed ten mainlines - including structure, track-work, control and communication/electrification - have been established at \$3,390 million in 1976 dollars. This is 27 percent higher than the corresponding costs shown in the proposal. (A \$200 million allowance for the Wilshire/La Brea line is included.)

- Total costs for the mainline and associated equipments has been estimated at \$6,050 million. This is more than 40 percent higher than the corresponding costs shown on the proposal.
- Costs for the feeder systems have not been evaluated because of the lack of supporting descriptive information. In general, it is felt that the feeder costs were underestimated.
- Total costs, including the unmodified allowance for the feeder system have been estimated at \$6,480 million in 1976 dollars. This is more than 40 percent higher than the comparable costs shown in the proposal.
- The modifications suggested by the Board's Rapid Transit Committee would reduce the capital costs by 10 to 15 percent.

CONCLUSIONS

- The capital costs have been underestimated by some 40 percent. The underestimate is due to the assumed lower costs for guideway construction in freeway, to the assumed lower costs of the construction of the interchanges and to the assumed low contingency factor.

OPERATIONS

Evaluation Prepared by De Leuw, Cather and Company

The SCL proposal provides local, interurban, airporter and special purpose transit service. Local service is provided by five car trains operating at five minute headways and making all stops. Interurban and airport services is provided at 30 minute headways. Average speeds for the 2 1/2 mile average spacing between stations is in the 50 -60 mph range. De Leuw, Cather's evaluation suggest that the SCL proposal assumed a patronage in the range of 1 million to 1 1/2 million passengers per day. Operating and maintenance costs were projected at one million dollars per mile or \$230 million per year.

FINDINGS

- Lack of adequate patronage data is a significant shortcoming in the current evaluation of the system's operation. Daily patronage has been estimated at 900,000 trips per day. This is not a firm projection but it is believed that it is a reasonable approximation of potential ridership on the fully developed system.
- An operational analysis based on an assumed system of routes and subject to the service specifications described in the proposal determined that a fleet of 800 to 1000 cars would be required and that 100 million vehicle miles would be accumulated in one year's operation. The systemwide average speed is 51 mph.
- Operating and maintenance costs of \$1.39 per vehicle mile have been estimated in 1976 dollars. Uncertainties in the estimate, particularly related to vehicle maintenance suggest that an appropriate unit operating and maintenance cost should be \$1.50 + \$.10 in 1976 dollars. This corresponds to \$652,000 per mile of mainline with a variation of about +7 percent.
- A precise comparison with the proposal estimates is difficult since no base year is given for the stated projection of \$ 1 million per mile. However, if the proposal estimate were based on 1987 costs, which could be inferred from the text, the costs corresponding to 1976 dollars would be in the range of \$450,000 to \$500,000 per mile.

CONCLUSIONS

The operating costs stated in the proposal appear to be underestimated by 30-40 percent.

March 12, 1976

GRUEN ASSOCIATES, INC.

ARCHITECTURE • PLANNING • ENGINEERING

EXECUTIVE SUMMARY

SOCIOECONOMIC, ENVIRONMENTAL AND PLANNING ANALYSIS OF THE SUNSET COAST LINE PROPOSAL

Gruen Associates reviewed the socioeconomic, environmental and planning aspects of the Sunset Coast Line (SCL) proposal presented to the Southern California Rapid Transit District. The review was undertaken in a short period of time. No attempt has been made to compare the SCL plan with any other alternatives which may be developed. The analysis has been performed to the level of detail required to establish areas of broad issues which may affect the Board of Directors' decision regarding placement of the proposal on the June 1976 ballot.

SCL PROPOSAL

- *The plan proposes a countywide rail transit system of over 281 miles consisting of approximately 230 miles of high-speed rail mass transit lines and approximately 51 miles of light rail, monorail or other fixed-guideway feeder system.*
- *The system will primarily use freeways, flood control channels, railroad rights-of-way, and arterials.*
- *The system will be built primarily on or above the surface of the ground. The principal construction method is an elevated structure. It minimizes subway construction.*
- *The cities will have the right of approval of location of stations within their own municipal boundaries.*
- *In order to reduce inflation-related costs, the plan proposes up to 48 months after the ballot approval as an observation-decision period for reaching agreements with affected political jurisdictions. The plan envisions that a number of construction starts will have been made within the first four years.*
- *The bulk of the system will be built in approximately 12 years.*
- *The entire proposal will be viewed as a contract between the people and their government. The system will be built substantially in accordance with the plan. The concept of guarantee means that construction funds cannot be diverted to other routes or concentrated for different purposes.*
- *The proposal stipulates certain fixed budgets for aerial guideways and stations. Any design modifications over and above these budgets must be paid by local jurisdictions.*
- *The system is also based on a low-fare policy. The proposed initial fare-collection device would not require a station attendant.*

FINDINGS

Transit Service Coverage

1. The SCL plan proposes extensive countywide rail rapid transit service coverage to most of the cities and towns in Los Angeles County. The system will provide an alternative travel choice on a scale commensurate with the size of the County and its population.
2. Because of the wide geographic coverage and local population and employment density variations, there is likely to be an imbalance in patronage levels from line to line. Certain lines will probably carry a high level of patronage, while others may capture only a very low level of patronage. If on the other hand those rail lines which may be underutilized are deleted from the plan, the rail transit service coverage will be smaller—and primarily limited to the central cities—thus weakening one of the key features of the plan (equity in service coverage on a countywide scale).
3. Without having line-by-line patronage estimates, it is still possible to suggest an alternative which could perhaps help overcome this dilemma. Such an alternative might be to keep the same geographic coverage but vary the mode and the level of service. The same lines designated in the plan would be followed; but, rather than having all rail transit, bus transit could be utilized on an interim basis until such time as patronage levels justified the more costly investment. Initial costs are reduced, transit service is provided, and the option for upgrading to rail transit service is left open.
4. The SCL system has the potential for achieving a major shift in our travel behavior and lessening the extent of our automobile dependency. It would make possible contingency plans to cope with energy or air quality crises. It would allow the use of other energy resources than oil. It would also provide maneuvering room for considering certain public policy measures which further encourage the use of public transit while discouraging automobile trips.

Use of Existing Public Rights-of-Way

1. The sharing of existing transportation rights-of-way, such as freeways, arterials, railroads and flood control channels, greatly minimizes the extent of probable displacement and relocation impacts due to transit right-of-way acquisition. Most of the displacement impacts are due to mainline stations (89), parking improvements (100,000 spaces), shops, yards, and interchanges.
2. The main lines in arterials (15 percent of 230 miles) directly serve many existing areas of population and employment concentrations. However, those segments of the main lines utilizing existing freeway rights-of-way (81 percent) do not, in general, directly or conveniently serve existing major centers of population and employment. These mainline stations must rely on local feeder buses or automobiles for making connection between trip origins and destinations.

On the other hand, if the main lines are shifted to the densely built-up areas to more directly serve the people, community impacts and opposition due to aerial guideways will be substantially greater, or costs of subway construction will escalate to a level where the size of the rail transit network may have to be drastically reduced. This reduction in rail transit coverage will again weaken the key feature of the SCL plan. Thus, the trade-off between displacement and construction cost impacts and direct service symbolizes the current transportation dilemma throughout the country.

3. Careful consideration should be given to those aerial guideways utilizing existing arterials, since impacts could vary significantly, depending on guideway and station locations and design. It can be anticipated that major community opposition, jurisdictional disagreement and environmental controversy would be developed if past experience in other parts of the country is any indication of things to come.

4. The concept of equal construction budget allocations for aerial stations and guideways must be related to the concept of equivalent environmental settings. For example, the environmental impact of the aerial guideway in a highly developed arterial setting would be quite different from the impact of a similar installation in a freeway median surrounded by industrial land uses. Thus, it would be necessary to vary design and impact mitigation measures and cost allocations, depending on each prototypical environmental setting.

5. The aerial guideway in a freeway median or side slope must periodically move up and down to clear street overcrossings (bridges), freeway-to-freeway interchanges, or interchange ramps. The guideway height may easily reach 45 to 50 feet (at the crossings) or 80 to 100 feet (at the freeway interchanges), either from freeway lanes or adjacent ground levels. This roller-coaster visual effect can be quite dramatic from the transit user's point of view, but can also be visually disruptive to adjacent residential areas if located along the freeway. Perhaps one of the ways to partially solve this problem is to move the line to a new right-of-way outside of the freeway-to-freeway interchanges.

6. Freeway-adjacent stations require many horizontal and vertical transitions connecting between a parking lot, a station concourse, and platforms. Additional costs for many sets of elevators, escalators, and long bridge connections over freeways can be anticipated. Because of a generally low level of pedestrian activity along freeways, the concept of stations without station agents may seriously affect feelings of security, thus discouraging the use of these stations, particularly in the evenings. There is a great need to provide all stations with attendants for safety and security of passengers, as well as a security force to constantly patrol the entire SCL system.

7. The concept of at-grade guideways taking two center freeway lanes will probably be the best solution if the displaced lanes do not have to be replaced and where the freeway volume is currently below its capacity. Where freeway widening were to take place, it might involve existing bridge reconstruction, addition of high retaining walls or viaducts, and encroachment on existing landscape improvements.

8. Slowdown of traffic will occur, and traffic congestion will develop on the freeways during construction. The construction phasing should be carefully worked out to minimize construction-related traffic disruptions. Up to 40 miles of existing freeways may be involved in construction at a given time.

Noise Impact

Because existing freeways are already high noise impact corridors, the introduction of transit guideways would not produce additional noise impacts in most instances. The same may not hold true in arterials, or in flood control embankments and railroad rights-of-way, where trains currently run once or twice a day and along which residential neighborhoods are located.

Air Quality Impact

Based on the BART experience and other nationwide transit studies, it is not anticipated that the proposed SCL system would lead to an immediate significant effect upon regional air quality. For Los Angeles County it is estimated that daily mobile source emissions would be reduced by about five percent. The solution of our regional air quality problem can best be achieved by control at the emission source (e.g., automobiles, power plants, and other stationary sources).

Net Job Formation

The SCL construction would produce new jobs during a peak year (based on a 16-year program) in the range of 25,000 to 35,000 direct and indirect jobs. However, it is a very complex task to assess whether the jobs created are considered entirely new in Los Angeles County. The flow of money equivalent to that generated by a one-cent sales tax would normally have created jobs in other sectors of the economy in Los Angeles County, not related to the construction and transit-vehicle manufacturing industries, such as in consumer goods, housing, etc. In addition, certain new jobs to be created by the SCL construction may go outside Los Angeles County, specifically, those jobs related to manufacturing transit vehicles.

Sales Tax Rate Differential

The one-cent sales tax rate differential may affect the purchasing pattern of consumers in border communities inside and outside of the Los Angeles County boundary. This would probably not affect the sales of convenience goods. However, it may contribute to a tax-induced sales migration with respect to large cost items in shopping goods (such as automobiles, heavy appliances, etc.).

Effects on Existing Activity Centers

Based on the BART experience, it is not likely that new development would automatically generate around every station on the main lines. In the Bay Area, even 15 years after the decision to build BART, no major land development intensification has taken place except in downtown San Francisco and, to some extent, in the central areas of Berkeley and Oakland. Because of the extensive mileage and coverage (230 miles and 89 stations) of the SCL, future development potentials would likely be diffused over its network and would have no significant effects on major existing centers. The economic viability of existing centers depends not only on accessibility, but also on so many other physical, environmental, social and economic factors.

Urban Sprawl

The SCL may encourage longer trips. Since most of the areas to be covered by the SCL have already been developed, the increased transit accessibility may provide an additional development impetus to the border communities both inside and outside of Los Angeles County.

Commitment Versus Flexibility

1. The SCL proposal makes a commitment that the system will be built substantially in accordance with the plan and in a relatively short time period (15 years). It specifically names those cities to be served directly or indirectly. It also gives the cities the right of approval on station location.
2. The SCL plan does not provide adequate time to allow institutional agreements and construction. If agreements cannot be reached in the first two to three years, either because of location and configuration of lines and stations or in terms of design or cost allocations, strategic missing links may develop and ultimately jeopardize the integrity and operation of the system network. The period of 15 years does not leave time for contingencies such as environmental impact report clearance, workable construction phasing, litigations, and strikes.
3. The SCL plan is defined too precisely. It would be desirable to have more flexibility in staging and scope (interim services, station locations, and alignments). However, if the plan is made too flexible, it will weaken the key feature of the plan—the concept of guarantee or commitment to the public.

CONCLUSIONS

- *The SCL provides extensive countywide rail transit coverage.*
- *It is generally a low-impact alternative along freeways. However, lines located in arterials and certain other rights-of-way may pose significant environmental impact and community opposition.*
- *It would be desirable if more time could be allocated to reaching institutional agreements and system construction (from the proposed 15 years to 20 or more years).*
- *Additionally, if more flexibility were built into the scope and phasing of the system (such as less mileage of the main lines in the first 20 years and possible delaying of some of the fixed-feeder and distribution line systems), many of the preceding issues could be resolved in time.*

EXECUTIVE SUMMARY

Evaluation of Supervisor Baxter Ward's SUNSET COAST LINE Proposal, prepared by MOBILITY SYSTEMS and EQUIPMENT COMPANY.

HIGHLIGHTS

Freeways and median (elevated or at-grade) and embankments (elevated or at-grade) are available and feasible rights-of-way to adapt and construct guideways for the S.C.L. Transit System.

U.S. suppliers have the sufficient capacity, capability and incentive to produce S.C.L. transit cars and equipment.

Los Angeles area suppliers of energy are able to produce the necessary electrical power to operate the S.C.L. system which requires approximately 2% of the demand in the area.

The S.C.L. proposes an efficient transit system, that with good implementation planning could resolve and develop a maintenance and service plan with satisfactory shops and yards.

FREEWAY ADAPTABILITY AND GUIDEWAY CONSTRUCTION

Issues and Approach

Application of freeway rights-of-way to be adapted for the construction of S.C.L. guideways. By evaluating the possible approaches that can permit the use of freeways in terms of location of guideways, median or embankment, the possible selection as to the type of guideway, elevated or at-grade, and its construction, and by reviewing each line alignment, a series of conclusions are established and described in detail.

Guideway and Freeway Median - Findings

There are two possible locations for a guideway on the freeway: in the median between opposing lanes of traffic flow and on the side or freeway embankment. These are applicable to depressed and/or elevated freeways. Two types of guideway are possible: elevated and at-grade. Each has inherent advantages and disadvantages. Although a guideway at-grade has a lower construction cost, the elevated type offers greater design flexibility and is less susceptible, from an interference standpoint, to freeway and pedestrian traffic. It is possible that operation cost and service reliability may be the important factor in the overall life cycle cost of the system. At-grade guideways have disadvantages in station location and size and may require freeway widening

to maintain traffic. For elevated guideways, it would appear that precast columns and running surfaces are to be preferred over the cast in place type.

Guideway and Freeway Embankment - Findings

Use of existing lanes must be weighed against the flexibility and accessibility advantages of using the outer freeway edge. Freeway entrance and exit capabilities will be affected and will require extensive engineering, design and additional construction cost.

General - Findings

The analysis of the lines of the S.C.L. has shown feasible application for guideway alignments on freeways with some possibilities for freeway widening. Railroad rights-of-way and flood channels are also feasible for guideway placement.

Interline rail junctions appear to be difficult and costly. The use of rail junctions should be weighed against the possibility of straight through lines with a dual level station for transfer. Such a station may be detrimental to patronage but only if the interline junction operation offers better service. It is not clear that it will. Studies should be performed to determine which and how many of the two methods should be employed.

It is believed that construction equipment either exists or can be obtained within the time schedule.

HARDWARE AVAILABILITY

Issues and Approach

The S.C.L. plan proposes various types of cars, describing and presenting limited specifications. The quantity of 1,000 cars is a determinant aspect of its availability. The use of simplified railroad signal system and driver on board, is significant. 600V D.C. power for the propelling and distribution system is also a significant consideration for equipment availability.

The task under consideration consists of the need to know how U.S. suppliers respond to the S.C.L. system requirement, specifically in terms of a three to sixteen years procurement phase, lead time and construction plans.

Findings

The dominant factor is the number of cars. A survey of the major suppliers indicates that in the time span allotted, and for the quantities stated, there is sufficient capacity, capability and incentive for producing the vehicles. Rough estimates of cost

indicate that this is higher than the cost stated in the S.C.L. proposal. The important issue is lead time. Approximately two to three years should be allocated to design, produce and test the cars.

A survey of U.S. suppliers of wayside, controls and communication equipment and guideway hardware indicates availability within the project schedule.

ENERGY

Issues and Approach

The energy to build the system, as well as to operate S.C.L. transit system, is an important consideration that could affect the electrical power in the area.

First, it is necessary to know how much energy is needed. This is accomplished by analysis and study, then compared with available power, in terms of future planned capacity, and estimates of the future demands in the area. The data is only available from the power suppliers of the area--Los Angeles Department of Water and Power, Southern California Edison, and others.

To plan and predict the power capacity for 1985-2000, and estimate the power demand in the Los Angeles area, is extremely difficult. The S.C.L. power requirements by 1990, might represent less than 2% of the demand.

Findings

The issue here is not with the power demands of the system. Although the calculations performed show a higher power demand than that stated in the S.C.L. proposal, the amount of power used by the S.C.L. systems is approximately two percent of the existing capability within the Los Angeles County area served by the Department of Water and Power and Southern California Edison Company. The issue is concerned with the general increasing power demand by consumers and the uncertain prospect of the power companies' ability to increase their capacity to keep in step with the increasing demand. While there appears to be an apparent power excess at present, this excess is illusionary in that power companies have 15-20% "down" time on their equipment on a continual basis. When this is subtracted, most of the excess disappears. The problem is that all of the future capacity is yet to be built.

In talks with the utility people, they feel that the S.C.L. line could entail additional generating capacity as is planned. Many express some doubt about their ability to meet total power demands because of the problems the industry is facing today.

The S.C.L. proposal considers the application of waste material power generating plants as an additional power source for the system. This concept is feasible and has been tried favorably in this country and overseas. The question is, will the Los Angeles Department of Water and Power in conjunction with Los Angeles County, establish this type of facility to serve the S.C.L. system?

SHOPS AND YARDS

Issues and Approach

The issue of the shops and yards for the S.C.L. is underestimated in the proposal. Planning and phasing maintenance facilities is a difficult task when the aspect of the final product and the interim steps is considered.

An evaluation of how other transit systems approach the needs for maintenance facilities and service with shops and yards, will permit identification of how S.C.L. should resolve and implement its needs.

Findings

The S.C.L. system operation represents a high efficiency transit system requiring an effective service and maintenance program that includes crews for service, maintenance and emergencies.

Based on the data in the S.C.L. proposal, it appears that at least sixteen miles of track are required just for storage of the vehicles. Even with high utilization factors, this would require about forty acres just for storage.

A service and maintenance plan must be established early in the development of the system. This plan should incorporate emergency service, approximately 10 to 12 off-line service facilities and two or more repair/overhaul facilities and yards, as well as an extensive parts inventory.

SUNSET COAST LINE FINANCIAL ANALYSIS EXECUTIVE SUMMARY

Evaluation Prepared by Stanford Research Institute

Stanford Research Institute reviewed the financial program portion of the Sunset Coast Line proposal presented to the Southern California Regional Transit District. The review was performed in a short period of time. It was based on data contained in the Coast Line proposal and additional information provided by consultants reviewing other portions of the proposal.

SUNSET COAST LINE PROPOSAL - FINANCIAL PROGRAM

Patronage:	1 million passengers per day.
Fares:	25¢ local and interurban, \$2.00 airporter, in 1976 dollars.
Fare Escalation:	none.
Operating Cost Escalation:	not explicit.
Construction Cost Escalation:	intended 10%; implicit rate below 8.5%.
Sales Tax Rate:	1%, with half reserved by 1987 for operations.
Sales Tax Revenue Escalation:	6.4%
Borrowing Terms:	8%, varying maturities.
Borrowing amount:	\$7.5 billion, 15 years.

Findings and Methodology

1. The growth factor of 6.4% stated in the proposal for sales tax revenues was reasonable and used in our analysis.
2. The patronage estimates on which fare revenues are calculated were deemed to be reasonable for purposes of financial analysis, but additional estimates 33% above and 33% below the assumed 1 million passengers per day at full system operation were also examined.
3. The construction cost inflation factor used in the analysis was stated to be 10%. However the inflation factor implicit in the calculations of the proposal in stating the cost of construction in future dollars was considerably below 10%, assuming a 15-year period for planning and construction. In our analysis we used a construction cost inflation rate of 8.5% per year.
4. The operating cost inflation factor was not explicitly stated in the Coast Line proposal. We used a 7 % rate.
5. Fare revenues were estimated in the proposal at a constant rate of 25 cents for local and interurban service and \$2.00 for airporter service, or a weighted average fare of 33 cents at full system operation. In our analysis we assumed the 1976 fares stated in the proposal would be escalated at the same rate as the increase in the Los Angeles Cost of Living Index, excluding food, or 3.2 percent. This gives a local fare structure at the beginning of operations in 1984 of 30 cents and a weighted average fare in that year of 42 cents. We also examined an alternative fare structure beginning operations in 1984 with a local fare of 50 cents and an airporter fare of \$4.00, and escalating at 3.2 percent thereafter.

6. The operating deficit of the system was calculated on a yearly basis for the growing number of miles in operation and related patronage and operating costs. The remaining deficit was financed by drawing, as necessary, from the 1/2 percent sales tax available to meet operating costs. The surplus available was applied to meeting construction costs.
7. Construction financing was derived from available sales tax receipts, after using the amount required to meet operating deficits up to a maximum of 1/2 percent, and borrowing.
8. Borrowing was assumed with 30 year maturities, at 7.5% interest, with equal annual debt service payments.
9. The amount of borrowing in any year was constrained to an assumed 1 percent of the amount of the total new issues projected for the national market for state and municipal bonds; and further constrained to be within 1/2 percent of the cumulative total of state and municipal bonds outstanding in each year. In addition, debt service from borrowing was required to have 1 1/4 times coverage from available sales tax receipts, after meeting operating deficits.
10. The construction schedule was constrained to be within the maximum yearly expenditures, as proposed by De Leuw, Cather in their analysis of the proposed system.

Conclusions

Based on these findings and analysis methods, the following conclusions were reached.

1. The system as proposed could not be financed in a 15-year period.
2. Financial constraints would require a period of up to 35 years to complete the system, under the 1% sales tax and assumptions used in our analysis. It would involve a construction cost of \$6.7 billion, expressed in 1976 dollars, and require an outstanding debt of \$16 billion by the end of construction in the year 2011.
3. Under the 1% sales tax, assuming the higher fare structure alternative, some design modifications and delay of a portion of the system, a 244 mile system could be financed in a 24 year period. It would incur construction costs of \$5.7 billion expressed in the 1976 dollars and require an outstanding debt of \$6.7 billion by the end of construction in 1994.
4. A sales tax of 1 1/2%, with up to 1/2% available for operation financing, would permit construction of the full system in 19 years with debt outstanding of \$4.2 billion at the end of construction in 1995. This assumes the basic escalating fare beginning at 30 cents in 1984.
5. A sales tax of 1 1/4%, coupled with the higher escalating fare, would permit construction of 244 miles of the modified system in 18 years with debt outstanding of \$4.2 billion at the end of construction in 1994.

SUMMARY OF FINANCIALLY FEASIBLE ALTERNATIVES

	<u>Full System</u>		<u>Modified System</u>	
	<u>1%</u>	<u>1 1/2%</u>	<u>1%</u>	<u>1 1/4%</u>
<u>Sales Tax Rate</u>				
Miles	281	281	244	244
Years	35	19	24	18
Construction Cost in 1976 Dollars	\$6.7 bn.	\$6.7 bn.	\$5.7 bn.	\$5.7 bn.
Debt at end of Construction	\$16 bn.	\$4.2 bn.	\$6.7 bn.	\$4.2 bn.

THE DISTRICT'S BUS SYSTEM
PRESENT AND PROJECTED STATUS AND FINANCIAL NEEDS

Evaluation Prepared by the Staff of the Southern
California Rapid Transit District

SUMMARY

The District's bus system has been expanded under County financial sponsorship and a Federal operating subsidy to meet a wide range of essential needs of a large portion of the County's population. It will continue to perform this function during the rail rapid transit development period and will be an essential element of an ultimate rail-bus system. To meet these present and future needs in the face of inflationary pressures, local financial support will be required in fiscal 1977 and an additional long-term support program must be secured through legislation.

DISCUSSION

The Southern California Rapid Transit District operates one of the largest public transportation systems in the nation. Although an all-bus system, it provides a wide variety of services tailored to the varying needs of the seven million people who live in the District. A grid of local bus lines cover the service area to provide inter- and intra-community service. Longer trips are served by limited stop interurban lines, many of which utilize the freeway system. A variety of expedited rush hour services, both regular lines and Park/Ride operations, meet the needs of the longer-haul commuters. A system of Mini-bus lines provide frequent circulation in the Central Business District, the Civic Center and the CRA redevelopment area.

The District's system provides service which is essential to large numbers of students, the elderly, and those who cannot readily provide themselves with private transportation. In increasing numbers, persons who do have a choice are also turning to public transportation. About one million passengers are now boarding District's buses each weekday.

The current effectiveness and consequent growing use of public transportation in Los Angeles County has been made possible by the support

of the County Board of Supervisors and a Federal operating subsidy, by the means of which the number of buses assigned to District services has increased from 1689 in January 1974 to a scheduled 2335 as of June 30, 1976. The increase of 646 buses has made it possible to meet the demand created by reduction of the base fare to 25¢ and the nearly complete elimination of incremental zone fares. It has also permitted the establishment of full coverage grid system services, expanded Park/Ride commuter services and expanded local circulation systems.

While the rapid expansion of the District's system has made new and improved service available to much of the entire County and reduced costs to the user, the financial problems involved in maintaining the system have been intensified. At the projected level of cost of operation for the next fiscal year, the 646 added buses will cost approximately \$52 million to maintain and operate. Offsetting passenger revenue will be some \$15 million. In addition, the inability to retire old buses has left the District with a pressing equipment replacement problem which must be met as soon as possible.

Fortunately, some of the District's needs for financial support of operations, resulting from the addition of new services, reduced fares and the impact of inflation upon operating costs, are being met by increased support funds from the Federal government, supplementing the aid provided by the County. However, it is essential that the District secure major new sources of assistance to enable the maintenance of its essential public service in future years.

The District's Board has under consideration a Five-Year Plan which was developed by the staff. This Plan, assuming only minor further expansions of service and the maintenance of present fares, forecasts that the pressures of inflation and the need for replacement equipment and capital facilities will require increasing amounts of new financial support in future years. The projected deficiencies range from \$34 million in the fiscal year ending June 30, 1977 to over \$100 million in the year ending June 30, 1981. These deficiencies cannot be substantially decreased by any feasible increase in rates of fare, and any substantial increase in patronage which may

occur will have the effect of increasing the deficiency. Any attempt to substantially reduce the deficiencies by service reductions would have a drastic impact upon the mobility of large segments of the population.

The Five-Year Plan concluded that legislative action, presumably at the State level, will be required to make available a reasonable level of support, and that the earliest period which might benefit from such action would be fiscal year 1977-1978. The maintenance of service during fiscal 1976-77 would appear to depend upon continuing support for the expanded service and reduced fare programs by the County and other local government sources.

Several sources of funds which might be sought through legislation were reviewed, including property tax, general sales tax, gasoline tax, motor vehicle license fee, personal income tax, and various excise taxes. Gasoline tax on a gallonage basis would require a constitutional amendment. A selective sales tax might be possible. Property tax would probably meet with major public reaction. If a general sales tax is preempted solely for rail rapid transit construction and operation, it would appear that an increase in the automobile license fee, relatively non-regressive and relatively out-of-phase with tax level trends since 1948, if enacted and allocated to transit operations support may offer best chance for adoption.

Regardless of the source which may be preferred, the time required to develop and carry out a program to secure legislative action makes it essential that the effort be initiated as soon as possible, in order that system support be secured for fiscal 1978 and following years.

While it would be difficult to underrate the importance of the District's bus system in meeting the needs of its hundreds of thousands of daily riders, the plan to develop a rail rapid transit system adds another dimension to the urgency of the need for its support. Not only will a strong bus system be required to serve as an auxiliary to the rail rapid transit system in terms of feeder service, but a very large proportion of the local trips made in the region will still require the full area coverage accessibility and the substantially door-to-door service characteristics of the bus system operating in the residential and commercial areas. It is probable that the total patronage by bus in the combined rail rapid transit-bus system will equal or exceed the levels of the present bus system.

EVALUATION OF SUNSET COAST LINE PROPOSAL
FINAL REPORT

PREPARED FOR
THE SOUTHERN CALIFORNIA RAPID TRANSIT DISTRICT

DE LEUW, CATHER & COMPANY

MARCH 12, 1976

DE LEUW, CATHER & COMPANY
ENGINEERS AND PLANNERS
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(213) 536-2010

12 March 1976

Mr. Ralph de la Cruz
Southern California Rapid Transit District
425 South Main Street
Los Angeles, California 90013

Subject: Evaluation of the Sunset Coast Line Proposal

Dear Mr. de la Cruz:

I am pleased to transmit forty copies of our final report. This is the second deliverable called for in our contract.

The evaluation of the Sunset Coast Line proposal was a challenging assignment and we felt privileged to be asked to participate in the effort. We will continue to be available to assist you and the Board with the evaluation of the proposal.

Sincerely yours,

DE LEUW, CATHER & COMPANY



E.S. Diamant
Staff Vice President

ESD:k

TABLE OF CONTENTS

	PAGE
ABSTRACT.....	i
INTRODUCTION	1-1
EVALUATION OF SYSTEM OPERATIONS.....	2-1
EVALUATION OF PROPOSED SYSTEM LOCATION.....	3-1
EVALUATION OF CONSTRUCTION RELATED ISSUES.....	4-1
CAPITAL COST EVALUATIONS.....	5-1
OPERATING COST EVALUATION.....	6-1
TECHNOLOGY EVALUATIONS.....	7-1
BUS FEEDER REQUIREMENTS.....	8-1
COST MODIFICATION	9-1

ABSTRACT

De Leuw Cather's evaluation of the Sunset Coast Line proposal's engineering and technical factors, capital and operating costs and factors related to the bus feeders produced the following findings:

- The proposed alignment of the Sunset Coast Line, predominantly along freeways, is physically feasible.
- The construction of the Sunset Coast Line in freeways will require the resolution of difficult engineering problems. In De Leuw, Cather's judgement these problems can be overcome but will require more time for implementation and more capital costs than stated in the Sunset Coast Line proposal.
- The construction of the Sunset Coast Line in freeways is largely achievable without extensive modification to the freeway system. The construction program will cause temporary inconvenience to motorists because of lane relocation, lane narrowing and attendant traffic slowdown.
- The Sunset Coast Line features local, interurban, and airporter service. Unless additional capital costs are committed for off-line stations or multiple trackage, the interurban trains would not provide faster transit service than that offered by the local trains. The retention of interurban service in the Sunset Coast Line proposal should, therefore, be reevaluated.
- The Sunset Coast Line proposal calls for the utilization of advanced-technology rail transit vehicles. This specification should be reevaluated as conventional equipment being currently produced for delivery to New York, Washington and elsewhere would be capable of providing the desired service with a minimum of modifications and considerably less additional cost and technological risk.
- The Sunset Coast Line proposal indicates that light rail and automated group rapid transit technology would be used for feeders.

This aspect of the proposal could not be evaluated adequately since specific data concerning the location of the fixed guideway feeders was not available. Utilization of light rail technology as an effective feeder depends on operational limitations caused by at-grade crossings of arterials. At those locations where the at-grade operation will not cause excessive degradation of service the light rail choice will appear to be advantageous. The use of group rapid transit technology for a majority of the feeders, as stated in the proposal, would require the deployment of developed but as yet not fully reliable automated technology for urban transit use. It is assumed that the technology applicable for these applications is provided by current industrial capabilities in the United States, such as the system produced by Westinghouse, LTV, Boeing, and Otis/TTD.

- The Sunset Coast Line proposal correctly states the facility unit costs but understates the cost of adapting the transit construction to the physical constraints of the freeways. As a result, the capital cost requirements for the mainline system in 1976 dollars are understated by as much as 40 percent.
- The Sunset Coast Line proposal underestimates the capital cost of fixed guideway feeders.
- The Sunset Coast Line proposal understates the operating and maintenance costs by 30 to 40 percent.
- The Sunset Coast Line proposal slightly underestimates the period required to design and construct the system. With effective project management and unimpaired availability of physical resources a 16 year program appears to be more reasonable. Excessive litigation or delays in reaching jurisdictional agreements may increase this forecast.
- Moderate reductions, of 10 to 15 percent, in the estimated capital cost of the Sunset Coast Line proposal are possible via certain design simplifications and deferrable capital expenditures which do not substantially impair the transit service as proposed.

- The deployment of the Sunset Coast Line is not likely to result in significant reduction of the bus fleet. It is likely that the bus feeder requirements to the widely spaced stations of this line will make a fleet increase necessary.

CHAPTER 1

INTRODUCTION

This report summarizes the findings of De Leuw, Cather & Company from its evaluation of the Sunset Coast Line proposal. This proposal, for the countywide transit system known as the Sunset Coast Line, (SCL), was prepared by Mr. Baxter Ward, Chairman of the Board of Supervisors and presented to the Southern California Rapid Transit District Board of Directors on January 28, 1976. De Leuw, Cather & Company, in conjunction with other consultants, was retained by the Board of Directors of the Southern California Rapid Transit District, to evaluate the SCL proposal. The results of this evaluation are intended to assist the Southern California Rapid Transit District Board in reaching a decision regarding the placement of this proposal on the ballot. Specifically, De Leuw, Cather & Company was charged with the responsibility of evaluating the proposal's engineering and technological factors, its capital and operating costs and the proposed bus feeder system.

In carrying out this evaluation, De Leuw, Cather & Company, (DCCO), has worked closely with the other consultants: Stanford Research Institute, which had the responsibility for evaluating the proposal's financial considerations; Gruen Associates, which had the responsibility for evaluating the proposal's environmental, urban design, and socioeconomic factors; and Mobility Systems, which was responsible for evaluating the proposal's implementation feasibility and other ancillary considerations.

In the course of the brief period devoted to the proposal's evaluation consultants frequently exchanged data and conclusions and generally collaborated in carrying out their respective responsibilities. To this extent DCCO's findings reflect significant inputs from Stanford Research Institute, Mobility Systems, and Gruen Associates.

There are certain limitations in the evaluation carried out by DCCO which should be recognized at the outset. Principal among these are the limitations of time and available data.

Less than three weeks were available for the evaluation of this comprehensive and far ranging proposal. As a result, the scope of DCCO's investigations, within the framework of its assigned responsibilities, was by necessity limited. In addition, only a limited amount of supporting data was available from the County. We found the supporting report prepared by Caltrans for Supervisor Baxter Ward's office to be particularly useful in their evaluation. Primary sources of additional data used by DCCO derived from previous transit studies carried out by numerous other consultants in the Los Angeles region as well as voluminous data developed by DCCO in the design of transit installations at other cities in the United States. The unavailability of patronage data should be noted. While its impact on the general conclusions drawn by DCCO and the other consultants were not considered to be particularly critical¹, the lack of patronage data contributed to the tentative nature of the conclusions reached with regards to the operational aspects of the proposed Sunset Coast Line.

Due to the severe time limitations, the evaluation methodology relied on a fair amount of analysis, employed similar and relevant data from other transit installations and stressed judgmental assessments. DCCO's assessment of the proposal's engineering and cost factors included cross-checking of data and details against available and reliable data sources, field investigations, analytical studies, application of available mathematical models and limited design evaluations.

The focus of this evaluation was the assessment of the proposal's feasibility and the reasonableness of the assumptions made and the conclusions drawn. While emphasis was placed on not carrying out evaluations of alternatives to the proposal, it was found necessary at times to evaluate minor variations of engineering, operations and other technical details in order to provide a fuller and more meaningful assessment of the Sunset Coast Line as described in the published document. Where these deviations have been used in the evaluation they are specifically cited in the discussion that follows.

¹ Evaluation of Sunset Coast Line Proposal - Preliminary Report, Prepared by De Leuw, Cather & Company, Gruen Associates, Mobility Systems, and Stanford Research Institute, February 25, 1976.

CHAPTER 2

EVALUATION OF SYSTEM OPERATIONS

The evaluation of the operational aspects of the SCL proposal is particularly difficult because of the absence of suitable transit patronage data. Although the proposal broadly describes the various types of service to be provided, the interpretation of the given data as it relates to the operational feasibility of the proposed system is particularly difficult. The evaluation required, therefore, that certain hypotheses be advanced and that certain assumptions be made that would enable DCCO to describe a feasible operational pattern and then use the results as a basis for estimating the operating costs. In making the necessary assumptions required by the analysis every effort was made to retain the basic philosophy of the proposal including among others the following points:

- The same level of service is to be provided throughout the entire transit system with equal weight being given to the peripheral segments as well as to the high density areas.
- The operational philosophy should lead to a high quality, high frequency transit service throughout the network.
- Extensive bus feeder service would be provided at all stations of the network.

DESCRIPTION OF THE OPERATIONAL ASPECTS OF THE PROPOSAL

The system described in the proposal consists of 230 miles of conventional rail transit in addition to the Union Station to Long Beach Starter Segment. A fixed guideway feeder system consisting of 15 separate segments would provide access to selected stations. Additional feeder service would be provided by RTD buses.

According to the proposal service on the mainline will be provided by three different forms of transit. Local service making stops at all stations would be provided by 148 trains of five vehicles each operating at headways of five minutes. A Red Car interurban system of trains would provide con-

nection between the more distant points of the regional network. It would consist of 40 trains of 5 cars each operating at headways of 30 minutes. In addition, the proposal calls for service to the L. A. International Airport on special airporter trains consisting of two cars each which originate at different points of the network at 30 minute headways. The proposal also calls for the provision of domed, bi-level cars and other specially designed cars for recreational travel purposes. The equipment would operate at a maximum speed of 85 mph on the mainline which reduces to an average of 55 to 60 mph for stations spaced approximately 2 1/2 miles apart. The interurban vehicles would have provisions for 75 seats while the local service vehicles would be sized for 110 seats and a maximum capacity of 200 passengers including standees. The airporter vehicles would only accommodate 50 seated passengers and would provide room for their baggage.

The proposal has estimated that the vehicle fleet would consist of 740 local service cars, 200 interurban service cars and 60 airporter vehicles. Sixty spare vehicles will be provided for a total fleet of 1060 vehicles.

SUPPLEMENTARY ASSUMPTIONS

In order to facilitate the operational analysis it was necessary to supplement the system description provided by the proposal. Certain assumptions were made concerning the daily patronage. This is discussed in more detail in the following section of this chapter. Additional assumptions were made concerning the operations of trains in stations and at interchanges. It was assumed that all stations would be located on line. This assumption prevents interurban and airporter trains from passing stations where local trains might be stopped. At interchanges it was assumed that only certain turning movements would be permitted. This assumption was founded on a number of hypothesized train routes. It had the effect of simplifying the geometric complexity of some of the interchanges illustrated in the proposal and thereby it reduced somewhat the total capital cost of the system.

In addition it was assumed that while the frequency of service was maintained as specified in the proposal the train lengths were not fixed but could be allowed to vary with diurnal demand. This assumption implies

that the equipment is easily assembled into trains of varying length as required by transit demand on each route and at various times during the day.

PATRONAGE ESTIMATES

The determination of the operational characteristics of the proposed SCL, including the required fleet size and the operating costs, is dependent on patronage forecasts. In principle, the patronage forecast should be given at each station and should reflect the characteristics and quality of the bus and fixed guideway feeder service.

The SCL proposal was prepared without the benefit of supporting patronage forecast. From the proposal's forecast for revenue, said to be \$2,025,000 per week on the basis of a 25¢ fare, it can be inferred that the authors of the proposal had in mind a weekday patronage in the range of one to one and a half million passengers.

A check of this estimate can be made by referring to previous computer projections made for large scale guideway networks proposed for the Los Angeles area. For example, in 1974 the LARTS forecast for the "R2A", 150 mile rail rapid transit network projected 610,000 daily trips,¹ assuming a SCAG region population of 13,900,000. This network is roughly comparable to that described in the SCL proposal. Principal differences exist in the coverage of the SCL network in areas of the County with low population density but these would not impact significantly the patronage forecast, i.e., it is not likely that the additional mileage would cause the projection to more than double. In addition it is noted that the 1974 estimate of 610,000 daily trips was based on calculations which assume an automobile operating cost of 5.76¢ per mile and a transit fare in excess of the 25¢ proposed for the SCL. In the light of current increases in automobile operating costs the 1974 projections would tend to understate the daily patronage. While current population projections are lower than the values used by LARTS a patronage for the SCL based on the current higher automobile operating costs and the assumed 25¢ fare, even for the basic network, should be in excess of the originally estimated 610,000 trips per day.

¹ "Technical Working Paper, Tasks 8.5.1 and 8.5.2, Evaluation and Analysis by Subarea and Total System of Basic System Concepts" prepared for SCRTD Study of Alternative Transit Corridors and Systems, May, 1974, p. 36.

An extrapolation of patronage and forecasts obtained from detailed computer models used for the Denver Metropolitan region for the year 2000,¹ was also used to firm up the projection of daily passenger trips. The characteristics of the year 2000 Denver Metropolitan model included a population of 2.5 million and a population density of about the same as that found in the developed portions of Los Angeles County. In the Denver analysis the rapid transit system was assumed to operate at top speeds in the range of 45 to 80 mph, 30¢ fares were used as a basis for estimating revenues and the transit lines were widely distributed throughout the metropolitan area. The perceived automobile operating costs were taken at 11¢ per mile and the proportion of guideway mileage to the level of the metropolitan population was about the same as that represented by the SCL proposal. The Denver analysis indicated that about 3400 daily trips could be expected for each two way mile of guideway. If the Denver estimates could be assumed to be roughly applicable to the Los Angeles County area some 970,000 daily trips would result. However, since the SCL utilizes freeways and other existing rights of way with the lines and stations located some distance from major activities, a situation somewhat at variance with the characteristics of the Denver analysis, it could be inferred that a rough estimate for the Los Angeles area forecast would be somewhere in the range of 900,000 trips per day.

Another approach to estimating the patronage can be arrived at by an examination of the bus ridership figures for the Los Angeles Metropolitan area. Currently, some 800,000 trips are made on the SCRTD buses. Because of the wide spacing of the Sunset Coast Line guideways it is unlikely that this volume will decline by more than 10 percent to 20 percent, if that service were to be in existence at this time. There is agreement among recent large model runs that areawide heavy rail systems less extensive than the Sunset Coast Line would capture about half of all transit trips. Similarly, the sub-mode split between bus and guideway predicted for area-wide guideway systems in the Denver region also suggests a 50 percent split between the buses and fixed guideway transit.

¹ "Patronage Results for the Analysis of Transit Alternatives for the Regional Transportation District", May 1975

On the basis of the reasonable agreement of all of these estimates, it was assumed for purposes of this evaluation that some 900,000 daily trips would be carried by the Sunset Coast Line. This assumption implies that an adequate bus feeder service would be provided at all stations of the system. The projection of 900,000 daily trips probably underestimates the effects of the fixed guideway systems, particularly in the intense activity centers, such as the Los Angeles CBD, the Century City-Westwood area, and certain locations in the San Fernando Valley, as well as in the South Bay commercial area. Much more reliable and detailed forecasts of patronage will eventually be required in order to place the operational estimates on a much firmer base than currently possible. However, the estimates made appear to be reasonable and sufficiently reliable for the purpose of this analysis.

This distribution of trips among station pairs is basic to system analysis since this determines the number of passengers per hour using each link, which in turn affects train lengths and headways. The relative fraction of trips between each station pair was extrapolated from a station-to-station trip table for the R2A LARTS projection. The trip table was a 73 by 73 matrix from a computer printout of January 25, 1974, which gave trips in production/attraction format. This trip table was adjusted for the different number and location of stations on the Sunset Coast Line and for the improved service to the airport. The trip table was then multiplied by a constant factor to bring the total number of daily trips up to 900,000.

OPERATIONS ANALYSIS

The operations of the SCL were analyzed with the aid of a macro-simulation computer program¹ developed by De Leuw, Cather. The program first determines passenger flow rates along each link in the network and along each service route. It then calculates the number of vehicles necessary to match capacity to demand at the peak load point. The program is called a macro-simulation because it only considers flow rates, and does not trace the movement of individual vehicles or passengers.

¹ "Automated Rapid Transit System Macro-Simulation-Program Documentation", report prepared for the Regional Transportation District, Denver, Colorado, June 1975.

The SCL was analyzed and modelled for the AM-peak-one-hour period. This gave fleet size and one-hour vehicle miles traveled. Daily and annual VMT was determined by using a factor of 8.5 to convert from peak-hour to daily statistics, and a factor of 310 to convert from daily to annual statistics. The origin-destination trip table for the AM-peak hour was developed by multiplying the daily Production-Attraction trip table by a factor of 0.18. This involved some degree of approximation since peak-period trips have different characteristics than off-peak trips.

Figure 1 shows the ten local service routes which were used in the computer analysis. In addition, ten airporter routes were included, but they accounted for only a small fraction of the VMT and fleet. No interurban routes were included. Due to time limitations, it was not possible to consider alternate sets of routes, and the ones shown in Figure 14 should not be taken as recommendations.

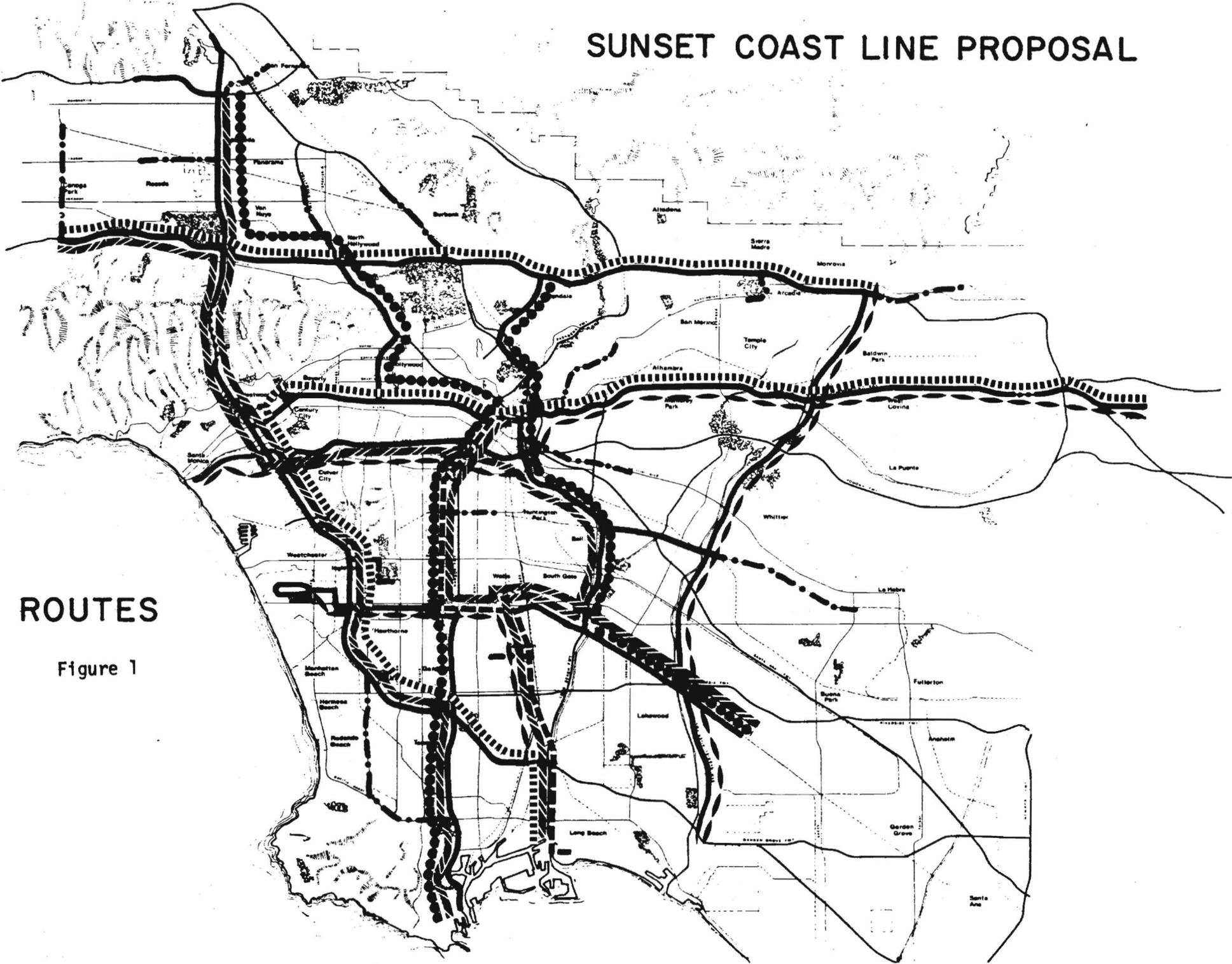
The following results were obtained from the analysis:

Fleet size	750
Annual VMT	100,000,000
Maximum link load	35,000/hour
Average vehicle speed	51 mph

The average vehicle speed includes station stops and slowing down to 30 mph for all interchanges. The maximum load occurred on the westbound link just west of Union Station. Since link loads are affected by the layout of service routes, the value of 35,000/hour probably would be reduced. However, if realized, this load could be carried by reducing the headway to less than two minutes. It is probably not possible to match capacity to demand at the peak load point for every route. It was assumed when determining fleet and VMT that a system-wide ratio of 85% between volume and capacity would be obtained at peak load points, averaged over all routes. This gave an annual VMT of 100 million and a fleet of 750. The fleet was increased to 1000 to account for vehicles which would be out of service while turning around at the ends of lines, the need for spares, and general operational inefficiencies.

A more detailed operational analysis taking into account practical operating limitations, costs and maintenance issues could produce a requirement for a larger fleet, e.g., on the average each of the 1000 vehicles

SUNSET COAST LINE PROPOSAL



ROUTES

Figure 1

2-7

called for by this analysis would operate more than 100,000 miles annually; this is two to three times more than experienced by current transit operators and might cause large increases in vehicle maintenance costs which could be offset by a larger fleet.

CHAPTER 3

EVALUATION OF PROPOSED SYSTEM LOCATION

The proposed SCL maximizes the use of existing transportation corridors. A predominant portion of the mainline network, some 186 miles, is located within existing or proposed freeways. The remainder is located along arterial streets - nineteen miles - or in railroad/river alignments, 17 miles. On one route, San Gabriel River Line, some 26 miles of mainline could alternatively be located on embankment along the San Gabriel River. Similar location alternatives may be found on portions of the other lines. Because some of the mainline segments could be replaced with feeders the total mileage of the mainline system may decrease by some ten miles, i.e., reduce to 220 miles as compared with the 230 miles cited on the proposal.

The principle of locating the transit lines along existing transportation corridors has some aspect of practicality in as much as it minimizes needs for private rights-of-way, people displacements and consequent disruption to the adjacent communities. However, because of established land use patterns in the adjacent communities it is more difficult and thereby more costly to develop the avenues of patron access to the system.

The evaluation of the engineering feasibility of locating the SCL within existing transportation corridors was a key feature of De Leuw, Cather's study. This assessment identified design opportunities, special design problems and provided the background for evaluating the capital costs and the construction feasibility of the regional system. The principal findings of this evaluation are summarized in this chapter.

LOCATION ON FREEWAYS

Freeways are by far the most prevalent form of existing transportation corridor in Los Angeles County. Many freeways are presently used to capacity and are developed as far as the dedicated right-of-way will allow. Medians are generally narrow most are about 22 feet in width, some considerably less, and only a few are 36 feet wide or more. Lanes are developed fully to the outside with narrow shoulders prevailing and overpass structures limiting further "easy" expansion in this direction. All freeways are well landscaped with most vegetation well developed. Construction work would be most difficult in the inner portions of the Santa Monica, Harbor and Hollywood Freeways

while the easiest would be in portions of the Foothill and San Bernadino Freeways and in part of the San Gabriel River Freeway. Freeway interchanges are large and complex structural configurations; this is particularly true where freeways interchange with each other.

Identification of Problem Areas

The colocation of the SCL within freeway rights-of-way requires that a wide spectrum of engineering problems be resolved. Principally these arise from the geometrical requirements of the transit system and the geometrical limitations of the existing freeways. The transit guideway structures are normally 30 feet wide for two tracks running side by side. Where the two tracks must be separated, the width of each guideway will be somewhat more than 15 feet. At stations the width requirements grow to 50-70 feet in order to accommodate the necessary platforms.

Locating a transit system within a freeway implies a transit alignment, both vertically and horizontally, which is similar to the freeway geometry. While most Los Angeles freeways are generously aligned, a transit operating speed of 85 mph requires a radius not less than 3400 feet. There are many areas where such a radius requirement cannot be met without costly framing of the freeway lanes. At these locations the operating speed should be reduced to match the existing freeway geometry. Problems with vertical gradients are not so prevalent. The transit system should be able to negotiate long grades of 4 percent. It is desirable not to increase the maximum grade to 6 percent except under extreme cost constraints since the increased steepness is likely to create operating problems for conventional rail transit equipment. Maintaining a predominant 4 percent grade in the alignment would require tunneling or deep cuts and high aerial structures through the Santa Monica mountains and at the San Jose hills.

A particularly sensitive problem in design of the guideway system which is likely to cause considerable incremental costs arises at freeway interchanges. The SCL proposal suggests that a number of guideway interchanges would be located in the general area of the freeway-to-freeway interchanges. The freeway interchanges, as it is well known, are complex tri-dimensional structures. Location of the transit line interchanges in the same area would

introduce additional complexities in the way of high structures, long span and special framing which will be not only costly but possibly result in adverse environmental reaction. Further consideration of the engineering problems that must be solved at interchanges will be the subject of a later section. For the moment it suffices to state that the worst situations occur at the Wilshire Boulevard/Harbor Freeway interchange, the Santa Monica/San Diego Freeway interchange, the Ventura/San Diego Freeway interchange and the Golden State/Santa Monica Freeway interchange.

There are certain areas away from the freeway-to-freeway interchanges where space within the existing freeway right-of-way is restricted and overpass structures occur so frequently that a coincident transit structure would be difficult to achieve. Much of the Santa Monica Freeway alignment is of this type and in particular the section between the Harbor Freeway and Golden State Freeway. A more cost effective alternative to this alignment may have to be searched for possibly along a parallel arterial. A structure along the freeway in this location would be very high and costly. The three level interchange at the Highway 90 intersection with the San Diego Freeway is another such area.

Evaluation of Interchanges

The SCL proposal identified the numerous interconnections among the system's lines. Interconnecting lines makes it possible to develop transit routes which connect most major origins and destinations in the County with a minimum of passenger transfers. Because of the considerable cost and environmental difficulties likely to arise in the actual design of the interchanges, it seemed desirable to identify a somewhat more restricted scheme for interconnecting the lines than shown in the SCL proposal. The scheme adopted for this evaluation would not severely impair the level of service specified in the proposal but would contribute to the general simplification of the design and the attendant implementation problems. The schematic in Figure 2 suggests the manner in which the interchange movements could be accomplished. Guideway interchange occur at 15 locations but none of these requires all interchange movements and six require only grade separated wyes. Passenger interchanges would only be made at four bi-level transfer stations, and 19 points of transfer between the feeder lines and the mainline are shown. In addition, connections to move vehicles to maintenance facilities are required.

SUNSET COAST LINE PROPOSAL

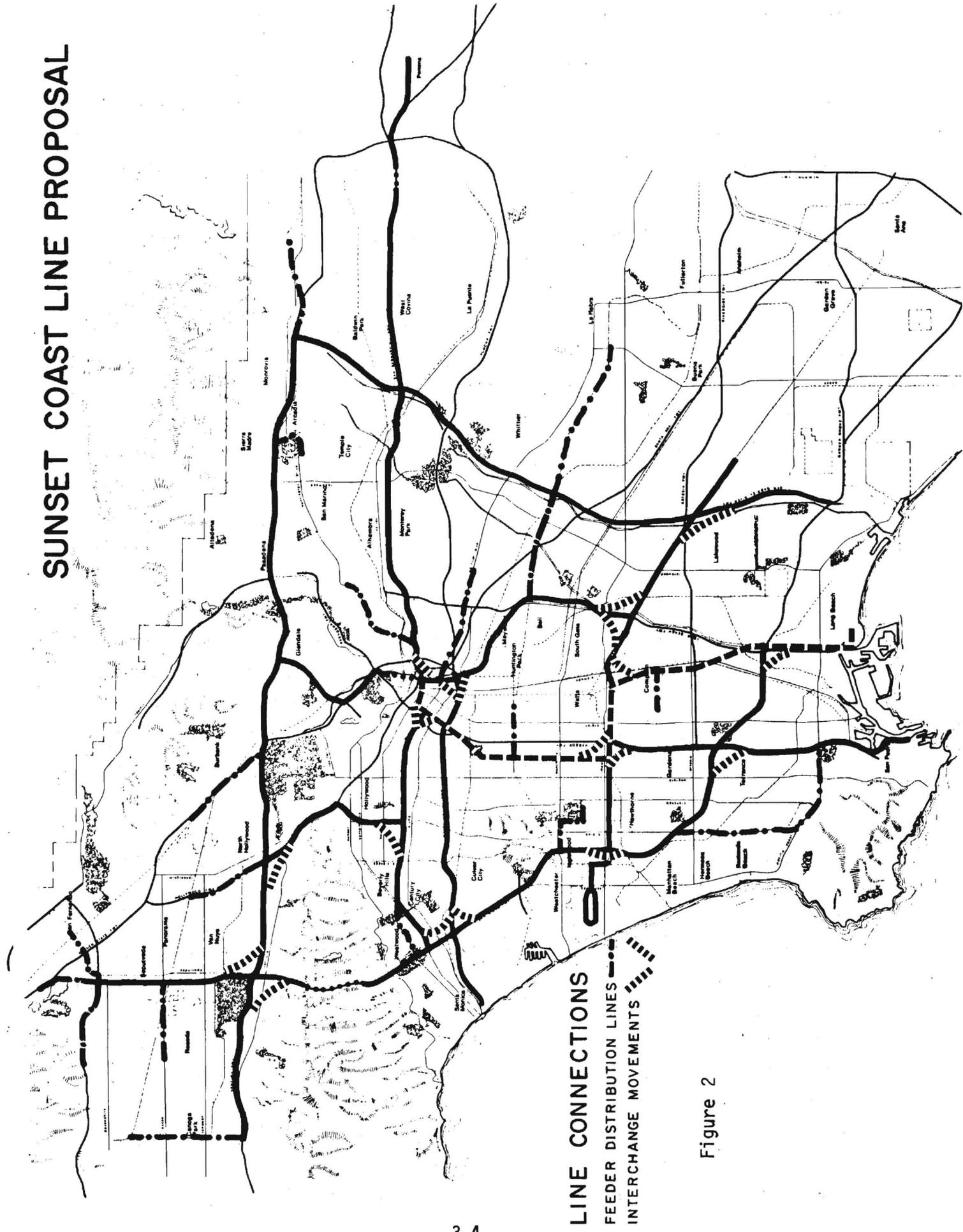


Figure 2

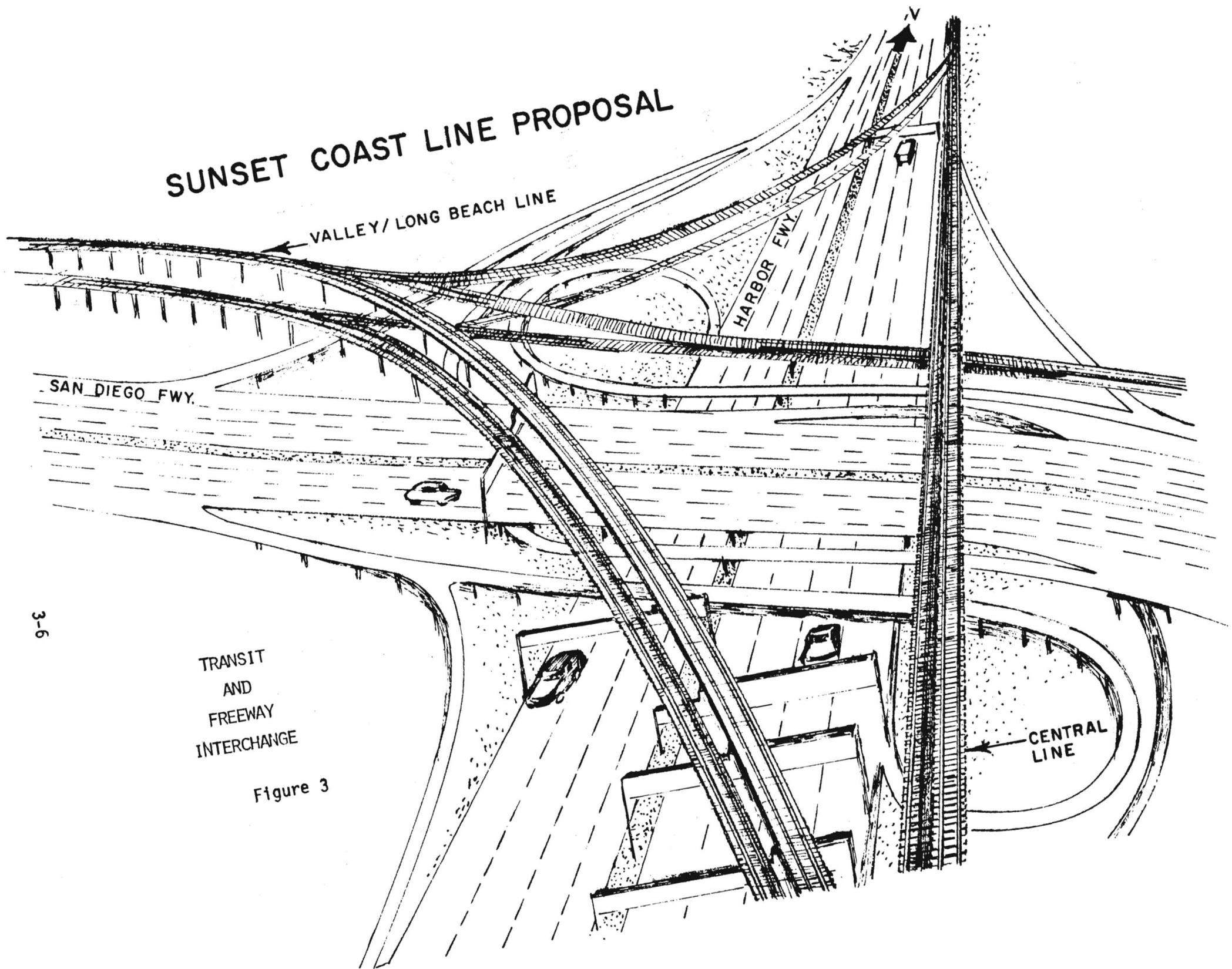
Transit operations at 85 mph and at the specified headways of 5 minutes or less, require that line intersections be grade separated in order to assure the highest adherence to the schedule of service and maintain safety. In addition a fairly advanced system of automated control would be required to control movements at interchanges.

At a transit interchange with four discrete interchange movements overlaying a two level freeway interchange, the resulting structure would be non-standard and costly because of construction accessibility problems. Such non-standard areas would extend up to a half a mile in either direction from the intersection point. Many multi-level frame supports could be required; spans would be over the 150 foot range, and the highest point of the guideway would be more than 65 feet above the freeway service level. In order to reduce traffic impacts it is likely that steel construction would be required. Precast concrete elements would be non-standard and very heavy requiring special equipment for transportation and erection. Cast in place concrete would necessitate elaborate falsework and result in severe traffic disruption.

An alternative to the above described site situation would be to relocate the guideway approach away from the freeway right-of-way interchanging in a less congested location. This procedure could simplify construction costs and alleviate motorist impacts but would involve considerable property acquisition. In our judgment, location alternative studies coupled with cost analysis are important first steps to selecting the final location for the interchange.

To better assess the specific engineering problems of interchange design, the Harbor/San Diego Freeway interchange, which can be classified as moderately complex, was selected for more detailed evaluation. A schematic of a possible configuration, albeit an expensive solution to the problem, is shown in Figure 3. The results of the Harbor/San Diego Freeway interchange study were then used as a guide to categorize and estimate the costs of other simpler or more complex interchanges. Among the latter we wish to call attention to the interchange between the Wilshire and the Starter Lines. The Starter Line at this point is in subway and it is anticipated that the interchange would also be underground. It is not possible at this time to address the feasibility and cost of this interchange but it can be inferred from similar structures constructed elsewhere that it is likely to be expensive due to its complexity, the geometry and the difficulty

SUNSET COAST LINE PROPOSAL



3-6

TRANSIT
AND
FREEWAY
INTERCHANGE

Figure 3

of using low cost tunneling construction techniques for a structure of this scale.

Median and Shoulder Locations

The SCL proposal indicates that the guideway would be located either in the freeway median or on the freeway shoulders. A considerable fraction of the system would be located at grade in the median. Where physical circumstances permit it, the configuration would appear as shown in Figure 4.

Where the width of the median or the construction of the overpasses prevents the at-grade emplacement of the track, aerial structures would be used. A graphic representation of this type of design is shown in Figure 5. The reduction to practice of the aerial-structure-in-freeway concept is illustrated in Figure 6 which shows a portion of the transit guideway on the Dan Ryan Expressway in Chicago north of the 18th Street station. An illustration of a modern aerial guideway design is shown in Figure 7 taken from the recently completed Washington Metro line extension to the Washington National airport. Structures of this type could be erected along medians without frequent overpasses; the latter would require much higher columns as shown in Figure 5.

The dilemma of median versus shoulder location is one of environmental impact rather than cost. In most cases where this question arises, the guideway would be in an aerial configuration. Column heights will be similar in either location although longer spans or framing will be required for the shoulder location where freeway ramps must be spanned. Figure 8 shows how a guideway might appear on a freeway shoulder.

A median location has a greater impact on traffic operations and safety because of the prevalence of generally narrow medians (usually 20-22 feet). Columns for high structures spanning overpasses will probably be of the order of six to eight feet in width. As such, the remaining inside shoulders would be about seven feet wide, measured from edge of running lane to the protective barrier. Traffic impacts during construction may be more severe for the median location depending on whether construction access to the freeway is available from adjacent property.

Figure 4

SUNSET COAST LINE PROPOSAL MEDIAN GUIDEWAY AT UNDERPASS

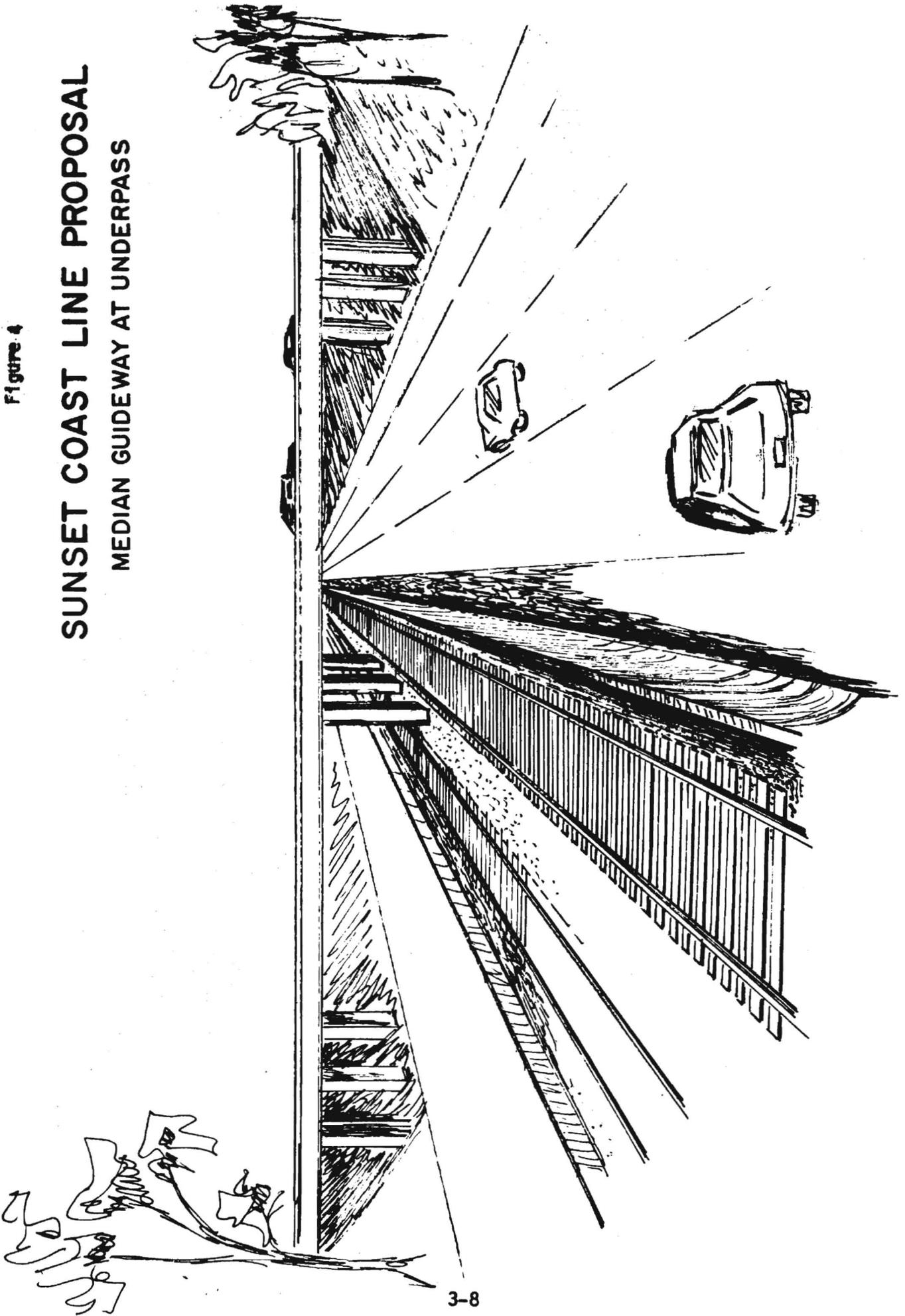
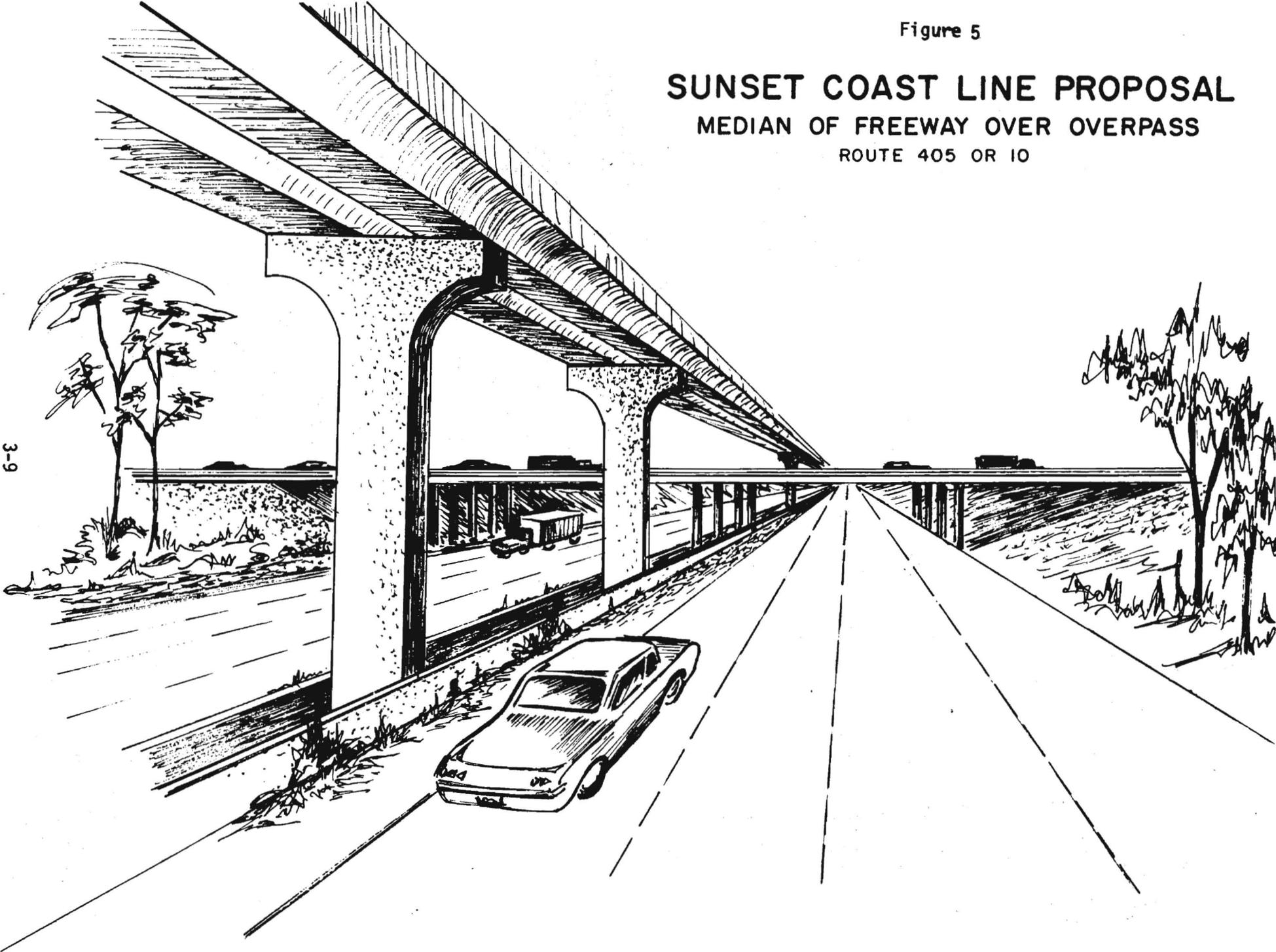


Figure 5

SUNSET COAST LINE PROPOSAL
MEDIAN OF FREEWAY OVER OVERPASS
ROUTE 405 OR 10

3-9



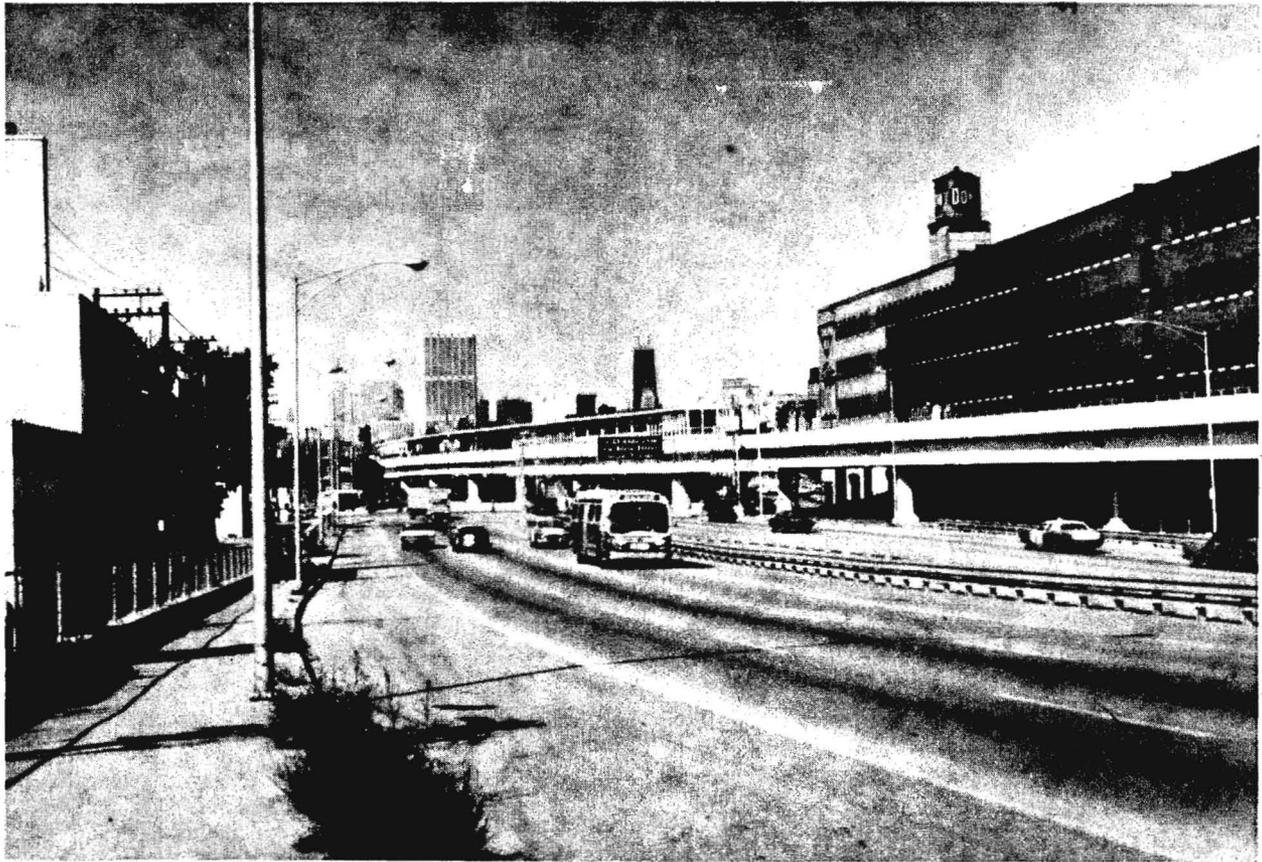


Figure 6

AERIAL GUIDEWAY STRUCTURE IN FREEWAY
- Dan Ryan Expressway, Chicago -

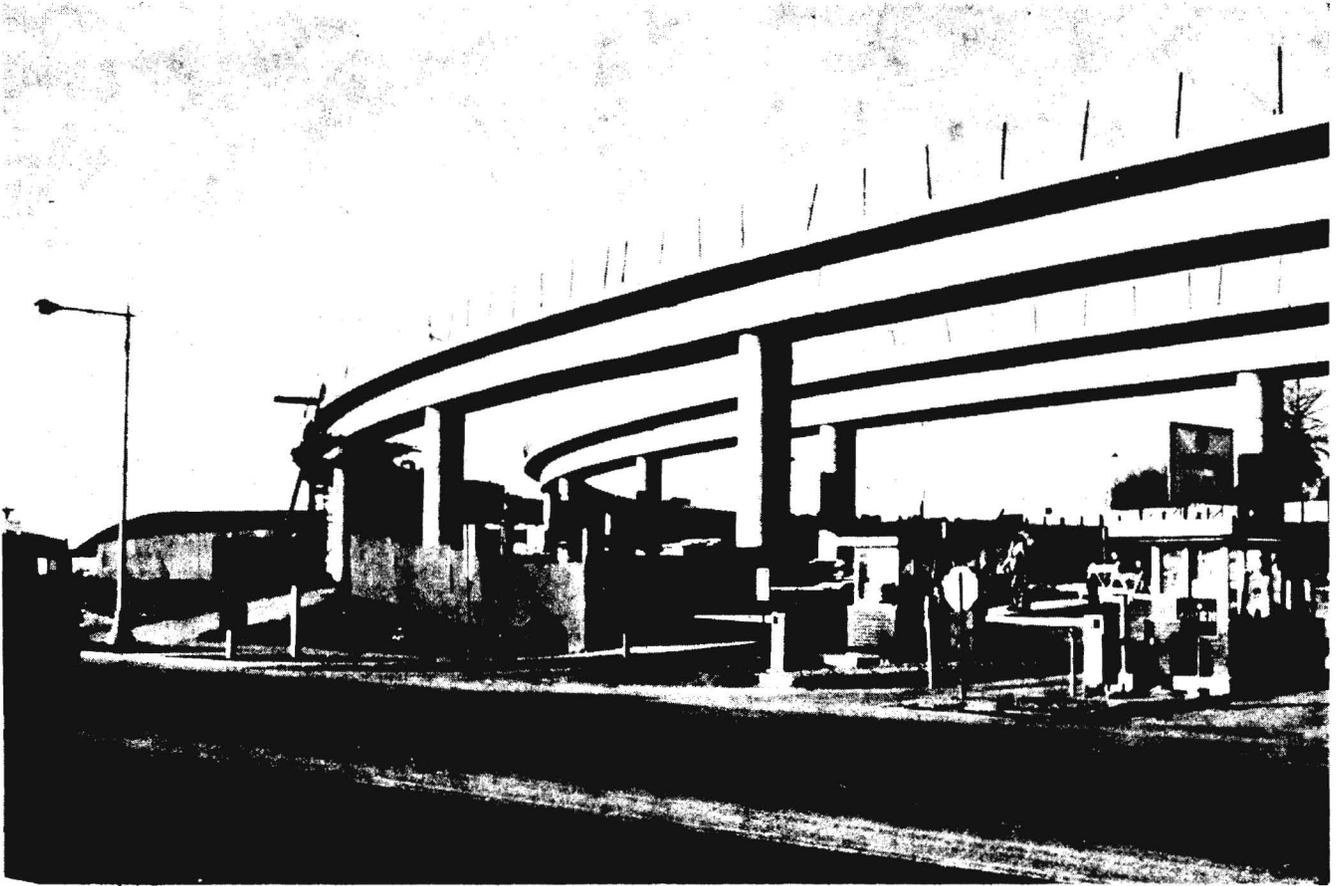


Figure 7
AERIAL GUIDEWAY STRUCTURES
- Washington Metro -

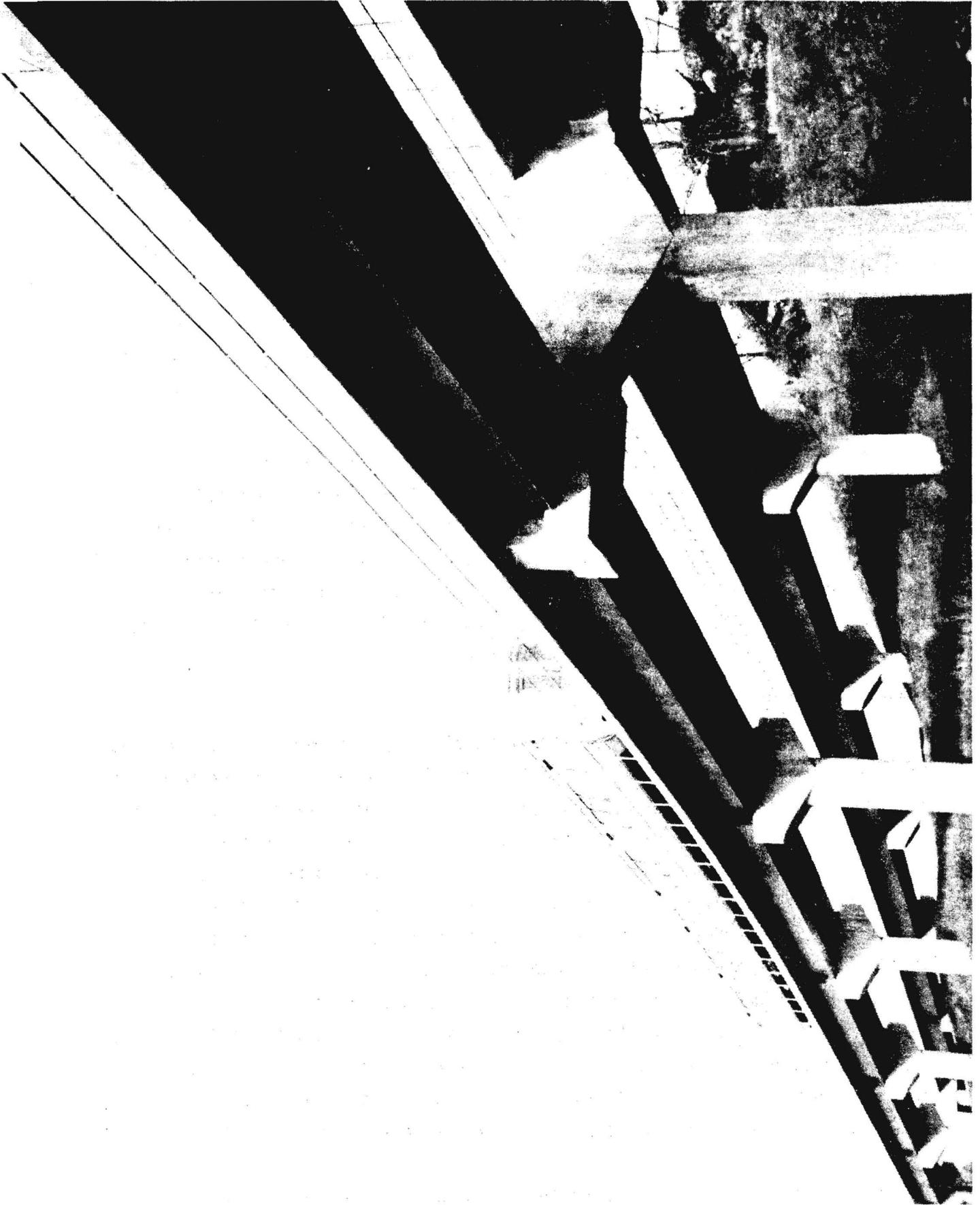


Figure 8 AERIAL TRANSIT GUIDEWAY - Washington Metro

The major problems with shoulder alignments are the adverse impacts to the property adjacent to the freeway. As stated earlier, most of the freeways are well landscaped with many mature trees. Construction adjacent to the shoulder would essentially remove such vegetation and expose properties to the full visual and noise impact of the freeway. In addition, there would be adverse visual and noise impacts from the transit line. Such an alignment may well necessitate additional property acquisition particularly in residential areas.

Despite the problems described above, it is judged feasible to physically locate an aerial transit guideway within the freeway right-of-way. Whether a median or shoulder location is better will depend on the specific circumstances at each section of the transit line.

There are a few areas within the network where existing or proposed freeway lanes can be dedicated to transit immediately and permanently. These occur along the Ventura Freeway and the yet to be constructed Century Freeway. In these locations, guideways can be easily constructed at grade within the medians. More difficult at-grade construction can be anticipated along the eastern segments of the Inter-Valley Line especially where the elevation of the freeway lanes opposing one another are different.

Freeway Widening

An alternative to aerial construction along the freeways is to add lanes to each side of the freeway, freeing the interior space left in the median to construct the transit line at grade (Figure 9). In most areas this is not a reasonable alternative due to the fact that the freeways are now fully developed within the right-of-way. Such a scheme would generally cause landscaping to be removed and freeway ramps, underpasses and overpasses to be reconstructed. For most freeways this alternative could be more expensive and less environmentally acceptable than an aerial configuration within the median. The northern end of the San Gabriel river line, however, is one place where this type of construction might be best used, and it has been assumed for the segment between the Foothill Freeway and the Artesia Freeway. Freeway widening was also assumed at two other locations in accordance with recommendations made by Caltrans¹ as shown in Figure 13.

¹Caltrans report to Supervisor Baxter Ward, dated 29 January 1976

SUNSET COAST LINE PROPOSAL

AT-GRADE GUIDEWAY WITH LANE WIDENING

(MEDIAN OF FREEWAY)

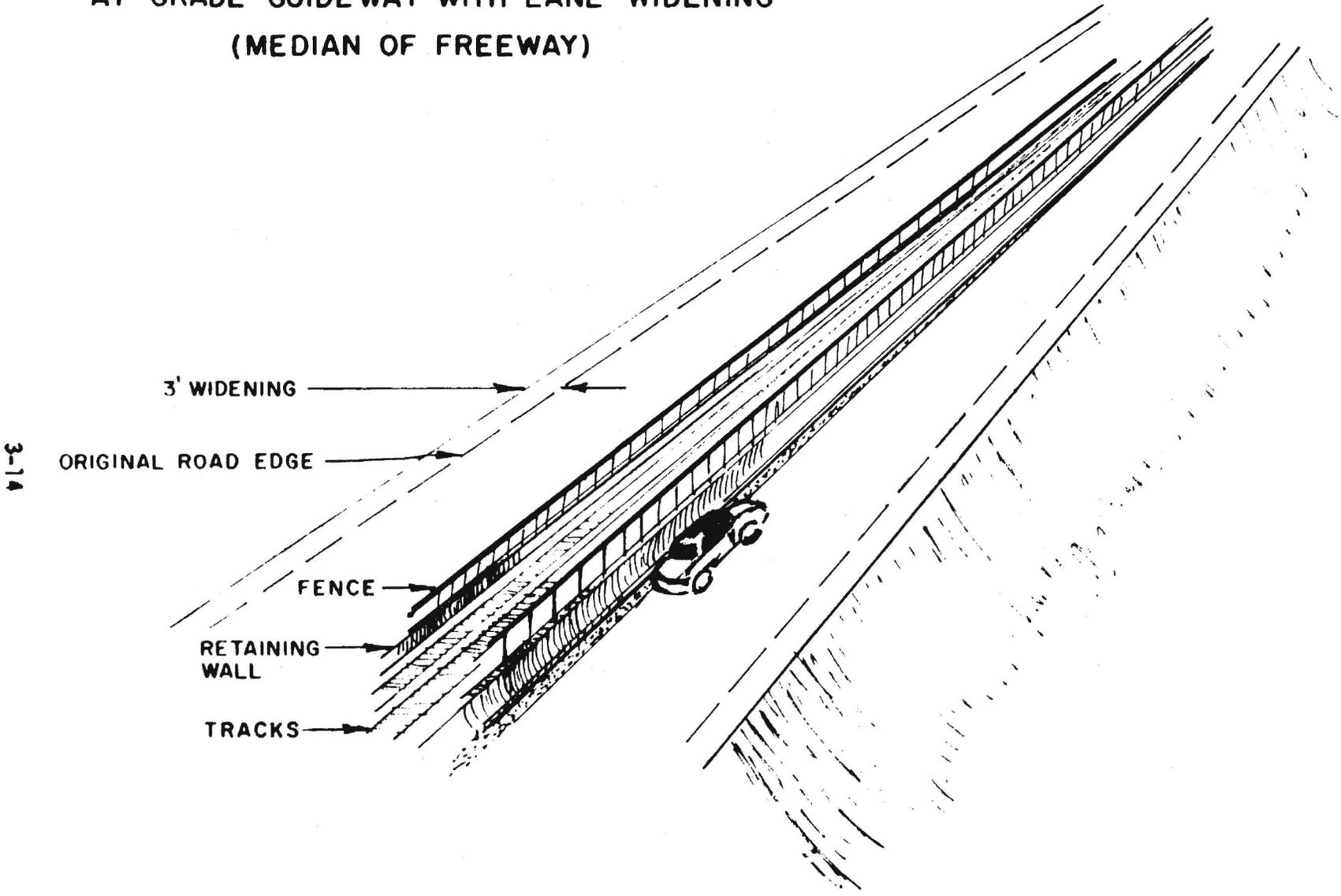


Figure 9

A graphical representation of the various levels of engineering difficulties for all the SCL lines is shown in Figure 10. This sketch summarizes De Leuw, Cather's analysis and field surveys and is generally consistent with the findings of the Caltrans report. The various symbols used in Figure 10 indicate that while there are no locations which would physically prevent the location of the SCL there are several segments of very difficult construction as well as substantial mileage of moderate or routine construction difficulty.

DCCO's assessment of the SCL's engineering issues also identified several segments which could benefit from changes in the vertical configuration of the guideway. These are shown in Figure 11. The suggested changes are not substantial but would result in some reduction in capital cost.

Stations

The SCL proposal envisions 89 stations located on the mainline. The alignment within the freeway often places the transit trackage a considerable distance away from the adjacent surface streets. Access would be difficult for pedestrians as well as for commuter buses unless special provisions were made requiring in some instances, the availability of freeway frontage. In some cases it may well be necessary to acquire property and construct special access. Parking lots will also require access from the surface street system. For transit lines located within freeway medians, passenger bridges will be required from the adjacent edges of the freeway. Mitigating this requirement is the observation that access can reasonably be provided from both sides of the freeway. The importance of this design aspect may be gauged by reference to the Dan Ryan Line in Chicago where it has been proposed that parking decks be constructed over the freeway with direct access provided to stations. Obviously, a design approach of this kind would have serious cost implications.

An alternative to the above design concept is to swing the transit line out of the freeway on to an adjacent property. This requires special structures and additional property acquisition but may be the only feasible alternative in locations where the freeway is very wide or very high.

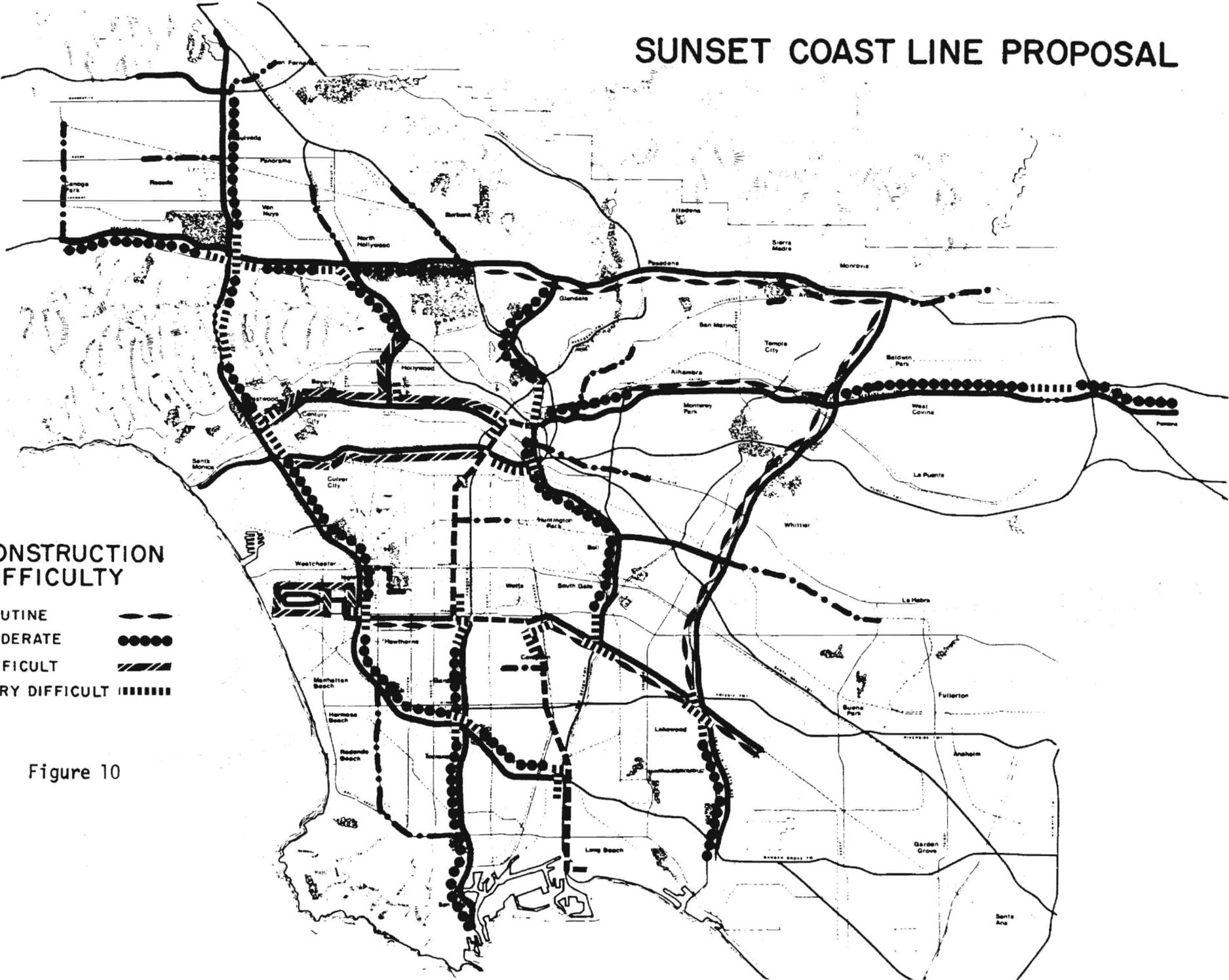
SUNSET COAST LINE PROPOSAL

3-16

CONSTRUCTION DIFFICULTY

- ROUTINE 
- MODERATE 
- DIFFICULT 
- VERY DIFFICULT 

Figure 10



For transit lines at grade in the median, freeway widening will be required to accommodate the station tracks and platforms. This factor may force station locations away from interchanges with local streets, impairing the accessibility to the stations.

There are several locations where stations provide for passenger transfers only. These call for a four track arrangement with two platforms connected via concourses on mezzanines. The platforms may be stacked vertically or located adjacent to each other on one level depending on the particular site conditions for each station.

LOCATION ON RAILROAD OR FLOOD CANAL RIGHT-OF-WAY

Excluding the Starter Line, only 17 miles or about 8 percent of the mainline system is currently located on railroad or flood canal right-of-way. No unusual design and construction problems are anticipated for this part of the system except as noted below. Techniques for collocating transit guideways in railroad right-of-way are well established (Figure 12).

The only difficult portion of this part of the system is on the section of the Central Line between the Pasadena Freeway and Union Station. Here it is anticipated that the guideway will be constructed in subway due to the congested railroad tracks, street crossings and dense development. Other railroad aerial or river alignments are routine requiring aerial or at-grade structures. The at-grade structures will have sections of embankments with overpasses as required for the main surface streets. A difficult transit interchange is required where the Airport Line intersects the San Gabriel River Freeway Line. At this location the freeway is quite high passing over the Southern Pacific Railroad tracks.

LOCATION ON SURFACE STREETS

Parts of the mainline system located on surface streets occur principally on the Wilshire and La Brea Lines. Other such construction is proposed for the Century City Line and the Airport Line. These parts of the system total approximately 19 miles or 9 percent of the mainline system excluding the Starter Line. It is also anticipated that much of the feeder system will be constructed on surface streets.



Figure 12 TRANSIT GUIDEWAY AND STATION IN RAILROAD RIGHT-OF-WAY - Washington Metro

Since the portions of the SCL proposal located on surface streets are principally associated with allocations of budgets to the various cities, and with a certain lack of precise definition of the design, no locational analysis was made, in these instances. It would be generally expected that typical engineering problems encountered in other cities with modern transit guideway structures would also be experienced in this area. These would include environmental concerns such as the aesthetics of the guideway and the supporting columns or frames, the abatement of noise, lighting and shadowing effects, etc.

The proposal states that during the initial few years of the project the cities will be responsible for design details of these segments of the system. In the absence of a more concrete description of the proposed facilities it was felt that no specific evaluation of engineering and cost factors should be made as part of this analysis. The report will limit itself only to the citation of the budgets allocated by the SCL proposal for the various surface elements.

CHAPTER 4

EVALUATION OF CONSTRUCTION RELATED ISSUES

Some 84 percent of the SCL mainline system, excluding the Starter Line, is located along existing or future freeways and a further 9 percent would be located along surface streets. There can be no doubt that the greatest perceived impact during construction will be to the traffic on Los Angeles' major traffic arterials. By proposing that the SCL be primarily located on freeways there is an advantageous reduction in construction-related displacement impacts. This chapter summarizes DCCO's findings regarding the extent and mitigations of construction-induced impacts on freeways. It also presents an assessment of the proposed implementation schedule.

Motorist Impacts

Most of the alignment along freeways will be aerial and for these line sections the only permanent additions at traffic level are the supporting columns. In a permanent sense these columns will affect the lateral clearances from running lanes and will interfere with sight distances. These changes must be coordinated with and approved by Caltrans.

In areas where travel lanes are dedicated to transit initially and permanently, or where freeways are widened in preparation for transit construction, a permanent impact to traffic will not occur. In such areas the temporary impact during construction will not be severe, as normal width travel lanes and shoulders will be maintained. Transportation of construction materials could be scheduled for off-peak hours. Staging areas could be set up off the freeway with most material storage and equipment space being maintained within the dedicated transit right-of-way. Traffic slow-down should only occur as it relates to motorists slowing down to observe some new activity.

Severe traffic impacts can be expected to occur during the construction of aerial transit structures either in the median or adjacent to the shoulder of fully developed freeways. The assumptions made in this review include the mandatory use of at least one travel lane for this type of construction.

This lane may generally be selected from either side of the freeway depending on any traffic or construction related advantages that could be obtained. For a median location, the lane appropriated would be the high speed lane adjacent to the median. For a shoulder transit alignment, the lane appropriated would be adjacent to the applicable shoulder. In this case, entry and exit ramps would be projected through to the next lane. A concrete barrier would be set up near the edge of the appropriated lane and the lane will be used for construction related access along the site. For a shoulder alignment, where construction access is possible from adjacent property, this lane may not have to be taken.

By utilizing all available space including shoulders and lateral clearance distances to bridge abutments and columns, it may be possible to rearrange the remaining part of the freeway in such a manner as to replace the lane taken for construction. This will require the use of narrow lanes (10 or 11 feet) and additional temporary paving up to existing barriers, berms, bridge abutments and piers. This procedure is similar to that used now for freeway maintenance or widening but some degradation of freeway capacity is expected. A speed reduction to about 30 mph can be expected at all times due to the substandard conditions in the area of construction. It is the slowdown that will be perceived as the major impact to traffic and source of annoyance to freeway users.

The situation on the freeway may be somewhat alleviated by the upgrading of parallel arterials or the introduction of contraflow lanes. Operation of reversible lanes is however quite costly and has not been considered in this analysis. Traffic impact studies for the express purpose of preparing a traffic plan during construction should be undertaken to accurately define the costs and other impacts of such proposals.

Preparatory widening of the freeways in order to eliminate transit related construction impacts will itself produce similar motorists impacts. However, if in the time span required to complete this project some of the older freeways have to be rebuilt or receive major maintenance, it might be possible to combine that work with the preparatory widening and so reduce the impact associated with the construction of the transit guideway.

A construction contract for a typical five mile section along a freeway would ordinarily be expected to take two to three years to complete. The implementation schedule called for in the SCL proposal would require concurrent contracts. Thus at any single time it could be expected that about 20 to 40 miles of freeway would be impacted by construction. Figure 13 shows the aggregate impact of constructing the SCL on Los Angeles freeways. Many of the most congested freeways, in particular the San Diego and Santa Monica Freeways, would suffer the loss of a lane for construction. Permanent lane loss, as suggested by CALTRANS, could occur on the Foothill Freeway and the San Bernardino Freeway with possible freeway widening taking place on the San Gabriel River Freeway and the Harbor Freeway.

Staging and Timing of Construction

Given the magnitude of the SCL proposal, it is estimated that the planning, design and construction could not be accomplished in less than a total of 16 years. This estimate assumes no constraints imposed by bonding or financing considerations. It allows for an average amount of time to gain federal, state, regional and local agreements. It is impossible to accurately estimate potential delays arising out of difficulty in obtaining such agreements but experience has shown that long delays can result, particularly in reaching agreements with the railroads for joint use of their right-of-way. The absence of federal funding requirements should, however, tend to simplify the process and reduce some of the delays.

For estimating the time of implementation, the project has been broken down into administration, preliminary design, final design, construction and equipment purchase and construction management phases. It is estimated that administration start-up will take 12 months and administrative work will carry through the entire project at a constant level. Preliminary design can begin after six months, will build up over the next six months and continue through the first five years of the project. Minor planning and preliminary design work will be required through out the remainder of the program. Final design work in straightforward areas can begin in the third year. This will build up and continue through the eighth year of the program

SUNSET COAST LINE PROPOSAL

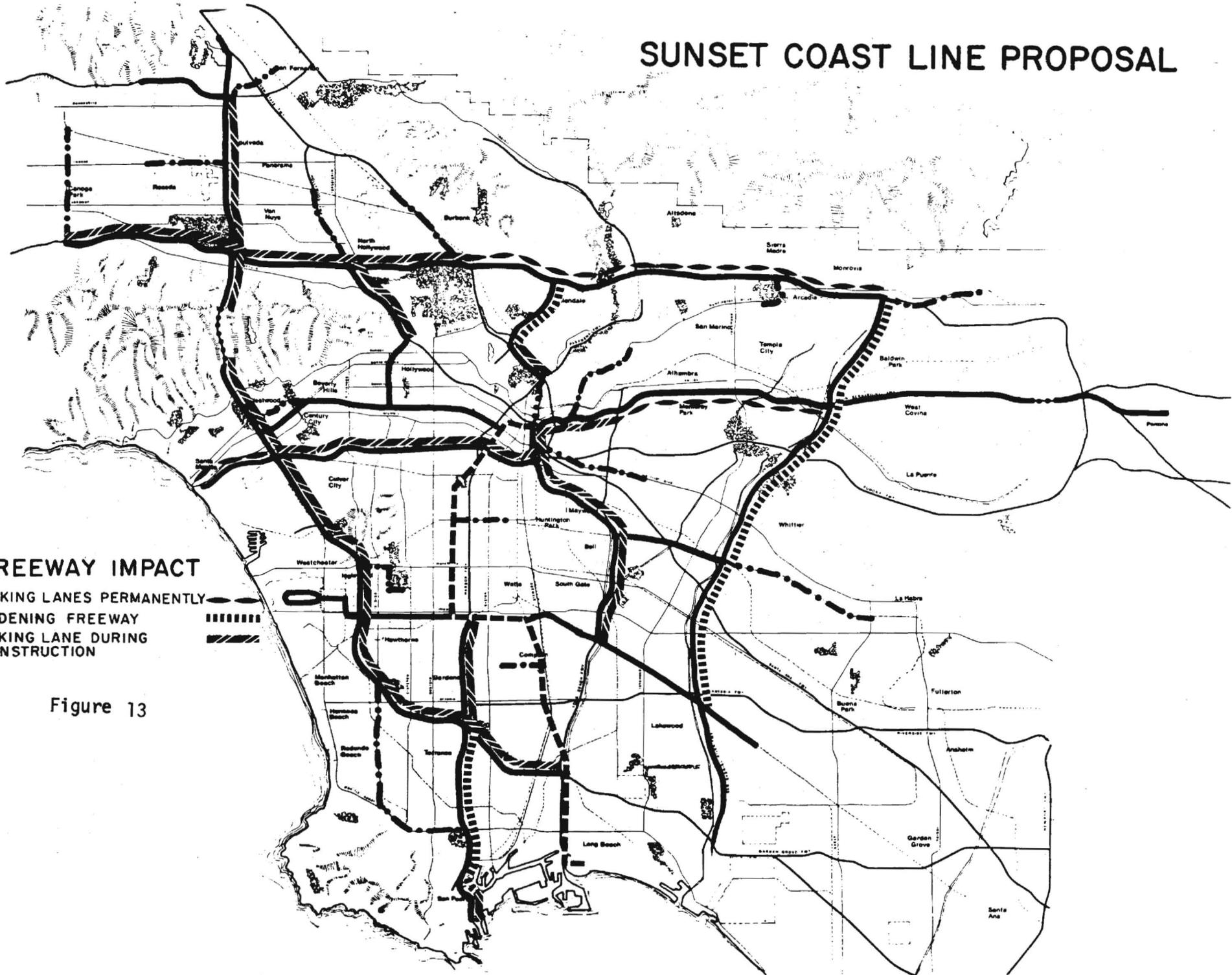
4-4

FREEWAY IMPACT

TAKING LANES PERMANENTLY
WIDENING FREEWAY
TAKING LANE DURING CONSTRUCTION



Figure 13



and taper off through approximately the fourteenth year. Construction management activities should start at about the same time as final design but will continue through to the end of the project. Construction and equipment purchase activities should be able to start during the fourth year of the program, build up through the end of the seventh year, continue at peak level through the twelfth year and taper off to the end of the program. Figure 14 shows the distribution of engineering, administration, design and construction activities envisioned for the duration of the implementation program.

Allowing one full year for pre-operation shakedown and testing, revenue operations should start toward the end of the eighth year and build to full system operations by the end of the seventeenth year.

The time estimate for construction was developed by two alternative methods which showed reasonable agreement. A review of industry experience showed that the Los Angeles transit construction peak capacity would be in the order of \$500 to \$750 million per year. Allowing for construction build up, this results in a total construction time of 11.5 to 17 years. An alternative analysis based on the number of contracts and rate of contract letting indicated a total construction time of 11 to 14.5 years. As a result of these analyses, a construction span of 13 years has been assumed in the implementation schedule and staging of costs. The pre-planning and preliminary design time of five years allows for the development of state and local agreements and the development of environmental impact statements and public hearings. The implementation schedule as described calls for full approvals on the first construction segment by about midway of the third year. This should be achievable as long as the first segments chosen do not present difficult engineering or environmental issues.

The average construction contract should be about four to five miles in length and the time to complete about two to three years. At the peak construction period, 20 to 40 miles of mainline construction would be underway at any single time and concurrent mainline construction contracts may total one billion dollars (in 1976 dollars) with annual mainline construction expenditure at about \$500 million (1976 dollars).

CHAPTER 5

CAPITAL COST EVALUATIONS

The evaluation of the SCL capital costs included a review of the unit costs and an estimation of segment and line costs. Total system costs were then estimated including all line costs, equipment costs and usual allowances. The most sensitive part of this evaluation involved the re-estimation of segment and line costs. It is at this point that engineering judgement and practical experience is applied to correctly apportion the various unit costs in line with anticipated engineering and construction requirements caused by the physical characteristics of the right-of-way.

This chapter summarizes DCCO's findings with regards to all of the items of capital cost.

EVALUATION OF UNIT COSTS AS DESCRIBED IN THE PROPOSAL

The SCL proposal presents unit costs for a variety of mainline configurations. Some, but not all, of these have been used to develop the line by line costs. In general, the indicated unit costs were found to be acceptable except as noted. While they are sufficient for routine or straightforward design situations, application to the network requires a clear understanding of the limitations inherent in the basic units and an appreciation of the engineering issues. The methodology used in the evaluation of system costs will be treated in a later section.

- Tunneling

The stated unit cost of tunneling of \$24.6 million per dual track mile seems to be appropriate for segments such as the Valley/Long Beach Line through the Santa Monica Mountains and will cover the cost of boring, lining, tunnel drainage, ventilation and miscellaneous mechanical and electrical.

- At-grade Guideways

The SCL proposal indicates at-grade guideway unit costs varying from \$230,000 per dual track mile for freeway lanes to \$8 million per dual track mile for retained cut structures. The estimate for construction in freeway medians or on freeway lanes is much too low. In virtually all cases retained earthworks, special traffic barriers and control facilities, pavement removal, drainage restructuring subbase placement and freeway sign relocation will be required to varying degrees. A basic unit cost for this work was estimated at \$2 million per dual track mile applicable, for instance, along sections of the Foothill Freeway from Arcadia to the San Gabriel River Freeway. Where minor freeway widening is required in addition to this basic construction, typically for the Foothill Freeway alignment from the Golden State to the Glendale Freeway, the cost was estimated about \$3.5 million per dual track mile. Locations on freeways such as on the San Gabriel River Line requiring the reconstruction of overpass structures at moderate, (3/4 mile), spacing increase the estimate to about \$4.1 million per mile. At-grade structures within fully developed and highly congested freeways will cost at least as much as aerial construction and have not been recommended. The unit costs for retained cut or fill suggested in the SCL proposal are adequate but have not been used by the authors of the proposal in the development of line costs.

- Utility Relocation

The SCL proposal suggests costs for utility relocation ranging from \$2 million to \$5 million per mile. Except in urban arterial streets these costs are adequate and possibly high. However, the SCL alignment contains only a very few places where these costs need to be taken into account.

- Trackwork

Unit costs for trackwork used in the SCL proposal are \$0.98M per dual track mile for aerial, subway and embankment alignments and \$0.5 million per dual track mile for at-grade freeway alignments. These costs are currently adequate for standard trackwork without consideration for special trackwork. They should be increased for special trackwork, such as crossovers between lines before and after each station. In the capital cost review a figure of \$1.19 million was used for aerial and subway alignments and \$ 0.8 million for at-grade

alignments.

- Electrification

This item is within 15 percent of currently experienced bid information and it is suggested that \$1.96 million per dual track be used. This is based on recent estimates and bid information from Chicago Urban Transportation District and Washington Metropolitan Area Transit Authority.

- Control and Communication

The SCL proposal specifies manual train control with supplementary automatic train protection (to prevent collisions). Normally the unit cost indicated, \$1.2 million/mile, would be sufficient. However, control system costs are dictated more by the number of interlocking points (that is, intersection and merge points) than by the length of track. For an extensive network with many interlockings, such as proposed for the SCL system, with train operations at 85 mph top speed, an average cost of \$2.0 million per route mile appears more appropriate.

- Stations

The SCL report gives unit costs for stations as follows:

Major subway	\$9.0 million
Minor subway	6.0 million
Major aerial	3.0 million
Minor aerial	1.5 million
Grade	1.5 million
Freeway alignment	5.0 million

The only subway stations cited in the SCL proposal are on the Starter Line and at Union Station. Should additional subway stations be required their cost would have to be based on higher unit estimates than presented in the proposal. The low end of the range for subway stations would probably not be less than \$10 million.

The \$5.0 million allocated for freeway stations seems a little high and for the capital cost review, a figure of \$4.25 million was used. This affects the majority of stations.

The SCL report suggests the use of \$500 per car for parking costs. This is reportedly based on minimal grading and paving with little or no landscaping. As such, this would be an adequate estimate. However, for at-grade parking lots with capacities of the order of 2000 cars and for station development adjacent to freeways, a good deal of circulation and access facilities need to be included. In view of this, a figure of \$800 per car is more appropriate. It should also be realized that if property cannot reasonably be acquired then structured parking will be required at a considerably greater cost.

- Maintenance and Storage Facilities

The SCL cost per car of \$80,200 for these facilities is in line with the costs for other systems and no change is suggested in this unit cost. Total cost must be adjusted for any change in fleet size.

- Vehicles

- Mainline

- Cost of vehicles for conventional rail rapid transit have increased dramatically during the last few years. Small orders, inflation and general underestimates by various manufacturers have resulted in considerable escalation of the cost of delivered units, sometimes in excess of bid prices. As a result, American manufacturers have increased considerably their estimates for new production and in some cases have shyed away from new procurements.

- A survey of the major manufacturers in the United States suggests that costs for modern equipment comparable to the equipment being delivered for the Washington Metro or contemplated for the Atlanta and Baltimore systems would range from \$500,000 to \$750,000 per unit. It is generally believed that new bid prices will be found at the upper end of this range.

The SCL proposal suggests that a fleet of approximately 1000 vehicles would be required for the system. The operational analysis described elsewhere in this report suggests that a fleet of this size and possibly even larger would be required to provide the specified service. On this basis, it was assumed for purposes of this cost estimate that vehicles procured in larger orders might be obtained for a cost of \$600,000 in 1976 dollars. This compares with an estimate of \$483,000 per unit made in the proposal.

This evaluation has made no allowance for special design cars that might be required for airporter service and for recreational vehicles. Undoubtedly these vehicles would cost more than the \$600,000 price ascribed to the bulk of the fleet. However, the number of the special design vehicles would be fairly low and given the uncertain size of the total fleet, the omission of these incremental costs is not likely to impact the cost estimates to any significant degree.

The SCL proposal specifies vehicles for the mainline with a seating capacity of 110 passengers and an overall capacity in peak hour of 200 passengers. These vehicles are somewhat larger than cars used in conventional rail rapid transit in this country. Should the eventual operational analysis indicate that the larger vehicles are in fact justified by the projected level of patronage it is likely that some modification to current design would be required. It is assumed, however, that the contingency factors discussed in the next section of this chapter will cover any incremental costs associated with the design modifications. The SCL proposal also stipulates a vehicle capable of 85 mph maximum speed. Modern vehicles are intrinsically capable of reaching this speed but it is possible that some design modification would be required in the traction and braking equipment in order to accommodate the higher speeds in routine sustained operations. Here too, it has been estimated that incremental costs required by this conversion, should it be found to be necessary and justified in the course of the subsequent operational analysis, would be covered out of contingency allowances.

It should be noted here, in line with the arguments presented in the chapter dealing with the operational analysis, that a determination of an optimum vehicle size, an optimum train size and fleet size are not possible at this stage of the evaluation in the absence of specific projections of patronage for the various lines of the system. A detailed operational analysis will be required as an essential preamble to any detailed design activities for the system. It is at that point that specific cost effectiveness evaluations can be made determining the desirable range of vehicle sizes, the size of trains to be used on the various lines of the systems and the means for accommodating in the most economical fashion the variable peak hour and off peak hour demand for transit.

Feeders

The capital costs of the light rail and group rapid transit feeders were not analyzed in this study because of the lack of specificity concerning the locational aspects of the proposed lines. The SCL proposal derived its feeder capital costs on the basis of an allowance of some \$5 million per mile. Available data suggests that light rail installations will cost approximately \$8 million per mile when a minimum of construction work is required for at-grade crossings. A range of unit costs from \$ 8 to \$15 million per mile would appear to be more realistic for estimating the feeder costs. This estimate includes an allowance for all capital cost elements including a fleet of vehicles costing \$500,000 to \$650,000 per unit (additional discussion on this subject can be found in Chapter 7). Available data for GRT systems suggests that unit costs would approximately range from \$15 to \$20 million per mile inclusive of all capital cost elements. Corresponding vehicle costs may range from \$150,000 to \$750,000 per unit depending on size and technological complexity (additional discussion on this subject can be found in Chapter 7).

- Contingency

A contingency factor of 25 percent is much more appropriate than the 15 percent used in the report. Estimates based on a conceptual type of design normally include a contingency allowance of 20-30 percent depending on the amount of design work done. This is intended to cover all unforeseen items which appear later in final design and construction. For example, there is no item in the estimate for upgrading parallel arterials but this may become necessary if traffic on the freeways is more severely degraded than is currently estimated. In general, the less detailed the design the higher the contingency factor. Contractors will include a contingency factor of 5 percent or more even when their estimates are based on contract drawings.

- Engineering and Administration

The allowance of 15 percent used in the SCL proposal is adequate for planning, preliminary and final design, construction management and administration costs. The allowance is typical of that used in most major transit engineering programs.

METHODOLOGY FOR CAPITAL COST REVIEW

Evaluation of the mainline capital costs required that guideway, track-work, station, control and communication and electrification costs be developed for each line of the proposed mainline network. These estimates were supported by the segment-by-segment analysis prepared by the County as backup material to the SCL proposal, the Caltrans report and field surveys. The unit costs described above were applied to the mileages in the segment-by-segment analysis. A few minor errors in the listed mileages were found and adjustments were made. It is emphasized that due to the constraints of time available for this brief evaluation of the SCL proposal, the line costs arrived at are more representative of a reasonable range of costs rather than of specific estimates which could have only been produced with the aid of detailed design and analysis. While the costs are shown as a single number for each line (back up segment-by-segment costs are available in DCCO's files) it should be understood that the figures cited in this report represent, at best, a reasonable range. More detailed studies of the more difficult engineering circumstances arising at interchanges and elsewhere are likely to suggest desirable or required design alternatives which may have a major impact on the costs described herein. In the professional judgment of DCCO,

however, the costs which are cited in this report are deemed reasonable for the purpose intended, namely to arrive at an overall evaluation of the feasibility and reasonableness of the SCL proposal.

In establishing the line costs, guideways were classified according to the particular conditions along each line. Where Caltrans indicated that a lane could be appropriated for transit use, this was used accordingly. In general the recommendations of Caltrans were followed throughout the network as these were supported by the field survey. This procedure for cost estimating guideways had to be modified for special conditions. Interchanges were treated as special conditions. These will be discussed in a later section. Other special conditions included high overpasses, four track-sections and aerial requirements within normally at-grade construction.

Stations were treated on an individual basis but since exact locations are not known at this time, stations were generally classified according to their generic type, that is, aerial, at grade or within the freeway right-of-way.

Trackwork unit costs were applied according to whether the guideway was aerial, subway or at grade. Control and communication and electrification costs were developed directly from the route mileage.

Systemwide items such as yards and shops, parking, right-of-way, contingency, vehicles, pre-operation shakedown and test, engineering and administration and the CBD distribution were not allocated to individual lines.

Several items in the SCL proposal are treated as contributory allocations and no attempt was made to re-estimate them. These items include the Wilshire and La Brea line costs, the CBD distributor costs, Union Station and the feeder lines. No new estimate was made for right-of-way costs due to a lack of specific information; however, this will be discussed later in the report.

Evaluation of Major Cost Elements

A summary of the capital costs broken down on a line-by-line basis is shown in Table 1. The subtotal of costs directly related to the mainline is \$3,390,000,000 which is 27 percent higher than the comparable number in the SCL estimate. This increase is related primarily to the application of

TABLE 1

CAPITAL COSTS (1976 \$ Millions)

LINE COSTS (including Structure, Trackwork, Control & Communication and Electrification)

1.	Valley/Long Beach	700.
2.	Inter-Valley	480.
3.	Hollywood Bowl	60.
4.	San Gabriel River	280.
5.	Century City	40.
6.	Cross County	360.
7.	International Airport	300.
8.	Central	330.
9.	Long Beach	250.
10.	Pomona	390.
	Wilshire/La Brea Lines*	200.

SUB TOTAL	<u>3390.</u>
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SYSTEM COSTS

Yards and Shops	120.
Parking	80.
Right-of-way*	50.
Contingency on construction related items	910.
Vehicles (1000 to 1200)	700.
Pre-operation shakedown & test	70.
Engineering and Administration	680.
CBD Distributor*	50.

SUB TOTAL	<u>2660</u>
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TOTAL MAINLINE	<u><u>6050.</u></u>
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FEEDER LINES**

Construction and Equipment Purchase	330.
Contingency	50.
Engineering and Administration	50.

TOTAL FEEDER	<u>430.</u>
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TOTAL MAINLINE & FEEDER	<u><u>6480.</u></u>
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*Sunset Coast Line Proposal allowance of estimate

**Sunset Coast Line Proposal unit costs.

the previously discussed unit costs to the specific physical constraints of the various freeways which would contain the major portion of the system alignment. The incremental costs for locating the guideway structure at grade and in medians or on shoulders and for traversing and developing the interchanges are included in the estimates shown in Table 1.

Table 1 also shows the total mainline costs in 1976 dollars which are increased some 44 percent above the estimate given on the SCL proposal. The increment results, in addition to the factors described above, due to the assumption of a higher contingency factor than stated in the proposal and a higher allocation of costs for the acquisition of a larger fleet of vehicles than contemplated on the proposal. Further interpretation of this item will be found in the section of this report dealing with the operational analysis.

Table 1 also shows a small increase in the estimated cost of the feeder system. This is primarily due to a reevaluation of the proposed mainline network which suggested that a small portion of the mainline mileage could be converted with certain cost advantages to feeder service without impairing the basic transit concept described in the proposal. The sections affected by this conversion are found at the northern end of the Valley/Long Beach Line and on the crosscounty line from the Long Beach Freeway to the San Gabriel Freeway.

Line Segments

Additional details helpful in the interpretation of the cost summaries listed in Table 1 are presented herein:

- Valley/Long Beach Line

The cost of this line is 12 percent higher than shown in the SCL proposal. The increase arises primarily from slight increments in the unit cost for trackwork, electrification, controls and communications. A significant increase in cost was estimated at the interchanges with the Inter-Valley/Cross-County, Airport, Central and Starter Lines.

- Inter-Valley Line

The cost of this line increases approximately 4 percent over that cited in the SCL proposal. The increase is due primarily to the higher unit cost for electrification and control and communication. Minor increases are accounted for at the interchanges.

- Hollywood Bowl Line

The cost of this line is estimated to increase about 16 percent beyond the cost cited in the SCL proposal. The same factors which contributed to the increase of the Inter-Valley Line account for the upward revisions here.

- San Gabriel River Line

The cost of this line is estimated to be more than 100 percent higher than the estimate shown in the proposal. This is due to the higher unit cost for at grade construction plus the increments arising at the interchanges with the Cross-County Line.

- Century City Line

Minor cost increases have been estimated for this line primarily due to small variations in the assumed unit costs.

- Cross-County Line

Considerable increase in the cost of this line has been calculated attributable to the quite difficult construction anticipated with some lengths of very high structures. The interchanges with the Valley/Long Beach Line and the Central Line also account for the incremental 20 percent change in the estimated cost.

- International Airport Line

Interchanges with the Valley/Long Beach Line, Central Line, Starter Line and the San Gabriel River Line are the primary reason for the 40 percent increase in the estimated cost of this line. Another element contributing to the increase was found in the at-grade construction along the railroad right-of-way envisioned for this line. It was assumed that this segment would require erection of an embankment and the construction of a number of overpasses at surface street crossings.

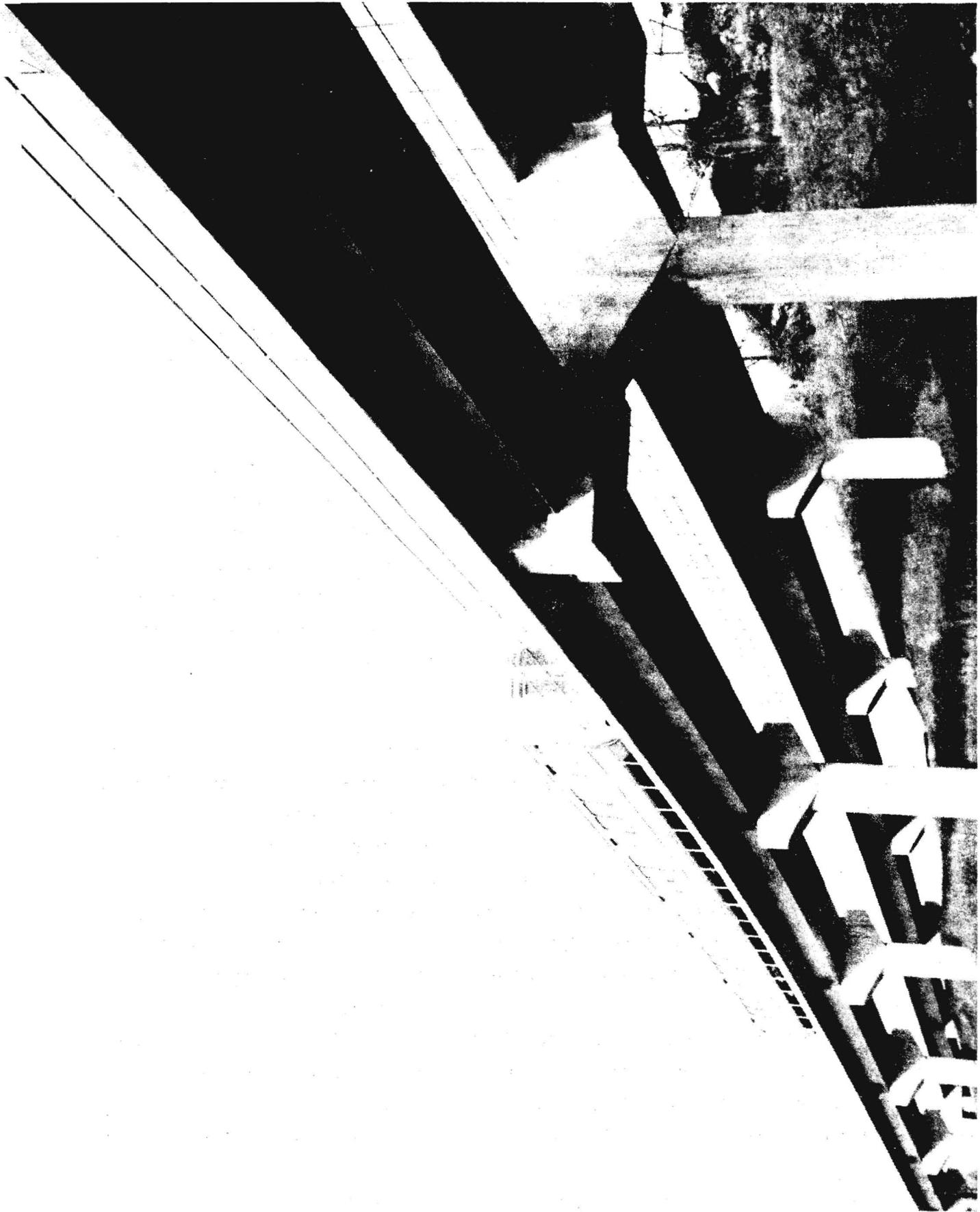


Figure 8 AERIAL TRANSIT GUIDEWAY - Washington Metro

The major problems with shoulder alignments are the adverse impacts to the property adjacent to the freeway. As stated earlier, most of the freeways are well landscaped with many mature trees. Construction adjacent to the shoulder would essentially remove such vegetation and expose properties to the full visual and noise impact of the freeway. In addition, there would be adverse visual and noise impacts from the transit line. Such an alignment may well necessitate additional property acquisition particularly in residential areas.

Despite the problems described above, it is judged feasible to physically locate an aerial transit guideway within the freeway right-of-way. Whether a median or shoulder location is better will depend on the specific circumstances at each section of the transit line.

There are a few areas within the network where existing or proposed freeway lanes can be dedicated to transit immediately and permanently. These occur along the Ventura Freeway and the yet to be constructed Century Freeway. In these locations, guideways can be easily constructed at grade within the medians. More difficult at-grade construction can be anticipated along the eastern segments of the Inter-Valley Line especially where the elevation of the freeway lanes opposing one another are different.

Freeway Widening

An alternative to aerial construction along the freeways is to add lanes to each side of the freeway, freeing the interior space left in the median to construct the transit line at grade (Figure 9). In most areas this is not a reasonable alternative due to the fact that the freeways are now fully developed within the right-of-way. Such a scheme would generally cause landscaping to be removed and freeway ramps, underpasses and overpasses to be reconstructed. For most freeways this alternative could be more expensive and less environmentally acceptable than an aerial configuration within the median. The northern end of the San Gabriel river line, however, is one place where this type of construction might be best used, and it has been assumed for the segment between the Foothill Freeway and the Artesia Freeway. Freeway widening was also assumed at two other locations in accordance with recommendations made by Caltrans¹ as shown in Figure 13.

¹Caltrans report to Supervisor Baxter Ward, dated 29 January 1976

- Central Line

Here too, the primary reasons for the increase are the additional costs for constructing the interchanges and higher unit costs for the at-grade sections. While Caltrans had suggested in its report that aerial structures be used for the entire line, this evaluation concluded that at-grade construction with freeway widening could be achieved at a lesser cost on segments along the Glendale Freeway and south of the San Diego Freeway.

- Long Beach Line

The estimate for the incremental costs of this line is attributable largely to the interchanges with the Pomona Line, the Cross-County line and the Airport Line.

- Pomona Line

A substantial increase, approximately 73 percent, was estimated for this line. The interchange with the Central Line and aerial structure adjacent to the Central and San Gabriel Line contribute to the estimated increase. The section east of the San Gabriel River Freeway has been assumed in aerial structure consistent with Caltrans' recommendations. This contrasts with the assumptions made on the SCL proposal that low cost at-grade construction would be employed on this segment.

Wilshire/La Brea Lines

The SCL report proposes that \$203 million be allocated for these lines based on average costs throughout the area. Because of this policy decision, the costs for these lines have not been evaluated. It should be noted that aerial construction of a heavy rail line along these alignments is problematical due to noise, visual and other impacts. Costs to mitigate these impacts could be quiet high and sections of subway might be required. The connection with the Starter Line requires a full delta interchange which would necessarily be constructed in subway at high cost. An alternative arrangement would be to interface with a high capacity collection/distribution line requiring passenger transfers.

Interchanges

The physical layout of interchanges has been discussed at length in an earlier section. It was not possible to individually examine each interchange for cost estimating purposes but an empirical procedure was adopted as follows. The size of each interchange was determined based on the number of turning movements provided and the number of grade separation points required to accomplish these turning movements. The inherent complexity of the setting of each interchange was determined based on the existing freeway structures. For example, the San Diego/Santa Monica Freeway interchange was considered more complex than the baseline San Diego/Harbor Freeway interchange. Interchanges with the proposed Century Freeway were considered much less complex because the freeway and transit interchange design can be coordinated. The cost estimate for each interchange was derived from the size factor, the complexity factor and the estimate for the baseline interchange studied in more detail. Table 2 summarizes the cost estimates that have been made for the various interchanges of the SCL system.

Support Facilities

The basic costs of support facilities such as maintenance shops, storage yards, turnbacks and sidings are shown in Table 1. However, it should be pointed out that these facilities will be located throughout the system based on operational needs as well as available space. Because of these, it will often be necessary to locate parts of the system outside of freeway rights-of-way with consequent displacement and other urban impacts.

Rights-of-Way

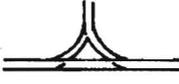
The SCL proposal estimates rights-of-way costs at \$45.76 million and this assumes that all parking rights-of-way requirements will be provided by local communities. No attempt has been made to estimate rights-of-way costs since the level of system design is insufficient to even roughly estimate such costs. In transit design at other localities it was found that costs for property and displacement increase as the level of design advances.

Rights-of-way costs for the SCL proposal are likely to be higher than indicated as property acquisition can be expected for the following items:

- Maintenance shops
- Tail tracks
- Stations & access requirements
- Storage yards
- Interchanges
- Guideways in railroad properties & sensitive areas

TABLE 2

SUNSET COAST LINE INTERCHANGES

<u>Interchange</u>	<u>Description</u>	<u>Setting Complexity</u>	<u>Additional Cost</u>
Valley/Long Beach - Inter-Valley		Moderate	\$30M - \$40M*
Hollywood Bowl - Inter-Valley		Difficult	\$ 5M - \$15M
Century City - Valley/Long Beach		Difficult	\$ 5M - \$15M
Wilshire - La Brea		Moderate	\$ 5M - \$10M
Wilshire - Starter		Extremely Difficult (subway)	\$70M - \$90M
Pomona - Central		Very Difficult (partial subway)	\$40M - \$50M
Cross County - Valley/Long Beach		Very Difficult	\$45M - \$55M
Cross County - Central		Very Difficult	\$30M - \$40M
Airport - Valley/Long Beach		Easiest (new freeway constr'n)	\$10M - \$20M
Airport - Starter (West)		Easiest	\$ 5M - \$10M
Airport - Central		Easiest	\$ 5M - \$10M
Airport - Starter (East)		Easiest	\$10M - \$15M
Airport - Long Beach		Moderate	\$20M - \$30M
Airport - San Gabriel River		Difficult	\$25M - \$35M
Valley/Long Beach - Central		Moderate	\$15M - \$25M
Valley/Long Beach - Starter		Difficult	\$ 5M - \$15M

*M = million

CHAPTER 6

OPERATING COST EVALUATION

Estimates of operating and maintenance, (O & M), costs are dependent on certain system design characteristics and details of the system's operational plan which are not currently available. In general, the O & M costs depend on:

- Characteristics of the maintenance facilities
- Scheduled vehicle maintenance cycles
- Scheduled trackwork maintenance
- Fleet size
- Type of vehicle equipment
- Transportation conducting policy
- Number and type of stations
- Station design, staffing
- Vehicle miles traveled
- Track miles maintained
- Unscheduled maintenance

The costs presented in the Sunset Coast Line proposal are stated unconventionally in terms of unit costs per track mile. Total O & M costs can be divided by track miles to provide a unit cost for a particular system. These unit costs can then be used for small variations of that system, but would not generally be applicable to other systems, nor to large variations from the system selected. The total O & M costs for a system are more properly defined as a function of fleet size, number and type of stations, fleet mileage, track mileage and an overhead factor. Typical unit costs are given below based only on track mileage, fleet size and vehicle miles for U. S. systems in 1973, inflated to 1976 dollars.

<u>System</u>	<u>Millions of Dollars per Track Mile</u>	<u>Thousands of Dollars/Vehicle</u>	<u>Cents per Vehicle Mile</u>
New York	2.8	91	197
Chicago	.6	54	132
Philadelphia	2.2	67	270
PATH	2.5	97	216
BARTD	.53	147	375
Cleveland	.22	36	116

The large variation in unit costs illustrates the problem of attempting to use these unit costs to extrapolate from one system to another. However, the close correlation between PATH and New York illustrates that similar unit costs occur for similar systems when any of the three parameters are used. The high costs per vehicle mile of BARTD are related partly to start-up costs and partly to lack of completion of the system at the time the data were collected. On the other hand BARTD shows one of the lowest unit costs based on track mileage again probably due to lack of completion of the system.

For the purpose of this evaluation the unit O & M cost estimates were synthesized from estimates of each cost component. Cost components were related to industry practice, to local wage rates, and were modified for some of the SCL's unique characteristics. The SCL concept, at least at this stage of conceptualization, is unique in terms of system size and operational factors. Hence, some of the component estimates are somewhat speculative at this time. While some uncertainty still exists regarding the exact value of the unit O & M costs, it is felt that the variance is small, on the order of 10 percent, and that the total yearly O & M costs projected in the SCL proposal are understated.

EVALUATION OF OPERATING COSTS IN PROPOSAL

Operating and maintenance costs for the Sunset Coast Line are estimated on page 106 of the proposal at \$1,000,000 per mile for a 230 mile system.

This gives an annual O & M cost of \$230 million, presumably in 1987 dollars. The costs are divided as follows:

<u>Category</u>	<u>Percent</u>	<u>Amount</u>
Maintenance of Way & Structure	25%	\$58M
Maintenance of Vehicles	18%	41M
Transportation (operating labor)	29%	67M
Energy	10%	23M
Insurance	4%	9M
General & Administration	<u>14%</u>	<u>32M</u>
Total	100%	\$230M

Insurance and General & Administration cost are usually calculated as a percentage of all other costs and the percentages used in the proposal seem reasonable. Other categories are difficult to evaluate since they depend on the particular service policy adopted which determines vehicle miles traveled per year. However, it appears that the high speed and large station spacing of the Sunset Coast Line will result in transportation costs which are lower relative to vehicle maintenance costs than the proposal indicates.

ESTIMATION OF OPERATING AND MAINTENANCE COSTS

Because the Sunset Coast line is dissimilar in one way or another to all existing transit systems, O & M costs were built up in detail rather than estimated from available system-wide parameters, such as vehicle miles traveled or guideway miles. Table 3 shows unit costs and absolute costs estimated for the Sunset Coast Line. It assumes the system is completed and "shaken down", and does not include start-up costs which are estimated at 1 percent of capital costs. The annual operating cost is \$139 million in 1976 dollars and is based on the following parameters:

Daily Trips	900,000
Fleet Size	1,000
Annual Vehicle Miles Traveled	100,000,000
Two-way Guideway Miles	244
Number of Stations	89

The O & M cost per vehicle mile is \$1.39. This is lower than some existing systems because the high average speeds and limited number of stations tend to reduce the operating-labor cost per vehicle mile. However, the estimated cost is in line with experienced costs on high efficient transit properties such as at Toronto. The high vehicle utilization factor of the Sunset Coast Line results in an O & M cost of \$139,000 per vehicle, which is probably higher than on any American system.

Many unit costs were based on research described in the report "Cost Estimates and Basis of Estimates for the Alternatives Analysis" prepared in April 1975, for the Regional Transportation District, Denver, Colorado. The heavy rail system analyzed in this report had a maximum speed of 80 mph, an average station spacing of two miles, and a vehicle capacity of 192. It should have unit operating costs which are applicable to the Sunset Coast Line. A number of cost categories, such as labor rates, vary by region, and these were adjusted for Los Angeles County.

The cost categories and sub-categories are listed below along with a brief discussion of the more important items.

Maintenance of Way & Structure

- Guideway

This includes structure and trackwork. Previous studies have found that this item correlates more closely with vehicle miles than with track miles. Data is from ATA's 1973 operating statistics and from other sources.

- Yards

Only maintenance of the yards themselves is included, not vehicle maintenance. This item is related most closely to fleet size.

- Electrification

- Control & Communication

- Stations

Includes escalators, elevators, air conditioning, fare collection equipment and lighting.

Maintenance of Vehicles

The figure of 30 cents per vehicle mile was obtained from 1973 APTA data. Assuming a vehicle cost of \$600,000 and a utilization of 100,000 miles per vehicle per year, the operating cost per vehicle would be 5 percent of the initial cost.

Transportation (Operating Labor)

- Operators

The hourly cost of \$8.85 includes fringe benefits and is from the alternatives analysis currently being conducted for the Southern California Rapid Transit District, "Starter Line". The 1.1 million operator hours is based on 200 trains of 5 cars each during peak periods, a factor of 2.5 to convert peak period operators to total number of the payroll, a factor of 1.1 to account for standby operators, and 2000 hours per operator per year.

- Stations

The figure of 120,000 per station assumes all stations are manned 24 hours a day, 7 days a week. It includes janitorial cost and the emptying of fare collection machines.

- Dispatching and Yard

- Control & Communication Operating Force

Based on 105 employees at \$10 per hour.

- Security

Assumes one man for every 5 trains plus one man for every 5 stations. Labor cost was \$8.85 per hour.

Energy

- Vehicles

A precise calculation of energy requirements would require a detailed simulation of vehicle travel including speed profiles, grades, and air drag. The figure of 21 cents per vehicle mile is based on 3¢/kw-hr and 7kw-hr/vehicle-mile. The cost of electricity is from the current "Starter Line" alternatives analysis, and the power consumption was adjusted upward from simulations run for the Denver region to account for grades in the Sunset Coast Line.

- Stations

Includes lighting, air conditioning, escalators and elevators.

- Yards

Insurance

General & Administration

This category includes all operating and maintenance costs not covered above. It does not include contingency.

The estimate suggests that O & M yearly costs were underestimated in the SCL proposal. The proposal's estimate of O & M costs of \$230 million per year in 1987 reduces to \$109 million in 1976 costs using a 7 percent escalation factor as suggested by Stanford Research Institute. This cost should be compared with \$139 million projected in this evaluation. Because of uncertainties regarding the fleet size and related maintenance costs it is felt that a reasonable O & M estimate would be based on \$1.50 ± \$.10 per vehicle mile. Using the projected 100,000,000 yearly vehicle mileage as a basis, the probable range of O & M costs would be \$150 million ± \$10 million in 1976 dollars.

TABLE 3

ESTIMATED ANNUAL OPERATING AND MAINTENANCE COSTS FOR THE SUNSET COAST LINE (1976 DOLLARS)

<u>Category</u>	<u>Sub-Category</u>	<u>Unit Cost</u>	<u>Unit</u>	<u>Quantity</u>	<u>Amount</u>	<u>Percent</u>
Maintenance of Way & Structure	Guideway	0.13	Vehicle mile	100M	13.0M*	
	Yards	4,000	Vehicle	1000	4.0M	
	Electrification	0.044	Vehicle mile	100M	4.4M	
	Control & Communication	44,000	Two-way Guideway mile	244	10.7M	
	Stations	33,000	Station	89	2.9M	
	Total				35.0M	25%
Maintenance of Vehicles		0.30	Vehicle mile	100M	30.0M	22%
Transportation (Operating labor)	Operators	8.85	Operator hour	1.1M	9.7M	
	Station Personnel	120,000	Station	89	10.7M	
	Dispatching & Yard	0.022	Vehicle mile	100M	2.2M	
	C & C Operating Force	10.00	Man hour	210,000	2.1M	
	Security	8.85	Man hour	400,000	3.5M	
	Total				28.2M	20%
Energy	Vehicles	0.21	Vehicle mile	100M	21.0M	
	Stations	11,000	Station	89	1.0M	
	Yards	500,000	Entire system	---	0.5M	
	Total				22.5M	16%
Subtotal					115.7M	83%
Insurance - 5% of subtotal					5.8M	4%
General & Administration - 15% of subtotal					17.4M	13%
Total					139.9M	100%

*M = 1,000,000

COMPARISON OF COST ESTIMATES

The precise comparison of the O & M costs stated in the SCL proposal and the O & M costs shown in the report is not straightforward. The SCL proposal's estimate of \$230 million yearly O & M costs is ambiguous insofar as the base year used for its calculation is concerned. If 1987 is taken as the base year, as can be inferred from the proposal's text, the corresponding 1976 costs may be estimated at \$109 million (using an escalation factor of 7 percent as suggested by Stanford Research Institute). The SCL projection would then fall some 27 percent below the estimates of Table 3 and would be as much as 46 percent below the high end of the range of O & M costs suggested in this report.

CHAPTER 7

TECHNOLOGY EVALUATIONS

The evaluation of the transit equipment specified in the SCL proposal is concerned with the various types of railroad vehicles specified for the mainline, the two alternate technologies called out for the fixed guideway feeders and the controls subsystem. The SCL proposal specifies the physical dimensions of the mainline vehicles, their speeds, and other ancillary characteristics. Less specificity is provided for the feeder line equipment.

This evaluation addresses only the feasibility and reasonableness of the equipment choices made in the proposal. The basis for the choices made is not questioned, nor is there an attempt made to improve upon the specifications. Where appropriate, suggestions for equipment alternatives are given when it is known that an alternate might reduce the costs or improve in some way the operations of the system.

It is likely that additional analysis might lead to substantially different equipment specifications. The physical and performance characteristics of the vehicle would reflect the results of tradeoffs involving initial costs, operating costs, station platform size requirements, the maintainability of the equipment, the advantages of equipment standardization and the goal of maintaining high schedule reliability. However, variations that might result from this more detailed analysis are not expected to significantly impact the overall assessment of the SCL system for the Board's purpose at this time.

EQUIPMENT FOR LOCAL SERVICE

In the SCL proposal, trains operated in local service provide the backbone of regional transit. Seven hundred and forty cars or approximately 70 percent of the entire fleet for vehicles is dedicated to local service. The proposal states that the required characteristics of vehicle size and speed could be met by equipment being used on the New York transit system. The newest equipment being delivered in quantity to the New York Metropolitan Transit Authority at this time is the R-46 car produced by Pullman. However, the characteristics

of this vehicle are at variance with the specifications contained in the SCL proposal. The R-46 vehicle is 75 feet long with a nominal seating capacity of 56 passengers and a maximum capacity, including standees, in excess of 200 passengers. This compares with the 85 feet length of the SCL vehicles, the seated capacity of 110 and the maximum capacity including standees of 200 passengers. While the maximum fleet required by the SCL system would be determined by the capacity of the vehicles including standees, which is not at variance with the New York vehicle, the degree of comfort provided to the riding public would be diminished because of the reduced seating capacity.

The R-46 vehicle has a design speed of 80 mph but is being operated at the most part of 55 mph. Sustained performance at 85 mph under actual physical constraints to be experienced on the SCL network might tax the component design of the R-46 vehicle to unacceptable levels. If that should be the case, some redesign of the traction and braking subsystems would be required. Larger motors and different improved brakes and brake controls would be required. The trucks would also require some redesign.

The R-46 car is supplied to New York under a contract that placed the 1972 price at \$280,000 per unit. It is reported that the manufacturer is losing money on this order. Similarly, the 1972 order for WMATA cars was placed at a price of \$300,000 per car.

Escalation of the costs cited above to 1976 levels and allowances for recovery of the excessive losses incurred by most manufacturers of rail rapid transit equipment in recent years would project a unit cost for the SCL local service vehicles ranging from \$500,000 to as high as \$750,000 per car. The actual contract price would vary with the size of the order placed and the extent of the modifications from current design required to meet the eventual specifications of the SCL system.

It is believed that re-evaluation of the seating requirements and of the maximum speed would result in not too serious or expensive deviations from existing vehicular designs. For orders approaching the size of the fleet required to operate the SCL system, prices in the range of \$600,000 per unit might be realized.

Interurban and Airporter Service and Special Equipment

The SCL proposal indicates that the advanced concept train, (ACT), currently under development by the United States Department of Transportation would be suitable for the more luxurious interurban and airporter service. These cars are expected to be fully capable of meeting the performance specification of 85 mph, but because of numerous technological innovations included in their design it is reasonable to expect that they will cost considerably more than the local service vehicles.

The ACT vehicles have a power rating of more than 1100 hp per car which is adequate for cruise speeds in excess of 100 mph. The cars include a self contained regenerative braking capability provided by a rotating flywheel system. They have large double glazed windows, nonmetallic vandal resistant exteriors, improved crash attenuation features and welded light weight aluminum frames. Should these vehicles be available in 1976, it is conservatively estimated that their cost would be far in excess of \$750,000 per unit.

A comparison of the length of local lines and the interurban lines does not reflect a significant difference in the extent of the route. While there would be many shorter trips on the local lines it is not certain that there would be a significantly greater volume of longer distance trips on the interurban service than found on the local lines. It is, therefore, not clear from the data contained in the SCL proposal that interurban service would require a substantially different vehicle. Both the interurban and local trains are expected to travel at the same speed. The travel time in local service according to the SCL proposal would, however, be somewhat longer because of the operating policy which requires local trains to make all stops in route. From the point of view of overall comfort therefore, it is not immediately apparent that the interurban service would require a more luxurious interior or more passenger amenities than provided in local service. It is in fact likely that a more cost-effective solution would be found by redesigning the seating arrangement in the local service vehicles to provide the more comfortable interurban ride described in the SCL proposal.

As indicated in the operational analysis chapter, the real service advantages of the interurban lines cannot be realized unless the Red Cars are allowed to travel over great distances without making intermediate stops. The basic design of the SCL system does not provide for offline stations which would enable the interurbans to bypass local trains stopped at the stations thus negating the principal advantages of the proposed long distance service. It was concluded therefore, that the specification for interurban type equipment might not be continued in a more detailed design of the system. The costs and vehicular requirements of the Red Car component of the fleet were absorbed in the specifications for local service as part of this evaluation.

A more definite requirement for a change in interior design of the vehicles is found in the airporter equipment. While it is imperative that convenient space be provided for baggage, it is questionable that a different type of car, as compared to the R-46, is required. Since the airporter trains will operate essentially on the same trackage with local service and will be at all times intermixed with normal operations, it is likely that the equipment will be required to have the same performance specifications. Another argument against the employment of the different technology for airporter service derives from a study of benefits associated with standardization of equipment.

Commonality of equipment produces not only reductions in acquisition costs but also results in operational economies related to the maintenance of a single set of spare parts and the development of standardized maintenance procedures and skills.

It was assumed, therefore, for purposes of this evaluation, that the airporter equipment would be a derivative of the vehicles used for local service. Since the fleet of airporter cars is relatively small the incremental initial costs for this equipment were not considered specifically in the capital cost estimates. Rather it was assumed that the contingency allowance would cover any increase in cost associated with the redesign of the interior configuration for airporter service.

A similar consideration was made with respect to the excursion cars which, according to the proposal, would have provisions for carrying surf boards and bicycles. Here too, the small size of the fleet did not appear to justify a separate cost estimate for this type of equipment and the contingency allowance was deemed to be sufficient to account for any differences in their cost.

Likewise, the domed cars are nonstandard in urban rail transit. Whether or not this type of service would be deployed in actual operations will depend on detailed evaluations and cost comparisons, which might involve the incremental costs of guideway structures designed to provide adequate clearance for the extra high domed vehicles. Should it be found advantageous, at a later date, to provide domed car service, it is likely that an adaptation of current commuter car designs might be found to be suitable. Again, the small size of the fleet of domed cars cannot justify the inclusion of separate costs for these vehicles. The contingency allowance is assumed to be sufficient to provide for the incremental capital costs of this service.

The SCL proposal also refers to gas turbine/electric cars with a dual mode capability making possible the operation on electrified as well as non-electrified track. Current design for gas turbine/electric cars provide for substantially greater performance than is needed in urban transit. At this time, two gas turbine/electric hybrids have been developed, one by the General Electric Company and the other by the Garrett-AiResearch Company. They are capable of speeds of up to 125 mph and are being operated by the New York Metropolitan Transit Authority on its Long Island commuter system. The prototypical gas turbine/electrical equipment is considerably more expensive than any of the vehicles cited so far. Lowering the vehicles' performance capability for urban transit use is not likely to impact their cost because the anticipated low volume purchase required for the SCL system would, in all probability, cancel any cost reductions associated with the downward modification in performance.

In final analysis, whether or not an eventual SCL system might utilize hybrid equipment will depend on the value associated with the fairly easy expansion of revenue routes onto non-electrified track which is possible with this equipment. No specific allowance was made for these vehicles in estimating the capital costs.

Equipment for Feeders

The SCL proposal identifies two principal types of systems, light rail service and automated Group Rapid Transit (GRT). The proposal also refers to the GRT, at times, as a monorail option. The specification of the fixed guideway feeder systems in the SCL proposal is considerably more sketchy than that given for the mainline. Fifteen separate feeder systems are identified. Of these, four are assumed to be light rail and the other eleven are assumed to be of a GRT type. Operating speeds in the range of 50-60 mph are specified. A lesser maximum speed than that provided on the mainline is justified because stations on the feeder lines are spaced more closely thus lowering the achievable service speeds. Light rail equipment currently in production in this country is designed for a maximum operating speed of 50 mph but the manufacturer (Boeing-Vertol) advises that speed can be increased to 60 mph without changing the basic traction system.

On the other hand no GRT system to date has been installed in urban transit service with a capability to operate in the 50-60 mph speed range. A number of systems have been described to have this capability and one of the American manufacturers has demonstrated this speed capability experimentally.

The light rail feeder service would be provided by a standard gauge steel wheeled, electrically powered vehicle with an overhead power collector. The light rail service differs primarily from conventional rail as described in the SCL proposal by the installation of the guideway at grade on railroad rights-of-way or on arterials with limited operation in mixed traffic particularly at intersections. As a result, the net operating speed of light rail transit is substantially lower than that projected for the mainline. However, the speed disadvantage is not considered to be serious because the service would operate primarily in a collection/distribution mode with closely spaced stations and would traverse routes of limited length, thus negating the significance of the higher speeds. Light rail equipment could be made to operate on the mainline as well with the simple provision of a third rail power pickup. Since the light rail equipment would be intrinsically slower than the local service, mixed operation would not be desirable nor safe.

In 1975, the only supplier of light rail equipment in North America was the Boeing-Vertol Company. The production of a light rail vehicle in Canada is projected for 1977. Several well known manufacturers of light rail equipment can be found in Western Europe, and particularly in West Germany. Costs for light rail equipment are projected in the \$600,000 to \$700,000 range in 1976 dollars for the equipment produced in accordance with American specifications. Somewhat lower costs would be projected for West German equipment and considerably lower costs would be anticipated for lower performance equipment produced elsewhere.

The GRT type feeders would utilize medium size electrically powered vehicles operating as single units or in trains of vehicles on exclusive guideways under fully automated control. Examples of GRT technology are the Boeing manufactured vehicles operating at Morgantown in West Virginia, the LTV manufactured vehicles operating under the designation of AIRTRANS at the Dallas/Ft. Worth airport and equipment produced by the Westinghouse Electric Corporation in operation at the Seattle/Tacoma and Tampa airports. Other manufacturers such as Ford and Otis/TTD have deployed equipment or are in the process of completing manufacture of equipment for installation at other airports, shopping centers, or medical facilities. The main advantage of the automated systems, as demonstrated to date in operation primarily at airports, is the ability to provide a level of service to match the fluctuations in demand for transit without incurring excessive costs for personnel.

When deployed in fairly simple network configurations such as in loops or in a shuttle mode, and operated in the controlled environment of the limited activity centers the automated systems have proven to be safe, economical and capable of providing high quality transit service. None of these systems have as yet been deployed to provide urban transit service even in the simplest forms as projected in the SCL proposal. Adaptation of the GRT technology to urban transit is expected to require certain refinements and technological modifications necessary to insure a higher reliability of service, an acceptable level of safety and the ability to provide uninterrupted operation during a variety of unusual circumstances which are typical of conditions in urban transit. The United States Department of Transportation has projected a demonstration of GRT technology in shuttle/loop service under urban transit operating conditions to take place in the near future.

The extent and cost of the technological modifications required by this type of service are not known at this time. It is hoped, however, that by the late 70's the technology would have been sufficiently developed and proved to be suitable for the type of application envisioned by the SCL proposal.

While GRT technology has as yet not been deployed in urban transit, a number of studies have been carried out recently defining the system characteristics as they might pertain to urban applications. As a result of these studies and recent quotations from the industry for delivery of vehicles and related subsystems to urban applications, it has been established that vehicle costs can range from \$150,000 to \$750,000 per unit depending on the size of the vehicle and the complexity of the technology involved. Overall system costs including vehicles, associated equipment, guideways and stations have been quoted in 1974 dollars, in the range of \$15 million to \$20 million per mile. Since it is not practical to separate the cost of vehicles from that of the overall system for any of the GRT systems that have been deployed in limited applications, it is not feasible to formulate a range of useful equipment costs for the evaluation of the SCL proposal. Rather, it is felt that the SCL costs, in the range of \$5 million per mile for the total system, are considerably lower than what is likely to be experienced in actual purchase of similar systems for feeder applications. A range from \$15 million to \$20 million per mile would seem to be more appropriate for the proposed applications.

CONTROLS

The SCL proposal indicates that a conventional block signal system would be used, that automated train protection (ATP) is to be provided for operation on the mainline but that otherwise the vehicles would function under the manual control of the operators. It appears that the specification is not adequate for the following reasons.

It is by no means certain that, given the high speed of up to 85 mph and the close headways of slightly less than 2 minutes required on some of the more congested lines of the system, adequate operational reliability and safety can be insured utilizing a conventional block signal control system with the ATP backup on manual control. As long as all vehicles are operating normally on dry rails, adequate safety factors can be maintained

with present wayside block signals. However, when the rails become wet due to rain or fog, or in the event of a car's traction and braking system failing the safety of the operations can be seriously impaired unless automated techniques are applied to increase the headway between successive trains to safe operating distances. Alternately, the speeds must be reduced to compensate for the temporary unsafe operating conditions. In a high speed, high frequency transit system of the type contemplated by the SCL adapting manually to the changed but safer operational limits is difficult and should be supported by a more sophisticated form of control.

The large number of interline junctions described in the SCL proposal create a second requirement for a more sophisticated form of control than that specified. The high speed, high frequency operation of the system would require that movements at junctions be automatically controlled in order to minimize delays and guarantee as high a schedule reliability as possible. In addition, the possibility of collisions at these intersections must be minimized at all costs. The only apparent alternative to an automated, sophisticated interchange traffic management procedure would be operation of the trains through the junction at very low speeds. While this could be found to be acceptable for brief periods of time, or during the early operational stages of the system, it is unlikely that satisfactory operations be maintained throughout the entire network without provisions for adequate speed and high safety operations at interline junctions. A form of automated control system is required to assist the manual operations and to take over some of the more routine decision making activities involved in scheduling and controlling the movements of trains throughout this large network.

The control system costs stated in the SCL proposal did not account for any incremental sophistication of the equipment. The unit costs used in this evaluation, however, have been increased to partially account for this necessary technological agumentation.

CHAPTER 8

BUS FEEDER REQUIREMENTS

The level of bus feeder service appropriate for the Sunset Coast Line is in large part dependent on policy decisions and available funding. However, it is useful to review the experience in other cities where heavy rail systems have been installed. In Chicago, the Dan Ryan (south) and Kennedy (northwest) rail rapid transit extensions, which were planned and built in the late 1960's, began service in September 1969 and February 1970 respectively. The Dan Ryan line was then eleven miles long and served nine stations; the Kennedy line was then 5.2 miles with six stations. Both lines operate in expressway medians. As a result of the Ryan and Kennedy lines alone, 94 buses out of a total bus fleet of 2,691 were completely eliminated from service, a decrease of 3.5 percent. There were significant realignments of remaining bus services related to the rail system extensions--- mainly elimination of long bus trips to the CBD (about 345 bus trips per weekday) and replacement by feeder operations to rail stations.

In the San Francisco area, the opening of the BART system provides another example. A large portion of BART's mileage is in the service area of AC Transit, and conversations with their planners indicate that the opening of the transbay tube resulted in only an eight to nine percent reduction in transbay bus fleet, with no system-wide reduction at all.

The Sunset Coast Line would displace most buses along Wilshire Boulevard as well as a majority of Freeway Flyers, resulting in a possible small fleet reduction. However, it is reasonable to expect that even with the guideway system completed, about half of all transit trips would be made solely by bus. This is because there will be very few short trips (under 4 - 5 miles) which will be well served by the guideway. In addition to buses to serve local trips, an extensive feeder system is required to effectively utilize the guideway system. Most guideway trips would still require a bus at one or both ends.

Based on experience in Chicago and San Francisco, it is unlikely that the construction of the Sunset Coast Line would result in a significant reduction in bus fleet. It is more probable that feeder requirements will make a fleet increase desirable.

CHAPTER 9 COST MODIFICATIONS

At the suggestion of the Rapid Transit Committee of the Board of Directors of the Southern California Rapid Transit District, DCCO undertook the evaluation of minor modifications to the original SCL proposal with the objective of identifying certain cost savings without significantly impairing the original transit service concept embodied on the proposal. A number of modifications were considered which have the potential effect of reducing the capital costs of the SCL by 10 to 15 percent. These changes include:

- Feeders

Under this assumption 13 of the 15 identified fixed guideway feeders would be deferred until the mainline system has reached the final stages of development. The Burbank and South Bay feeders would be retained. In addition, three segments of the mainline network would be converted to light rail feeder service. These include the segment from Reseda to the San Diego Freeway joining with the Valley/Long Beach Line, the Golden State to the Simi Freeway segment also joining with the Valley/Long Beach Line and the segment from the Long Beach Freeway to the San Gabriel River Freeway contained within the Cross-County line. It is estimated that total savings approximating \$120 million attributable in the feeder modifications could be achieved.

- Interchanges

The cost of the interchanges could be reduced by simplifying the interchange layout to minimize the number of vehicle transfers from line to line but retaining enough flexibility to operate the airporter system. The simplification would retain provisions to route vehicles to maintenance and service yards and would provide

for a minimum of interline transfers. Table 4 lists the modifications and savings achievable at select interchanges. The interchange modifications could realize a savings of approximately \$151 million.

- Union Station

Following the guidance of the Rapid Transit Committee, a 50 percent cost sharing in the capital cost for the Union Station complex would result in an additional savings of \$50 million.

- CBD Distributor

A deferral of the allowance stated for the CBD distributor will result in a temporary savings of \$50 million.

- Vehicles

Assuming an initial acquisition of only 1000 vehicles a saving of \$200 million in the initial costs of the system could be realized.

- San Gabriel River Line

Because of the initial low patronage on this line some \$344 million could be temporarily saved by delaying the deployment of a rail segment along this line and constructing first a busway.

- Starter Line

According to instructions from the Rapid Transit Committee, the capital budget for the SCL would be charged with a once only allocation of \$52 million to round out the initial local share for funding the Starter Line.

As a result of these modifications, it is anticipated that the capital cost budget for the SCL expressed in 1976 dollars could be reduced by approximately \$900 million compared with the figures shown in Table 1.

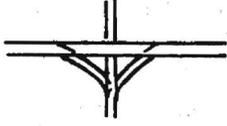
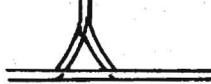
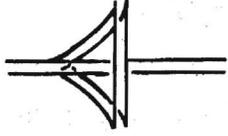
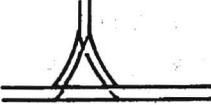
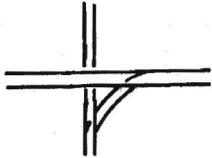
Whether or not these savings will be realized is a matter for policy decisions to be exercised by the Southern California Rapid Transit District Board of Directors. This brief evaluation suggests that certain savings could be accomplished while still maintaining an adequate level of service

on the SCL system at least in the initial years of operation. The resulting service while providing access among all of the origins and destinations reached by the SCL network will rely largely on shuttle service on each of the system's line and require that some passenger transfers take place at the major network interchanges. The network interchanges will be constructed to facilitate the passenger transfers and will be prepared for eventual interconnection. However, the structural complexity and any land taking associated with an eventual interconnection would be deferred until a later date.

While the modified SCL system would entail some variation in operating costs, no attempt was made to assess the changes. Of the SCL modifications listed here only two are likely to have some impact on the estimated operating costs: the change on the San Gabriel River Line and the modification of the interchanges. The other modifications affect mainly the timing of capital expenditures. The impact of temporary bus operations on the San Gabriel River Line on overall SCL O & M costs is probably not significant; i.e., while labor costs could increase other maintenance costs would drop. Likewise, the impact of modifications of the interchanges would have some effect on O & M costs but these are also deemed to be small with respect to the overall values estimated in Chapter 6. Thus, it is felt that the projected cost of \$1.50 \pm \$.10 per vehicle mile would be a reasonable estimate for the modified SCL as well.

TABLE 4

OPTIONAL SUNSET COAST LINE INTERCHANGES

<u>Interchange</u>	<u>Description</u>	<u>Setting Complexity</u>	<u>Additional Cost</u>
Valley/Long Beach - Inter-Valley		Moderate	\$25M* - \$35M
Century City - Valley/Long 3 each		Difficult	\$ 5M - \$15M
Wilshire - La Brea		Moderate	\$15M - \$25M
Airport - Valley/Long Beach		Easiest	\$10M - \$20M
Starter - Airport		Easiest	\$10M - \$20M
Central - Airport		Easiest	\$ 5M - \$10M
Long Beach - Airport		Moderate	\$ 5M - \$15M
Service only connection			\$ 5M - \$10M

not grade separated

*M = 1 million

**SOCIOECONOMIC, ENVIRONMENTAL AND PLANNING ANALYSIS
OF THE SUNSET COAST LINE PROPOSAL**

**Prepared For The
SOUTHERN CALIFORNIA RAPID TRANSIT DISTRICT**

**Prepared By
GRUEN ASSOCIATES, INC.**

March 12, 1976

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DEPARTMENT OF CHEMISTRY
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1964
1965
1966



March 12, 1976

GRUEN ASSOCIATES, INC.

ARCHITECTURE • PLANNING • ENGINEERING

EXECUTIVE SUMMARY

SOCIOECONOMIC, ENVIRONMENTAL AND PLANNING ANALYSIS OF THE SUNSET COAST LINE PROPOSAL

Gruen Associates reviewed the socioeconomic, environmental and planning aspects of the Sunset Coast Line (SCL) proposal presented to the Southern California Rapid Transit District. The review was undertaken in a short period of time. No attempt has been made to compare the SCL plan with any other alternatives which may be developed. The analysis has been performed to the level of detail required to establish areas of broad issues which may affect the Board of Directors' decision regarding placement of the proposal on the June 1976 ballot.

SCL PROPOSAL

- *The plan proposes a countywide rail transit system of over 281 miles consisting of approximately 230 miles of high-speed rail mass transit lines and approximately 51 miles of light rail, monorail or other fixed-guideway feeder system.*
- *The system will primarily use freeways, flood control channels, railroad rights-of-way, and arterials.*
- *The system will be built primarily on or above the surface of the ground. The principal construction method is an elevated structure. It minimizes subway construction.*
- *The cities will have the right of approval of location of stations within their own municipal boundaries.*
- *In order to reduce inflation-related costs, the plan proposes up to 48 months after the ballot approval as an observation-decision period for reaching agreements with affected political jurisdictions. The plan envisions that a number of construction starts will have been made within the first four years.*
- *The bulk of the system will be built in approximately 12 years.*
- *The entire proposal will be viewed as a contract between the people and their government. The system will be built substantially in accordance with the plan. The concept of guarantee means that construction funds cannot be diverted to other routes or concentrated for different purposes.*
- *The proposal stipulates certain fixed budgets for aerial guideways and stations. Any design modifications over and above these budgets must be paid by local jurisdictions.*
- *The system is also based on a low-fare policy. The proposed initial fare-collection device would not require a station attendant.*

FINDINGS

Transit Service Coverage

1. The SCL plan proposes extensive countywide rail rapid transit service coverage to most of the cities and towns in Los Angeles County. The system will provide an alternative travel choice on a scale commensurate with the size of the County and its population.
2. Because of the wide geographic coverage and local population and employment density variations, there is likely to be an imbalance in patronage levels from line to line. Certain lines will probably carry a high level of patronage, while others may capture only a very low level of patronage. If on the other hand those rail lines which may be underutilized are deleted from the plan, the rail transit service coverage will be smaller—and primarily limited to the central cities—thus weakening one of the key features of the plan (equity in service coverage on a countywide scale).
3. Without having line-by-line patronage estimates, it is still possible to suggest an alternative which could perhaps help overcome this dilemma. Such an alternative might be to keep the same geographic coverage but vary the mode and the level of service. The same lines designated in the plan would be followed; but, rather than having all rail transit, bus transit could be utilized on an interim basis until such time as patronage levels justified the more costly investment. Initial costs are reduced, transit service is provided, and the option for upgrading to rail transit service is left open.
4. The SCL system has the potential for achieving a major shift in our travel behavior and lessening the extent of our automobile dependency. It would make possible contingency plans to cope with energy or air quality crises. It would allow the use of other energy resources than oil. It would also provide maneuvering room for considering certain public policy measures which further encourage the use of public transit while discouraging automobile trips.

Use of Existing Public Rights-of-Way

1. The sharing of existing transportation rights-of-way, such as freeways, arterials, railroads and flood control channels, greatly minimizes the extent of probable displacement and relocation impacts due to transit right-of-way acquisition. Most of the displacement impacts are due to mainline stations (89), parking improvements (100,000 spaces), shops, yards, and interchanges.
2. The main lines in arterials (15 percent of 230 miles) directly serve many existing areas of population and employment concentrations. However, those segments of the main lines utilizing existing freeway rights-of-way (81 percent) do not, in general, directly or conveniently serve existing major centers of population and employment. These mainline stations must rely on local feeder buses or automobiles for making connection between trip origins and destinations.

On the other hand, if the main lines are shifted to the densely built-up areas to more directly serve the people, community impacts and opposition due to aerial guideways will be substantially greater, or costs of subway construction will escalate to a level where the size of the rail transit network may have to be drastically reduced. This reduction in rail transit coverage will again weaken the key feature of the SCL plan. Thus, the trade-off between displacement and construction cost impacts and direct service symbolizes the current transportation dilemma throughout the country.

3. Careful consideration should be given to those aerial guideways utilizing existing arterials, since impacts could vary significantly, depending on guideway and station locations and design. It can be anticipated that major community opposition, jurisdictional disagreement and environmental controversy would be developed if past experience in other parts of the country is any indication of things to come.

4. The concept of equal construction budget allocations for aerial stations and guideways must be related to the concept of equivalent environmental settings. For example, the environmental impact of the aerial guideway in a highly developed arterial setting would be quite different from the impact of a similar installation in a freeway median surrounded by industrial land uses. Thus, it would be necessary to vary design and impact mitigation measures and cost allocations, depending on each prototypical environmental setting.

5. The aerial guideway in a freeway median or side slope must periodically move up and down to clear street overcrossings (bridges), freeway-to-freeway interchanges, or interchange ramps. The guideway height may easily reach 45 to 50 feet (at the crossings) or 80 to 100 feet (at the freeway interchanges), either from freeway lanes or adjacent ground levels. This roller-coaster visual effect can be quite dramatic from the transit user's point of view, but can also be visually disruptive to adjacent residential areas if located along the freeway. Perhaps one of the ways to partially solve this problem is to move the line to a new right-of-way outside of the freeway-to-freeway interchanges.

6. Freeway-adjacent stations require many horizontal and vertical transitions connecting between a parking lot, a station concourse, and platforms. Additional costs for many sets of elevators, escalators, and long bridge connections over freeways can be anticipated. Because of a generally low level of pedestrian activity along freeways, the concept of stations without station agents may seriously affect feelings of security, thus discouraging the use of these stations, particularly in the evenings. There is a great need to provide all stations with attendants for safety and security of passengers, as well as a security force to constantly patrol the entire SCL system.

7. The concept of at-grade guideways taking two center freeway lanes will probably be the best solution if the displaced lanes do not have to be replaced and where the freeway volume is currently below its capacity. Where freeway widening were to take place, it might involve existing bridge reconstruction, addition of high retaining walls or viaducts, and encroachment on existing landscape improvements.

8. Slowdown of traffic will occur, and traffic congestion will develop on the freeways during construction. The construction phasing should be carefully worked out to minimize construction-related traffic disruptions. Up to 40 miles of existing freeways may be involved in construction at a given time.

Noise Impact

Because existing freeways are already high noise impact corridors, the introduction of transit guideways would not produce additional noise impacts in most instances. The same may not hold true in arterials, or in flood control embankments and railroad rights-of-way, where trains currently run once or twice a day and along which residential neighborhoods are located.

Air Quality Impact

Based on the BART experience and other nationwide transit studies, it is not anticipated that the proposed SCL system would lead to an immediate significant effect upon regional air quality. For Los Angeles County it is estimated that daily mobile source emissions would be reduced by about five percent. The solution of our regional air quality problem can best be achieved by control at the emission source (e.g., automobiles, power plants, and other stationary sources).

Net Job Formation

The SCL construction would produce new jobs during a peak year (based on a 16-year program) in the range of 25,000 to 35,000 direct and indirect jobs. However, it is a very complex task to assess whether the jobs created are considered entirely new in Los Angeles County. The flow of money equivalent to that generated by a one-cent sales tax would normally have created jobs in other sectors of the economy in Los Angeles County, not related to the construction and transit-vehicle manufacturing industries, such as in consumer goods, housing, etc. In addition, certain new jobs to be created by the SCL construction may go outside Los Angeles County, specifically, those jobs related to manufacturing transit vehicles.

Sales Tax Rate Differential

The one-cent sales tax rate differential may affect the purchasing pattern of consumers in border communities inside and outside of the Los Angeles County boundary. This would probably not affect the sales of convenience goods. However, it may contribute to a tax-induced sales migration with respect to large cost items in shopping goods (such as automobiles, heavy appliances, etc.).

Effects on Existing Activity Centers

Based on the BART experience, it is not likely that new development would automatically generate around every station on the main lines. In the Bay Area, even 15 years after the decision to build BART, no major land development intensification has taken place except in downtown San Francisco and, to some extent, in the central areas of Berkeley and Oakland. Because of the extensive mileage and coverage (230 miles and 89 stations) of the SCL, future development potentials would likely be diffused over its network and would have no significant effects on major existing centers. The economic viability of existing centers depends not only on accessibility, but also on so many other physical, environmental, social and economic factors.

Urban Sprawl

The SCL may encourage longer trips. Since most of the areas to be covered by the SCL have already been developed, the increased transit accessibility may provide an additional development impetus to the border communities both inside and outside of Los Angeles County.

Commitment Versus Flexibility

1. The SCL proposal makes a commitment that the system will be built substantially in accordance with the plan and in a relatively short time period (15 years). It specifically names those cities to be served directly or indirectly. It also gives the cities the right of approval on station location.
2. The SCL plan does not provide adequate time to allow institutional agreements and construction. If agreements cannot be reached in the first two to three years, either because of location and configuration of lines and stations or in terms of design or cost allocations, strategic missing links may develop and ultimately jeopardize the integrity and operation of the system network. The period of 15 years does not leave time for contingencies such as environmental impact report clearance, workable construction phasing, litigations, and strikes.
3. The SCL plan is defined too precisely. It would be desirable to have more flexibility in staging and scope (interim services, station locations, and alignments). However, if the plan is made too flexible, it will weaken the key feature of the plan—the concept of guarantee or commitment to the public.

CONCLUSIONS

- *The SCL provides extensive countywide rail transit coverage.*
- *It is generally a low-impact alternative along freeways. However, lines located in arterials and certain other rights-of-way may pose significant environmental impact and community opposition.*
- *It would be desirable if more time could be allocated to reaching institutional agreements and system construction (from the proposed 15 years to 20 or more years).*
- *Additionally, if more flexibility were built into the scope and phasing of the system (such as less mileage of the main lines in the first 20 years and possible delaying of some of the fixed-feeder and distribution line systems); many of the preceding issues could be resolved in time.*

TABLE OF CONTENTS

	Page
1. INTRODUCTION	
1.1 Objective of the Study	1-1
1.2 Limitations of the Study	1-1
1.3 SCL Proposal	1-1
1.4 Modified SCL Proposal	1-4
2. TRANSIT SERVICE COVERAGE	
2.1 Countywide Service	2-1
2.2 Service to Regional Centers	2-1
3. ENVIRONMENTAL AND SOCIOECONOMIC IMPACTS	
3.1 Use of Existing Transportation Rights-of-Way	3-1
3.1.1 Freeways	3-1
3.1.2 Railroads and Flood Control Channels	3-11
3.1.3 Arterials	3-12
3.2 Displacement	3-16
3.3 Freeway Traffic Disruptions	3-18
3.4 Service to Transit Dependents	3-20
3.5 Noise Impact	3-22
3.6 Air Quality Impact	3-23
3.7 Net Job Formation	3-25
3.8 Sales Tax Rate Differential	3-28
4. PUBLIC POLICY IMPLICATIONS	
4.1 Contingency Plans	4-1
4.2 Federal Funding Participation	4-1
4.3 Commitment Versus Flexibility	4-2
4.3.1 Time Schedule for Construction and Jurisdictional Agreements	4-2
4.3.2 Scope and Staging	4-3
5. LAND USE AND URBAN GROWTH IMPLICATIONS	
5.1 Options for Balanced Land Use Decisions	5-1
5.2 Growth Inducement	5-1
5.2.1 Intensification	5-1
5.2.2 Urban Sprawl	5-2
6. SUMMARY CONCLUSIONS	

1. INTRODUCTION

1.1 Objective of the Study

The objective of the study is to review the socioeconomic, environmental and planning aspects of the Sunset Coast Line (SCL) proposal prepared by the office of Baxter Ward, Chairman of the Los Angeles County Board of Supervisors and presented to the Southern California Rapid Transit District Board on January 28, 1976. The analysis has been performed to the level of detail required to establish areas of broad issues which may affect the Board of Directors' decision regarding placement of the proposal on the June 1976 Ballot.

Gruen Associates is one of the four consultants retained to undertake the evaluation of the Sunset Coast Line proposal. Other consultants and their respective areas of evaluation are:

- o De Leuw, Cather & Company, with respect to capital and operating costs and engineering factors;
- o Mobility Systems, with respect to right-of-way adaptability, guideway construction, hardware availability, energy requirements and maintenance facilities;
- o Stanford Research Institute, with respect to overall financial feasibility.

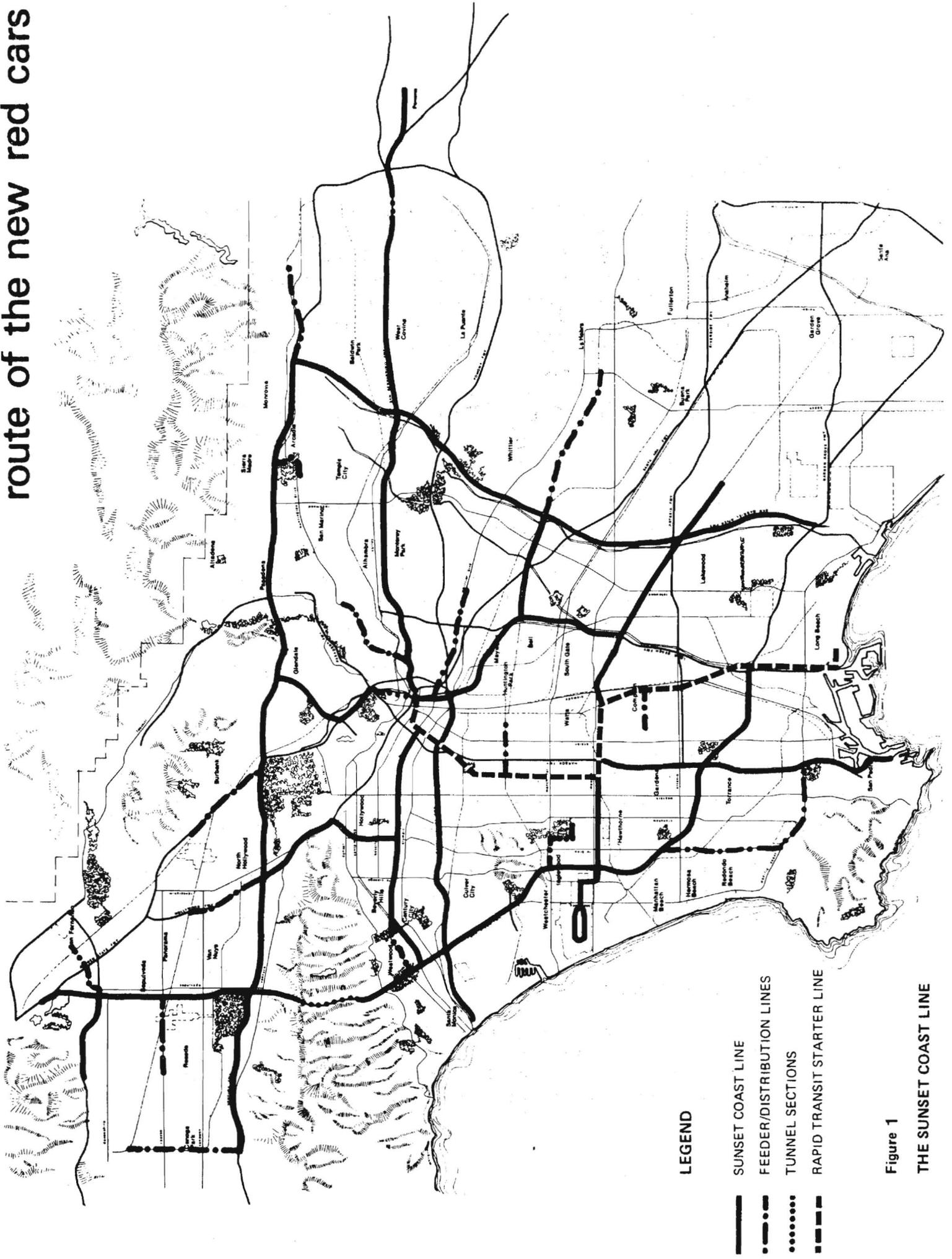
1.2 Limitations of the Study

The study period consisted of approximately four weeks starting in the third week of February, 1976. Due to this severe limitation of time, our evaluation methodology relied partially on analysis and partially on judgmental assessments. The analysis was mostly based on the information presented in the SCL report and no attempt has been made to compare the SCL proposal with any other alternatives which may be developed.

1.3 The SCL Proposal

- o The plan proposes a countywide rail transit system of over 281 miles consisting of approximately 230 miles of high-speed rail mass transit (main) lines and approximately 51 miles of light rail, monorail or other fixed-guideway feeder system (Figure 1).

route of the new red cars



LEGEND

-  SUNSET COAST LINE
-  FEEDER/DISTRIBUTION LINES
-  TUNNEL SECTIONS
-  RAPID TRANSIT STARTER LINE

Figure 1

THE SUNSET COAST LINE

- o The system will primarily use freeways, flood control channels, railroad rights-of-way, and arterials.
- o The system will be built primarily on or above the surface of the ground. The principal construction method is an elevated structure. It minimizes subway construction. There are about 89 miles of aerial guideway and 94 miles of at-grade guideway within freeway rights-of-way, 7 miles in subway, about 34 miles of aerial guideways in arterials, flood control channels and railroad rights-of-way, and 5 miles of at-grade guideway on embankment.
- o The cities will have the right of approval of location of stations within their own municipal boundaries. The plan envisions 89 main line stations, of which 64 are located along freeways, 100,000 parking spaces, and 102 aerial stations for the feeder system.
- o The system will provide a connection to the proposed Orange County rail transit line.
- o The District will be authorized to levy a one-cent transactions and use tax and any limited tax bonds will be supported only by those taxes.
- o In order to reduce inflation-related costs, the plan proposes up to 40 months after the ballot approval as an observation-decision period for reaching agreements with affected political jurisdictions. The plan envisions that a number of construction starts will have been made within the first four years.
- o The period of construction is 15 years and the bulk of the system will be built in approximately 12 years.
- o The entire proposal will be viewed as a contract between the people and their government. The system will be built substantially in accordance with the plan. The concept of guarantee means that construction funds cannot be diverted to other routes or concentrated for different purposes.
- o The proposal stipulates certain fixed budgets for aerial guideways and stations. Any design modifications over and above these budgets must be paid by local jurisdictions.
- o The system is also based on a low-fare policy. The proposed initial fare-collection device would not require a station attendant.

1.4 Modified SCL Proposal

Based on the meeting with the Rapid Transit Committee of the SCRTD Board in early March, a modified SCL plan¹ was developed for additional sensitivity analysis (Figure 2). This modified plan would contain about 244 miles of rail transit fixed guideways, consisting of 222 miles of main lines and 22 miles of feeder and distribution lines. The segments of the original SCL plan not included in the modified version would be implemented in the second phase of the project.² Of 222 miles of the main lines, approximately 19 miles are located in existing arterials, 17 miles along railroads and flood control channels, and 186 miles in freeway rights-of-way.

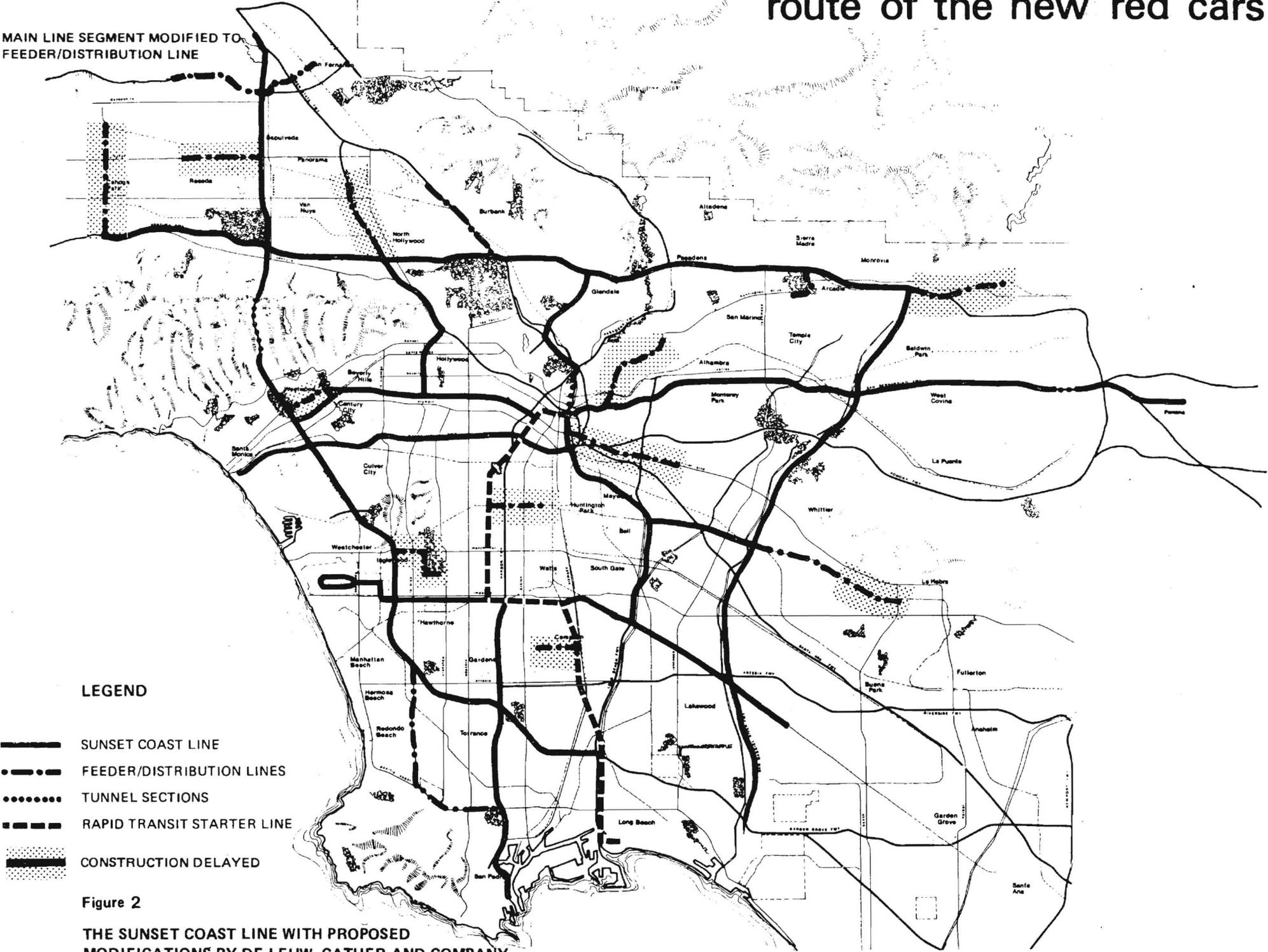
However, the bulk of the analysis findings by Gruen Associates has been based on the original SCL proposal with specific reference to the modified plan, where applicable.

¹For details, see the companion report prepared by De Leuw, Cather & Company.

²The anticipated planning and construction schedule for the first phase to be determined by the financial sensitivity analysis by Stanford Research Institute.

route of the new red cars

MAIN LINE SEGMENT MODIFIED TO FEEDER/DISTRIBUTION LINE



LEGEND

-  SUNSET COAST LINE
-  FEEDER/DISTRIBUTION LINES
-  TUNNEL SECTIONS
-  RAPID TRANSIT STARTER LINE
-  CONSTRUCTION DELAYED

Figure 2

THE SUNSET COAST LINE WITH PROPOSED MODIFICATIONS BY DE LEUW, CATHER AND COMPANY

2. TRANSIT SERVICE COVERAGE

2.1 Countywide Service

The SCL plan proposes extensive countywide rail rapid transit service coverage to most of the cities and towns in Los Angeles County. The system will provide an alternative travel choice on a scale commensurate with the size of the County and its population.

Because of the wide geographic coverage and local population and employment density variations, there is likely to be an imbalance in patronage levels from line to line. Certain lines will probably carry a high level of patronage, while others may capture only a very low level of patronage. If on the other hand those rail lines which may be underutilized are deleted from the plan, the rail transit service coverage will be smaller--and primarily limited to the central cities--thus weakening one of the key features of the plan (equity in service coverage on countywide scale).

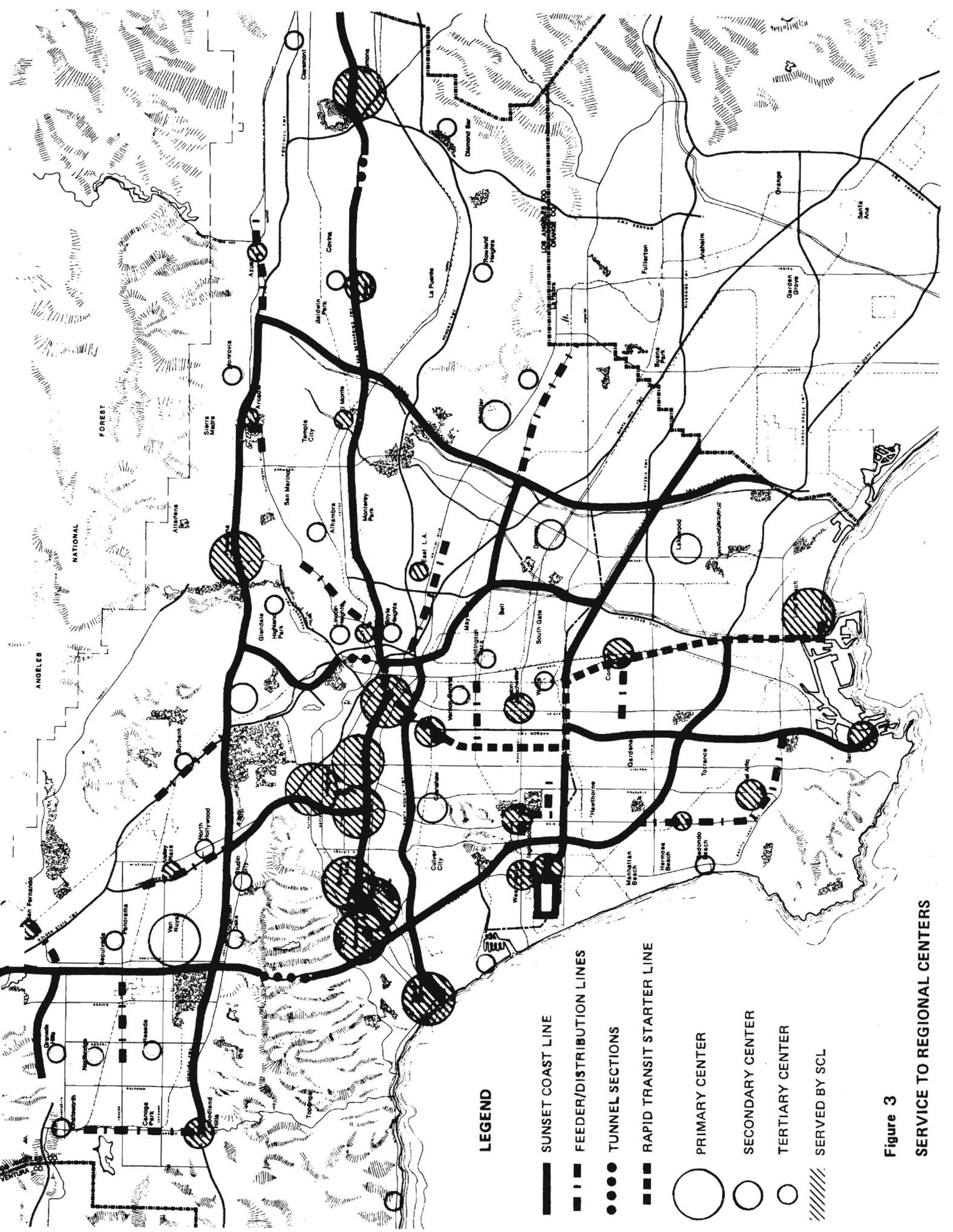
Without having line-by-line patronage estimates, it is still possible to suggest an alternative which could perhaps help overcome this dilemma. Such an alternative might be to keep the same geographic coverage but vary the mode and the level of service. The same lines designated in the plan would be followed; but, rather than having all rail transit, bus transit could be utilized on an interim basis until such time as patronage levels justified the more costly investment. Initial costs are reduced, transit service is provided, and the option for upgrading to rail transit service is left open.

2.2 Service to Regional Centers

The proposed SCL system would provide service to 11 out of 12 primary regional centers, 10 out of 15 secondary centers, and 9 out of 33 tertiary centers (see Figure 3).¹ To better define the level of service to the three classes of regional centers, Table 1 indicates whether the centers would be served by the main line system, the fixed guideway feeder system (either light rail or group rapid transit), or by both the main line and feeder system.

The lines in arterials (namely the Wilshire and La Brea corridors and others) would directly serve existing areas of population and employment concentrations. However, those stations in the freeways must rely on local

¹Regional Centers designated by the City of Los Angeles, the County of Los Angeles, and SCAG.



LEGEND

- SUNSET COAST LINE
- - - FEEDER/DISTRIBUTION LINES
- TUNNEL SECTIONS
- ■ ■ RAPID TRANSIT STARTER LINE
- PRIMARY CENTER
- SECONDARY CENTER
- TERTIARY CENTER
- ▨ SERVED BY SCL

Figure 3
SERVICE TO REGIONAL CENTERS

feeder buses or automobiles for making connection between trip origins and destinations. As Figure 3 and Table 1 indicate, the majority of primary and secondary activity centers are located either on or near the proposed main lines. However, the activity centers nearby are so located that movement by foot may not be the best means of travel to these centers. If, on the other hand, the main lines were shifted to the densely built-up areas to more directly and conveniently serve the people, community impacts and opposition due to aerial guideways will be substantially greater, or costs of improvements and mitigating impacts (i. e., subways, relocation etc.) would escalate to a point where the size of the rail transit network would be greatly reduced. This reduction in transit coverage will weaken one of the key features of the plan. This symbolizes the current transportation dilemma.

TABLE 1
SERVICE TO REGIONAL CENTERS*

Sunset Coast Line Service	Regional Centers			Total
	Primary	Secondary	Tertiary	
Main Line System	9	6	1	16
Guideway Feeder System	--	2	8	10
Both Main Line and Feeder	2	2	--	4
TOTAL	11^a	10^b	9^c	30^d

* This evaluation indicates that the SCL system (main lines and/or guideway feeder system) physically reaches the indicated number of regional centers.

^a Out of a total of 12 primary regional centers.

^b Out of a total of 15 secondary regional centers.

^c Out of a total of 33 tertiary regional centers.

^d Out of an overall total of 60.

3. ENVIRONMENTAL AND SOCIOECONOMIC IMPACTS

3.1 Use of Existing Transportation Rights-of-Way

The SCL plan proposes extensive regionwide rail rapid transit service to most of the communities in Los Angeles County. In order to provide this coverage, the SCL plan proposes the use of existing transportation corridors or public rights-of-way so as to almost completely eliminate the need for condemnation of private property.¹ The types of public rights-of-way which are identified for utilization as transit corridors for the 222 miles of main line include 186 miles of freeways, 19 miles of arterials and 17 miles of flood control channels and railroad rights-of-way.²

Each right-of-way (ROW) type has varying characteristics which affect its suitability as a potential transit corridor. Therefore each of the ROW types considered must be examined to clearly define the particular set of effects and potential conflicts which may occur as a result of the implementation of the SCL plan.

3.1.1 Freeways

Aerial Guideways in Freeway Medians

- o Because of the extensive use of existing freeway medians (186 miles), potential adverse impacts of the SCL system can be reduced to a low level in terms of:
 - Displacement and relocation of people and businesses. Aerial guideways located in freeways with substandard medians may require widening of freeways in some locations to replace freeway lanes (two). This may impose additional impacts in adjacent areas along the ROW.
 - By locating transit in existing high volume travel and high noise-generating corridors, the adverse impacts of transit can be reduced.
 - Construction can be facilitated by working in established rights-of-way which require no clearance of existing uses.

¹The Sunset Coast Line, prepared by the office of Baxter Ward, Supervisor of the Board of Supervisors, Los Angeles County, January 28, 1976, p. 117.

²The modified SCL plan consisting of 244 miles of main lines and feeder systems.

- Coordination with the State and the Federal agencies will be required to utilize freeways as opposed to local agencies when local arterials are used for transit.
- o While the use of freeway medians may reduce certain adverse environmental impacts associated with the development of a fixed guideway system, other problems may be created:
 - A high percentage of the main lines are located in an aerial configuration in the median of the freeway (Figure 4). The aerial guideway alignment would not result in loss of any existing freeway lanes in most instances.
 - The aerial guideway in a freeway median must periodically move up and down to clear street overcrossings (bridges), freeway-to-freeway interchanges or interchange ramps (Figures 5, 6, 7). The guideway height may easily reach 45 to 50 feet (at the crossings) or 80 to 100 feet (at the freeway interchanges) either from freeway lanes or adjacent ground levels. This roller-coaster visual effect can be quite dramatic from the transit users' point of view, but can also be visually disruptive to adjacent residential areas, if located along the freeway. Perhaps one of the ways to partially solve this problem is to move the line to a new right-of-way outside of the freeway-to-freeway interchanges.
- o Aerial station platforms in freeway medians create a series of special conditions which must be satisfied if the station is to provide safe, convenient access to the transit line:
 - At stations, side platforms must be cantilevered over the median and inside traffic lanes (Figure 8). This will require special structural detailing during the design and engineering phase of the system.
 - When station platforms are located on aerial structures in freeway medians, long and sometimes complex horizontal and vertical transitions are required to make the connection between the station concourse located alongside the freeway and the station platforms (Figures 8, 9, 10). In some instances the horizontal transfer distance exceeds 150-200 feet and the vertical transfer three-level changes (Figure 9).

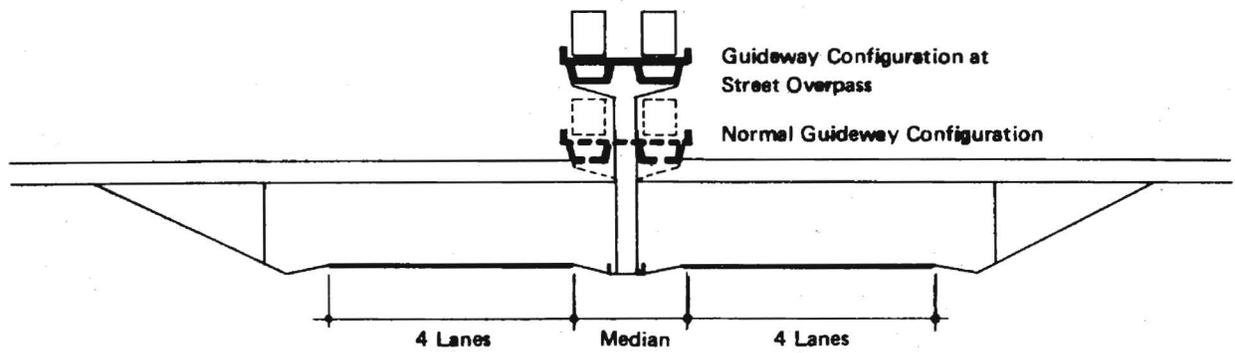


Figure 5
AERIAL GUIDEWAY IN MEDIAN OF DEPRESSED FREEWAY *

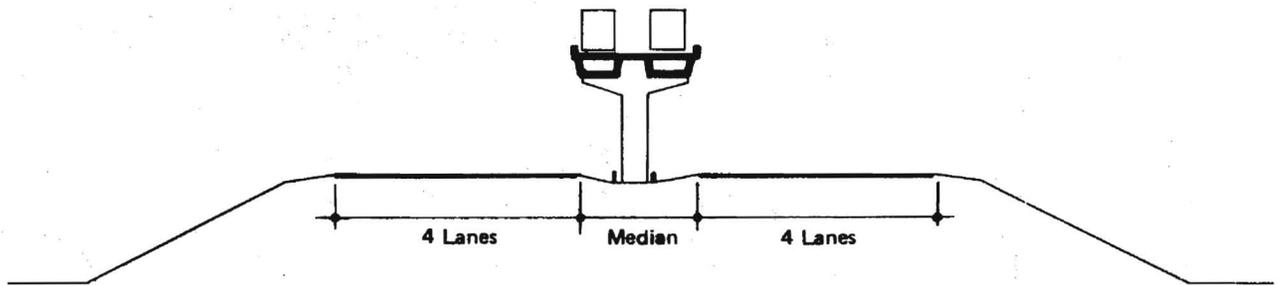


Figure 6
AERIAL GUIDEWAY IN MEDIAN OF ELEVATED FREEWAY *

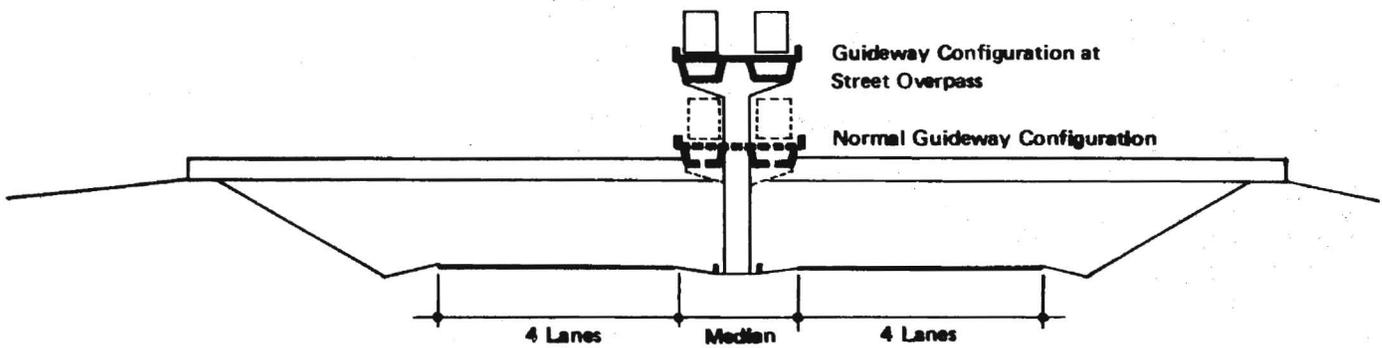


Figure 7
AERIAL GUIDEWAY IN MEDIAN OF AT-GRADE FREEWAY
AT STREET OVERPASS *

* For Illustrative Purposes Only

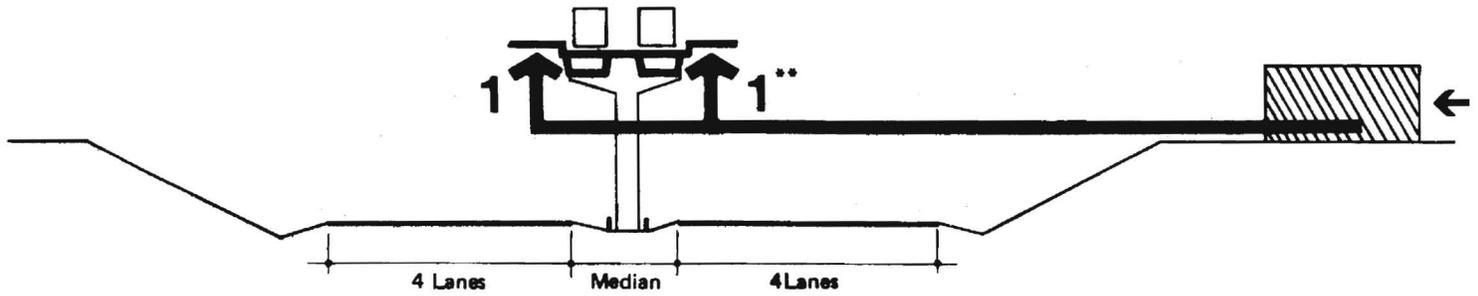


Figure 8
CIRCULATION BETWEEN CONCOURSE AND PLATFORM—
AERIAL PLATFORM IN MEDIAN OF DEPRESSED FREEWAY *

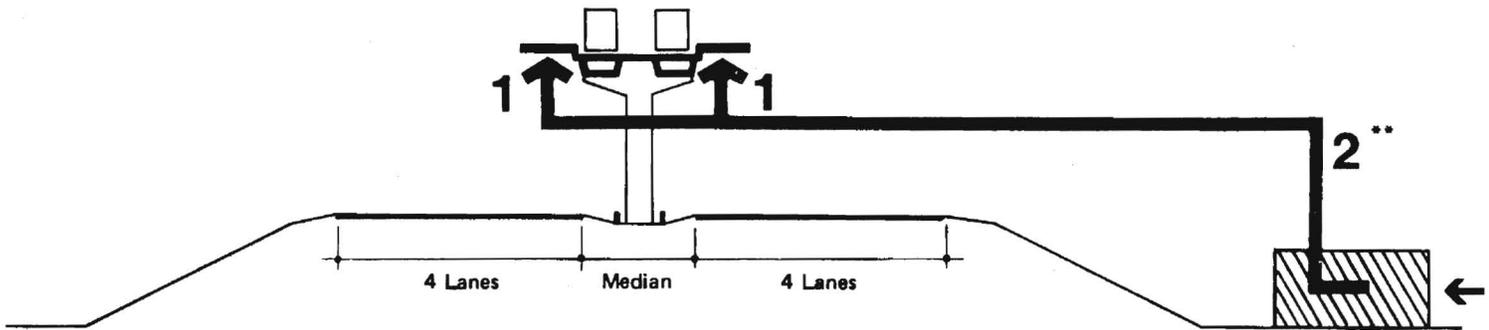


Figure 9
CIRCULATION BETWEEN CONCOURSE AND PLATFORM—
AERIAL PLATFORM IN MEDIAN OF ELEVATED FREEWAY *

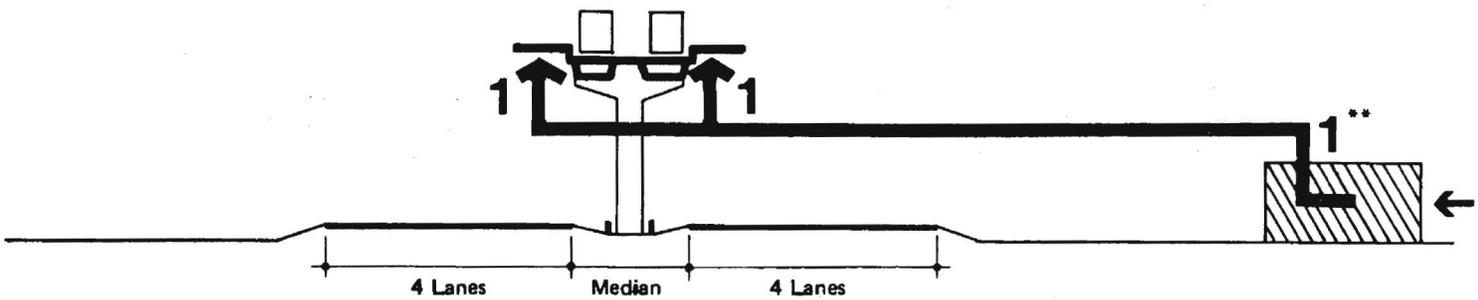


Figure 10
CIRCULATION BETWEEN CONCOURSE AND PLATFORM—
AERIAL PLATFORM IN MEDIAN OF AT-GRADE FREEWAY *

* For Illustrative Purposes Only

** Indicates the Number of
 Level Transitions Required

- o Extended vertical and horizontal transitions between station concourses and platforms may create security and surveillance problems and may require station attendants or security personnel.¹
- o Stations on freeways should be located away from freeway-to-arterial ramp locations to avoid traffic congestion and accessibility problems. Stations should be located to one side of the freeway rather than on both sides to minimize station-related costs and to simplify pedestrian access to station concourses and platforms.
- o Construction of aerial guideways and stations in freeway medians may require the temporary relocation of one or more traffic lanes on the following freeway segments (Figure 11):
 - Ventura Freeway from Topanga Canyon to the Golden State Freeway.
 - San Diego Freeway from the Simi Valley Freeway to the Long Beach Freeway.
 - Santa Monica Freeway from Santa Monica to the Long Beach Freeway.
 - Long Beach Freeway from the CBD to the I-105 corridor.

Relocation of lanes on these freeway segments will cause lowering the speed and additional traffic congestion during the construction phase of the system.

At-Grade Guideways in Freeway Medians

- o A substantial portion of the SCL main line is located at-grade in freeway medians (Figure 4). Locating transit at-grade will generally result in the displacement of existing traffic lanes or require the widening of the existing freeway (Figure 12).
- o In most instances, additional widening would be required to accommodate station platforms (Figures 13, 14). This additional widening may require the use of retaining walls or viaducts along some segments.

¹ Environmental settings in which most freeways are located are not conducive to creating a feeling of safety and security.

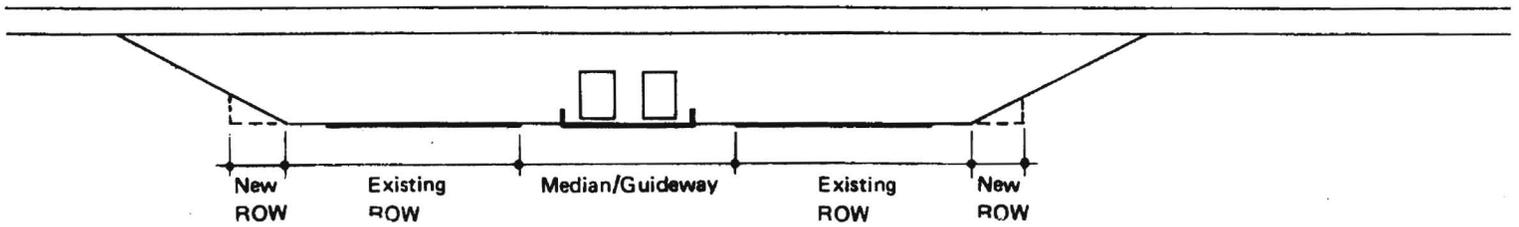


Figure 12
AT-GRADE GUIDEWAY IN MEDIAN OF DEPRESSED FREEWAY *

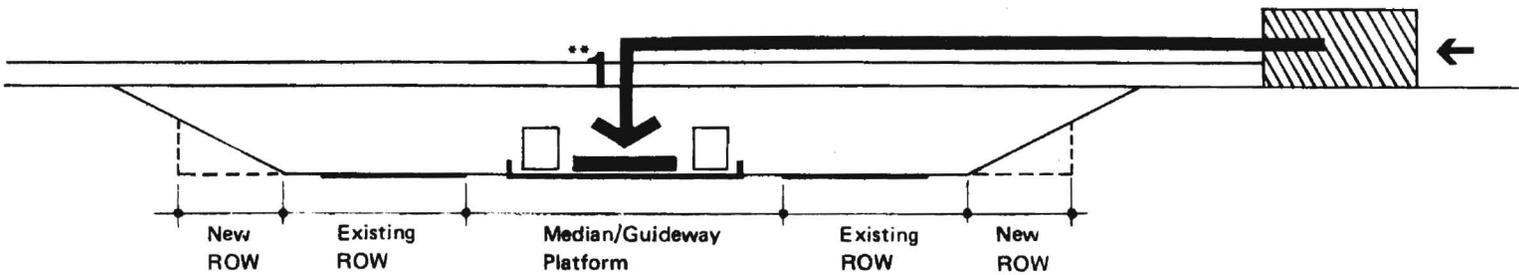


Figure 13
CIRCULATION BETWEEN CONCOURSE AND PLATFORM—
AT-GRADE PLATFORM IN MEDIAN OF DEPRESSED FREEWAY *

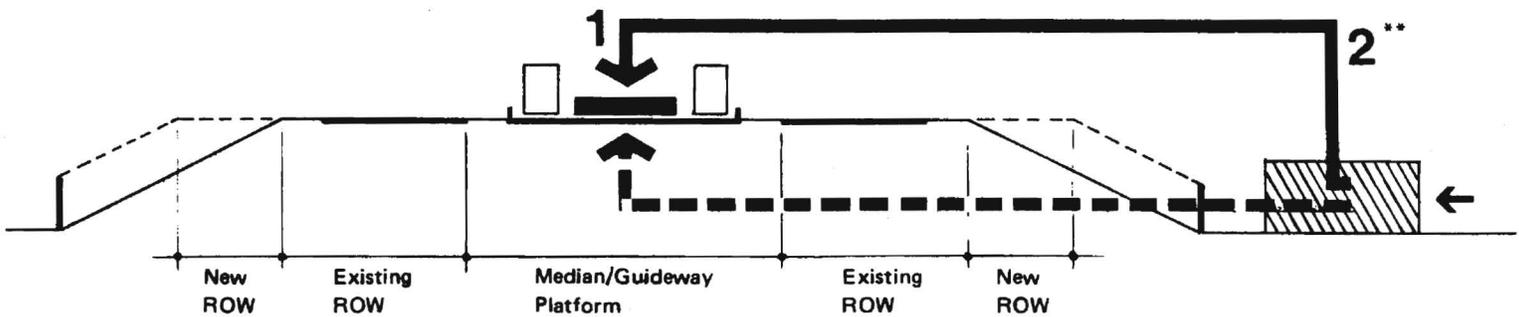


Figure 14
CIRCULATION BETWEEN CONCOURSE AND PLATFORM—
AT-GRADE PLATFORM IN MEDIAN OF ELEVATED FREEWAY *

* For Illustrative Purposes Only

** Indicates the Number of
 Level Transitions Required

- o The taking of two freeway lanes and freeway widening would also require reconstruction of existing bridges where the bridge abutment is located at the edge of the shoulder.
- o Widening the freeway to replace the two displaced lanes would mean either the widening of the right-of-way requiring further property displacement or additional construction of retaining walls or viaducts encroaching on existing landscape improvements.

Aerial Guideways on Freeway Side Slopes

- o The use of freeway side slopes for transit alignments is feasible along depressed freeways and elevated freeways on embankments. The placement of the aerial guideways on these slopes (where adequate ROW exists) eliminates the need for modifying the existing configuration of the freeway.
- o The same conflict occurs at aerial overpasses where the guideway must be elevated to clear the bridge structures or interchange ramps (Figures 15, 16). This additional height may have increased adverse visual impacts on adjacent land uses.
- o Elevated guideways on freeway side slopes should be avoided as much as possible where sensitive residential uses are located adjacent to the ROW.

Freeways -- Adjacent Stations

- o Many of the 89 SCL main line stations are located at freeway interchange ramps. A transit station located at a freeway interchange would create many problems in terms of pedestrian and vehicular access, guideway routing and accommodation, and security. It may be more practical to examine alternative station locations near freeway interchanges where access is simplified, development is less intense and access to nearby activity centers located adjacent to freeway interchanges is viable.

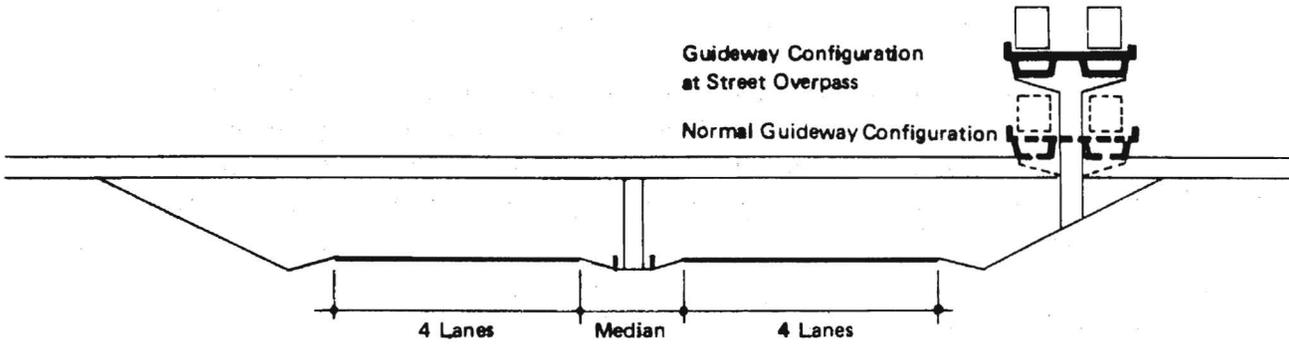


Figure 15
AERIAL GUIDEWAY ALONGSIDE DEPRESSED FREEWAY *

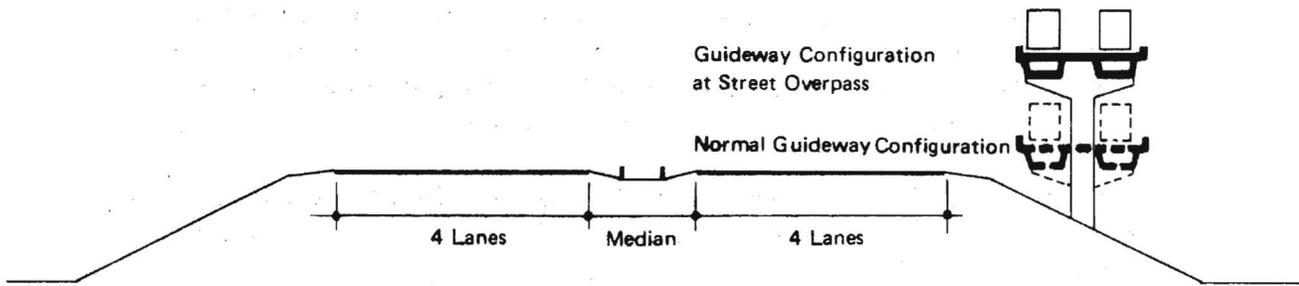


Figure 16
AERIAL GUIDEWAY ALONGSIDE ELEVATED FREEWAY *

* For illustrative Purposes Only

3.1.2 Railroads and Flood Control Channels

Railroad Rights-of-Way

- o The SCL plan utilizes aerial guideways for its main line segments along the major portions of the railroad rights-of-way. An aerial alignment in a railroad ROW eliminates potential conflicts between transit and rail operations and does not adversely affect industrial uses along the corridor which depend on rail service to deliver materials and ship products. However, aerial guideways located over active railroad rights-of-way must maintain sufficient vertical (22 feet) and horizontal clearances to allow for the operation of the railroad (Figure 17).

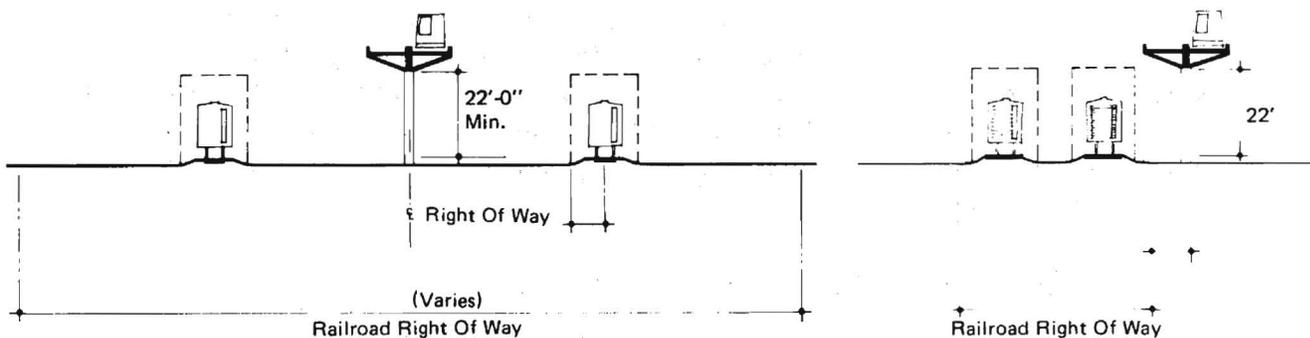


Figure 17

- o Stations located alongside the ROW may require both vertical and horizontal transition elements depending on the location of the guideway and platform (Figure 18).

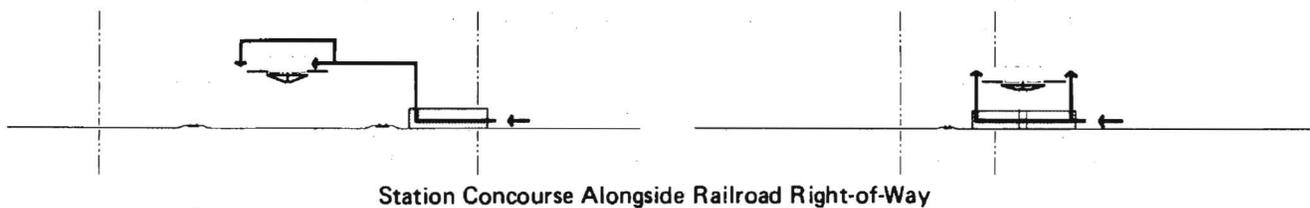


Figure 18

- o Location of transit in railroad rights-of-way may result in minimizing adverse environmental and socioeconomic impacts since these corridors generally pass through industrial and undeveloped land. However, portions of these transit alignments located in railroad rights-of-way (the eastern segment of the International Airport Line) pass through areas developed with residential uses. In these areas, the adverse impacts of transit in the railroad ROW may be significant to those residents whose homes are adjacent to the ROW.

Flood Control Channels

- o Transit segments which utilize flood control channels are also likely to result in impacts similar to those created by transit in railroad rights-of-way on existing developed areas. In some areas, flood control channels to be used for transit pass through residential areas. In these areas, some adverse impacts from transit on residential uses may be anticipated.

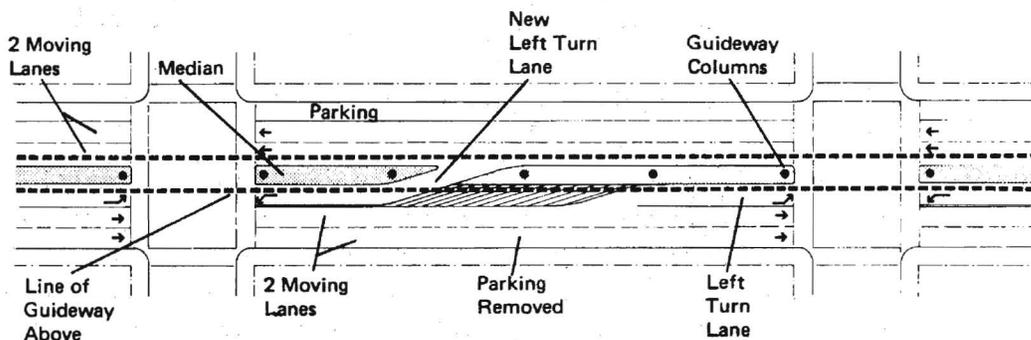
3.1.3 Arterials

Of the 222 miles of main line proposed by the modified SCL plan, 19 miles utilize arterial rights-of-way.¹ Careful consideration should be given to those aerial guideways which utilize existing arterials since potential impacts can vary substantially depending on guideway and station design and location. It can be anticipated that major community opposition, jurisdictional disagreement and environmental controversy would be developed if past experience in other parts of the country is any indication of things to come.

Arterial Medians (Two-Way Guideways)

The introduction of main line aerial guideways in highly-developed arterials will result in some displacement and disruption of existing traffic and parking patterns (automobiles, bus, and commercial traffic).

- o A two-way aerial guideway may be located in the median of an arterial or on one side. The consequences of installing the guideway on existing street section configuration, traffic flow, and parking are shown in Figure 19.

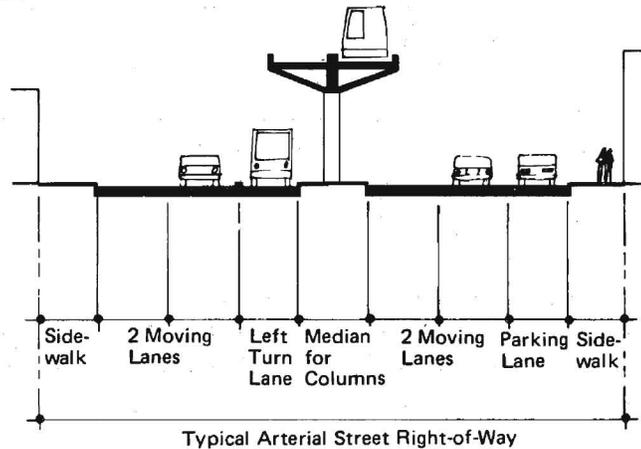


Arterial Street - Plan View of Aerial Guideway Columns and Median

Figure 19

¹The major portions of this main line mileage are located in the Wilshire and La Brea corridors.

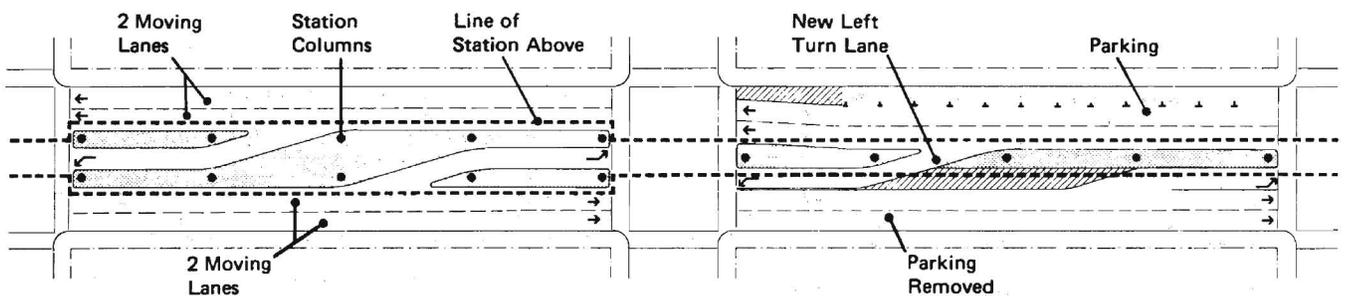
- o To maintain existing left-turn lanes and to avoid the necessity of constantly shifting from one row of supporting columns to two rows of columns to accommodate left-turn pockets, a design concept may be developed to solve these functional problems. A section of this concept is shown on Figure 20. The introduction of an aerial guideway may result in the loss of either one parking lane or one traffic lane in areas where the median width is insufficient to accommodate the aerial guideway and station support structure.



Arterial Street – Aerial Guideway in Median

Figure 20

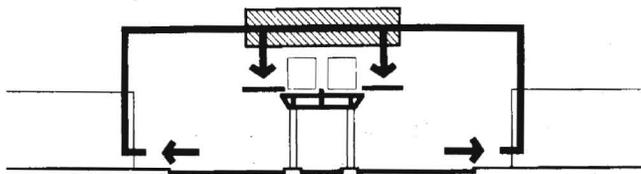
- o At stations the aerial structure must be modified to accommodate two rows of columns approximately 20 feet apart, supporting a two-track guideway, two side platforms, and vertical circulation elements. Figure 21 shows this condition in plan.



Arterial Street – Plan View of Aerial Guideway Columns and Median at Station

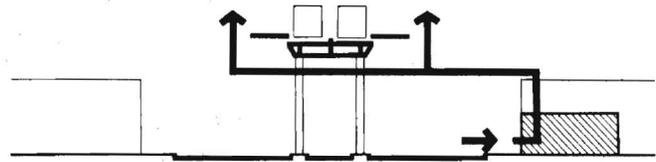
Figure 21

- o In both the Wilshire and La Brea corridors, the parking lanes are converted to traffic lanes during peak hour periods. The permanent loss of one parking or moving lane in either direction would result in an unbalanced flow of traffic and reduced traffic capacities during peak periods. This potential reduction in capacity would result in increased congestion in these corridors.
- o Buses running on Wilshire Boulevard and La Brea Avenue form an essential element of the feeder/distribution system in getting persons to and from transit stations in the corridor. If capacities are reduced and congestion increases on these major north-south and east-west surface arterials as a result of parking/traffic lanes being removed to accommodate an aerial guideway, bus transit service will be adversely affected.
- o When a two-way aerial guideway is located in the median of a major surface street, it is necessary to place the station and concourse outside the right-of-way or over the guideway to maintain existing traffic, parking, and left-turn lanes. There are basically four possible alternatives to station concourse and platform combinations (Figures 22, 23, 24, 25).



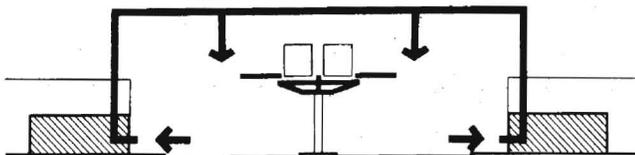
Aerial Station - Median - Single Concourse

Figure 22



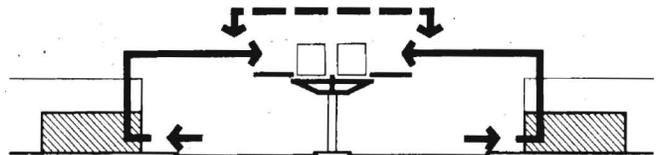
Aerial Station - Edge of Street - Single Concourse

Figure 23



Aerial Station - Double At-Grade Concourses

Figure 24



Aerial Station - Pedestrian Bridge over Platform

Figure 25

- o Each of these combinations requires a vertical transition of two levels above the street level and some require a vertical transition of two levels up and one down to reach the platform. In addition, some alternatives require multiple concourse facilities on both sides of the street for a single aerial station (Figures 24, 25). Based on this analysis, the alternative illustrated in Figure 23 appears to function best providing a simpler vertical and horizontal connection between the station concourse and the station platforms.
- o As can be seen from Figure 23, the adverse visual effects of accommodating an aerial main line guideway with long platforms and connecting vertical and horizontal transitions could be substantial.

One-Way Guideways in Arterials

As an alternative to a median location for two-way aerial guideways, one-way aerial guideways could be located in arterials on the edges of the sidewalks.

- o In areas where sidewalk widths are narrow, it would be necessary to remove parking lanes in order to retain sidewalks for pedestrian circulation.
- o The visual impact of two one-way aerial guideways may be greater than for a two-way aerial guideway structure since the vertical supporting elements would have to be duplicated for each guideway.
- o A one-way guideway system in an arterial would require two stations, two concourses and two aerial platforms, one for each guideway on each side of the street (Figure 6). If a single station is desired, a complex overhead bridge must be provided to connect between the station concourse and two station platforms.



Aerial Stations—Double At-Grade Concourses—One-Way Guideways

Figure 26

Mitigation of Adverse Impacts

In those areas where aerial guideways are proposed in arterial rights-of-way, special impact conditions may exist which require extraordinary mitigation measures to make transit acceptable to the community. The concept of equal construction budget allocations for aerial stations and guideways must be related to the concept of equivalent environmental settings. For example, the environmental impact of the aerial guideway in a highly-developed arterial setting would be quite different from the impact of a similar installation in a freeway median surrounded by industrial land uses. Thus, it would be necessary to vary design and impact mitigation measures and construction budget allocations depending on each specific environmental setting.

3.2 Displacement

The sharing of existing transportation and public rights-of-way, such as freeways, arterials, railroad rights-of-way and flood control channels, will greatly reduce the extent of potential displacement and relocation of people and businesses resulting from implementation of the SCL plan. The most significant displacement impacts of existing uses will result from the construction and operation of main line stations (89), long- and short-term parking facilities (100,000 parking spaces are assumed for the entire SCL system), maintenance shops and yards, and inter-line rail junctions (12).

Stations

- o Displacement at station sites will be dependent on the design of the station, location of the concourse, as well as the location and size of parking facilities. Of the 89 stations proposed by the SCL plan, approximately 64 stations are located alongside freeway rights-of-way near major arterial intersections or freeway-to-freeway interchanges. In most developed areas, these freeway corridors are directly adjacent to existing development. In these areas, station facilities will displace existing uses. The degree of displacement will depend on the selection of specific sites and the design and location of stations and related facilities.
- o The SCL plan proposes that many of these stations be located at freeway-to-freeway interchanges. While this location may provide adequate site area for station and parking facilities in some instances, the problems of accommodating inter-line rail

junctions, vehicular access and interface between transit-related and freeway traffic may offset any potential advantages.¹

- o Stations proposed for freeway-to-freeway interchange sites may have to be relocated away from the interchange, outside of the existing freeway ROW, in order to simplify access and the interface between freeway and transit elements. If this relocation occurs, additional new ROW will be required which would increase potential displacement of established uses adjacent to the ROW.
- o Since the SCL plan provides that the specific location of stations within a community may be modified by the affected community, displacement may vary depending on the final site selection. Site selection should be made utilizing criteria which will minimize the displacement of existing uses by locating station and parking facilities on vacant land.

Parking

- o The SCL plan proposes that approximately 100,000 long-term parking spaces be provided for the entire transit system. Of the 89 stations proposed for the system, 70 stations will have long-term parking. If it is assumed that each of these 70 stations provides similar parking facilities, spaces for approximately, 1,430 automobiles will be required at each station. If all parking is assumed to be surface parking, approximately 13 acres² of paved parking area will be required at each of these 70 stations. Acquiring this amount of land at station sites in built-up areas will result in significant displacement of people and businesses in some locations where sufficient vacant land is not available. Careful consideration should be given to site selection and facility design in order to minimize displacement.
- o The introduction of large surface parking lots into existing residential neighborhoods can create visual disruption and adversely affect the quality of their visual environment. This condition has been identified for several of the BART stations which have been located in residential neighborhoods.
- o Stations located along arterial ROW in built-up areas may result in significant displacement of existing uses since they will be located outside of existing rights-of-way. However, those stations which are located on the Wilshire and La Brea lines do not provide any substantial long-term parking facilities, thereby eliminating this displacement impact.

¹ New circulation patterns around the stations will have to be established. Traffic congestion may occur especially when the stations are located next to on-and-off ramps to the freeway. Problems of pedestrian and vehicular safety will have to be solved with new street patterns, signalization, signs, and other improvements. Potential increase in security problems may necessitate additional local policing of these areas. One of BART's major ongoing impacts has been auto theft in its parking lots and in adjacent neighborhoods. In part this is due to the lack of adequate police surveillance.

² Assumes 400 sq. ft. per parking space and required circulation areas.

3.3 Freeway Traffic Disruptions

Since over 80 percent of the system would be constructed in freeway rights-of-way, major impact on community traffic flow would occur while the transit system was being built. It is anticipated that 40-50 miles of freeway would be directly affected by transit construction during peak construction years, based on a 16-year construction period.¹

To minimize potential traffic disruptions, an effective construction program should be developed to build the system as a series of coordinated segments, permitting individual lines to be placed in service as early as possible. A particular line would be selected for initial construction, completed and tested for its construction effects on freeway traffic flow. The first line would preferably be a high-demand corridor to provide maximum initial service, but it would also constitute a prototypical line that would incorporate all of the conditions to be encountered on the full system.

Causes of Disruptions

Construction of transit lines in freeway rights-of-way will result in freeway traffic disruptions due to relocation (or removal) of travel lanes, narrowing of lanes, removal of shoulders, reconstruction of bridges and structures, modification of drainage systems, deliveries of construction equipment and materials, construction operations, and motorists gawking. These construction activities will materially reduce travel speeds on affected freeways and result in reduced traffic capacity, even though the same number of travel lanes are maintained in service.

Driver Acceptance

These inconveniences may be accepted by motorists for limited periods of time, when they recognize that the inconveniences will be eliminated by a certain date, and they will again travel in a normal manner along their regular route. If a particular freeway route is disrupted for about two years while an entire transit line is completed within that corridor, motorist opposition to the inconveniences involved will be minimal, since this period corresponds to normally experienced inconveniences in the past while a freeway is being widened. However, if construction is spread over many different routes at the same time, the period of time during which a given route is impacted will extend over a greater period of time. Some routes could be impacted in this manner for six to eight years.

¹ See a separate report prepared for SCRTD by De Leuw, Cather & Company.

Construction Period Effects

The effects of construction activities on a particular route extend for a considerable distance on either side of the construction zone. The bottleneck condition created by construction activity reduces capacity, resulting in traffic congestion that extends for many miles along the route. Traffic congestion impact resulting from construction on a short section of freeway is frequently not appreciably less than construction that is taking place on a lengthy section of freeway. From this standpoint, it is much less detrimental to impact the entire route for a period of two years than to impact successive shorter sections of that route over a construction period of several years. The effects on the motorist are experienced, mostly according to the period of time of inconvenience rather than in proportion to the length of freeway under construction at any given period. Motorist frustration is especially acute when a traffic impediment is finally removed, only to be succeeded by new sections of traffic impediment.

When one route is impacted at a time, paralleling routes retain their traffic capacity and many motorists can reroute their trip to avoid impacted sections of freeway. The motorist also experiences traffic congestion over a limited length of route and can flow freely along other sections of freeway. The effects of traffic congestion are also confined to motorists who frequent the particular route affected. If construction operations are conducted on several freeways at the same time, detrimental traffic impacts are experienced over greater lengths of route for greater periods of time by more motorists. Opportunities for rerouting are reduced and the effects of congestion are experienced more widely.

Freeway Traffic Diversion

Increased freeway traffic congestion tends to divert motorists away from freeways and onto surface streets. This further congests surface arterials and causes some motorists to travel on collector streets. The net effect of conducting construction operations on many freeways at the same time would be to increase traffic congestion on arterials and increase use of residential streets by extraneous through traffic.

Effects on Cross Traffic

When a freeway must be widened, reconstruction or widening of existing bridges may be quite disruptive to cross traffic. The affected bridge may be removed from traffic service, diverting existing traffic to paralleling streets and causing increased traffic congestion on those streets. Lengthening an existing bridge may involve a reduction in the number of cross traffic lanes during construction, which will usually increase congestion.

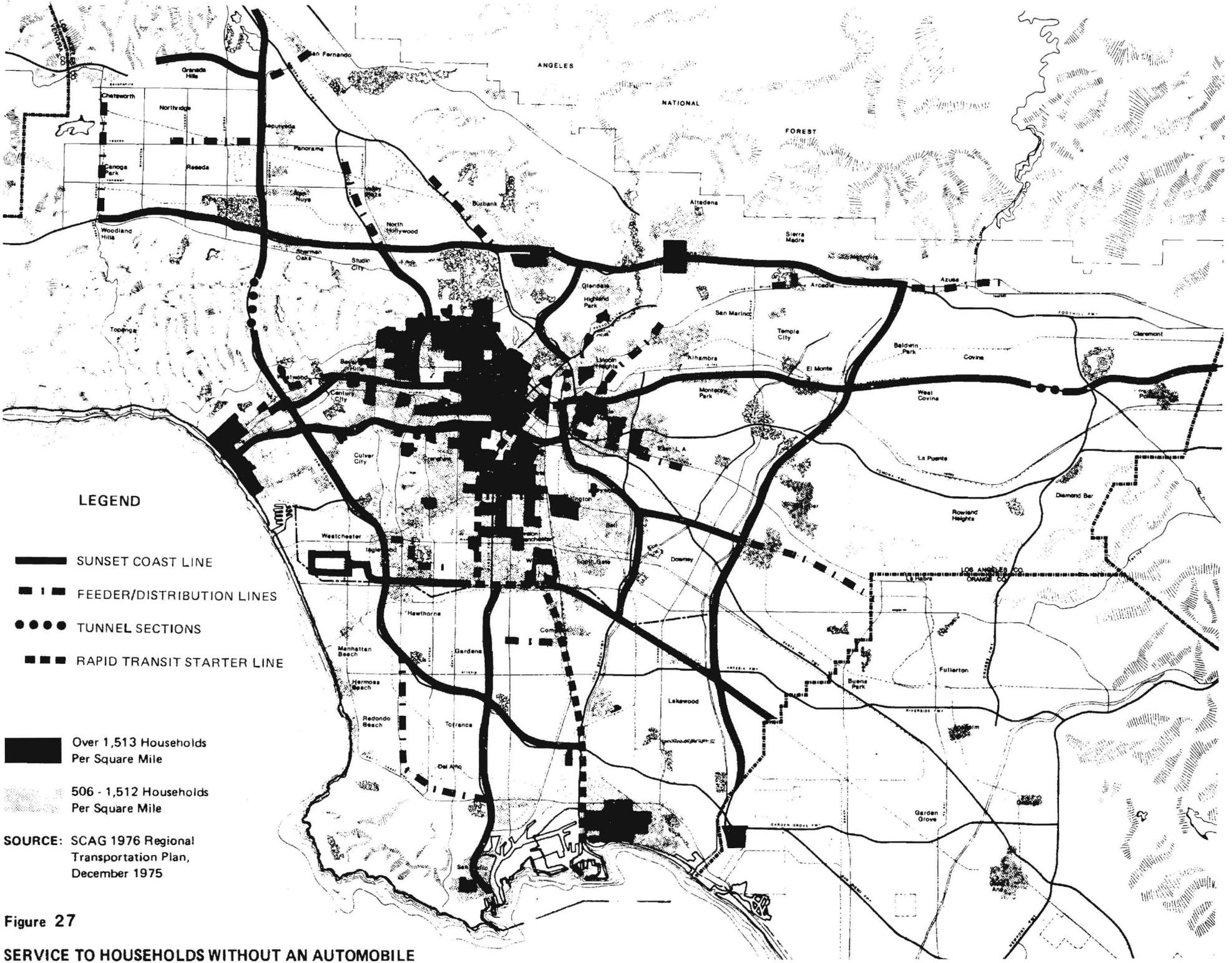
3.4 Service to Transit Dependents

One of the primary user groups of the proposed SCL system is likely to be "transit dependents", such as:

- o Households without an automobile.
- o Handicapped persons.
- o Elderly (65 years of age and over).
- o Youth (16 years of age and under).

Figures 27 through 30 present a comparison of the proposed SCL system with regional transit dependent population data developed by the Southern California Association of Governments. Table 2 indicates those locations where the SCL system (main line and/or feeder) would provide service to one or more of the four transit dependent groups. Service to East and South-Central Los Angeles would reach all four of the transit dependent groups. Service to Pasadena, Santa Monica-West Los Angeles, Central Los Angeles, and Hollywood would service concentrations of all groups except the young. Service to significant numbers of elderly and no automobile households would occur in Long Beach, Pasadena, and Glendale. Elderly and handicapped persons in San Pedro and the San Fernando Valley would also benefit from the proposed SCL system. Youth in the Hermosa Beach area and West Covina are also likely to find the proposed system attractive for regional trips.

While this preliminary assessment of potential service indicates that the SCL system would reach most significant concentrations of transit dependents in the region, these groups are unlikely to fully utilize the system unless an extensive feeder bus service is also provided utilizing appropriate equipment (e. g. , special buses to serve the handicapped) and operating policies (low fares, etc.).



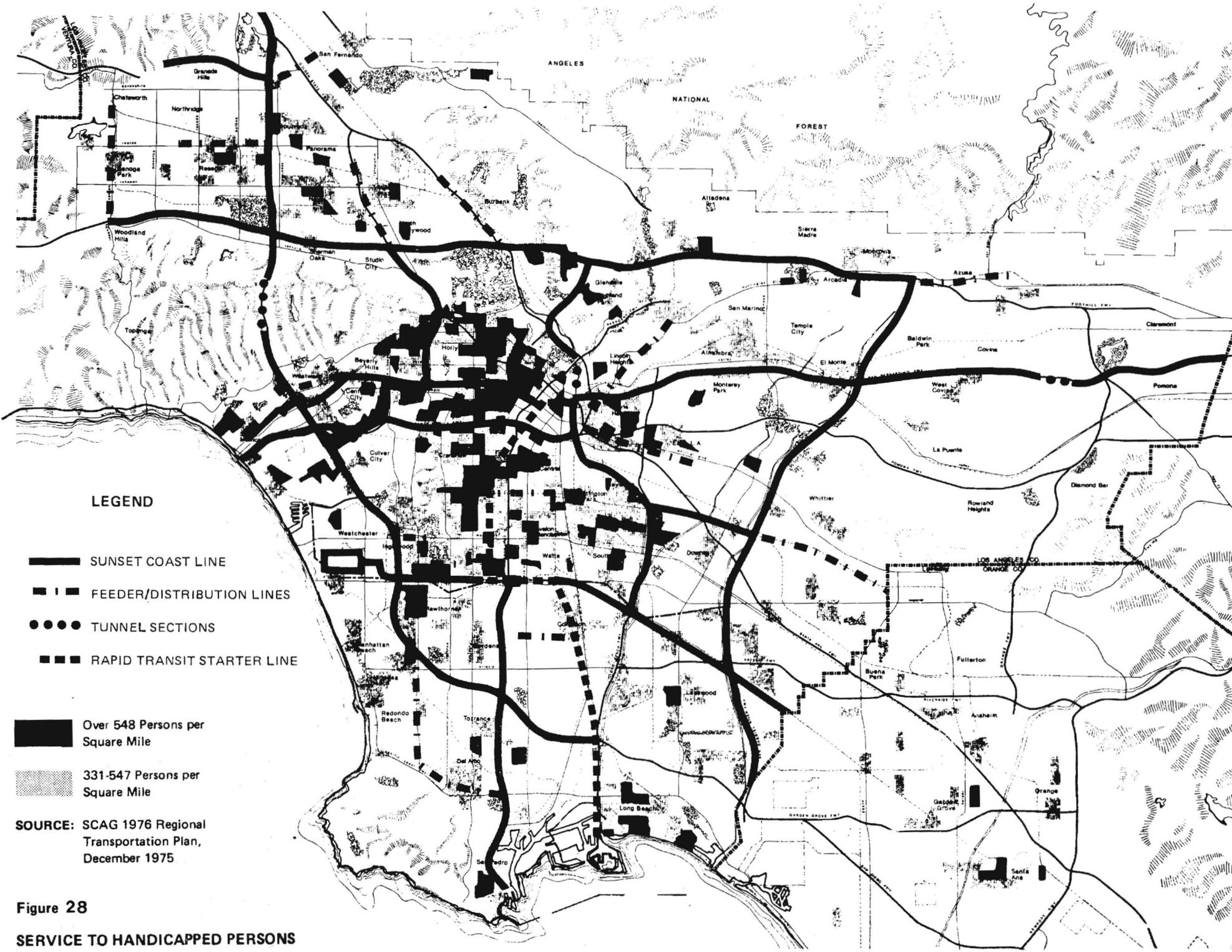
LEGEND

-  SUNSET COAST LINE
-  FEEDER/DISTRIBUTION LINES
-  TUNNEL SECTIONS
-  RAPID TRANSIT STARTER LINE

-  Over 1,513 Households Per Square Mile
-  506 - 1,512 Households Per Square Mile

SOURCE: SCAG 1976 Regional Transportation Plan, December 1975

Figure 27
SERVICE TO HOUSEHOLDS WITHOUT AN AUTOMOBILE



LEGEND

- SUNSET COAST LINE
- - - -** FEEDER/DISTRIBUTION LINES
- ● ● ●** TUNNEL SECTIONS
- - - -** RAPID TRANSIT STARTER LINE

- Over 548 Persons per Square Mile
- ▨** 331-547 Persons per Square Mile

SOURCE: SCAG 1976 Regional Transportation Plan, December 1975

Figure 28
SERVICE TO HANDICAPPED PERSONS

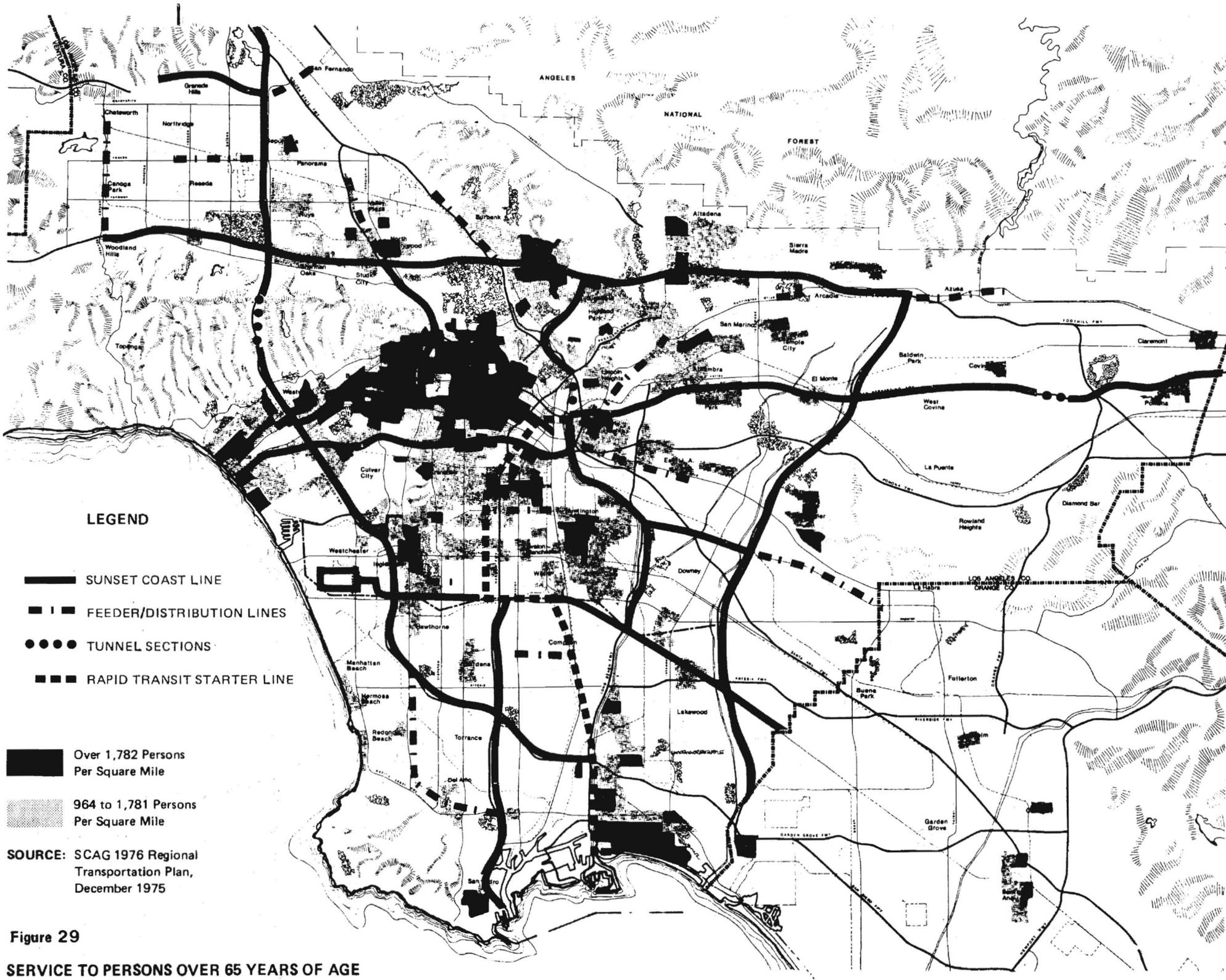
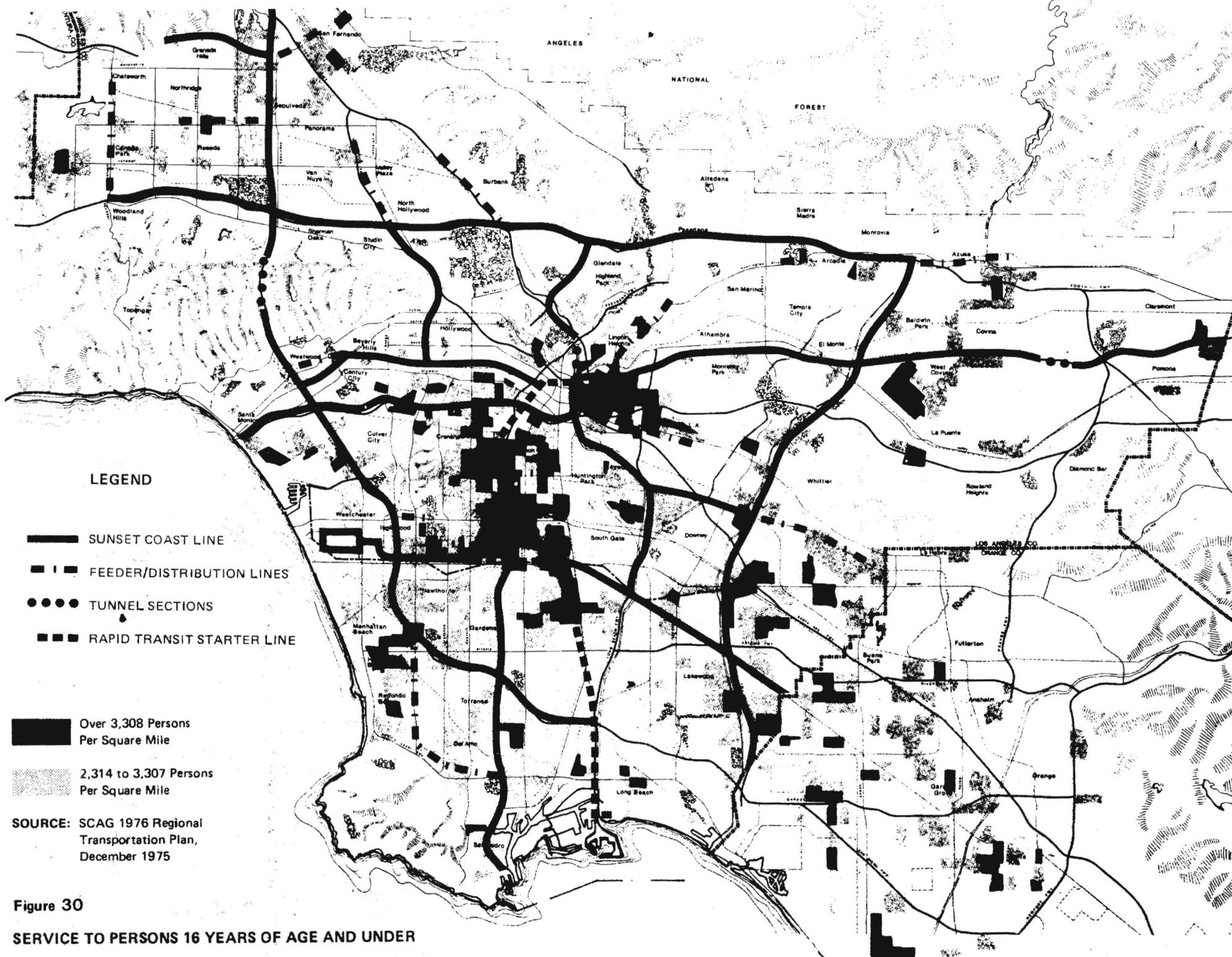


Figure 29

SERVICE TO PERSONS OVER 65 YEARS OF AGE



LEGEND

-  SUNSET COAST LINE
-  FEEDER/DISTRIBUTION LINES
-  TUNNEL SECTIONS
-  RAPID TRANSIT STARTER LINE

-  Over 3,308 Persons Per Square Mile
-  2,314 to 3,307 Persons Per Square Mile

SOURCE: SCAG 1976 Regional Transportation Plan, December 1975

Figure 30
SERVICE TO PERSONS 16 YEARS OF AGE AND UNDER

TABLE 2
SERVICE TO TRANSIT DEPENDENTS

Location	POPULATION GROUP			
	Households With No Automobile	Handicapped	Elderly	Youth
Central Los Angeles	x	x	x	
East Los Angeles	x	x	x	x
Glendale	x		x	
Hawthorne-Inglewood		x	x	
Hermosa Beach				x
Hollywood	x	x	x	
Long Beach	x		x	
Pasadena	x	x	x	
San Fernando Valley		x	x	
San Pedro		x	x	
Santa Monica-West Los Angeles	x	x	x	
South-Central Los Angeles	x	x	x	x
West Covina				x

x Locations where the SCL system (main line and/or feeder) would provide service to concentrations of the indicated transit dependent group(s).

The proposed flat fare policy should be an added inducement to use of the system by the indicated groups. Currently, many of these groups make mostly intra-community, rather than regional trips. Thus, current needs may best be met by community-scale public transit service improvements. In the longer time frame (say the year 2000), travel behavior may shift to the regional scale. Research being conducted at UCLA indicates that travel behavior of the future elderly can best be assessed by studying the current travel behavior of persons in their 30s and 40s.

In summary, the SCL system should provide a substantial benefit to transit dependents in Los Angeles County if:

- o Regional-scale trips are important to these groups; and,
- o Extensive and effective feeder bus service is provided.

3.5 Noise Impact¹

As proposed, the SCL system would generally result in a low, or insignificant, level of noise impact due to exclusive utilization of existing rights-of-way. The low speed of the fixed-guideway feeder system, and the utilization of appropriate noise mitigation measures, should yield acceptable noise levels in most environmental settings.

Approximately 84 percent² of the main line mileage is within freeway rights-of-way; therefore, insignificant noise impacts to adjoining uses are anticipated due to the masking of transit-generated noise by existing freeway vehicular traffic. From a noise impact perspective, an at-grade transit alignment within the freeway median is the optimum configuration. The least attractive configuration from a noise standpoint would be an aerial configuration along the freeway shoulder. With appropriate mitigation measures, however, this configuration should result in acceptable noise levels.

While less than nine percent³ of the main line mileage is within arterial rights-of-way, potentially adverse noise impacts could occur in sensitive-use areas--even with state-of-the-art mitigation measures. In a similar fashion, potentially adverse noise impacts could occur adjacent to the 17-miles of main line mileage within railroad and flood-control-channel rights-of-way. These situations are potentially more adverse than the arterial case, if many of the affected railroads have limited operations

¹ Based on the modified SCL plan consisting of 222 miles of main lines and 22 miles of feeder and distribution systems.

² 81 percent under the original SCL plan.

³ 15 percent under the original SCL Plan.

(e.g., one or two trains per day). Also, the flood-control channels are generally characterized by low ambient noise levels--particularly in residential areas.

Other potential sources of system-related noise impacts are automobiles and feeder buses arriving and departing from SCL stations. However, sensitive station site selection, coupled with sensitive routing of automobile and bus traffic to and from stations, should minimize this potential noise impact.

In summary, from a systemwide perspective, the SCL system would generate very modest noise impacts compared to the overall scale of the system. However, additional investigation of the noise impacts associated with the 36 miles of main line mileage within arterial, railroad and flood-control-channel rights-of-way is required to develop acceptable noise mitigation measures.

3.6 Air Quality Impact

Based on the BART experience and other nationwide transit studies, it is not anticipated that the SCL system would lead to an immediate, significant improvement on regional air quality. As the BART studies have shown, many BART patrons have either switched from bus-transit and carpools or moved out to suburbs because of the BART accessibility. Thus, the actual reduction of automobile trips and the attendant air quality improvement is proportionately less than the total BART patronage would indicate. For Los Angeles County, it is estimated that daily mobile source emissions would be reduced by less than five percent¹.

While the short-term SCL system-related improvements in regional air quality would not be significant compared to the overall scale of the regional air quality problem, these improvements would likely lead to a net, positive benefit when possible localized adverse impacts are considered. For example, localized air quality impacts at major park-and-ride facilities are not likely to create problems (based on the BART experience). Also, the impact to patrons waiting for the SCL system at stations over, or adjacent to, freeways should not be significant by the mid-to-late 1980s when most automotive emissions will be substantially controlled.

In the long-run (say the year 2000), if the SCL system encourages more intensive use of already developed areas and discourages further expansion of the region, and if the system attracts substantially higher patronage than anticipated, the significance of system-related air quality improvement may increase. However, in this same time frame, it is quite likely that

¹ Assuming a SCL system daily patronage of 1.1 million, a County population of 7 million and a daily trip generation rate of 3.5 trips per person.

major improvements in mobile-and-stationary source emission control may also occur--thus, reducing the potential SCL system-related air quality effects.

In summary, the solution of our current regional air quality problems can best be achieved by control at the source (e.g., automobile, power plants, etc.). The cost-effectiveness of major investments in transportation improvements is unlikely to be greatly influenced by potential improvements to regional air quality.

3.7 Net Job Formation

The SCL construction would produce new jobs during a peak year (based on a 16-year program) in the range of 25,000 to 35,000¹ direct and indirect jobs. However, it is a very complex task to assess whether the jobs created are considered entirely new in Los Angeles County. The flow of money equivalent to that generated by a one-cent sales tax would normally have created jobs in other sectors of the economy in Los Angeles County, not related to the construction and transit-vehicle manufacturing industries, such as in consumer goods, housing, etc. In addition, certain new jobs to be created by the SCL construction may go outside Los Angeles County, specifically, those jobs related to manufacturing transit vehicles.

The above analysis has been based on a suggested planning and construction schedule based on a 16-year program (Table 4). The program is anticipated to build up gradually and reach a high level of activity in the eighth year. It will continue at that rate for five years and then taper off until the completion of the program. Table 3 illustrates a possible level of activity during a peak period.

TABLE 3

POSSIBLE EXPENDITURES IN A PEAK YEAR
BASED ON A 16-YEAR SCHEDULE

<u>Cost Item</u>	<u>Annual Costs (\$ Million)</u>
Administration	10
Design	30
Construction Management	20
Construction and Equipment Purchase	<u>660^a</u>
TOTAL	720

^a Assume 28% for vehicles and control equipment and 72% for construction. Of the total assumed construction costs of \$475 million, 25% and 35% are allocated to on-site labor (construction) and off-site labor (materials, equipment, and others), respectively.

¹ Under the modified SCL plan in 20 years or more, this range would be correspondingly less.

TABLE 4

CONSULTANTS 16-YEAR PLANNING AND
CONSTRUCTION SCHEDULE AND COSTS
(\$ MILLIONS)

	<u>1976 Dollars</u>			
	<u>Miles</u>	<u>Miles Cum.</u>	<u>Construction Costs</u>	<u>Operating Costs</u>
1977			68*	
1978			54	
1979			64	
1980			156	
1981			311	
1982			473	
1983			637	
1984	25		720	12
1985	38	63	717	30
1986	38	101	712	49
1987	38	139	707	67
1988	38	177	702	85
1989	25	202	612	97
1990	25	227	436	109
1991	26	253	264	121
1992	28	<u>281</u>	89	135
TOTAL		281	\$6,721	

* Includes one-time cost for starter system.

Source: De Leuw, Cather & Company
Stanford Research Institute

In order to compare the total number of jobs, both direct and indirect, that would be created by the development of the SCL system funded by the one-cent sales tax versus the expenditure of those same funds in a normal manner, it would be necessary to ascertain the economic pathways of the flow of those funds through the local Los Angeles County economy for each of these alternatives. In essence, what is required is the utilization of input-output model of the economy of Los Angeles County, one which indicates in some detail both the internal economic relationships as well as the coefficients quantifying these relationships. Additionally, it would be necessary to determine the linkages and interconnections of the County's economy with areas outside the County.

Undoubtedly, the expenditure of sales tax funds by consumers on normal items of consumption would have a different impact on the local economy (i. e. , Los Angeles County employment and income) than would its expenditure on the development of a new transportation system. At this writing it is not possible to establish whether a net job increase exists at all or if it does what its magnitude might be.

Where the trade-off in job generation is implicit in the development of the SCL (since almost all financing is locally generated), the utilization of federal funds would, on a local basis, be completely positive with respect to net new job generation. The utilization of such funds from outside the local area would create new jobs which would not have been produced in its absence. Federal funds create no local diversion from one form of expenditure to another and thus would always create a positive net job increase.

3.8 Sales Tax Rate Differential

The one-cent sales tax rate differential may affect the purchasing pattern of consumers in border communities inside and outside of the Los Angeles County boundary. This would probably not affect the sales of convenience goods. However, it may contribute to a tax-induced sales migration with respect to large cost items in shopping goods (such as automobiles, heavy appliances, etc.).

Convenience goods stores generally refer to establishments meeting the day-to-day requirements of a population. Such stores include food, super-market, drug, local eating and drinking establishments as well as personal service stores, i. e., barber and beauty shops, laundry, tailoring and similar stores. For such stores, proximity to the individual is the important factor in shopping choice. Price, as well as a sales tax differential of one cent, would probably be very unimportant, particularly in view of the fact that with respect to food purchases (purchases which constitute a substantial portion of convenience goods purchases), there is no sales tax applicable in the State of California.

On the other hand, other goods known as shopping goods and automotive goods, i. e., automobiles and trucks, are all subject to sales tax. These goods are generally sold in concentrated complexes of retail facilities known as regional shopping centers as well as in concentrated locations for automotive products. Shopping goods (and automotive goods) are high-priced items which are sold in major retail facilities such as department stores or major discount stores, as well as in general merchandise stores, apparel and accessory stores, furniture and home furnishing stores, etc. With respect to these types of goods, consumers usually wish to compare prices and quality at different shopping complexes, often covering considerable distances and spending considerable time in order to obtain desired quality at the best possible price.

As indicated above, for people living at or near the Los Angeles County border, the imposition of an additional one-cent sales tax on stores located within Los Angeles County would probably have insignificant effect with respect to diversion of expenditures for convenience goods from facilities located in Los Angeles County to facilities located in another county, e. g., Orange County. Only in those cases where similar facilities are available side by side in both counties would there be any diversion.

On the other hand, with respect to shopping goods and automotive goods (passenger automobiles and trucks), the imposition of an additional one-cent sales tax could have greater effect. It is beyond the scope of this report to estimate the possible diversion of expenditures from Los Angeles County

to, say, Orange County stores and facilities. Nevertheless, it is important to note the possibility of diversion since such diversion would affect sales in Los Angeles establishments causing, perhaps, reduction of sales, revenues and employment in those stores. Additionally, a reduction in profits could also take place if affected Los Angeles stores were called upon to absorb the one-cent tax in order to remain competitive with Orange County facilities.

The potential magnitude of diversion would depend upon such matters as population concentration at the Orange County border, the location and size of competing retail complexes at or near the border, family or household income and its distribution by type of expenditure, etc. Finally, this problem would also occur with other counties which border Los Angeles County, e. g., San Bernardino and Ventura Counties.

While the discussion of consumer diversion indicated above is tied to the proposed transportation system, it should be noted that the situation would occur as long as differences in sales tax rates exist between adjacent counties. Additionally, it should also be noted that, as a possibility, the successful implementation of the proposed program might induce adjacent counties to extend the system through their own territories, that extension to be funded in the same manner as that of Los Angeles County. In this event, with equal sales tax rates, there would be no diversion from Los Angeles County to other counties.

4. PUBLIC POLICY IMPLICATIONS

4.1 Contingency Plans

The 1973 oil embargo highlighted the near-term problems of rapid increases in energy prices and uncertainties in the supply of imported petroleum. Transportation is particularly vulnerable to increased costs and supply interruptions since it currently is almost completely dependent on petroleum-based energy.¹

With the extensive rail transit coverage, the SCL system will have the built-in contingency capability to handle a significantly greater level of patronage than currently anticipated.² The system has the potential for achieving a major shift in our travel behavior and lessening the extent of our automobile dependency. It would make possible contingency plans to cope with energy or air quality crises. It would allow the use of other energy resources than oil. It would also provide ample room for considering major urban traffic management measures which further encourage the use of public transportation and the reduction of unnecessary automobile usage. There is a clear need to maintain decision options for our future with regard to transportation, environment, urban development, energy, foreign trade, etc.

4.2 Federal Funding Participation

Use of local funds to build a rail rapid transit system would probably not adversely influence decisions affecting future capital grant applications for federal funds to construct fixed guideway segments. However, any SCL segments which may be proposed for federal participation must meet all federal requirements. This means that any segments the SCRTD may contemplate in the future for federal funding must rigorously pass the test in such areas as:

- (1) analysis of the cost-effectiveness (including environmental impact analysis) of transportation alternatives; and
- (2) effective processes for resolving jurisdictional conflicts.

¹ A Statement of National Transportation Policy by the Secretary of Transportation, 1975, p. 39.

² For the purpose of evaluation, about 1,100,000 trips a weekday were used.

4.3 Commitment Versus Flexibility

The SCL proposal makes a commitment that the system will be built substantially in accordance with the plan and in a relatively short time period (15 years). It specifically names those cities to be served directly or indirectly. It also gives the cities the right of approval on station location.

4.3.1 Time Schedule for Construction and Jurisdictional Agreements

The SCL plan does not provide adequate time to allow institutional agreements and construction. If agreements cannot be reached in the first two to three years, either because of location and configuration of lines and stations or in terms of design and cost allocations, strategic missing links may develop and ultimately jeopardize the integrity and operation of the system network. The period of 15 years does not leave time for contingencies such as workable construction phasing, environmental impact report clearance, litigations, and strikes.

The analysis by De Leuw, Cather & Company indicates that, even under the most optimum circumstances, the construction for the entire SCL system will require at least 16 years. It does not assume any major litigations or difficulties in reaching agreements with local jurisdictions (and communities), the State, and railroads.

The provision that "the cities shall have the right of approval of location of stations within their municipal boundaries" may significantly affect the extent of time required in reaching jurisdictional agreements. Even though it specifically refers to station locations, this right can be easily extended over such matters as line location and vertical configuration, construction budget allocations¹ for aerial guideways and stations, etc.

Section 30836.1 of the Public Utilities Code presently reads that:

" (e) In the event that any local jurisdiction rejects the report as prepared by the district, all points of issues outlined in the rejection report required of the local jurisdiction shall be submitted to an arbitration board.

(f) The arbitration board shall be composed of the Director of Transportation, two representatives of the district, one of whom shall be a member of the board of directors, and two representatives of the local jurisdiction rejecting the report.

¹The SCL proposal calls for local jurisdictions to contribute land for station parking facilities.

The decision of a majority of the arbitration board shall be final and binding upon the parties thereto. The expenses of the Director of Transportation shall be provided half by the district and half by the local jurisdiction. If, within 30 days, the arbitration board cannot reach a decision, the Director of Transportation shall render a decision which shall be final and binding upon the parties."

Thus, the right of approval of location of station(s) by each city appears to preempt the above provisions as far as stations are concerned. In addition to the above, disagreement over elevated guideways and stations in arterials, as well as design and the stipulated construction budget allocations, may inevitably affect the location approval process of stations. The approval process may be even more complex when a number of stations and lines are located in a single local jurisdiction.

The potential magnitude of the problem in reaching agreement with local jurisdictions can be demonstrated by the BART experience. For that transit system, BART was required to secure agreements with local jurisdictions on route location, station location and other matters affecting BART-local relationships. The agreements had to be reached before proceeding with construction so, consequently, BART tended to be conciliatory with the local jurisdictions. The only major battle in which BART remained firm was Berkeley's insistence on planning its portion of the line in subway. Ultimately, the city paid the difference between BART's proposed configuration (aerial structure) and the higher costs of subway. This process took over seven years.

Based on BART's community agreements, 15 miles (out of a total possible 71 miles) were rerouted and 16 of 34 stations were relocated. In all, BART had to execute 166 agreements with various cities, counties, special districts, railroads and highway departments. It has been estimated the agreements directly cost BART over \$160 million, and indirectly, through inflationary expenses caused by two delays, another \$150 million. This total of over \$300 million was an "unanticipated" additional project cost.

4.3.2 Scope and Staging

The SCL plan is defined too precisely. It would be desirable to have more flexibility in staging and scope (interim services, station and line locations, and vertical configurations). Thus, careful consideration¹ should be given (in drafting the appropriate state legislation, the ballot language, etc.) to provide ample flexibility capable of responding to unanticipated future conditions.

¹ If the decision is made by the SCRTD Board to place the proposal on the June 1976 Ballot.

5. LAND USE AND URBAN GROWTH IMPLICATIONS

5.1 Options for Balanced Land Use Decisions

If the proposed SCL system is implemented, one of the possible benefits is the partial resolution of the current land use impasse which is evident in many areas of the County. Many development proposals are currently being opposed because of current street congestion, likely environmental effects and neighborhood disruption. The SCL system improvement would lessen our automobile dependency and could make a significant contribution toward opening up the possibility of minimizing these land use-traffic-environmental conflicts, and thereby encourage the implementation of balanced land use policies.

5.2 Growth Inducement

5.2.1 Intensification

Based on the BART experience, it is not likely that new development would automatically generate around every station on the main lines. In the Bay Area, even 15 years after the decision to build BART, no major land development intensification has taken place except in downtown San Francisco and, to some extent, in the central areas of Berkeley and Oakland. Because of the extensive mileage and coverage (230 miles or 222 miles under the modified SCL plan and 89 stations), future development potentials would likely be diffused over its network and would have no significant effects on major existing centers. The economic viability of existing centers depends not only on accessibility, but also on so many other physical, environmental, social, and economic factors.

However, if the decision is made to implement the SCL plan, intensive efforts should be made to work with local jurisdictions and communities during the planning and design phase and jointly select a best course of action (with regard to location and design of lines and stations) so as to insure that effective land use controls are instituted around the stations, discouraging undesirable land development and encouraging those uses which are desired.

It can be expected that despite the fact that areas adjacent to the proposed main lines are mostly developed today, small incremental growth and development (through private initiatives on a parcel-by-parcel basis) would likely occur taking advantage of improved transit accessibility.

As previously discussed in Section 2.2, the proposed system would provide service to the majority of the primary and secondary regional centers. Service to the regional centers via a main line system, feeder line, or both main line station and feeder is a first indicator of support of a regional Centers Concept. However, only by provision of effective intra-center circulation systems (tied into the SCL system) would the potential for support of the Concept be realized at those centers served by the SCL system. If the economic potential at these centers is significant, the local public and private sectors should be willing and able to capitalize on these potentials by developing adequate intra-center circulation systems.

5.2.2 Urban Sprawl

By virtue of its high average speed (55-60 mph) and flat fare policy, the SCL system has been considered to have the potential to encourage long-distance trips and thereby promote "urban sprawl." To test this hypothesis, comparison of automobile versus transit travel times from selected peripheral locations in the region to downtown Los Angeles were made. If the SCL offers significant travel time advantages at these locations, a resident/transit user at these locations could either: (1) "pocket the time savings"; or, (2) "trade the time savings" to obtain a more remote residential location while maintaining the pre-transit travel time.

Five locations were tested: (1) Woodland Hills; (2) Newhall; (3) Pomona; (4) Azusa; and (5) Irvine.¹ The results of the comparative travel time calculations are presented in Table 5. In all cases considered, a patron driving to a SCL park-and-ride station, taking a SCL main line to Union Station and a feeder bus to work could save time compared to a similar all-auto trip.

For a person living in the Newhall area, the time savings (two minutes) is insignificant, and the SCL is unlikely to foster growth in this area. The SCL offers significant time savings (10-20 minutes) for the other locations considered. Given their proximity to relatively uncongested freeways which link them with lightly-developed, outlying areas (for example, Westlake Village via Ventura Freeway from Woodland Hills), a resident of these locations who has a job in downtown Los Angeles could opt to use the SCL and move to an outlying location with no commute-time penalty

¹ Assuming no rail transit line connection in Orange County.

TABLE 5
 TRAVEL TIME COMPARISONS FROM SELECTED LOCATIONS
 TO DOWNTOWN LOS ANGELES
 (In Minutes)

Travel Time Components	Woodland Hills	Newhall	Pomona	Azusa	Irvine
Automobile Trip:					
- Drive to freeway	5	5	5	5	5
- Freeway trip to Downtown Los Angeles	50	52	55	45	70
- Parking and walk to job	<u>10</u>	<u>10</u>	<u>10</u>	<u>10</u>	<u>10</u>
TOTAL	65	67	70	60	85
SCL Transit Trip:					
- Drive to station, park, wait for train	10	20	10	10	35
- SCL trip to Downtown Los Angeles	30	30	25	20	20
- Feeder bus from Union Station to job	<u>15</u>	<u>15</u>	<u>15</u>	<u>15</u>	<u>15</u>
TOTAL	55	65	50	45	70
NET SCL TRANSIT ADVANTAGE	10	2	20	15	15

Sources:

Freeway Travel Times. SCAG 1990 Transportation Study, Phase 1, Methodology, Analysis, Results, December 1972.

Transit Travel Times. The Sunset Coast Line, Route of the New Red Cars, February 1976.

In summary, the proposed SCL system does have potential to foster "urban sprawl" in certain outlying areas of the region. The extent to which this potential would be realized depends on many complex factors. One of the chief factors is regional travel behavior. According to the LARTS Origin-Destination Survey, less than 14 percent of the region's commuters traveled more than 40 minutes to work in 1967. The total travel times computed for the five outlying areas are greater than 40 minutes. Unless the SCL system and other factors are instrumental in changing travel behavior toward the direction of longer commute times, the indicated "urban sprawl" potential is unlikely to be realized to a significant extent.

6. SUMMARY CONCLUSIONS

- o The SCL provides extensive countywide rail transit coverage.
- o It is generally a low-impact alternative along freeways. However, lines located in arterials and certain other rights-of-way may pose significant environmental impact and community opposition.
- o It would be desirable if more time could be allocated to reaching institutional agreements and system construction (from the proposed 15 years to 20 or more years).
- o Additionally, if more flexibility were built into the scope and phasing of the system (such as less mileage of the main lines in the first 20 years and possible delaying of some of the fixed-feeder and distribution line systems), many of the preceding issues could be resolved in time.

EVALUATION
of
SUPERVISOR BAXTER WARD'S
SUNSET COAST LINE PROPOSAL
for
SOUTHERN CALIFORNIA
RAPID TRANSIT DISTRICT

TECHNICAL ANALYSIS
by
MOBILITY SYSTEMS and EQUIPMENT COMPANY
LOS ANGELES, CALIFORNIA

STUDY MSE 0376-01

INTRODUCTION

The performance analysis of technical aspects of the SUNSET COAST LINE transit system proposal documented in this report was carried out as a member of a "committee of principals" of expert consultants that included De Leuw Cather & Company, Gruen Associates, Stanford Research Institute, MOBILITY SYSTEMS & EQUIPMENT COMPANY, under contract to the Southern California Rapid Transit District Board of Directors.

The tasks assigned to MOBILITY SYSTEMS & EQUIPMENT COMPANY included the technical investigations in the areas of freeway availability and guideway construction, hardware availability, energy requirements and maintenance, shops and yards. The intent of the study is confined to identifying critical and significant issues rather than presenting problem solutions or alternatives--to the SCL proposal. MOBILITY SYSTEMS' participation included transmitting early evaluation results in the areas of freeway availability and guideway construction, especially to the Le Leuw Cather tasks of preparing a cost analysis of the SCL proposal.

To accomplish the task, MOBILITY SYSTEMS assigned and relied on its staff of professionals in the disciplines of civil, electrical/energy, transportation and systems engineering, and also consultants who regularly contribute to MOBILITY SYSTEMS' projects.

The methods applied to evaluate the SCL proposal in the areas of assigned tasks consisted of carefully reviewing the proposed plan elements related to the assignments and comparing them with available information data and the experiences of systems in operation throughout the country and overseas. In the areas related to the Los Angeles freeway rights-of-way, a great deal of information was obtained from District 7 of Cal Trans from reports and discussions with their engineering and planning staff. In addition, MOBILITY SYSTEMS performed an extensive investigation throughout the system by visual observation and measurements. The results established the critical and significant issues and the technical findings.

TABLE OF CONTENTS

	Page
INTRODUCTION	i
SCOPE	1
SUMMARY	2
GENERAL	2
FREEWAY ADAPTABILITY AND GUIDEWAY CONSTRUCTION	2
HARDWARE AVAILABILITY	3
ENERGY	3
MAINTENANCE SHOPS AND YARDS	3
ISSUES AND FINDINGS	5
GENERAL	5
FREEWAY ADAPTABILITY AND GUIDEWAY CONSTRUCTION - FINDINGS	7
HARDWARE AVAILABILITY - FINDINGS	17
ENERGY CONSIDERATIONS - FINDINGS	23
MAINTENANCE SHOPS AND YARDS - FINDINGS	32
STAFF AND AREAS OF EVALUATION ASSIGNMENTS	36
BIBLIOGRAPHY	38
APPENDIXES	39
TECHNICAL ISSUES ASSOCIATED WITH S.C.L. ALIGNMENTS	I-1-88
RELATIVE ADVANTAGES/DISADVANTAGES OF GUIDEWAY PLACEMENT	II-1-4
POSSIBLE GUIDEWAY LOCATIONS	III-1-6
FREEWAYS THAT CAN BE WIDENED	IV-1-2
ENERGY CALCULATIONS FOR THE S.C.L. SYSTEM	V-1-18

1.0 SCOPE

The investigation and analysis findings of technical aspects of the SUNSET COAST Line Proposal are described and reported herein.

MOBILITY SYSTEMS task objectives are related to a series of critical and significant issues and problems, determined and established early in this project.

The task objectives are in four categories, which are:
(1) General Areas of R.O.W. Adaptability and Guideway Construction,
(2) Hardware Availability, (3) Energy Considerations, and (4) Maintenance, Yards and Shops.

Two basic levels of issues were established early in the project of relative importance. These may be defined as (1) those issues considered critical in regard to the Ballot Measure, and (2) those issues under review which could be resolved and reported in time to affect decisions of the S.C.R.T.D. Board. Many of the latter issues may be, individually, of minor importance. However, in the aggregate, these could be of appreciable significance.

The investigation and analysis task has been conducted in an objective manner, relating the descriptions and factors, facts and figures presented in the S.C.L. Proposal, to available technical data and information, by analytical review and comparison to existing transportation systems in operation in this country and overseas.

No attempt has been made to directly offer alternatives or solutions. However, as a natural fallout of such an investigation a product or products relating to alternatives, suggestive methods, etc., are discussed. This should be an aid in addressing the issues.

2.0 SUMMARY

2.1 GENERAL

The following summary is provided to present an overview of the findings related to critical and significant issues. The assigned categories of investigation are (1) Freeway Adaptability and Guideway Construction, (2) Hardware Availability, (3) Energy Requirements, (4) Maintenance, Shops and Yards. The scope of the study is confined to identifying the issues rather than problem solutions or alternatives--to the proposal.

2.2 FREEWAY ADAPTABILITY AND GUIDEWAY CONSTRUCTION

2.2.1 GUIDEWAY AND FREEWAY MEDIAN

There are two possible locations for a guideway on the freeway: in the median between opposing lanes of traffic flow and on the side or freeway embankment. These are applicable to depressed and/or elevated freeways. Two types of guideways are possible: elevated and at grade. Each has inherent advantages and disadvantages. Although a guideway at grade has a lower construction cost, the elevated type offers greater design flexibility and is less susceptible, from an interference standpoint, to freeway and pedestrian traffic. It is possible that operation cost and service reliability may be the important factor in the overall life cycle cost of the system. At-grade guideways have disadvantages in station location and size and may require freeway widening to maintain traffic. For elevated guideways, it would appear that precast columns and running surfaces are to be preferred over the cast-in-place type.

2.2.2 GUIDEWAY AND FREEWAY EMBANKMENT

Use of existing lanes must be weighed against the flexibility and accessibility advantages of using the outer freeway edge. Freeway entrance and exit capabilities will be affected and will require extensive engineering, design and additional construction cost.

2.2.3 GENERAL

The analysis of the lines of the S.C.L. has shown feasible application for guideway alignments on freeways with some possibilities for freeway widening. Railroad rights-of-way and flood channels are also feasible for guideway placement.

Interline rail junctions appear to be difficult and costly. The use of rail junctions should be weighed against the possibility of straight through lines with a dual level station for transfer. Such a station may be detrimental to patronage but only if the interline junction operation offers better service. It is not clear that it will. Studies should be performed to determine which and how many of the two methods should be employed.

It is believed that construction equipment either exists or can be obtained within the time schedule.

2.3 HARDWARE AVAILABILITY

The dominant factor is the cars. A survey of the major suppliers indicates that in the time span allotted and for the quantities stated there is sufficient capacity, capability and incentive for producing the vehicles. Rough estimates of cost indicate that this is somewhat higher than the cost stated in the S.C.L. proposal. The important issue is lead time. Approximately two to three years should be allocated to design, produce and test the cars.

A survey of U.S. suppliers of wayside, controls and communication equipment and guideway hardware indicates availability within the project schedule.

2.4 ENERGY

The issue here is not with the power demands of the system. Although the calculations performed show a higher power demand than that stated in the S.C.L. proposal, the amount of power used by the S.C.L. systems is approximately two percent of the existing capability within the Los Angeles County area served by the Department of Water and Power and Southern California Edison Company. The issue is concerned with the general increasing power demand by consumers and the uncertain prospect of the power companies' ability to increase their capacity to keep in step with the increasing demand. While there appears to be an apparent power excess at present, this excess is illusionary in that power companies have 15-20% "down" time on their equipment on a continual basis. When this is subtracted, most of the excess disappears. The problem is that all of the future capacity is yet to be built.

In talks with the utility people, they feel that the S.C.L. line could entail additional generating capacity as is planned. They express some doubt about their ability to meet total future demands because of the problems the industry is facing today.

The S.C.L. proposal considers the application of waste material power generating plant as an additional power source for the system. This concept is feasible and has been tried favorably in this country and overseas. The question is, will the Los Angeles Department of Water and Power in conjunction with Los Angeles County establish this type of facility to serve the S.C.L. system?

2.5 MAINTENANCE SHOPS AND YARDS

The issue of the shops and yards for the S.C.L. is underestimated in the proposal. Planning and phasing maintenance facilities is a difficult task when the aspect of the final product and the interim steps is considered.

Based on the data in the S.C.L. proposal it appears that at least 16 miles of track is required just for storage of the vehicles. Even with high utilization factor, this would require about 40 acres just for storage.

The S.C.L. system operation represents a high efficiency transit system requiring an effective service and maintenance program that includes crews for service, maintenance and emergencies.

A service and maintenance plan must be established early in the development of the system. This plan should incorporate emergency service, approximately 10 to 12 off-line service facilities and two or more repair/overhaul facilities and yards as well as an extensive parts inventory.

3.0 ISSUES AND FINDINGS

3.1 GENERAL

As a guide to the scope of work, it was necessary to define the types of issues that would constitute the ground rules and boundaries for the work. These are categorized as (1) Critical Issues, and (2) Significant issues. In this section the issues are first defined and then discussed in subsequent paragraphs.

3.1.1 CRITICAL ISSUES

These are deemed to be particularly significant in the deliberations leading to the decision for placing the S.C.L. proposal on the ballot.

3.1.1.1 Adaptability of Existing Public and/or Semi-Public Rights-of-way to Guideway Construction.

There are three issues of criticality that must be addressed. (1) To what extent, and at what cost, can freeways, flood channels and railroad rights-of-way be adapted for guideway utilization? (2) Can freeway shoulders and service roads be used for minimum freeway traffic dislocation? (3) Are the S.C.L. line junctions adaptable to freeway interchanges and what are the land requirements to accommodate line junctions? Can stations be located at line junctions to facilitate passenger transfers and minimize land needs?

3.1.1.2 Maintenance Shops and Yards

The size, complexity and diversity of the S.C.L. proposal makes the problems of servicing, maintenance and repair a very difficult and critical problem.

A service plan must be developed to assure the quality of service necessary to produce the degree of reliability commensurate with the low levels of down time and emergency failure required by the proposal. The plan must have the service potential and facilities required to generate prompt emergency service, offline service, and major repair shop service.

Maintenance shop and yards must be provided for at one (or more) location(s). It must be pointed out that these yards are a major element in system design; if all of the system's vehicles were put into off track locations, 85,000 to 90,000 feet of extra track would be required, i.e., about 16 miles.

3.1.2 SIGNIFICANT ISSUES

The issues identified below are deemed to be of interest to the Board at this time but to be of lesser consequence to the ballot decision. The issues represent, generally, uncertainties which can be resolved later.

3.1.2.1 Energy Requirements

The important issues are:

Energy Used in System Operations. Is there adequate power for trains operating at maximum capability over the foreseeable future?

Power Adequacy. To determine power adequacy, it will be necessary to determine availability, present and future. This will include the total power available as a function of time obtained from local steam plants, hydro electric power, and power purchased from other systems. The power available for transit usage is the difference between power available and power needed to operate the system.

Additional issues related to power requirements of the proposal are:

Will the peak load coincide or be out of phase with that of the suppliers? Is the planned power availability firm, i.e., is the purchased power guaranteed? Is the local power "safe" from ARB reductions? (Several years ago the APCB said there would be no more steam plants in L.A. County.) Assuming a reduction to total planned power or an unexpected increase in other demands (private or public) what alternatives are available, e.g., the waste use energy generation method? What is the sensitivity of power use per passenger? Will the energy requirements to construct the system in the scheduled time be available? The trade-off between energy use and time should be made clear.

3.1.2.2 Energy Savings

When operational, the S.C.L. should divert a considerable amount of traffic from the streets and result in direct savings of fuel (gasoline). Overall savings will be affected by all freeways and surface streets as vehicles move at a speed nearer to optimal (fewer traffic jams and long waits). It may be possible to have some energy savings by allowing concentration of some activities in particular areas. (In many cases a desired level of concentration cannot be achieved due to traffic/parking problems.) What are the possibilities/probabilities of major technical improvements in any part of the power process use chain? Savings due to regenerative braking? When, if ever, would the proposed system require construction of new generating capabilities? What type would be constructed? Would the trash-gas generator plants offer a possibility?

What will be the effects of the Proposal on the overall power distribution system? Will new substations be required, new equipment, new techniques? Can conventional power transmission lines be used, existing lines?

3.1.2.3 Vehicle Selection

Can vendors/manufacturers be found (or are they available) who can produce the specified cars with a high probability of success, can produce the number of cars desired in the required time period, and are deemed creditable in their ability to perform the foregoing two items?

3.1.2.4 Equipment Selection

It will also be necessary to develop design specifications for off vehicle equipment, wayside equipment, signals, track, controls, switches, communications equipment adapted to the selected vehicles and commensurate with the vehicle specifications; again the same three criteria must be considered. Can the vendor produce the equipment? Can the vendor produce the quantities required in the time period? Is the vendor creditable?

3.1.2.5 Reliability of Subsystems

How will the plan's divergences from off-the-shelf hardware affect the equipment's reliability?

Vehicle Type and Mission Mix:

What problems of systems integration will occur due to the diversity of vehicle used? What problems of system integration will be caused by the fact that at least two or more systems of different service performance and schedule of operations share the same line.

3.1.2.6 Availability of Vendors of Off-the-Shelf Equipment

The recent experience of transit stock and equipment supplies results in a potential issue, especially in terms of shipping schedules, quality control, reliability and cost.

3.2 FREEWAY ADAPTABILITY AND GUIDEWAY CONSTRUCTION - FINDINGS

The S.C.L. guideways propose extensive use of freeway right-of-way (R/W). The compatibility between the present freeway usage and its future function must be well established. In this respect, it has been found that except for relatively short sections the freeways can be adapted to include SCL and guideways within their R/W. In many cases, however, an alternative to freeway R/W may be found to be better overall than the freeway alternative. Factors affecting this adaptability are freeway geometrics, the type of guideway, stations and junctions (their numbers and size requirements). These findings are presented in this section, and detailed supporting data are included in Appendices I, II and III.

3.2.1 TYPES OF GUIDEWAYS

3.2.1.1 General

Most mileage of the SUNSET COAST LINE guideways is proposed on public R/W, namely freeways and flood control channels. In addition, railroad R/W are proposed. Guideways can be constructed elevated, at-grade, or underground. For cost reasons, tunnels should be kept to an absolute minimum, thus at-grade and elevated are the two prime types of guideway placement. It is technically possible to use either type of guideway on all three types of R/W. However, there are many inherent issues that determine the best suitability of guideway to a particular R/W. These issues involve the planning, construction, maintenance and operation of the entire system.

An analysis of each type of guideway with each type of right-of-way requires a major engineering study and is beyond the scope of this effort. However, there are broad issues which should be discussed so that comprehensive grasp of what is involved may be obtained. The following discusses the important issues to be considered.

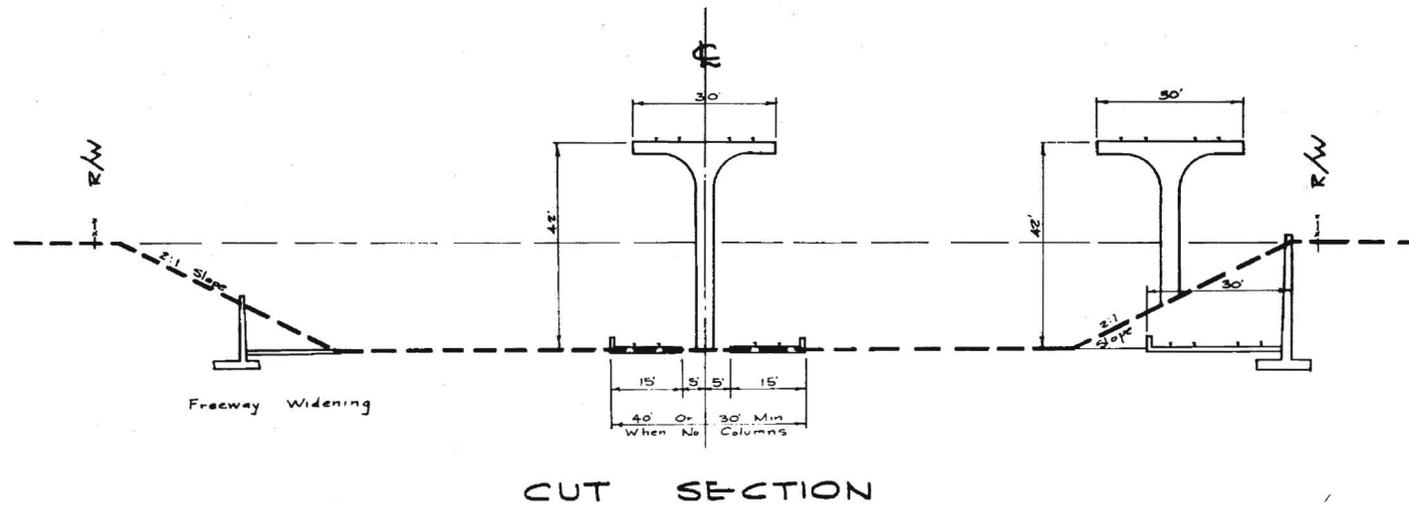
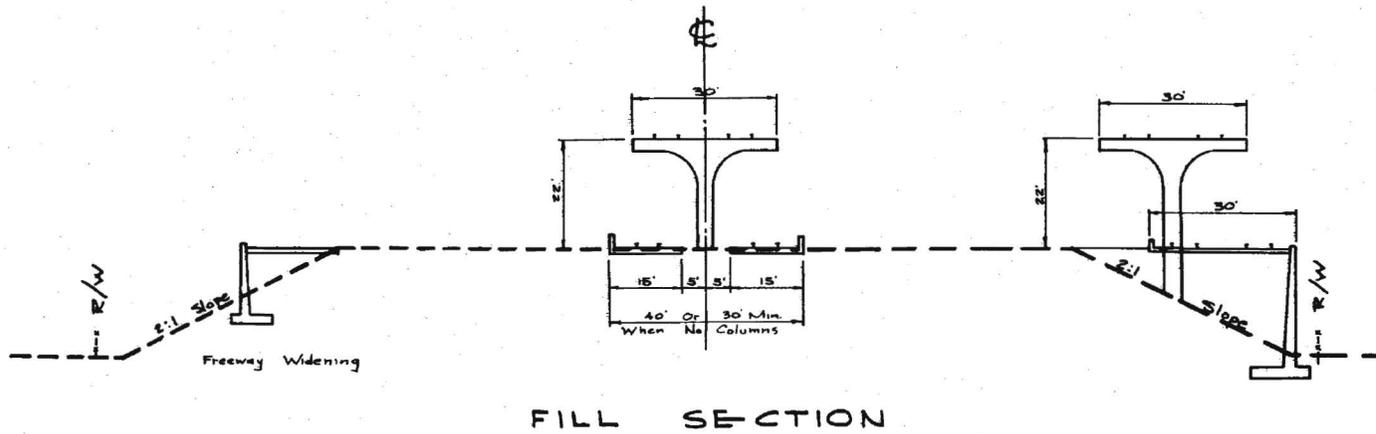
3.2.1.2 At-Grade & Elevated

There are important differences between at-grade and elevated guideways. At-grade guideways are generally less costly and less conspicuous. Elevated facilities are more costly, more conspicuous, but require less R/W than at-grade guideways and offer more design flexibility.

At-grade guideways, wherever possible from a R/W point of view, must still be physically separated from public accessibility for safety reasons, a problem that is virtually non-existent for elevated guideways.

At-grade guideways have a typical width of approximately 30 feet, considered ample for double-track installation. Elevated facilities require some air rights and considerably less R/W since the requirement is only for support structures. Simultaneous and compatible land use is thereby facilitated.

The critical issues involving guideway type for the SUNSET COAST LINE are likely to be construction cost (including R/W), traffic disruption, and the potential for smooth, trouble-free system operation. This smoothness depends in part on the extent to which the line is affected by its surroundings (freeway traffic, residences, etc.). Qualitative statements are perhaps adequate to describe such tradeoffs, but comprehensive quantitative analysis of all involved costs and probabilities is essential before a choice of guideway type can be made. A reliable and valid quantification is a considerable task.



POSSIBLE GUIDEWAY ALTERNATIVES
 WITHIN FREEWAY RIGHT-OF-WAY

Figure 3.2.1.3

3.2.1.4 Method of Construction

A related question is that of the method of construction of the elevated structure. The S.C.L. proposal has advocated use of off-site, pre-cast members for both the columns and the beams. The alternative is the cast-in-place, conventional method.

Briefly, the advantages of pre-cast construction are:

Better quality control

Ability of pre-testing (prior to erection)

Economies of scale

No falsework, less clean-up, increased traffic safety

Better control over construction scheduling.

On the other hand, the cast-in-place method is likely to offer:

Better joints of columns and beams

Easier construction of large and unusual structures

No need for massive installation equipment.

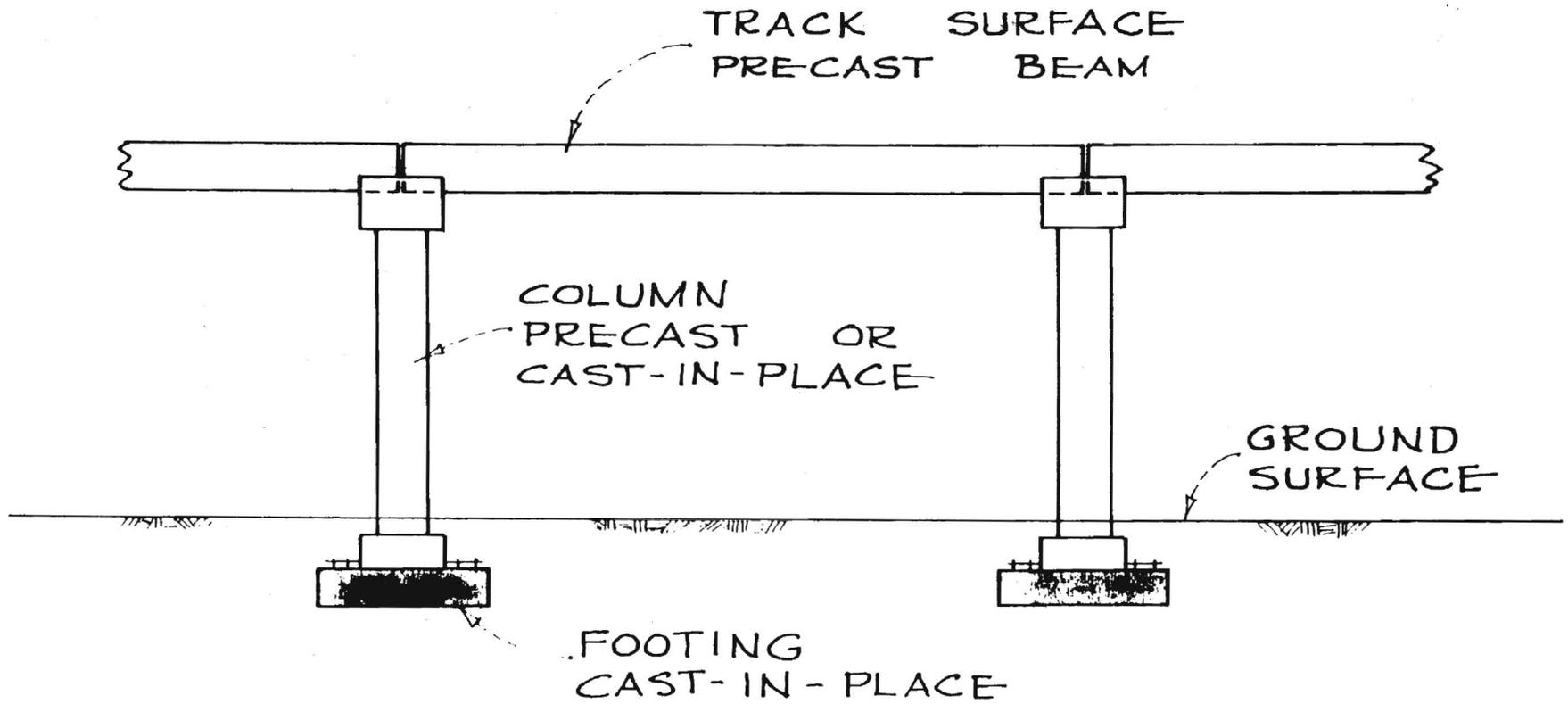
The quantification mentioned above will have to include the construction method, both for its own cost and for its impact on freeway traffic (often a wrongfully neglected cost item). The probability of freeway traffic interference due to system, maintenance and traffic accidents when the system is in operation must also be considered in the analysis.

3.2.2 REVIEW OF S.C.L. LINE ELEMENTS - FINDINGS

3.2.2.1 General

The S.C.L. system consists of ten lines, varying in length from about 2 miles to 44 miles. Alignments within these corridors have been defined, but not finalized. Final adoption of each alignment will follow a detailed engineering study to be made after general adoption of the S.C.L. system. The use of public R/W is one of the main characteristics of the proposal.

The proposed alignments were used as a basis for an investigation of significant technical issues associated with each line. In many instances the investigation uncovered potential deviations from the original proposal. Each line was surveyed using visual inspection, aerial photos and other references with a resulting list of important technical issues which warrant special attention in early stages of S.C.L. planning. The lists for each of the ten lines can be found in Appendix I.



GUIDEWAY CONSTRUCTION APPROACH

Figure 3.2.1.5

The most adequate type of alignment for each line (such as grade on freeway shoulder or elevated on flood control channel) was plotted on maps. A table showing the breakdown of system mileage by type of alignment and by line is also given in the Appendix, together with the ten maps.

3.2.2.2 Assumptions

There will be no legal or administrative cause to prevent freeway median, shoulder or traffic lane usage for S.C.L. lines.

There would be no legal or administrative cause to prevent usage of flood control channels.

Railroads would come to terms with the S.C.L. authority (to be created) regarding the usage of RR rights-of-way.

The general location of the S.C.L. corridors was accepted as given and no investigation into their general desirability from a transport service point of view was made.

Existing railroad tracks would be adequate for 85 mph speeds.

Typical alignments to be used would be 30' wide and accommodate two sets of tracks.

3.2.2.3 Findings and Conclusions

Alignments as defined by the SUNSET COAST LINES are feasible.

Many potential alternative alignments exist within all corridors described in the S.C.L. Some lines have the flexibility of different rights-of-way such as freeway versus flood control channel or railroad.

There would be few horizontal and vertical alignment problems with the rail transit alignments. The lines would generally follow freeway, flood control channel, and railroad improvements which have similar design criteria for such items as grades and curves.

Existing flood control channel and railroad rights-of-way will be less costly and therefore might be used more often. Most of these alternate alignments are adjacent to the corridors described in the S.C.L.

Alternatives exist for more elevated alignments and less grade alignments than stated in the SCL proposal.

Flood control channel alignments will generally be elevated. This would be because much of the land adjacent to levees is low, columns will in many instances be within the channel side slopes, and in cases of inadequate right-of-way for an at-grade alignment.

Railroad alignments should generally be elevated. This is due to inadequate railroad right-of-way width and grade crossing problems at major city streets.

Complexity of interline rail junction will affect alignments, but only in the vicinity of the junctions (major difficulties are likely due to the anticipated overlap between rail junctions and freeway interchanges).

Alignments at-grade on the outer freeway edge and all elevated alignments were found to have fewer serious problems than the median at-grade option.

The proposed alignments would necessarily depend on reliable feeder service to many activity centers. This is especially true on flood control channel and railroad alignments.

The need for tunnels can be greatly reduced. This would necessitate alignment modifications to overcome adverse grades. If there is willingness to compromise on speeds (at short uphill sections) the availability of appropriate vehicles is likely.

At some sections alternative alignments run along high voltage power lines. Public policies permitting such joint usage of R/W will have to be established first.

Major technical issues pertaining to specific S.C.L. lines were identified and listed in the appendix, together with detailed alignment maps.

3.2.3 FREEWAY R/W ADAPTABILITY FOR SUNSET COAST LINE GUIDEWAYS

3.2.3.1 Freeway R/W Adaptability

It is advantageous (mainly from cost and convenience point of view) to locate guideways within freeway right-of-way. A large portion of the S.C.L. guideways are proposed accordingly.

This may be accomplished in three ways:

On existing traffic lanes

In freeway median areas

Along the outer edge of the freeway.

The critical issues likely to be associated with freeway R/W usage are:

Cost

Technical feasibility

Traffic disruption during and after construction

Operational factors.

3.2.3.2 Existing Traffic Lanes

Placing guideways on existing freeway traffic lanes without the addition of traffic lanes involves important transportation policies in addition to the questions of technical feasibility. In addition, typical problems associated with at-grade guideways are present as well. The concept implies a limitation of road space available for auto traffic, i.e., an active impediment for existing traffic. This may be commensurate with adopted regional policies of limiting the growth of (and eventually reducing) automobile traffic, in favor of transit and multi-occupant vehicle usage but does nothing for solving the existing problems of auto users. Traffic on some freeway sections is currently light enough to permit this technique. On other sections it is hoped that the modal shift from autos to transit would eventually reduce auto demand to a level that can be reasonably well served by the remaining lanes. Cal Trans District 7, has identified four freeway sections where traffic lanes may be converted to guideways without the need for freeway widening. These sections were incorporated in the S.C.L. proposal.

This method of guideway placement is the least costly of the three, from a construction point of view. The cost to motorists (due to delay, added wear-and-tear, potential for accidents, etc.) has not been estimated, but should be considered in the final analysis. Interference with traffic during construction will be unavoidable (see Appendix II).

3.2.3.3 Freeway Medians

Using freeway median is similar to the above, if done at-grade. Costs, traffic interference and operational limitations are comparable. Where wide medians exist, no severe traffic disruption need be expected during construction. One limitation of the concept is its difficult adaptability to interline junctions. However, the main drawback lies in its requirements for R/W. Any lateral space for stations must be at the expense of traffic lanes or shoulders, or necessarily implies lower standards for the stations. Installation of a third set of tracks becomes very difficult when the guideway is at-grade in the median. The lack of such tracks (at least along part of the line) is likely to complicate the transit system operation plan and affect service reliability.

Interurban and airporter trains service is uncertain without a third track. An at-grade guideway in the median is also more exposed to freeway traffic (than elevated guideways), thus the probability of freeway accidents affecting the S.C.L. should not be discounted.

Using the median space for an elevated guideway may alleviate many of the adverse issues listed for the at-grade alternative, such as safety, traffic disruption, junctions and stations. This alternative is more flexible than at-grade, more easily adaptable to junctions and stations than at-grade and requires less R/W. These benefits are at least partially offset by the fact that the construction is more costly and complicated (than at-grade) and emergency procedures are more difficult.

A careful quantification of all involved trade-offs may be required to help in the decision which of the concepts should be adopted. This analytical task limited time does not permit a comparative technical evaluation to support a conclusion and recommendation (see Appendixes III and IV).

3.2.3.4 Outer Edge of Freeways

Guideway placement along the outer edge of the freeway is a third approach of freeway usage. This can be accomplished at-grade, by widening the freeway and erecting retaining walls in place of embankments. It can also be accomplished using an elevated guideway at the outer freeway edge.

There are many advantages to the use of the freeway outer edge over the use of the median. Station locations, design, expansion and accessibility are superior. Construction, maintenance, emergency procedures and the ability to circumvent freeway interchanges are technically simpler. On the other hand, such alignment limits future freeway widening and is more conspicuous to the public eyes and ears.

Despite the inherent cost differential, an elevated alignment is generally a desirable alternative. It solves the problem of ramp interference and is more adaptable to interline rail junctions. The investigation indicates that along many freeway sections this configuration (elevated guideway at the outer freeway edge) is technically feasible and desirable.

3.2.4 STATIONS AND JUNCTIONS

3.2.4.1 Stations

The number, location and accessibility of stations are important factors affecting the expected patronage of the S.C.L. Few and inaccessible stations are not conducive to high patronage. The critical issues concerning stations will be freeway design limitations, station accessibility and freeway traffic disruption during construction.

Placing stations at-grade would necessitate widening the freeway. If stations are to be built close to intersections with major city streets, the interchanges with those streets might have to be modified, resulting in inconvenience, delay and impaired service to the community. The additional auto traffic, generated by the S.C.L. stations, will also have to be accommodated on city streets. On the other hand, if stations are moved away from major streets, to overcome this limitation, the SUNSET COAST LINE is likely to be less attractive to the public. Important trade-offs are involved in the location and configuration of many stations. Careful consideration of all of these must precede the final decisions. Modifications and future redesign of facilities will be costly and delay operation.

Placement of stations at junctions is desirable from a patronage standpoint. Each of such stations would have to be designed individually due to particular spatial limitations and to conform to train movements through each junction. The availability of parking and feeder service for these stations would also depend on the eventual configuration of the large transportation mode that would result. In dual- or triple-junctions, the location and design of stations may be made difficult because of complicated passenger transfers between S.C.L. lines. This complexity and the reduction of attractiveness associated with awkward transfers may be alleviated by simple dual-level transfer stations at junctions and reduction of the freedom of movement of trains at junctions. This would mean the curtailment of interline non-transfer service. Such a feature would involve major policy decisions.

3.2.4.2 Junctions

The number, locations and configurations of interline rail junctions have an immediate effect on the S.C.L. cost, as well as on patronage. Convenient passenger transfers at junctions, and frequent interline trains are important factors in maintaining high patronage. However, widespread use of interline junctions may mean that somewhere along the line service will suffer. A study should be made to determine the trade-offs of straight through lines with a dual-level station for transfer vs. interline junctions with no need for transfers, as proposed in the S.C.L.

In addition, junction complexity as proposed may be simplified by transit operation plan to limit the interline components of junctions. The S.C.L. Plan proposes a dozen interline rail junctions, to be used by the Interurban and Airport trains. Since virtually all S.C.L. lines follow freeways for much of their length, many of the interline rail junctions overlap freeway to freeway interchanges. The complexity of such an overlap is apparent. The degree of complexity varies from one junction to another. Most interchanges involve multi-level structures which were not designed with rail junctions in mind. In some cases the interline junction and the freeway interchange will complicate the design and construction of both junctions and stations.

The expected problems can be alleviated in certain ways. The most obvious is physically separating the rail junctions from the freeway interchanges, either by locating them at different locations or by vertical separation. Since some existing freeway interchanges are already multi-level, the latter may not be feasible or particularly attractive, from cost and environmental points of view. Serious consideration should be given to inter-connection of S.C.L. lines at the fringes of existing freeway interchanges. Removal of some interline rail junctions from such interchanges must be considered by transit operation plan and if the junction cannot be blended at least partially into the existing interchange.

3.3 HARDWARE AVAILABILITY - FINDINGS

The SUNSET COAST LINE proposal describes various types of transit cars to serve the system in train configuration. Applying heavy rail guideway, SCL incorporates wayside and train control system of conventional type applying train operation on board.

3.3.1 The SCL proposes four major types of heavy rail cars to operate through the 11 (eleven) lines of the system in train configuration and offering four types of service.

3.3.1.1 CARS--"LOCAL SERVICE"

The cars described for "local service" train requiring a fleet of approximately 750 cars are to be used extensively through the system. Some of these cars are domed roof.

LOCAL CAR CHARACTERISTICS

Height	13 feet - 0 inches
Weight	91,600 pounds
Length	85 feet - 0 inches
Doors per side	3 per side
Seats	110
Maximum Load	200
Service Speed	85 miles per hour
Acceleration	2.5 miles per hour per second
Grade	4 percent +

3.3.1.2 CARS--"AIRPORT SERVICE"

The proposed system also includes the "airport service" applying the airporter car of a different design and specifications than the local service train. The number of airporter cars is not established in the S.C.L., but could represent from 12 to 20 cars to service the operation plan established at the time the system is developed. The airporter car also operates the train configuration.

AIRPORTER CAR CHARACTERISTICS

Height	12 feet - 0 inches
Weight	64,000 pounds
Length	85 feet - 0 inches
Doors per side	2 per side
Seats	50
Maximum Load	(Not stated)
Service Speed	85 miles per hour
Acceleration	4 miles per hour per second
Grade	7 percent <u>±</u>

3.3.1.3 CARS--"INTERURBAN--RED CAR--SERVICE"

The SCL proposal incorporates an "interurban service" applying what is called the "red car." This car in a train configuration will serve the major lines of the system. The specifications are comparable to the airporter car, but the seating arrangements result in a higher passenger capacity. The number of interurban "red cars" is not specified, but it is estimated that from 140 to 250 cars of this type will be required for the interurban service.

INTERURBAN "RED CAR" CHARACTERISTICS

Height	12 feet - 0 inches
Weight	64,000 pounds
Length	85 feet - 0 inches
Doors per side	2 per side
Seats	75
Maximum Load	135
Service Speed	85 miles per hour
Acceleration	4 miles per hour per second
Grade	7 percent <u>±</u>

3.3.1.4 CARS--"EXCURSION SERVICE"

The SCL proposes the "excursion service" applying a car with a special design with domed roofing and special interiors. The service will provide transit for tourists, beach visitors, and excursion travelers throughout the system. The excursion service cars will be of modern design, with appropriate interiors and seats for this special type of service, and will provide racks to store bicycles, surfboards, and the like.

The number of cars for this service might be small, possibly 20 to 40. The characteristics of the excursion car are comparable to the airporter and the interurban "red car."

EXCURSION CAR CHARACTERISTICS

Height	12 feet - 0 inches
Weight	60,000 pounds
Length	85 feet - 0 inches
Doors per side	2 per side
Seats	40
Maximum Load	60
Service Speed	85 miles per hour
Acceleration	(Non-motorized)
Grade	n.a.

3.3.2 MONORAIL VEHICLE--FEEDERLINE

The system also describes a monorail vehicle conceived to be applicable to feeder and distribution service. This vehicle design has not been established, but could either be a monorail type riding on a beam or a live-rail type of vehicle.

3.3.3 VENDOR SELECTION

The availability of vendors in the United States to produce the cars described in the SCL has been surveyed. A number of United States suppliers who are acquainted with the SCL proposal are as follows:

- Rohr Corporation, of Chula Vista, California, developers and suppliers of BART and WMATA cars.
- Pullman Standard, of Chicago, Illinois, developers and suppliers of Cleveland Airport Transit Car and the Boston No. 1 South Shore Rapid Transit Car.
- Boeing Vertol Company of Philadelphia, Pennsylvania, developers and suppliers of the Chicago New Rapid Transit Cars and the State-of-the-Art Car for DOT-UMTA, URRV Program in conjunction with St. Louis Car Division of St. Louis, Missouri, builder of the experimental (SOAC) Car.
- Transportation Systems, Business Division of General Electric Corporation, of Erie Parkway, developers and suppliers of the Erie Lakawawa Railroad New Cars.

Their response has been generally favorable in terms of their ability, capacity, and willingness to produce the SCL cars.

There has been a distinctive response related to the need of establishing car specification that has some similarity to current production and the means to assure efficient production at a competitive cost.

It is purported that the number of cars for the local service fleet might be as large as 800 or more units. The large quantity is an incentive for car suppliers to compete to produce a car meeting the descriptions and specifications of the "local service" car. In the case of the "airporter," the interurban "red car" and the "Excursion car," the descriptions and specifications are somewhat different than the "local service" car. They are closer to comparable current production vehicles which permit competitive pricing even though the quantity would be smaller than the number of "local service" cars. The interior and exterior design would need special treatment, seat type and arrangements.

3.3.4 VENDOR CAPACITY TO PRODUCE ON SCHEDULE

The responses from the United States suppliers surveyed by MOBILITY SYSTEMS have been favorable and affirmative as to their capacity and schedule of availability to satisfy the SUNSET COAST LINE proposed project development schedule.

3.3.5 DELIVERY SCHEDULE AFFECTING COST

The delivery schedule discussed in the survey corresponds favorably in terms of cost because the SCL plan permits sufficient time for design development, tooling and testing by the suppliers, without being affected by tight schedules or difficulties of procuring component and auxiliary equipment, as well as the necessary time for development and testing. The testing phase of a new design car is a priority item which appears not to conflict with the SCL proposed project development schedule.

3.3.6 EQUIPMENT AVAILABILITY FOR WAYSIDE AND TRAIN CONTROL SYSTEM AND RAIL GUIDEWAY

3.3.6.1 WAYSIDE AND TRAIN CONTROL

United States suppliers of wayside and train controls as well as electrification hardware have been surveyed in terms of the need for the SCL project. The requirements of the SCL project for this type of equipment are of less complicated nature than those of BART, produced by Westinghouse Corporation, which incorporates heavy automation technology and vehicle computer control. The SCL system proposes train operators on board and a train control system to assure train headways and fail-safe operation.

The United States suppliers have responded affirmatively to their capacity and interest in competing to supply this type of equipment.

- Union Switch & Signal, suppliers of wayside and train controls, Pittsburgh, Pennsylvania.
- General R/W Signal, supplier of wayside and train controls, Watertown, New York.
- Westinghouse Electric Corporation, supplier of electric/electronic train controls, propelling equipment and computer system automated controls, Pittsburgh, Pennsylvania.

3.3.6.2 RAIL GUIDEWAY

Rail guideway hardware, including switches, mechanical components, etc., produced by United States suppliers is not a problem because we have excess capacity in this country for this type of steel product.

- Railroad Products, of U. S. Steel, Pittsburgh, Pennsylvania.
- CFI - Colorado Fuel & Iron Corporation (reopened facilities) at Pueblo, Colorado.
- Railroad Product Division of ABEX Corporation, Los Angeles, California.
- Pacific Car and Foundry at Renton, Washington.

The above-listed United States manufacturers have indicated an interest in being a supplier for rail components and hardware for the SCL project.

3.3.7 MONORAIL DESIGN, DEVELOPMENT, CONSTRUCTION AND COMPONENT DELIVERY SCHEDULE

SCL proposes the application of monorail and light rail service as a feeder line to the system. The proposals do not define monorail or light rail design car, guideway, system operation or stations to any extent. Consequently, we have concluded that there are many possible ways, approaches and concepts that can be applied for this type of service.

In the United States and overseas, suppliers have been offering systems that correspond to this service requirement in a diversity of conceptions and design approaches. The proposed SCL describes a monorail as an articulated train riding above a single concrete guideway structure comparable, but not equal to the Alweg Monorail developed by Alweg GmbH. of West Germany and produced by various companies throughout the world, including Japan, Canada and England. This concept is used at Disneyland in Anaheim, California; Seattle, Washington; and other places in the United States. There are other concepts that also could be applicable, for instance, the JETRAIL system developed by Stanray Corporation, Monocab developed by Rohr Corporation and other concepts including "Project 21" developed by Lockheed Corporation.

Any of these concepts, with the exception of those that have been fully developed and have been made operational as a transit service, might respond to the needs of this project in terms of cost and time schedule for development and installation.

3.3.8 RELIABILITY OF HARDWARE FOR FAIL-SAFE CHARACTERISTICS AND OPERATION PREDICTABILITY

The SUNSET COAST LINE car design concepts, train control approach responds to the state-of-the-arts and has been produced, developed, constructed and applied to service for many years in various configurations of public transit systems.

The SCL plan schedule does not represent a critical element in the development phase of the required hardware. Consequently, there is no doubt that the system design, implementation and development could be performed to operate at a fail-safe level required for a public transit system of the magnitude proposed in the SCL. The same applies to the reliability of products and components that will be required to implement the system because they are currently in production in most cases. From the design approach, the changes--or adaptability--are only to conform to the service required in the SCL proposal.

3.3.9 EQUIPMENT STANDARDIZATION

The SCL approach permits the application of a large number of components, cars, guideway train control systems, electrification, etc., to a high level of standardization especially because of the extent and quantity level of proposed system elements.

The proposed plan describes basically two types of cars--one type, the "local service" car; the other type that includes the "airporter," interurban "red car" and the possibility of also including "excursion" cars. The minimum quantities are from 800 and 200 units, respectively.

The only problem appears in the approach proposed for "feederline service." The SCL proposes that there could be various types of monorail or light rail type systems and vehicles. The concept describes a process of selection through the developing of the project from which one system concept is applied at one feeder line location and later others of more advanced concept are selected to conform with the will of the people of the locality.

This aspect of the plan produces a standardization problem and also might affect the service and maintenance plan and facility multiplicity that would increase the cost of the SUNSET COAST LINE project.

3.4 ENERGY CONSIDERATIONS - FINDINGS

This section will consider the energy requirements of the SUNSET COAST LINE (S.C.L.) relative to the energy available. The energy necessary to operate and construct the S.C.L. will be considered as well as the energy saving that will result from the displaced cars (see Appendix V).

Some general discussion and the results will be presented in this section; the detailed calculations appear in Appendix I.

It should be noted that all of the analysis, at this point in time, is to some extent superficial and by no means final. That this must be the case is obvious for several reasons; first, the time period in which the analysis was made has been very brief; second, the S.C.L. system description is, in some instances, not precise enough to allow a really complete analysis, and third, there is enough diversity of interest to make suspect some of the information given to the consultant.

Finally, it should be noted that the energy projections are for the most part on the high side. This was done intentionally, then if there is the power available for the system discussed here, there will certainly be power available for the actual system.

3.4.1 ENERGY REQUIRED FOR S.C.L. OPERATION

The following is a summary of the energy requirements of the S.C.L. system.

The operating power requirements for the S.C.L. system are those imposed by the trains themselves. This includes the power used for traction and for the auxiliary on-board equipment (the compressor, air conditioning, heating, lighting). A very minimal amount of power is used by the stations and for command and control. In addition, the energy losses related to equipment efficiency must be considered.

The methodology was as follows: first, the retarding forces were calculated. These included drag (frontal, parasitic and base). Then the retarding forces due to rolling friction was introduced.

The energy necessary to accelerate and decelerate the trains was also estimated. Regenerative braking was assumed. The regenerative braking could be of either the electrical or mechanical (via the use of an inertia wheel) nature. After this power used by on-board auxiliary systems was estimated (the compressor, the air conditioning system, lights).

The actual power used is summarized in Table I, it is an "all up" calculation, i.e., it assumes all cars to be operating in three-car trains. The same information is plotted in Figure 3.4.1.1.

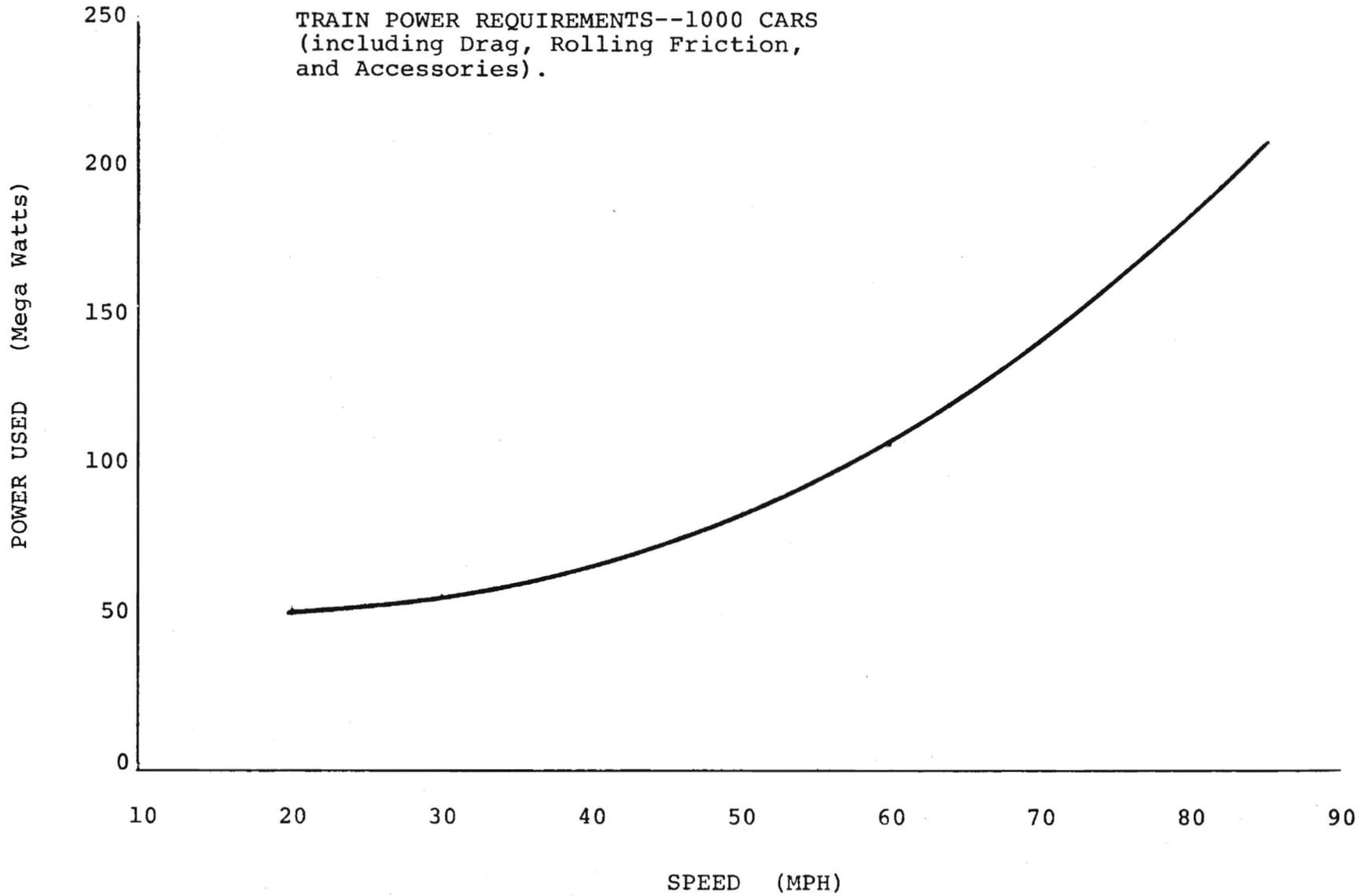


FIGURE 3.4.1.1 -- TRAIN POWER REQUIREMENTS--1000 CARS (including Drag, Rolling Friction, and Accessories).

Table I

Summary of S.C.L. Systems Power Use

	<u>Power at 50 mph (megawatts)</u>	<u>Power at 85 mph (megawatts)</u>
Traction (constant cruising speed)	32	121
Acceleration (regeneration braking in use)	6	19
Auxiliary Equipment (on board)	37	37
Stations & Command and Control	<u>1</u>	<u>1</u>
Total	76	178
Total (with losses) at input to transformers	89	209

Total use in equivalent barrels of oil (EBO), assuming about a 35% efficiency for the steam plant is given in Table II.

Table II

Power in EBO Per Day, Input to the Steam Plant

	<u>50 mph</u>	<u>85 mph</u>
Total EBO	2017	4171

3.4.2 POWER AVAILABLE

This section discusses the power available and the overall demand by other power users in the Los Angeles Area.

Power is furnished by the Los Angeles Department of Water and Power (DWP) and the Southern California Edison Company.

This forecasted power available, and their estimated power demand for the Los Angeles County area are summarized in Figures 3.4.2.1 and 3.4.2.2. Figure 3.4.2.3 summarizes figures 3.4.2.1 and 3.4.2.2, i.e., it presents total supply and demand exclusive of the S.C.L. uses.

The real issue here is not with the power demands of the system. Although the calculations performed show a higher power demand than that stated in the S.C.L. proposal, the amount of power used by the S.C.L. systems is approximately two percent of the existing capability within the Los Angeles County area served by

D.W.P. POWER SUPPLY AND DEMAND
(Estimated).

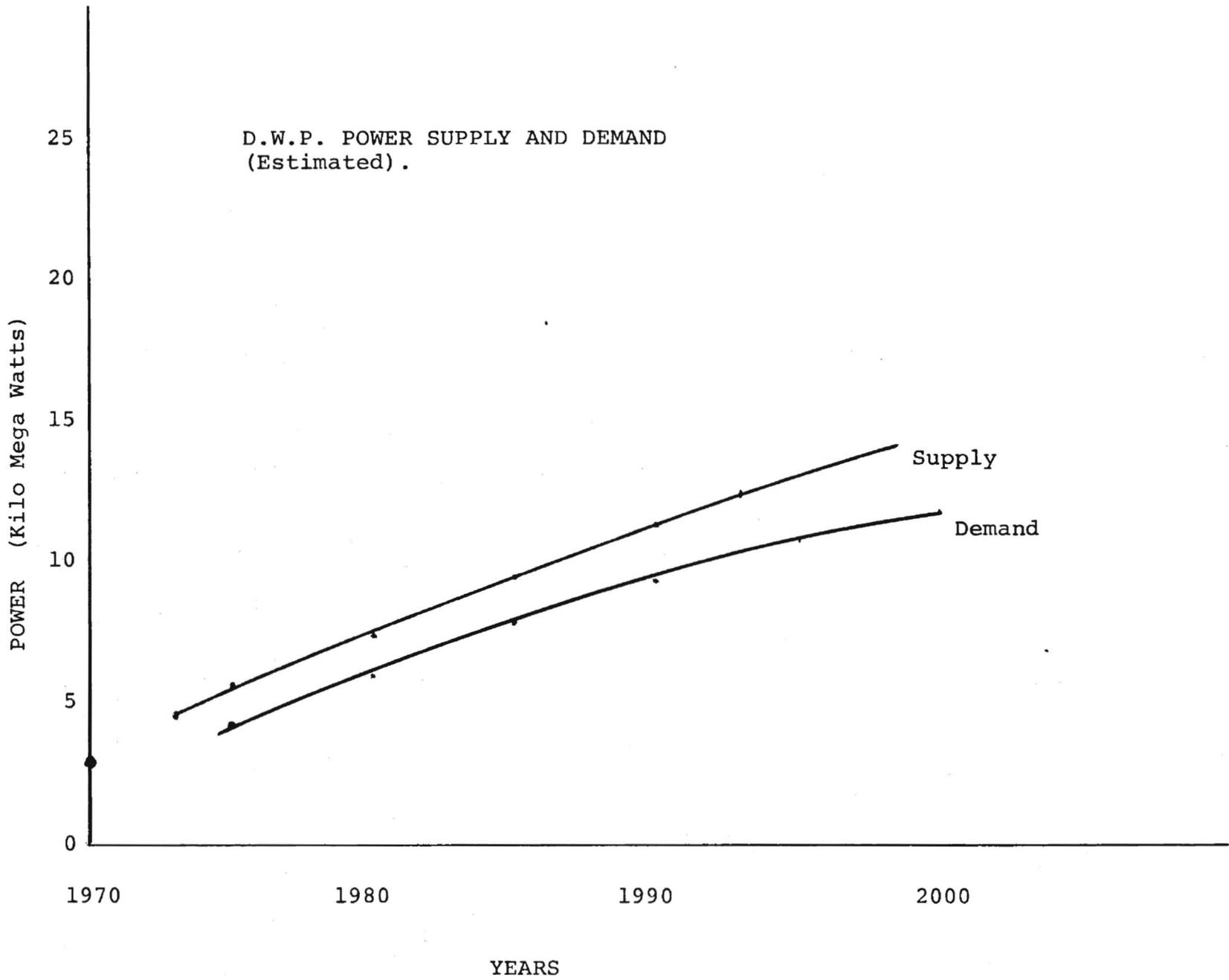


FIGURE 3.4.2.1 -- D. W. P. POWER SUPPLY AND DEMAND (Estimated).

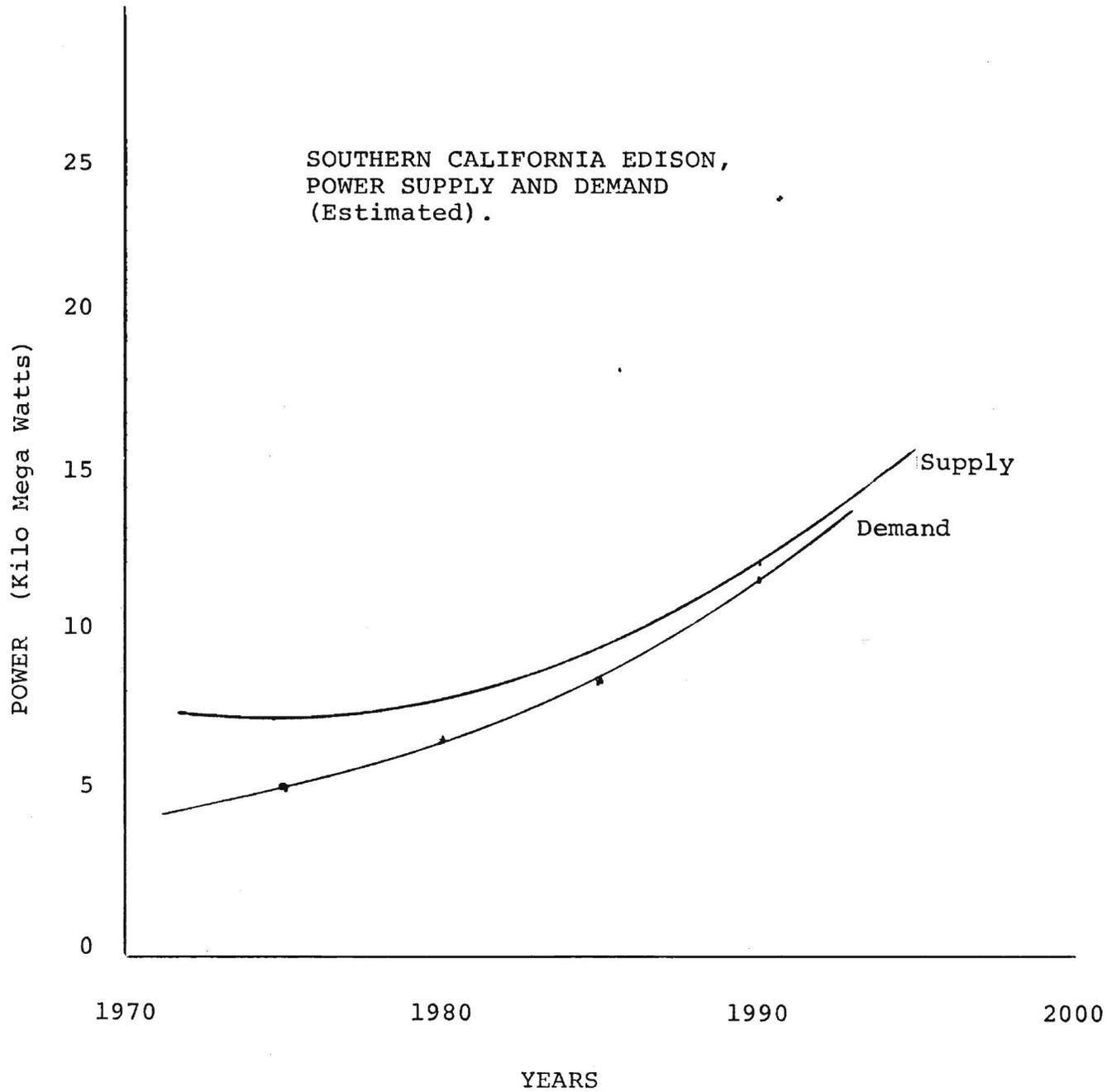


FIGURE 3.4.2.2 -- SOUTHERN CALIFORNIA EDISON, POWER SUPPLY AND DEMAND (Estimated).

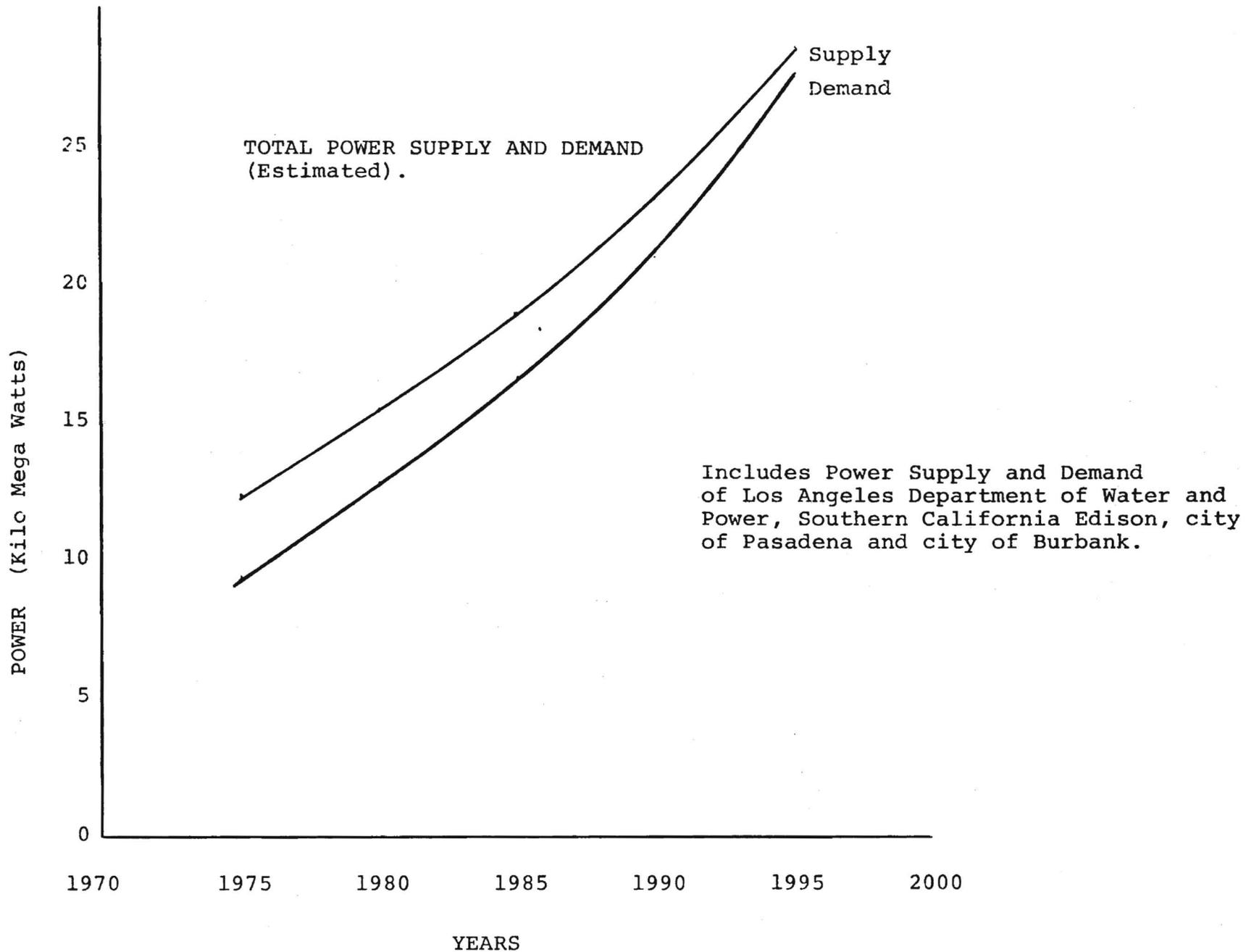


FIGURE 3.4.2.3 -- TOTAL POWER SUPPLY AND DEMAND (Estimated).

the Department of Water and Power and Southern California Edison Company. The issue is concerned with the general increasing power demand by consumers and the uncertain prospect of the power companies' ability to increase their capacity to keep in step with the increasing demand. While there appears to be an apparent power excess at present, this excess is illusory in that power companies have 15-20% "down" time on their equipment on a continual basis. When this is subtracted, most of the excess disappears. The problem is that all of the future capacity is yet to be built.

In talks with the utility people, they feel that the S.C.L. line will entail additional generating capacity and express some doubt about their ability to meet this demand. (There appeared to be some doubt as to whether they will be able to meet the normal demands.)

This opinion is to some extent contradicted by an RTD memo by Mr. Gardner, and the RTD power committee (consisting of members of all of the electrical power activities in the County). In this memo, written specifically for the power required by the RTD starter line, it was maintained that there was a great deal of power available.

3.4.3 ENERGY REQUIRED IN SYSTEM CONSTRUCTION

During the construction of the system substantial amounts of energy will be required. Some of the principal energy users will be mixing and hauling concrete, tunneling, earth moving, digging, grading, and the construction workers' trip to work.

As before, the details of the calculations appear in Appendix I, only a summary is given here.

The summary in EBO appears in Table III.

Table III

Energy Required for System Construction

<u>Activity</u>	<u>EBOS/week</u>
Concrete moving, mixing	50
Trip to work (workers)	6,330
Tunneling (1 year)	8,400
Earth moving, digging	<u>1,000</u>
Total	15,780 EBO/week
After tunnel completion	7,380 EBO/week

3.4.4 SUMMARY OF RELATED MATTER

This section will summarize some matters related to the energy issues of the S.C.L. system. These include peak power loading, purchased and planned, alternate power sources, energy savings, connecting in to existing electrical systems, and improvements in electrical systems.

Again, the details will appear in Appendix A.

The peak power demand occurs between 3 and 7 in the evening; this will coincide with the evening peak load imposed by the S.C.L. system. This additional load amounts to only 2 - 2-1/2% of the total power.

All of the local utilities purchase some power from sources which they do not own; this varies from year to year, and is on an availability basis. DWP and Southern California Edison have contracts covering several years; there is no guarantee that the contracts will be renewed.

The S.C.L. proposal considers the application of waste material power generating plants as an additional power source for the system. This concept is feasible and has been tried favorably in this country and overseas.

Various methods of energy recovery from organic wastes have been in existence for over one hundred years, and in use for seventy years (a methane plant was built in 1905 in Bombay, India).

Thermal facilities producing electric power from organic trash and refuse are found in various United States locations including St. Louis, MO, Escondido, CA, and in Tennessee for producing steam for heating.

3.4.4.1 Preliminary Technical Data for a Facility in L.A.

Approximately 2,000,000 tons of trash are collected per year in Los Angeles City and the County (not including Los Angeles) or 5,500 tons per day. If a process like pyrolysis, which yields about one barrel of "oil" (of less heat content than natural oil, about 75% of the BTU's) could be used, we should get a considerable amount of "oil," assuming the solid waste collected is 50% recoverable organic material. We should have the equivalent of approximately 2,750 barrels of oil. Obviously some of this energy will be absorbed in the process, assume 20% of the output. This leaves us with about 2,200 EBO. This should suffice to cover most of the S.C.L. system needs.

Energy savings would result from cars which are displaced by the S.C.L. system. Various estimates of ridership have been made. The S.C.L. uses a figure of 80% of daily capacity (about 4,000,000); others have mentioned figures as low as 1,000,000

per trip per day. If round trip, the figures come to 500,000 or 2,000,000 per day. The energy savings are summarized for each case in EBO's in Table IV.

Table IV

Energy Savings

<u>Trip</u>	<u>EBO's</u>
1,000,000	7,523
4,000,000	62,300

Another source of energy savings would be the decreased traffic (i.e., fewer traffic jams). This effect could result in about 10,000 EBO for the larger ridership estimates (4,000 per trip). The smaller estimate 1,000,000 trips is probably less than 1/4 of the 10,000 EBO mentioned above.

The only possible improvement that might become practical in the S.C.L. time period is the use of AC motors with pulse width modulation for the starting phase. This is being developed by Westinghouse.

Conversations with the utility people indicate that there should be no difficulty connecting into the existing power network at substations or distribution points.

3.5 MAINTENANCE SHOPS AND YARDS - FINDINGS

The proposed SUNSET COAST LINE transit system describes briefly throughout various sections of the proposal, elements related to maintenance facilities, shops and yards. The fact is that the S.C.L. is the largest transit system proposed, constructed, or operating anywhere in the world. The transit system of more modest capacity incorporates facilities, shops and yards as well as equipment to handle the emergencies and repairs to the extent not discussed in this proposal. There is a need to consider a maintenance program, preventive and for repairs, with a large quantity of service parts.

We have reviewed aspects concerning a service plan to incorporate those needed elements not appearing nor discussed in the S.C.L. proposal for service and maintenance, shops and yards.

3.5.1 SERVICE PLAN

The service plan should be developed in the early stages of the project development and should be related closely to the equipment selected and systems operating plan. The level of standardization applicable is a major consideration to assure that the high level of efficiency operation plan of the system can be effectively implemented. The service plan should include service policies, method of implementation, equipment and personnel (training) response to the expected reliability of the system operation in terms of efficiency and utilization.

3.5.2 SHOPS AND FACILITIES: EMERGENCY SERVICE, OFF-LINE SERVICE, MAJOR SHOPS

S.C.L. proposal consists of a transit system that should operate at a very high efficiency and utilization level. To maintain a level of reliability expected to satisfy the transit service proposed--a number of major and minor emergency breakdowns can be expected--an emergency service should be implemented with a minimum of dislocation of the system's operation.

EMERGENCY
SERVICE

MOBILE CREWS &
EQUIPMENT

MINOR REPAIR &
ADJUSTMENTS

ON BOARD &
AT STATIONS

FREQUENTLY USED
MINOR SERVICE PARTS

OFF-LINE SERVICE
FACILITIES

VARIOUS LOCATIONS

SERVICE BY MODULAR
COMPONENT EXCHANGE
& REPAIRS

WASHING/CLEANING FACILITIES
TOWING EQUIPMENT

CAR STORAGE/STAGING

OFF-LINE TRACK

SERVICE PARTS STORAGE

REPAIR & OVERHAUL
FACILITIES

1 OR MORE LOCATIONS
SHOPS & YARDS

COMPLETE OVERHAUL
& MAJOR REPAIRS

MACHINE SHOPS
TOWING & CRANE EQUIPMENT

STORAGE/STAGING

YARDS--EXTENSIVE
TRACKING

FULL SERVICE PARTS
INVENTORY

3.5.2.1 SERVICE AND MAINTENANCE

YARDS AND SHOPS

3.5.2.2 Emergency Service

This emergency service may require mobile crews and equipment with direct radio communication to service operation center in order to quickly respond to emergency calls for equipment repairs and adjustments. Most work would be done on board the cars or at stations, changing minor parts and making necessary adjustments while the cars are still carrying passengers. Assuming 90,000,000 car miles a year of operation, the possibility would be that this work would be done 90,000 times a year or 245 times a day. If we assume that a crew of two mechanics could perform repairs lasting from 10 minutes to an hour on 10 to 12 emergency services, it is possible that twenty-five crews would be needed, operating around the clock, possibly sixteen crews during the heavy transit hours from 7:00 a.m. to 4:00 p.m., six crews working from 4:00 p.m. to 12:00 p.m., and three crews the rest of the time.

3.5.2.3 Off-Line Services

For off-line service facilities, the approach to this service should incorporate off-line tracks. Off-line facilities should be located at ten to twelve different strategic points throughout the system. Off-line service to the car should include those repairs that can be accomplished by modular component exchange and those repairs that take from four to twenty-four hours. Washing and cleaning facilities of the cars could be included. The off-line service track will also permit the staging of cars for incorporating trains during peak hours as well as replacing disabled cars. At the off-line facilities, equipment for towing disabled trains are placed on stand-by basis. Modular components for exchange service and repair should be stored at this location. Off-line service facilities, under the supervision of a service manager, should include a crew of four to six mechanics and electricians to perform necessary work. It is possible that some of these men will also participate as mobile crews for emergency service.

3.5.2.4 Repair and Overhaul Facilities

Major overhaul shops incorporate yards sufficient to permit the storage of a large number of cars, some disabled, and those standing-by during the low peak service. Repair and overhaul facilities should be located at a favorable place close to the center of the system's network, in two or more places at the Los Angeles Central Station, and possibly close to the junction of major lines.

Facilities for major overhauling require machine and welding shops. For the repair of motors, electrical equipment, and for rail and track equipment repair and replacement, need to include testing facilities of various types. At these locations a full inventory should be established. The personnel required

in these facilities should include a number of specialists in various mechanical and electrical areas such as machinists, welders, electricians, electronic service personnel and others.

From these locations also, crews and equipment needed for the maintenance and repair of the tracks should be established. There will be cranes for removing the cars out of the line as well as towing and transporting disabled vehicles from the system.

3.5.3 YARDS

It must be pointed out that these yards are a major element in system design; if all of the system's vehicles were put into off-track locations 85,000 to 90,000 feet of extra track would be required, i.e., about 16 miles.

Yard tracks in a large transit system such as S.C.L., should incorporate full electrification, wayside control and train signals systems.

The number of switching facilities and the need for yard operation for identification, sorting cars and coupling trains results in an extensive and somehow complicated network.

The S.C.L. yards are to be operated by well trained crews and the application of a sophisticated control center.

3.5.4 MAINTENANCE AND REPAIR SERVICE--FEEDER LINES

S.C.L. provides feeder lines, that includes monorails and light rail systems.

There is a need for standardization of the feederline in terms of service facilities and repair, paint, methods and trained personnel.

If the feeder lines, as proposed, will include diverse types of system design installation, facilities for servicing the equipment will have to be located at each installation with a complement of service personnel and parts.

In the case of monorail feeder lines, some types of equipment for removal of passengers from a disabled car will be needed or there should be provisions in the guideway for this operation to be accomplished safely and comfortably.

4.0 STAFF AND AREAS OF EVALUATION ASSIGNMENTS

1. George J. Adams, P.E., President of Mobility Systems and Equipment Company is a registered Professional Engineer, State of California, with over twenty-five years experience in engineering, research management and consulting in transportation, mobility and automotive, and transit technology.

Assignment: Program manager and general advisor, responsible for directing the following tasks: Hardware Availability and the preparation of Critical and Significant Issues.

2. Irwin Rowe has over twenty years of experience as Project and Engineering Manager in the manufacturing of electro-mechanical and rotating equipment and for the development of linear electric motors and controls. Manager of major urban projects related to transportation systems--A.G.T.

Assignment: Alternate Program Manager, final report, Energy Requirements & Hardware Availability.

3. Dr. Leroy Hoover has twenty-two years of experience in Physics, Engineering and Economics with emphasis on Urban and Regional Planning, Transportation, Environmental Systems and Economic Analysis. He has served as consultant and manager for a number of major urban and regional planning projects involving economic analysis, social and physical design of urban systems, environmental technologies, transportation network analysis and design, urban form analysis, simulation, modeling, resource allocation, facility development, etc.

Assignment: Major Responsibility for Energy Requirement Analysis and Preparation of Critical and Significant Issues.

4. Dr. Dan Link, Civil and Transportation Engineer, has majored in many phases of transportation planning and research. Formerly with Cal Trans, he is familiar with the freeway system and its associated details. Vehicle dynamics, highway design, traffic control, mass transit on freeways, busways are some of the many areas of his transportation experience.

Assignment: Responsible for Guideway Adaptability and Construction and Maintenance--Shops and Yards.

5. Ronald B. Kendricks, P.E., Civil Engineer, is a registered Professional Engineer, State of California, C-13324. He has fifteen years of experience in civil engineering on municipal projects including land planning, grading, street and highway design and pipeline planning and design. He has been an expert witness on drainage problems.

Assignment: Responsibility for Guideway Adaptability and Construction.

6. Dr. George A. Hoffman, P.E., Professor of Transportation Engineering at the University of Southern California, has over twenty-five years of experience in the fields of transportation engineering education at U.C.L.A. and U.S.C. and transportation planning and analysis, energy systems, vehicle technology and social economics, transportation and transit systems design and environmental impacts, assessment of national needs and plans for fuel and energy independence and industrial planning for automotive futures.

Assignment: Participated in preparing the Critical and Significant Issues Review.

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Mr. F. Hotchkiss, S.C.A.G.
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Mr. W. Quintel, Bechtel Corp., San Francisco, California.
Mr. F. Gaarde, Parsons Co., Pasadena, California.
Messrs. James T. Brodie and A. E. Koutras, City of Pasadena, Cal.

APPENDIX I

TECHNICAL ISSUES ASSOCIATED WITH SCL ALIGNMENTS

This appendix includes alignment maps of the ten SCL lines, heavy rail mileage breakdown, and comments on technical issues pertaining specifically to each line.

MAPS OF ALIGNMENT LOCATIONS AND TYPE OF RAIL TRANSIT SECTIONS

LINES

Valley/Long Beach
Inter-Valley
Hollywood Bowl
San Gabriel River
Century City
Cross-County
International Airport
Central
Long Beach
Pomona

MAP LEGEND

 Elevated on Freeway Right-of-Way

 Grade on Freeway Right-of-Way

 Flood Control Channel or River

 Railroad

 Grade and Elimination of Freeway Lane

 Grade and Elimination of Bus Lane

 Tunnel

BREAKDOWN OF HEAVY RAIL TRANSIT ALIGNMENT

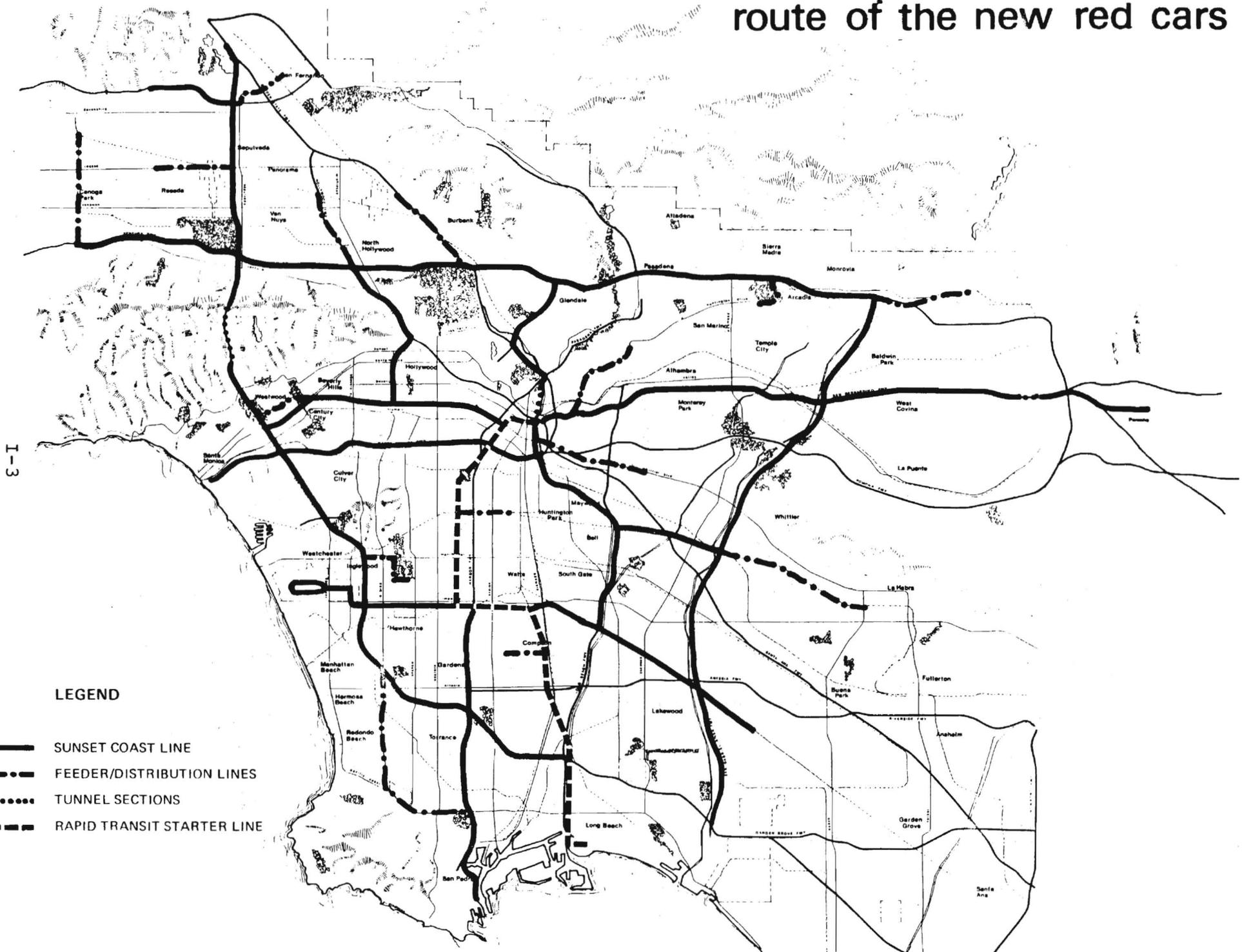
(Distance in Miles)

Line	Elevated On Freeway Right-Of-Way	Grade On Freeway Right-Of-Way	Flood Control Channel Or River	Railroad	Tunnel	Grade And Elimination Of Freeway Lane	Grade And Elimination Of Bus Lane	To
Valley/Long Beach	35.5	1.2			3.2	3.6		4
Inter-Valley	2.0	13.6	2.9			18.8		37
Hollywood Bowl	3.8							5.
San Gabriel River	0.9		20.2			5.0		2
Century City				2.3				2.
Cross-County			3.9	20.6				2
International Airport	2.6	8.4		9.2				20.
Central	12.8	4.2	2.4		1.7			2
Long Beach			5.6	2.3				7
Pomona	2.8	10.6		2.0	2.5		9.9	27.
Totals	60.4	38.0	35.0	36.4	7.4	27.4	9.9	21

NOTE:

1. Right-of-way alternates (a) through (d) as discussed in THE SUNSET COASTLINE study, page 43, were used in computing the above distances.
2. Heavy Rail transit in flood control channels or river areas will be mostly elevated sections.
3. Heavy Rail transit in railroad right-of-way will be a combination of sections both at grade and elevated, but mostly elevated.
4. The grand total mileage differs from the 230 mile grand total in the S.C.L. proposal since the latter includes the mileage for the Wilshire-La Brea corridor.

route of the new red cars



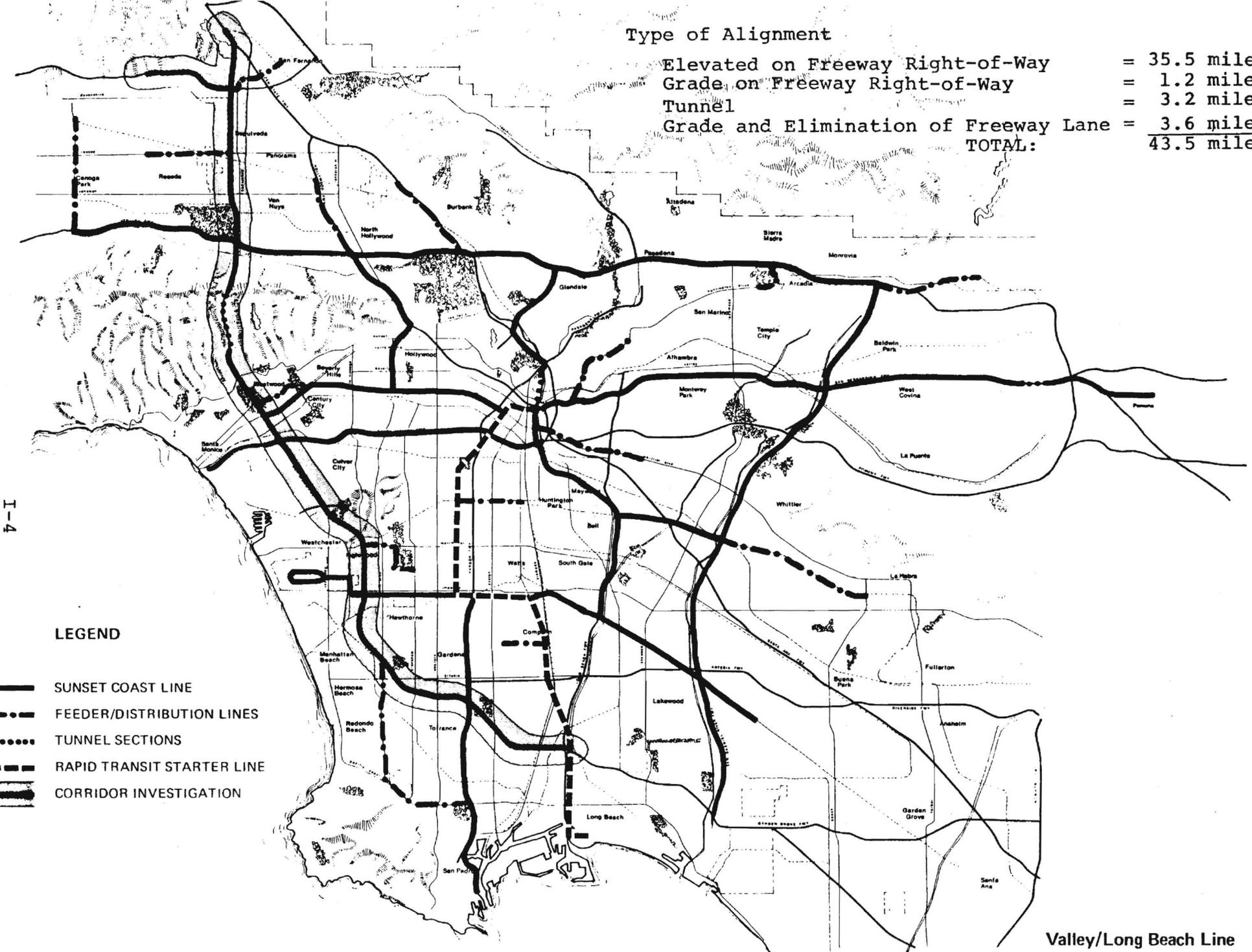
I-3

LEGEND

- SUNSET COAST LINE
- - - FEEDER/DISTRIBUTION LINES
- TUNNEL SECTIONS
- · - · - RAPID TRANSIT STARTER LINE

Type of Alignment

Elevated on Freeway Right-of-Way	= 35.5 miles
Grade on Freeway Right-of-Way	= 1.2 miles
Tunnel	= 3.2 miles
Grade and Elimination of Freeway Lane	= 3.6 miles
TOTAL:	43.5 miles



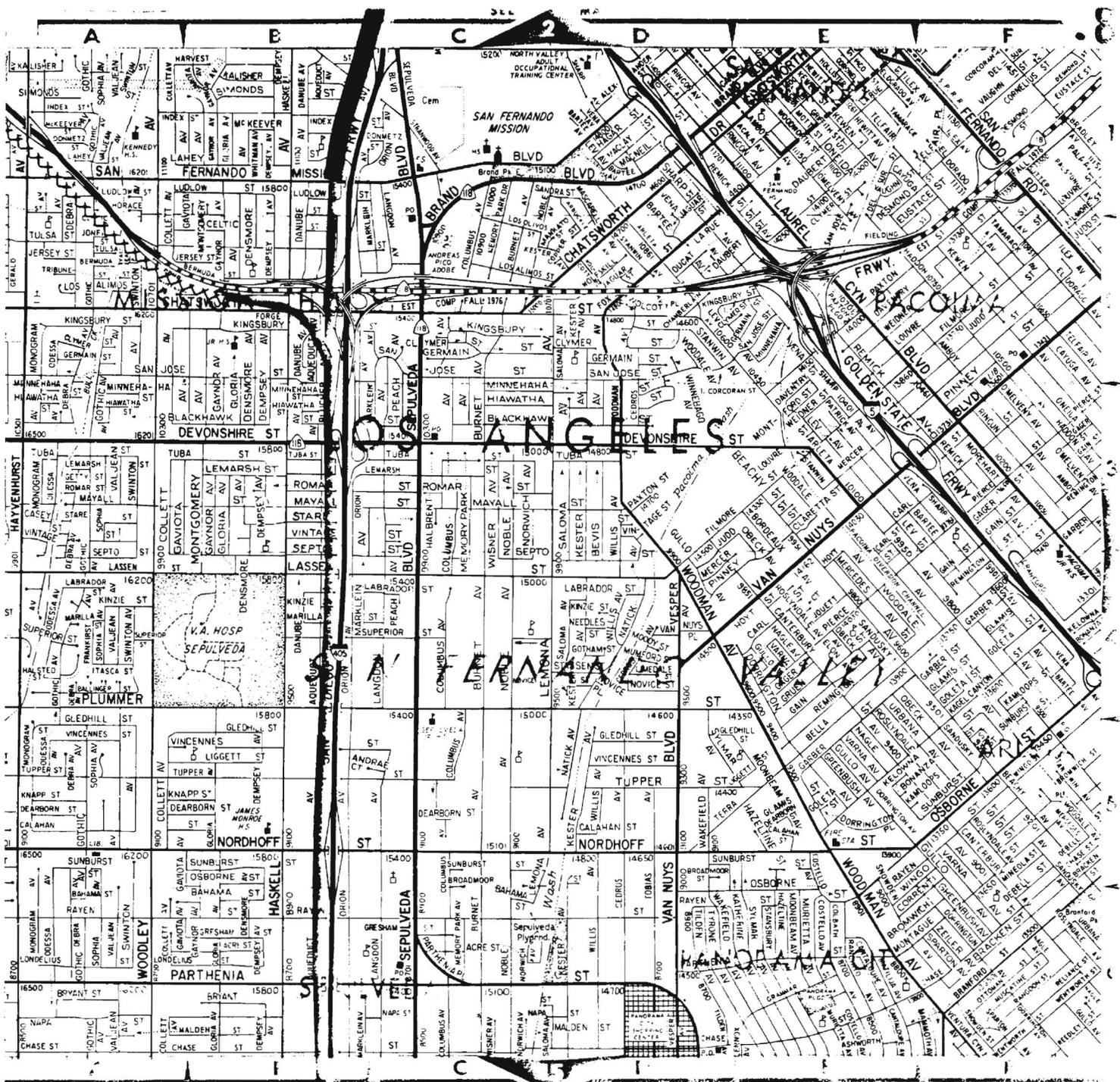
LEGEND

-  SUNSET COAST LINE
-  FEEDER/DISTRIBUTION LINES
-  TUNNEL SECTIONS
-  RAPID TRANSIT STARTER LINE
-  CORRIDOR INVESTIGATION

I-4

Valley/Long Beach Line





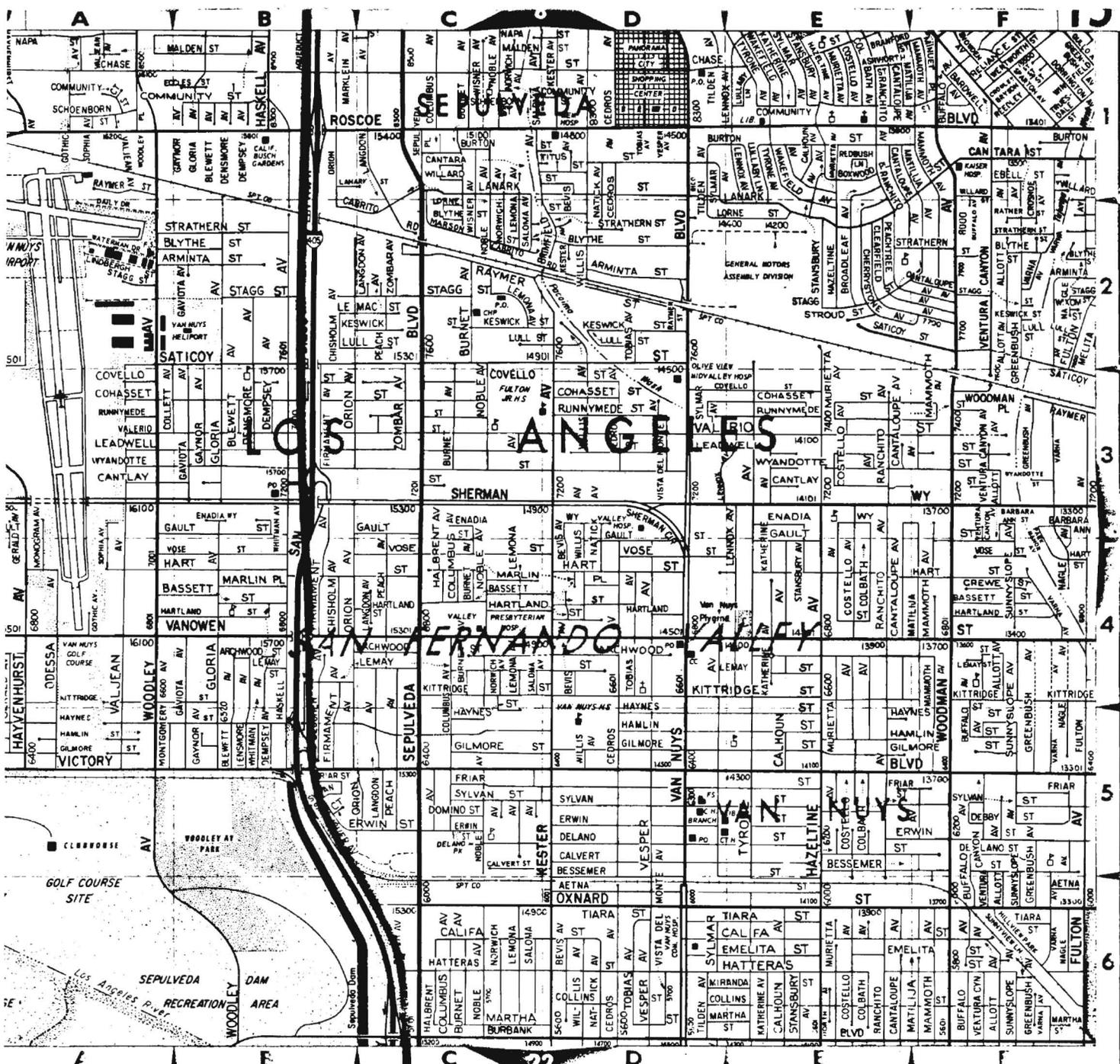
VALLEY/ LONG BEACH LINE

At the Simi Freeway the line may be constructed on center lanes, rather than elevated (if freeway is constructed by that time).

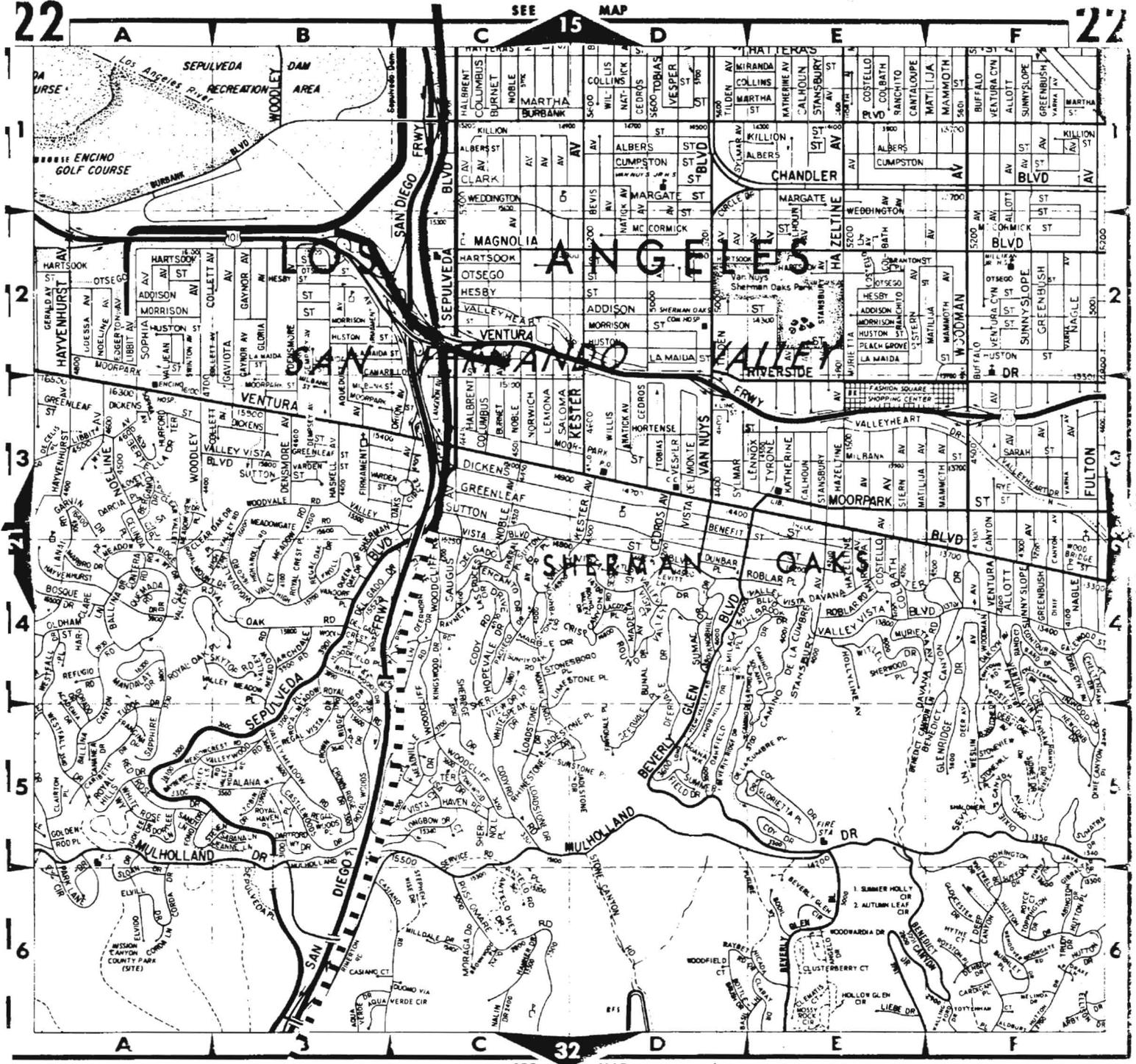
The interchange of the Simi and San Diego Freeways may necessitate the location of the interline junction in the southwest quadrant.



At the Simi Freeway the line may be constructed on center lanes, rather than elevated (if freeway is constructed by that time).



SEE MAP
 VALLEY / LONG BEACH LINE

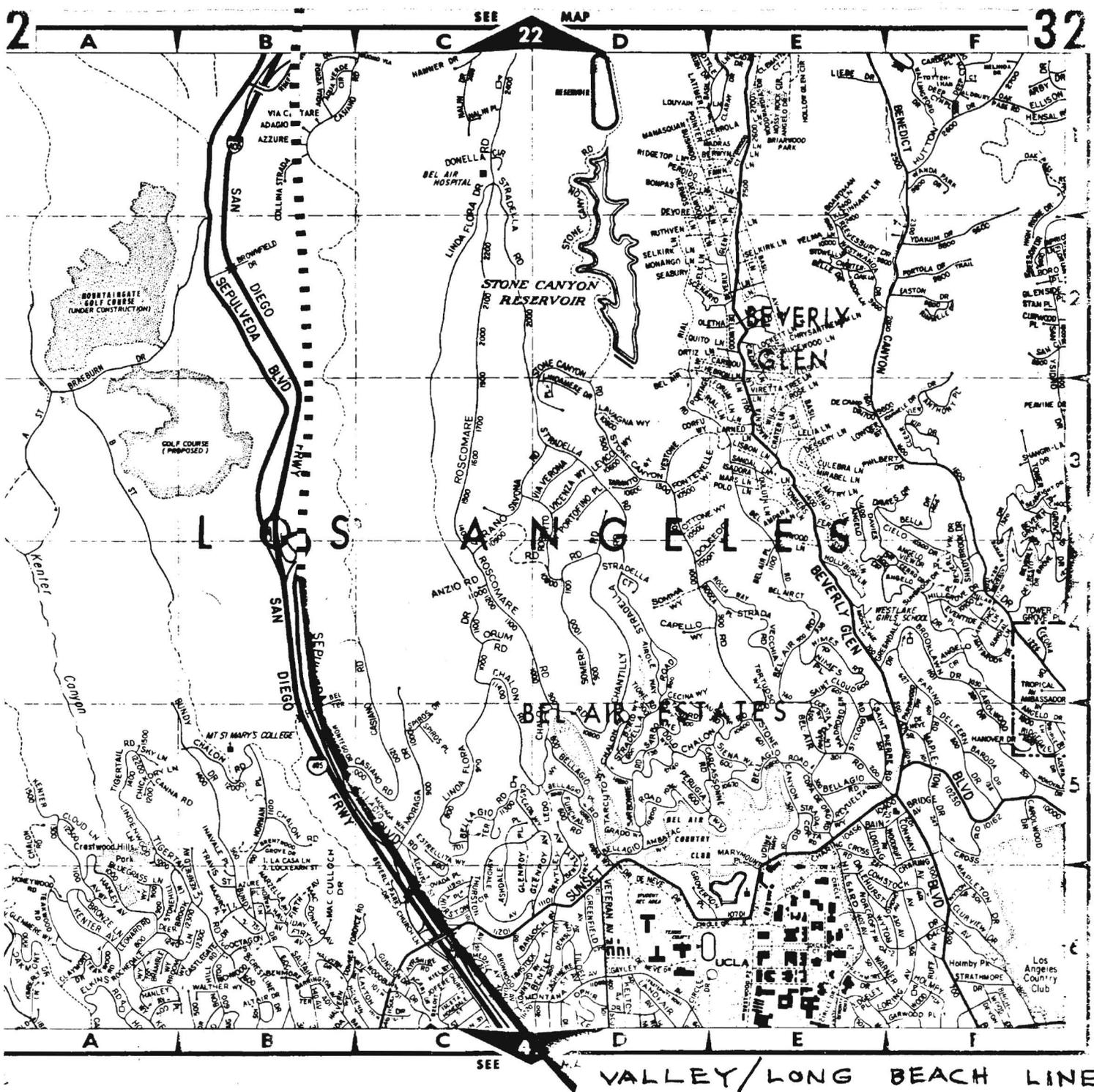


SEE MAP 32 VALLEY / LONG BEACH LINE

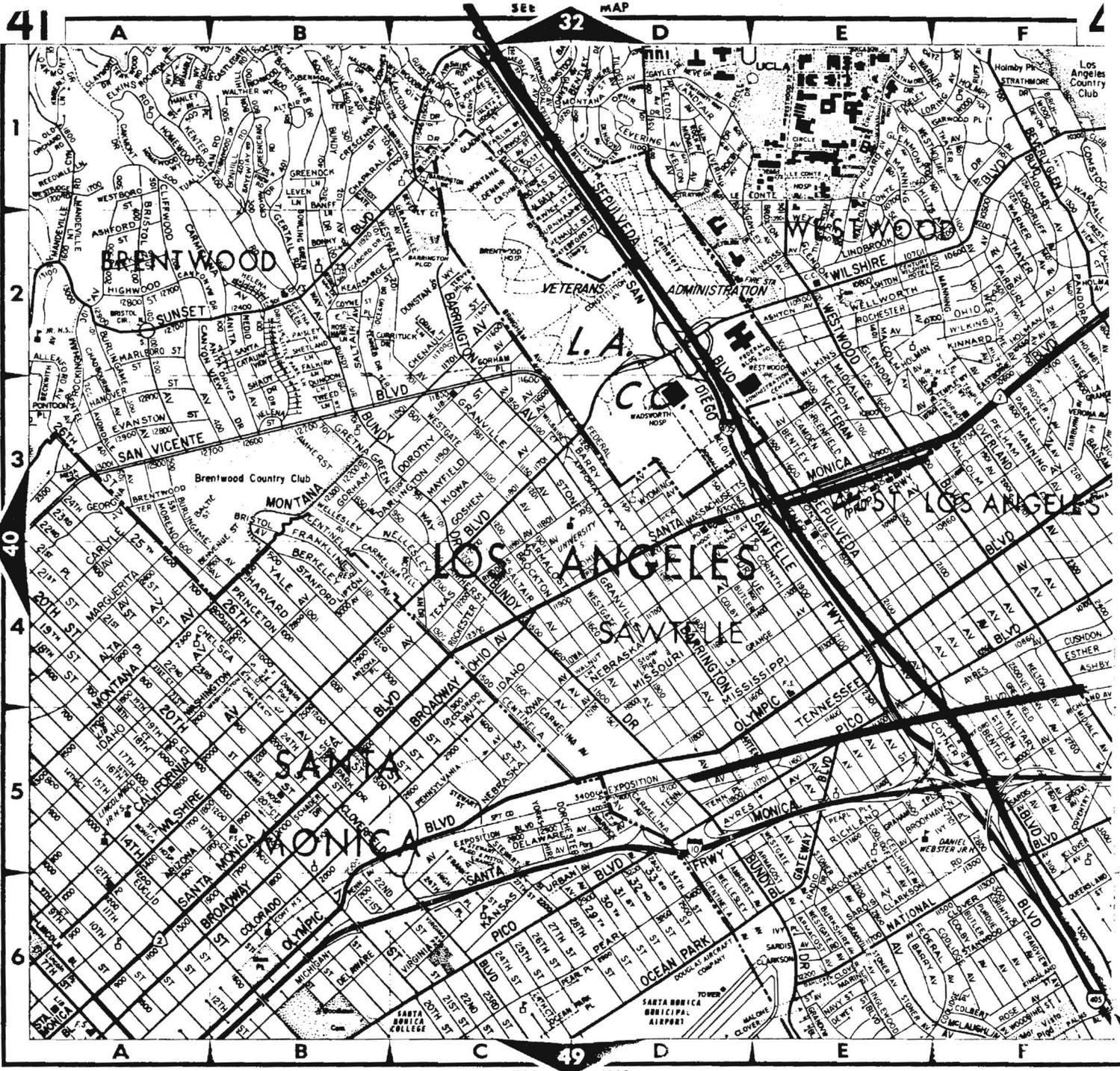
The 101/405 interchange will necessitate special considerations for the location and configuration of the interline junction.

Long spans may be necessary to transfer the line from the median of I-405 to the last shoulder for the tunnel portal.

A tunnel is not necessarily the best means of traversing the Santa Monica Mountains.

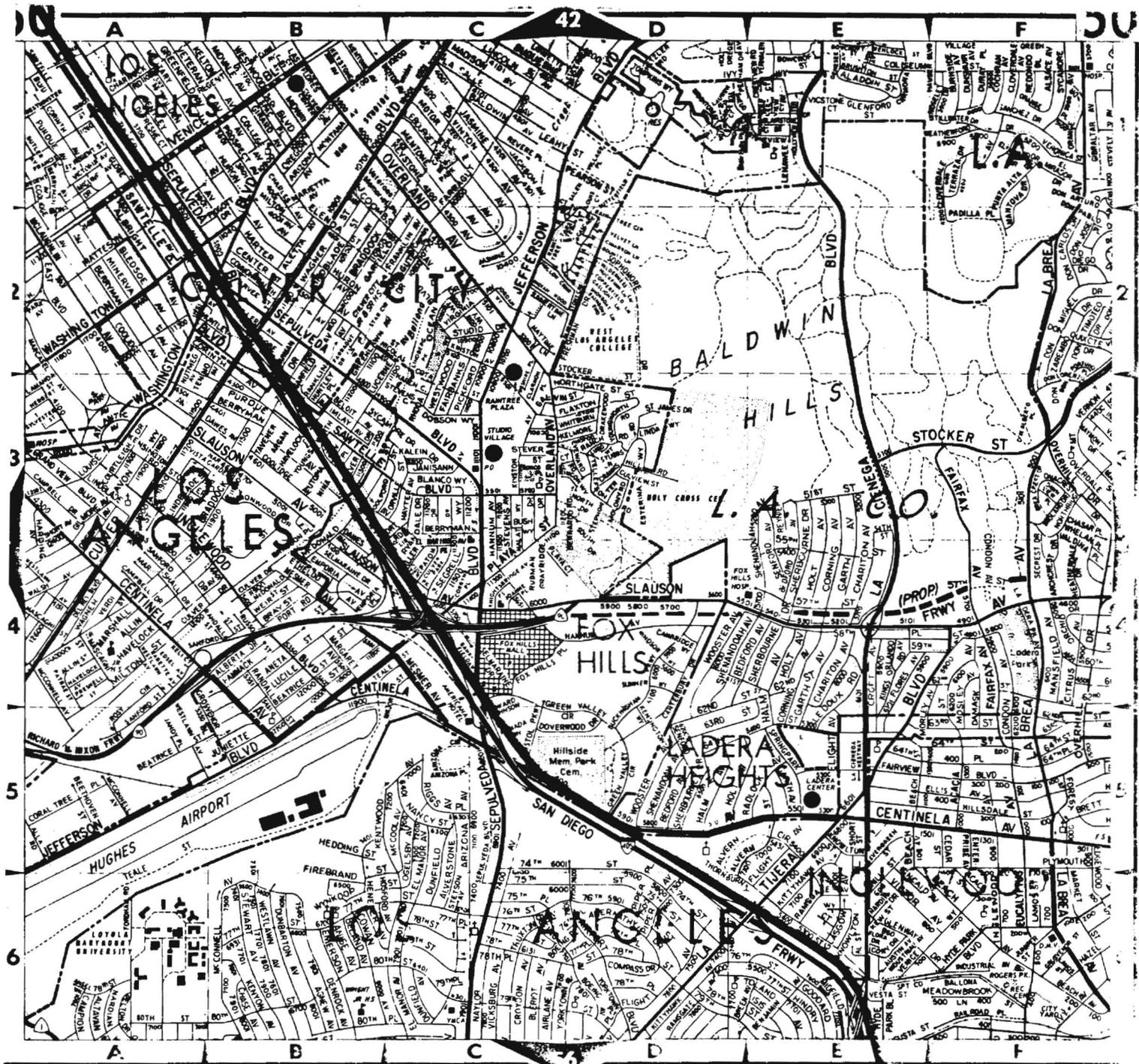


A tunnel is not necessarily the best means of traversing the Santa Monica Mountains.



VALLEY / LONG BEACH LINE

The 405/10 Interchange will pose serious difficulty on location and configuration of the interline junction, unless adjustments are made in the Cross County Line (see there).



SEE MA: VALLEY / LONG BEACH LINE

The 405/90 Interchange may prohibit a median location for the line due to the multi-level structure.

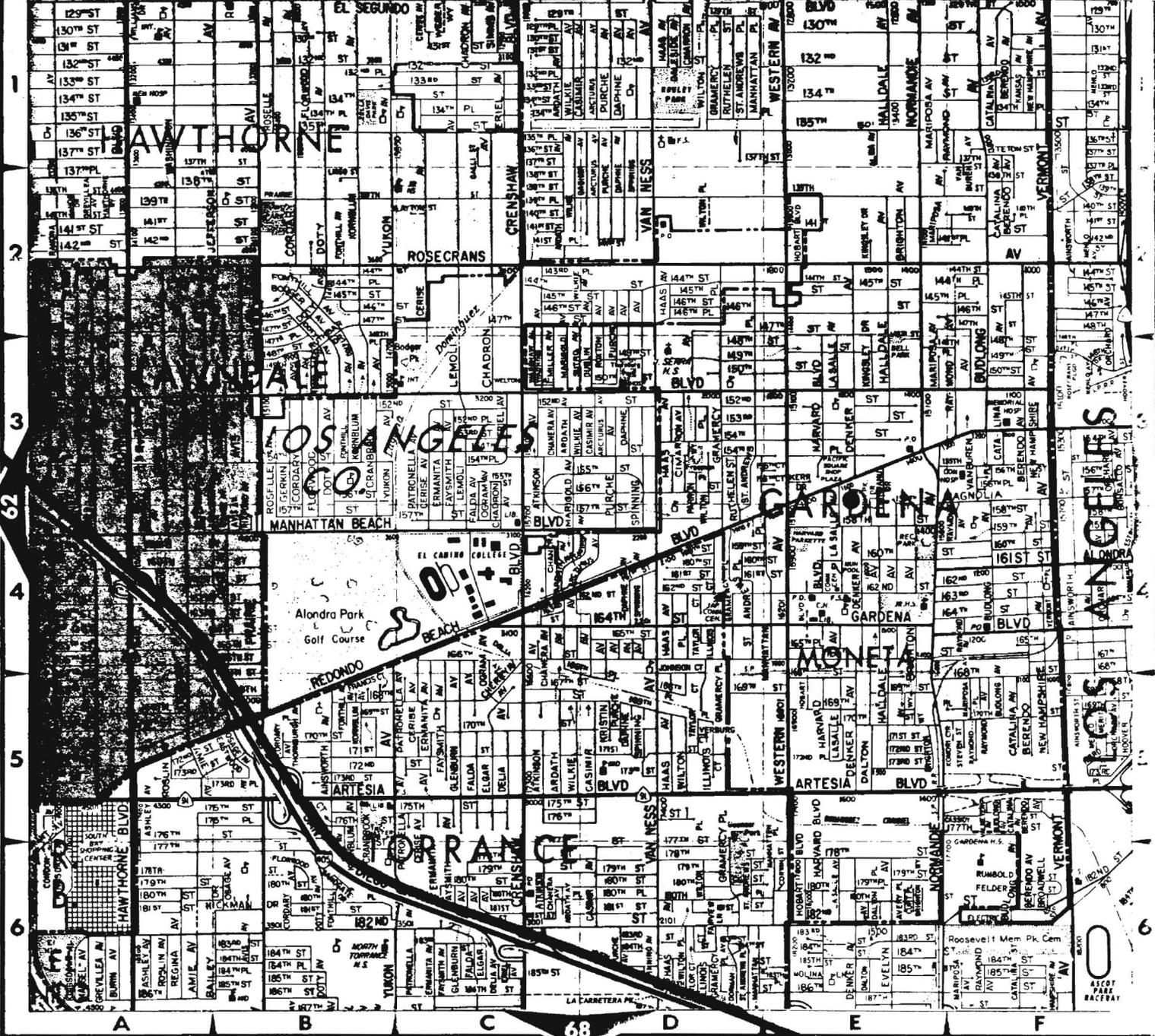


Frequent structures may necessitate a high elevation of the line in the vicinity of LAX. The interchange will necessitate special attention to the location and configuration of the interline rail junction.

The future interchange of the Century and San Diego Freeways will necessitate special attention to the location and configuration of the innerline rail junction with the Airport Line. The Century Freeway has not yet been constructed.

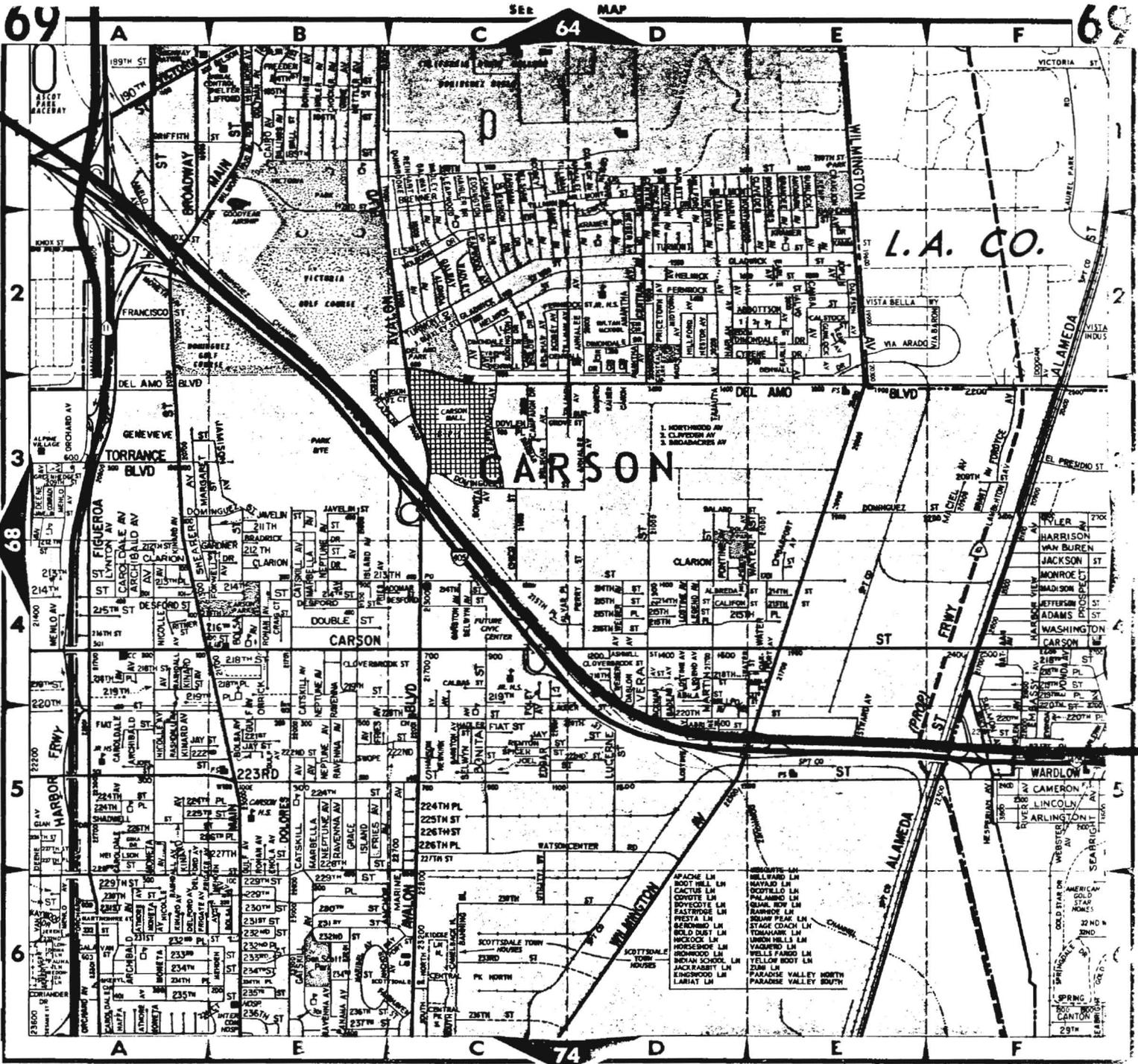


10 VALLEY / LONG BEACH LINE



SEE 68 MAP VALLEY/ LONG BEACH LINE

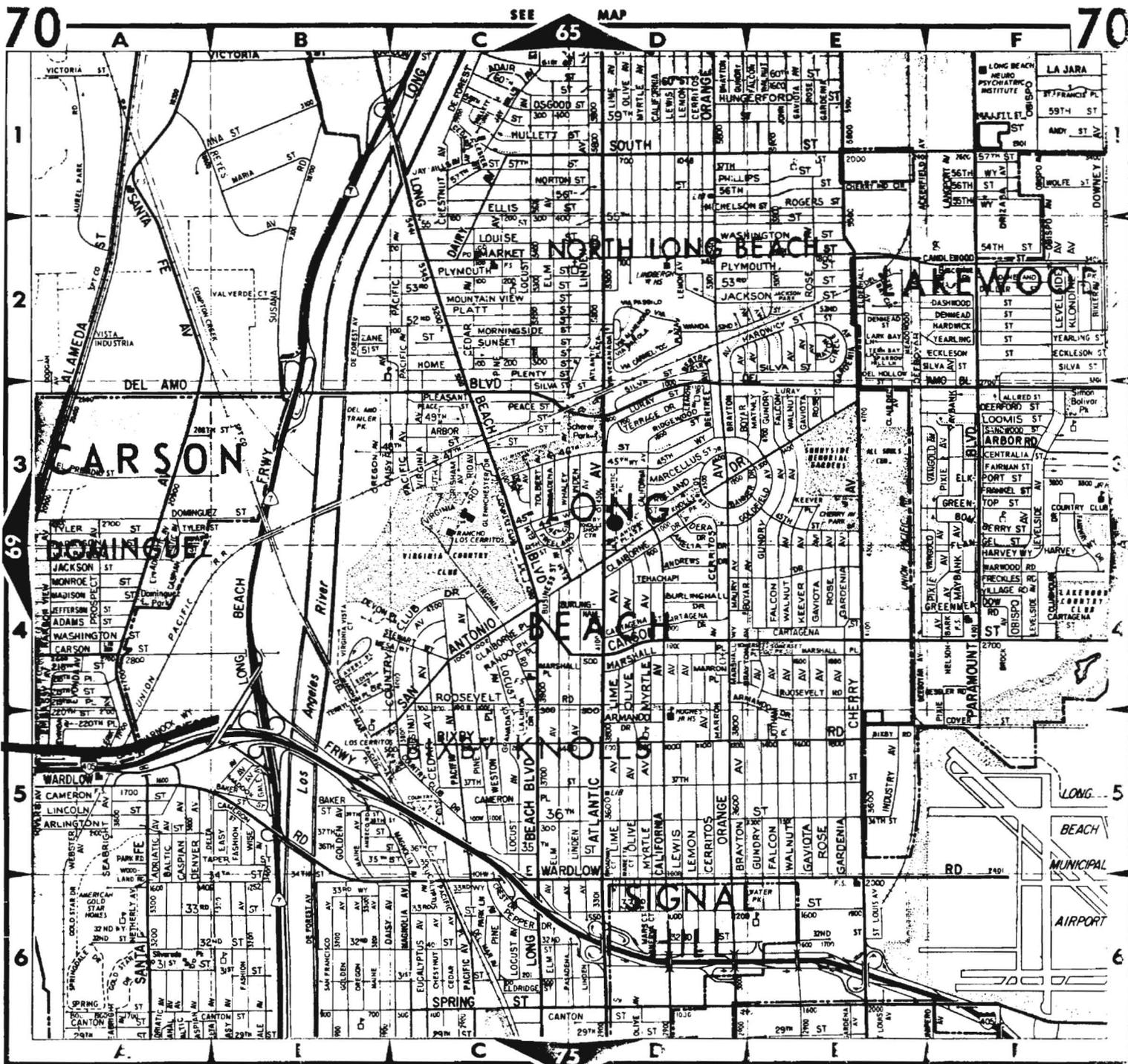




13

SEE MAP VALLEY/LONG BEACH LINE

The interchange will necessitate special attention to the location and configuration of the interline rail junction.



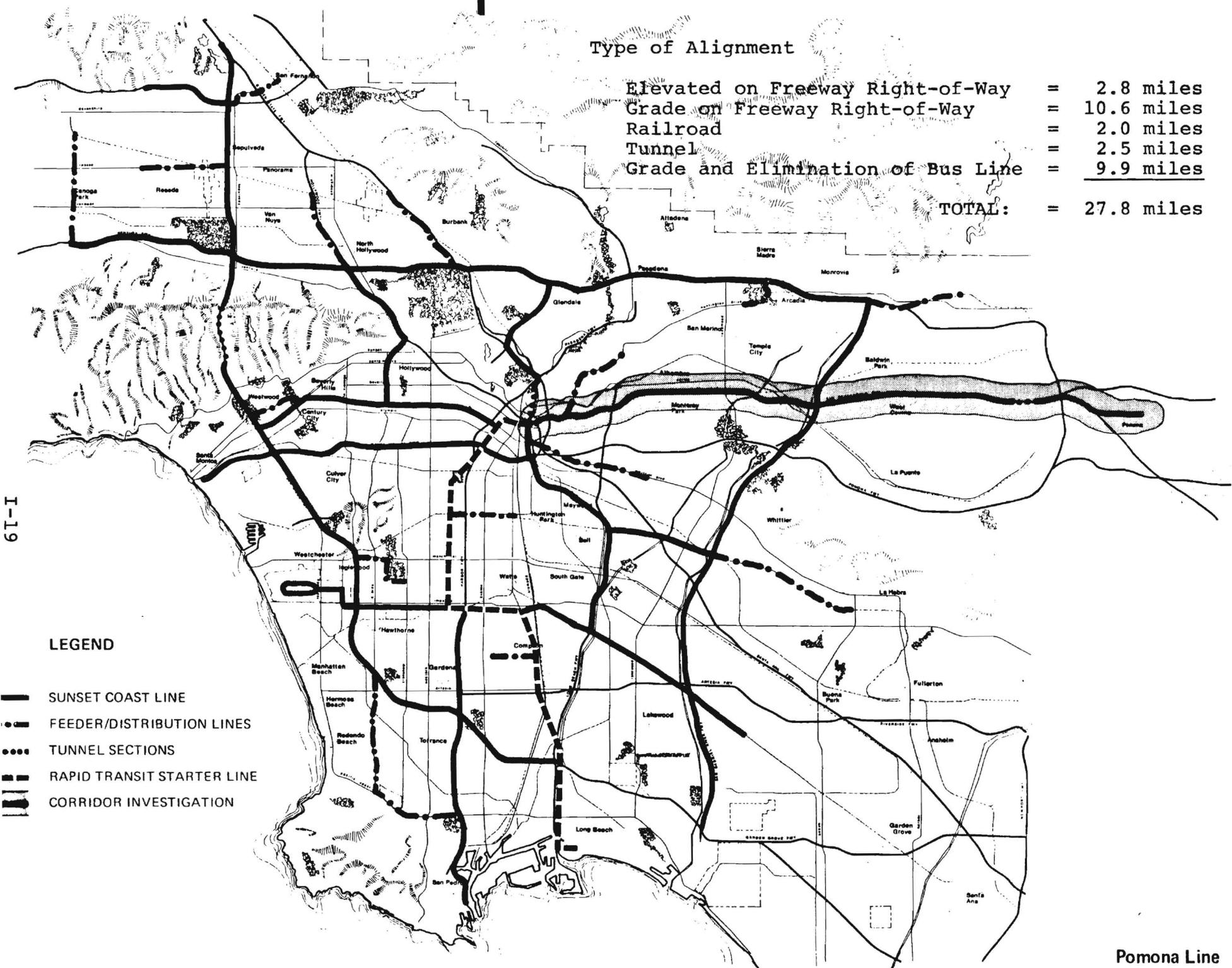
14

VALLEY/LONG BEACH LINE

The interchange will necessitate special attention to the location and configuration of the interline rail junction.

Type of Alignment

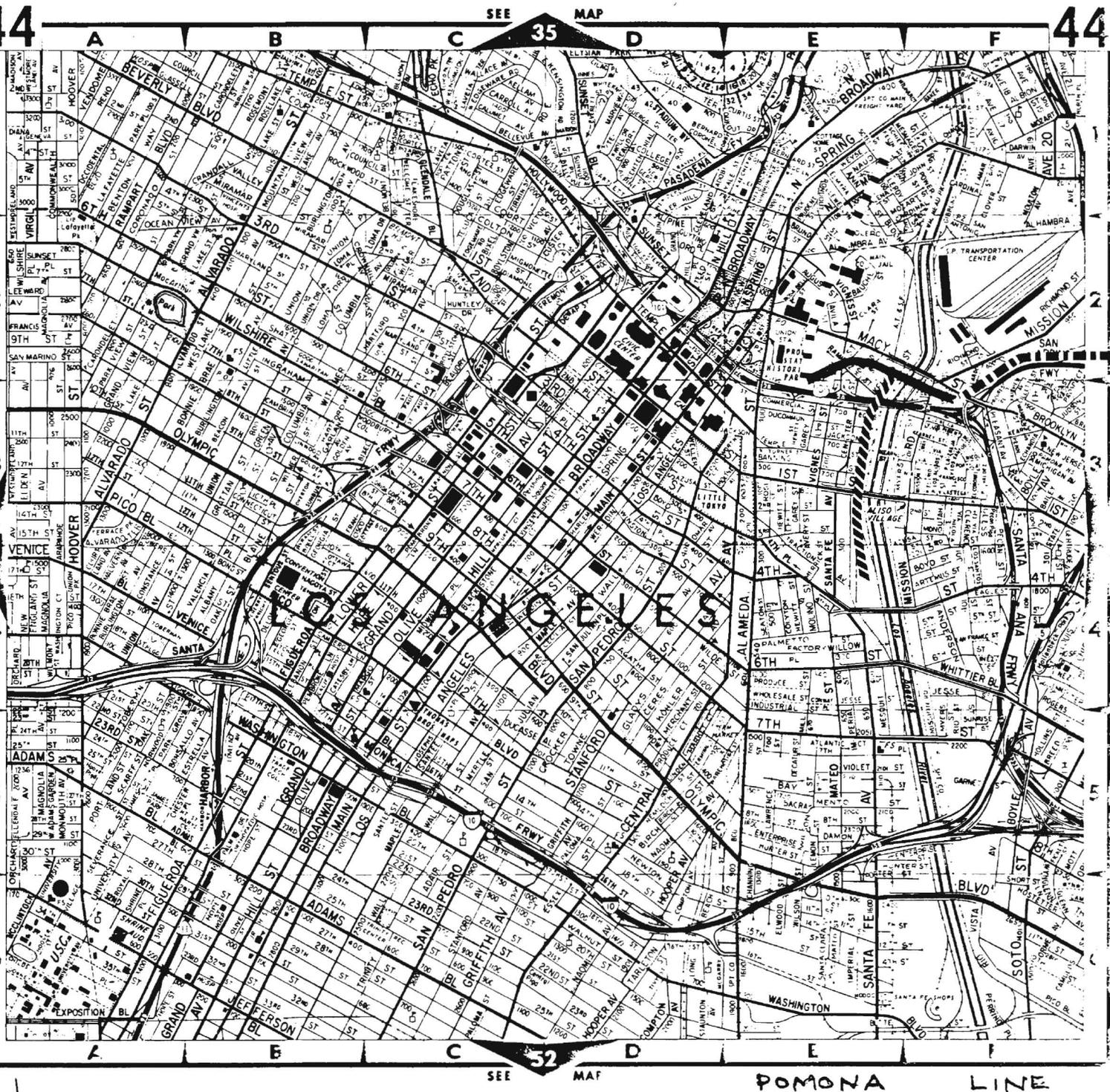
Elevated on Freeway Right-of-Way	=	2.8 miles
Grade on Freeway Right-of-Way	=	10.6 miles
Railroad	=	2.0 miles
Tunnel	=	2.5 miles
Grade and Elimination of Bus Line	=	<u>9.9 miles</u>
TOTAL:	=	27.8 miles

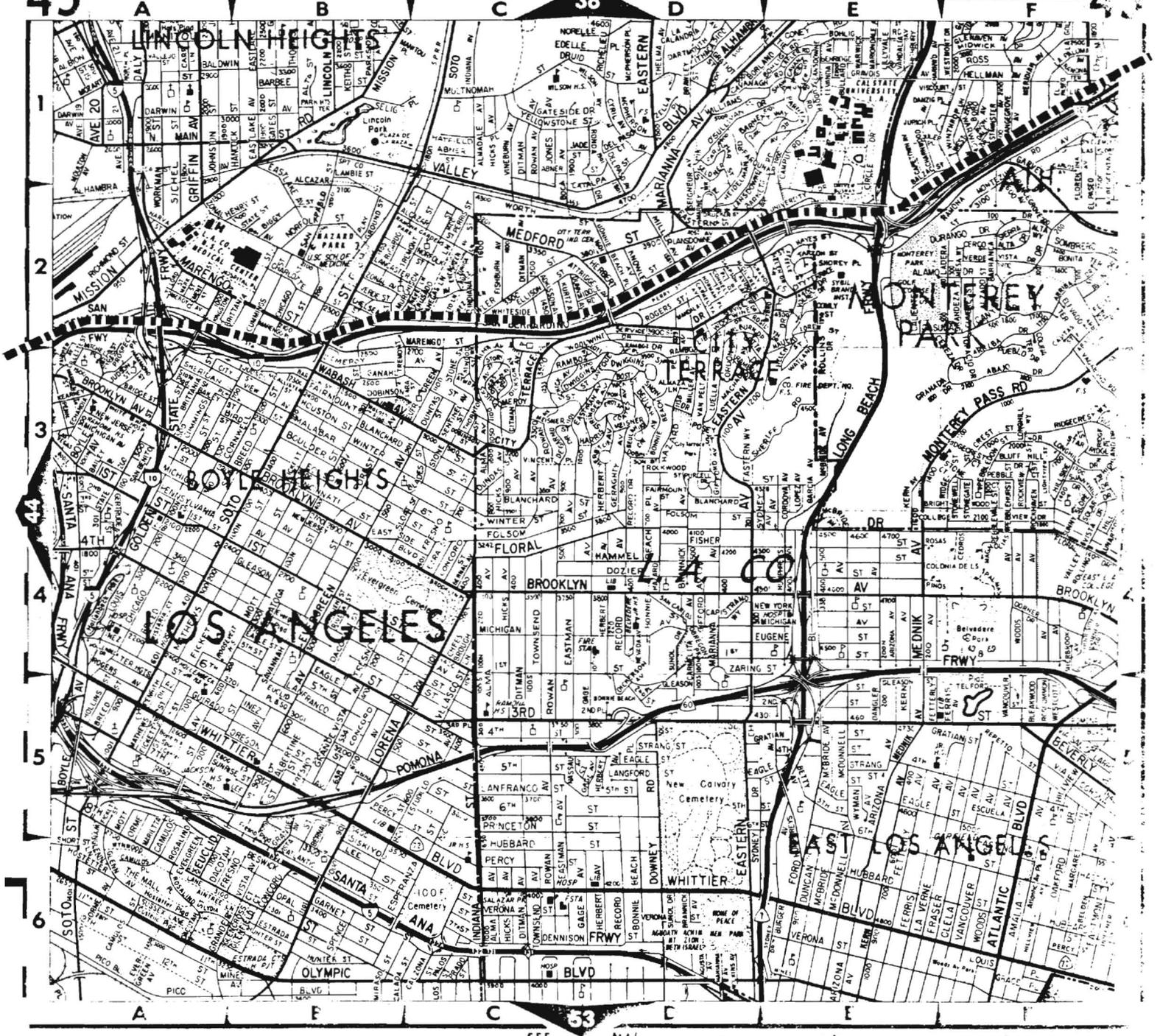


6T-19

LEGEND

-  SUNSET COAST LINE
-  FEEDER/DISTRIBUTION LINES
-  TUNNEL SECTIONS
-  RAPID TRANSIT STARTER LINE
-  CORRIDOR INVESTIGATION

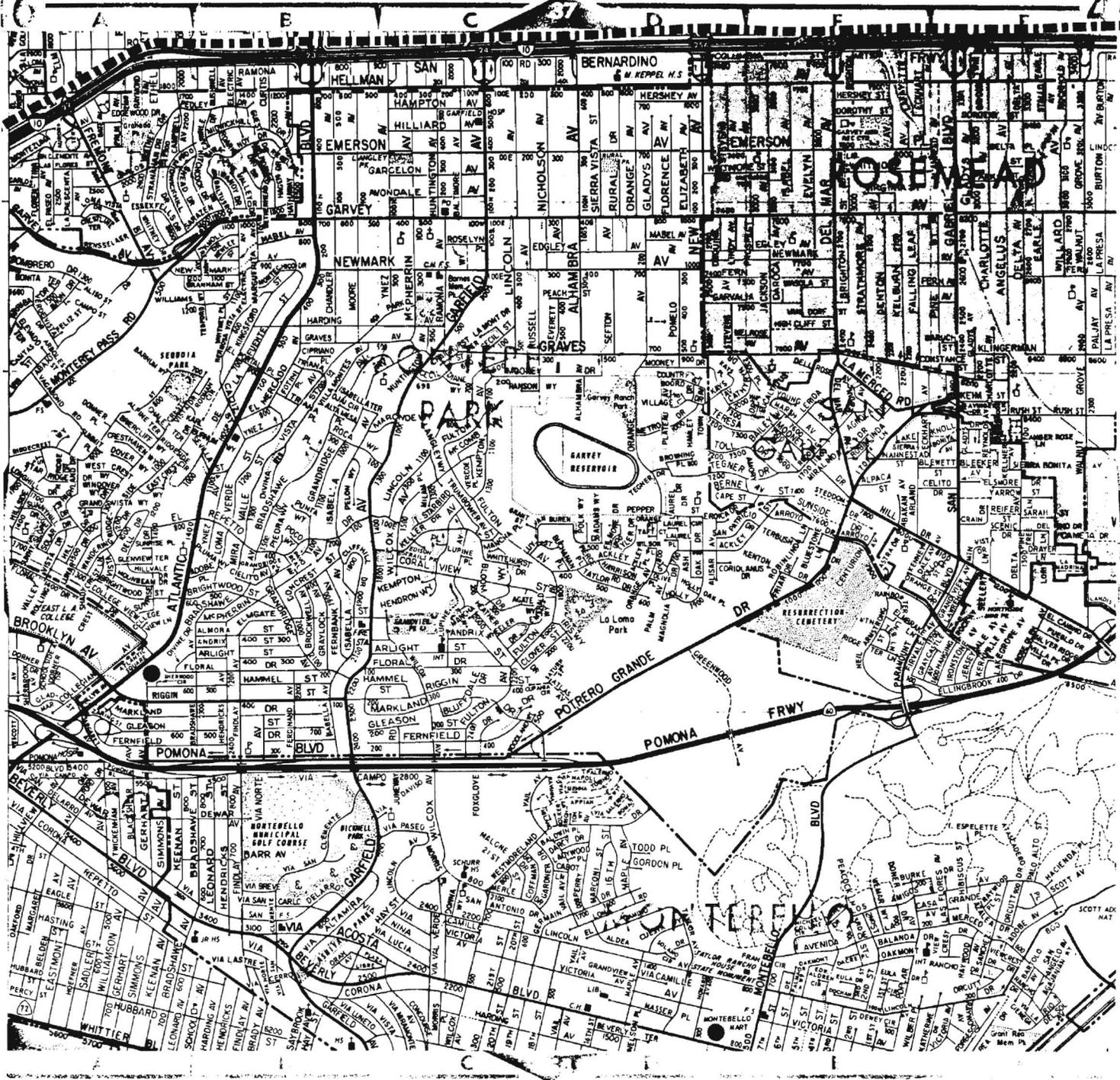




The County-U.S.C. Medical Center Busway Station may have to be rebuilt to facilitate adequate platforms.

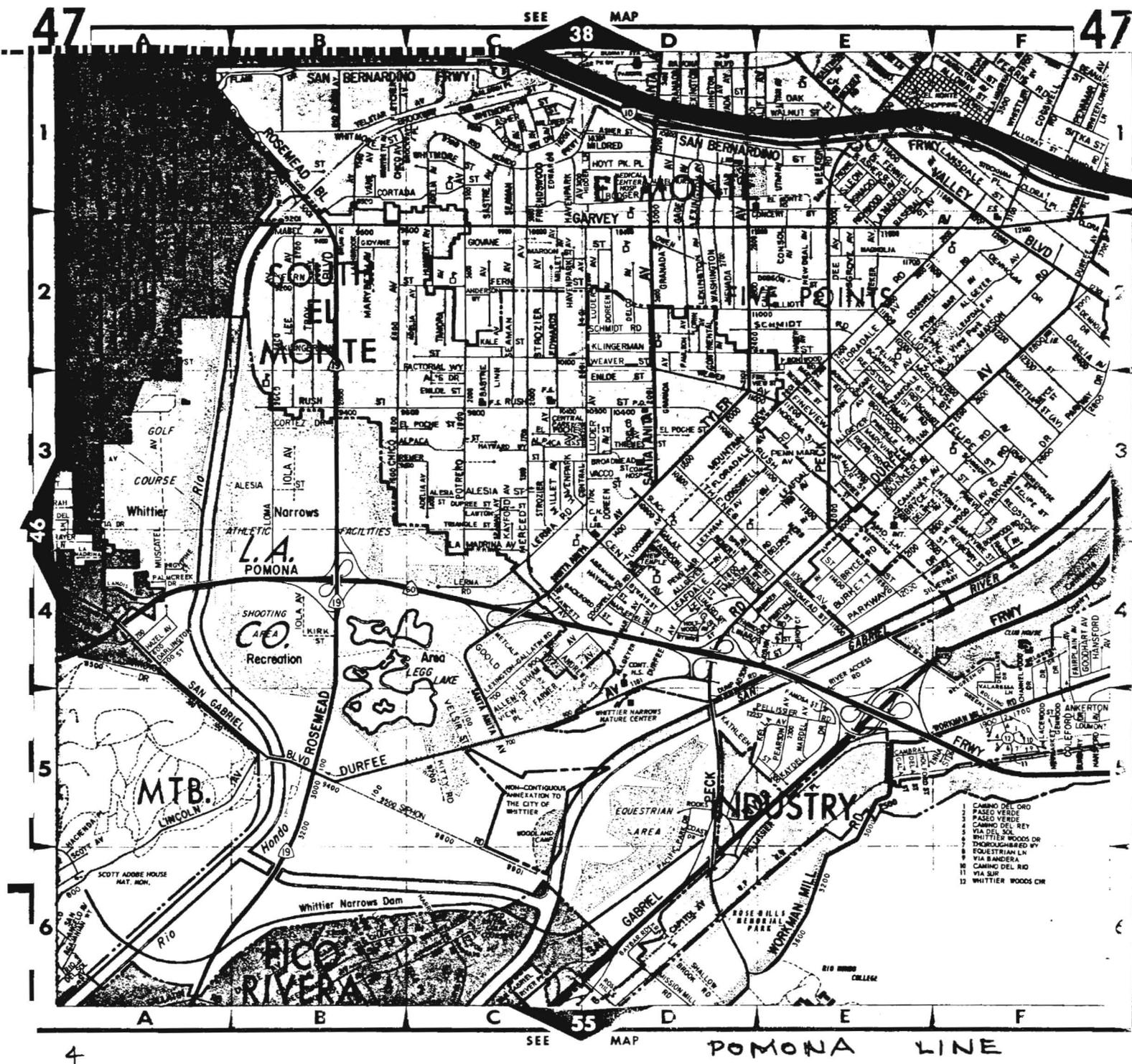
The Cal State Los Angeles Busway Station will also have to be rebuilt for the same reasons.

Stations to accommodate the grade situation with elimination of the Busway lane, may have freeway widening problems in the loading area.



POMONA LINE

Stations to accommodate the grade situation, with elimination of the Busway lane, may have freeway widening problems in the loading area.



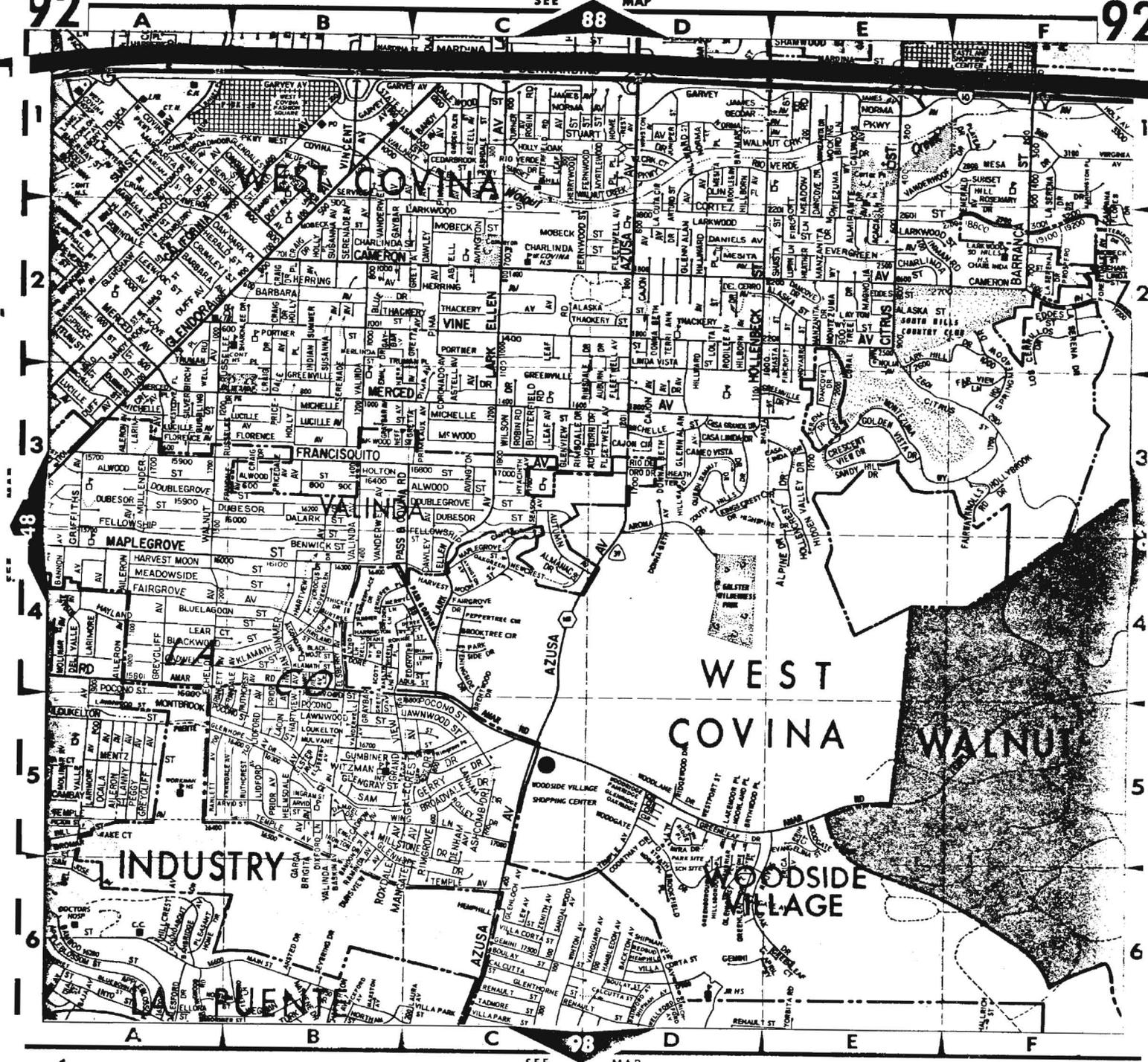
Stations to accommodate the grade situation, with elimination of the Busway lane, may have freeway widening problems in the loading area.

The use of the inner freeway lanes may be feasible, commensurate with recent proposals (SCAG, etc.) to extend the Busway to Ontario. The Sunset Line may be a more favorable alternate.



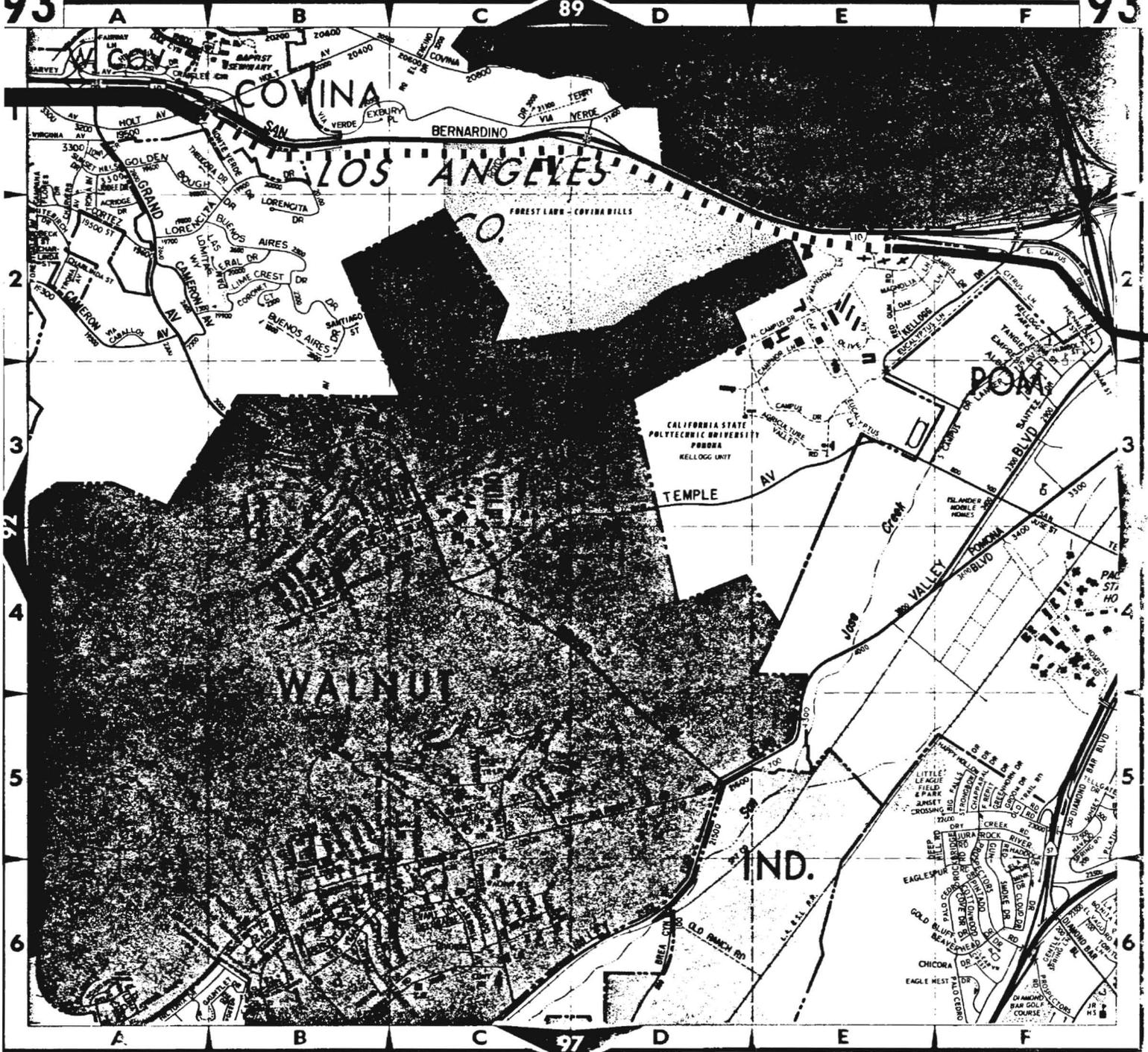
The 10/605 interchange may necessitate the location of the interline junction in the southwest quadrant.

The use of the inner freeway lanes may be feasible, commensurate with recent proposals (SCAG, etc.) to extend the Busway to Ontario. The Sunset Line may be a more favorable alternate.



The use of the inner freeway lanes may be feasible, commensurate with recent proposals (SCAG, etc.) to extend the Busway to Ontario. The Sunset Line may be a more favorable alternate.

Although a median elevated structure is feasible, consideration should be given to adaptation of the line to large shopping centers on either side of the line, specifically the West Covina Fashion Square (south) and the Eastland Shopping Center (north).



A tunnel at Kellogg Hill might not be necessary.

It might be possible to avoid the large 10/210 interchange. An alternate route leaving the freeway west of the interchange, entering East Campus Drive to Valley Boulevard and then using the railroad right-of-way south of Valley Boulevard to Freeway 71 might be less costly. Service to California State Polytechnic University may also be improved.

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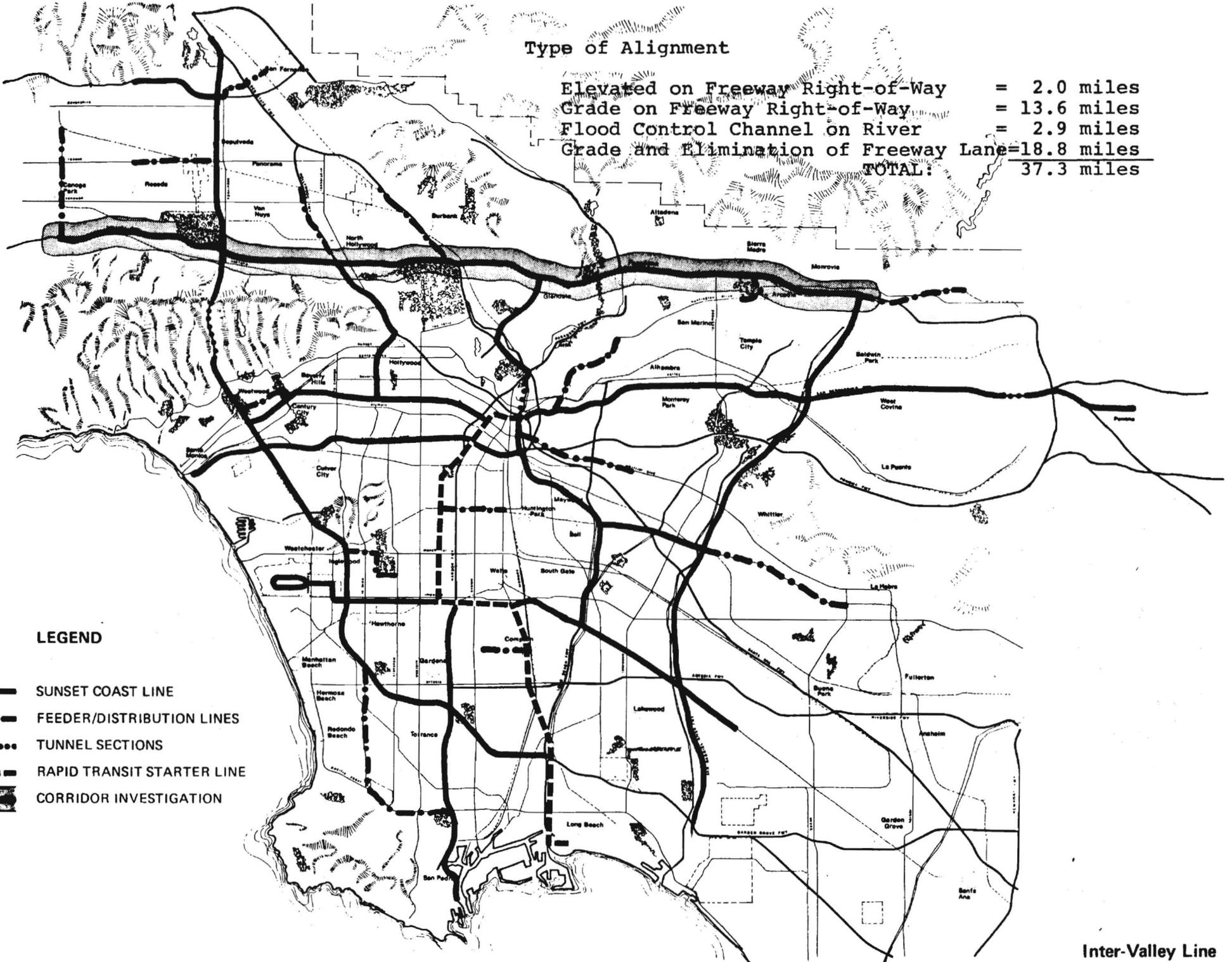
Type of Alignment

Elevated on Freeway Right-of-Way	= 2.0 miles
Grade on Freeway Right-of-Way	= 13.6 miles
Flood Control Channel on River	= 2.9 miles
Grade and Elimination of Freeway Lane	= 18.8 miles
TOTAL:	37.3 miles

I-28

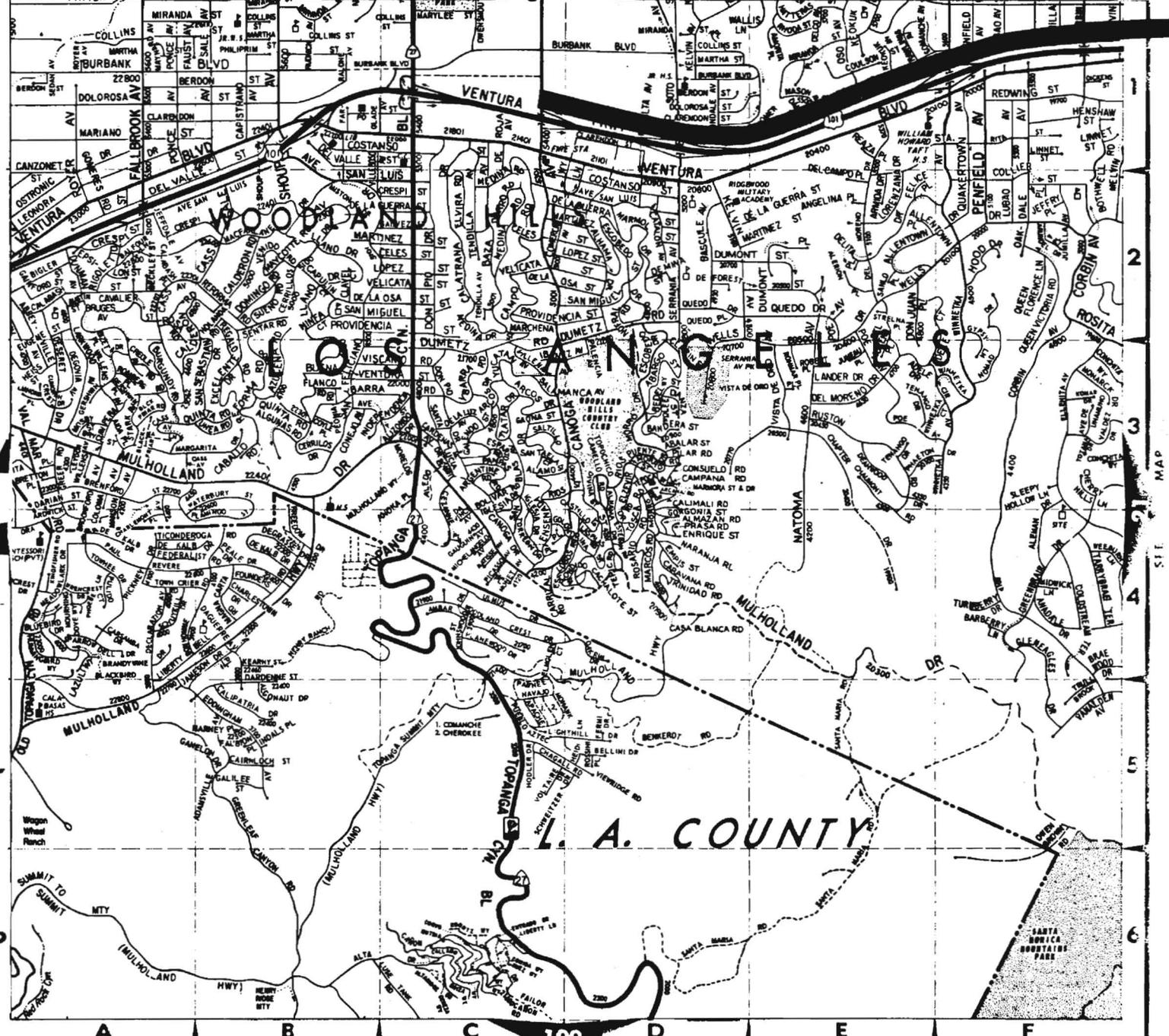
LEGEND

-  SUNSET COAST LINE
-  FEEDER/DISTRIBUTION LINES
-  TUNNEL SECTIONS
-  RAPID TRANSIT STARTER LINE
-  CORRIDOR INVESTIGATION



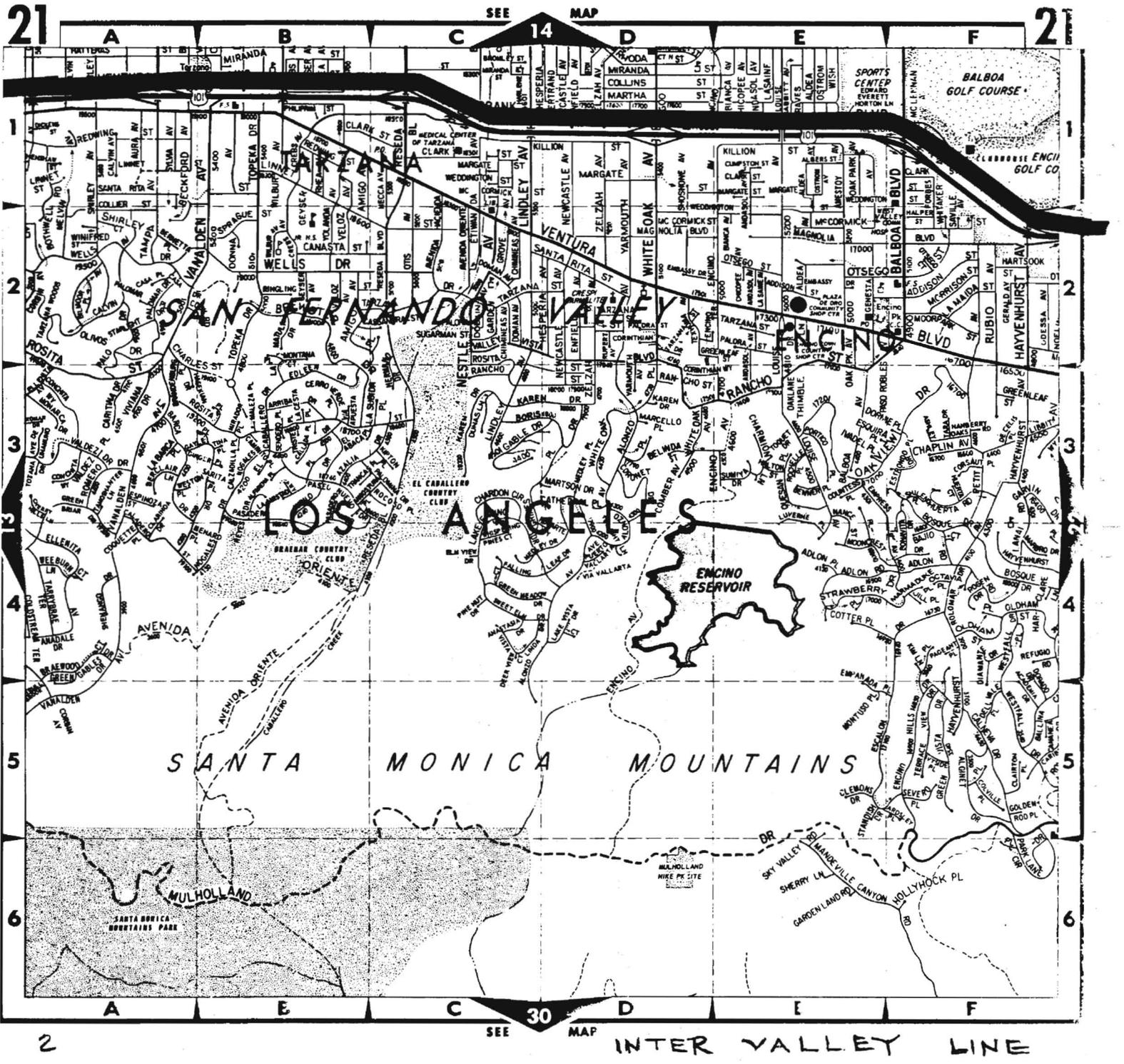
Inter-Valley Line

A B C D E F

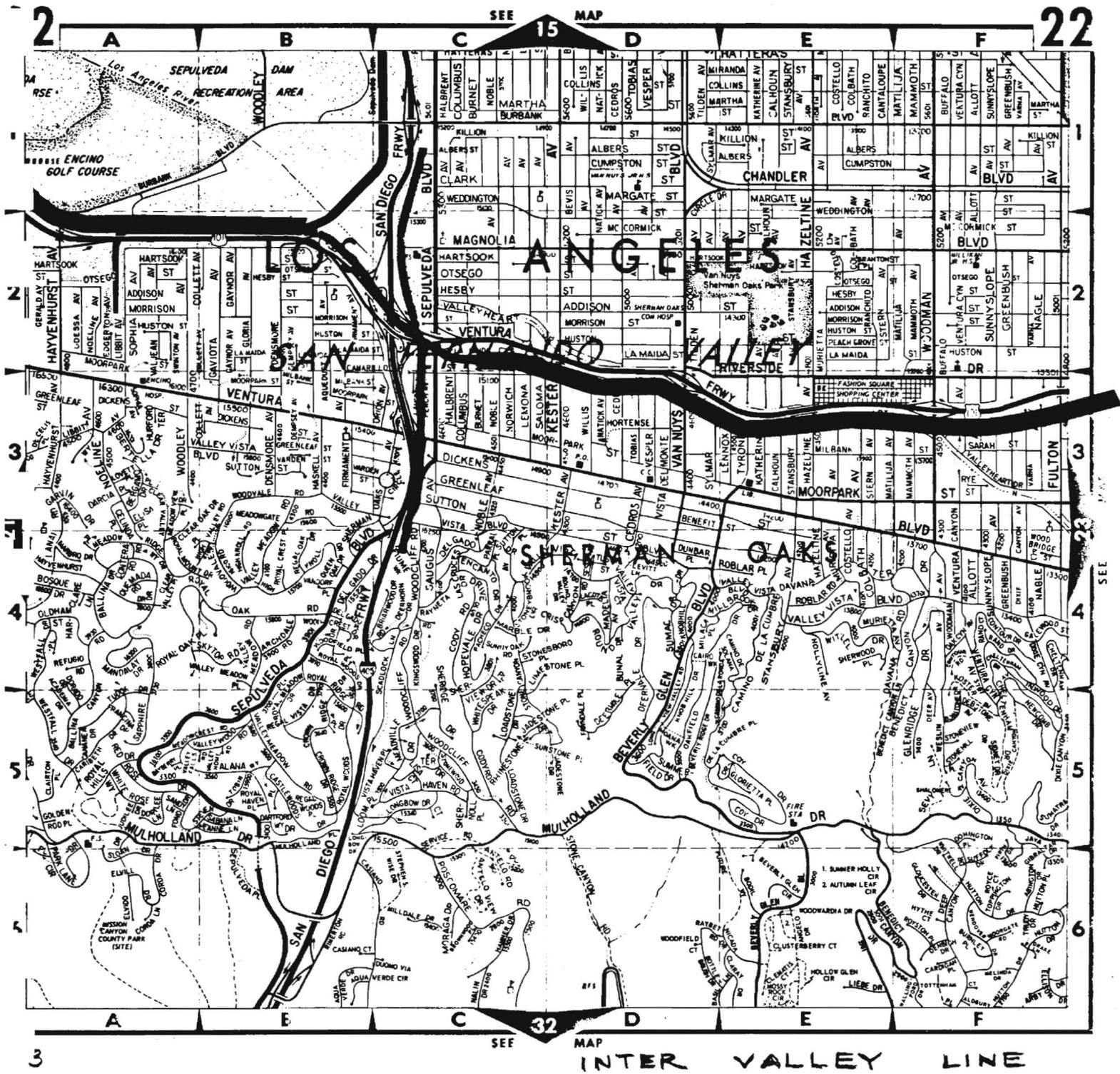


INTER VALLEY LINE

Widening freeway sections for stations in the median will be more difficult at the interchanges with major surface streets. The location of both station and line on the outer shoulder or on the embankment should be considered.

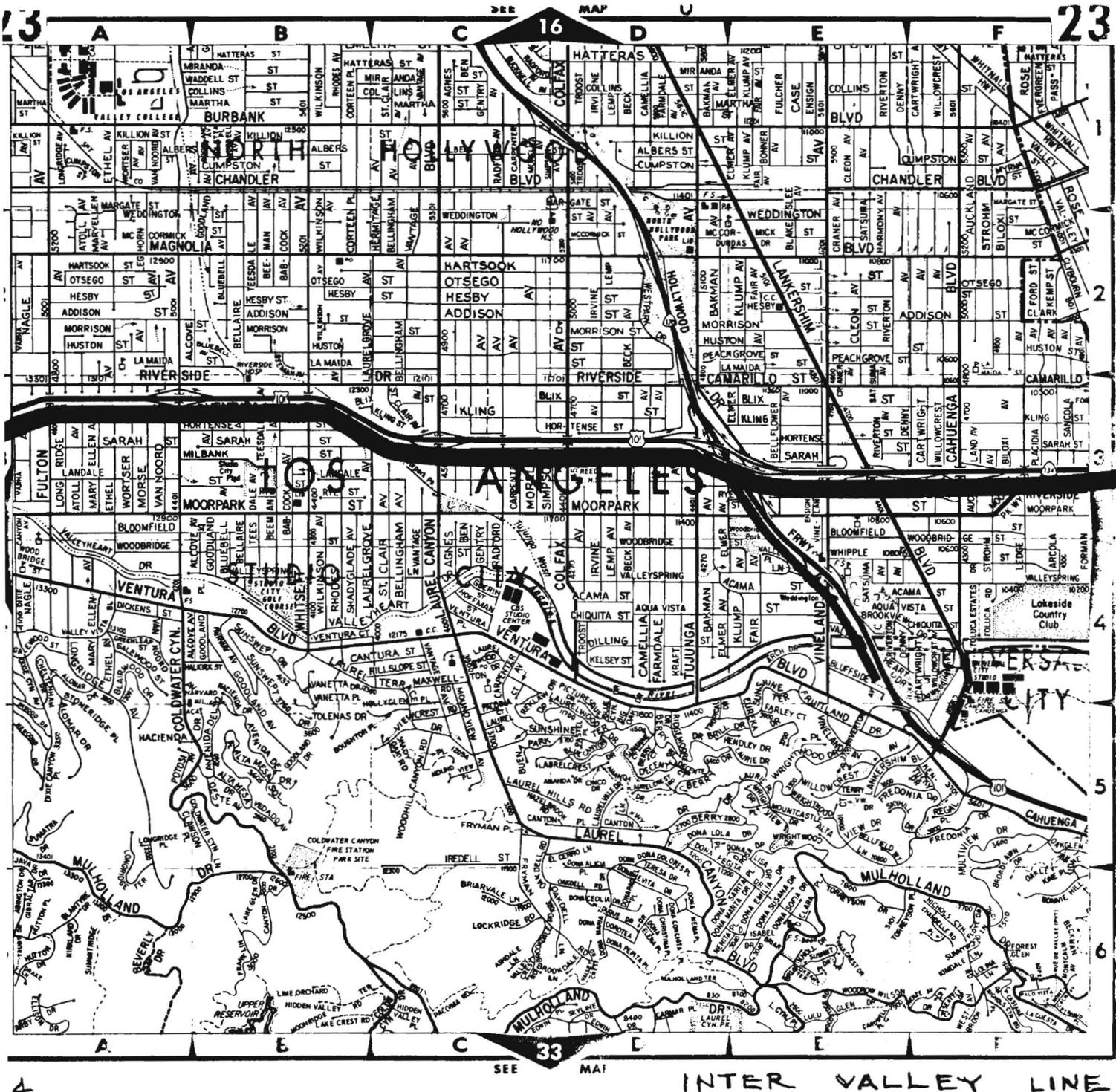


Widening freeway sections for stations in the median will be more difficult at the interchanges with major surface streets. The location of both station and line on the outer shoulder or on the embankment should be considered.



The 101/405 interchange will necessitate special consideration for the location and configuration of the interline rail function of the Inter-Valley and the Valley-Long Beach lines. The possibility of using the space between the Eastbound and Westbound roadways of the Ventura Freeway may be considered.

Widening freeway sections for stations in the median will be more difficult at the interchanges with major surface streets. The location of both station and line on the outer shoulder or on the embankment should be considered.



Widening freeway sections for stations in the median will be more difficult at the interchanges with major surface streets. The location of both station and line on the outer shoulder or on the embankment should be considered.

The inter-line rail junction at the Hollywood-Ventura Freeways interchange would have to be adjusted to the shape of the existing interchange, probably on the southwest quadrant.



The existence of frequent overcrossings over Route 134 around Hollywood Way may necessitate high elevation of the line above the freeway.



The 134/5 interchange will necessitate careful considerations for the location of the Inter-Valley line. If the line is directed from the freeway into the Los Angeles River channel upstream of the interchange this difficulty will be less severe.

The proposed elevated line from the Golden State to the San Gabriel River Freeway is not necessarily the best alternative. Consideration should be given to location of the line on the inner freeway lanes.

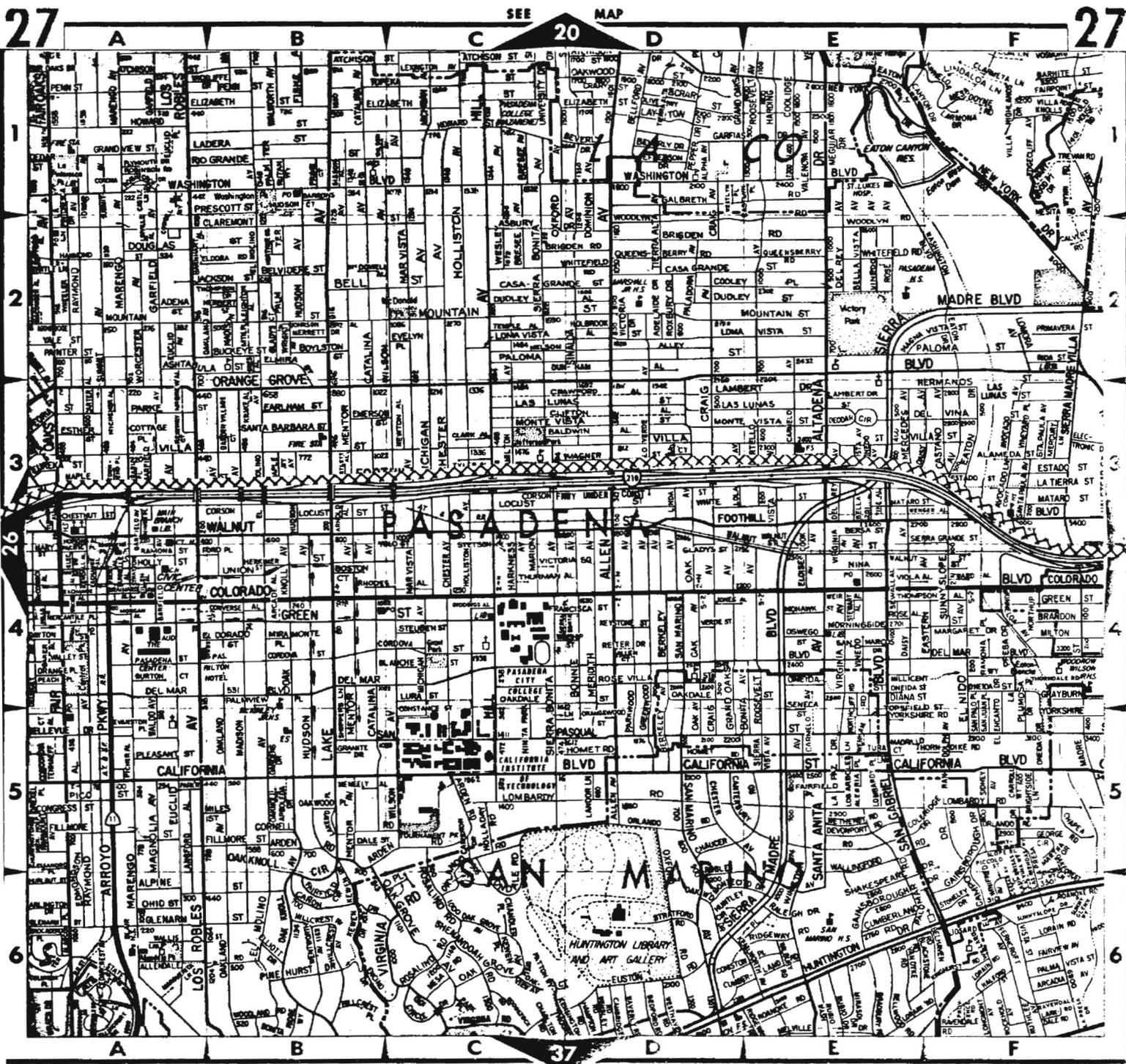


The proposed elevated line from the Golden State to the San Gabriel River Freeway is not necessarily the best alternative. Consideration should be given to location of the line on the inner freeway lanes.

The long eastbound incline west of the 210/134/7 interchange may slow down eastbound trains.

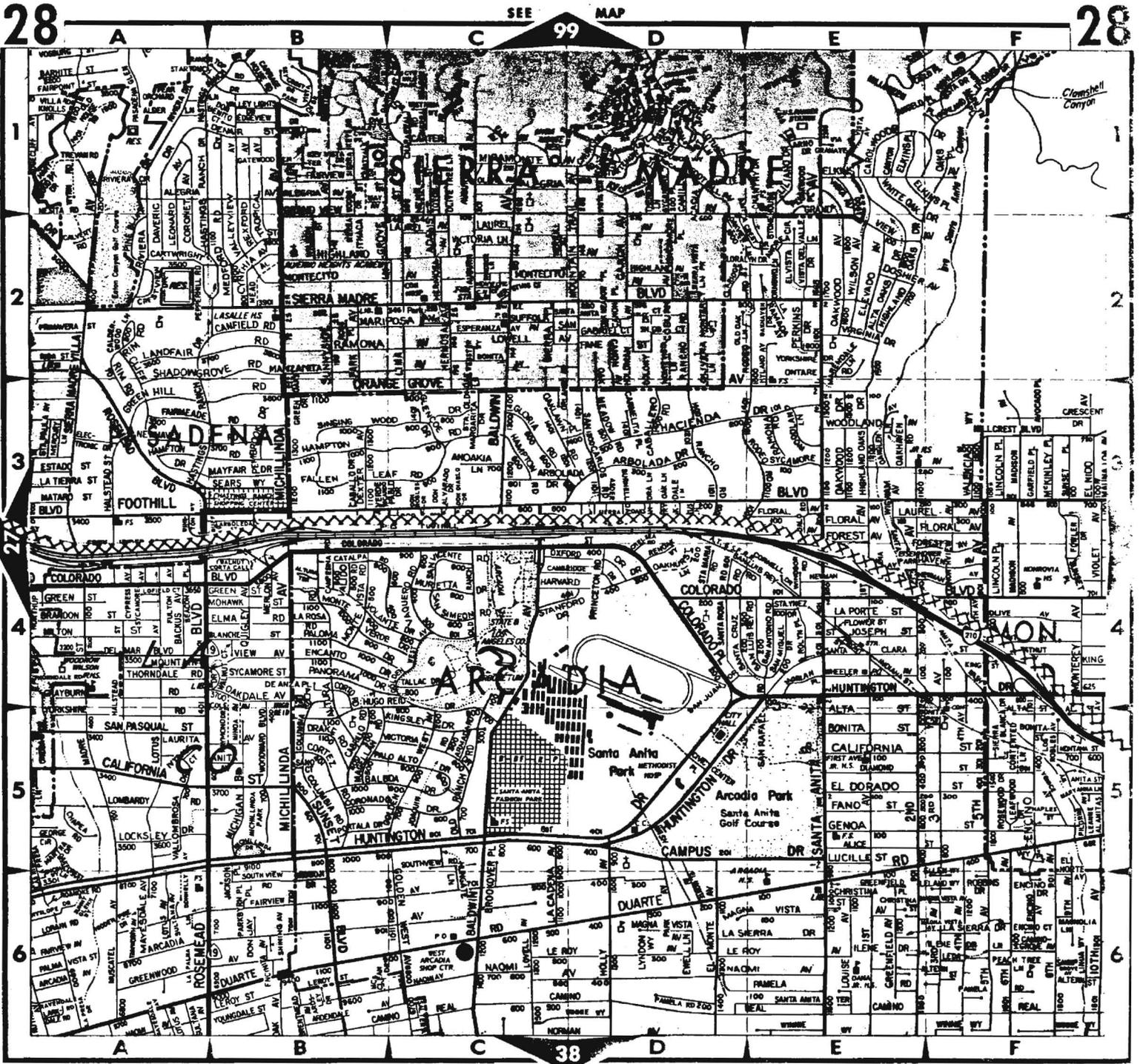
The complexity of the 210/134/7 interchange will necessitate special configuration of the line passing through it.

The station may be located outside the freeway right-of-way since the freeway is in cut at this section. Consideration should be given for the utilization of available areas along the freeway on the outer edges.



The proposed elevated line from the Golden State to the San Gabriel River Freeway is not necessarily the best alternative. Consideration should be given to location on the line of the inner freeway lanes.

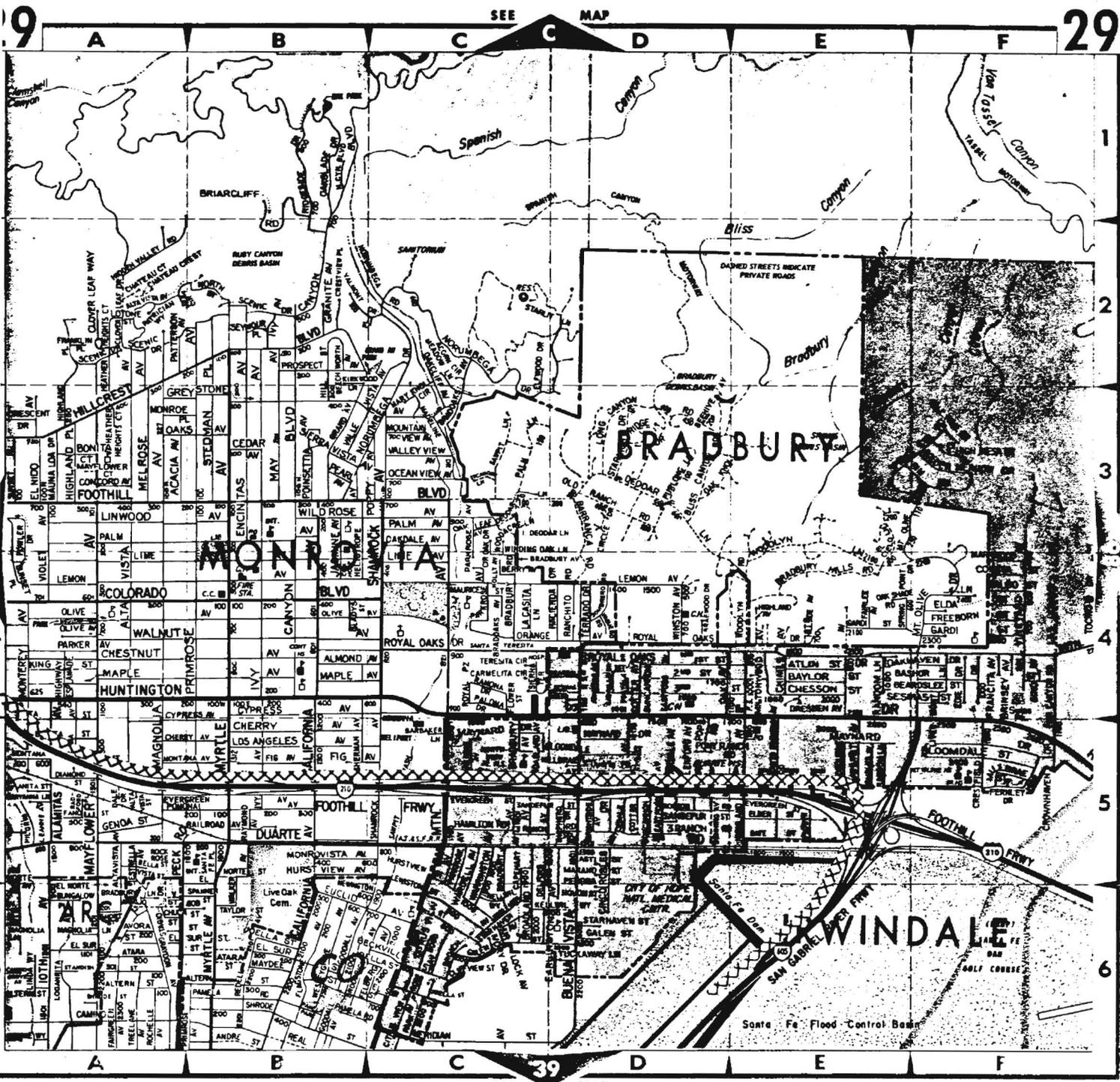
The stations may be located outside the freeway right-of-way since the freeway is in cut at this section. Consideration should be given for the utilization of available areas along the freeway on the outer edges.



INTER VALLEY LINE

The proposed elevated line from the Golden State to the San Gabriel River Freeway is not necessarily the best alternative. Consideration should be given to location of the line on the inner freeway lanes.

The possibility of using the railroad (A.T.&S.F.) line along Route 210 between Santa Anita Park and Route 605 should be considered as an alternative to the freeway.

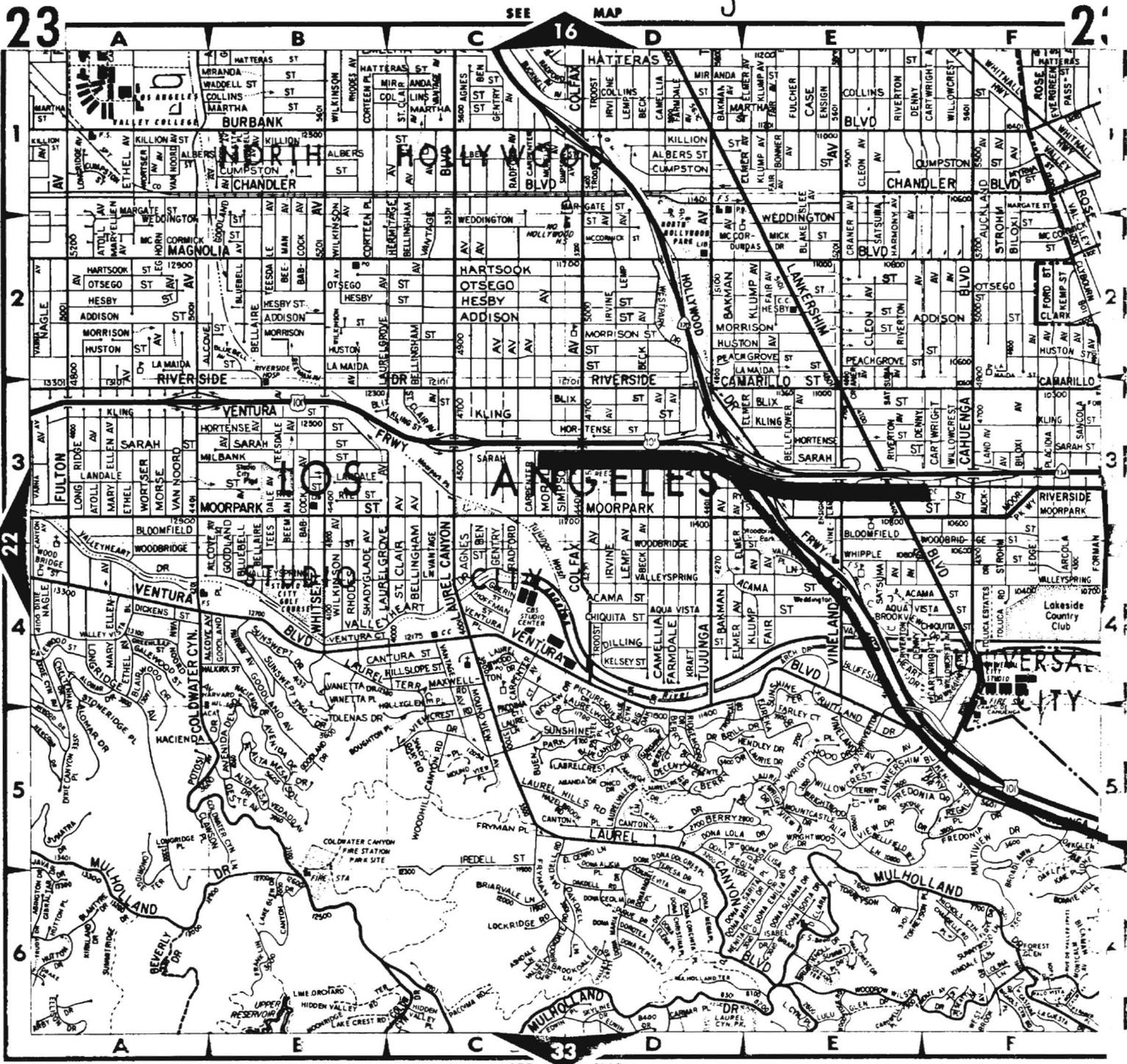


SEE MAP INTER VALLEY LINE

The proposed elevated line from the Golden State to the San Gabriel River Freeway is not necessarily the best alternative. Consideration should be given to location of the line on the inner freeway lanes.

The possibility of using the railroad (A.T.&S.F.) line along Route 210 between Santa Anita Park and Route 605 should be considered as an alternative to the freeway.

The 210/605 interchange will necessitate special consideration for the location and configuration of the interline junction. If the railroad line is followed the problem may be made easier.



HOLLY WOOD BOWL LINE

The 101/170/134 interchange would necessitate careful consideration of the location and configuration of the interline rail junction. The southeast quadrant may be found to offer the best location.

An alignment on the south side of the freeway may prove to be preferable to a median alignment from a station configuration and construction point of view.



HOLLYWOOD BOWL LINE

An alignment on the south side of the freeway may prove to be preferable to a median alignment from a station configuration and construction point of view.

Barham overcrossing may necessitate a high structure over the crest of the Hollywood Freeway.



An alignment on the south side of the freeway may prove to be preferable to a median alignment from a station configuration and construction point of view.

Large loading platforms at Hollywood Bowl Station will be required and may be conflicting with Highland Avenue, Hollywood Freeway and the Bowl, necessitating considerable attention to station design.

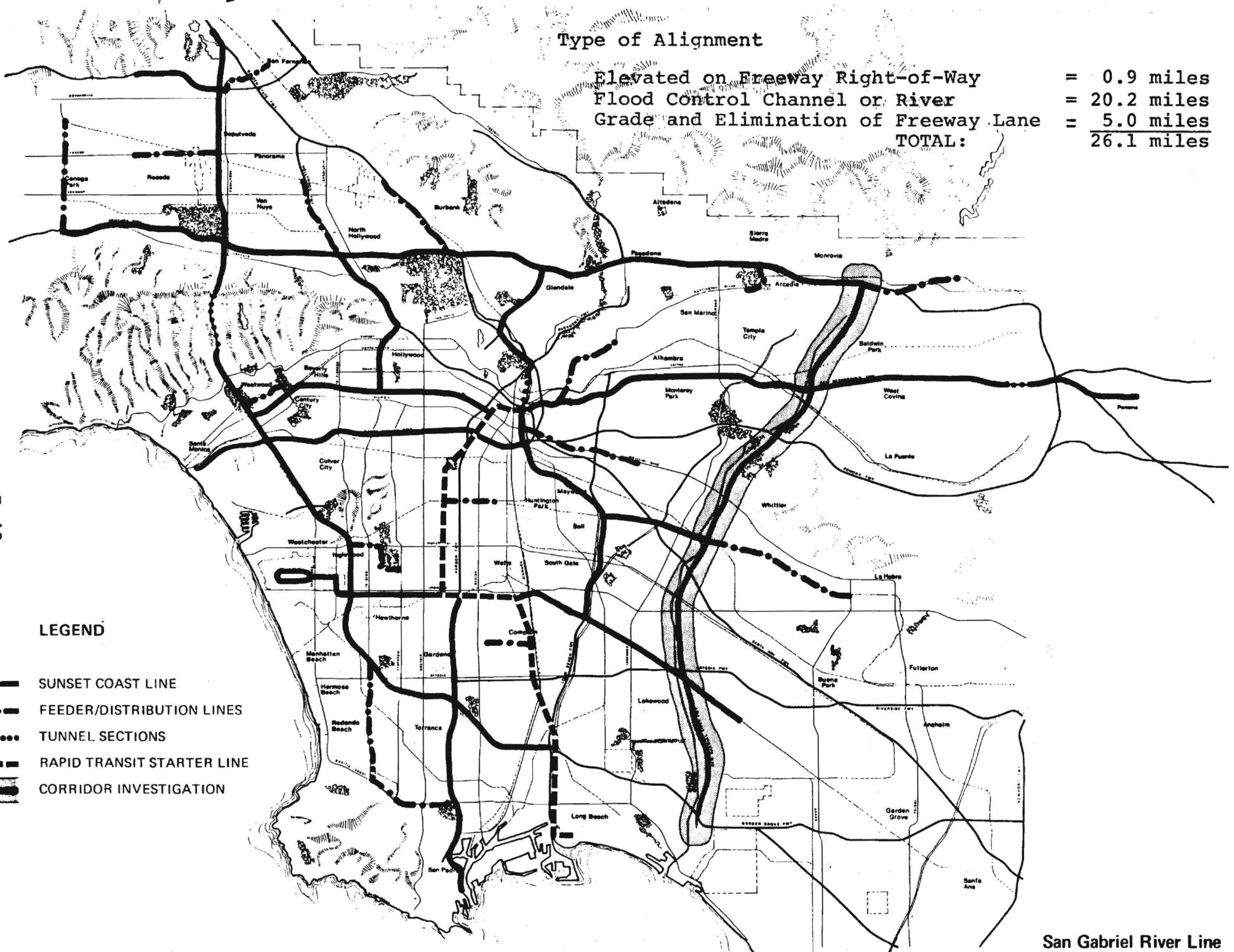
Type of Alignment

Elevated on Freeway Right-of-Way	= 0.9 miles
Flood Control Channel or River	= 20.2 miles
Grade and Elimination of Freeway Lane	= 5.0 miles
TOTAL:	<u>26.1 miles</u>

I-43

LEGEND

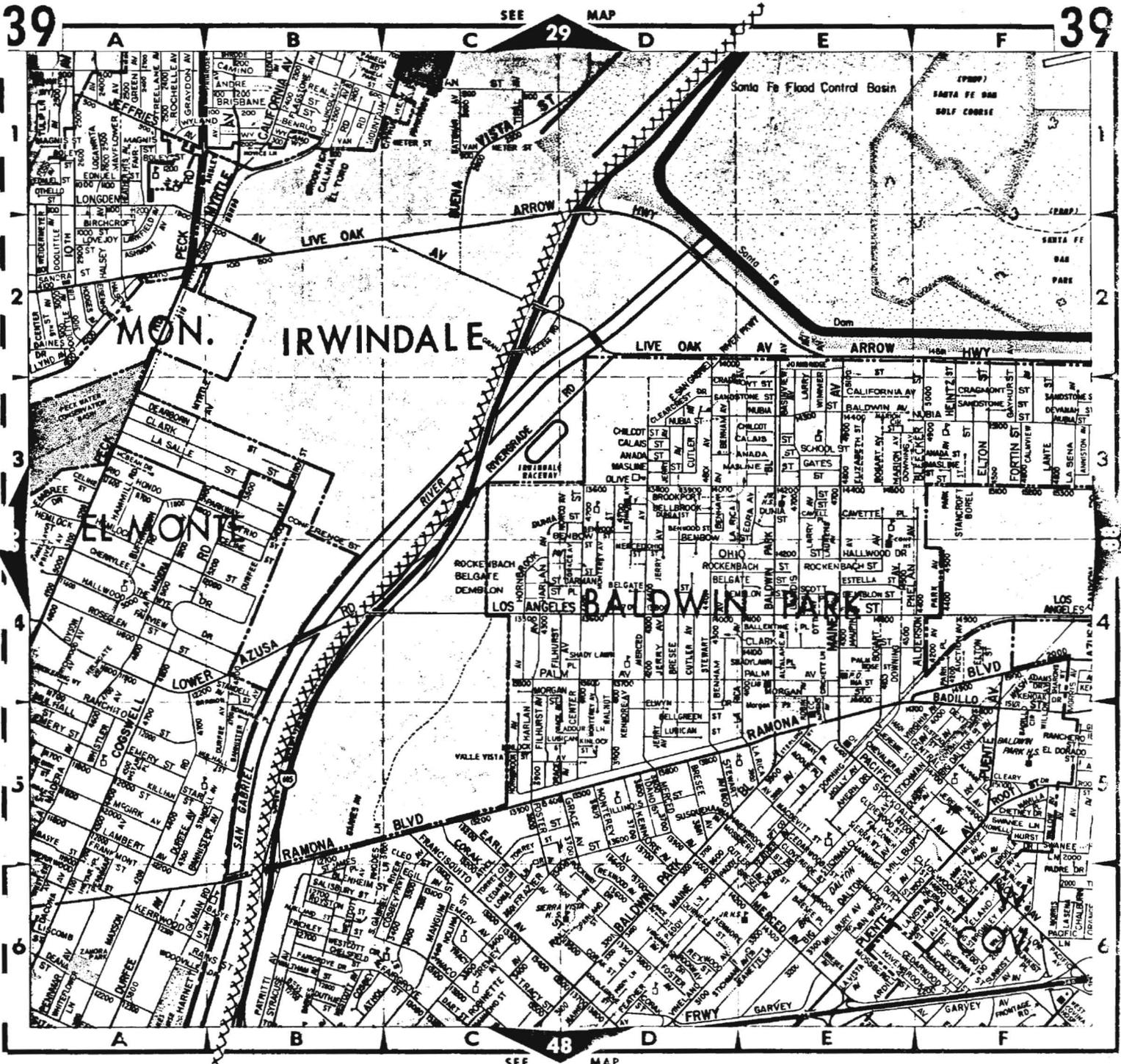
-  SUNSET COAST LINE
-  FEEDER/DISTRIBUTION LINES
-  TUNNEL SECTIONS
-  RAPID TRANSIT STARTER LINE
-  CORRIDOR INVESTIGATION



San Gabriel River Line

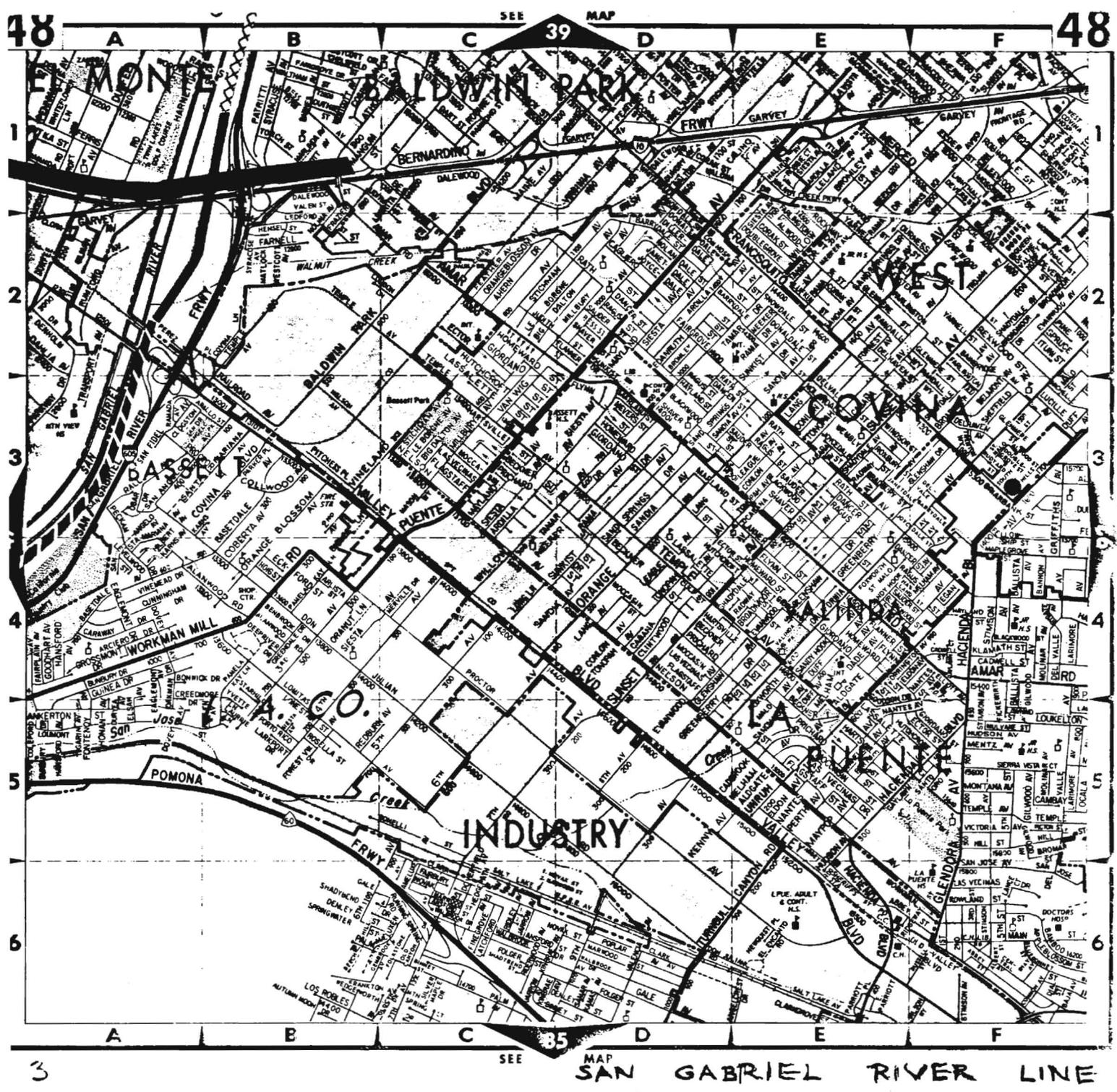


Between Route 210 and 10, widening of the freeway to allow use of the center lanes at grade may not be necessary. Existing interior lanes may be considered for conversion into rail usage.



2 SAN GABRIEL RIVER LINE

Between Route 210 and 10, widening of the freeway to allow use of the center lanes at grade may not be necessary. Existing interior lanes may be considered for conversion into rail usage.



Between Route 210 and 10, widening of the freeway to allow use of the center lanes at grade may not be necessary. Existing interior lanes may be considered for conversion into rail usage.

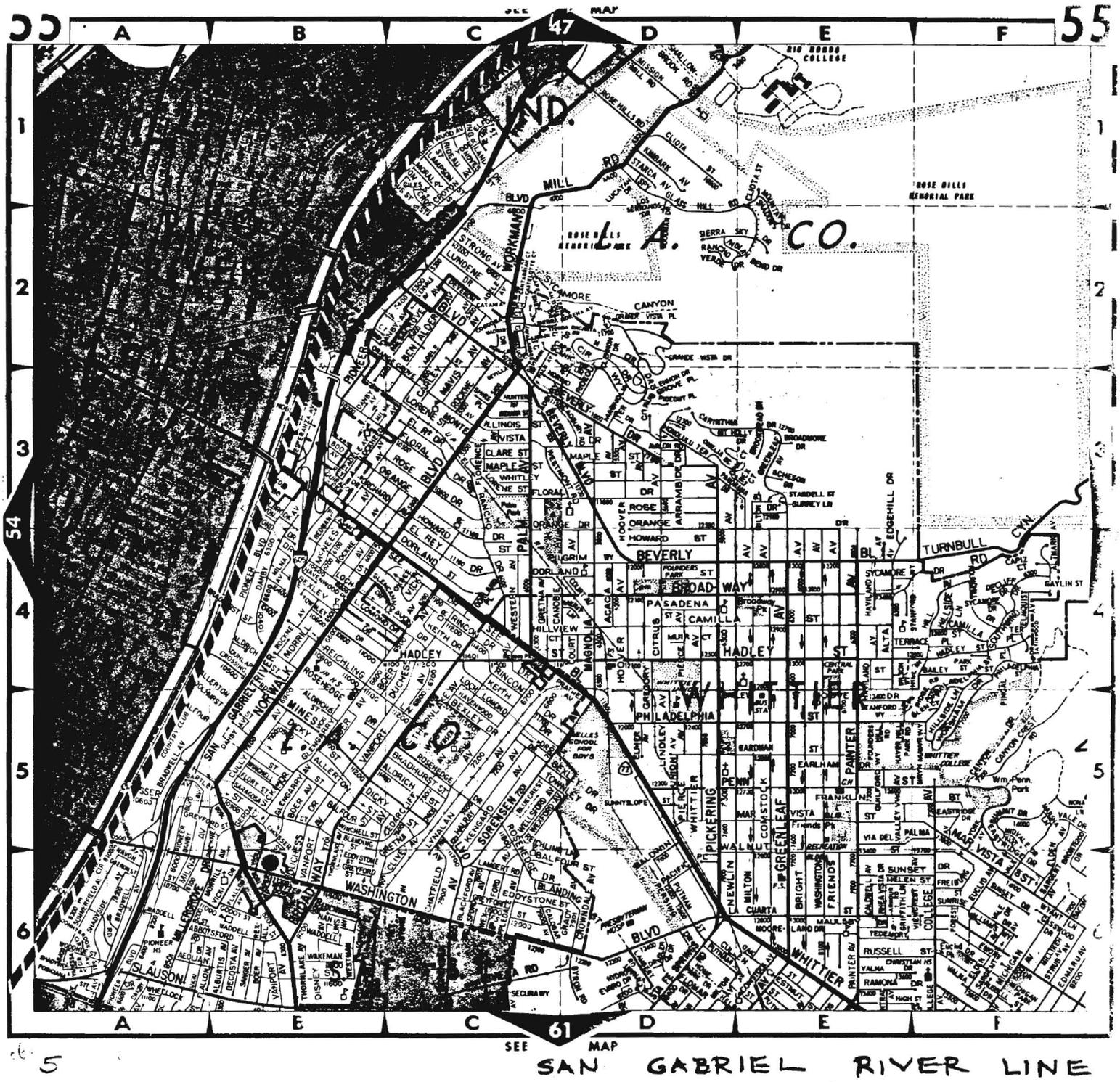
The 10/605 interchange may necessitate the location of the interline junction in the southwest quadrant.

The San Gabriel River Embankment alternate (d) may be less costly than the 605 Freeway.



The San Gabriel River Embankment alternate (d) may be less costly than the 605 Freeway.

The 605/60 interchange would make it difficult to construct on the 605 alignment, a difficulty that can be avoided if the San Gabriel River alternative is adopted.



The San Gabriel River Embankment alternate (d) may be less costly than the 605 Freeway.

The railroad right-of-way adjacent to the San Gabriel River between Beverly Boulevard and Slauson Avenue may be less costly than the San Gabriel River Embankment.



The 605/5 interchange would also make it difficult to construct on the 605 alignment, making the river alternative more attractive.

66

SEE MAP 60

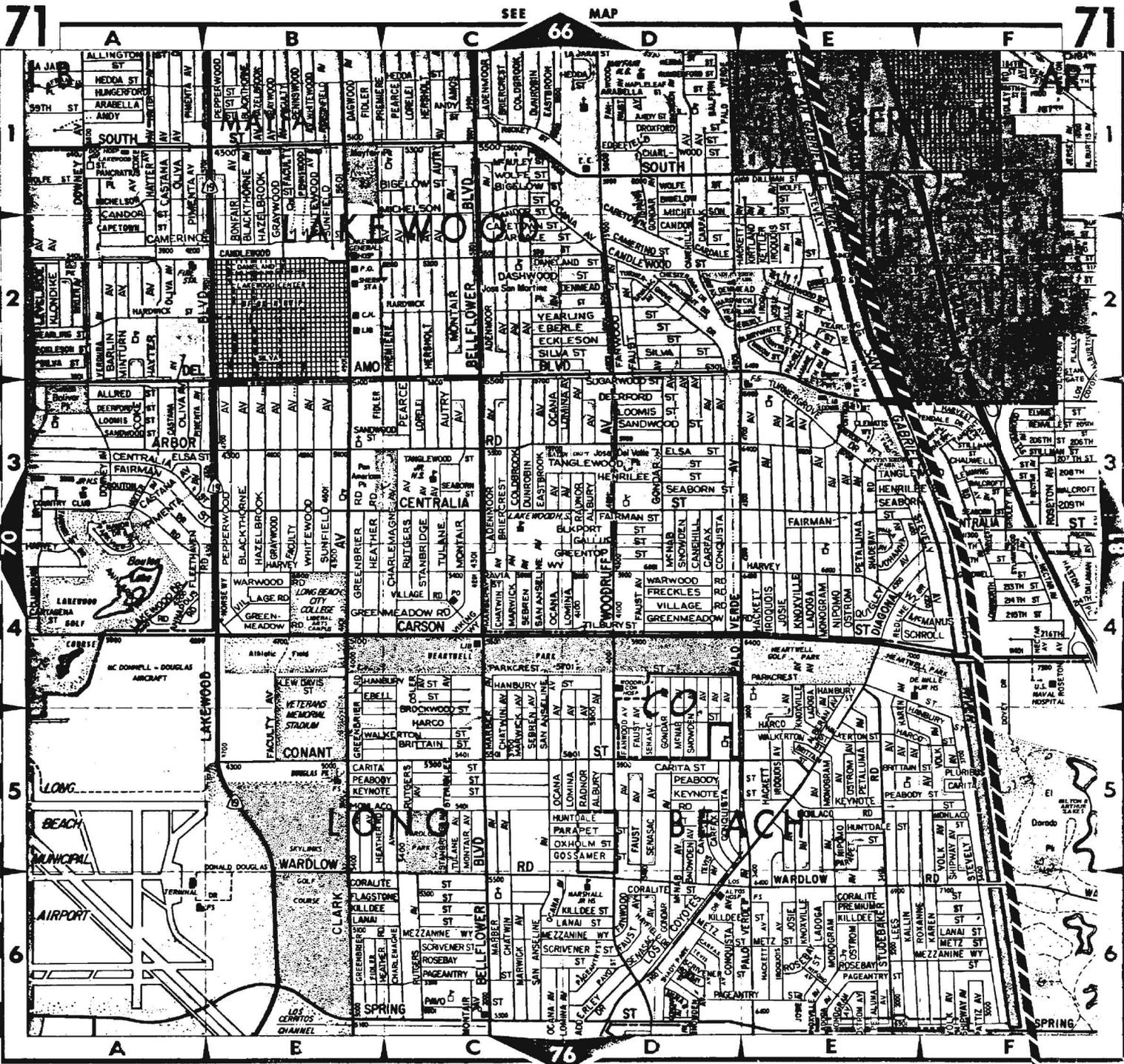
66



8

SEE MAP 71

SAN GABRIEL RIVER LINE



SEE MAP 66

MAP 76

SAN GABRIEL RIVER LINE



10

SEE MAP SAN GABRIEL RIVER LINE

Future design around the 405/605 interchange should be considered because of the geometrics and height of the interchange. This line is proposed to end in a temporary terminus. A future heavy rail line or feeder line might join at this terminus to provide service to the coastal towns along I-405.

Type of Alignment

Railroad

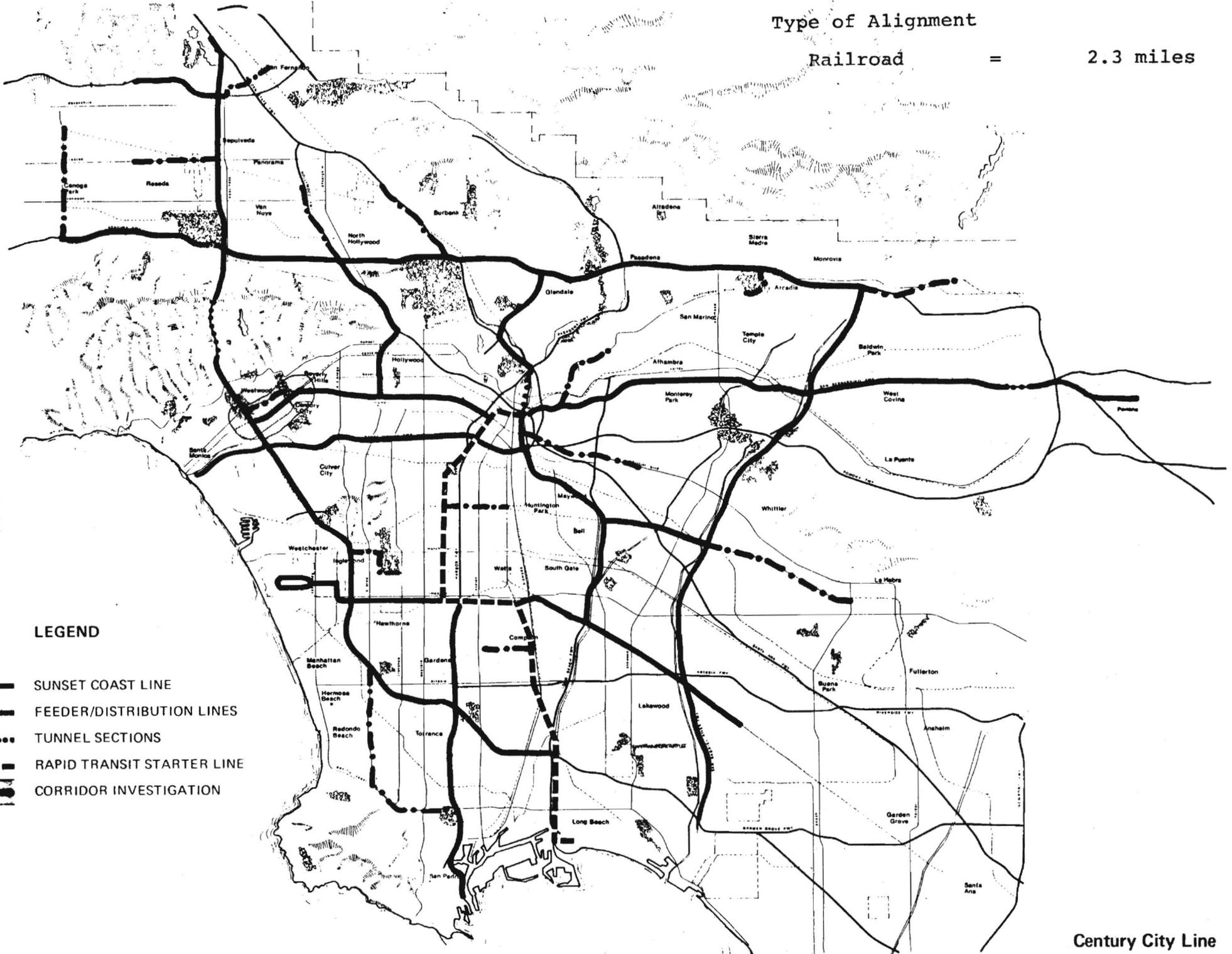
=

2.3 miles

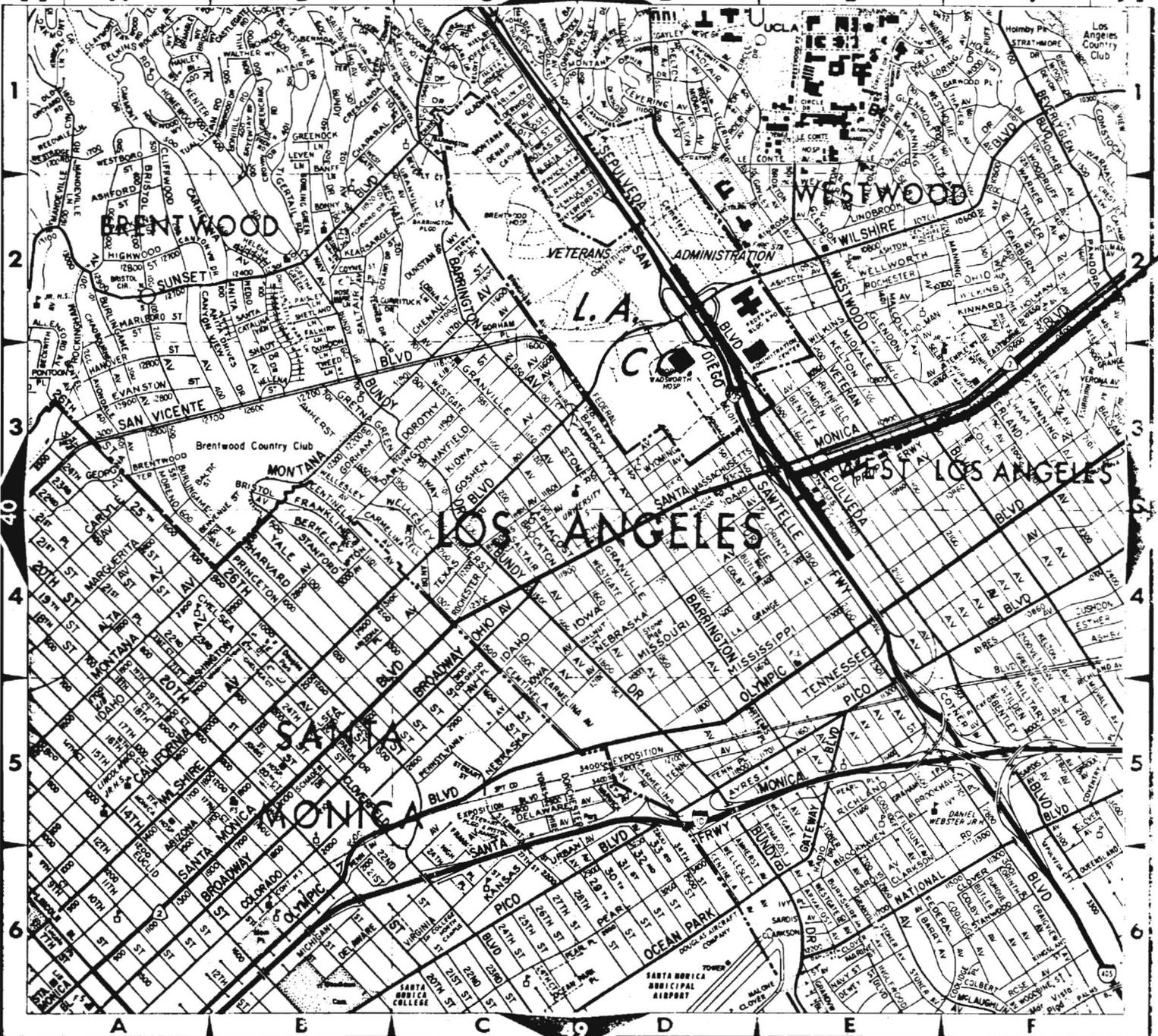
I-53

LEGEND

-  SUNSET COAST LINE
-  FEEDER/DISTRIBUTION LINES
-  TUNNEL SECTIONS
-  RAPID TRANSIT STARTER LINE
-  CORRIDOR INVESTIGATION



Century City Line



No adverse issues have been identified relative to the Century City Line. If use of Southern Pacific right-of-way is accomplished as planned there are no major structures or other difficulties that are likely to slow down the project. High voltage power lines will have to be relocated along the line (Santa Monica Boulevard).



No adverse issues have been identified relative to the Century City Line. If use of Southern Pacific right-of-way is accomplished as planned there are no major structures or other difficulties that are likely to slow down the project. High voltage power lines will have to be relocated along the line (Santa Monica Boulevard).

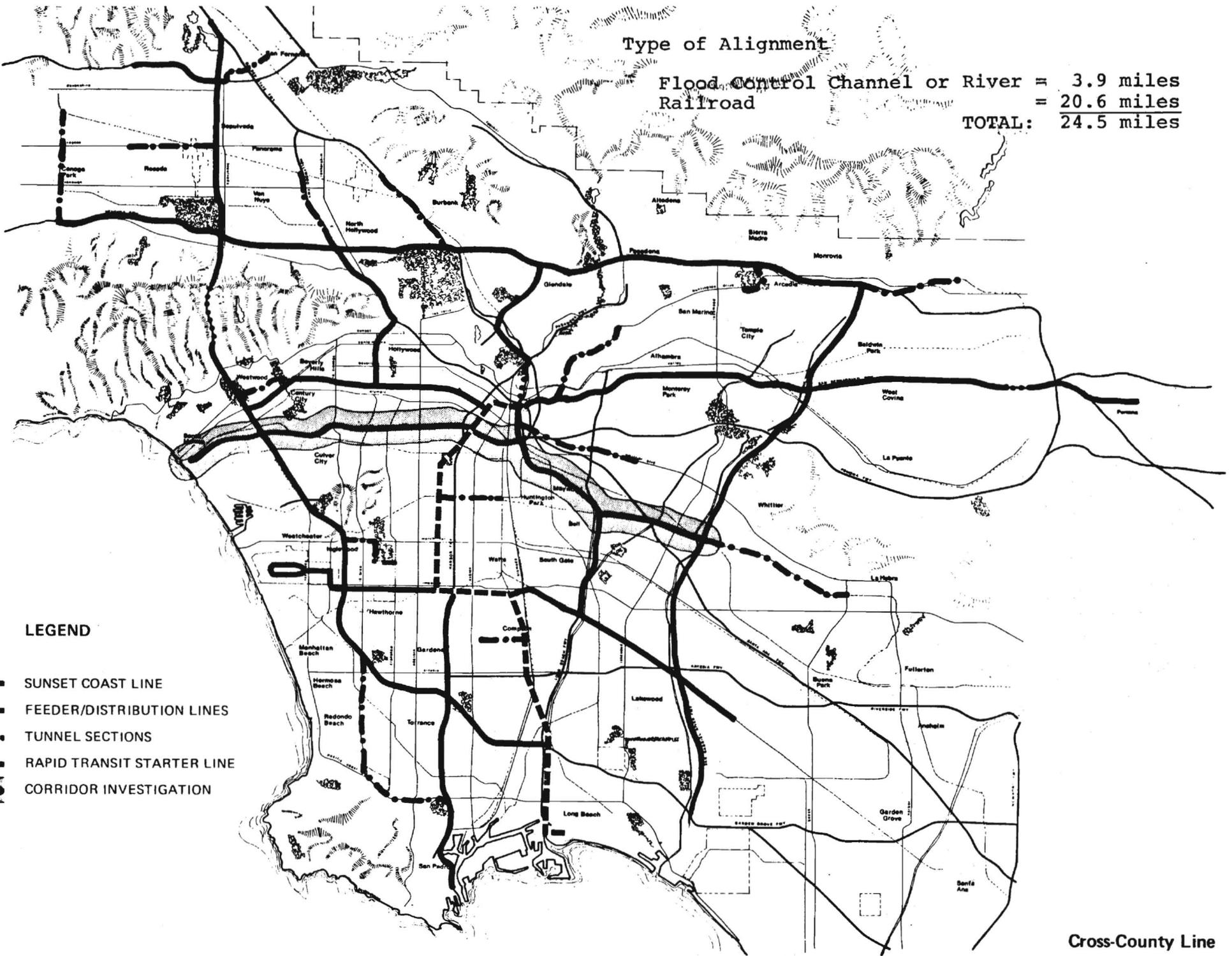
Type of Alignment

Flood Control Channel or River = 3.9 miles
 Railroad = 20.6 miles
TOTAL: 24.5 miles

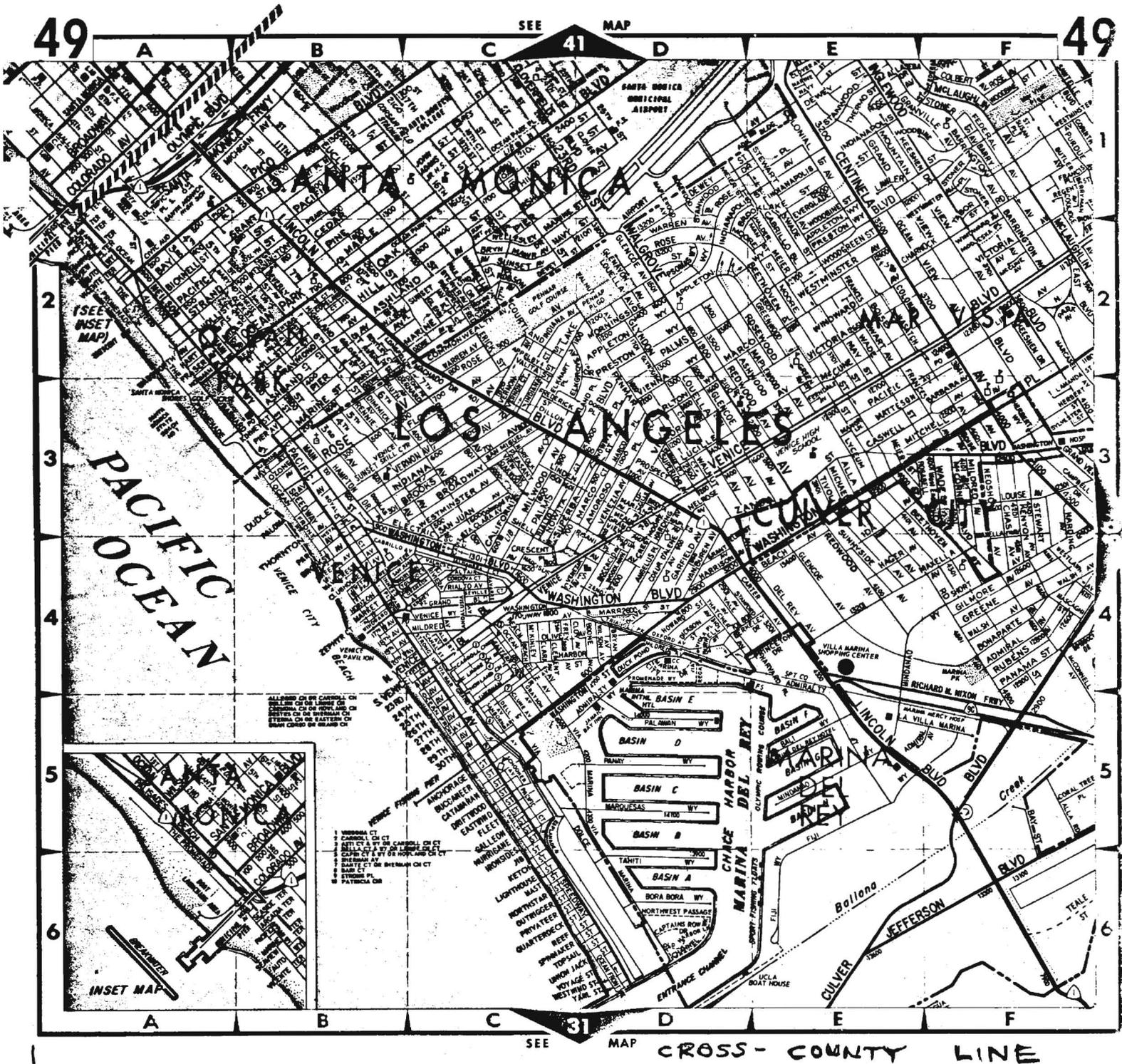
I-56

LEGEND

-  SUNSET COAST LINE
-  FEEDER/DISTRIBUTION LINES
-  TUNNEL SECTIONS
-  RAPID TRANSIT STARTER LINE
-  CORRIDOR INVESTIGATION



Cross-County Line



Location of Ocean Boulevard Station is made difficult due to density of development in the vicinity of the Pacific Coast Highway tunnel.

If the Santa Monica Freeway median is adopted for the route the line may have to be elevated above the surface streets which cross over the freeway. This would require high structures for the elevated line.

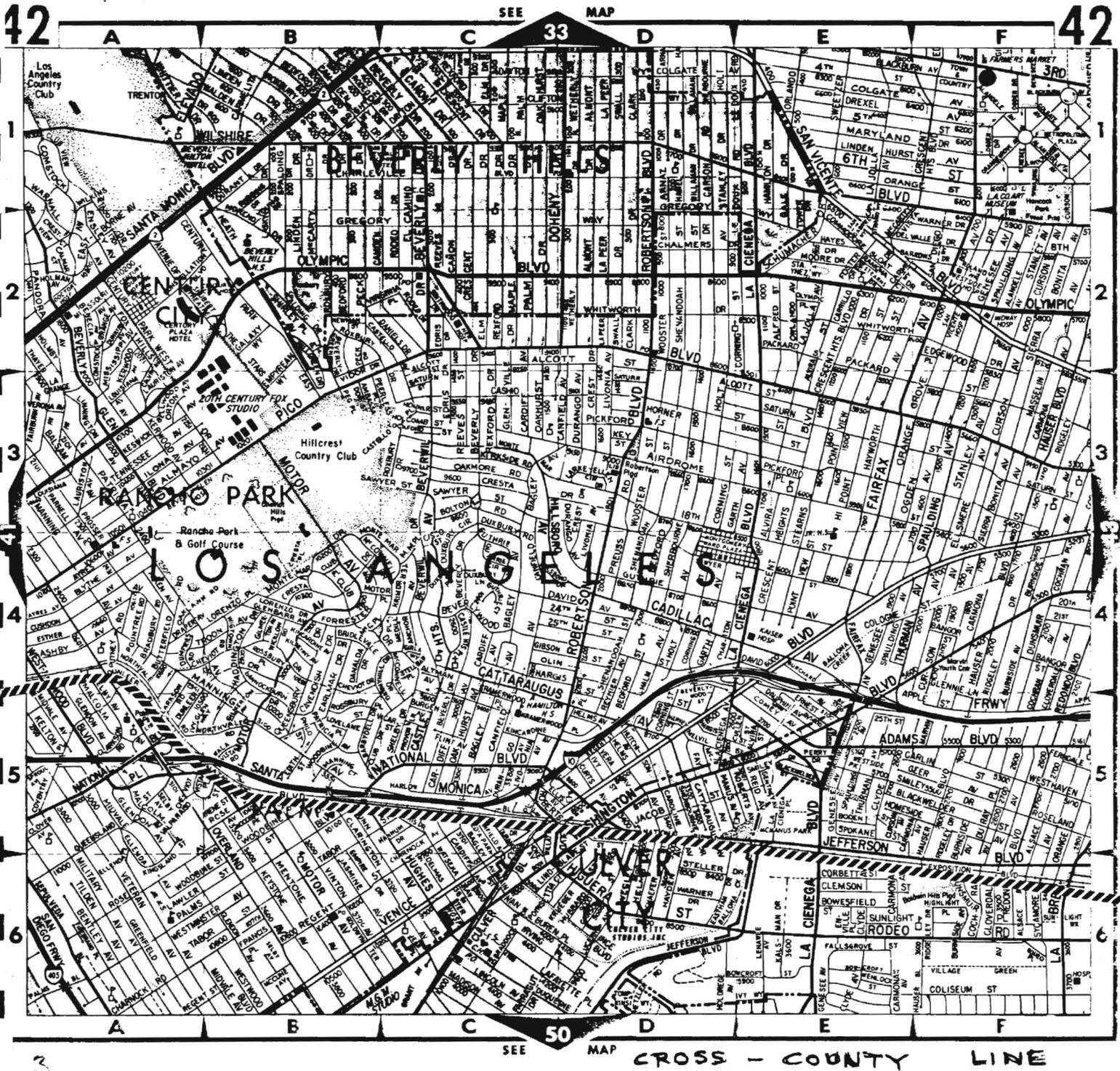
An existing railroad line may offer a less costly alternative to use of the freeway. The Exposition Line (as indicated in alternative (a), page 43, of the SUNSET COAST LINE study) follows the Santa Monica Freeway from the coast all the way to the Los Angeles River.



If the Santa Monica Freeway median is adopted for the route the line may have to be elevated above the surface streets which cross over the freeway. This would require high structures for the elevated line.

An existing railroad line may offer a less costly alternative to use of the freeway. The Exposition Line (as indicated in alternative (a), page 43, of the SUNSET COAST LINE study) follows the Santa Monica Freeway from the coast all the way to the Los Angeles River.

The 10/405 interchange will pose difficulties in the location and configuration of the interline rail junction of the Cross-County and Valley-Long Beach lines. This problem may be considerably alleviated if the Exposition Line is adopted instead of the Santa Monica Freeway.



The structures of National/Overland in West Los Angeles will necessitate high structures for the line if the Santa Monica Freeway median option is adopted.



CROSS-COUNTY LINE

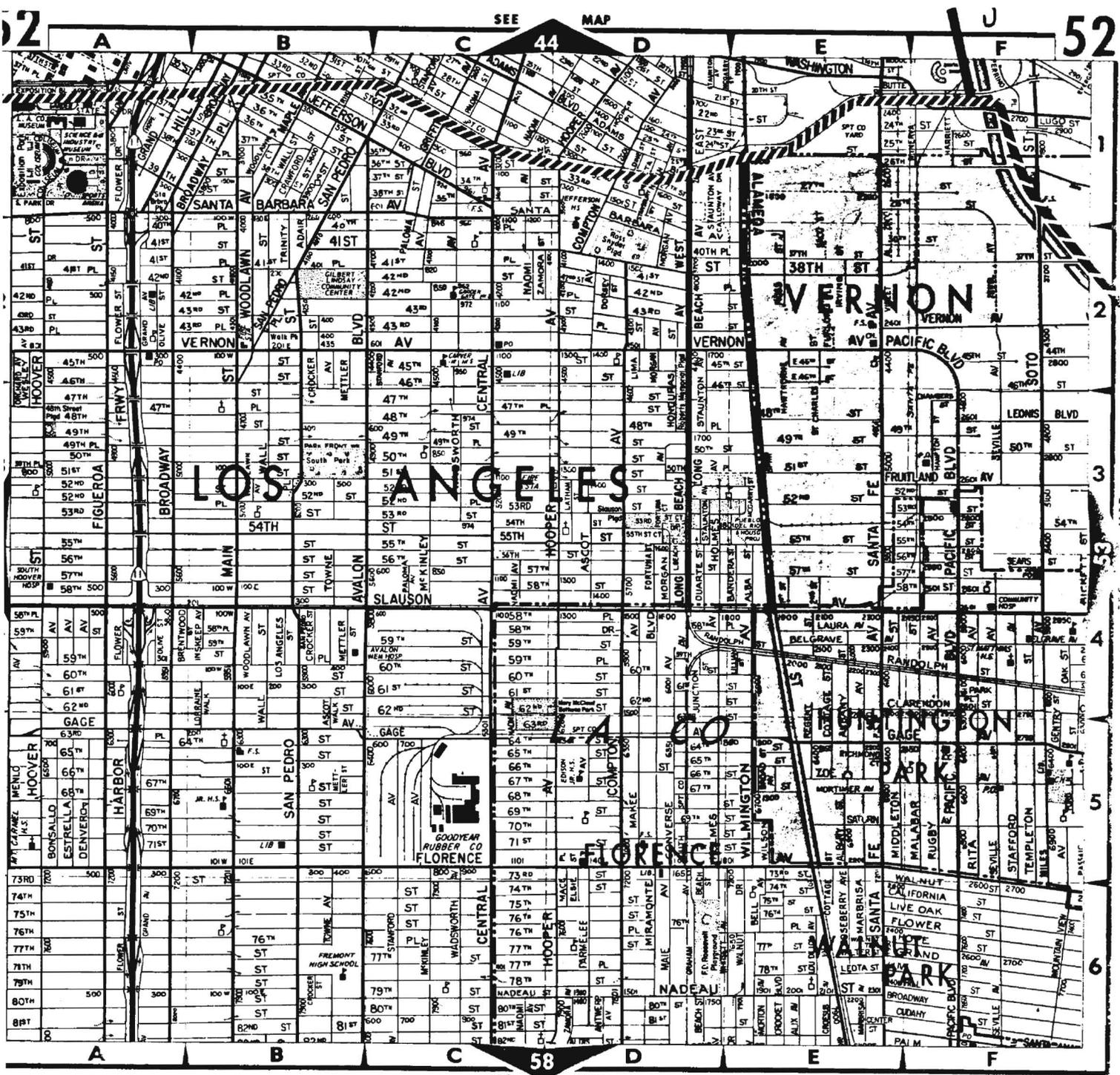
Traffic considerations (both during and following completion of construction) may prohibit construction in the median of the Santa Monica Freeway between La Brea and the Harbor Freeway. An alternative may be construction of a structure along the embankment or adoption of the rail option (see (3) above).

The Santa Monica Freeway line stops short of providing superb service to the University of Southern California and the Coliseum/Sports Arena complex, two large traffic generators. The Exposition railroad alternative may provide a marked service improvement to these activity centers.



Traffic considerations (both during and following completion of construction) may prohibit construction in the median of the Santa Monica Freeway between La Brea and the Harbor Freeway. An alternative may be construction of a structure along the embankment or adoption of the rail option (see (3) above).

Construction in the median between the Harbor Freeway and the East Los Angeles interchange will be extremely difficult from both traffic and geometric points of view and consideration should be given to an alternate.



CROSS-COUNTY LINE

The Santa Monica Freeway line stops short of providing superb service to the University of Southern California and the Coliseum/Sports Arena complex, two large traffic generators. The Exposition railroad alternative may provide a marked service improvement to these activity centers.

The transition between the Los Angeles River and the Santa Monica Freeway alignment will be difficult due to elevation differentials.



The use of the Los Angeles River alignment between the Santa Monica Freeway and Randolph Street may not be the least costly alternative. The utilization of two rail lines, one along East 26th Street and the other just south of the Los Angeles River (between Downey Road and Randolph) should be carefully considered. The former seems particularly attractive.



Crossing over or going through the interchange of Slauson/Telegraph, Santa Ana Freeway will be difficult due to the structures involved, heavy traffic and land use of the area.

60

60

SEE

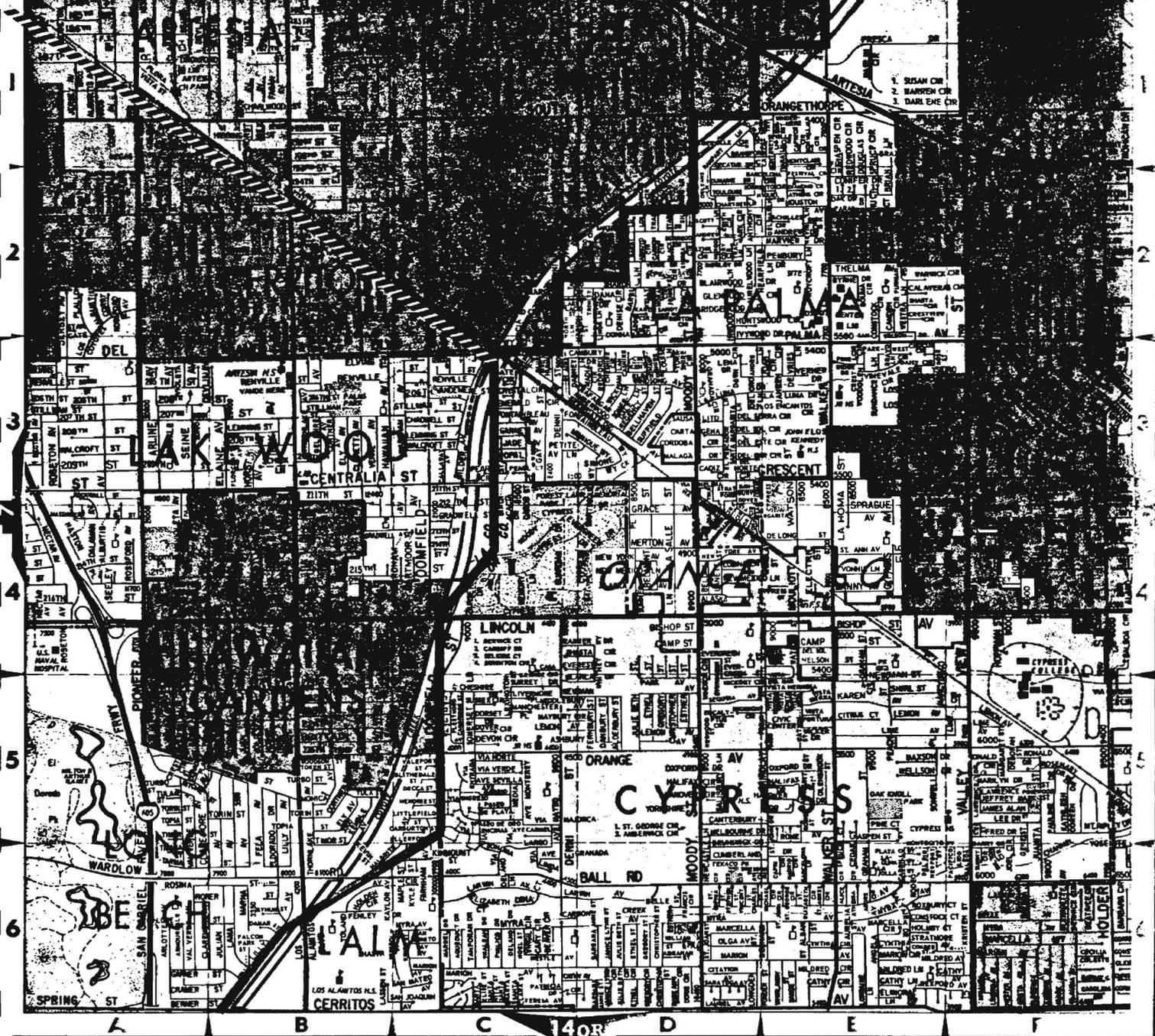
54

SEE

66

CROSS-COUNTY LINE

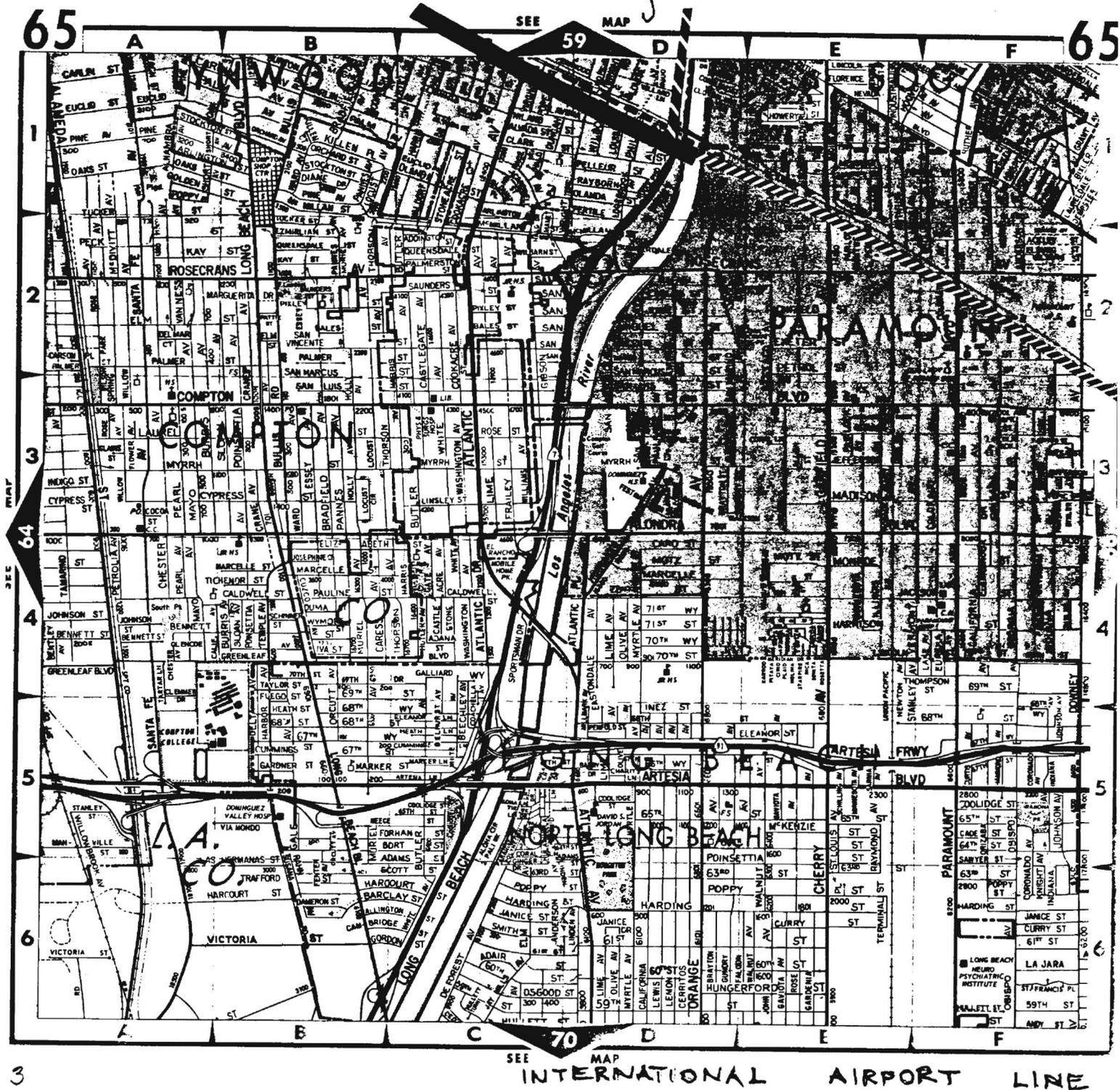




SEE MAP 140R INTERNATIONAL AIRPORT LINE

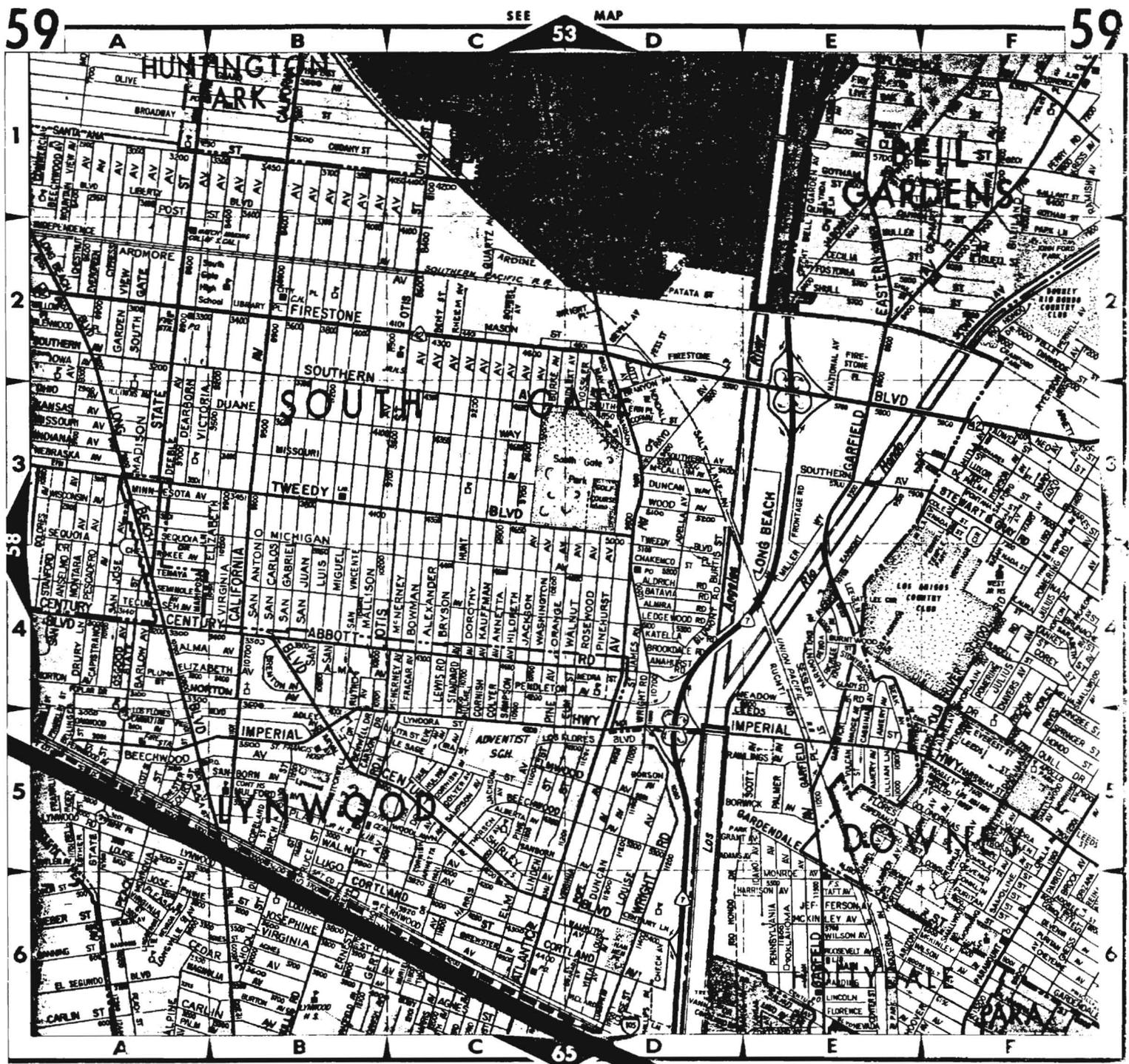


INTERNATIONAL AIRPORT LINE



The interline junction at the Long Beach Freeway might best be located at the Northwest quadrant of the Century-Long Beach Freeways interchange. This would necessitate long spans while crossing over the Long Beach Freeway if the Los Angeles River alternate is used.

It should be resolved whether the Century Freeway will be constructed. The freeway has been designed with rapid transit in mind. However, there is no tentative construction schedule.



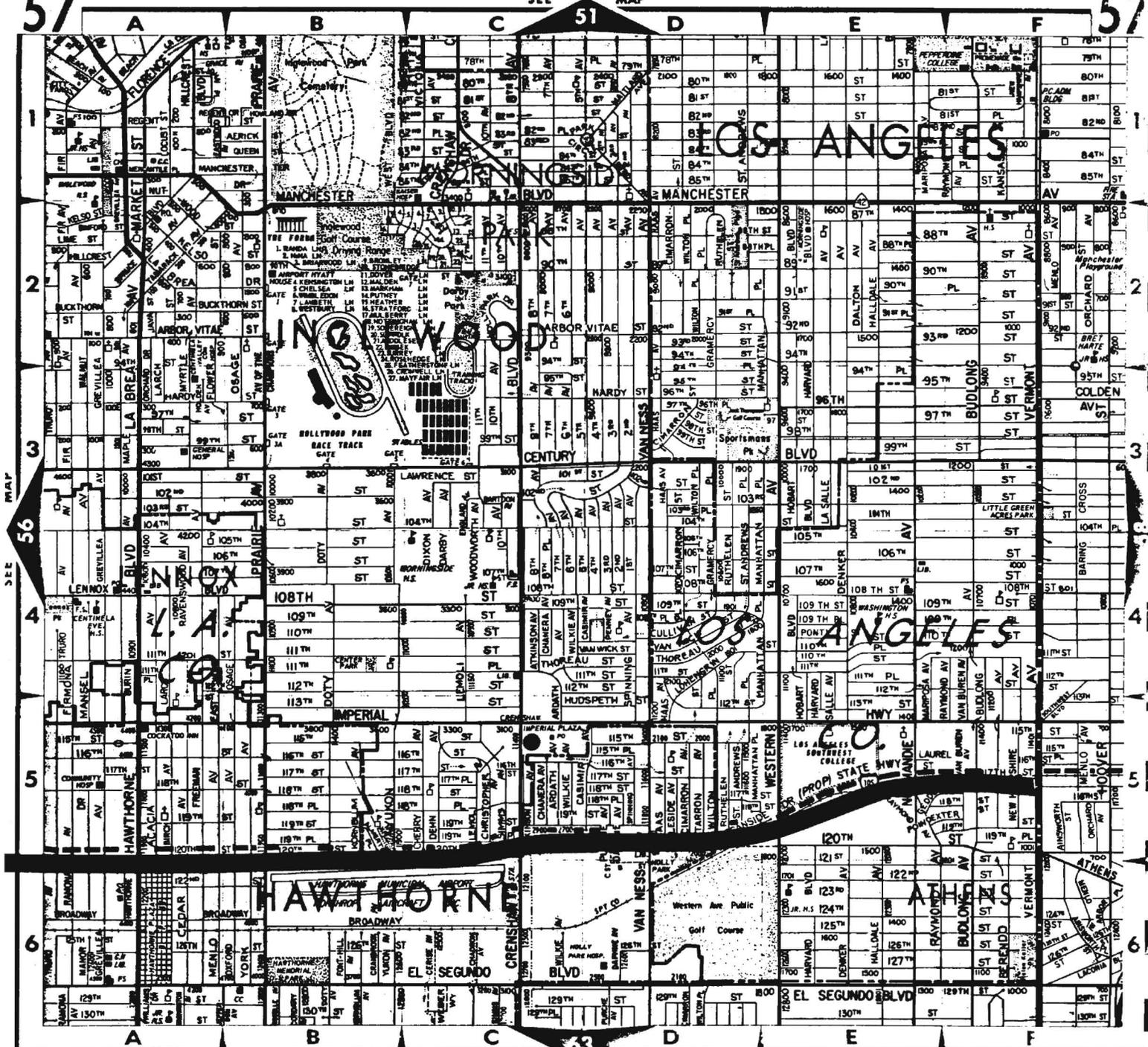
4 SEE MAP 65 INTERNATIONAL AIRPORT LINE

It should be resolved whether the Century Freeway will be constructed. The freeway has been designed with rapid transit in mind. However, there is no tentative construction schedule.



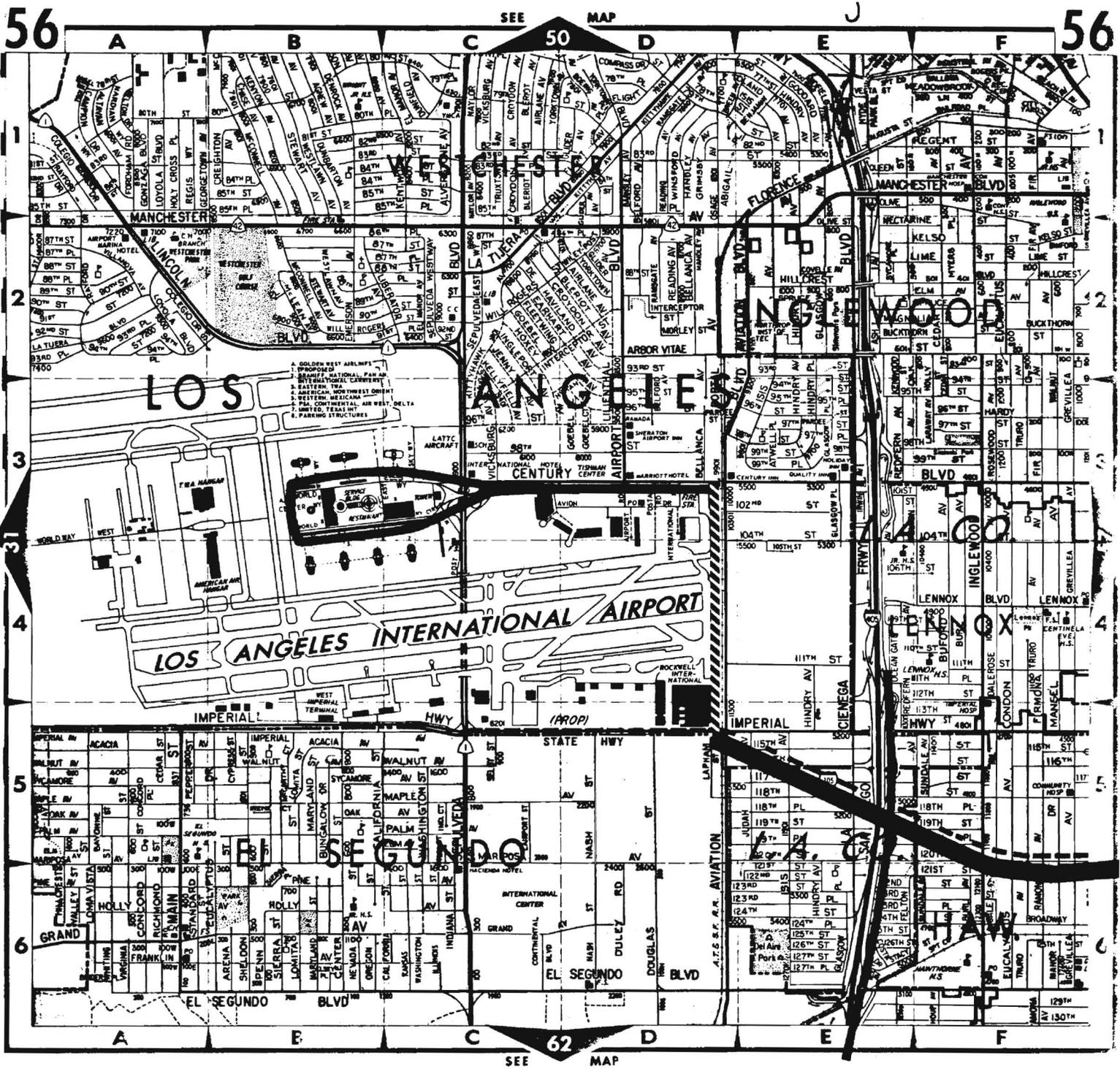
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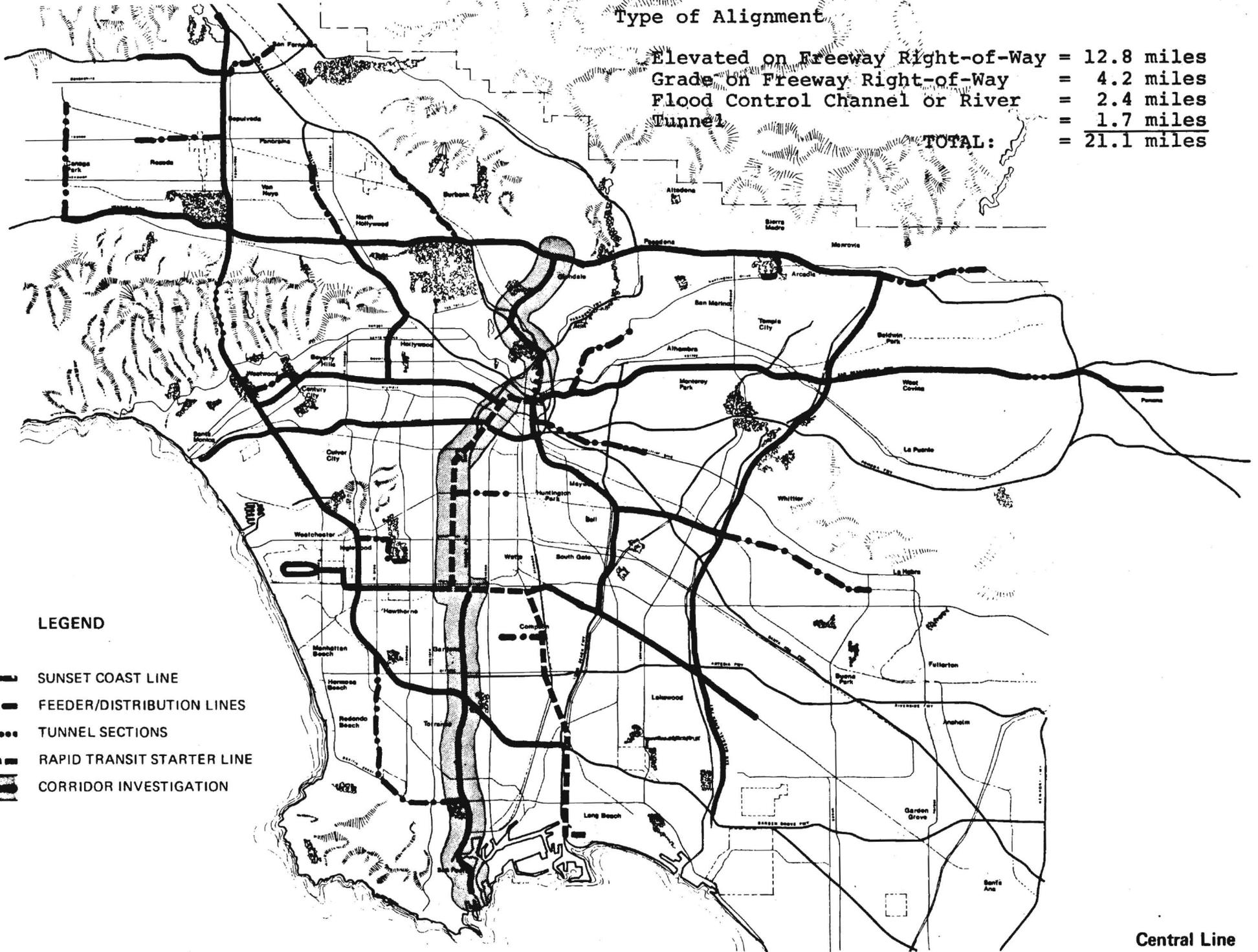
It should be resolved whether the Century Freeway will be constructed. The freeway has been designed with rapid transit in mind. However, there is no tentative construction schedule.

The 105/405 interchange will necessitate special considerations for the location and configuration of the interline junction.

An alternate route for Century Boulevard, such as 98th Street, may be less costly and less disruptive to traffic both during and after completion of construction.

Type of Alignment

Elevated on Freeway Right-of-Way	= 12.8 miles
Grade on Freeway Right-of-Way	= 4.2 miles
Flood Control Channel or River	= 2.4 miles
Tunnel	= 1.7 miles
TOTAL:	= 21.1 miles



I-74

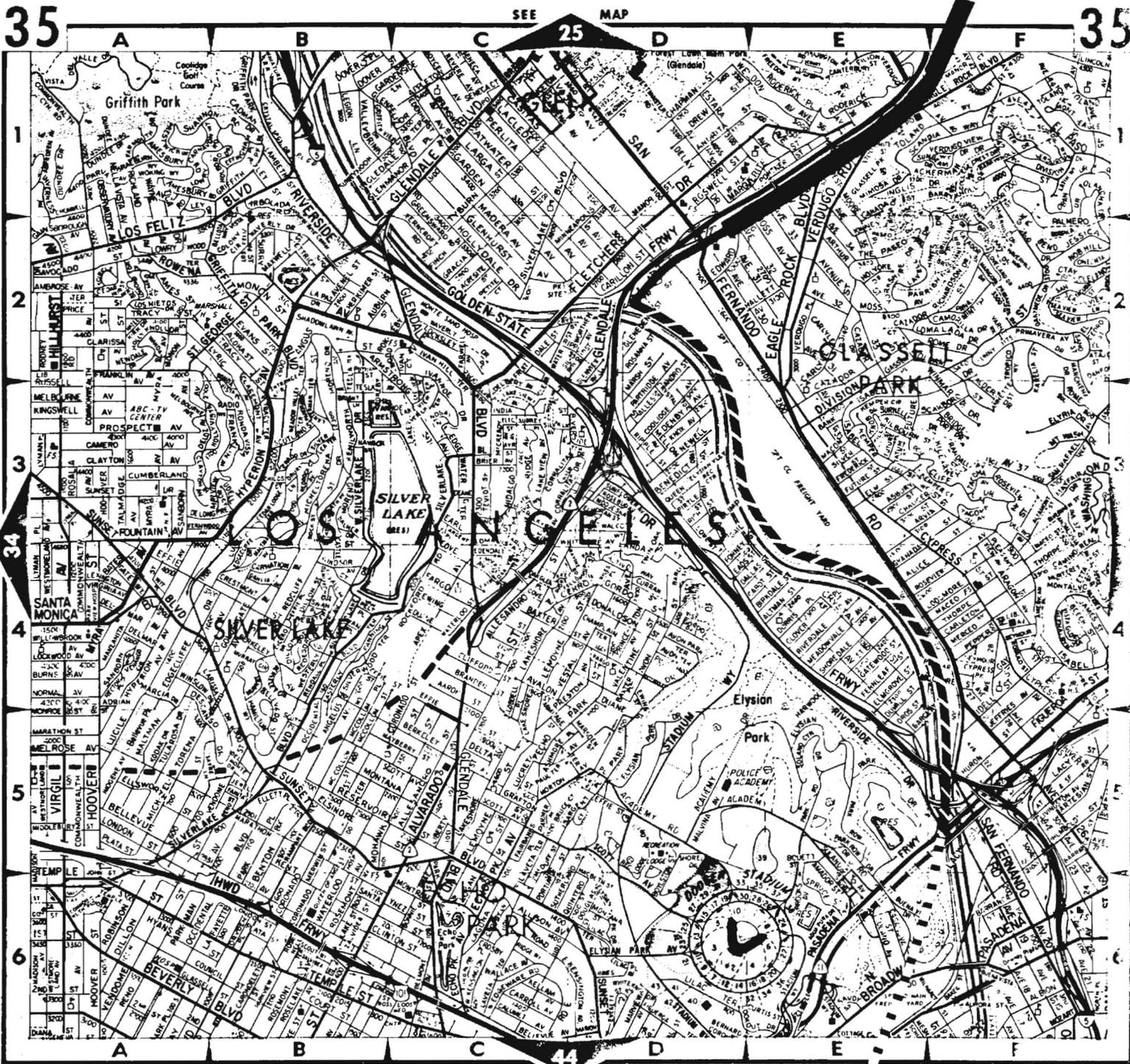
LEGEND

-  SUNSET COAST LINE
-  FEEDER/DISTRIBUTION LINES
-  TUNNEL SECTIONS
-  RAPID TRANSIT STARTER LINE
-  CORRIDOR INVESTIGATION

Central Line



The 2/134 interchange would necessitate careful consideration for the location and configuration of the interline rail junction and stations. Land is available, however, on the north side of Route 134.



2 SEE MAP CENTRAL LINE

Serious consideration should be given to using the Los Angeles River channel or the Southern Pacific Railroad line along San Fernando Road as alternates to the freeway alternative.

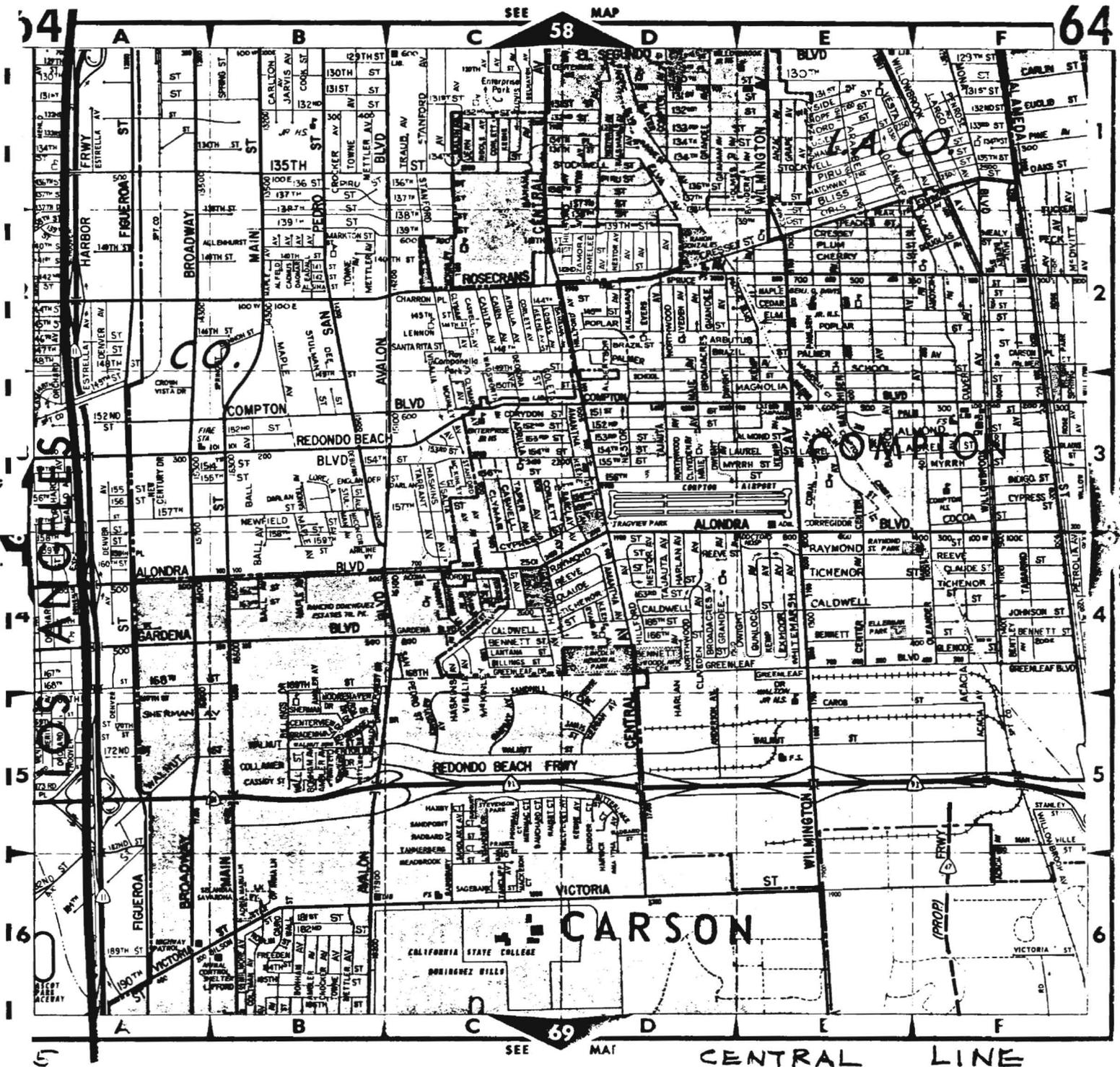
If the freeway alternative is still adhered to the Glendale/Golden State Freeways interchange will pose some difficulty in the location of the rail line.

The necessity of subway into Union Station from the north should be unequivocally determined before this mode is adopted. The availability of railroad lines along Los Angeles River between Union Station and the Pasadena Freeway will have to be clarified.



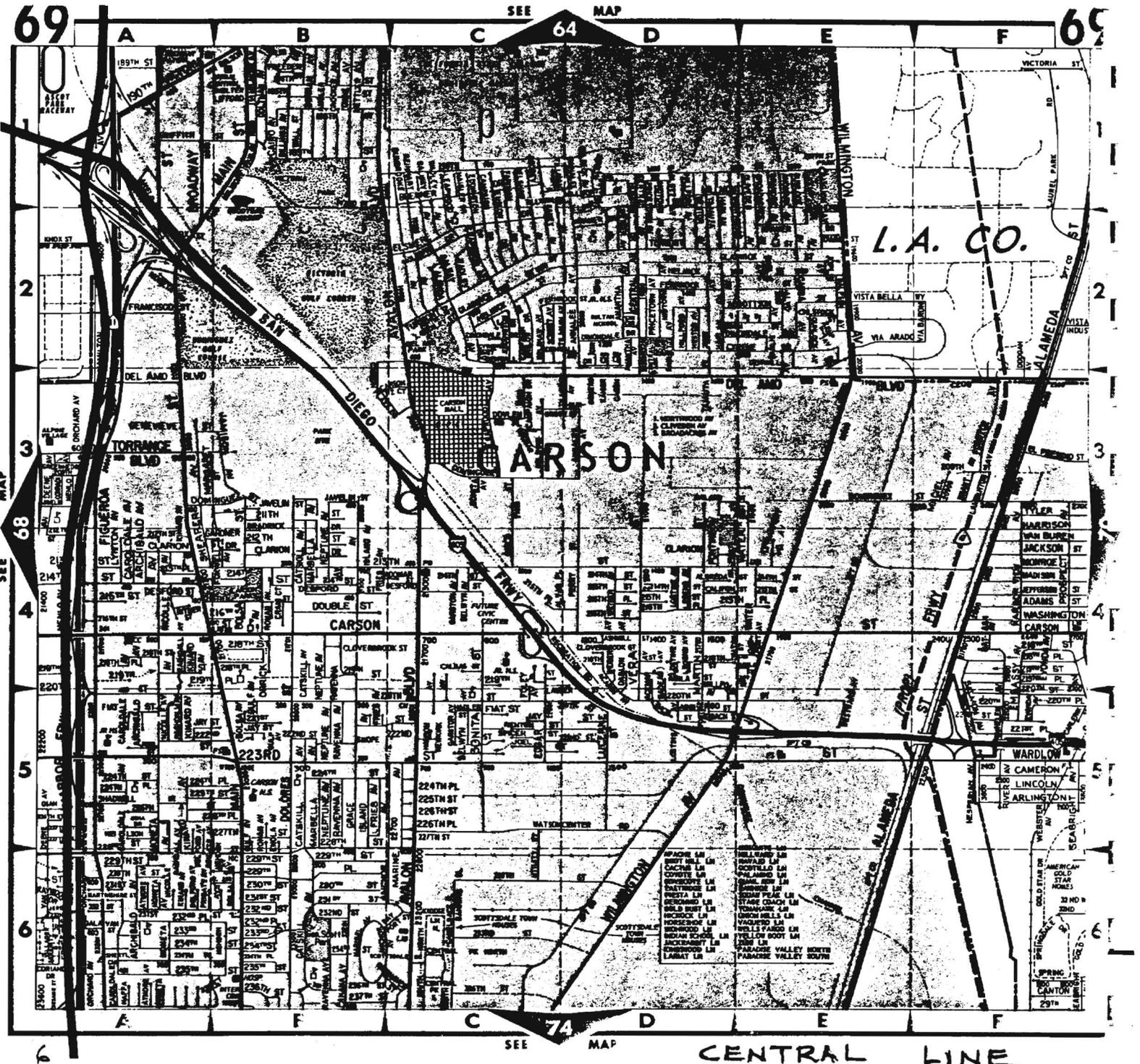
The necessity of subway into Union Station from the north should be unequivocally determined before this mode is adopted. The availability of railroad lines along Los Angeles River between Union Station and the Pasadena Freeway will have to be clarified.





The possibility of having the railroad running along the Harbor Freeway on the east (and southward on the west) should be considered before the Freeway Line is finalized.

If the Freeway route is adopted, the design of stations should minimize freeway modifications. A shoulder (rather than median) alignment may prove more beneficial in this respect.

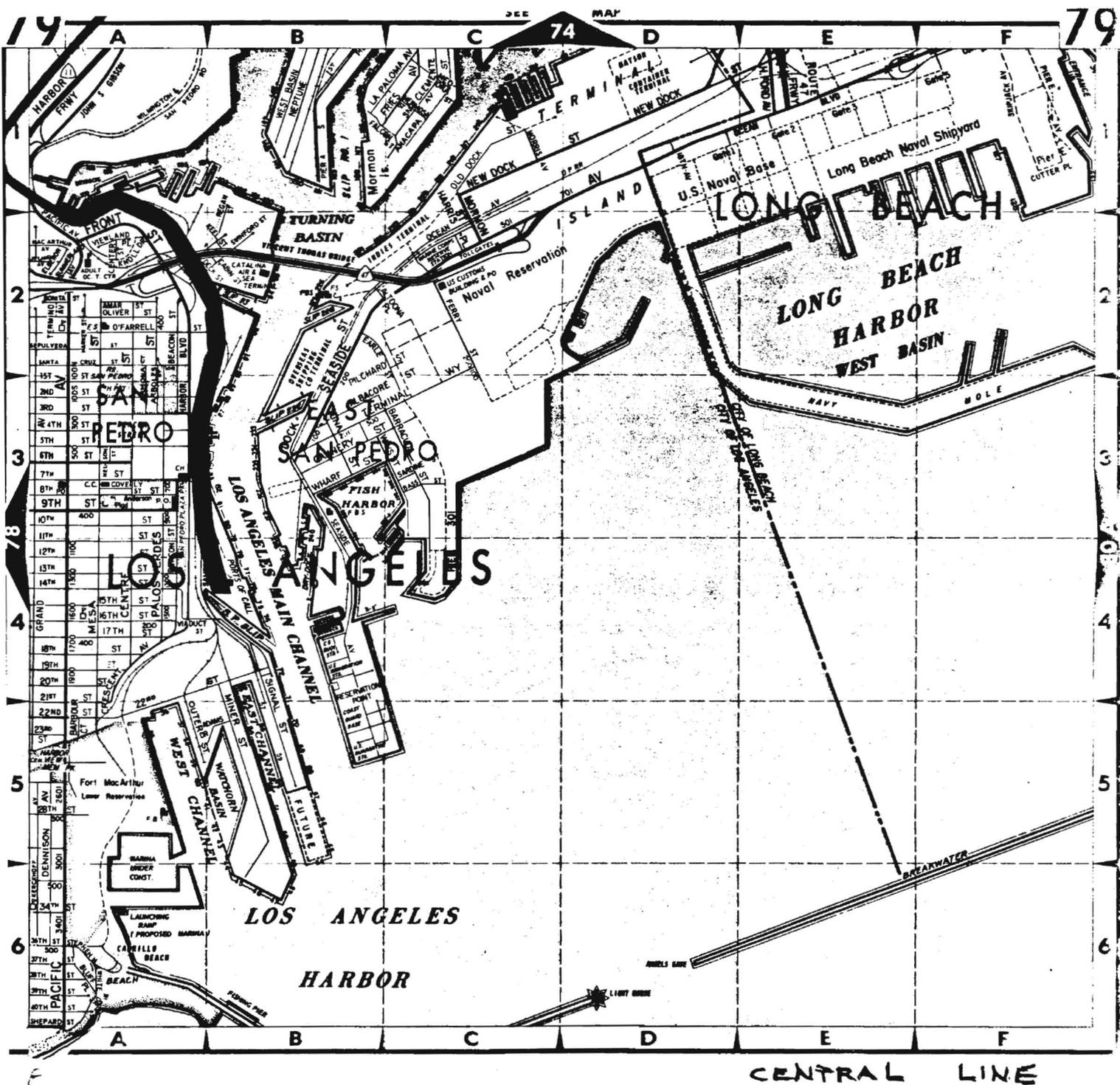


The possibility of having the railroad running along the Harbor Freeway on the east (and southward on the west) should be considered before the Freeway Line is finalized.

If the Freeway route is adopted, the design of stations should minimize freeway modifications. A shoulder (rather than median) alignment may prove more beneficial in this respect.

The 11/405 interchange would necessitate special consideration of the location and configuration of the rail junction between the central and the Valley-Long Beach lines.





Tight decline from Harbor Freeway to Front Street.

Clearance under Vincent Thomas Bridge will have impact on location and height of line.

The structures (both supports and horizontal beams) are likely to interface with the operation of other modes of transportation in the harbor area, such as cranes and other materials handling equipment.

Type of Alignment

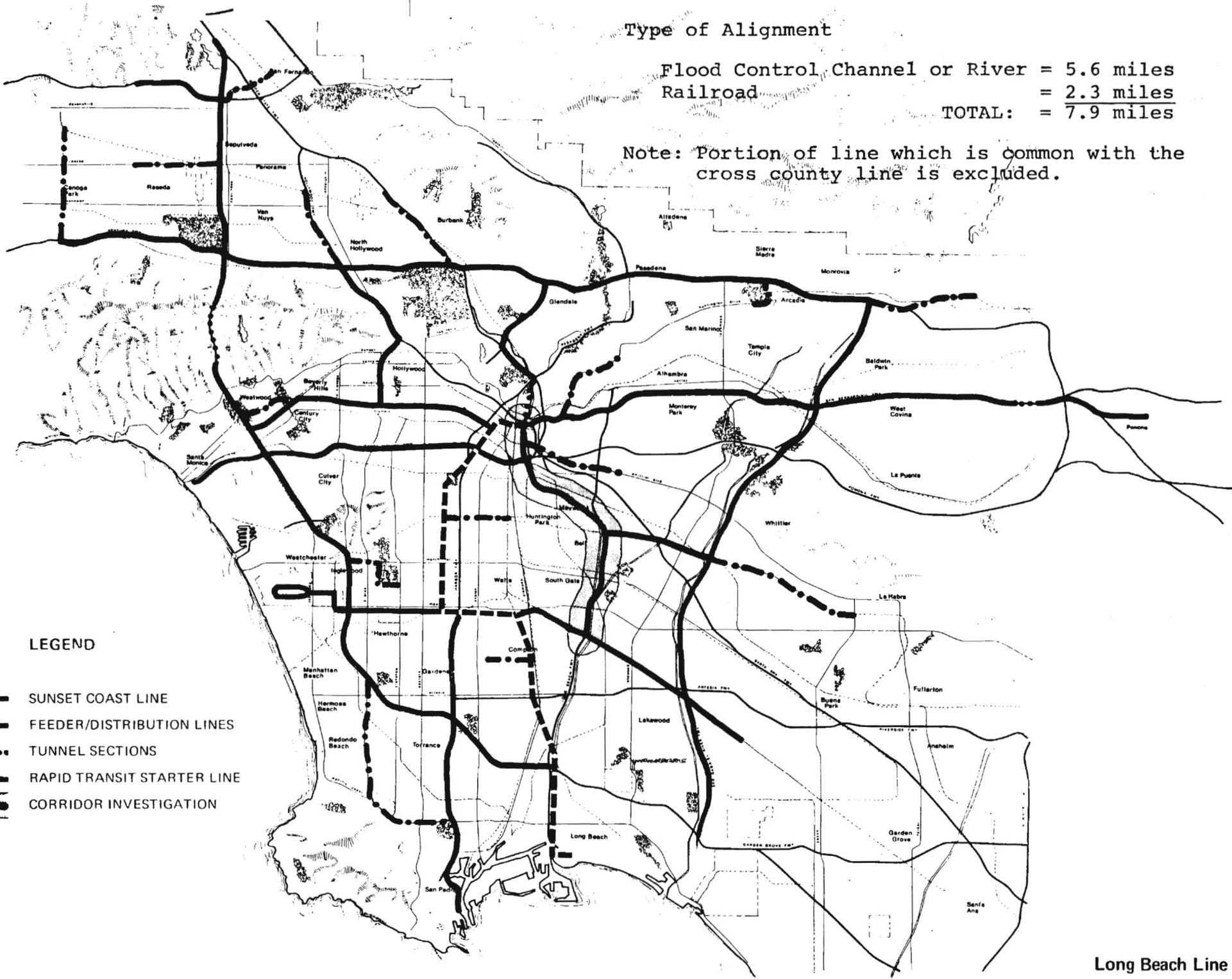
Flood Control Channel or River = 5.6 miles
 Railroad = 2.3 miles
 TOTAL: = 7.9 miles

Note: Portion of line which is common with the cross county line is excluded.

I-83

LEGEND

-  SUNSET COAST LINE
-  FEEDER/DISTRIBUTION LINES
-  TUNNEL SECTIONS
-  RAPID TRANSIT STARTER LINE
-  CORRIDOR INVESTIGATION

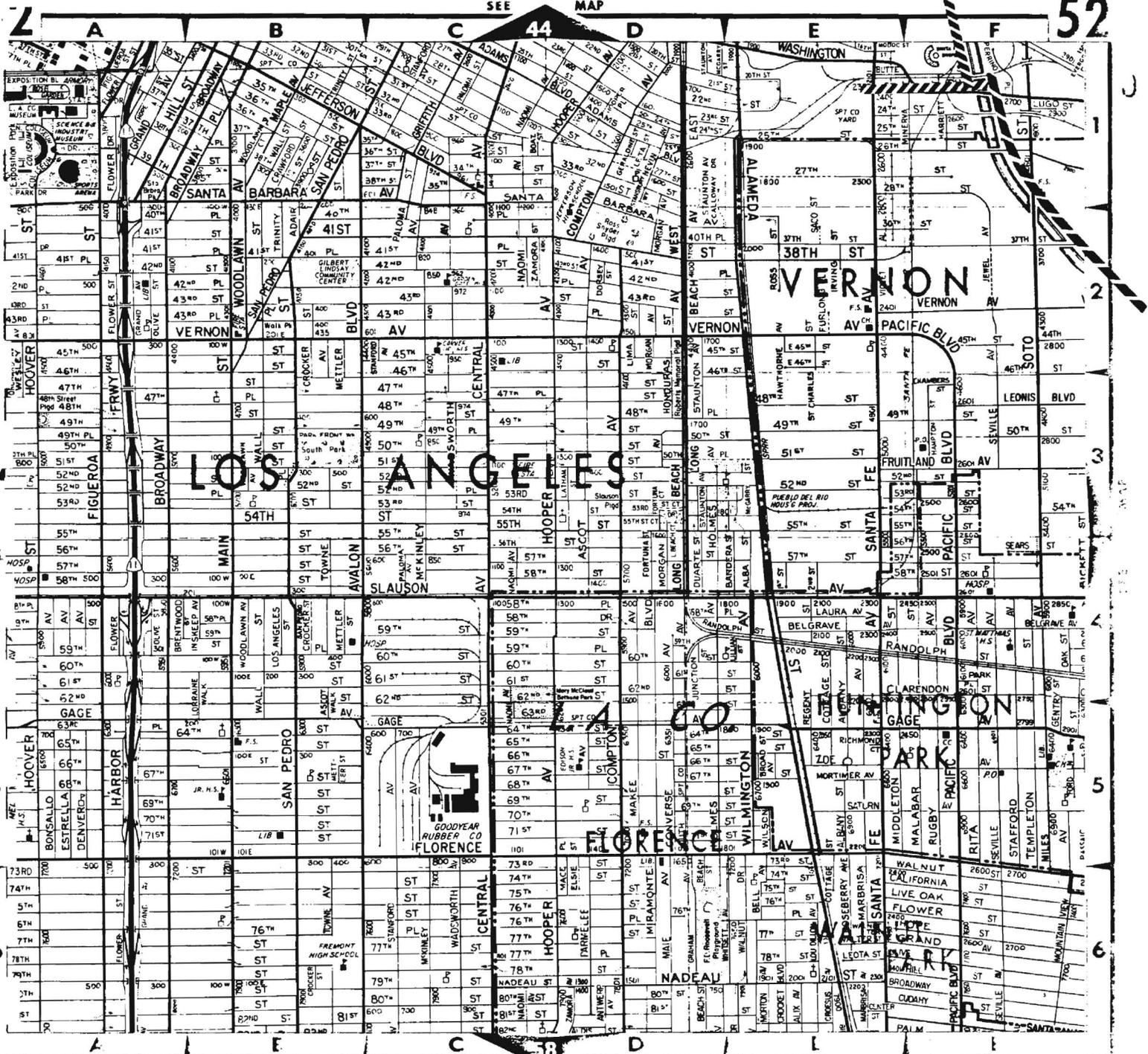


Long Beach Line



The crossing of Route 101 will cause some difficulty in the downtown area due to existence of bridges, railroads and structures.

The Route 10 crossing will also necessitate further considerations if the Cross County Line (Route 10 alternate) is opted for, since an interline junction may be necessitated in the southwest quadrant.





The railroad right-of-way south of Washington Boulevard between Soto Street and the Long Beach Freeway may be less costly than the originally proposed route.

The railroad right-of-way adjacent to the Los Angeles River from Downey Road to Randolph Street may be less costly.



It might be necessary to cross over the Long Beach Freeway at a severe skew where the freeway crosses over the Los Angeles River. This would necessitate long spans.

The railroad right-of-way east of Garfield Avenue between Rio Hondo River and the Airport Line may be less costly.



The railroad right-of-way east of Garfield Avenue between Rio Hondo River and the Airport Line may be less costly.

APPENDIX II

RELATIVE ADVANTAGES/DISADVANTAGES OF GUIDEWAY PLACEMENT

FWY MEDIAN

ADVANTAGES

DISADVANTAGES

AT GRADE

Simple construction (no structures)	Requires freeway widening
Simple emergency treatment	Freeway traffic disruption
No major R/W problems	Safety (freeway interference)
Less costly than elevated	Stations severely restricted
Little utility relocation	Third track severely restricted
Little environmental impact	Junctions difficult
Traffic disincentive (may be commensurate with regional policies)	

ELEVATED

Less traffic disruption upon completion	More difficult construction
Less R/W required than at grade	Unsafe work area
Safety/security of rapid transit - OK	Traffic interference during construction
Simpler design (no ramps, etc.)	Difficult maintenance
Little utility relocation and drainage needs	Difficult emergency treatment
Easier (than at-grade) for junctions	Security of freeway traffic
Easier (than at-grade) for stations	Junctions difficult
	More conspicuous, visual impact

FWY EMBANKMENT

ADVANTAGES

DISADVANTAGES

AT GRADE

Good station location and expansion

Easy street accessibility

Easier construction

Easier maintenance

Easier emergency procedures

Easier junction circumvention

)
)
)
(than median
)
)
)

Ramp interference

Impairs future freeway
widening

Environmental problems

ELEVATED

Same as above, plus

No ramp interference

Impairs future freeway
widening

Environmental problems

RAILROAD R/W

ADVANTAGES

DISADVANTAGES

AT GRADE

Simple construction & maintenance

Poor security (from public)

Least cost

Poor safety (of public)

Existing tracks

Traversing problem (at-grade crossings)

Good alignments & grade

Interference with regular railroad usage

Station accessibility OK

Effect on land use growth redirection

Easier emergency arrangements

More acceptable environmentally than freeway

ELEVATED

Good alignments & grades

Maintenance more complicated

R/W: only easement may be necessary

Structure costly

No safety/security problems

Emergency more complicated

No traffic interference

Environmental impacts

Easy station location and expansion

Effect on land use

No interference with railroad traffic

FLOOD CONTROL CHANNELS

ADVANTAGES

Simple maintenance
Simple construction, not
disruptive
No R/W costs
No residence relocation,
condemnation
Good alignments, grades
Ample land for stations

DISADVANTAGES

Requires precautions against floods
Distant from activity centers
Reduces accessibility for channel
maintenance
Requires grade separation from
public

APPENDIX III

POSSIBLE GUIDEWAY LOCATIONS

Freeway Median at Grade (sections where freeway right-of-way is adequate to allow freeway widening)

Valley/Long Beach Line (Route 405 and Route 118)

1. Route 5 to Route 101
2. Route 11 to Route 7
3. Route 118, from Reseda Avenue to Route 405

Inter-Valley Line (Route 210)

1. Canoga Avenue to Route 170
2. Route 5 to Route 605

Hollywood Bowl Line (Route 101)

1. None

San Gabriel River (Route 605)

1. Route 210 to Route 405

Century City Line

1. No freeways involved.

Cross-County Line (Route 10)

1. From Coast Hwy. to Robertson Blvd.

International Airport Line (Route 105)

1. Aviation Blvd. to Vermont Ave.
2. Willowbrook Ave. to Route 7

Central Line (Route 2 and Route 5)

1. None

Long Beach Line (Route 7)

1. Florence Ave. to Airport Line

Pomona Line (Route 10)

1. Los Angeles River to Santa Anita Ave.

Freeway Shoulder at Grade (where freeway R/W is adequate to allow freeway widening)

Valley/Long Beach Line (Route 405 and Route 118)

1. Route 5 to Route 101
2. Route 11 to Route 7
3. Route 118 from Reseda Ave. to Route 405

Inter-Valley Line (Route 210)

1. Canoga Ave. to Forman Ave.
2. Route 5 to Route 605

Hollywood Bowl Line (Route 101)

1. None

San Gabriel River (Route 605)

1. Route 210 to Route 405

Century City Line

1. No freeways involved

Cross/County Line (Route 10)

1. Coast Hwy. to Robertson Blvd.

International Airport Line (Route 105)

1. Aviation Blvd. to Vermont Ave.
2. Willowbrook Ave. to Route 7

Central Line (Route 2 and Route 5)

1. Route 134 to San Fernando Road

Long Beach Line (Route 7)

1. Florence Ave. to Airport Line

Pomona Line (Route 10)

1. Los Angeles River to Grand Ave.

Elevated in Freeway Mediar.

All locations except where tunnel is necessary

Elevated in Freeway Shoulder

All locations except where tunnel is necessary

Railroad Right-of-Way, Includes Both Elevated and at Grade Situations

Valley/Long Beach Line (Route 405 and Route 118)

1. West of Sepulveda Blvd. from Ohio Ave. to Exposition Blvd.

Inter-Valley Line (Route 210)

1. A.T. and S.F. line south of Route 210 between Santa Anita Park and Route 605.

Hollywood Bowl Line (Route 101)

1. No railroad lines in this vicinity

San Gabriel River Line (Route 605)

1. S.P.T. line east of San Gabriel River between Beverly Blvd. and Slauson Ave.

Century City Line

1. Adjacent to Santa Monica Blvd. from Route 405 to the easterly terminus.

Cross-County Line (Route 10)

1. S.P.T. line along Exposition Blvd. from Coast Hwy. to the Los Angeles River.
2. A.T. and S.F. line north of 26th St. between the Los Angeles River and the San Gabriel River
3. Railroad line south of the Los Angeles River between Downey Rd. and Randolph St.
4. S.P.T. line north of Randolph St. between Route 7 and Route 605

International Airport Line (Route 105)

1. A.T. and S.F. line west of Aviation Blvd. between Imperial Hwy. and Century Blvd.

2. S.P.T. line from Los Angeles River to Orange County

Central Line (Route 2 and Route 5)

1. S.P.T. line west of San Fernando Rd. between the Glendale Fry. and the Pasadena Fry.
2. S.P.T. line east of Harbor Fry. from the Starter line to Compton Blvd., thence running westerly to west of the Route 11, thence running southerly from Compton Blvd. to 204th St., thence running easterly to Route 11.

Long Beach Line (Route 7)

1. A.T. and S.F. line west of Los Angeles River between Route 101 and Route 10
2. A.T. and S.F. line north of 26th St. between the Los Angeles River and Route 7
3. Railroad line south of the Los Angeles River between Downey Road and Randolph St.
4. S.P.T. line east of Garfield Ave. between the Rio Hondo River and the Airport Line.

Pomona Line (Route 10)

1. S.P.T. line south of Valley Blvd. from Route 57 to Garey Ave.

Flood Control Channel on River Right-of-Way, Includes Both Elevated and at Grade Situations

Valley/Long Beach Line (Route 405 and Route 118)

1. None involved.

Inter-Valley Line (Route 210)

1. Los Angeles River between Buena Vista St. and Route 134

Hollywood Bowl Line

1. None involved

San Gabriel River Line (Route 605)

1. San Gabriel River between Arrow Hwy. and Route 405)

Century City Line

1. None involved

Cross-County Line

1. Los Angeles River between Washington St. and Randolph St.

International Airport Line (Route 105)

1. None involved

Central Line (Route 2 and Route 5)

1. Los Angeles River between Route 2 and Route 11

Long Beach Line (Route 7)

1. Los Angeles River between Route 101 and the Airport Line

Pomona Line

1. None involved

Century City Line No freeways involved

Cross County Line

I-10	from Coast Highway to Robertson	Possible (some problems)
	from Robertson to 11	Not Recommended
	from 11 to Los Angeles River	Not Recommended

International Airport Line

I-105	Widening is	Not Necessary
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<u>Central Line</u>	Rte. 2, Rte. 5	Not Recommended
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Long Beach Line

Rte. 7	South of Florence to Rte. 91	Possible
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Pomona Line

I-10	Los Angeles River to Santa Anita	Not Necessary (Busway)
	East of Santa Anita to 605	Not Recommended

Reference:

This information based on CAL TRANS Study of January, 1976.

Century City Line No freeways involved

Cross County Line

I-10	from Coast Highway to Robertson	Possible (some problems)
	from Robertson to 11	Not Recommended
	from 11 to Los Angeles River	Not Recommended

International Airport Line

I-105	Widening is	Not Necessary
-------	-------------	---------------

<u>Central Line</u>	Rte. 2, Rte. 5	Not Recommended
---------------------	----------------	-----------------

Long Beach Line

Rte. 7	South of Florence to Rte. 91	Possible
--------	---------------------------------	----------

Pomona Line

I-10	Los Angeles River to Santa Anita	Not Necessary (Busway)
	East of Santa Anita to 605	Not Recommended

Reference:
This information based on CAL TRANS Study of January, 1976.

APPENDIX V

ENERGY CALCULATIONS FOR THE S.C.L. SYSTEM

In this section, the actual power requirements of the S.C.L. trains will be estimated. The calculations are made in several different ways in order to check the estimates. These will be compared with available power. Several related calculations will be made (energy saving, etc) and several other problems will be discussed. The basic approach is to calculate the retarding forces on the train and determine $\int Fds = \text{Energy}$ (in ft.-lbs.). This is then transformed into megawatts.

There are a number of assumptions that are made in connection with the calculations. The most significant of these assumptions are:

1. Calculations start at the transformer - rectifying locations.
2. The resistances of the third rail are low enough and the density of the transformer-rectify stations high enough so that the line drop in the third rail is not a significant factor.
3. The system is an "all up" mode, i.e., all cars operating. All are assumed to be in three car trains.
4. The guigeway is assumed to be level.
5. A regeneration braking system is assumed. Further, it is assumed that the energy used to decelerate the train can be used to accelerate the train or to bring it "home" when power losses occur.
6. Sea level operation, standard temperature and pressure.

DIRECT CALCULATIONS

In this approach, the drag and friction are estimated directly (i.e., from basic relationships).

We will start with the frontal drag.

Frontal Drag:

$$\text{Drag} = 1/2 \rho V^2 S C_D$$

$$\rho = \text{density} = \text{slug/cft.}^3 = .0023$$

$$S = \text{frontal area} = 12 \times 10 = 120 \text{ sq. ft.}$$

V = velocity, ft. sec.⁻¹

$$C_D = .35^1$$

TABLE 1

<u>V mph</u>	<u>V(ft.sec.⁻¹)</u>	<u>V²</u>	<u>D</u>	<u>D_p</u>	<u>Total</u>
20	29	841	40.6	19	39.6
40	58.6	3433	165.8	35	200.8
50	73.3	4373	259.5	93	352
60	88	7744	374.03	175	449
70	102.6	10526.7	510	238	748
80	117.3	13759	664.5	311	975
85	126	15876	766	360	1120

Parasitic Drag: C_{D_F} for Reynolds's Number = $R = 2.41 \times 10^8$

$$C_{D_F} = .0043 \text{ DOUBLE SURFACE}^2 \text{ (2 sides of a plate)}$$
$$= .0021 \text{ Wetter Area (single surface)}$$

$$D_p = 1/2 (.0023) (V)^2 (3 \times 270 \times 12) (.0021)$$

ROLLING FRICTION

100,000 = w (weight of car) (3 cars)

$$P = \frac{Wa}{r} \quad a = \text{coefficient of rolling friction}^3$$

r = radius in inches

$$\text{per car } p = \frac{100,000 (.02)}{20} = \frac{2000}{20} = 100 \text{ lbs.}$$

Total/Train = 300 lbs.

¹L. S. Marks, Mechanical Engineers Handbook, MacGraw-Hill, p. 1540.

²Ibid., pp. 1480-81.

³O. W. Eshbacl, Handbook of Engineering Fundamentals.

TABLE 2

TOTAL RETARDING FORCE

<u>V</u>	<u>Total</u>
20	339.6
40	500.8
50	652
60	749
70	1048
80	1275
85	1420

By use of Marks' Graph entitled Train Resistance.⁴ At 70 mph the total resistance of a car is 900 lbs., and for a 3-car train 2700 lbs.

By use of Marks' Composite Formula,⁵ at 85 mph assumed velocity:

$$F = W(1.3 + \frac{29}{w} + .03V) + .00034 AV^2 \text{ --lbs per car}$$

W = weight in tons

V = velocity, mph

w = weight per axle

A = frontal area, sq. ft.

Thus the retarding force: (for 3 cars)

$$F = 3(50)[1.3 + \frac{2}{12.5} + .03V] + .0003 (120)(85)^2$$

$$F(3 \text{ cars}) = 1800 \text{ pounds}$$

⁴L. S. Marks, Handbook for Mechanical Engineers, 5th Edition, MacGraw-Hill, p. 1434.

⁵Ibid.

By use of Muller's Formula from the Rand Corporation,⁶ the computation is made at 85 mph for a three-car train.

$$F = W (3.8 + .00805V) + .00255 (N + 2.7) + A (V + 7.45)^2$$

W = weight of car (kilograms)

V = velocity (kilometers/sec.⁻¹)

N = number of cars

A = frontal area of car divided by 8 (square meters)

$$F = 44 (3.8 + .00805 \times .138) + .00255 (3 + 2.7) + \frac{12}{8} (138 + 7.45)^2$$

$$F = 1465 \text{ Kg or } 3200 \text{ lbs.}$$

We now have several figures for the steady state retarding forces acting on the train. They are:

Mark Formula 1800 lbs. (These two should be the same. Presumably the same thinking went into
Mark Graph 2700 lbs. the graph as the formula.)

Independent Calculations $D + D_p + R \text{ Friction} = 1400 \text{ lbs.}$

Muller's Formula 3700 lbs.

As estimates of drag coefficients seem to vary rather widely, as do the rolling coefficients of friction, the divergence is not surprising.

We will arbitrarily add 50% to ours (and Muller's) estimates. This is essentially an average of the high and low values.

$$F = 7000\# \text{ (Retarding)}$$

⁶R. H. Haase and W. H. T. Holden, Performance of Land Transportation Vehicles, The Rand Corporation.

TABLE 3

<u>V</u>	<u>Adjusted Fd</u>	<u>Ft. Traveled in 1 sec.</u>	<u>HP</u>	<u>For 333 Trains</u>
20	523	29	27	8,991
40	750	58	79	26,307
50	975	73	129	42,957
60	1123	88	179	59,607
70	1574	102	291	96,903
80	1912	117	406	135,198
85	2130	126	494	163,020

Air Conditioners, Lighting, Compressors

The air conditioner load is estimated to be 35 K.W. per car. The compressor is less than 2 K.W. per car. The lights are less than 1 or 2 K.W. per car.

Thus for 1,000 cars:

35 megawatts for air conditioner

2 megawatts for compressor, lights

37 megawatts

Stations

Most of the stations as illustrated in the S.C.L. report, appear to be open. Thus, there is no heating or cooling involved. At night there would presently be some lighting. (Probably less than 1 K.W. per station.) This energy use can be ignored.

Acceleration

The forces necessary to accelerate the trains are estimated in this section. A rather important assumption is made in this calculation, namely that regenerative braking will be used. The fashion in which it will be used we have assumed is in accelerating the train. The braking may be electrical or mechanical, an 80% efficiency is assumed. Under these assumptions, the energy necessary to accelerate the train will be computed.

With the S.C.L. report, we assume the acceleration is 4 mph/sec. This amounts to $5.86 \text{ ft/sec.}^{-2}$ as $V = At$, we can determine the train to reach a velocity, and as $S = 1/2 At^2/\text{ft.}$ We can find the distance on which the force ($f = ma$) must operate. Note that the mass is in slugs = $W/32.2$.

The force acting to produce the $5.86 \text{ ft. sec}^{-2}$ acceleration will be given by $F = ma$, $F = \frac{300,000}{32} (5.8) = 54,596 \text{ lbs.}$ Thus the energy used during the acceleration phase is: distance x 54,596 lbs. The result is expressed in ft. lbs.

Under the above assumptions, the energy requirements are calculated in Table 4.

TABLE 4

<u>Velocity (sec)</u>	<u>Time (sec)</u>	<u>Distance (ft.)</u>	<u>Horse- power</u>	<u>Energy Use (80% efficiency on regenerate brak- ing assumed)</u>	<u>Mega- watts</u>
29	4.9	70	6,972	1,394	1.0
58	9.8	282	28,088	5,617	4.1
73	12	423	42,133	8,426	6.3
88	14.9	653	65,042	13,008	9.7
103	17.5	900	89,644	17,928	13.3
117	19.8	1152	114,745	22,949	17.1
126	21.4	1346	130,068	26,014	19.4

The total energy requirements are listed below in Table 5. As previously noted, this includes train traction energy (drag, rolling, friction, acceleration), air conditioning, compressor, lights, etc.

Allowances are made for the efficiency of various processes. Transformers are assumed to be 98% efficient, rectifiers about 90%, and the traction motors about 96% efficient.

TABLE 5

S.C.L. SYSTEMS ENERGY REQUIREMENTS

<u>V</u>	<u>H.P. for 333 Trains</u>	<u>Mega- watts</u>	<u>Air Condition Compressor</u>	<u>Accel. (Regen.)</u>	<u>Light Stations</u>	<u>Total</u>	<u>At Sub Station (Before Rectifi- cation Megawatts</u>
20	8,990	6.7	37	1.0	1	45.7	53
40	26,310	19.6	37	4	1	61.6	72
50	42,960	32	37	6	1	76	89
60	59,610	44	37	9.7	1	91.7	107.8
70	96,900	72	37	13	1	123	144
80	135,199	101	37	17	1	156	183
85	163,000	121	37	19	1	178	209

CONVERSION TO EBO'S

It is desired to express the power usage of the train in terms of EBO's. To do this, it is necessary to make some assumptions on hours of operation per day. We will assume that the system runs at 100% capacity six hours per day, at 50% for another twelve hours at 50% capacity, and the remainder at 25% capacity. Thus, we can compute the kilo watt hours and, since 1,700 kilo watt hours = 1 EBO, we can determine the amount of oil used.

TABLE 6

Megawatts

53
72
89
108
144
183
209

This does not include live drops or the losses in the steam plant itself.

If the lines lost are assured to be nominal, say 10%, and the steam plants assured to be 35% efficient, we have about 767,600 barrels per year of oil required.

TABLE 7

Velout (Hrw-1)	Power (KW)	6 hrs. 100%	12 hrs. 50%	6 hrs. 25%	KWH Total	EBO's/ Day
20	53,000	318,000	318,000	78,000	714,000	1,200
40	72,000	432,000	432,000	108,000	972,000	1,631
50	89,000	534,000	534,000	133,500	1,201,500	2,017
60	108,000	648,000	648,000	162,000	1,458,000	2,451
70	144,000	864,000	864,000	216,000	1,944,000	4,100
80	183,000	1,098,000	1,098,000	274,000	2,470,000	4,151
85	209,000	1,254,000	1,254,000	313,200	2,820,000	4,171

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85	209,000	1,254,000	1,254,000	313,200	2,820,000	4,171

TRIP TO WORK

It is estimated that 35,000 people would be involved in constructing the S.C.L. If the average trip to work is 10 miles (the Los Angeles average), we would run about 35,000 gallons each way, or 70,000 gallons per day.

This is 1.666 barrels/day (at 5.8×10^6 BTU/barrel) we have 9.66×10^9 BTU/day, or 6,330 barrels a week or 32,918 barrels per year.

TUNNELING

It will be assumed that the tunneling will be done by tunneling machines. Typically, they would use several thousand horsepower engines. We will assume 5,000 hp. It is estimated that an engine of this size would use about 1 barrel/minute, 60 barrels/hour (20 hour operations/day), and 1,200 barrels/day. This would continue for about one year (thus using 436,800 EBO).

EARTH MOVING, DIGGING DEMOLITION

Assuming a fleet of two hundred large earth movers, compactors, tractors are employed five days a week. Each is extracted to use about one barrel/day. Thus we have 200 barrels per day, or 1,000 barrels per week.

TABLE 8

Summary (in EBO) Energy Use During Construction

	EBO Per Week
Concrete moving/mixing	50
Workers trip to work	6,330
Tunneling (for one year)	8,400
Earth Moving, Digging	<u>1,000</u>
Total	15,780 EBO/week at peak use
<u>After Tunneling</u>	
Completion	7,380 EBO/week

POWER AVAILABILITY

Los Angeles County is served principally by two suppliers of power. They are (1) the City of Los Angeles Department of Water and Power, and (2) Southern California Edison.

The Department of Water and Power's supply and demand for power⁴ since 1970, and projections of power (planned), are plotted in Figure 3.5.1.1. The curve, although drawn reasonably smooth, is actually discontinuous, i.e., the curve goes up in stages. The same information is plotted for Southern California Edison in Figure 3.5.1.2.

The projected demand in the DWP's segment of the County is also plotted on the same figure.

The total system supply and demand for power in the Southern California Edison's area⁵ is plotted in Figure 3.5.1.3. Note again that the supply curve is actually discontinuous, i.e., it increases in steps at particular times, each time corresponding to bringing a new unit "one line." This is not the power going to Los Angeles County. Consultants with Edison people say that they have no records (at least none readily available) that indicate what part of their power goes to the County area users.

Hence, the Edison power supplied to Los Angeles County must be estimated in some fashion. The approach used⁶ while not completely satisfactory, at least has some validity.⁶ Basically what has been done is to ratio the power available by populations, thus if Los Angeles County were to have 70% of the population served by Southern California Edison, we would assume that it would use 70% of the power Edison had available. (This percentage changes as the percentages of Edison's customers in Los Angeles County changes.) The demand has been handled in the same fashion.

Two things are at once apparent: (1) in both cases there appears to be enough excess supply over demand to easily accommodate the SUNSET COAST LINE System (i.e., 200 megawatts).⁷

⁴J. Roberts (DWP), An Analysis of the Electrical Energy and Load Growth Problems of Los Angeles for the Years 1973-2000, published in 1973.

⁵M. Douglas Whyte, System Forecast, 1975-1994, by the Southern California Edison Company, 1975.

⁶About 80% of the power is used by residential and commercial users (commercial is usually rather closely related to residential).

⁷S.C.L. System would use about 200 megawatts; this would make it the largest single user in the Los Angeles area.

The second thing that should be noted is that the future supply depends on facilities that do not exist yet.

Returning to the apparent excess power that Edison and the DWP have, it turns out that the excess is largely illusory because every power company has 15-20% of their equipment "down" at any time -- for maintenance or because of equipment failure -- and when this 15-20% is subtracted, most of the excess disappears.

An additional problem finds its source in the fact that all of the future capacity is still to be built.

There is, of course, no guarantee that the planned facilities will actually be constructed. This is particularly true for the nuclear plants. The DWP plans to get 1/3 of their power in 1990, and about 60-66% by 2000, from nuclear plants. Southern California Edison is currently obtaining power from its San Onofre nuclear plant which is in the process of expansion now. In 1990, 20% of Southern California Edison's power will be coming from nuclear plants. That this power is doubtful is an understatement. Environmentalists are fighting every "foot" of the way.

It must be noted that coal fired steam plants, particularly the larger ones (the 4 Corners Plant) are under attack from environmentalists.

In talks with the DWP and Southern California Edison people, both organizations maintain that the S.C.L. will entail additional generating capacity, and they express some doubt as to their ability to meet this demand. In fact, both groups express doubt as to whether they can meet normal demands.

ADDITIONAL ISSUES RELATED TO POWER REQUIREMENTS

1. Peak Loading Considerations

The peak load for the transit system should be from about 7:00 to 9:00 a.m., and again from 4:30 to 6:30 p.m., i.e., the rush hours.

The peak load varies with the seasons. In the winter, it occurs close to 7:00 p.m., and in the summer, at about 3:00 p.m. It invariably falls somewhere between these time periods. This will coincide with the evening peak load of the S.C.L. system. However, as it amounts to 2% to 3% of the total system power, it should present no serious problems.

PLANNED POWER

2. Purchased Power

A certain amount of power is purchased by the DWP and Southern California Edison from firms outside of the area, not part of the DWP or Edison companies. The power is purchased under contracts that run for a number of years. There is no guarantee that the contracts will be renewed. In the case of the DWP, only a small amount of power is purchased. It will continue to be purchased for much of the 1970's, but according to forecasts, will be phased out by 1980. At present, it amounts to about 16% of the DWP's total delivered power.

In the case of Southern California Edison, about 10% of the power is purchased, much of it from the northwest, from a series of dams on the Columbia River. This supply is variable, as it depends on the rains, and is not guaranteed.

In conclusion, the planned power in both the Southern California Edison and DWP can meet the forecasted demand through the year 2000. However, much of the planned capacity is on rather uncertain ground.

3. Reduction in Planned Power or Unexpected Increase in Private Demand

If an unexpected increase in private demand occurs, or there is a decrease in planned generating capacity, it would obviously be necessary to increase the system power production.

There is no easy way to do this, particularly with short load times. Possibly by the end of the century some acceptable alternate to coal (or oil) steam plants or nuclear energy will be usable.

Among the possibilities are solar power, geothermal power, fuel cells, magnitohydrodynamic generators, wind, fusion, utilization of solid wastes, tidal power or thermo electricity and fuel cells. The most immediate method is probably the fuel cell.

One possible alternate source of energy is via the use of waste material as fuel. Using trash in this fashion has two attractive features. The latter function is a fairly costly process, and further more, uses valuable land. The most frequently employed process is sanitary land fill. In spite of its name, sanitary land fill can cause considerable trouble if water permeates through the waste and enters the aquifer. In some cases, underground fires have started that couldn't be extinguished.

To make matters worse, it is estimated that by about 1978 to 1980, almost half of the United States cities will have run out of space to dump trash.

The first method involves simply burning the fuel in special furnaces. This method has been tried in many places over the last several decades, and is currently being used in St. Louis where 1,000 tons of trash per day is shredded and added to coal and burned for a steam plant. Nashville, Tennessee, also burns trash to make steam, which is then used to heat several nearby buildings.

A second method is Hydrogenation. This process involves putting organic wastes in a closed (sealed) crucible and heating it to about 360°C for 20 minutes (CO₂ is added). At the end of the time, about one-half of the material is converted to a liquid fuel. The fuel has a fairly high energy content, 15,000 BTU's/pound, compared to Oil at 20,000 BTU's/pound.

Still another process is Pyrolysis. In this method, the waste is sealed and heated to 900°C. Three fuels result: (1) a gaseous fuel, (2) a liquid oil-like fuel, and (3) combustible solids.

The Pittsburg Energy Research Center at the University of Pittsburg, recently received a \$750,000 NSF contract to construct an experimental Pyrolysis plant.

The Garret Corporation has built a small plant of this nature which produces oil that is used by a steam plant which services Escondido and San Marcos, California. The plant processes 200 tons of waste per day, and produces about 200 barrels of "oil" per day. The Garret plant produces the oil for about \$8.00 a barrel, which turns out to be cheaper than the land fill operation formerly used to dispose of trash.

The Garret Corporation claims that a plant ten times as large would pay for itself and make a profit.

Monsanto is currently building a \$14,000,000 pyrolysis plant for the City of Baltimore.

A third process uses bacteria. It is called Bioconversion, and uses anaerobic bacteria to generate methane. This process was demonstrated in 1871 in England, and has been in extensive use in India. The first large plant of this nature was built in Bombay in 1905.

A plant in Delphi, India, uses the waste to power a 45,000 hp internal combustion engine which powers a generator. Thus in this fashion about 3 megawatts are produced. One of the primary designers of this type of system (Ram Singh) says that several thousand of these plants have been installed in India.

A considerable amount of work was done along these lines in Germany during World War II; several methane plants were built and used.

There are several other methods of Bioconversion that vary from single "composting" to systems that use sewerage. In the latter case, the primary technique is to use sewerage ponds to grow algae (algae is the most efficient and fastest growing plant life in existence), dry it out, and burn it. This is largely theoretical--algae has been grown from sewerage in a systematic fashion, but not for use as fuel.

One final thing should be noted: trash and waste are generated in vast quantities in this country. Los Angeles City alone generates over 1,000,000 tons of solid waste per year, which it collects and disposes of at a cost of about \$20,000,000 per year.

ENERGY SAVINGS

1. Displaced Cars

The SUNSET COAST LINE estimate of ridership varies from 1,000,000 to 4,000,000 per day. Assuming that people go to a location and return to where they began, the actual number of people riding the system would be 500,000 to 2,000,000.

This will obviously decrease the number of cars in use in the county. (The total number of registered vehicles is 3,293,000, and the occupancy figure is between 1.1 and 1.2 on week days, and 1.6 to 1.8 on weekends.)

Thus, the weighted average occupancy is approximately 1.3 people per car. Hence, the number of cars involved is between 192,000 and 1,540,000. If the average trip to work is 10.2 miles, the round trip is 20.4 miles per day. The total mileage then, is 3,800,000 to 31,400,000 miles per day. At 12 miles per gallon, this is 316,000 gallons (or 2,600,000 gallons), in EBO 75,235 to 62,300.

2. Savings Due to Higher Speeds, Having Fewer Traffic Jams

Due to the removal of the estimated 192,000 vehicles, if the higher estimate is correct, there should be a reduction in traffic jams, and higher speeds would be achieved on the freeways. It is estimated that the freeway speeds would increase from about 18 mph to 36-40 mph during rush hour. Surface street speeds would not increase too much since they are signal controlled. Average speeds should go up from 15 mph to 20 mph.

The average trip length will be assumed to be twelve miles on the freeway and eight miles on surface streets. The freeways carry about 900,000 cars into the CBD daily, and another 170,000 travel on the surface streets.

The savings per car on the freeway would be about one-third of an hour at a gasoline consumption rate of two gallons per hour. There would be a savings of two-thirds of a gallon per car.

On surface streets, the savings in crowded areas would be about 1.33 hours or one-quarter of a gallon.

Savings effected in outlying areas would be considerably less; a value of .1 gallons will be assumed. We will further assume that of the 1,250,000 cars not displaced by the S.C.L., 80% operate some time during the day, most likely on a relatively short trip (about four miles).

Thus we have 170,000 cars coming into the CBD and about 1,000,000 operating elsewhere in the county.

Trips To and From the CBD

Freeways (rush hour) 2-way = $1-1/3$ gallons/day/car
= 1.33×10^5

Surface street (rush hour)
2-way = $170,000 \times 1/4 \times 2$
= 85,000 gallons

Trip (not to CBD) (rush)
2-way = $1,000,000 \times .1 \times 2$
= 200,000 gallons

Total gasoline saved
per day = 418,000 gallons

(under the assumed ridership = 9,950 barrels of oil (EBO))

This is probably an over-estimate, because some of the 170,000 cars now coming into the CBD wouldn't come.

3. Concentration

The S.C.L. would make it possible for more people to utilize the crowded areas, i.e., the CBD and Wilshire strip, for both business and shopping.

It is possible if the number of cars coming into the CBD's decrease, that new buildings could replace the parking lots. While this directly would not save energy, it might allow for increased efficiency of some organization by allowing them to locate all of their activities at one place.

4. Improvements in the Train Electrical Systems

There would seem to be little hope for really major improvements in the overall efficiency of the system. The original possibility would be (providing it is successful) using A.C. equipment with a pulse width modulation. This would allow lighter motors with the same performance as the D.C. motors. However, actual improvement in power consumption appears doubtful.

5. New Generating Capacity

Both Southern California Edison and the DWP maintain that if the S.C.L. system is produced they will have to add extra capacity to operate the system. Neither utility would specify how much extra power would have to be added.

Due to the long lead times needed to install additional generating capacity, it would be necessary to initiate action in this direction at once.

CONNECTING INTO THE EXISTING POWER SYSTEM

Conversations with DWP and Southern California Edison personnel indicate that there should be no serious problem in hooking into the existing network, and that for the most part, we can connect to distribution points and substations. It would, of course, be necessary to run the line from the existing facilities to the train stations where, most likely, the transformer-rectifier would be located.

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REPORT TO THE
SOUTHERN CALIFORNIA RAPID TRANSIT DISTRICT
ON
THE FINANCIAL PROGRAM OF THE
PROPOSED SUNSET COAST LINE

Prepared by:

Donald S. Green
Associate Executive Director
Management Systems Division

March 10, 1976

At the request of the SCRTD, SRI agreed to provide an analysis of the overall financing feasibility of the Sunset Coast Line Proposal. The analysis was to include the following: cost escalation factors; sales tax revenues; fare revenues; bonding feasibility; cash flow; related impacts.

The analysis was to be performed in a limited period of time and be based on information presented in the Sunset Coast Line proposal and information provided by other consultants engaged for the proposal review.

The research and analysis performed by SRI was under the direction of Donald S. Green, Associate Executive Director, Management Systems Division. He was assisted by Ms. Joan Carter, Dr. Dudley Andersen, Dr. Claire Starry, Charles E. Erickson, Marc F. Roddin, Dr. Randall J. Pozdena and Jack Bland.

SUNSET COAST LINE FINANCIAL ANALYSIS EXECUTIVE SUMMARY

March 12, 1976

Stanford Research Institute reviewed the financial program portion of the Sunset Coast Line proposal presented to the Southern California Regional Transit District. The review was performed in a short period of time. It was based on data contained in the Coast Line proposal and additional information provided by consultants reviewing other portions of the proposal.

SUNSET COAST LINE PROPOSAL - FINANCIAL PROGRAM

Patronage:	1 million passengers per day.
Fares:	25¢ local and interurban, \$2.00 airporter, in 1976 dollars.
Fare Escalation:	none.
Operating Cost Escalation:	not explicit.
Construction Cost Escalation:	intended 10%; implicit rate below 8.5%.
Sales Tax Rate:	1%, with half reserved by 1987 for operations.
Sales Tax Revenue Escalation:	6.4%
Borrowing Terms:	8%, varying maturities.
Borrowing amount:	\$7.5 billion, 15 years.

Findings and Methodology

1. The growth factor of 6.4% stated in the proposal for sales tax revenues was reasonable and used in our analysis.
2. The patronage estimates on which fare revenues are calculated were deemed to be reasonable for purposes of financial analysis, but additional estimates 33% above and 33% below the assumed 1 million passengers per day at full system operation were also examined.
3. The construction cost inflation factor used in the analysis was stated to be 10%. However the inflation factor implicit in the calculations of the proposal in stating the cost of construction in future dollars was considerably below 10%, assuming a 15-year period for planning and construction. In our analysis we used a construction cost inflation rate of 8.5% per year.
4. The operating cost inflation factor was not explicitly stated in the Coast Line proposal. We used a 7 % rate.
5. Fare revenues were estimated in the proposal at a constant rate of 25 cents for local and interurban service and \$2.00 for airporter service, or a weighted average fare of 33 cents at full system operation. In our analysis we assumed the 1976 fares stated in the proposal would be escalated at the same rate as the increase in the Los Angeles Cost of Living Index, excluding food, or 3.2 percent. This gives a local fare structure at the beginning of operations in 1984 of 30 cents and a weighted average fare in that year of 42 cents. We also examined an alternative fare structure beginning operations in 1984 with a local fare of 50 cents and an airporter fare of \$4.00, and escalating at 3.2 percent thereafter.

6. The operating deficit of the system was calculated on a yearly basis for the growing number of miles in operation and related patronage and operating costs. The remaining deficit was financed by drawing, as necessary, from the 1/2 percent sales tax available to meet operating costs. The surplus available was applied to meeting construction costs.
7. Construction financing was derived from available sales tax receipts, after using the amount required to meet operating deficits up to a maximum of 1/2 percent, and borrowing.
8. Borrowing was assumed with 30 year maturities, at 7.5% interest, with equal annual debt service payments.
9. The amount of borrowing in any year was constrained to an assumed 1 percent of the amount of the total new issues projected for the national market for state and municipal bonds; and further constrained to be within 1/2 percent of the cumulative total of state and municipal bonds outstanding in each year. In addition, debt service from borrowing was required to have 1 1/4 times coverage from available sales tax receipts, after meeting operating deficits.
10. The construction schedule was constrained to be within the maximum yearly expenditures, as proposed by De Leuw, Cather in their analysis of the proposed system.

Conclusions

Based on these findings and analysis methods, the following conclusions were reached.

1. The system as proposed could not be financed in a 15-year period.
2. Financial constraints would require a period of up to 35 years to complete the system, under the 1% sales tax and assumptions used in our analysis. It would involve a construction cost of \$6.7 billion, expressed in 1976 dollars, and require an outstanding debt of \$16 billion by the end of construction in the year 2011.
3. Under the 1% sales tax, assuming the higher fare structure alternative, some design modifications and delay of a portion of the system, a 244 mile system could be financed in a 24 year period. It would incur construction costs of \$5.7 billion expressed in the 1976 dollars and require an outstanding debt of \$6.7 billion by the end of construction in 1994.
4. A sales tax of 1 1/2%, with up to 1/2% available for operation financing, would permit construction of the full system in 19 years with debt outstanding of \$4.2 billion at the end of construction in 1995. This assumes the basic escalating fare beginning at 30 cents in 1984.
5. A sales tax of 1 1/4%, coupled with the higher escalating fare, would permit construction of 244 miles of the modified system in 18 years with debt outstanding of \$4.2 billion at the end of construction in 1994.

SUMMARY OF FINANCIALLY FEASIBLE ALTERNATIVES

<u>Sales Tax Rate</u>	<u>Full System</u>		<u>Modified System</u>	
	<u>1%</u>	<u>1 1/2%</u>	<u>1%</u>	<u>1 1/4%</u>
Miles	281	281	244	244
Years	35	19	24	18
Construction Cost in 1976 Dollars	\$6.7 bn.	\$6.7 bn.	\$5.7 bn.	\$5.7 bn.
Debt at end of Construction	\$16 bn.	\$4.2 bn.	\$6.7 bn.	\$4.2 bn.

1. Cost Escalation Factors

A. Construction Costs

The Coast Line Proposal states that ten percent was used to inflate the 1976 dollar estimates to arrive at the expected total sum of future construction and equipment expenditures. The total of future construction and equipment expenditures over the 15 year period of construction was stated as \$7.5 billion in the Coast Line proposal. In fact, assuming a 15-year period of construction with equal annual expenditures of the 1976 dollars of \$4.72 billion, the sum of the inflated annual expenditures would be \$11 billion; inflated at 8.5% it would be \$9.6 billion.

The difference between the proposal's estimate of \$7.2 billion and the amount of \$11.0 billion and \$9.6 billion figures calculated as described may be explained perhaps by the shorter period of construction used in the proposal calculation or other approximate mathematical techniques used to estimate the sum of future expenditures.

The historic rates of inflation in construction costs for the Los Angeles area is shown in Table 1. From 1960-1974 the rate of increase was 6.7%, rising to over 10% from 1968 to 1974. In recent years rates ranged from 7% to 16%.

Engineering News Record and Caltrans (California Department of Transportation) have used 8% to 8.5% as their long range forecast of the rate of inflation in construction and equipment costs. SRI finds these estimates reasonable and has used 8.5% as the construction cost inflator in this analysis.

B. Operating and Maintenance Costs

The Sunset Coast Line proposal indicated no specific rate of increase of operating costs. It did state \$40 million for 25 miles in 1982 and that the average rate would be \$1 million per mile at an unspecified date. SRI constructed an operating and maintenance cost index for Los Angeles County from published Bureau of Labor Statistics indices on wages paid to skilled workers in the Los Angeles area and on wholesale prices for equipment and machines. The index is shown in Table 1. The historic rate of growth in this index was 4.3 percent for the 15-year period 1960-1974 and 6.1 percent during 1968-1974. However, in recent years the rate of increase varied from 4 percent to ten percent. Caltrans and A. Alan Post have assumed long run future operating and maintenance cost inflation in the transit industry to be in the 6.0 to 7.5 percent range. SRI finds these estimates reasonable and uses 7 percent in this analysis.

TABLE 1
 CONSTRUCTION, OPERATING AND MAINTENANCE COST INDICES
 IN LOS ANGELES

	<u>Construction Cost Index¹</u>	<u>Operating and Maintenance² Cost Index</u>
1960	76	82
1961	80	84
1962	82	86
1963	84	88
1964	86	90
1965	90	92
1966	95	96
1967	100	100
1968	108	104
1969	111	109
1970	125	116
1971	145	125
1972	167	132
1973	178	137
1974	193	150
 <u>Compound Rate</u>		
1960-1974	6.1%	4.3%
1960-1967	3.7%	2.8%
1968-1974	10.6%	6.1%

¹ Source: Engineering News Record, various issues.

² Source: SRI, BLS. Wholesale Price Index for machinery and equipment and L.A. County skilled wage rates.

2. Sales Tax Revenues

The Sunset Coast Line proposal uses a forecast of growth in taxable transactions of 6.4 percent per annum based on historic experience of both the State of California and the County of Los Angeles. SRI analyzed historic data for Los Angeles County and concluded the 6.4 percent annual rate of growth is a reasonable estimate and uses that rate in the analysis.

Two methods of analysis were used by SRI. The first is a simple analysis of historic growth of taxable transactions for the county (excluding gasoline tax). The results of this analysis as shown in Table 2 indicate over the past 10 to 15 years total taxable transactions have grown between 6.0 and 6.5 percent per year with a slight acceleration in recent years.

The second method used by SRI is to separately investigate real and nominal growth in taxable transactions, also shown in Table 2. The real component was broken down into population growth and growth in real per capita transactions. Per capita constant dollar transactions increased at about 3.2 percent annually over the nine year period 1965-1974.* Population during this period increased at a rate of .5 percent. Using 3.0 - 3.2 percent average growth in real per capita taxable transactions, one obtains approximately a 3.5 percent annual growth rate for total taxable transactions in constant dollars.

Inflation rate forecasts for taxable transactions of 3.0 - 4.0 percent for the long term can be inferred from historic data on consumer prices in Los Angeles County, as shown in Table 2. Adding that to the 3.5 percent increase in constant dollars, we would expect the annual rate of increase in taxable transactions to be from 6.5 - 7.0 percent for the long term.

* The deflator used to adjust current dollar taxable transactions to constant dollars was constructed by SRI and was based on the consumer price index for Los Angeles-Long Beach and on the difference between the U.S. CPI and the U.S. CPI for commodities less food.

Based on these analyses, SRI concurs in the expected rate of growth in taxable transactions of 6.4 percent used in the Coast Line proposal, and that rate is used in this analysis.

TABLE 2
TOTAL TAXABLE TRANSACTIONS
LOS ANGELES COUNTY

	L.A. County Total Taxable Transactions (\$ millions)	L.A. County CPI for Tax Transactions (1967=100)	L.A. County Constant Dollar Per Capita Taxable Transactions (millions 1967 \$)
1950	5,283.7	79.14	1,602
1951	5,692.2	85.48	1,549
1952	6,152.5	86.86	1,570
1953	6,767.0	87.17	1,641
1954	6,856.9	85.65	1,606
1955	8,049.9	85.38	1,817
1956	8,508.8	86.79	1,748
1957	8,854.9	88.78	1,777
1958	8,436.4	90.34	1,614
1959	9,635.4	92.28	1,761
1960	9,841.1	92.89	1,744
1961	9,973.0	93.40	1,717
1962	10,809.9	94.10	1,808
1963	11,411.1	95.11	1,888
1964	12,178.7	96.42	1,896
1965	12,393.3	97.42	1,880
1966	13,397.8	97.80	2,011
1967	13,575.0	100.00	1,962
1968	14,783.6	103.40	2,052
1969	15,953.7	107.10	2,119
1970	15,839.7	110.60	2,035
1971	16,537.7	114.10	2,053
1972	18,169.0	116.50	2,223
1973	20,604.0	119.90	2,465
1974	22,610.0	131.80	2,464
<u>Growth Rates</u>			
1960-74	6.4%	2.5%	
1960-67		1.1%	
1968-74		4.1%	
1965-74			3.2%

3. Fare Revenues

A. Patronage

The bases for the patronage estimates and fare revenue estimates contained in the Sunset Coast Line proposal are shown in Table 3. These tables were constructed from data presented in a memorandum dated February 19, 1976, made available from Baxter Ward's office.

SRI and De Leuw, Cather reviewed the aggregate estimates. For purposes of the fare revenue analysis, SRI has used an average daily ridership of close to 1 million passengers, or 365 million fares per year at the time of full systems operation, as proposed in the Coast Line. We also examined revenues assuming a level of ridership 33 percent above and below the 1 million per day. We believe these ranges are not unreasonable, but further analysis is required.

We have assumed in the fare revenue analysis that ridership will be distributed over the period of system construction in proportion to the miles in operation.

B. Fares

The Coast Line proposal assumes no increase in the level of fares during the entire period of construction. We believe that assumption is inconsistent with the projected rate of 3.2 percent inflation in the Los Angeles Cost of Living Index used by SRI in the tax revenue analyses, and with the escalation factors of 8.5 percent and 7.0 percent used by SRI respectively in the construction and operating cost analysis.

We have projected an increase in fares equal to the Los Angeles Cost of Living increase implicit in the Tax Revenue forecast. In the analysis, the fare is increased at 5 cent increments. The 25 cent local and interurban fares in 1976 dollars used in the Coast Line

proposal would be 30 cents when the system starts operations in 1984. The airporter fare would be \$2.50. For one of the alternatives analyzed, we assumed a 50 cent local fare and \$4.00 airporter fare in 1984.

Table 3

SUMMARY OF SUNSET COAST LINE PATRONAGE ESTIMATES
AND FARE REVENUES FOR FULL SYSTEM OPERATION

	Weekday Rush	Weekday Off Peak	Weekend	Total Weekly Passengers	Total Weekly Revenue ^{xx}	Average Fare Per Passenger	Annual Passengers	Annual Revenues
Airporter	19,200	38,400	115,200	403,200	\$ 806,400	\$2		
Local	781,440	520,960*	781,440*	7,293,440*	\$1,823,360*	25c		
Red Car (Interurban)	144,000	96,000	224,000*	1,424,000*	\$ 356,000*	25c		
 TOTAL	 944,640	 655,360	 1,120,640	 9,120,640	 \$2,985,760	 33c	 474 mn	 \$155 mn
Reduced 25%	709,000	491,520	840,000	6,840,000	\$2,239,320		356 mn	\$116 mn

^{xx} Assumes no increase in fares.

* Based on corrected calculation.

Source: Baxter Ward Memorandum, February 19, 1976

4. Financial Analysis

A. Borrowing Requirements

Table 4 presents the schedule of construction developed by De Leuw, Cather. The Table shows annual expenditures expressed in 1976 dollars and miles completed by year for both construction and operating costs. It also shows the construction and operating costs in future dollars by year after applying compound interest rates. The schedule is the basic data used in the financial analysis.

Table 5 presents expected patronage and fare revenues using an escalating fare structure, as shown.

Table 6 presents an abbreviated operational financial schedule. After subtracting operating costs from fare revenues, it shows the balance available from the 1/2 percent operating finance portion of the sales tax available for construction finance.

Table 7 presents an abbreviated pro forma schedule for estimating cash flow and borrowing requirements to finance construction. The specific entries depend upon the actual year-to-year borrowings, interest rates and maturities. The actual cash flow analysis is presented in Section C, following the discussion on available financing.

TABLE 4

CONSULTANTS 16 YEAR PLANNING AND
CONSTRUCTION SCHEDULE AND COSTS, EXPRESSED
IN 1976 DOLLARS AND CURRENT DOLLARS
(\$ millions)

Miles	Miles Cum.	1976 Dollars		Current Dollars		
		Construction Costs	Operating Costs	Construction Costs	Operating Costs	
1977		68*		74		
1978		54		64		
1979		64		82		
1980		156		216		
1981		311		468		
1982		473		772		
1983		637		1,127		
1984	25	720	12	1,345	21	
1985	38	63	717	30	1,494	56
1986	38	101	712	49	1,609	96
1987	38	139	707	67	1,733	141
1989	38	177	702	85	1,869	192
1989	25	202	612	97	1,765	235
1990	25	227	436	109	1,367	282
1991	26	253	264	121	898	336
1992	28	281	89	135	329	399
Total	281	\$6,721		\$15,212		

* Includes one-time cost for starter system.

TABLE 5
 FARE REVENUE PROJECTIONS IN FUTURE DOLLARS¹
 FOR CONSULTANTS' 16 YEAR CONSTRUCTION SCHEDULE

	<u>System Miles</u>	<u>Passengers</u> ² (millions)	<u>Average Fare</u>	<u>Revenue</u> (\$ mn.)
1984	25	33	.42	13
1985	63	82	.44	35
1986	101	132	.45	57
1987	139	181	.47	81
1988	177	230	.48	107
1989	202	263	.50	126
1990	228	296	.51	146
1991	253	329	.53	168
1992	281	351	.55	192

¹3.2% Escalation Factor, 1976 base of 25¢ local and \$2.00 airporter.

²Number of yearly passengers calculated as percent of full system miles completed each year applied to full system passengers.

TABLE 6

OPERATING FINANCIAL ANALYSIS
CONSULTANTS' 16 YEAR CONSTRUCTION SCHEDULE
(\$ millions)

	<u>1985</u>	<u>1990</u>	<u>1992</u>	<u>1995</u>	<u>2000</u>
Fare Revenue	35	146	192	211	247
Less Operating Costs	<u>-56</u>	<u>-282</u>	<u>-399</u>	<u>-488</u>	<u>-685</u>
Operating Surplus or Deficit	-21	-136	-207	-277	-438
Plus: 1/2% Sales Tax Receipts	<u>233</u>	<u>318</u>	<u>360</u>	<u>433</u>	<u>591</u>
Balance Available or Subsidy Required	212	182	153	156	153

TABLE 7
PRO FORMA
CONSTRUCTION FINANCING REQUIREMENTS
16 YEAR CONSTRUCTION SCHEDULE
(\$ millions)

<u>Expenditures</u>	<u>1980</u>	<u>1985</u>	<u>1990</u>	<u>1992</u>
Construction & Equipment	216	1,494	1,366	328
(Debt Service)	X	X	X	X
 <u>Income</u>				
1/2% Construction Sales Tax	171	233	317	359
Balance Available from 1/2% Operating Sales Tax	171	212	187	160
Subtotal	342	445	504	519
Interest Income	55	-	-	-
Total	397	445	504	519
 Financing Required (excluding debt service)	 -	 1,140	 862	 (191)

B. Financing Available

The requirements for financing the Sunset Coast Line were estimated in the proposal at \$7.5 billion over a 15 year period. Preliminary analysis by SRI of the financing required for the \$15.2 billion in escalated values of construction also was of a substantial magnitude. Before working out specific financing plans, SRI proceeded to determine what constraints might be imposed by the market on SCRTD borrowing.

Interviews with selected brokerage houses, banks, underwriters, and municipal bond specialists found that the bond market was not likely to accept offerings by SCRTD in the near or long term future in the amounts indicated by the financial analysis. Opinions suggested that bonds might be placed in the average amount of \$300 million per year over a 5 year period, but that there would be a limit as to how many years such offerings would be accepted in those magnitudes. Few persons wished to estimate the longer term availability of funds.

The reasons given for the difficulty in raising the required funds were principally the limitations imposed by banks on investment in any one institution and by the desire of investors to diversify their portfolios. While additional bonds might be placed above the \$300 million near term annual estimate, it would be difficult and would probably require a substantial premium in interest rate.

An approach was developed by SRI to estimate a reasonable volume of bonds that might be placed in the long run, assuming continued growth in the municipal bond market. Table 8 presents data on the amount of State and municipal tax exempt general obligation and revenue bonds issued and outstanding over the past 10 years.

Discussions with government, banking and municipal finance officials suggest that the municipal bond market may be expected to grow at its long term historic rate of about 8 percent. While New York City and certain New York State agencies will leave the market, the gap will probably be closed in the near term by increasing demands by other borrowers. There may be also some near term shifting from short term funds into longer term funds.

SRI calculations assume a long term growth rate of 8 percent in municipal bonds outstanding, a retirement rate of 7 percent.

The maximum cumulative amount of funds likely to be available to any single issuer is assumed to be 1/2 percent of total outstandings in the municipal bond market; in any one year, no more than 1 percent of the amount of total new issues expected may be placed by a single issuer. These factors are taken as rules of thumb based on current and past experience of issuers and discussions with researchers in the field. While year to year variations are to be expected, the 1/2 percent and 1 percent factors are considered appropriate for the period of time and type of analysis required to assess the Coast Line proposal.

Table 9 presents a forecast of the municipal bond market and the amounts assumed to be available to a single issuer in any year and cumulatively.

The specific nature of the SCRTD sales tax revenue bond presented no special marketing problems to persons interviewed, assuming one and one quarter times coverage of debt service from the projected sales tax revenue available and planned for debt service. Some persons mentioned that the size and method of meeting operating deficits of the proposed system would be of some concern.

TABLE 8
STATE AND MUNICIPAL BONDS
(billions of dollars)

	<u>General Obligation and Revenue Bonds</u>			<u>New Issues</u>	
	<u>New Issues</u>	<u>Estimated Retirements</u>	<u>Outstanding</u>	<u>G.O.</u>	<u>Revenues</u>
1965	11.0		94.8	7.4	3.6
1966	11.0		99.8	7.0	4.0
1967	14.0		105.7	9.0	5.0
1968	16.0		115.1	9.5	6.5
1969	11.5		122.2	8.0	3.5
1970	17.8	8.8	131.2	11.8	6.0
1971	24.3	10.1	145.4	16.2	8.1
1972	22.9	10.1	158.3	14.1	8.8
1973	22.9	13.9	167.3	12.8	10.1
1974	22.8	n.a.	188.1	13.0	9.8
1975 est.	29.3	10.4	207.0	15.0	14.3
1965-74 compound rate			7.9%		

Table 9

MUNICIPAL BOND MARKET FORECAST
AND SINGLE ISSUER CEILINGS

	Market		Single Issuer Maximum	
	Outstanding (billions)	New Issues (billions)	Outstanding (millions)	New Issues (millions)
1977	240	33	1,200	330
1980	301	42	1,500	420
1985	434	62	2,200	620
1990	640	90	3,200	900
1995	936	130	4,700	1,300
2000	1,376	190	6,900	1,900

assumes 8 percent growth in market outstandings and 7 percent retirement rate.

C. Financing Plan

Based on data presented, interviews, and the analysis framework presented above, it is highly unlikely that the SCRTD could raise \$7.5 billion in bonds over a 15 year period (\$500 million per year) as presented in the Sunset Coast Line proposal financing model. It would be substantially higher than the annual ceiling of \$300 million assumed for the next few years, and bump against the cumulative ceiling by 1980 and thereafter.

The Coast Line financial program assumed borrowing throughout the entire construction period, and building a reserve fund for operations by taking 1/4 percent (beginning in 1982) and then 1/2 percent (beginning in 1987) of the sales tax available for operation.

In the SRI analysis, we use all the revenues available from the 1 percent sales tax to finance construction, until operations commence in 1984. At that time and thereafter, we use the 1/2 percent portion of the sales tax available for operating expenses to the extent needed to finance the fare revenue less expenses deficit, and keep the balance to finance construction.

The borrowing schedule is designed to be within the annual and cumulative market imposed ceilings. It also is designed with sales tax revenues available to finance debt service of at least one and one-quarter times coverage, after using a portion of the 1/2%, as needed to meet operating deficits.

The borrowing terms used in the analysis are 30 year maturity, 7 1/2% interest, with equal annual payments for interest and principal. These terms appeared reasonable for the long term period of analysis. Actual debt issues could include a mixture of 30-year bonds and shorter term serial strip issues made up to allow equal annual payments. Accumulated debt outstanding would be bonds issued, less repayments. While the schedule of new bonds issued shows magnitudes by year, actual yearly issuance would vary somewhat and be scheduled to accommodate

market conditions. However, a major deviation would be inconsistent with our analysis.

Interest on accumulated reserves is calculated at 7.5%.

Based on the analysis framework presented, a cash flow analysis was prepared, as shown in Table 10A for the 281-mile system. The borrowing schedule is summarized in Table 10. The analysis indicates that \$19 billion in bonds would be issued over a 35 year period, with cumulative bonds outstanding amounting to \$16 billion. The cost of the system and borrowing requirements are substantially above the estimates in the Coast Line proposal because of several factors:

1. The construction costs in 1976 dollars are 40% higher than the proposal.
2. The escalation rate is higher.
3. The financial market constraint imposes a longer period of construction, with associated inflated costs of construction and substantial debt service payments.

In response to a request from the Transit Committee of the Board, we examined the effect of having a 1 1/2% sales tax. This cash flow analysis is shown in Table 10B. At the 1 1/2% sales tax, the full 281 mile system could be financed in a 19 year construction period with net borrowing of \$4.7 billion.

We also analyzed an alternative plan designed to finance a modified system costing \$1 billion less in 1976 dollars, extending over about 244 miles. For this alternative we assumed a slightly higher fare structure, including a 50¢ local fare in 1984. The cash flow analysis is presented in Table 10C. This system could be constructed and financed within a 24 year period and net borrowings of \$6.9 billion.

Lastly, we examined the effect of a 1 1/4 percent sales tax and the higher fare structure on the modified 244 mile system. This analysis is shown in Table 10D. The 244 mile system could be constructed in 18 years with the 1 1/4% sales tax, with net borrowing of \$4.4 billion.

A summary of these alternatives is shown in Table 11.

The alternatives presented in Table 11 and analyzed in Tables 10A-D should be interpreted as indicating the likely order of magnitude of the effects imposed on the system by financial limitations.

Table 10

FEASIBLE FINANCING SCHEDULE
FOR THE 281 MILE SYSTEM

(millions of dollars)

	<u>1977</u>	<u>1980</u>	<u>1985</u>	<u>1990</u>	<u>2000</u>	<u>Final Year 2011</u>
Annual Issuance	320	420	190	284	676	1,575
Cumulative Issuance	320	1,474	2,330	3,541	8,298	19,117
Cumulative Out- standing	320	1,453	2,200	3,200	6,900	16,064

TABLE 10A

CASH FLOW ANALYSIS

281 MILE SYSTEM - \$6.7 BILLION IN 1976 DOLLARS

1% SALES TAX

(millions of dollars)

Year	Miles	Fare Rev.	Optg. Costs	Optg. Def.	1/2% Tax Revenue	Surplus for Constr.	1/2% Const. Tax Rev.	New Bonds	Debt Servc.	Int.on Res.	Res. Acct.	Cash Avail.	Constr. Exp.	Bal. Res. Acct.	Cum. Bonds Out	Cum. Bond Face
1977					142	142	142	320	0	0	0	604	74	530	320	320
1978					151	151	151	350	-27	40	530	1,195	64	1,131	667	670
1979					161	161	160	384	-57	85	1,131	1,864	82	1,782	1,044	1,054
1980					171	171	171	420	-89	134	1,782	2,589	216	2,373	1,453	1,474
1981					182	182	182	482	-125	178	2,373	2,972	468	2,504	1,619	1,656
1982					193	193	194	548	-140	188	2,504	3,087	772	2,315	1,748	1,804
1983					206	206	206	622	-153	174	2,315	2,910	1,127	1,783	1,888	1,966
1984	25.3	14	21	-7	219	212	219	715	-166	134	1,783	2,357	899	1,458	2,038	2,140
1985	63.3	36	56	-20	233	213	233	819	-181	109	1,458	2,022	1,418	604	2,200	2,330
1986	90.7	53	86	-33	248	215	248	923	-197	45	604	1,119	1,119	0	2,371	2,533
1987	101.0	61	102	-41	264	223	263	1,022	-214	0	0	494	494	0	2,556	2,755
1988	111.1	69	120	-51	281	230	280	1,140	-233	0	0	517	517	0	2,755	2,996
1989	121.2	78	140	-62	299	237	298	1,261	-254	0	0	542	542	0	2,969	3,257
1990	131.3	87	163	-76	318	242	317	1,384	-276	0	0	568	568	0	3,200	3,541
1991	141.2	97	187	-90	338	248	338	1,506	-300	0	0	602	602	0	3,456	3,857
1992	151.0	107	214	-107	360	253	359	1,629	-327	0	0	630	630	0	3,732	4,200
1993	160.8	118	244	-126	382	256	383	1,757	-356	0	0	657	657	0	4,030	4,574
1994	170.1	129	276	-147	407	260	407	1,887	-387	0	0	687	687	0	4,352	4,981
1995	179.1	140	311	-171	433	262	433	2,014	-422	0	0	717	717	0	4,700	5,424
1996	187.7	151	349	-198	461	263	461	2,142	-459	0	0	747	747	0	5,075	5,906
1997	196.0	163	390	-227	490	263	491	2,266	-500	0	0	779	779	0	5,480	6,430
1998	204.0	175	434	-259	522	263	522	2,389	-544	0	0	812	812	0	5,918	7,001
1999	211.6	187	482	-295	555	260	555	2,511	-593	0	0	843	843	0	6,390	7,622
2000	218.9	200	533	-333	591	258	591	2,636	-645	0	0	880	880	0	6,900	8,298
2001	225.9	213	589	-376	629	253	628	2,766	-703	0	0	914	914	0	7,451	9,034
2002	232.7	226	649	-423	669	246	669	2,890	-765	0	0	954	954	0	8,049	9,838
2003	239.1	240	714	-474	712	238	711	3,008	-833	0	0	984	984	0	8,688	10,706
2004	245.3	254	784	-530	757	227	757	3,135	-906	0	0	1,025	1,025	0	9,381	11,653
2005	251.2	268	859	-591	806	215	805	3,250	-987	0	0	1,063	1,063	0	10,130	12,685
2006	256.9	283	940	-657	857	200	857	3,350	-1,074	0	0	1,105	1,105	0	10,938	13,807
2007	262.3	299	1,026	-727	912	185	912	3,435	-1,169	0	0	1,150	1,150	0	11,811	14,709
2008	267.5	314	1,120	-806	970	164	971	3,500	-1,245	0	0	1,192	1,192	0	12,754	15,661
2009	272.4	330	1,220	-890	1,033	143	1,032	3,543	-1,326	0	0	1,236	1,236	0	13,772	16,664
2010	277.1	347	1,328	-981	1,099	118	1,098	3,575	-1,411	0	0	1,284	1,284	0	14,874	17,724
2011	281.0	363	1,441	-1,078	1,169	91	1,169	3,575	-1,501	0	0	1,333	1,147	186	16,064	19,117

CASH FLOW ANALYSIS

281 MILE SYSTEM - \$6.7 BILLION IN 1976 DOLLARS

1 1/2% SALES TAX

(millions of dollars)

Year	Miles	Fare Rev.	Oper. Costs	Oper. Def.	1/2% Tax Rev.	Surplus for Constr.	1% Const. Tax Rev.	New Bonds	Debt Svc.	Int.on Res.	Res. Acct.	Cash Avail.	Constr. Exp.	Bal. Res. Acct.	Cum. Bonds Out	Cum. Bond Face
1977					142	142	284	320	-0	0	0	745	74	671	320	320
1978					151	151	302	350	-27	50	671	1,497	64	1,433	667	670
1979					161	161	321	384	-57	107	1,433	2,349	82	2,267	1,044	1,054
1980					171	171	342	420	-89	170	2,267	3,281	216	3,065	1,453	1,474
1981					182	182	364	482	-125	230	3,065	3,897	468	3,429	1,619	1,656
1982					193	193	387	482	-140	257	3,429	4,274	772	3,502	1,748	1,804
1983					206	206	412	512	-153	263	3,502	4,391	1,127	3,264	1,888	1,966
1984	25.3	14	21	-7	219	212	438	545	-166	245	3,264	4,168	899	3,269	2,038	2,140
1985	63.3	36	56	-20	233	213	466	616	-181	245	3,269	4,202	1,418	2,784	2,200	2,330
1986	101.3	60	96	-36	248	212	496	728	-197	209	2,784	3,707	1,527	2,180	2,371	2,533
1987	139.3	84	141	-56	264	208	527	835	-214	164	2,180	3,087	1,644	1,443	2,556	2,755
1988	177.3	111	192	-81	281	200	561	1,035	-233	108	1,443	2,318	1,771	547	2,755	2,996
1989	202.6	131	235	-104	299	195	597	1,230	-254	41	547	1,387	1,286	101	2,969	3,257
1990	219.7	146	272	-126	318	192	635	1,422	-276	8	101	945	945	0	3,200	3,541
1991	234.4	161	311	-150	338	188	676	1,610	-300	0	0	880	880	0	3,456	3,857
1992	248.8	177	353	-176	360	184	719	1,794	-327	0	0	916	916	0	3,732	4,200
1993	263.0	193	399	-206	382	176	765	1,970	-356	0	0	959	959	0	4,030	4,574
1994	276.6	209	449	-240	407	167	814	2,137	-387	0	0	1,002	1,002	0	4,352	4,981
1995	281.0	219	488	-269	433	164	866	2,301	-422	0	0	608	351	257	4,257	4,981
1996	281.0	226	522	-296	461	165	922	2,466	-422	19	93	777	0	777	4,154	4,981
1997	281.0	233	559	-326	490	164	981	2,630	-422	58	777	1,558	0	1,558	4,044	4,981
1998	281.0	241	598	-357	522	165	1,044	2,795	-422	63	1,558	2,408	0	2,408	3,926	4,981
1999	281.0	249	640	-391	555	164	1,110	2,959	-422	181	2,408	3,441	0	3,441	3,798	4,981
2000	281.0	257	685	-428	591	163	1,182	3,121	-422	258	3,441	4,622	0	4,622	3,661	4,981
2001	281.0	265	733	-468	629	161	1,257	3,282	-422	347	4,622	5,965	0	5,965	3,514	4,981
2002	281.0	273	784	-511	669	158	1,338	3,440	-422	447	5,965	7,486	0	7,486	3,356	4,981
2003	281.0	282	839	-557	712	155	1,423	3,595	-422	561	7,486	9,203	0	9,203	3,186	4,981
2004	281.0	291	898	-607	757	150	1,514	3,745	-422	690	9,203	11,135	0	11,135	3,003	4,981
2005	281.0	300	960	-660	806	146	1,611	3,891	-422						2,807	4,981
2006	281.0	310	1,028	-718	857	139	1,714	4,030	-422						2,595	4,981
2007	281.0	320	1,100	-780	912	132	1,824	4,162	-422						2,368	4,661
2008	281.0	330	1,177	-847	970	123	1,941	4,285	-395						2,151	4,311
2009	281.0	341	1,259	-918	1,033	115	2,065	4,370	-365						1,947	3,927
2010	281.0	352	1,347	-995	1,099	104	2,197	4,474	-333						1,760	3,507
2011	281.0	363	1,441	-1078	1,169	91	2,338	4,565	-297						1,595	3,325

CASH FLOW ANALYSIS

244 MILE MODIFIED SYSTEM - \$5.7 Bn 1976 DOLLARS

1% Sales Tax; Higher Fares

(millions of dollars)

Year	Miles	Fare Rev.	Oper. Costs	Oper. Def.	1/2% Tax Rev.	Surplus for Constr.	1/2% Const Tax Rev.	New Bonds	Debt Svc.	Int. on Res.	Res. Acct.	Cash Avail.	Constr. Exp.	Bal. Res. Acct.	Cum. Bonds Out	Cum. Bond Face
1977					142	142	142	320	0	0	0	604	72	532	320	320
1978					151	151	151	350	-27	40	533	1,197	55	1,142	667	670
1979					161	161	160	384	-57	86	1,142	1,876	72	1,804	1,044	1,054
1980					171	171	171	420	-89	135	1,804	2,612	187	2,425	1,453	1,474
1981					182	182	182	182	-125	182	2,425	3,028	406	2,622	1,619	1,656
1982					193	193	194	148	-140	197	2,622	3,214	670	2,544	1,748	1,804
1983					206	206	206	162	-153	191	2,544	3,156	979	2,177	1,888	1,966
1984	22.0	19	18	1	219	220	219	175	-166	163	2,177	2,788	781	2,007	2,038	2,140
1985	55.0	49	49	0	233	233	233	190	-181	151	2,007	2,633	1,231	1,402	2,200	2,330
1986	88.0	80	83	-3	248	245	248	203	-197	105	1,402	2,006	1,326	680	2,371	2,533
1987	116.9	110	118	-8	264	256	263	222	-214	51	680	1,258	1,258	0	2,556	2,755
1988	128.0	124	138	-14	281	267	280	240	-233	0	0	554	554	0	2,755	2,996
1989	139.0	140	161	-21	299	278	298	261	-254	0	0	583	583	0	2,969	3,257
1990	149.9	155	185	-30	318	288	317	284	-276	0	0	613	613	0	3,200	3,541
1991	160.7	172	213	-41	338	297	338	316	-300	0	0	651	651	0	3,456	3,857
1992	171.4	189	243	-54	360	306	359	343	-327	0	0	681	681	0	3,732	4,200
1993	181.9	207	276	-69	382	313	383	374	-356	0	0	714	714	0	4,030	4,574
1994	192.1	226	312	-86	407	321	407	407	-387	0	0	748	748	0	4,352	4,981
1995	201.9	245	351	-106	433	327	433	443	-422	0	0	781	781	0	4,700	5,424
1996	211.3	265	393	-128	461	333	461	482	-459	0	0	817	817	0	5,075	5,906
1997	220.4	284	438	-154	490	336	491	524	-500	0	0	851	851	0	5,480	6,430
1998	229.1	306	488	-182	522	340	522	571	-544	0	0	889	889	0	5,918	7,001
1999	237.5	327	541	-214	555	341	555	621	-593	0	0	924	924	0	6,390	7,622
2000	244.0	346	594	-248	591	343	591	490	-645	0	0	779	779	0	6,714	8,112
2001	244.0	357	636	-297	629	332	628	0	-687	0	0	273	0	273	6,530	8,112
2002	244.0	369	681	-312	669	357	669	0	-687	20	273	632	0	632	6,333	8,112
2003	244.0	381	728	-347	712	365	711	0	-687	47	632	1,068	0	1,068	6,121	8,112
2004	244.0	393	779	-386	757	371	757	0	-687	80	1,068	1,589	0	1,589	5,893	8,112
2005	244.0	405	834	-429	806	377	805	0	-687	119	1,589	2,203	0	2,203	5,648	8,112
2006	244.0	418	892	-474	857	383	857	0	-687	165	2,203	2,921	0	2,921	5,385	8,112
2007	244.0	432	955	-523	912	389	912	0	-687	219	2,921	3,754	0	3,754	5,101	7,792
2008	244.0	446	1,022	-576	970	394	971	0	-660	282	3,754	4,741	0	4,741	4,824	7,442
2009	244.0	460	1,093	-633	1,033	400	1,032	0	-630	356	4,741	5,899	0	5,899	4,555	7,058
2010	244.0	475	1,170	-695	1,099	404	1,098	0	-598	442	5,899	7,245	0	7,245	4,299	6,638
2011	244.0	490	1,252	-762	1,169	407	1,169	0	-562	543	7,245	8,802	0	8,802	4,059	6,456

CASH FLOW ANALYSIS

244 MILE MODIFIED SYSTEM - \$5.7 Bn 1976 DOLLARS

1-1/4% Sales Tax; Higher Fares

(millions of dollars)

Year	Miles	Fare Rev.	Oper. Costs	Oper. Def.	1/2% Tax Rev.	Surplus for Constr.	3/4% Const Tax Rev.	New Bonds.	Debt Svc.	Int on Res.	Res. Acct.	Cash Avail.	Constr. Exp.	Bal. Res. Acct.	Cum. Bonds Out	Cum. Bond Face
1977					142	142	213	320	0	0	0	675	72	603	320	320
1978					151	151	226	350	-27	45	603	1,348	55	1,293	667	670
1979					161	161	241	384	-57	97	1,293	2,118	72	2,046	1,044	1,054
1980					171	171	256	420	-89	153	2,046	2,957	187	2,770	1,453	1,474
1981					182	182	273	482	-125	208	2,770	3,489	406	3,083	1,619	1,656
1982					193	193	290	548	-140	231	3,083	3,806	670	3,136	1,748	1,804
1983					206	206	309	620	-153	235	3,136	3,894	979	2,915	1,888	1,966
1984	22.0	19	18	1	219	220	328	695	-166	219	2,915	3,691	783	2,908	2,038	2,140
1985	55.0	49	49	0	233	233	349	800	-181	218	2,908	3,717	1,231	2,486	2,200	2,330
1986	88.0	80	83	-3	248	245	372	903	-197	186	2,486	3,295	1,326	1,969	2,371	2,533
1987	121.0	114	122	-8	264	256	395	1,000	-214	148	1,969	2,776	1,428	1,348	2,556	2,755
1988	154.0	150	167	-17	281	264	421	1,120	-233	101	1,348	2,141	1,538	603	2,755	2,996
1989	176.0	177	204	-27	299	272	448	1,240	-254	45	603	1,374	1,118	256	2,969	3,257
1990	194.9	202	241	-39	318	279	476	1,360	-276	19	256	1,037	1,037	0	3,200	3,541
1991	208.4	223	276	-53	338	285	507	1,480	-300	0	0	808	808	0	3,456	3,857
1992	221.7	245	314	-69	360	291	539	1,600	-327	0	0	845	845	0	3,732	4,200
1993	234.8	267	356	-89	382	293	574	1,720	-356	0	0	886	886	0	4,030	4,574
1994	244.0	287	396	-109	407	298	610	1,840	-387	0	0	733	733	0	4,157	4,786
1995	244.0	296	424	-128	433	305	649	1,960	-405	0	0	549	0	549	4,064	4,786
1996	244.0	305	454	-149	461	312	691	2,080	-405	41	549	1,188	0	1,188	3,963	4,786
1997	244.0	315	485	-170	490	320	736	2,200	-405	89	1,188	1,928	0	1,928	3,855	4,786
1998	244.0	325	519	-194	522	328	783	2,320	-405	145	1,928	2,779	0	2,779	3,739	4,786
1999	244.0	336	556	-220	555	335	832	2,440	-405	208	2,779	3,749	0	3,749	3,614	4,786
2000	244.0	346	595	-249	591	342	886	2,560	-405	281	3,749	4,853	0	4,853	3,480	4,786
2001	244.0	357	636	-279	629	350	943	2,680	-405						3,336	4,786
2002	244.0	369	681	-312	669	357	1,003	2,800	-405						3,181	4,786
2003	244.0	381	728	-347	712	365	1,067	2,920	-405						3,014	4,786
2004	244.0	393	779	-386	757	371	1,135	3,040	-405						2,835	4,786
2005	244.0	405	834	-429	806	377	1,208	3,160	-405						2,642	4,786
2006	244.0	418	892	-474	857	383	1,285	3,280	-405						2,435	4,786
2007	244.0	432	955	-523	912	389	1,368	3,400	-378						2,240	4,466
2008	244.0	446	1,022	-576	970	394	1,456	3,520	-349						2,059	4,116
2009	244.0	460	1,093	-633	1,033	400	1,548	3,640	-316						1,897	3,732
2010	244.0	475	1,170	-695	1,099	404	1,648	3,760	-280						1,759	3,312
2011	244.0	490	1,252	-762	1,169	407	1,753	3,880	-265						1,626	3,130

Table 11

FINANCIALLY FEASIBLE ALTERNATIVES

	<u>Full System</u>		<u>Modified System</u>	
Sales Tax Rate	1%	1 1/2%	1%	1 1/4%
Miles	281	281	244	244
Years	35	18	24	18
Construction Cost in 1976 dollars	\$6.7bn	\$6.7bn	\$5.7bn	\$5.7bn
Debt at End of Construction	\$16bn	\$4.2bn	\$6.7bn	\$4.2bn

5. Sensitivity Analysis

a. If the municipal bond market were to grow at a substantially higher rate than in the past, or if the share available to a single issuer such as SCRTD were to be as large as two percent of new issues and one percent of outstandings, it would not make a significant difference in our findings for the 1% tax rate because of the limitations of the sales tax and fare revenues to generate cash in excess of mounting debt service. Even in the absence of severe market limitations, there would be inherent cash flow constraints on a faster borrowing schedule.

b. If the expected patronage were 33 percent higher or lower than assumed in the analysis, it would not significantly affect the results of the alternative financing plans, either in terms of total borrowing requirements, time period needed for completion, or number of miles completed. This is because fare revenues represent a small portion of total cash available in each year. Nor would a 33% reduction in fare revenues lead to an operating deficit in excess of the 1/2% sales tax.

6. Related Impacts

a. The limitation on total bonds outstanding by SCRTD of 15 percent of the assessed value of property in Los Angeles County will not impose a restraint on the program if the assessed value grows at least by 4 percent, substantially less than the past rate of 6 to 6.5 percent (see Table 12). (Exception: Assuming a 4% growth, the 281 mile system would be at the 15% limit in the year 2005, with the 1% tax rate.)

b. The analysis shows no operating subsidies are required for the Coast Line from sources other than the 1/2 percent sales tax. The analysis does not include the costs or subsidies required for the bus feeder system.

c. The analysis assumes no federal or state financing for construction or operating expenses, except for UMTA financing of part of the starter line.

d. The construction sales tax may be discontinued when the revenue is sufficient to pay off the bonds. This occurs in each plan in a period shorter than the thirty year period of the last bond maturity.

e. An economic analysis of benefits and costs has not been made comparing alternative transit systems.

f. The impact of SCRTD borrowing on the cost of borrowing or on the availability of funds to other Los Angeles City, County, or regional authorities has not been estimated.

Table 12

SCRTD BONDING LIMITATIONS
(dollars in billions)

<u>Year</u>	<u>Assessed Value</u>	<u>Maximum Indebtedness</u> *	<u>Maximum Indebtedness at Alternative Growth Rates</u>		
			2%	4%	6%
1975	23.3	3.5			
1980			3.9	4.3	4.7
1985			4.3	5.2	6.3
1990			4.7	6.3	8.4
1995			5.2	7.7	11.2
2000			5.7	9.3	15.0
2005			6.3	11.3	20.1

* 15% of assessed value

