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REPORT VOLUME TWO – SUPPORTING ANALYSES

SOUTHERN CALIFORNIA ACCELERATED RAIL ELECTRIFICATION PROGRAM

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5.1 ELECTRICAL POWER SUPPLY AND DISTRIBUTION SYSTEM

The traction electrification system is considered to consist of two parts – the power supply system (power utility provisions and the traction substations, switching stations, paralleling stations and autotransformer stations) and the power distribution system (overhead catenary). The report provides an overview of applicable system configurations for electrification systems and considers key design parameters, voltage selection, potential interference problems, power utility interface and environmental issues. The systems considered most technically suitable for electrification include the 25kV system, 50kV system and 25kV Autotransformer system (25kV AT).

In order to estimate the electrification project cost, comprehensive estimates of the traction electrification system were performed. The unit cost estimates include installation of electrical equipment at the power utility substation, transmission line to the traction substation, and all components of traction power supply and distribution systems. The unit costs and conceptual design data were used to derive the traction electrification cost for each route as well as for the entire network of railroads considered in the study.

The cost of an electrification system depends, to the first degree, on the traffic density and length of route and, therefore, generalization of costs should be avoided. However, as a first indication of the electrification costs Table 5-1 presents per mile cost averages for the routes under consideration.

TABLE 5-1

Electrification Cost per Mile for Routes Under Consideration

Thousands of 1992 Dollars	**Electrification System Type**		
Traffic Type	**25kV**	**50kV**	**25kV AT**
Commuter	888	856	935
Commuter Freight	1103	1039	1243

For electrification of commuter traffic alone or commuter and freight traffic combined, 50kV is slightly less expensive than 25kV. However, due to higher overhead clearance requirements for the 50kV system, some civil reconstruction will be necessary at bridges, overpasses and in tunnels. (The civil costs are addressed in Section 5.2.) The 25kV system is the most prevalent modern electrification system and its use is recommended for commuter line electrification. Considering the commuter and freight traffic, the 25kV is recommended in the event that the civil reconstruction will increase the 50kV system cost above the 25kV system cost. The 25kV autotransformer system, being compatible with the 25kV system without autotransformers, may find its use in areas where distances between utility power supply points necessitates a longer traction substation feeding distances than possible with system without autotransformers.

5.1.1 System Configuration

5.1.1.1 Typical System Overview

A typical configuration of an electrified system is shown in Exhibit 5-1. The system consists of power supply system substations located along the system route which supply power to a single-phase overhead distribution system.

Substations are connected to local power utility company high voltage transmission system at commercial frequency of 60Hz via high voltage disconnect switches and circuit breakers. The high voltage is transformed to electrification voltage by traction transformers. In order to minimize the utility system unbalance, various connections of traction transformers can be used. For simplicity, one single-phase transformer connection is shown in the diagrams throughout this report, where the utility system unbalance is minimized by connecting the transformer high voltage windings of adjacent substation transformers to alternate phases of the utility system. The traction power is supplied to the distribution system via low voltage circuit breakers. The feeder breakers can use either vacuum or sulfur hexafluoride (SF_6) to extinguish an arc during switching. A signal power supply system and a Supervisory Control and Data Acquisition (SCADA) system are often integral parts of the traction power system. Refer to Exhibit 5-2 for a simplified schematic illustration of traction power supply system.

The distribution system for most of the route is proposed to be of a simple catenary type. Such a system consists of overhead messenger and contact wires attached to along-track structures. Catenary sections which may operate at different phases or voltages are separated by phase breaks or voltage breaks. Switching stations are installed between substations to improve electrical performance of the system and to afford greater flexibility in system sectioning.

Propulsion power from the catenary system is collected by the locomotive pantograph and returned to the substations via rails, ground wire and earth.

5.1.1.2 Power Supply System Types

The distribution system can be supplied with electrical power by the following basic systems:

- Center-fed system
- Single-end-fed system.

The center-fed system uses one transformer in each substation and supplies a section of catenary at the approximate midpoint, as shown in Exhibit 5-3. The single-end-fed system has two transformers in each substation and feeds two adjacent sections of catenary at their end points, as shown in Exhibit 5-4. The traction transformer secondary windings are simply connected to the distribution system and the rails via impedance bonds and therefore the transformer secondary voltage is equal to the traction voltage.

EXHIBIT 5-1

Typical Configuration of an Electrification System

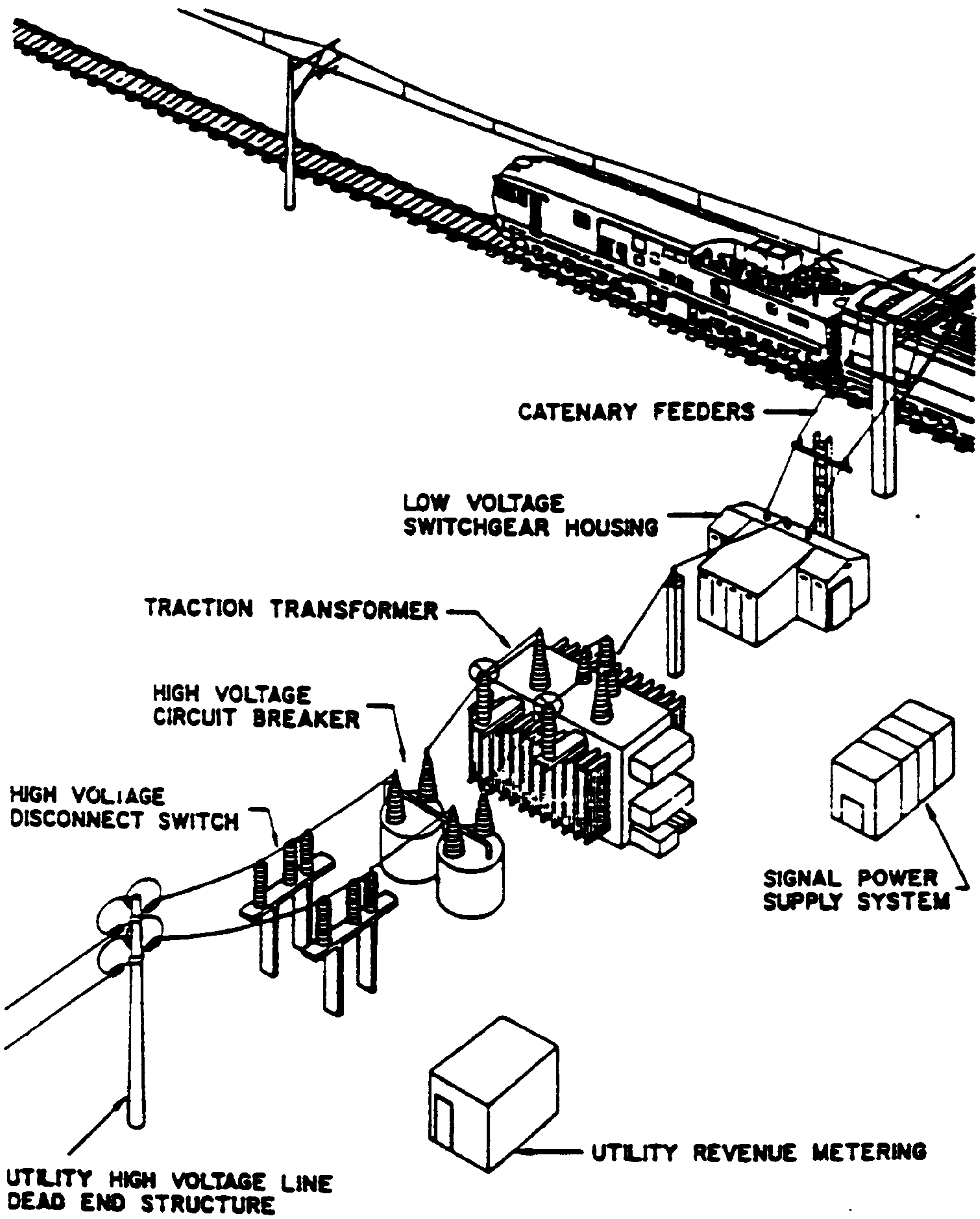

EXHIBIT 5-2
Simplified Schematic of a Traction Electrification System

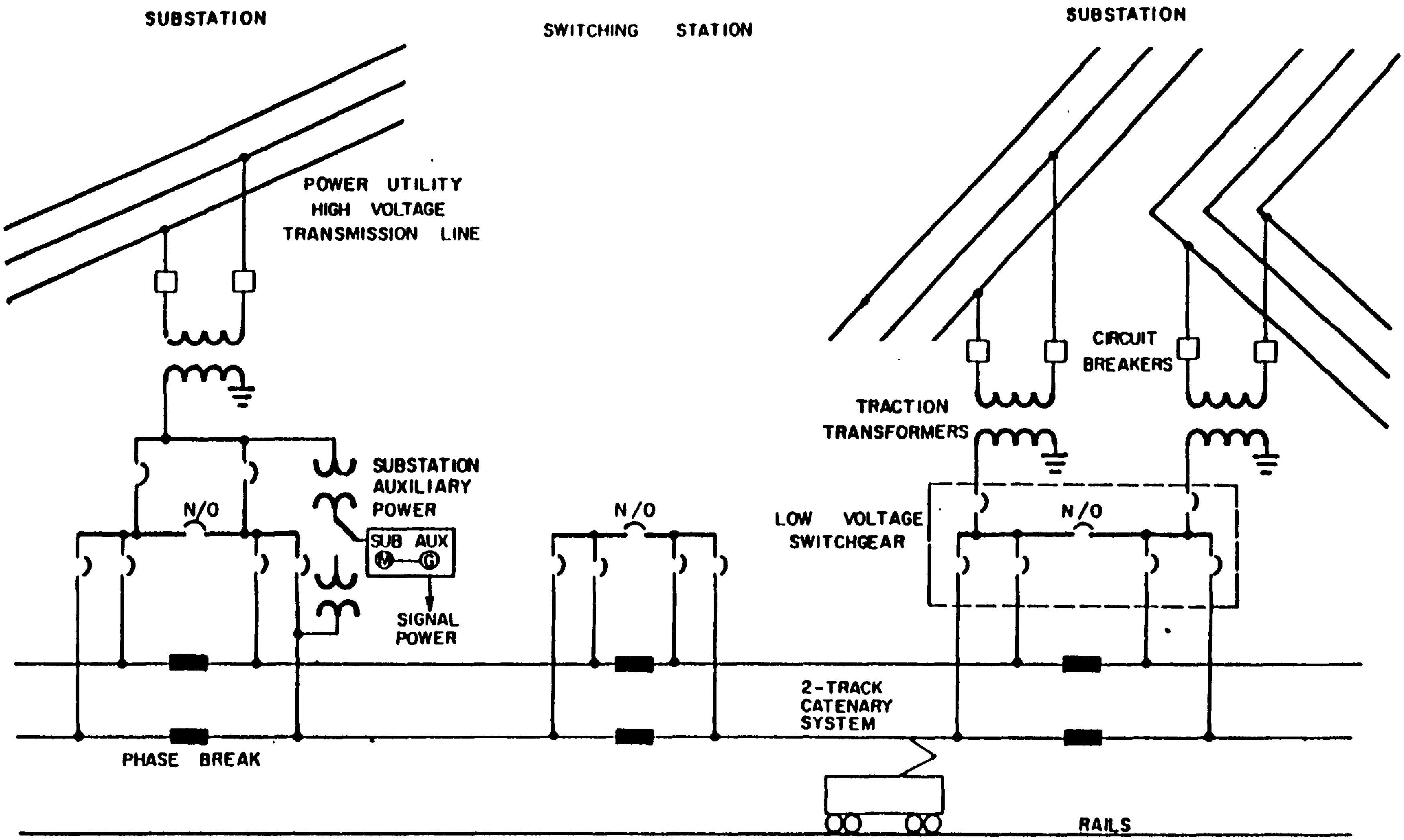

EXHIBIT 5-3
Center Fed System

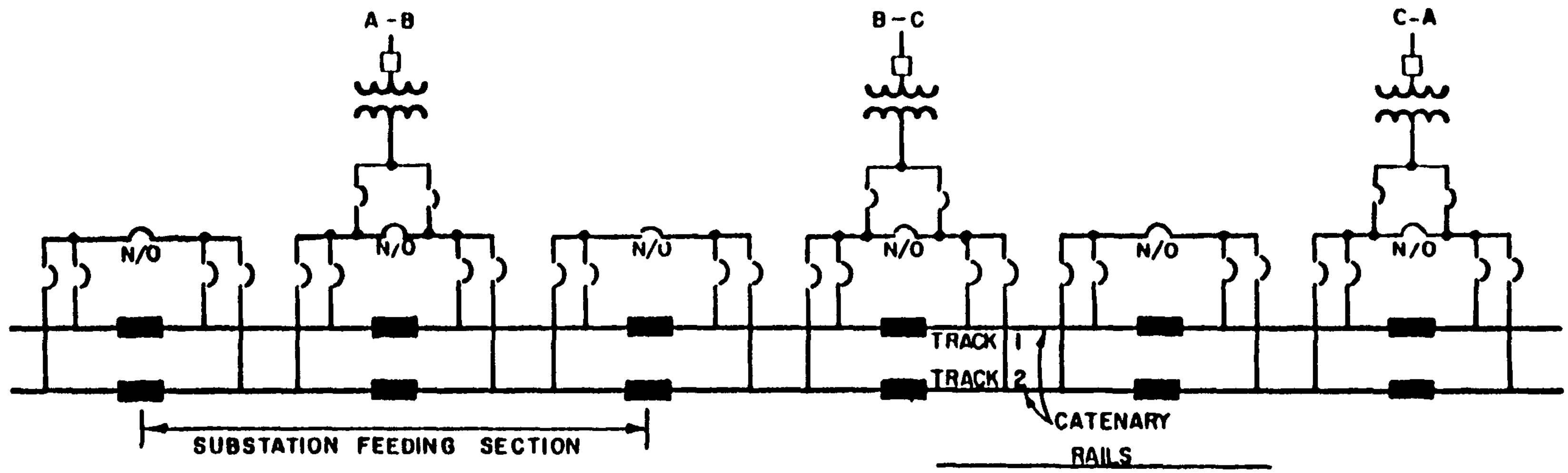

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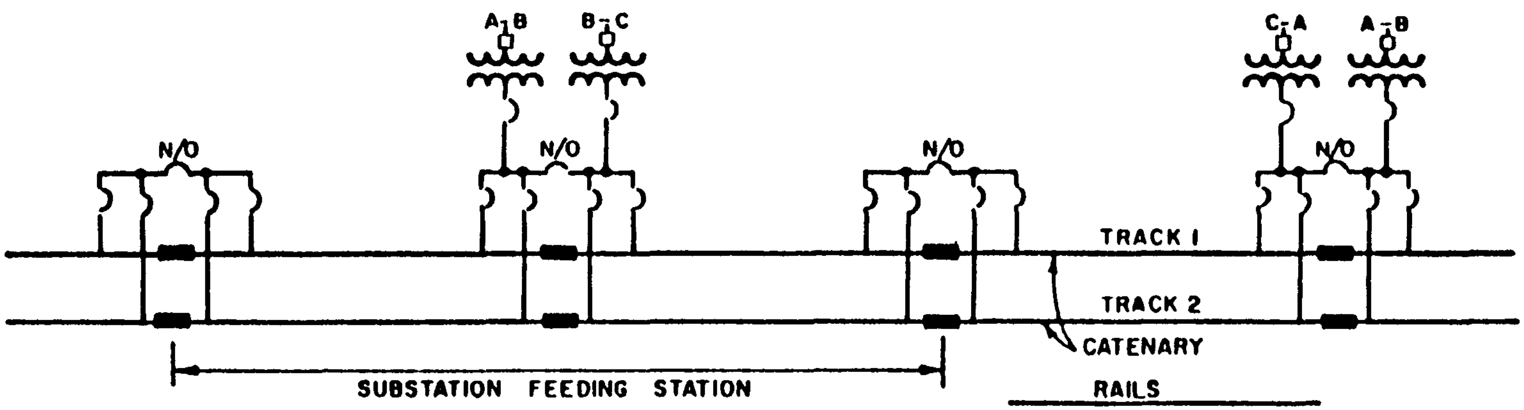
EXHIBIT 5-4
Single Fed System



An important alternative to the above systems are configurations using autotransformers:

- Autotransformer center-fed system
- Autotransformer single-end-fed system.

In the autotransformer system, refer to Exhibit 5-5, the traction transformer secondary windings are connected to the catenary and feeder conductors which are in turn connected to the autotransformer primary windings. The secondary windings of the autotransformers are connected between the catenary and rail impedance bonds. Therefore, when power is being transmitted along the substation feeding section at a higher than traction voltage, longer substation spacings are achieved than would be possible with system not using autotransformers. The ratio of the transmission voltage (feeder-to-catenary) and the traction voltage (catenary-to-rail depends on the autotransformer winding ratio. The 2:1 ratio is the most commonly used and requires, for example, a 50kV catenary-feeder voltage for 25kV traction. A higher ratio such as 3:1 may be used where long substation feeding distances are necessary.

Due to the fact that the feeder currents are often in the direction opposite the catenary currents, the electromagnetic fields of the catenary and feeder conductors tend to cancel out. Therefore, in comparison to center-fed and single-end-fed systems, the interference effects of autotransformer system are lower.

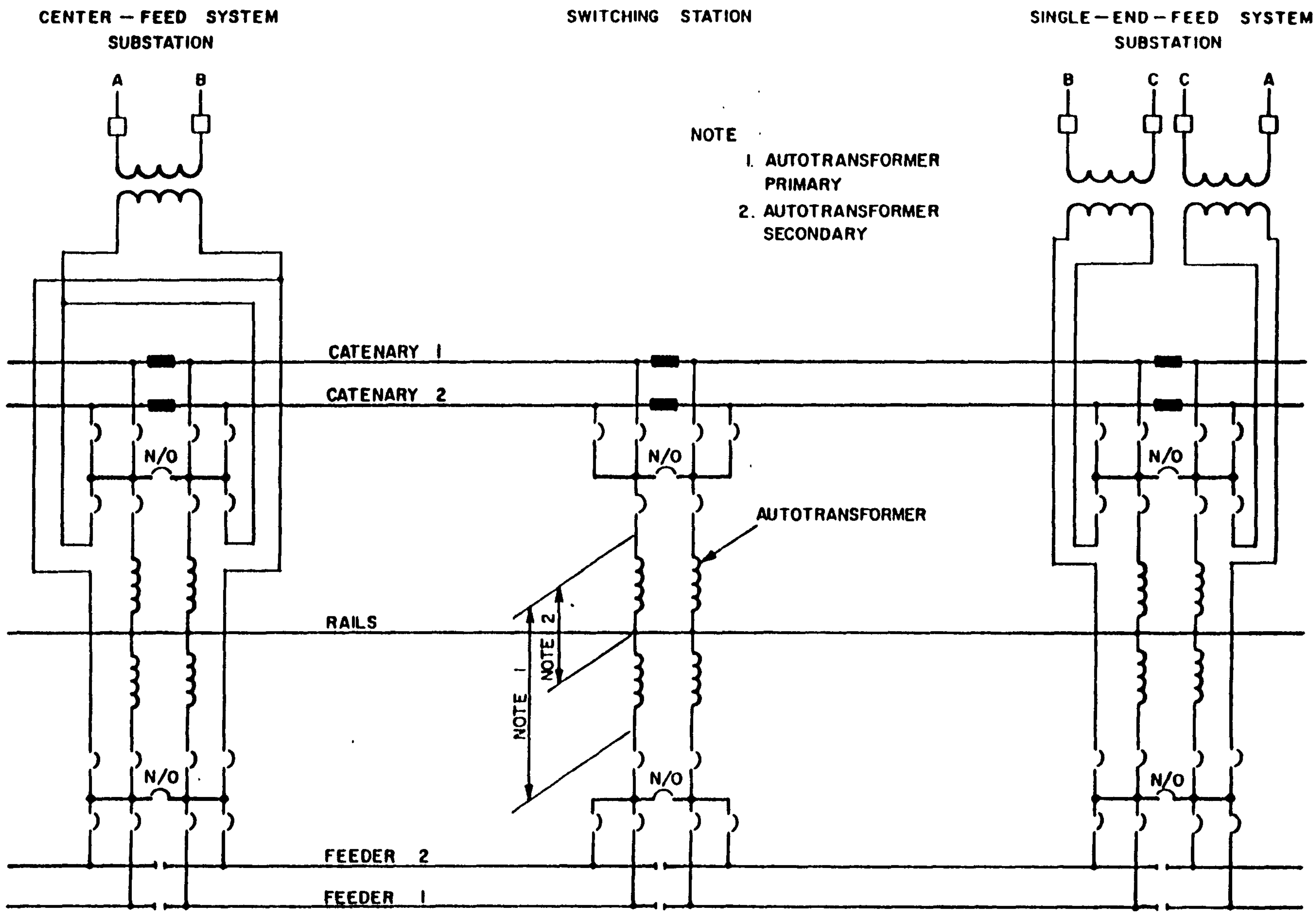
5.1.1.3 Power Distribution System Types

The traction power distribution system will consist of simple catenary system, twin contact wire system and single contact wire system as described below:

- Simple Catenary System – Consists of a messenger wire supporting a contact wire by the means of hangers. The catenary conductors will be auto-tensioned by means of counterweights, which will be mounted on anchor poles located at the ends of each tension length. As the conductors contract and expand with temperature variation, the counterweights rise and fall and thus maintain a constant conductor tension throughout the specified temperature range.

  The catenary system is supported and registered by means of hinged cantilevers attached to steel poles located between the tracks wherever possible. At special locations such as track crossovers, turnouts and junctions, the catenary system may be supported by cantilevers mounted on poles located on the outer sides of the track or attached to cross-span wire arrangements. The contact is offset (staggered) at registration points.
- Twin Contact Wire System – Used in areas where the vertical clearance does not allow the use of the simple catenary system, as may be the case at certain low clearance overhead bridges. A section of contact wire is spliced into the messenger wire to form a twin contact wire system. The two contact wires are installed side by side and are supported by insulated support arms attached to the underside of the bridge. The system is designed to form an integral part of the simple catenary system on either side of the bridge.
- Single Contact Wire System – Used in tunnels and yard areas. The system uses fixed conductor terminations. In the fixed-termination system the conductor tension varies with temperature variation. In the tunnel sections, the system is supported and registered by means of insulated arms attached to the tunnel roof or wall. The system in the Yards is supported and registered by means of single cantilevers, back-to-back pole mounted cantilevers and cross-span wires.

EXHIBIT 5-5
Autotransformer System



The distribution system can be equipped with special purpose equipment such as series capacitors to extend the substation spacing, booster transformers to mitigate electromagnetic interference with signaling and communication circuits, and shunt harmonic filters and power factor correction capacitors in order to minimize the utility system impact.

Because substation transformers along a route are connected to different phases of the utility system, sections of the overhead distribution system are also operating at different phases. These sections are required to be separated by phase breaks. The phase breaks must be designed to be capable of adequately isolating the electrical sections and provide a smooth and continuous contact path for the pantograph.

5.1.1.4 Normal Operation

During normal operation (i.e., when all substations are in service) each substation supplies its own section of distribution system between two adjacent switching stations. The switching stations serve the following purposes:

- Voltage Regulation – By paralleling the catenary system, the effective system resistance and the consequent voltage drop are reduced. This permits selection of longer substation spacing where needed or provides for a higher pantograph voltage which in turn enhances train performance.
- Current Sharing – The switching stations allow the train power requirements to be shared by the catenary system of both tracks. Such multiple feeding achieves a more uniform current flow and conductor heating. This is of particular importance in locations where daily peak ambient temperature often coincides with the maximum power load during the evening rush hour period.
- Short Circuit Detection – Detection of short circuits may be a problem in the event of a resistive fault. By reducing the effective system resistance, switching stations can help significantly in this respect.
- System Sectioning – If substations are located further apart, as in a 50kV system, the length of switchable sections becomes longer. This means that sections of track deenergized for routine maintenance or during emergencies are also longer. By employing switching stations to improve sectioning, trip time delays caused by single track operation can be substantially reduced.

The switching stations are equipped with normally closed feeder circuit breakers which enable sections of catenary system to be disconnected following a fault or for maintenance. The bus tie circuit breakers remain normally open to separate the adjacent sections of the distribution system operating at different phases or voltages.

Systems with long substation to switching station distances can be designed with paralleling stations which are located at intermediate points between substations and switching stations. Similarly to the switching stations, the purpose of paralleling stations is to improve the system voltage profile, current sharing, fault detection and operational flexibility during faults and system maintenance. However, because the voltage on either side of the paralleling station is of the same phase and magnitude, there is no need for a bus tie circuit breaker.

Exhibits 5-3, 5-4 and 5-5 show the supply systems under normal operating conditions.

5.1.1.5 Emergency Operation

Under emergency conditions each substation must be capable of supplying its own catenary section and, depending on the type of supply configuration, part or all of the adjacent section.

In the event of a substation failure in a center-fed system, continuity of supply will be maintained by the two neighboring substations. This is achieved at switching stations situated at the midpoint between feeding substations. The normally opened switching station bus-tie breakers are closed, thus extending the supply area of each substation by half of a section. The bus-tie breaker in the disabled substation remains open to separate the two supplies which are at different phases.

In the case of a single-end-fed system, the continuity of supply during a transformer outage is achieved by closing the substation bus-tie breaker. In case of failure of both substation transformers the bus-tie breakers in adjacent switching stations are closed as in the center-fed system.

In autotransformer systems the same basic switching procedures are followed as for the above systems. However, because the feeder system is sectionalized in the same way as the catenary system, feeder switching is also required in the substations and switching stations.

5.1.2 Design Parameters

5.1.2.1 Train Power Demand

The power supply system must be able to meet power requirements of all trains in a substation feeding section. Individual train power demand is a function of the train weight, speed, acceleration and the track profile, while the system demand is dependent on the number of trains expected in the feeding section and their individual power demand requirements. Operating plans discussed in Section 6.0 will serve as a source of the probable and maximum numbers of trains in various sections to establish design requirements.

Railroad traffic can be divided into two major types: freight and passenger. Both freight and passenger traffic have a specific impact on the design of electrical supply systems due to their different power demand characteristics. Freight trains operate at low acceleration rates and therefore the power demands during acceleration and cruising are comparable. The power demand of passenger trains is significantly higher during their acceleration and falls off once the train has attained cruising speed.

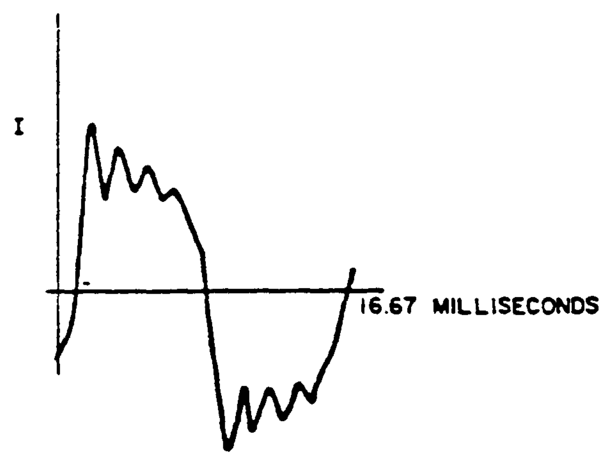
5.1.2.2 Characteristics of Traction Load

The electrification equipment is required to supply traction load of the following characteristics:

- Unbalance – When a single-phase distribution system load is supplied form two phases of a three-phase system, some voltage unbalance occurs at the utility bus-bars.
- Harmonics – Due to the harmonic currents generated by locomotive thyristor control equipment the traction current wave form is not sinusoidal. Exhibit 5-6 shows one cycle of typical traction current.

EXHIBIT 5-6

One Cycle of Typical Traction Current



- Fluctuating Pattern – The traction power demand is of a highly fluctuating nature resulting from the abrupt power requirement changes as trains accelerate, decelerate and as they encounter or leave track grades. The degree of fluctuation depends on the individual train power demands and traffic density in a substation feeding section. A representative traction load current demand curve is shown in Exhibit 5-7.
- Power Factor – The power factor of traction loads is dependent on the power factor of individual locomotives. The locomotive power factor depends on the vehicle design and varies with speed. Generally, the power factor at low speeds is low and improves as speed increases. An increase in the power factor causes a lower reactive voltage drop, which permits an increase in the substation spacing and a corresponding decrease in the power supply costs.

5.1.2.3 System Voltage

Modern electrified railroads operate at standard nominal voltage of 25kV or 50kV. The maximum substation and catenary voltage should not exceed 110 percent of the nominal electrification voltage, taking into account the voltage variation of the power utility high voltage system.

Substations and switching stations are spaced so that the voltage at the pantograph should not fall below 80 percent of the nominal value under normal operating conditions with all substations in service. Under emergency conditions, with one or more substations out of service, the minimum voltage limit is 70 percent of the nominal voltage. The emergency condition voltage applies to vehicle design only and is not used for the system design. Table 5-2 summarizes the voltage levels for both 25kV and 50kV electrification voltages.

Table 5-2
Electrification Voltage Ranges

Nominal Electrification Voltage	Maximum Voltage	Normal Minimum Voltage	Emergency Minimum Voltage
25kV	27.5kV	20.0kV	7.5kV
50kV	55.0kV	40.0kV	35.0kV

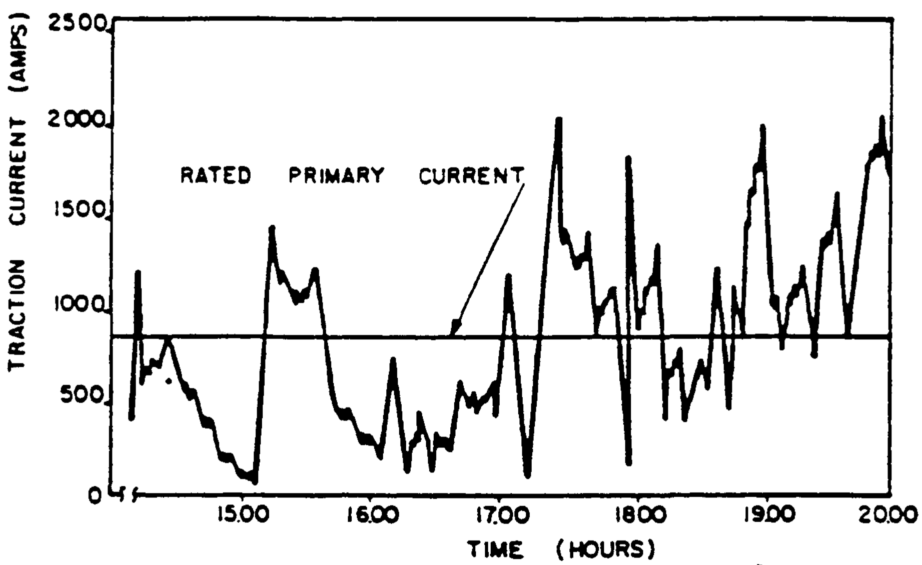
The above voltage levels conform to the AREA Manual for Railway Engineering recommendations.

5.1.2.4 Substation Spacing

The traction power substations represent one of the major cost items of a railroad electrification project. Therefore, it is advantageous to obtain the longest possible feeding distance for each substation in order to achieve the most cost effective arrangement.

EXHIBIT 5-7

Representative Traction Current Load Demand Curve



5.1.2.6 Distribution System Conductors

The overhead system conductors need to be of sufficient cross-sectional area to supply all the trains operating on the system without overheating. Messenger wires are usually manufactured of hard-drawn stranded copper, copper-weld or bronze alloy conductors while the contact wires are manufactured of grooved hard-drawn copper or bronze alloy conductors. The copper conductors have better conductivity and are less expensive in comparison to the copper-weld and alloy conductors. However, the copper-weld and alloy conductors can operate at higher conductor temperatures and can be installed at higher tensions. The system feeders and grounding conductors can be either hard-drawn stranded copper, copper-weld, bronze alloy or aluminum cable steel reinforced (ACSR) conductors.

5.1.3 Electrical Power Utility Design Issues

5.1.3.1 Utility Power Supply

The source of electrical power for electrification substations along the route will be the local power utility companies. Selection of feeding points for traction power substations will often be limited. During the process of substation siting, preference should be given to the feeding points which fulfill the following railroad and utility requirements most satisfactorily:

Railroad requirements:

- <u>High Fault Level</u> – Desired to obtain a good voltage profile along the distribution system to enable the system to supply the traction loads with economically spaced substations
- <u>Low Voltage Variation</u> – Desired to maintain a satisfactory voltage profile along the catenary distribution system
- <u>High Reliability</u> – Desired to avoid frequent emergency operation and the possibility of some degradation in train performance.

Utility requirements:

- <u>High Fault Level</u> – Necessary to limit the effects of load unbalance and harmonic distortion which could disrupt operation of the utility systems and consumer equipment
- <u>Low Voltage Drop in the Utility Equipment</u> – Necessary to avoid objectionable light flicker, increased current loading of consumer equipment and frequent operation of voltage regulators and transformer on-load tap changers
- <u>Sufficient Spare Capacity</u> – Necessary to supply the new electrification load.

The utility systems which meet the above criteria most satisfactorily are high voltage transmission lines or substations. The preferable utility supply voltage levels are in the range of 69kV to 230kV. Systems below 69kV usually have low fault level causing excessive unbalance, harmonic distortion and voltage regulation. Using supply voltage above 230kV is generally not cost effective due to additional cost required for traction substation high voltage equipment and insulation.

The high voltage transmission line towers, poles and conductors are built with a sufficient margin of mechanical strength, are generally situated in well cleared right-of-ways and have high degree of resistance to lightning disturbances. Bus-bar and line sectionalizing with automatically reclosing circuit breakers and fast acting main and backup protective schemes increase the reliability of the high voltage utility supply.

5.1.3.4 Utility System Voltage Flicker

The rapid variation of the traction current resulting from changes in the power demand of the trains causes some voltage variation on the utility bus-bars immediately adjacent to the traction substations. In some cases, this voltage variation could cause flickering of customer's lights and affect operation of electronic equipment such as computers. The severity of the problem depends on the magnitude of the load fluctuation, the frequency of these fluctuations and the utility system fault level. During the design stage it is possible to predict the magnitude and frequency of the voltage dips and compare them with the borderline curves of flicker visibility and irritation. Based on this analysis it is often possible to select a part of the utility system with sufficiently high fault level which would supply the traction load without unacceptable effects on other utility customers.

5.1.3.5 Utility System Power Factor

A low power factor causes large reactive power flows and may cause large voltage regulation on the utility system.

The requirement for power factor correction depends on the utility system arrangement and location. A utility system with a significant portion of its electrical network in urban areas is likely to use underground cables for a large portion of its network. The high capacitance of cables usually generates enough reactive power to maintain a high power factor on the utility system and correction may not be required. On the other hand, when the utility system consists primarily of long overhead transmission lines, large consumers may be required to maintain their power factor above a certain level.

The average power factor at the traction power substation connection point can be predicted over the utility billing interval. In the event that the power factor is lower than the power utility limits, the power factor can be corrected be shunt capacitors. The capacitors should be installed where the reactive power is needed (i.e., as close as possible to the load point). Options include installing the capacitors on board the locomotives, at the catenary distribution system wayside or at the traction power substation. The capacitors can be permanently connected or can be switched in banks for finer power factor control.

Power factor can also be improved by using a "forced commutation" arrangement of the locomotive thyristor phase control propulsion circuit. The circuit essentially centers the applied voltage in phase with the current and this results in a considerable improvement of power factor. The advantage of this approach is that any possibility of resonance inherent in large blocks of capacitors is eliminated.

5.1.3.6 Utility System Load Factor

The load factor is defined as the ratio of average power demand to peak power demand in the same time interval. The factor should be as high as possible to achieve the most economical operation. Because the traction load is of fluctuating pattern, the load factor of an individual substation may be low especially where the train traffic density is low. For high tonnage operation, such as considered in this study, the load factor is likely to be comparable to the average national utility load factor.

Depending on the rate structure negotiated between the utility and railroads, it may be advantageous for the railroads to control the electrical power demand by continuous demand monitoring and train schedule adjustments.

5.1.4 Electrical Interference

Equipment along railroad rights-of-way can be subjected to interference from traction and power utility systems. Traction systems with single-phase distribution and thyristor-controlled electric locomotives produce currents and voltages at fundamental and harmonic frequencies which produce interfering currents and voltages in adjacent equipment. The utility system is a balanced three-phase network, and therefore the disturbing fields tend to cancel out under normal conditions; however, the possibility of interference exists for unbalanced system faults.

Interference occurs by induction and conduction and gives rise to extraneous voltages and currents which, if unmitigated, can attain sufficiently high values to endanger personnel and damage equipment or prevent satisfactory operation of the equipment. The most susceptible equipment includes the railroad signaling circuits, telephone and other communication circuits,television, radio and computers. Electrical potential can also be induced into long metal fences and roofs. The induction effects are caused by electromagnetic and electrostatic coupling between the disturbing and disturbed circuits, while the conduction effects result from ground potential rise and metallic cross-conduction.

The electromagnetic interference can be reduced by grounding, shielding, isolating transformers, protectors, drainage to ground, neutralizing transformers, booster transformer system, neutralizing wire system and autotransformer system. The electrostatic induction can be eliminated by shielding and grounding. The over voltages caused by ground potential rise and metallic cross-conduction can be reduced to safe levels by adequate grounding and by applying protective measures.

The interference voltages must be maintained within acceptable limits to ensure safety of personnel, prevent damage to equipment, and maintain satisfactory operation of the railroad equipment. Therefore, detailed interference studies should be performed during the project design phase to evaluate the magnitudes of the disturbing effects, assess their acceptability with reference to industry guidelines, and recommend mitigating equipment and systems as necessary.

5.1.5 Environmental Considerations

5.1.5.1 Aesthetic Impact

Modern transmission line and catenary system design practices enable construction of streamlined and low profile installations. Transmission lines required to supply power to the substations are typically 70 to 80 feet high. The catenary system has structures typically 30 feet high and 150 to 200 feet apart. The design of basic hinged cantilever catenary structures is functional and simple, and usually blends well with the surrounding environment. The autotransformer and booster transformer systems have a marginally higher impact due to the requirement of feeder wires. Exhibit 5-8 shows a comparison of hinged cantilever structures for system with and without autotransformers.

Portal or headspan structures are used where simple hinged cantilever structures are not suitable due to obstruction along the track, unstable ground or where multi-track electrification is required. Headspans require higher structures than portals and have a higher environmental impact (see Exhibit 5-9 for typical arrangements).

The traction substations and switching stations do not have a significant impact. Substations with two transformers and signal power generators are typically 250 feet x 120 feet in area. The highest point is the utility incoming line structure with the rest of the equipment being significantly lower. Switching station dimensions are about 70 feet x 60 feet. Installation in sensitive areas may be shielded by trees and shrubs.

EXHIBIT 5-8

Comparison of Typical Cantilever Structures

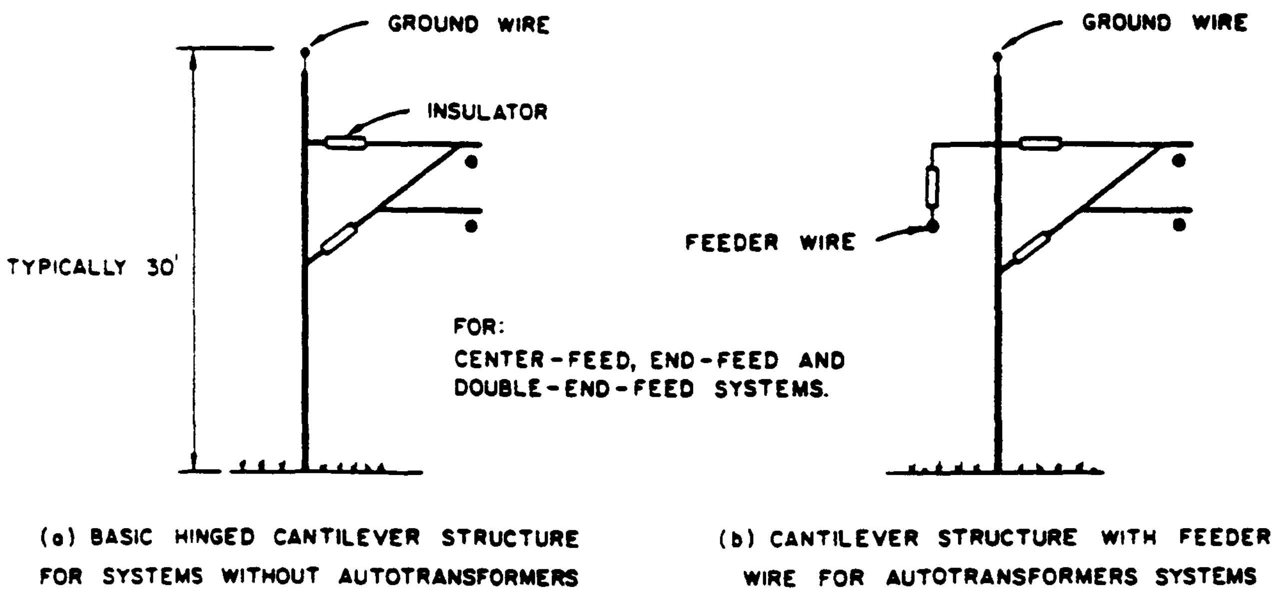
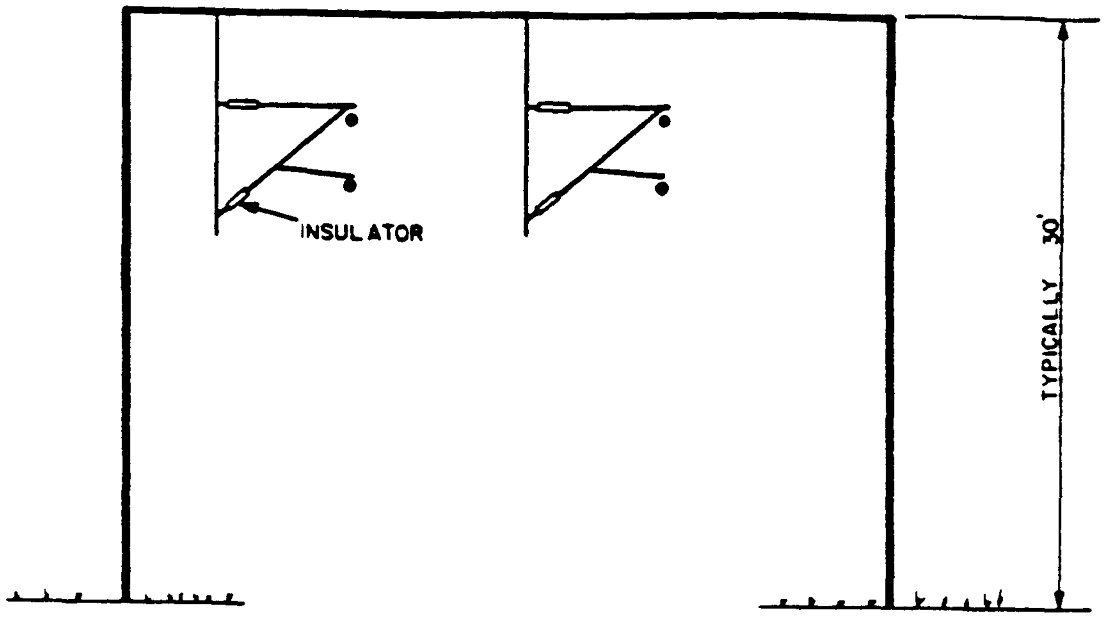
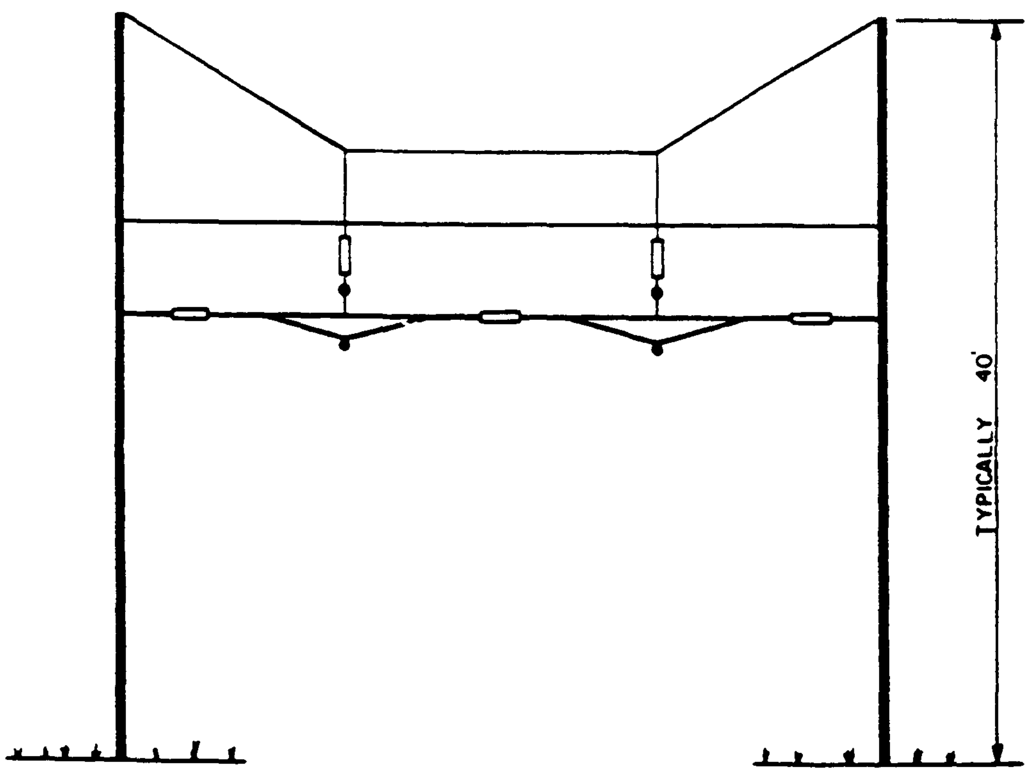


EXHIBIT 5-9
Comparison of Typical Portal and Headspan Structures



(a) TYPICAL PORTAL STRUCTURE



(b) TYPICAL HEADSPAN

5.1.6 Electrification Voltage Selection

5.1.6.1 Substation Feeding Distance

One of the major factors governing substation spacing is the maximum allowable voltage drop in the power supply and distribution systems. Assuming that for normal train operation the minimum train voltage is 80 percent of the nominal voltage (20kV for a 25kV system and 40kV for 50kV system) it is permissible to drop 5kV in a 25kV system and 10kV in a 50kV system. For the same load, the current in the 25kV system is twice the current expected in the 50kV system. For example a train requiring 5MW would draw 200 amps when supplied at 25kV and 100 amps when supplied at 50kV. A train operating at 50kV would therefore cause half the voltage drop in the traction power supply and distribution systems than the same train operating at 25kV.

Since the 50kV trains can operate with available voltage drop twice that of the 25kV trains, and since the voltage in the 50kV system is being "dropped" at half the rate of the 25kV system, a 50kV system can be supplied by considerably fewer substations than the 25kV system. When, other parameters being equal, the train headways are longer than substation spacings, the 50kV system in theory can be supplied by as few as one-fourth the number of substations in comparison to the 25kV system. In the event that the train headways are less than the substation spacings, an increase in substation feeding distance due to higher electrification voltage results in substations supplying a higher number of trains and the four-fold increase in substation spacings will not be realized. Therefore, depending on the actual traffic density, substations in a 50kV system can be expected to be spaced at 2-3 times the interval of substations in the 25kV system.

5.1.6.2 Substation Rating

Due to the longer substation feeding distances in 50kV system, the 50kV system will often supply more trains in comparison to 25kV system. Therefore the nominal substation rating can also be expected to be higher for 50kV electrification.

5.1.6.3 Electrical Clearance

The available overhead clearance may influence the choice of the electrification voltage. When developing overhead clearance requirements, the major items that need to be accounted for include provision for the rolling stock clearance envelope, overhead distribution system depth and electrical clearances. The normal minimum electrical clearance is dependent on electrification voltage as follows shown in Table 5-3. This issue is addressed in detail in Section 5.2.1.

Considering the electrical clearance below and above the live conductors, the net difference between the 25kV and 50kV system normal minimum electrical clearance requirements is 21.0 inches and the difference between the reduced minimum electrical clearance requirements is 16 inches. For further clearance requirements refer to AREA Manual for Railway Engineering, Chapter 33.

5.1.6.4 Power Losses

Since the currents in a 50kV system are generally lower than in a 25kV system, the resistive copper losses (I^2R) can be expected to be lower in the 50kV system. The energy savings over the system life span can be substantial if the higher nominal voltage is selected.

TABLE 5-3

Electrical Clearances

Electrification Voltage	Normal Minimum Electrical Clearance	Reduced Minimum Electrical Clearances
25kV	10.5 inches	8 inches
50kV	21.0 inches	16 inches

5.1.6.5 Utility System Unbalance

The 50kV system with longer substation spacings will usually have more trains in a substation feeding section than the 25kV system. The higher number of the trains will produce a higher power demand and, therefore, cause higher utility unbalance.

5.1.6.6 Utility System Harmonic Distortion

When a number of locomotives or MU cars operate simultaneously, they do not take identically shaped pantograph currents. The small differences are sufficient to cause some cancellations of harmonics and make the resulting wave form at the utility bus-bar smoother. Therefore, with higher number of trains supplied by substations in the 50kV system it can be expected that the harmonic distortion will be lower than in the 25kV system.

5.1.6.7 Utility System Voltage Flicker

Because of the longer substation spacings, higher number of trains and consequently higher substation power demand in the 50kV system, the voltage flicker can be expected higher than in the 25kV system.

5.1.6.8 Electromagnetic Radiation and Interference

Due to lower currents and lower harmonic distortion in the 50kV system , the electromagnetic radiation and interference at a given location can be expected to be lower than in the 25kV system.

5.1.6.9 Regeneration

With the longer substation spacings used in the 50kV system, there would be more trains in a substation feeding section available to receive regenerated energy from the braking trains than in the 25kV system. Therefore, regeneration would be more effective at 50kV especially when the system is equipped with paralleling stations.

5.1.6.10 Equipment Availability

The availability of power supply equipment, distribution equipment and electric locomotives for both electrification voltages is comparable.

5.1.6.11 Equipment Maintainability

Both electrification systems use the same type of equipment; the difference is in the voltage, current and power ratings. Therefore, the maintainability of equipment as well as maintenance effort per substation and track mile can be considered approximately the same. However, due to lower number of substations required for the 50kV system, the total maintenance effort and cost for 50kV electrification can be expected to be correspondingly lower.

5.1.6.12 Environmental Impact

The difference in environmental impact of 25kV and 50kV substation and distribution system is negligible. However, on system-wide basis, the lower number of 50kV system substations will have a lower impact than the higher number of 25kV system substations.

5.1.6.13 Equipment and Real Estate Cost

The unit cost of each 50kV traction power substation will be slightly higher than the cost of 25kV substation because of the higher insulation levels required for the transformer secondary windings and switchgear. However, because fewer substations are required for 50kV than for 25kV electrification system, significant overall savings in equipment and real estate costs can be realized.

When 50kV and 25kV catenary systems are built with the same conductor sizes, the 50kV system cost is slightly higher than the 25kV cost due to the requirement for higher insulation level. Because of the lower currents in the 50kV system, the designer has also an option to select overhead conductors of lower size and therefore compensate fully, or in part, for cost increase due to the higher electrification voltage.

5.1.6.14 Summary Matrix

Table 5-4 presents a summary of the 25kV and 50kV system advantages and disadvantages. The bold type indicates the more advantageous condition in comparison to the competing system.

5.1.6.15 Voltage Selection Considerations

All the factors identified in the preceding sections should be considered and evaluated during preliminary stages of an electrification project to determine the degree of impact of each individual factor on the electrification system configuration and cost. The factors which will have a major cost impact on any electrification project include the traction substation spacings and availability of overhead clearances for the distribution system.

As already noted, systems operating at 50kV can be built with lower number of substations than systems operating at 25kV and, therefore, 50kV electrification can result in significant savings in the power supply system. However, due to higher overhead clearance requirement for the 50kV system, some track lowering and civil reconstruction may be necessary at bridges, overpasses and in tunnels. Such civil work can often be costly and offset the savings in substations.

TABLE 5-4

Comparison of 25kV and 50kV Electrification Systems

Technical Issue	25kV System	50kV System
Substation Spacing	Lower	Higher
Substation Rating	Lower	Higher
Overhead Clearance	Lower	Higher
Power Losses	Higher	Lower
Unbalance	Lower	Higher
Harmonic Distortion	Higher	Lower
Voltage Flicker	Lower	Higher
Electromagnetic Effects	Higher	Lower
Regeneration	Lower	Higher
Equipment Availability	Same	Same
Equipment Maintainability	Higher	Lower
Environmental Impact	Higher	Lower
Power Supply System Cost	Higher	Lower
Distribution System Cost	Lower	Higher
Overall System Cost	Higher	Lower

The 50kV system should be considered whenever sufficient clearance under bridges, tunnels, and other overhead structures is available. However, where sufficient clearances are not available, the cost of the civil reconstruction necessary to provide the additional electrical clearance and the cost of the higher level of insulation should be determined. These costs should then be compared with the savings realized because of decrease in the number of substations, before the voltage level can be selected.

Occasionally, in the early years of a major undertaking such as an electrification project it may not be desirable to make a final decision regarding the electrification voltage. For example, there may be the uncertainty whether the cost of providing the 50kV clearances initially can be justified in anticipation of a significant future electrification extension at 50kV which would achieve significant savings. In order to keep options open, the traction system can be designed in such a way as to be readily convertible to the 50kV operation at some later date. The substation equipment and the catenary system can be insulated for 50kV to ground. The traction power transformers can be designed with two 25kV windings which will be initially connected in parallel for 25kV operation and reconnected in series later on when operation at 50kV is desired. The low voltage circuit breakers must be able to operate at the future electrification voltage of 50kV and also interrupt the maximum short circuit currents which occur during the initial operation at 25kV. In any case, only one electrification voltage should be selected to avoid the requirement for dual voltage locomotives.

5.1.7 Conceptual Design

5.1.7.1 Feeding Arrangement

The traction power supply system will be of the center-fed, single-end-fed or autotransformer type as described above. The substations will be equipped with one or two single-phase transformers depending on the load demand and the degree of supply reliability required in a given location. The primary of each transformer will consist of one winding whose terminals are connected to two phases of the utility network. The secondary is again comprised of one winding. One terminal will feed the overhead catenary system while the other terminal will be grounded.

The catenary system will be supplied and protected by single-pole vacuum or SF_6 circuit breakers. These types of breakers demonstrated their ability to withstand frequent operation inherent in traction power systems with minimum of maintenance and have proven record on railroads in many countries. Vacuum circuit breakers are factory wired and tested modular units, ready for mounting on previously installed foundations. This approach can achieve a substantial savings in design and construction costs, while maintaining flexibility of the system should the feeding requirements change as a result of system expansion.

5.1.7.2 Substation Spacings

As already stated, traction power substations represent one of the major cost items of a railroad electrification project. Subject to power utility impact studies and interference studies, it is advantageous to obtain the longest possible feeding distance for each substation in order to achieve the most cost effective arrangement.

The results of substation spacing calculations presented below are based on voltage drop principle ensuring that, in the system comprising the utility network, substation transformers, feeders, catenary conductors, and rails, every train on the system has adequate voltage level available at the pantograph for traction power purposes. This means that the train voltage should not decrease below the Normal Minimum Voltage recommended value.

Typical substation spacings were calculated for the considered systems with and without autotransformers and for electrification voltages of 25kV and 50kV. Considering representative data for future projected traffic density, substation spacings can be expected as shown in Table 5-5:

TABLE 5-5

Substation Spacings

	Traffic Type	25kV	50kV
System without Autotransformers	Commuter	30-34 miles	60-64 miles
	Commuter and Freight	18-22 miles	34-38 miles
Autotransformer Systems	Commuter	58-62 miles	Note [1]
	Commuter and Freight	32-36 miles	Note [1]

Note [1] The 50kV Autotransformer System has not been studied. Although technically feasible, this system has not been used in electrification projects to date.

5.1.7.3 Location of Substations, Switching Stations, Paralleling Stations and Autotransformer Stations

The task of preliminary substation siting for this study involved coordination of several requirements. The railroad routes were superimposed onto the electric utility power system map and the utility substations as well as the transmission lines crossing or running parallel to the tracks to be electrified were identified. To be considered suitable as a substation location, a site needed to satisfy the railroad and utility criteria identified earlier and discussed with the power utility on a very preliminary basis. The goal was to locate the substations within the calculated substation spacings distances and in close proximity to a utility substation or a power line.

Switching stations will be located at an approximate midpoint between substations while paralleling stations and autotransformer stations will be spaced at intervals of about 10 to 20 miles.

5.1.7.4 Catenary System Type

A simple catenary system consisting of single messenger and contact wires has been selected for the project. The conductors will be supported by hinged cantilevers attached to wide-flange beam steel poles and auto-tensioned by balance weights at both ends of each tension length. This system will permit optimum performance throughout a wide range of ambient temperatures and can be built with longer spans and lighter structures than a fixed termination system.

The overhead distribution system will also include an overhead ground wire attached to the top of the catenary support structures. The purpose of the ground wire is to provide system ground for various items of equipment, decrease the return system impedance and provide a measure of protection against lightning strikes.

Under bridges and overpasses a twin contact wire system can be used; in tunnels a single contact wire supplemented with a feeder will be suitable.

5.1.7.5 Conductor Sizes and Materials

Preliminary investigations indicate that a total cross-sectional area of approximately 350-400 MCM copper equivalent is needed for the catenary system conductors, allowing for the contact wire to be worn to 80% of its original cross-section. The total cross-sectional area requirement can be satisfied by the following conductors:

- Messenger wire: 4/0 Hard-drawn, stranded copper wire
- Contact wire: 4/0 Hard-drawn, copper wire
- Ground return wire: 4/0 Aluminum Conductor Steel Reinforced (ACSR)
- Autotransformer feeder: 350 MCM Hard-drawn, stranded copper wire.

5.2 CIVIL ASPECTS

5.2.1 Clearances

5.2.1.1 Vertical Clearances

An inventory of the existing vertical clearances for the overhead bridges, tunnels and railroad truss bridges located along the 13 routes/72 segments under study, was compiled. A total of 265 overhead bridges, six (6) tunnels and seven (7) railroad undergrade bridges were identified. The majority of the information was supplied by the railroads participating in the study (UP, SP, ATSF). The balance was supplied by the California PUC and field investigations. The physical characteristics for each structure were identified as follows:

- Route # and Segment #
- Railroad owner
- Railroad milepost
- County
- Description
- Type of structure
- Existing vertical clearance
- Clearance impacts
- Clearance recommendations.

Calculations for the vertical impact, defined as the additional clearance required for electrification and subsequent recommendations to achieve the additional clearance, were based on traction power system voltages of 25kV(AC), 50kV(AC) and four (4) sets of vertical clearance criteria. Standards utilized to develop vertical clearance criteria included:

- Federal-Aid Highway Program Manual
  Transmittal 194, May 10, 1976
  Vol. 6, Ch. 6, Sec. 2, Subsection 1, Attachment 1

- AREA Track Design Criteria Manual dated 1991, Volume II, Chapter 33, Part 2

- Federal Highway Administrators Policy for Horizontal and Vertical Clearances effective October 24, 1988 as published in the Federal Register on August 24, 1988.

The electrical clearances for high-voltage alternating-current catenaries were based primarily on those railroads already electrified at 25kV, the most recent being the Morris and Essex Line (formerly Erie-Lackawanna) on the New Jersey Transit system. The electrical clearances for 50kV are based on twice the proven and accepted clearance requirements for 25kV per AREA standards.

The four (4) sets of vertical clearance criteria utilized are identified in Table 5-6.

TABLE 5-6

Vertical Clearance Criteria

	Tunnel Minimum		**Minimum**		**Desirable**		**Railroad**	
	25kV	**50kV**	**25kV**	**50kV**	**25kV**	**50kV**	**25kV**	**50kV**
Total Clearance to Contact Wire	21'-9"	22'-3"	22'-3"	22'-11"	22'-11"	23'-10"	24'-2 1/2"	25'-1"
Total Vertical Clearance	22'-8"	23'-8"	23'4"	24'-8"	24'-5"	26'-2"	25'-8"	27'-5"

Exhibit 5-10 entitled "Regional Rail Electrification Program Vertical Clearance Diagram" includes the various component measurements that are included in the above criteria.

Double stack freight cars at an allowable 21'-0" height was a constant dimension utilized in developing all four (4) sets of clearance criteria.

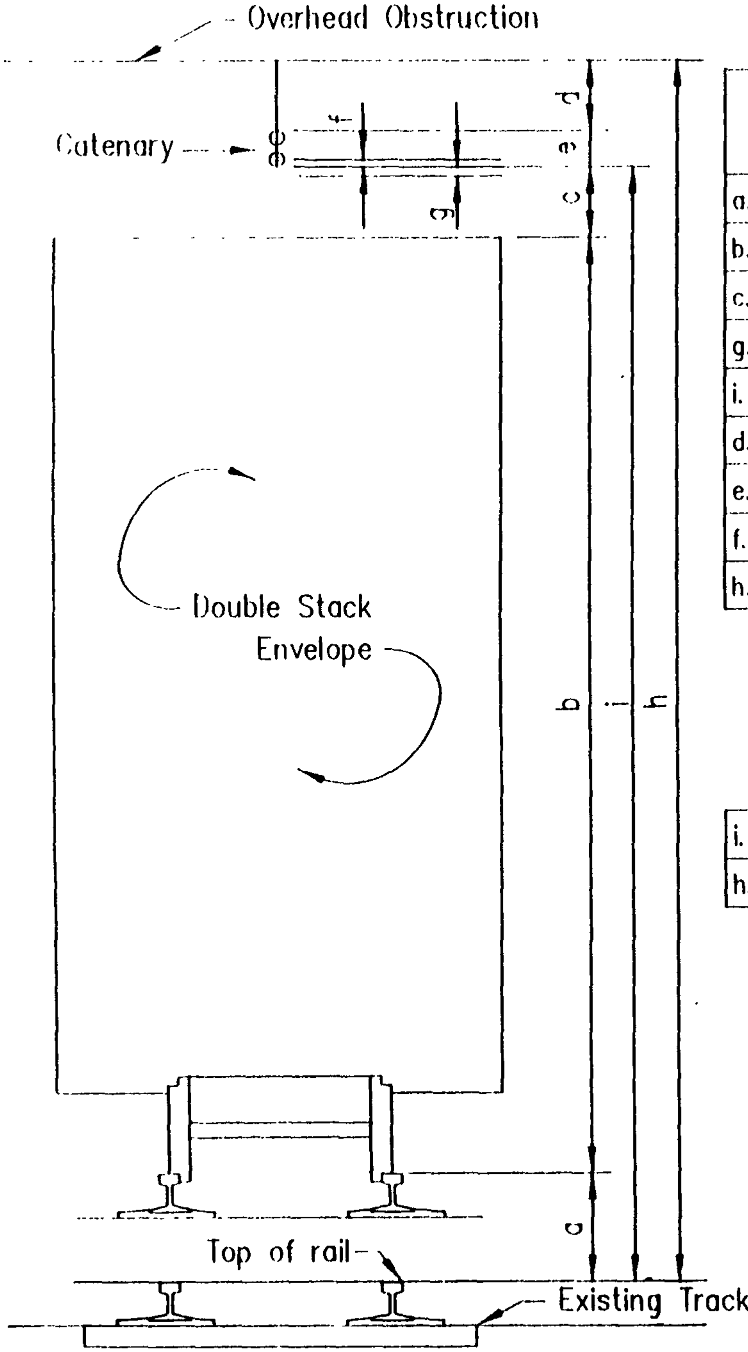
For existing tunnels where physical constraints exist and considerable expense is involved, recommended absolute clearance minimums must be considered. Information for six (6) tunnels investigated are identified in Table 5-7:

TABLE 5-7

Tunnel Clearance Constraints

Route #	**Segment #**	**Owner**	**Milepost**	**Length**	**Description**	**Vertical Clearance**
3	15	SP	441.23	7,368'	TUNNEL #26	21'-0"
3	15	SP	442.92	769'	TUNNEL #27	22'-0"
3	15	SP	443.90	537'	TUNNEL #28	21'-2"
4	13	SP	454.92	6,976'	TUNNEL #25	21'-8"
1,12,13	57	ATSF	58.86	380'	TUNNEL #1	23'-8"
1,12,13	57	ATSF	59.18	468'	TUNNEL #2	23'-8"

EXHIBIT 5-10



	RECOMMENDED REQUIREMENTS					
	25 Kv			50 Kv		
	Tunnel Min.	Min.	Des.	Tunnel Min.	Min.	Des.
a. Future Track Lift	0'-0"	0'-6"	1'-0"	0'-0"	0'-6"	1'-0"
b. Double Stack Height	21'-0"	21'-0"	21'-0"	21'-0"	21'-0"	21'-0"
c. Car to Contact Wire	0'-6"	0'-8"	0'-10 1/2"	1'-0"	1'-4"	1'-9"
g. Catenary Down Clearance	0'-1"	0'-1"	0'-1"	0'-1"	0'-1"	0'-1"
i. Total Clearance to Contact Wire	*21'-9"	22'-3"	22'-11 1/2"	*22'-3"	22'-11"	23'-10"
d. Catenary Clearance	0'-6"	0'-8"	0'-10 1/2"	1'-0"	1'-4"	1'-9"
e. Catenary Construction	0'-3"	0'-4"	0'-6"	0'-3"	0'-4"	0'-6"
f. Catenary Uplift	0'-1"	0'-1"	0'-1"	0'-1"	0'-1"	0'-1"
h. Total Vertical Clearance	**22'-8"	23'-4"	24'-5"	**23'-8"	24'-8"	26'-2"

NOTE:

* INCLUDES 2" FOR TOLERANCE

** INCLUDES 1" FOR BOUNCE

	RAILROAD REQUIREMENTS					
i. Total Clearance to Contact Wire	–	–	24'-2 1/2"	–	–	25'-1"
h. Total Vertical Clearance	–	–	25'-8"	–	–	27'-5"

REGIONAL RAIL ELECTRIFICATION PROGRAM VERTICAL CLEARANCE DIAGRAM

The SP tunnels #25, 26, 27 and 28 presently have extremely close clearances. If electrified at 50kV, these tunnels will require internal structural modifications. If electrified at 25kV, they will require track lowering utilizing the tunnel minimum clearance criteria. In addition, if Tunnel #27, located on a six degree (6°) curve, is electrified at 25kV, it will also require special consideration with internal structural modifications. All six (6) tunnels will require a variation of substandard ballast section. All six (6) tunnels are of concrete construction.

A total of seven (7) railroad through truss bridges exist which must be structurally modified to permit adequate clearance for electrification. These bridges are identified in Table 5-8.

TABLE 5-8

Through Truss Bridge Clearance Constraints

Route #	Segment #	Owner	Milepost	Length	Description	Vertical Clearance
1,12,13	59	ATSF	34.10	371'	MOHAVE RIVER	21'-11"
9,12,13	55	ATSF	0.90	149'	B YARD	21'-0"
5,7,12	18	ATSF	143.5	298'	NORTH BRIDGE	22'-0"
5	23	ATSF	223.10	607'	FALLBROOK JCT.	21'-9"
1,6,13	31	UP	10.8	392'	SAN GABRIEL RIVER	21'-2"
2,3,4,6	2	SP	482.58	72'	L.A. RIVER	21'-10"
1,11	45	SP	732.29	400'	COLORADO RIVER	23'-3"

The truss structure must be built-up in place allowing the upper structural reinforcing members to be raised. This will provide adequate clearance for electrification while maintaining the load capacities of the bridge. Once the built-up sections are constructed and tied in, the existing structural sections can be removed. The majority of this work can be accomplished under normal train traffic conditions.

Due to the age and condition of the existing portal signal bridges, it was deemed more cost effective to replace the existing portal signal bridges with new bridges constructed allowing adequate clearance for electrification.

Recommendations made to provide additional clearance at overhead bridges varies depending on the criteria utilized. Three (3) methods of increasing clearances include:

- Lower track
- Raise bridge
- Replace bridge to provide a shallower superstructure.

5.2.1.1.1 Lower Track

The advantages and disadvantages for each method are as follows:

- Undercutting – Relatively easy to achieve with modern track equipment, but constrained by many factors such as drainage, track grades, adjacent footings, etc.
- Interlockings – Undercutting at interlockings is very time and labor intensive. Very difficult to maintain operations, impacts multiple tracks. Should be avoided, if any practical alternative.
- Switches & Sidings – Similar problems to interlockings, but less impact particularly to mainline. Grade run-outs required for sidings.
- Undergrade Bridges – Very difficult to accommodate significant grade change over undergrade bridges. Some adjustment to bridge tie depth for open decks or ballast depth may be practical. Under grade vertical clearances usually preclude moving it.
- Drainage – Good drainage is imperative in order to maintain proper track alignment and train ride quality. Undercutting may create drainage problems that are expensive to correct.
- Operations – Lowering track will have significant impacts on train operations during construction. Resolution of trade–offs between operations and construction constraints must be coordinated with the railroads.

5.2.1.1.2 Raise Bridges

The alternative of raising a bridge may certainly be feasible in many cases, but it must be carefully considered in the context of the increased level of cooperation and coordination with affected municipalities and the impacts to the public along the route.

- Modern Design Standards – Existing deficient structures may need to be significantly improved or replaced to achieve modern standards, if modified. More generally all or most costs associated with bridge adjustments will possibly be borne by the railroads while not improving its property.
- Roadway Approach Geometry – Significant modifications to roadway approach geometry may be required for sight distances and speeds, which will trigger an extensive coordination process with local agencies.
- Ownership – Will work on a structure affect the railroads position concerning ownership or future maintenance in some jurisdictions?
- Utility Commissions – As the result of a petition to modify a crossing, the railroads may be ordered by the PUC to assume substantial costs over and above those reasonably assumed.
- Local Jurisdictions – Input and opinions must be solicited from local agencies to achieve the highest level of cooperation possible when dealing with the overhead bridges.

5.2.1.1.3 Replace Bridges to Reduce Depth of Superstructure

This is sometimes possible for a reconstructed bridge. Many of the issues associated with raising or reconditioning the structure apply, and this alternative may best be utilized in combination with another method in order to achieve the required extra clearance. Economically, this is generally the least cost effective measure, but some individual cases may require it.

Selection of the method recommended for increasing clearances for electrification at each overhead bridge was based on the following criteria:

- Lower the track if < 2'-0"
- Raise bridge if > 2'-0" and < 5'-0"
- Replace bridge if > 5'-0".

Overhead freeway bridges were the exception to this criteria where the only recommendation was to lower the track regardless of the additional clearance required at each location.

Four (4) types of bridge construction most commonly encountered include:

- Concrete box/slab (monolithic) – CBSM
- Concrete precast girder (non–attached) – CPGN
- Concrete precast girder (monolithic) – CPGM
- Steel (non–attached) – SN.

Bridges with non–attached bearing construction can be raised with standard industry procedures. Bridges constructed in accordance with the 1973 revised structural code for seismic conditions are monolithic construction and may or may not be raised. Each bridge must be inspected at the next level of study to determine if it can be raised or replaced. For the purpose of this study, it was assumed that the monolithic constructed bridges may be raised.

A summary of the recommendations made for the 265 overhead bridges based on the 25kV and 50kV traction power systems and the three (3) sets of vertical clearance criteria relative to the bridges is provided in Table 5-9.

TABLE 5-9

Preliminary Recommended Bridge Clearance Improvements

	25kV			**50kV**		
	Minimum	**Desirable**	**Railroad**	**Minimum**	**Desirable**	**Railroad**
Lower Track	62	95	162	185	151	131
Raise Bridge	8	17	61	28	74	92
Replace Bridge	0	0	0	0	0	4

A detailed inventory for each segment and route, as well as a summary inventory, is included in the appendix of this study report.

The next level of study will require a thorough review, and include field inspection of each individual structure included in the study area to more clearly define existing conditions and subsequent recommendations.

Modern technology must be researched and incorporated into the bridge clearance issue through further study.

Determining the responsibility for resolving each overhead bridge clearance problem must be addressed.

The costs of the structural clearance modifications for electrification related to the recommendations made, are estimated in Section 7.4 of the study report.

5.2.2 Grade Crossings/Grade Separation

An inventory of the roadway grade crossings for the 13 routes and 72 segments under study was compiled. A total of 558 grade crossings were identified. Much of the inventory information was readily available from the California PUC. Additional information was secured from the cities or other agencies controlling the subject roadway. Physical characteristics for each roadway grade crossing were identified as follows:

- Route # and Segment #
- Railroad owner
- Railroad milepost
- County
- Crossing description
- Number of road lanes
- Number of tracks
- Average Daily Traffic volume (ADT).

Recommendations regarding the elimination of the grade crossing with or without specific mitigation measures or those involving the grade separation of the tracks and the roadway were unable to be made at this level of the design process with the exception of Route #1, the UP/SP Consolidated Corridor. The next level of design will focus on the ability of the physical facilities to accommodate the increased demand on the facilities from both automobile and rail traffic.

Rail traffic projections for the three (3) railroads developed elsewhere in this study report state between eighty (80) and one hundred and twenty (120) freight trains originating from the Port of Los Angeles, in addition to joint occupancy commuter trains, will travel along the Consolidated Corridor to West Colton Yard. This magnitude of rail traffic will result in excessive downtime of roadway grade crossing gates, causing lengthy delays for automobile traffic. Additionally, this will contribute to an increased risk of accidents due to the increased volume of rail traffic.

Forty–three (43) roadway grade crossings are recommended for grade separation between East Yard (Los Angeles) and West Colton Yard. A detailed inventory for each segment and route, as well as a summary inventory, is included in the appendix of this study report.

The most cost effective and least disruptive recommendation for grade separation for Route #1, the UP/SP Corridor, is to maintain the vertical alignment of the tracks and adjust the street profiles. This is the preferred solution for eliminating the at–grade crossings. The best overall solution for existing streets paralleling the railroad and commercial or residential developments located in close proximity to the tracks is to adjust the railroad profile, resulting in an elevated section of track.

The costs related to the grade separation of grade crossings on the Consolidated Corridor are estimated in Section 7.1 of the study report.

5.3 ELECTRIC LOCOMOTIVES

In addition to the traction electrification system, the report also covers the electric locomotives. Technical issues regarding passenger and freight electric locomotives are evaluated and cost estimates are derived for each. The estimate resulted in the freight locomotive cost of $4,1410,000 and passenger locomotive cost of $5,350,000.

This section includes discussion of some of the major technical design issues of electric locomotives that need be resolved during preparation of locomotive technical specification. A typical specification outline is developed. Based on the service requirements for the identified routes, technical data for electric locomotives suitable for freight and passenger service are identified. Finally, cost estimates are developed for both the freight and passenger electric locomotives.

5.3.1 Technical Issues

5.3.1.1 Traction Current Harmonics

The electric locomotive current contains harmonic frequencies which are generated by the thyristor control equipment. The harmonics can cause a distortion in the public utility system, increased voltage drop in the system and interference with communication and signal circuits.

These effects can be mitigated by reducing the traction current harmonic content by on–board or wayside filters.

5.3.1.2 Power Factor Correction

The locomotive power factor, the ratio of useful power to total power, should be as high as possible to obtain minimum system voltage drop. The power factor can be increased by on–board or wayside equipment.

On–board equipment may include capacitors or "forced commutation" circuitry in the locomotive thyristor phase control propulsion equipment. The circuit essentially centers the applied voltage in phase with the current and this results in a considerable improvement of power factor. The advantage of this approach is that any possibility of resonance inherent in the blocks of capacitors is eliminated.

5.3.1.3 On-Board Circuit Breaker

An on board circuit breaker should be installed between the locomotive pantograph and transformer for two reasons:

- The locomotive can negotiate phase and voltage breaks at full speed without lowering its pantograph.
- Faults in the locomotive equipment can be cleared without tripping the catenary system.

Ideally the circuit breaker rating should be equivalent to the maximum available substation fault level. This would always enable the locomotive to clear its own faults without causing outages in the catenary.

A compromise solution due to economic reasons is to install a breaker of lower rating. In this case, the locomotive breaker will be able to open on load currents and clear low–level faults such as resistance faults or faults when the locomotive if far from a substation. In the event of high–level faults, the opening of the breaker is blocked by an instantaneous over current relay located on–board the locomotive and the fault cleared by the catenary feeder breakers.

5.3.1.4 Performance at Low Voltage

The locomotives should be designed so that no significant performance degradation occurs under "all substations in" conditions (i.e., at and above the minimum pantograph voltage of 80% nominal value).

Some degradation of performance can be expected during substation outages when the pantograph voltage may drop to 70% nominal value. However, the locomotive propulsion control circuitry should be designed to minimize the tractive effort decrease.

5.3.2 Outline Electrical Locomotive Technical Specification

The specification outline and major section headings are presented below:

- Scope
- Performance Requirements
- Propulsion System
- Main Circuit Breaker
- Main Transformer
- Smoothing Reactors
- Electrical Auxiliary System (including Head End Power on passenger locomotives)
- Lighting
- Cooling System
- Air Brake System
- Dynamic Brakes (blended on passenger locomotives only)
- Sanding

- Multiple Unit Control
- Electric and Pneumatic Train lines
- Cab Signal and Speed Control System (depending on operation territory)
- Radio and Communications
- Carbody
- Coupler, Draft Gear and End Arrangement
- Cab
- Trucks
- Styling and Painting
- Testing
- Materials and Workmanship
- Shipment
- Drawings
  - Tractive Effort
  - Clearance Diagram
  - Cab Arrangement, Plan View and Interior Elevation
  - General Outline.

5.3.3 Typical Data For Freight And Passenger Locomotives

Table 5-10 summarizes key technical data for freight and passenger locomotives which are appropriate for use on the electrified railroad system under study. The data are based on the General Motors – Electric Motive Division GM 10 B freight locomotive and the ASEA-Brown-Bovieri ALP 44 passenger locomotive, which are the most advanced electrical locomotives used in the United States. However, since the GM 10 B was an experimental locomotive of which only one (1) was built, for cost estimating purposes we have substituted the General Motors/ASEA GF 6 C.

TABLE 5-10

Typical Data for Electric Freight and Passenger Locomotive

Locomotive Data	Freight Locomotive	Passenger Locomotive
Line Voltage and Frequency	25kV, 60 Hz	25kV, 60 Hz
Gauge	1,435 mm/56.5 in.	1,435 mm/56.5 in.
Driving Wheel Diameter (New)	1,270 mm/50 in	1,300 mm/51.2 in.
Truck (Bogie) Wheel Base	2,921 mm/115 in.	2,760 mm/108.7 in.
Total Wheel Base	15,418 mm/607 in.	10,560 mm/415.8 in.
Height Over Pantograph (Down)	4,832 mm/190.2 in.	4,510 mm/177.6 in.
Maximum Width	3,125 mm/123 in.	3,100 mm/122 in.
Length Over Couplers	22,352 mm/880 in.	15,590 mm/613.8 in.
Number of Traction Motors	6	4
Traction Motor Control	Thyristor	Thyristor
Auxiliary Machines	60Hz, Three-phase	60Hz, Three-phase
Brake System	Clasp & Dynamic	Dynamic, Disc & Clasp
Maximum Speed	117 km/h (72.7 mi/hr)	201 km/h (124.8 mi/hr)
Continuous Transformer Rating (excl. auxiliaries and car power)	6,900kVA	6,560kVA
Rating as per IEC 349	6,210kW (10,000 eqv. diesel h.p.)	4,320kW (7,000 eqv. diesel h.p.)
Maximum Starting Effort	368kN (82,696 lbs.)	230kN (51,685 lbs.)
Maximum Axle Load	30 tons	22.75 tons
Total Weight	180 tons	91 tons

5.4 COMMUNICATIONS & SIGNALS

5.4.1 Signals

5.4.1.1 Required Modifications to the Signal Systems:

Electrification of the rail corridors will require replacement of the train detection equipment for all currently equipped corridor segments. This is due to the non-compatibility of the existing track circuits with the propulsion return currents. The remaining portions of the signal systems should not be impacted by the planned electrification and can remain in service.

The train detection system that has been proven to operate safely and reliable in the electrified environment similar to that planned by
is the Phase Selective track circuit and the TRU-II track circuit. Attachment 1 contains a discussion of these track circuits and the implications of electrifying existing railroads.

5.4.1.2 DC Coded Track Circuit with Electrified Track Interface:

DC coded track circuits are not compatible with electrification. However, Harmon Industries, Inc. of Blue Springs, Missouri is currently developing a new product to enhance their ELECTRO CODE DC coded track circuit. Page 4 and Figures 4 through 7 of Attachment 2 are a brief discussion of this emerging product.

Although the cost of this type system is estimated to be significantly less than the phase selective alternative, this product is not yet available to the industry. The product is still in development and has not been proven in operations. For this reason this system can not be recommended as a viable candidate for the project.

5.4.2 SCADA Communications System and Control Centers:

5.4.2.1 SCADA Communications

A fiber optics transmission system has been used as the concept for data and voice communications for the SCADA system. The system consists of a single mode fiber optic cable installed between each substation to form a backbone communications system. The cable is also requires to be installed to each SCADA control center. The estimated cost for the fiber optic system terminal insufficient to accommodate a leased line between the substation group and the control center. The leased line may prove the only viable alternative due to the location of the control center relative to the railroad. Each substation will require an add/drop multiplexer, channel bank and channel cards for the local RTU and maintenance telephone. A similar terminal will be required at each control center to interface with the SCADA computer system. If leased lines are used to tie the fiber network to the control center, the cost of one fiber optics terminal for the control center will cover the hardware and phone company installation costs. In addition to the initial procurement cost, the leased lines within the SCRRA area have an ongoing operating cost which can range between approximately $6,000 to $7,500 per year for a dedicated line and approximately $600 per year for a dial-up line is in use.

5.4.2.2 SCADA Control Centers

SCADA control centers are composed of a control computer, consoles and a display system. The architecture is based on modular components and distributed processing. The SCADA system will communicate with the RTRs at each substation to provide control and to monitor status. Workstation processors are provided for each of two operators' consoles to run the applications software and provide the person-machine interface. In addition to the operator's console display, there will be an overview display of the status of the power distribution system. Another microcomputer is included on a local area network (LAN) with the workstations. This system will serve as the communications processor and will control network communications and systems functions within the control center and with the RTUs at each substation. Archival storage and report generation will also be provided by the communications processor.

Voice communications consists of telephone and radio subsystems. The telephone service will be provided by the local telephone company and will be completely independent of the radio system. A separate maintenance telephone is included, and will use one channel in the fiber optics system for direct voice communications with each substation. A radio dispatcher station will be associated with each operator's console in the control center. These dispatcher's stations will tie directly, via leased lines, to the radio master station for each railroad. A multi-channel voice recorder is included to recorder is included to record all voice communications.

One control room and one equipment room are required for the control center. The cost estimate includes the cost of the basic improvements to an existing building space. Basic power, lighting, UPS, grounding and a raised computer floor are included in the estimate for each control center.

6.0 OPERATIONAL CONSIDERATIONS

6.0 OPERATIONAL CONSIDERATIONS

In Chapter 5.0, the technology or rail electrification was discussed in the context of the design parameters which would apply to the Southern California Accelerated Rail Electrification Program. In Chapter 6.0 Electrification Program parameters which are driven by railroad operational requirements are addressed. The program parameters and design requirements which result from operational considerations are no less significant than those related to electrification technology itself. Operational considerations largely determine such important and diverse program elements as the logical limits of the territory to be electrified, locations where additional track capacity will be needed, and the number of electric locomotives required.

6.1 CURRENT RAILROAD OPERATIONS

There are some 2500 miles of railroad track in the California South Coast Air Basin and the immediate surrounding area. The majority of these tracks is shown on the map provided in Exhibit 6-1. Conditions vary widely from location to location and from railroad to railroad. There are stretches of relatively level, well-maintained main line where freight trains can achieve high speeds. There are main lines through mountain passes where steep grades and tight curves severely limit train speeds. There are switching operations consisting of mazes of yard trackwork. And there are light density branch lines where trains operate infrequently and at low speed.

In summary, of the roughly 2500 miles of track in the region, approximately 400 are considered main line, freight-only, 1200 are main line freight and passenger (Amtrak), 400 are light density lines and 500 are yards and industrial trackage. As discussed in Section 2.0, this study focuses on only those lines which meet one or both of the following criteria:

- High density freight operations
- Planned commuter rail route.

Each of the railroads which operate in the region follow their own operating philosophy and practices, which differ substantially in some cases. For example, a preponderance of high speed intermodal trains on one railroad would dictate a different character of operations from a preponderance of slow, heavy trains on another road. These differences will be discussed further in each railroad's individual subsection.

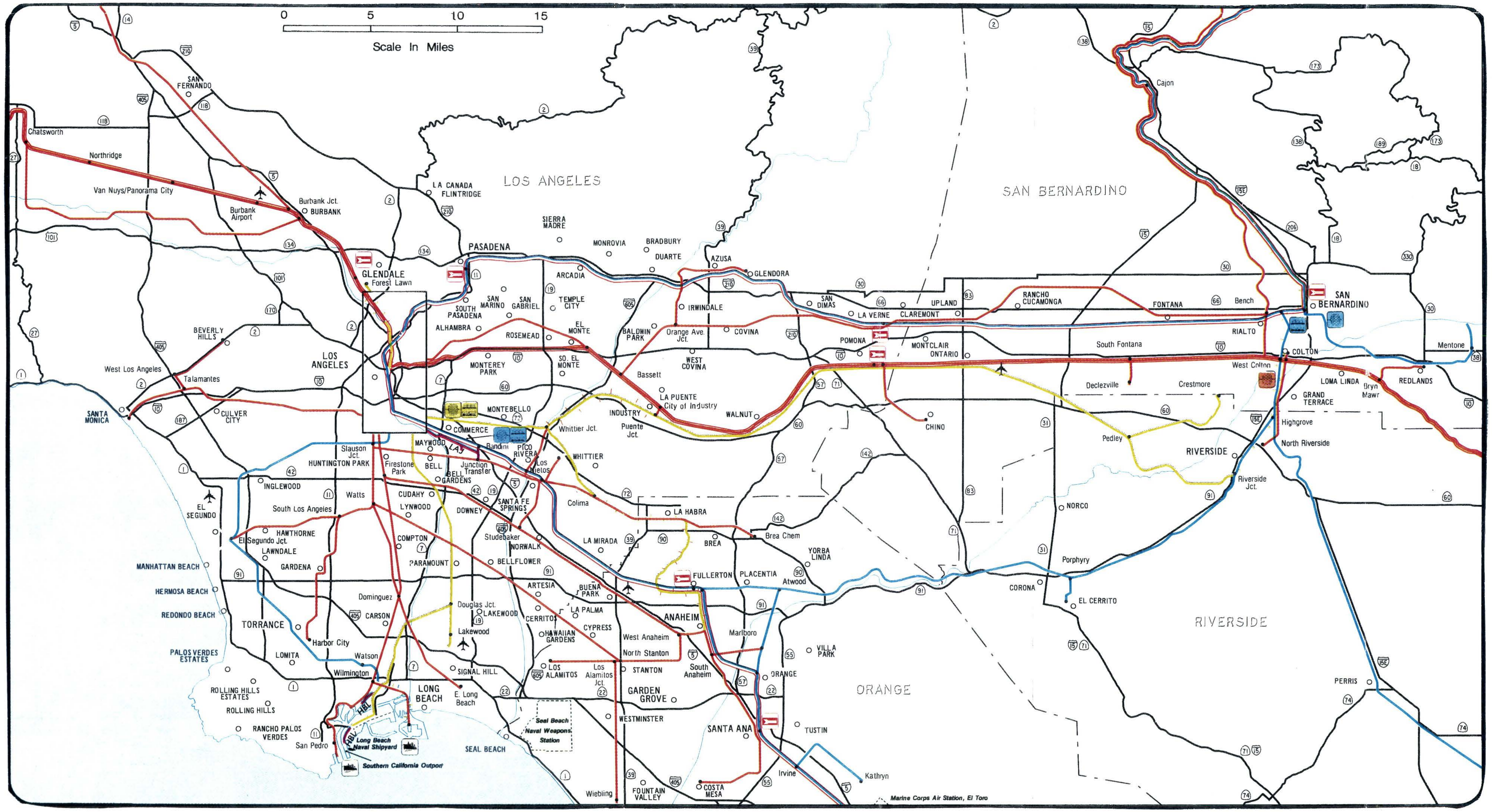
6.1.1 Current Freight Operations

Rail freight operations in the subject region include three major (i.e., Class I) carriers: Southern Pacific Transportation Company (SP); the Atchison, Topeka & Santa Fe Railway (ATSF); and the Union Pacific Railroad (UP).

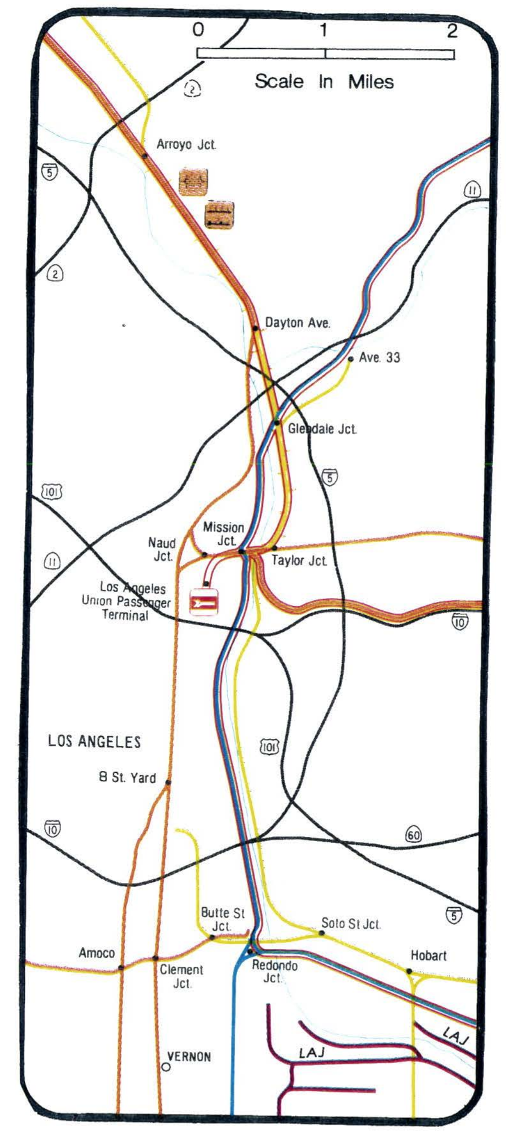
- The Southern Pacific operates about 1400 miles of main line, branch line, secondary trackage and yard and industrial trackage in the Basin. Their current total locomotive ownership is 2111 units consisting of 1326 locomotive units generally used in main line service, 428 generally used in local freight and secondary service and 357 in yard and industrial service.
- The Santa Fe operates about 800 miles of main line, branch line, secondary trackage and yard and industrial tracks in the Basin. Their current total locomotive ownership is 1757 units consisting of 1037 locomotive units generally used on main line trains, 572 units generally used in local freight and secondary service and 148 used in yard and industrial service.

EXHIBIT 6-1

Southern California Rail Lines



Downtown Los Angeles



Map Courtesy of

Caltrans

- The Union Pacific has 300 miles of main line, secondary and yard trackage in the Basin. Their total fleet of locomotives consists of 3014 units of which 1787 units are generally used in main line service, 877 units in local freight and secondary services, and 350 units for yard use.

All three railroads have a high percentage of locomotive ownership that can be used efficiently in several classes of train service. Note also the trends in declining overall fleet sizes and in shifts away from yard and local units to line haul units, illustrated in Table 6-1.

TABLE 6-1

Locomotive Ownership Trends by Railroad

		1987		1991		
		Number	% Of Total	Number	% Of Total	% Decline
SP						
	LINE	1234	56%	1326	63%	
	LOCAL	643	29%	468	22%	
	YARD	334	15%	317	15%	
	TOTAL	2211		2111		4.52%
ATSF						
	LINE	940	50%	1037	59%	
	LOCAL	596	32%	502	29%	
	YARD	334	18%	218	12%	
	TOTAL	1870		1757		6.04%
UP						
	LINE	1383	46%	1787	59%	
	LOCAL	1071	35%	877	29%	
	YARD	570	19%	350	12%	
	TOTAL	3024		3014		0.33%

There are also two switching railroads in the South Coast Air Basin, the Los Angeles Junction Railway (consisting of 64 track miles in and around downtown Los Angeles, and having 4 locomotives) and the Harbor Belt Line Railroad (consisting of 70 track miles in and around Long Beach, and having 2 locomotives). However, neither of these switching roads are included in the study based upon the criteria developed in Section 2.0 and applied as discussed above.

The current operations of each of the three major rail freight carriers, the SP, ATSF, UP, are addressed in detail individually in the following sections.

6.1.1.1 Southern Pacific Transportation Company

The SP has the largest rail network with the most route miles and trackage in the Basin, and therefore, has the most origins/destinations in Southern California. Given the size and complexity of Southern Pacific's rail network in Southern California, it is understandable that the SP has the most complicated rail freight operation in the Basin. Southern Pacific trains enter and leave the South Coast Air Basin via 4 different routes:

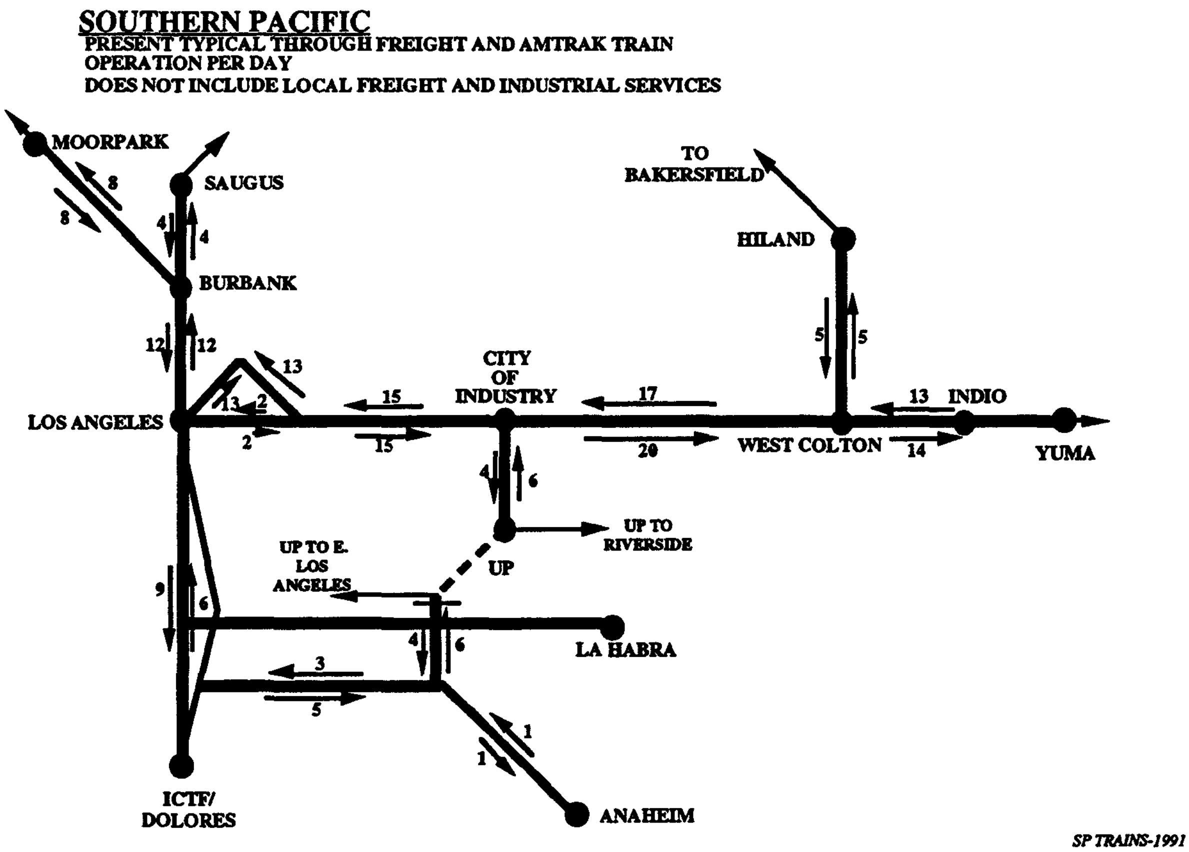
- The Sunset route, extending eastward from West Colton Yard over Beaumont Hill to Yuma, Arizona

- The Palmdale cutoff, extending northward from West Colton Yard through the Cajon Pass to Palmdale and Bakersfield
- The Saugus Line, extending northward from downtown Los Angeles through Burbank Jct. and Saugus to Palmdale and Bakersfield
- The Coast Line, extending northwestward from Burbank Jct. through Chatsworth, Simi Valley, to Santa Barbara and San Jose.

Not only do SP trains enter and leave the Basin via four different routes, they operate to and from several points of origin or destination in the Basin. These points include: West Colton Yard, the Los Angeles Transportation Center east of downtown Los Angeles, the ICTF near Long Beach, the Ports of Long Beach and Los Angeles, served through Dolores Yard, City of Industry Yard, Anaheim, and Van Nuys. A schematic diagram which illustrates the typical number of trains per day operating between those points is provided in Exhibit 6-2.

EXHIBIT 6-2

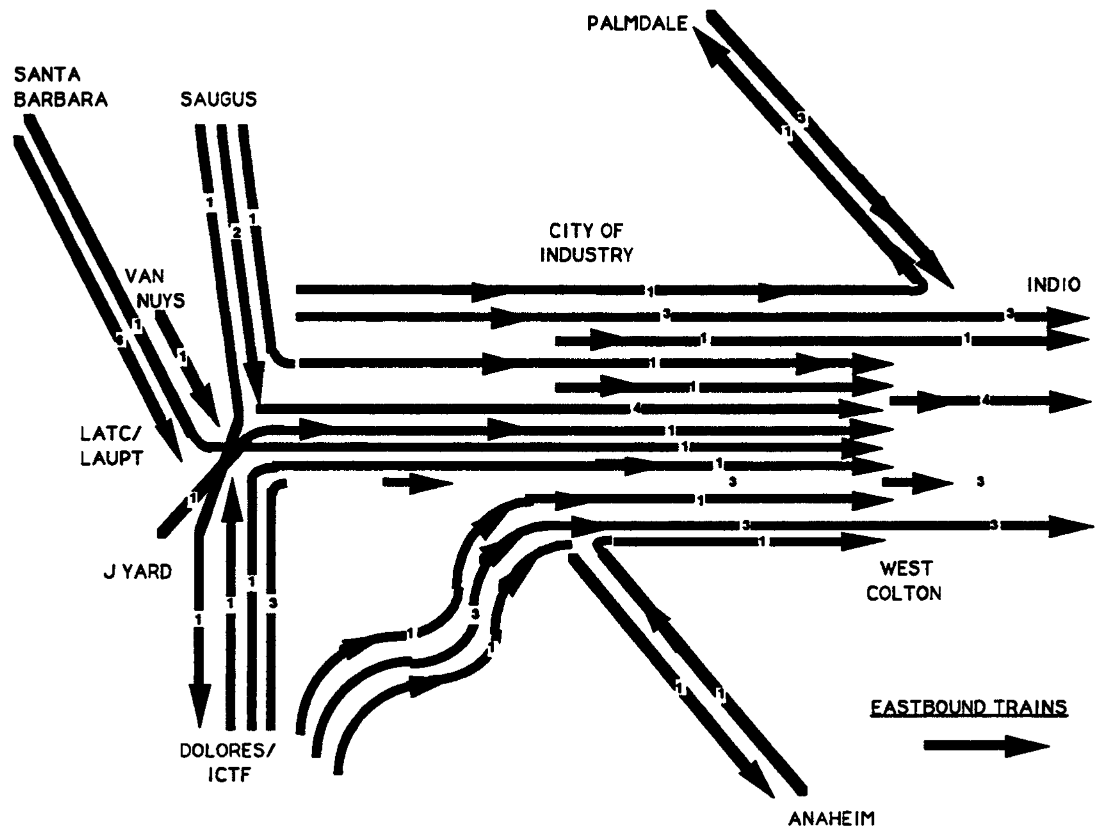
Current Southern Pacific Traffic Pattern



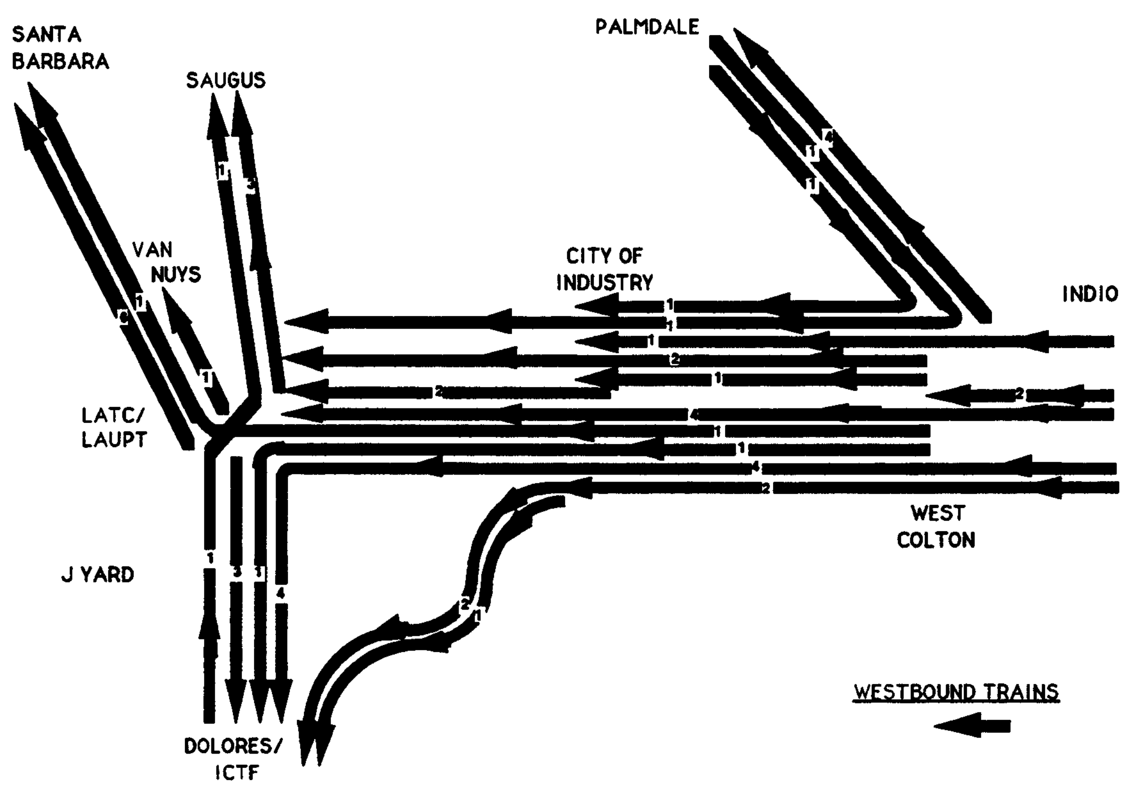
As an alternative illustration of the complexity of Southern Pacific's operations in the Basin is provided in Exhibit 6-3, which includes two graphs which detail the number of trains moving in each direction to and from specific origin/destination points. Exhibit 6-3 is also useful in considering which trains would likely remain diesel powered in electrified territory.

EXHIBIT 6-3

Current Southern Pacific Origin/Destination Schematic



GRAPHIC NAME



GRAPHIC NAME

6.1.1.2 Atchison, Topeka & Santa Fe Railway

The Santa Fe enters the South Coast Air Basin via two routes:

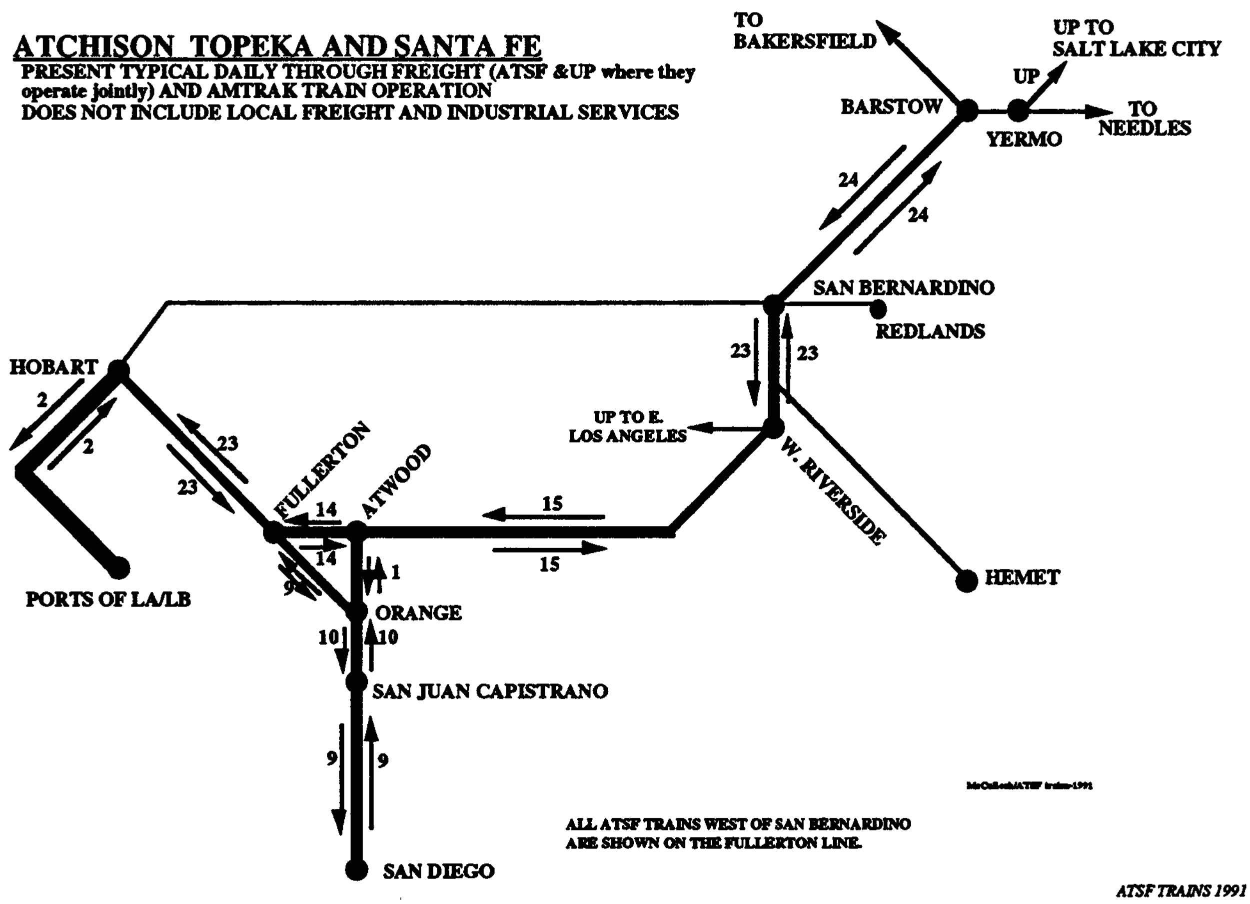
- Through the Cajon Pass
- On the San Diego Subdivision from San Diego.

From San Bernardino, the Santa Fe has two lines both extending westward, the Pasadena Subdivision through Pasadena to Hobart Yard, and the Fullerton Subdivision through Atwood and Fullerton to Hobart Yard. At Atwood, the line to San Diego diverges to the south. From Hobart Yard, the Santa Fe extends southwestward and then southeastward through Torrance to the Ports of San Pedro Bay. There are two primary destinations for ATSF trains in the Basin. They are: Hobart Yard in the vicinity of downtown Los Angeles, and the ports of Long Beach and Los Angeles. Trains also operate through the South Coast Air Basin on the Santa Fe from Barstow in the northeast to San Diego to the south. A schematic diagram which illustrates the typical number of trains per day operating between those points is provided in Exhibit 6-4.

The ATSF operates a variety of train services in the Basin and is expected to soon begin unit trains operations. The ATSF lines also have the highest concentration of present day passenger service, which is operated by Amtrak.

EXHIBIT 6-4

Current Santa Fe Traffic Pattern

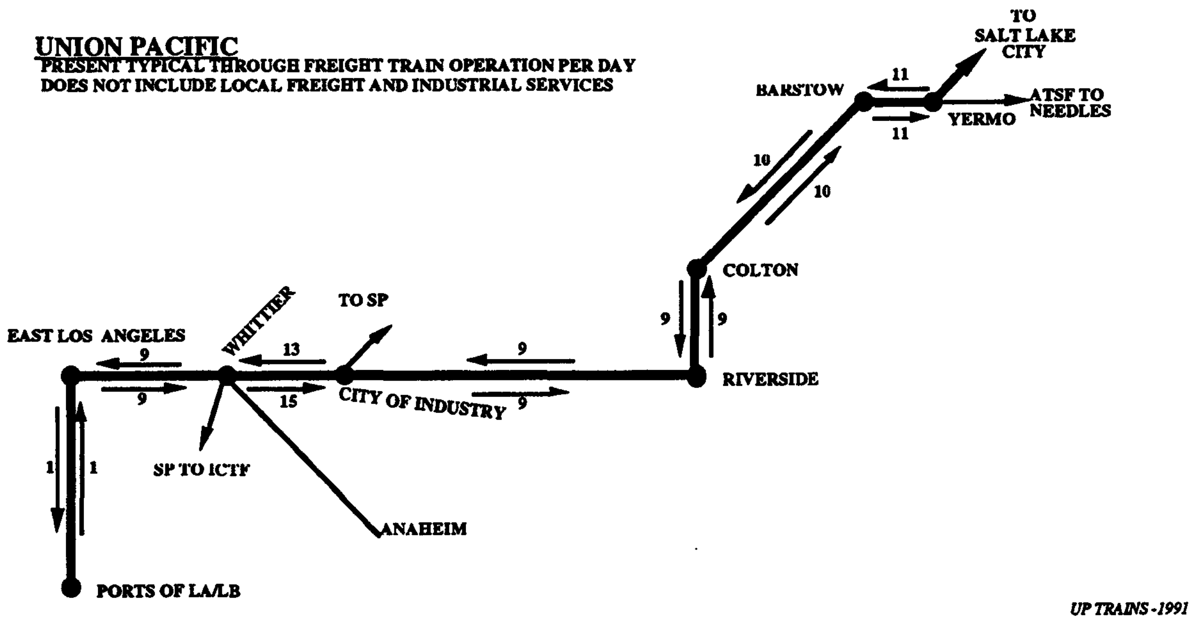


6.1.1.3 Union Pacific Railroad

The Union Pacific Railroad enters the South Coast Basin through the Cajon Pass, as a tenant on the tracks of the ATSF. 10 miles south of San Bernardino at Riverside, the Union Pacific returns to its own lines for the remainder of the trip to Los Angeles and the Ports of San Pedro Bay. There are two primary destinations for UP trains in the Basin. These are the East Los Angeles Yard in the vicinity of downtown Los Angeles and the ports of Long Beach and Los Angeles. A schematic diagram which illustrates the typical number of trains per day operating between those points is provided in Exhibit 6-5. The Union Pacific covers the full array of freight services including the only current regular operation of heavy unit coal trains to the Ports of Los Angeles and Long Beach.

EXHIBIT 6-5

Current Union Pacific Traffic Pattern



6.1.2 Current Passenger Operations

Current rail passenger service in the South Coast Air Basin is provided by Amtrak. Amtrak operates several types of passenger service including its own network of long distance trains which typically operate once a day; the San Diegans providing frequent, daily "corridor" service between Los Angeles and San Diego and which are partially subsidized by the State of California; and the Orange County Commuter train between San Juan Capistrano and Los Angeles, which Amtrak operates under contract for OCTC.

The current operations of Amtrak are addressed in the following subsection.

6.1.2.1 Amtrak

Amtrak Passenger Trains enter the South Coast Air Basin via four routes:

- The ATSF San Diego Subdivision
- The SP Sunset route
- The ATSF main line through the Cajon Pass
- The SP Coast Line.

The Amtrak San Diegans operate on the ATSF San Diego Subdivision providing eight daily round trip trains between Los Angeles and San Diego and serving several intermediate municipalities and one weekday-only round trip commuter train operated by Amtrak for the Orange County Transportation Commission (OCTC) between San Juan Capistrano and Los Angeles.

The SP Coast Line hosts Amtrak's daily Coast Starlight between Los Angeles, the Bay area and the Pacific Northwest, and two daily "San Diegan" round trip trains serving the Los Angeles – Santa Barbara Corridor.

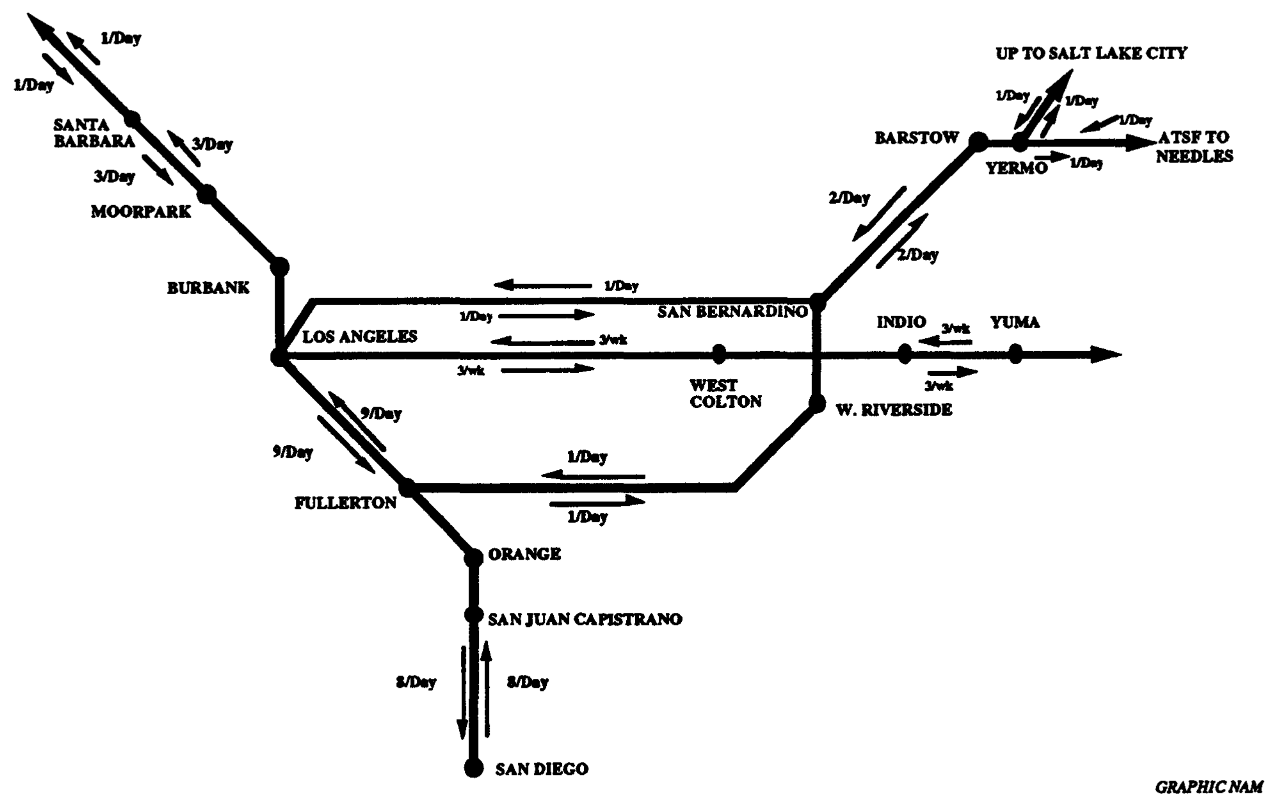
The SP Sunset route hosts Amtrak's tri-weekly Sunset Limited between New Orleans, Yuma and Los Angeles.

The ATSF main line through the Cajon Pass hosts Amtrak's daily Southwest Chief, which operates between Los Angeles and Chicago, via the ATSF Railway beyond the pass, and Amtrak's daily Desert Wind, continuing via UP beyond Yermo, to Las Vegas and East.

All Amtrak trains in the South Coast Air Basin originate or terminate at Los Angeles Union Passenger Terminal (LAUPT) in downtown Los Angeles. A schematic diagram of Amtrak Routes in the South Coast Air Basin is provided in Exhibit 6-6.

EXHIBIT 6-6

Current Amtrak Traffic Pattern



6.1.3 Railroad Traffic Data Base

A detailed data base of all existing rail traffic was necessary for a variety of purposes, including: selection of candidate routes, evaluation of candidate routes, operations planning to confirm viability of design/plans and to support cost estimating, etc. Consultant Team members Booz, Allen & Hamiliton assembled such a database by obtaining records of every rail movement in the California South Coast Air Basin during a one week period and entering them into a data base so that the data can be sorted or organized by a variety of criteria, including:

- date
- railroad
- train symbol
- type of train
- direction of travel
- origin/destination.

The traffic database was utilized to assemble the baseline traffic information illustrated in Appendices 6-1 and 6-2.

6.2 FORECAST RAIL TRAFFIC GROWTH

6.2.1 Data Sources

Several existing data sources were considered in preparing projections of future traffic on the lines under study. Previous projections, in which the consultant team was able to develop a high degree of confidence, were used whenever possible to maximize the consistency of this study with those which have preceded it. The existing data sources considered and the bases of these projections are:

- Alameda Corridor Study, 9/91 Draft – This study includes port traffic projections based primarily on anticipated demand for specific commodities and capacities of individual port facilities to handle those commodities. These projections were then allocated among the three freight railroads on the basis of access to particular port facilities and markets served by each railroad.
- San Pedro Bay Cargo Forecasting Project 2020, 3/88 – The projections in this report are based on trends for individual port terminal operators, broken down by imports and exports.
- Double Stack Train Study, Port of Long Beach, 3/88 – The projections in this study were developed using a single-cycle Delphi Method, interviewing executives of each of the major shipping companies operating in the Port. These projections were then corroborated using an econometric model.
- Riverside-Orange County Commuter Rail Study, 2/91 – The projections in this study were developed using market data provided to the authors of the study by the marketing departments of the freight railroads (Santa Fe and Union Pacific).

As a means by which to establish the Accelerated Electrification Program consultant team's confidence in previous data, such data was considered in light of two economic forecasts:

- The Value Line Economic Series
- The Business Outlook, U.S. Department of Commerce.

The consultant team's review suggested that the Riverside Study provided the most realistic traffic projection for the UP and the ATSF, and that the Alameda Corridor Study provided the most realistic traffic projection for the SP.

6.2.2 Freight Forecasts

As mentioned in subsection 6.2.1, the consultant team concluded that the Riverside-Orange County Study provided the most realistic traffic projections for the UP and ATSF, and the Alameda Corridor Study provided the most realistic traffic projection for the SP. These data were interpolated and extrapolated as necessary to develop projections by railroad and route for the years 1991, 1993, 1995, 2000, and 2010. These data are presented for the 72 segments which make-up Candidate routes 2 through 13, in Appendix 6-1, and for the consolidated corridor only (candidate route 1) in Appendix 6-2. This data reflects the trends which appear to be present in some measure on all railroads in North America. Specifically,

- Virtually all new traffic is being handled in unit trains, including double stack containers, single level container, piggyback, coal and other minerals, and solid waste.
- Yard activity levels are expected to remain relatively static due in large part to the growth in unit train traffic which involves virtually no yard activity. Further, although some new box car traffic is expected, a portion of the existing box car traffic will likely shift to piggyback, resulting in an neutral effect on yard activity.

6.2.2.1 Impacts of Freight Forecasts on Operations

6.2.2.1.1 Alameda Corridor

The Alameda Corridor Project predates the Southern California Accelerated Electrification Program by several years. Although commitment to implement either improves the likelihood of implementing the other due to their complementary nature, there is a significant probability that the Alameda Corridor will be implemented regardless of whether electrification takes place. This is due to the significant adverse impacts, both environmental and economic, which would result from attempting to accommodate the anticipated traffic growth without increasing track capacity.

6.2.2.1.2 Consolidated Corridor

Although the Consolidated Corridor is not as likely as the Alameda Corridor to be implemented based on a need to avoid adverse environmental and economic consequences, and regardless of the fact that the Consolidated Corridor was germinated as a means by which to increase freight traffic density and thereby improve the cost effectiveness of electrification, it is possible that there may be sufficient economic advantages to justify the consolidation with or without electrification.

6.2.3.1.3 Change In Operating Practices

Additional capacity will someday be needed to accommodate growth. Additional capacity can be provided by adding facilities, usually at great cost, or by increasing, typical operating speeds. The latter alternative is particularly applicable to Southern Pacific, which typically operates its trains longer, heavier and slower than trains of its competitors ATSF and UP. This operating practice on the part of SP may be the result of SP applying a higher priority to direct out-of-pocket costs such as train crew labor, than its competitors, which are financially better able to take a long term view with regard to asset utilization and profits.

The consultant team anticipates that SP will, over time, change its operating practices and increase typical operating speeds to accommodate traffic growth. This in turn is expected to reduce turnaround times for equipment at terminals. Both expectations are reflected in analyses and projections provided in this report and pertaining to future rail freight operations.

6.2.3 Passenger Forecasts

6.2.3.1 Amtrak

Amtrak staff were interviewed to obtain their perspective on potential growth. Their suggested timing of future increases of the frequency of service were found to be consistent with historical data on demand growth and anticipated constraints due to equipment availability. These projections are summarized in Table 6-2.

TABLE 6-2

Amtrak Traffic Projections

	FREQUENCY EACH WAY		
Train	**Current**	**1992-93**	**1995-96**
San Diegans			
L.A. – San Diego	8/day	8/day	10/day
L.A. – Santa Barbara	2/day	3/day	4/day
Coast Starlight	1/day	1/day	2/day
Sunset Limited	3/week	3/week	1/day
Southwest Limited	1/day	1/day	1/day
Desert Wind	1/day	1/day	1/day

6.2.3.2 SCRRA Commuter Rail

Nine SCRRA commuter rail routes are planned to be in operation by the year 2000. Service frequencies for each line are indicated for the years 1993, 1995, 2000 and 2010 in Table 6-3 below. These service levels are consistent with those provided in the Southern California Commuter Rail 1991 Regional System Plan (June 14, 1991).

TABLE 6-3

SCRRA Commuter Rail Service Levels

	Candidate	**Planned Daily Round Trips**			
Route	**Route Number**	1993	1995	2000	2010
Los Angeles – San Bernardino	2	5	14	19	19
Los Angeles – Moorpark	3	4	12	19	19
Los Angeles – Santa Clarita	4	3	4	12	12
Los Angeles – Oceanside (ATSF)	5	3	4	6	6
Los Angeles – Riverside (UP)	6	3	5	5	5
Los Angeles – Riverside (ATSF)	7		2	19	19
Hemet – Riverside	8		2	5	5
San Bernardino – Irvine	9		4	24	24
Redlands – San Bernardino	10			2	5

The four initial routes (candidate numbers 2, 3, 4, and 6) are illustrated on the map provided in Exhibit 6-7; all nine planned routes are shown in Exhibit 6-8.

EXHIBIT 6-7

ELECTRIFICATION STUDY
Four Initial Routes

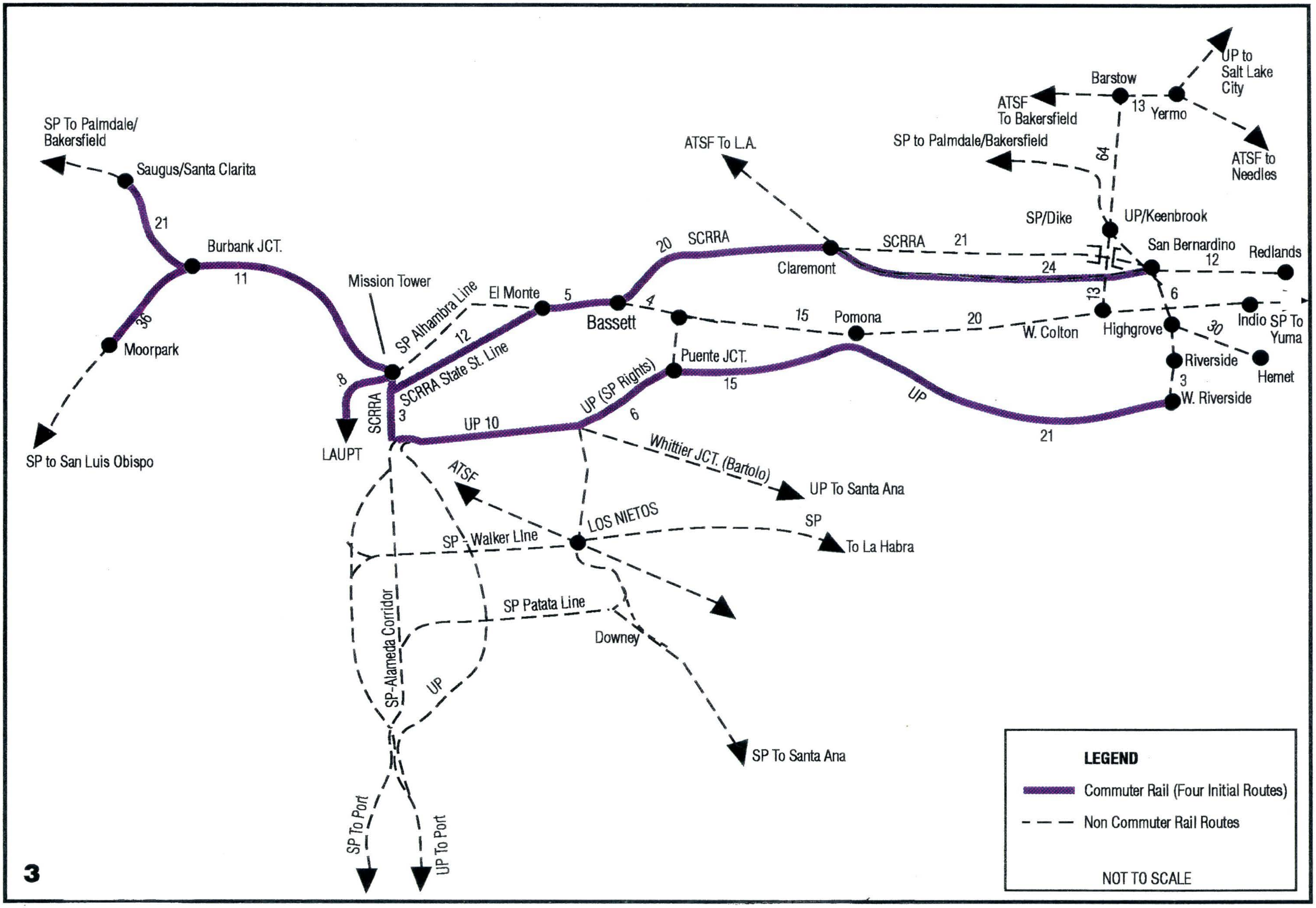
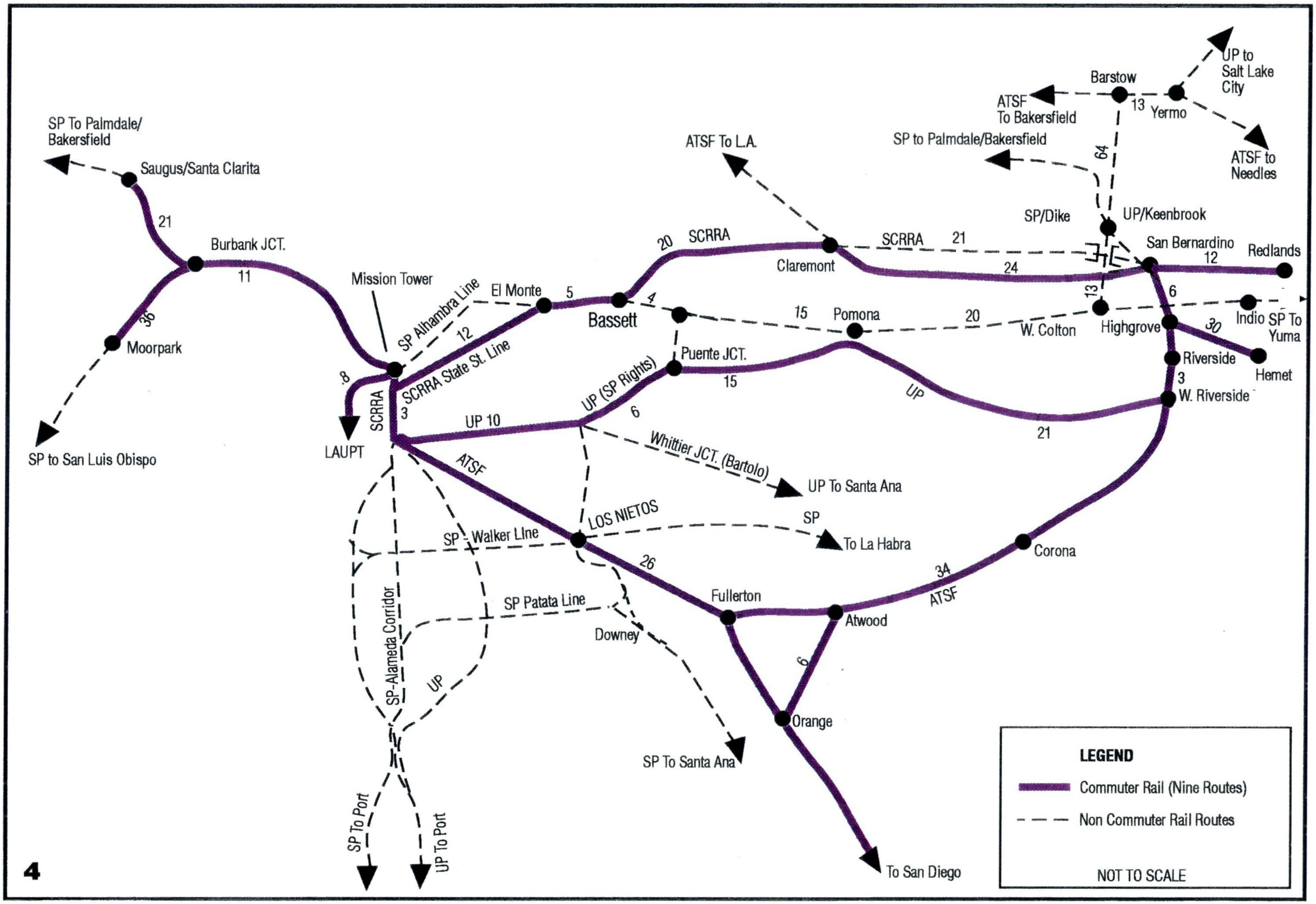


EXHIBIT 6-8

METROLINK

ELECTRIFICATION STUDY
Nine Routes



6.3 CONSOLIDATED CORRIDOR ANALYSIS

6.3.1 Original Concept

The Consolidated Corridor concept was originated by the South Coast Air Quality Management District (SCAQMD) subsequent to the release of the 1982 Air Quality Management Plan (AQMP). In the 1982 AQMP, SCAQMD proposed the "Electrification of Railroad Line Haul Operations". The Consolidated Corridor concept was a natural outgrowth of Measure M8 in that the combination on a shared route of "all freight traffic from the Ports of L.A. and Long Beach through East Los Angeles and Colton to the Cajon Pass" was intended to create a line with very high traffic density thereby improving the cost effectiveness and viability of electrification.

Since its inception and until 1991, the Consolidated Corridor received virtually no attention with the exception of the portion of the route between downtown Los Angeles and the Ports of San Pedro Bay. This portion was advanced as a separate line consolidation projection, the Alameda Corridor. However, the Alameda Corridor was not planned to be electrified, and its project justification was to mitigate adverse environmental impacts (primarily noise and highway traffic congestion) and freight mobility constraints, which would result from attempting to accommodate anticipated growth in freight traffic on the existing rail network.

At the beginning of the Accelerated Electrification Program, a Consolidated Corridor was proposed. This version of the concept was to combine the traffic of the SP and UP on a single shared route, the limits of the which were defined as the northern end of the Alameda corridor, near and south of downtown Los Angeles, and West Colton Yard on the SP.

6.3.2 Corridor Route Extension and Intermediate Route Selection

Shortly after the presentation of the proposed Consolidated Corridor described above, the railroads requested the limits of the proposed electrification be extended to Yuma on the SP and Yermo on the UP. (The SP electrification is planned to end at Indio initially, and be extended to Yuma subsequently.) The reasons for this extension were:

- The economic impact, in terms of additional labor cost, associated with changing locomotives at other then existing crew-change points
- The absence from the original concept of those lines with heavy grades to the north (Cajon Pass) and east Beaumont Hill precluded some of the greatest potential emission reductions from being realized
- The ATSF was included, at their request, on the basis that more than 70 miles of the ATSF mainline was included in the extension of the UP to Yermo.

The traffic anticipated on the consolidated corridor is described by individual railroad in Exhibits 6-9 (SP), 6-10 (ATSF) and 6-11 (UP). A detailed description of the consolidated corridor is provided in tabular form in Table 6-4.

The decision to extend the Consolidated Corridor eastward from West Colton on the SP route was relatively simple, adding the SP main line to the next crew change location, Yuma. (Indio had been a crew change location in the past but is now closed.) However, the extension to the UP crew change location at Yermo required selection of one of several possible routes.

- Option One is to continue east on the SP from West Colton to Colton, use the existing connection with the ATSF at Colton and continue east to Yermo as can be done presently. This connection is a slow speed, single track that is restricted by the close confines of adjacent Interstate 10. The crossing of the SP and ATSF/UP at Colton in its current configuration is the cause of delays to all three railroads and would not be acceptable for use with the increase in traffic which would result from consolidation.
- Option Two is to improve and grade-separate the Colton alignment to improve the speed on the existing connection. But that routing would still be hampered by the slow speed "S" curve at San Bernardino. Also unacceptable for increased traffic.
- Option Three is to improve the Colton Connection, by building a new route, in conjunction with a proposed widening of Interstate 215 in the San Bernardino area, from ATSF "B" yard, southwest of the San Bernardino station, north along the Lytle Creek, to connect with the SP's Palmdale Line near Dike and continue to the Keenbrook connection back onto the ATSF 13 miles north of San Bernardino.
- Option Four is to build a new double-track connection from the SP main line to the SP Palmdale cut off, in the area of the present connection, and continue on the Palmdale Cutoff with 2 main tracks to the present unused Keenbrook connection and there reconnect with the ATSF. Option Four was selected by the SP and the UP as the most desirable, and is endorsed by the consultant team, primarily because it appears to be the least expensive option, and it is shorter than the other alternatives.

6.3.3 Corridor Track Requirements

An analysis of track requirements was performed based on the forecast rail traffic growth analyzed as described in Section 6.2. From this analysis, the number of trains on the Corridor was quantified by railroad and by train type. The methodology was as follows:

Traffic which would enter the Consolidated Corridor from the Alameda Corridor connection at "J" yard near Redondo Junction would be augmented by traffic and trains that are generated in the Los Angeles area. The combined number of trains by railroad was then determined. An analysis was performed to determine how many trains would use the Consolidated Corridor exclusively, and how many would require some diversion to handle off-corridor traffic. Every attempt was made to represent each railroad's operating strategy with some adjustment for the anticipated change in mix of commodities handled. Therefore, some of the SP trains from the Alameda Corridor would continue to operate to the SP's Los Angeles Transportation Center. Other SP trains would use the Consolidated Corridor to the SP City of Industry yard and have their train "filled out" at that location. Other SP trains would bypass the City of Industry yard and continue east on the Consolidated Corridor to West Colton and Yuma. ATSF trains from the Alameda Corridor are expected to bypass the ATSF Hobart yard and continue east on the Consolidated Corridor to Barstow. Trains from the ATSF Hobart yard that had no intermediate work between Hobart and Barstow were assumed to enter the Consolidated Corridor from the west end of Hobart yard, onto the Consolidated Corridor main tracks at Downey Road (CPC-004) and continue east. Some ATSF trains are expected to operate via Fullerton to handle traffic on that corridor, and some of the San Bernardino traffic. The additional San Bernardino traffic would be handled by trains operating between Barstow and San Bernardino.

UP trains from the Alameda Corridor have the most straight forward operating pattern. They would be able to pick up cars as required or bypass their East Los Angeles yard. There would be some trains that would diverge from the Consolidated Corridor at Montclair to accommodate traffic on that route.

The analysis of the westbound traffic and allocation of westbound trains, were performed for all three railroads in the same manner.

Once the number of trains by type and railroad was known, the current operating pattern of each railroad was analyzed. In view of the fact that none of the railroads have disclosed plans for any capital improvement projects to substantially increase their present railroad facilities to accommodate the anticipated growth, it was assumed that the increased traffic would be handled by increasing the present "through-put" of their present facilities. This means that existing container facilities would have to decrease detention time at terminals. This, in-turn, has a positive effect on car and locomotive utilization as well as utilization of the railroads' main line's (their primary capital assets). This improvement in equipment utilization is reflected in the locomotive fleet size analysis provided in Section 6.4.

The required track configuration was developed based on the preceding factors. A description of the resultant Consolidated Corridor configuration is given in Table 6-4. This table describes the corridor from west to east, indicating the "from" point and "to" point of individual segments, the distance between points, the owning railroad, mileposts, the present number of main tracks, the required number of main tracks and the detailed segment sheet that represent the described location. Table 6-5 has a non-scaled schematic of the proposed route configuration and shows the number of trains by railroad and motive power between described locations. The sum of trains operated, including SCRRA commuter trains, and Amtrak trains is included. As is illustrated by Table 6-5, the number of trains varies by segment, and the number of tracks varies as corridor electrified traffic and off-corridor and industrial traffic varies. The corridor is configured to be not less than double track CTC which allows trains to run in either direction on any track, with 3 and seven main tracks in some locations. Control points are proposed to be located approximately every seven miles to permit the required operating flexibility.

6.4 LOCOMOTIVE FLEET SIZE ANALYSIS

The purchase of a fleet of electric locomotives would represent a substantial portion of the capital cost of electrification. Accordingly, an analysis was performed to consider the railroad operating conditions specific to the South Coast Air Basin. This analysis incorporates the effects of operating practices of the individual freight railroads and of anticipated traffic growth.

6.4.1 Methodology

The analysis assumes that the current diesel locomotive fleet consists of passenger units rated at 3,000 horsepower (such as EMD models F40PH and F59PM) and freight units rated at between 3,000 and 4,000 horsepower (such as EMD models SD-40, SD-50 and SD-60 and GE models C30-8, B40-8, and C40-8). The electric locomotives to be substituted are assumed to be one of two types: the Asea Brown Bovieri ALP-44/AEM-7 for passenger service, or a generic 6000 horsepower locomotive like the General Electric E60 for freight and some passenger service. Electric locomotive alternatives were limited in this way based upon these being two currently available locomotive designs with a demonstrated, recent performance record.

TABLE 6-4
Consolidated Corridor Description
(West to East)

RR	From	To	Distance	RR	Mile Post	Main Tracks Present	Main Tracks Future	Seg. #
UP	Alameda Corridor Connection		—		0.0			29
UP	AL CO Connection	Soto St. Junction	1.0	UP	2.0	0	2	29
UP	Soto St. Junction	Garfield Avenue	5.5	UP	7.5	2	4	30,31,46
UP	Garfield Avenue							
UP		City of Industry	9.0	UP	16.5	1	3	31, 32
UP	City of Industry	Puente Junction	2.0	UP	18.5	2	4	32
UP	Puente Junction	Pomona (on UP)	12.5	UP	31.0	1	2	33
Parallel Alignment								
SP	Puente Junction	SP City of Industry	1.6	SP	501.3	1	2	49
SP	City of Industry	Marne (East Switch)	2.6	SP	503.9	2	3	40
SP	Marne	Pomona	9.4	SP	513.3	1	2	40
SP	Pomona UP 31.0 = SP 513.3	Kaiser (West Switch)	14.1	SP	527.4	1	3	34,41,42 ,50,51
SP	Kaiser	West End/West Colton	5.1	SP	532.5	2	4	42
SP	New dedicated main line West End West Colton	Palmdale Line	5.4	SP	537.9	0	2	42
SP	Palmdale SP 537.9 = SP492.9	Keenbrook	13.9	SP	479.0	1	2	62,63,66
ATSF	Keenbrook SP 479.0 = ATSF 69.4	Victorville	34.4	ATSF	37.0	2	3	57,58
ATSF	Victorville	Barstow	33.6	ATSF	3.4	2	2	59
ATSF	Barstow (3.4 = 749.8)	East Barstow	6.2	ATSF	743.6	3	4	59
ATSF	East Barstow	Daggett	6.2	ATSF	737.4 =158.8	2	3	60
UP	Daggett 158.8	East & Yermo	5.2	UP	164.0	2	2	61
			154.1					
SP Mainline East (West Colton - Yuma)								
SP	East Palmdale	Apex	25.3	SP	563.2	2	2+	43,44
SP	Apex	Yuma (East Yard)	174.3		737.5	1	1	44,45

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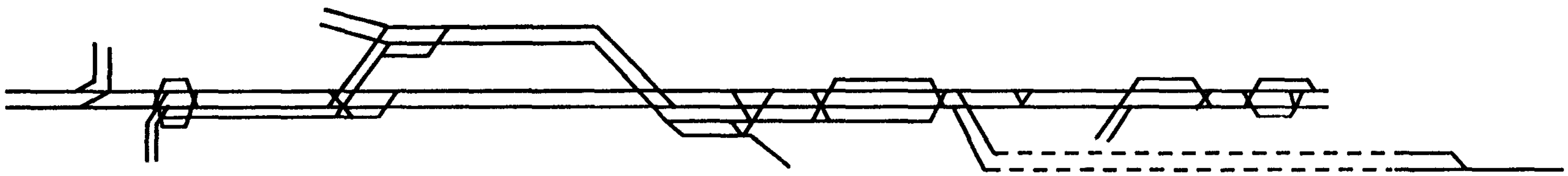
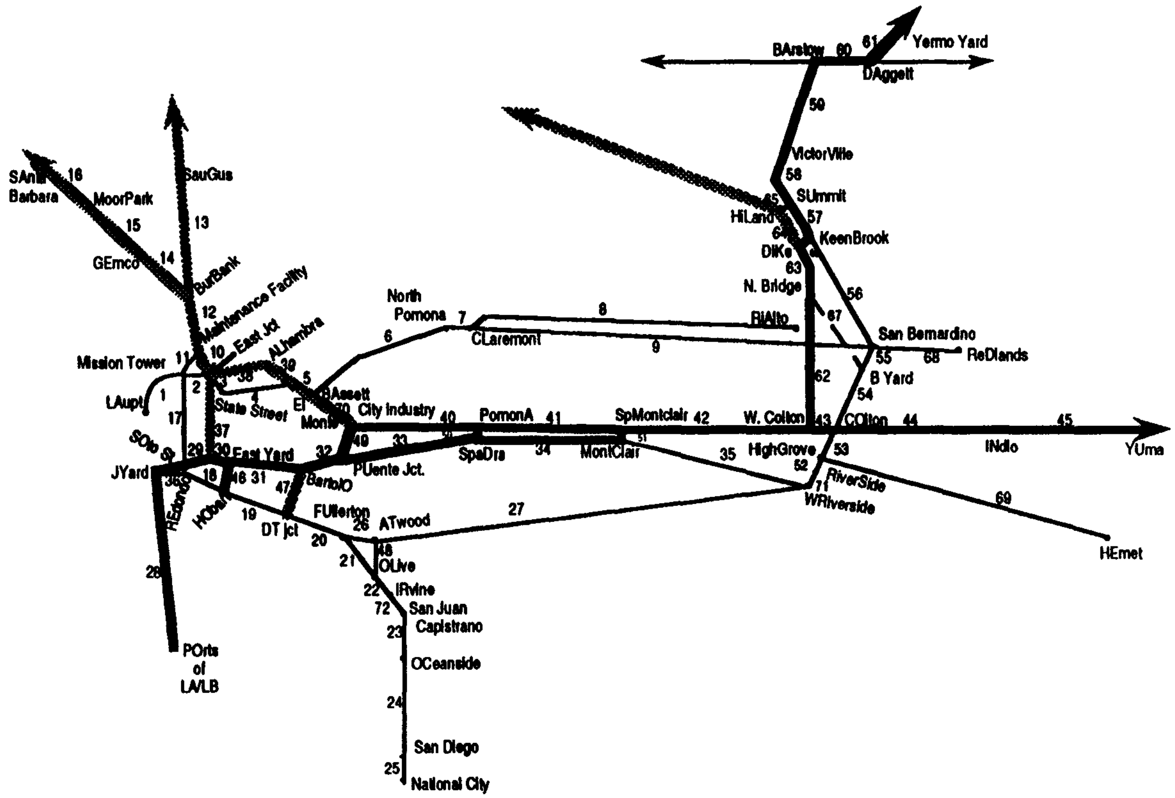
TABLE 6-5
Route 1
Segment Train Densities in 2000

Route Schematic



Between And Route	Ports/ITCF LA East Yd Alameda Corr	LA East Yd City of Ind. UP	City of Ind. Pomona UP	City of Ind. Pomona SP	Pomona Ontario SP	Ontario West Colton SP	West Colton Keenbrook SP	Keenbrook Barstow ATSF	Barstow Yermo ATSF/UP	West Colton Yuma SP
ATSF										
by Electric Powered	8	24	24	0	24	24	24	24	--	--
Diesel Powered	0	0	0	0	0	0	0	15	--	--
ATSF TOTAL	8	24	24	0	24	24	24	39	--	0
SP										
Electric Powered	22	22	14	20	34	34	--	--	--	44
Diesel Powered	9	0	0	20	20	20	7	--	--	2
SP TOTAL	31	22	14	40	54	54	7	0	--	46
UP										
Electric Powered	13	24	24	--	24	24	26	26	26	--
Diesel Powered	--	6	6	--	6	0	0	6	6	--
UP TOTAL	13	30	30	0	30	24	26	32	32	0
SEGMENT TOTALS FREIGHT										
Electric Powered	43	70	62	20	82	82	50	50	26	44
Diesel Powered	9	6	6	20	26	20	7	21	--	2
SCRRA Commuter	0	10	10	0	10	0	0	--	--	--
Amtrak	0	0	0	4	4	4	0	4	2	2
TOTAL TRAINS	52	86	78	44	122	106	57	75	34	48

EXHIBIT 6-9

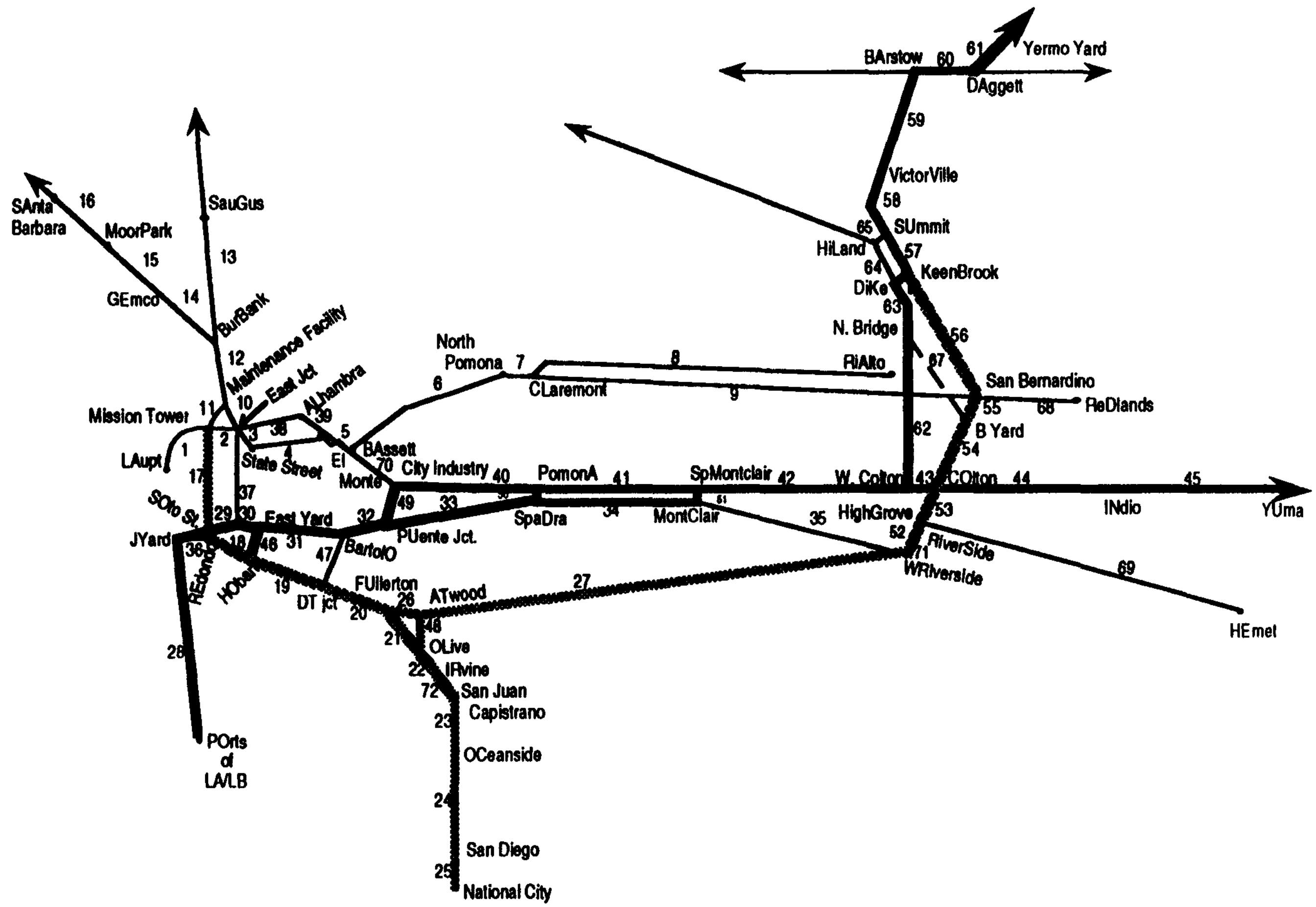


SP AND THE CONSOLIDATED CORRIDOR
Segment Map For The Accelerated Electrification Program

TRAIN CLASS	1991						2000 E – CORRIDOR TRAINS ELECTRIC = HAULED D – OFF CORRIDOR TRAINS DIESEL = HAULED					
	PTs/LA	LA/BBk	LACof I	Cof I/WC	WC/YU	WC/PALM	PTs/LA	LA/BBk	LA/Cof I	Cof I/WC	WC/YU	WC/DK
PRIORITY TRAINS	12	8	13	20	19	0	22	8-D	30	30	30	0
							E=16		E=16	E=20	E=30	
							D=6		D=14	D=10	D=0	
GENERAL TRAINS	2	7	11	19	7	7	3	7-D	20	20	10	7
							E=2		E=2	E=10	E=10	
							D=1		D=18	D=10	D=0	D=7
UNIT TRAINS	3	1	2	2	2	0	6	2-D	4	4	4	0
							E=4		E=4	E=4	E=4	
							D=2		D=0	D=0	D=0	
AMTRAK	--	6	1	1	1	0	--	12	4	4	4	0
COMMUTER	--	0	--	--	--	--	--	62	0	0	0	0
TOTAL TRAINS	17	22	27	42	29	7	31	91	58	58	48	7
							E=22	E=74	E=22	E=38	E=48	E=0
							D=9	D=17	D=32	D=20	D=0	D=7

Typical Heavy Day, But Not Peak Day

EXHIBIT 6-10

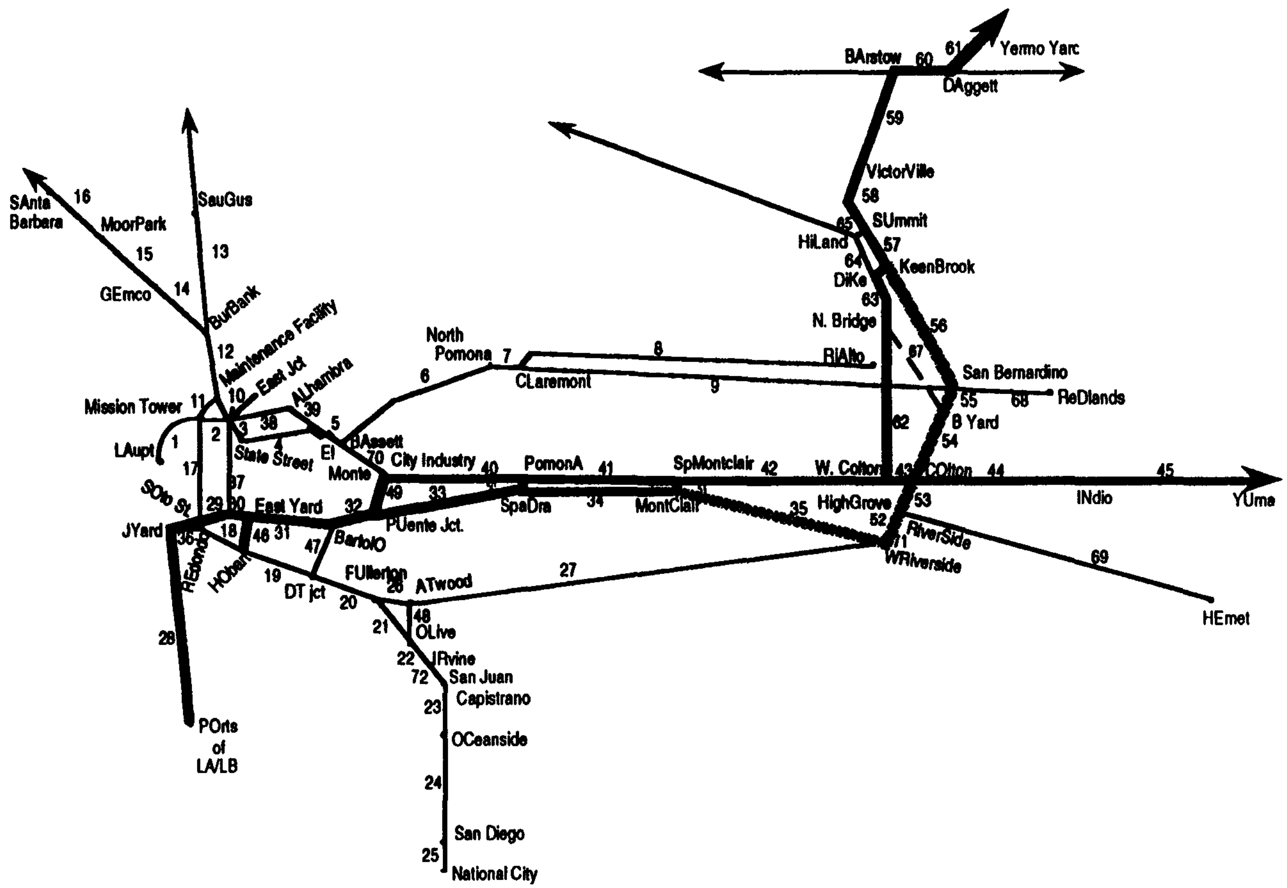


ATSF AND THE CONSOLIDATED CORRIDOR
Segment Map For The Accelerated Electrification Program

TRAIN CLASS	1991				2000				
					CORRIDOR TRAINS ELECTRIC HAULED		OFF CORRIDOR TRAINS FREIGHT DIESEL HAULED		
	PT/HO LA	LA/AT	AT/SB	SB/BA	PT/LA	LA/BA	LA/AT	AT/SB	SB/BA
PRIORITY TRAINS	1	17	17	17	5	20	3	3	4
GENERAL TRAINS	2	6	8	8	1	2	4	8	11
UNIT TRAINS	0	0	0	0	2	2	--	--	--
AMTRAK	--	18	2	4	--	--	32E	2E	4
COMMUTER	--	2	--	--	--	--	12E	38E	--
TOTAL TRAINS	3	43	27	29	8	24	51	51	19

Typical Heavy Day, But Not Peak Day

EXHIBIT 6-11



UP AND THE CONSOLIDATED CORRIDOR
Segment Map For The Accelerated Electrification Program

TRAIN CLASS	1991			2000			
				CORRIDOR TRAINS ELECTRIC HAULED			OFF CORRIDOR TRAINS DIESEL HAULED
	PORTS/ LA	LA/ COLTON	COLT/ YERMO	PORTS/ LA	LA/ WC	WC/ YERMO	LA/VIA RIVERSIDE/YERMO
PRIORITY TRAINS	1	11	11	7	16	16	2
GENERAL TRAINS	0	5	7	0	2	4	4
UNIT TRAINS	2	2	2	6	6	6	0
AMTRAK	--	0	0	--	0*	0	4
COMMUTER	--	0	--	--	10*	--	--
TOTAL TRAINS	3	18	20	13	34	26	10

Typically Heavy Day, But Not Peak Day

* SCRRA Riverside/LA Via Ontario

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6.4.2 Freight Locomotives

The substitution ratio of electric locomotives for diesels depends primarily upon the type of service in which the locomotives are operated, and particularly the speed at which they are operated. For example, on trains operated at higher speeds, such as intermodal trains maintaining a minimum speed of 25-40 miles per hour on grades, electrics can be substituted for diesels on the basis of horsepower (i.e., one 6,000 horsepower electric locomotive can replace two 3,000 horsepower diesel locomotives). This is because in the 25 MPH and above speed regime, the tractive effort of the locomotive is primarily horsepower-limited.

On trains operated at lower speeds, such as coal or other mineral-carrying trains with minimum speeds of as low as 10-15 miles per hour on grades, electrics would be substituted on the basis of tractive effort, which is primarily a function of locomotive weight (i.e., two 6,000 horsepower electric locomotives would replace three 3,000 horsepower diesel locomotives). This is because in the 10-15 MPH speed regime, the tractive effort of the locomotive is adhesion-limited and the additional horsepower cannot be fully utilized.

In addition to the foregoing, the analysis must take into account the traffic volume anticipated in the future. This is because electrification is a long term improvement which would take several years to be implemented. When the operating practices in use today are applied to the projected traffic volume in future years, several operating lines are constrained by track capacity. Since it is generally more cost effective to increase the effective capacity of a rail line by increasing the typical operating speed than to build additional tracks, the consultant team assumed such an operational change would take place to accommodate the anticipated growth in traffic. The resultant operating pattern, discussed in Section 6.2.2, was evaluated by type of train, and the number of electric locomotives required was estimated based upon that evaluation. The anticipated numbers of electric locomotives required for freight operations, based on year 2000 traffic projections are described first by railroad for the Candidate Route 1, the Consolidated Corridor, and by railroad assuming each uses only their own main line. Table 6-6, Southern Pacific Electric Locomotive Requirements For Route 1 in Year 2000, describes the SP electric locomotive requirements based on origin-destination points, e.g., Ports-Yuma, train type between those locations. (e.g., priority and unit trains). The Total Eastbound Use Time which includes the time the units are committed to a train and a crew is on duty at the origin, the Port in this case, the movement to the destination, Yuma, and the move to the motor storage or service facility at destination. The Connect Time includes the trip inspection servicing and dwell time awaiting the next movement. The typical number of units for each train type and the number of train cycles per day are shown. The base units required to provide a heavy but not peak day service is then shown. The number of helper units is shown, as all three railroads will continue to use helpers either mid-train or added to the rear of trains to allow longer and somewhat heavier trains to transverse the Cajon and Beaumont grades. These helpers not only push upgrade to relieve coupler tension, but frequently retard downhill movements with dynamic brakes to relieve entrain buff forces. Additional units for traffic protection and maintenance allocation are also indicated. The traffic protection units are to cover the peak traffic days. These peaks may tend to level out as traffic grows, but the traffic analysis confirmed sufficient present weekly fluctuation to justify the additional traffic protection units.

Tables 6-6 through 6-11 appear on the following pages. Tables 6-6 through 6-8 describe each of the three railroads' individual locomotive requirements for the Consolidated Corridor. Tables 6-9 through 6-11 describe each as stand-alone electrification projects.

6.4.3 Passenger Locomotives

The analysis of the number of electric locomotives required is somewhat different from freight locomotive analysis; while only one generic 6000 HP C-C electric locomotive such as the E60, was considered in the freight analysis, both the ALP44/AEM7 and the E60 are considered for passenger service.

TABLE 6-6
Southern Pacific
Electric Locomotive Requirements
For Route 1 In Year 2000

SP	Train Type	Total Eastbound Use Time	East End Connect Time	Total Westbound Use Time	West End Connect Time	Units/ Train	Unit Hours	One Way Trains	Total Unit Hours/Day
Ports –	Priority	12	6	12	5	3	105	8	840
Yuma	Unit	16.5	6	16.5	3	3	126	2	252
Ports – WC	General	6.5	5	6.5	6	2	48	1	48
City of Ind.– WC	General	3.5	5	3.5	6	2	3.6	2	72
C of I –	Priority	9	6	9	6	3	90	2	180
Yuma	General	12	6	12	6	3	108	2	216
W. Colton –	Priority	8	6	8	5	3	81	5	405
Yuma	General	10.5	6	10.5	5	3	96	3	288

Base Units Required For Service	96
Helper Units	10
Traffic Protection & Maintenance Units	16
SP Electric Units Required	122

TABLE 6-7
Atchison, Topeka and Santa Fe
Electric Locomotive Requirements
For Route 1 In Year 2000

ATSF	Train Type	Total Eastbound Use Time	East End Connect Time	Total Westbound Use Time	West End Connect Time	Units/ Train	Unit Hours	One Way Trains	Total Unit Hours/Day
LA – Barstow	General	8	6	8	6	3	84	.5	42
	Priority	6	6	6	6	3	72	7.5	540
Ports – Barstow	General	10	6	10	6	3	96	.5	48
	Priority	8	6	8	5	3	81	2.5	203
	Unit	11	6	11	3	3	93	1.0	93

Base Units Required For Service	39
Helper Units	5
Traffic Protection & Maintenance Units	6
ATSF Electric Units Required	50

TABLE 6-8
Union Pacific
Electric Locomotive Requirements
For Route 1 In Year 2000

UP	Train Type	Total Eastbound Use Time	East End Connect Time	Total Westbound Use Time	West End Connect Time	Units/ Train	Unit Hours	One Way Trains	Total Unit Hours/Day
Ports –	Priority	8.25	6	8.25	5	3	83	3.5	291
Yermo	Unit	11.5	6	11.5	3	3	96	3	288
LA –	Priority	6.25	6	6.25	6	3	74	4.5	333
Yermo	General	8.5	6	8.5	6	3	87	1	87
W. Colton – Yermo	General	6	6	6	6	2	48	1	48

Base Units Required For Service	44
Helper Units	5
Traffic Protection & Maintenance Units	7
UP Electric Units Required	56
Total Freight Electric Units for Route 1	228

TABLE 6-9
Southern Pacific
Electric Locomotive Requirements
For Route 11 (SP Yuma to Ports) In Year 2000

SP	Train Type	Total Eastbound Use Time	East End Connect Time	Total Westbound Use Time	West End Connect Time	Units/ Train	Unit Hours	Trains	Total Unit Hours/Day
Ports –	Priority	12	5	12	5	3	102	11	1122
Yuma	Unit	16.5	6	16.5	3	3	123	2	252
Ports – W. Colton	General	6.5	5	6.5	6	2	48	2	96
LATC –	Priority	10	5	10	6	3	93	3	279
Yuma	General	13	5	13	6	3	108	1	111
C of Ind.	Priority	9	6	9	6	3	87	1	90
Yuma	General	12	6	12	6	3	105	1	108
C of Ind. W. Colton	General	3.5	6	3.5	6	2	36	3	114
W. Colton	Priority	8	6	8	5	3	81	0	—
Yuma	General	10.5	6	10.5	5	3	96	3	288

Base Units Required For Service	103
Helpers Units	10
Traffic Protection & Maintenance Units	17
Total SP Electric Units Required	130

TABLE 6-10

Atchison, Topeka and Santa Fe

Electric Locomotive Requirements

For Route 12 (ATSF Routes to Ports) In Year 2000

ATSF	Train Type	Total Use East-Bound Time	East End Connect Time	Total Run West-Bound Time	West End Connect Time	Units/ Train	Unit Hours	Trains	Total Unit Hours/Day
Ports –	Priority	8	5	8	5	3	78	2.5	195
Barstow	General	10	5	10	6	3	93	.5	45
	Unit	11	5	11	3	3	90	1.0	90
LA –	Priority	6	5	6	5	3	66	9.0	594
Barstow	General	8	5	8	5	3	78	2.0	156
San Bernardino	Priority	4	5	4	6	2	38	.5	19
– Barstow	General	5.5	5	5.5	6	2	44	1.5	66

Base Units Required For Service	49
Helpers Units	7
Traffic Protection & Maintenance Units	9
Total ATSF Electric Units Required	65

TABLE 6-11
Union Pacific Requirements
Electric Locomotive Worksheets
For Route 13 (UP Routes to Ports) In Year 2000

UP	Train Type	Total Eastbound Use Time	East End Connect Time	Total Westbound Use Time	West End Connect Time	Units/ Train	Unit Hours	Trains	Total Unit Hours/Day
Ports –	Priority	8.25	5	8.25	5	3	80	3.5	280
Yermo	Unit	11.5	5	11.5	3	3	93	3.0	279
LA –	Priority	6.25	5	6.25	5	3	68	5.5	374
Yermo	General	8.5	5	8.5	5	3	81	3.0	243
W. Colton – Yermo	General	6	5	6	5	2	44	1.0	44

Base Units Required For Service	51
Helpers Units	6
Per Day Traffic Protection & Maintenance Requirements	9
Total UP Electric Units Required	66

As in the case of freight operations, different passenger train operating environments dictate different locomotive substitution arrangements. For example, those trains which require one diesel unit (such as one F-40 on Amtrak's San Diegans or one F-59 on SCRRA commuter trains) can be handled effectively by the smaller, lighter ALP44/AEM7. Heavier long distance trains, such as Amtrak's Southwest Chief, Sunset Limited and Desert Wind, which currently require two diesel units, would require two ALP44/AEM7 locomotives or could be handled by a single, heavier E60.

As in the case of freight operations, future traffic growth was considered regarding passenger locomotive requirements. Application of the foregoing methodology to the projected level of traffic provided in subsection 6.2.3 results in the number of required electric locomotives shown in Table 6-5 below.

TABLE 6-12

Electric Passenger Locomotive Requirements

	AEM7	E60
SCRRA	56	0
Amtrak	12	6*

* *These units would be required if ATSF is electrified to Barstow and SP is electrified to Yuma.*

6.4.4 Summary of Electric Locomotive Requirements

Electrification of all nine planned SCRRA commuter rail routes and the Consolidated Corridor would require 296 electric locomotives, 68 of which would be passenger units and 228 of which would be freight units. Electrification of the entire Candidate Network consisting of Candidate Routes 1 through 13, would require 345 electric locomotives, 74 of which would be passenger units and 271 of which would be freight units.

The electric locomotive requirements estimated for each candidate route are summarized on Table 6-13. The breakdown by owner/user and type of locomotive is provided for Candidate routes 1 through 10 in Table 6-14, and for Candidate routes 1 through 13 in Table 6-15.

6.5 OPERATING AND MAINTENANCE COSTS

This study addresses four categories of operating and maintenance (O&M) costs:

- Locomotive Maintenance
- Traction Power System Maintenance
- Other Facilities Maintenance
- Energy Costs

In some categories, specific cost estimates have been prepared, in other categories, where estimates are affected by too many subjective factors or where additional data is still needed, the issues which must be resolved are identified.

TABLE 6-13

Electric Locomotive Requirements for the Accelerated Electrification Program in the Year 2000

Route	Description	Units
1	UP/SP Corridor	
	ATSF Units Required	50
	SP	122
	UP	56
	Total	228
2	Baldwin Park Commuter	9
3	Moorpark Commuter	8
4	Santa Clarita Commuter	7
5	LOSSAN Corridor	
	Commuter	6
	Amtrak	12
6	Riverside via Ontario Commuter	5
7	Riverside – LAUPT via Fullerton Commuter	9
8	Hemet – Riverside Commuter	3
9	San Bernardino – Irvine Commuter	8
10	Redlands Commuter	1
11	SP – Ports to Yuma – Freight	130
	Amtrak	3
12	ATSF – Ports to Barstow – Freight	65*
	Amtrak	3
	Commuter (Also in Route 7)	9
	* (10 additional units required to cover Barstow – San Diego freight service)	
13	UP – Ports to Yermo Freight	66
	(Also in Route 6) Commuter	5
	Total Units Required for Routes 1 – 10	296
	Total Units Required for Routes 1 – 13	345

TABLE 6-14

Electric Locomotive Requirements by Unit Type for Routes 1-10

Year 2000

ELECTRIC LOCOMOTIVES – 296 UNITS			
Passenger Service			
Number of Units	**Type of Unit**	**User**	**Service**
56	7000 HP ALP44 (B-B)	SCRRA	Commuter
12	7000 HP ALP44 (B-B)	Amtrak	San Diegans
68	Units		
Freight Service			
Number of Units	**Type of Unit**	**User**	**Service**
50	6000 HP (C-C) E60	ATSF	Road Freight Including San Diego
122	6000 HP (C-C) E60	SP	Road Freight and Some Transfer Runs
56	6000 HP (C-C) E60	UP	Road Freight
228	Units		

TABLE 6-15

Electric Locomotive Requirements by Unit Type for Routes 1-13

Year 2000

ELECTRIC LOCOMOTIVES – 345 UNITS			
Passenger Service			
Number of Units	**Type of Unit**	**User**	**Service**
56	7000 HP ALP44 (B-B)	SCRRA	Commuter
12	7000 HP ALP44 (B-B)	Amtrak	San Diegans
6	6000 HP E60 (C-C)	Amtrak	Long Distance
74	Units		
Freight Service			
Number of Units	**Type of Unit**	**User**	**Service**
75	6000 HP (C-C) E60	ATSF	Road Freight Including San Diego
130	6000 HP (C-C) E60	SP	Road Freight and Some Transfer Runs
66	6000 HP (C-C) E60	UP	Road Freight
271	Units		

6.5.1 Locomotive Maintenance

6.5.1.1 Diesel Locomotive Maintenance

Diesel Locomotive Maintenance includes labor and materials associated with performing servicing, FRA inspections, handling of locomotive failures, scheduled overhauls, running repairs, and unscheduled shopping. Servicing includes costs associated with fueling (excluding cost of fuel), lube oil changes, sanding, hostling (non-labor), and cleaning of cabs. Locomotive failure costs include the material and labor expended to bring a unit that has failed in service, back to a maintenance facility.

Maintenance costs for passenger and freight diesel locomotives were preliminarily concluded based on the following data.

Diesel passenger locomotive maintenance costs are preliminarily concluded to be **$1.07 per unit mile** based on information obtained from Amtrak for the F40PH locomotive, which is currently the predominant model unit used in passenger service. Given Amtrak's extensive experience with this model locomotive, their cost data is presumed to be reliable. Coincidentally, the F40 locomotives operated by CALTRAIN on the Penninsula Commute Service are reported to incur maintenance incur maintenance costs of $1.07 per mile as well. ($37,500 per year/35,000 miles per year.)

Diesel freight locomotive maintenance costs are preliminarily concluded to average $1.41 per unit mile based on the cost experience of the following railroads:

Conrail:	$1.18 per unit mile
Union Pacific:	$1.32 per unit mile
AT&SF:	$1.32 per unit mile
EMD:	$1.55 per unit mile
CSX:	$1.67 per unit mile

This data is presented graphically in Exhibit 6-12.

Differences between basic maintenance costs are dependent on duty cycles and operating environments. Passenger locomotives are subject to a lower duty cycle than freight locomotives as they typically operate at higher speeds and under lower loading. Basic maintenance costs for the F40PH, which is currently the standard passenger locomotive in the U.S., are as such expected to be lower than those for a comparable freight unit. However, additional maintenance costs that are not applicable to freight units must be considered for maintaining the Head End Power (HEP) alternator and gearbox, which are driven off of the prime mover and are necessary to provide 480 VAC hotel power to a train in passenger service. Freight unit operations at higher loadings and lower speeds subject the locomotive prime mover to an increased rate of wear and causes a higher rate of deterioration to locomotive electrical components (i.e. traction motors, dynamic brake grids, cable insulation, etc.). The HEP feature on the F40PH results in increased fuel consumption as the engine is constantly in Run 8 in order to provide HEP, however the load to the engine is relatively light in comparison to a freight unit. On freight locomotives, higher maintenance costs are expected for units that are operated under consistently high current load conditions (drag service and mountain territory) than for units that are operated in less demanding duties on trains with higher horsepower-to-ton ratios that allow higher speed train operation and impose lower current loads.

EXHIBIT 6-12
Locomotive Maintenance Costs per Unit Mile
(1991 Dollars)

PASSENGER

<u>Diesel</u>

Amtrak F-40	$1.07
Caltrain F-40	$1.07

<u>Electric</u>

Amtrak AEM7	$1.38

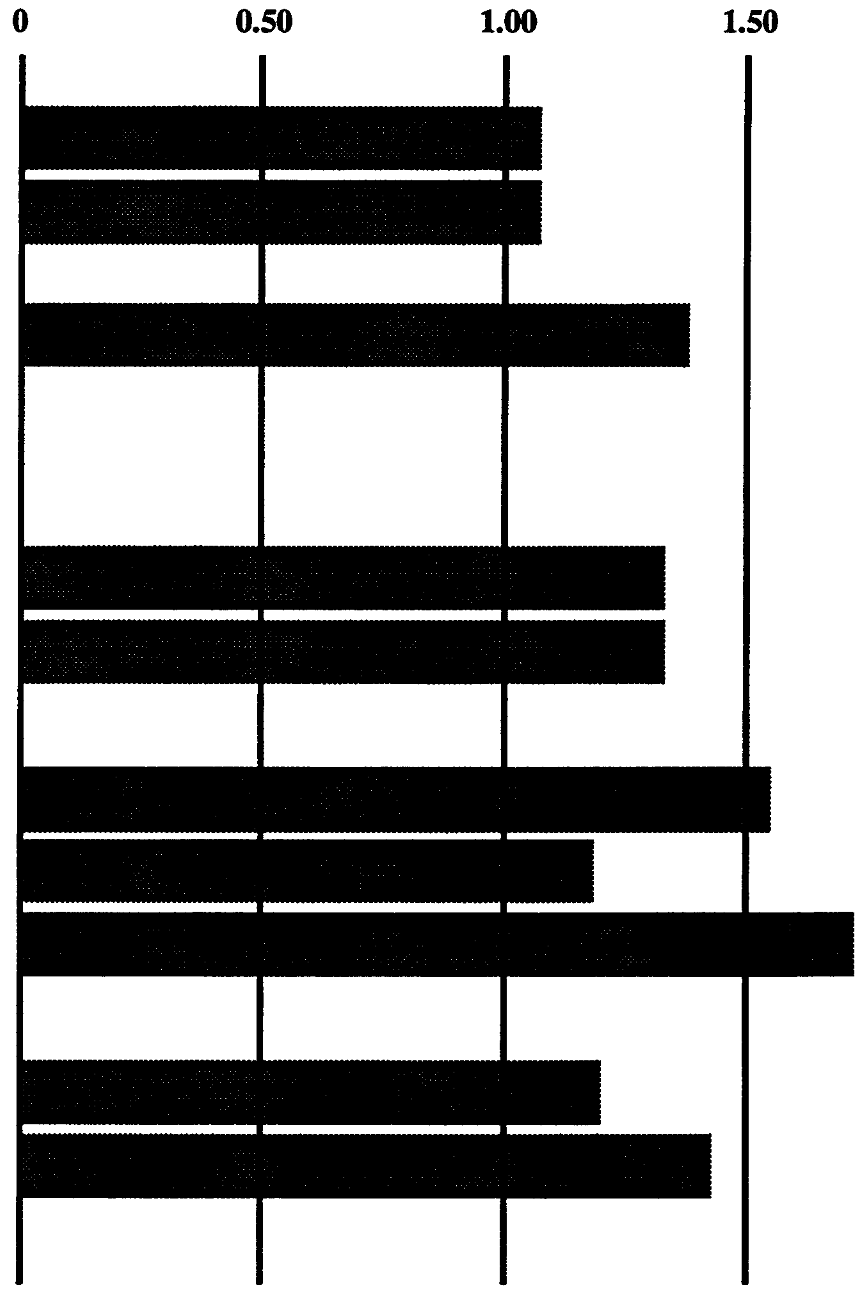
FREIGHT

<u>Diesel (Road Unit Averages)</u>

ATSF	$1.32
UP	1.32
SP	To Be Provided
EMD	1.55
CONRAIL	1.18
CSX	1.67

<u>Electric</u>

BCR E60	1.20
CONRAIL E44a	1.43



6.5.1.2 Electric Locomotive Maintenance Costs

Electric Locomotive maintenance costs include labor and material costs associated with performing servicing, FRA inspections, handling of locomotive failures, scheduled overhauls, running repairs, and unscheduled shopping. Servicing includes costs associated with replacement of pantograph shoes, sanding, hostling (non-labor), and cleaning of cabs. Locomotive failure costs include the material and labor expended to bring a unit that has failed in service, back to a maintenance facility.

Electric passenger locomotive maintenance costs are concluded preliminarily to be **$1.38 per unit mile** , based on information obtained from Amtrak for the AEM-7 (ALP-44) locomotive. This cost excludes the cost of maintaining traction power system facilities.

Electric freight locomotive maintenance costs are estimated to be **$1.20 per unit mile,** based on information received from BC Rail for the GF6C locomotive. This cost excludes the cost of maintaining traction power system facilities. BC Rail reported their electric locomotive maintenance costs in 1985 to be $0.71 (Canadian) per unit km ($1.14C per unit mile) at an annual cost of $88,790C per unit based on 1985 prices. $1.20 per unit mile is obtained by adjusting the 1985 BCR cost by 4 percent annually to arrive at a 1991 cost and converting to U.S. dollars at the rate of $1.20 Canadian to $1.00 U.S.

The maintenance costs for an electric freight locomotive on a unit basis are generally estimated to be 20-30 percent higher than for a 3,000 HP diesel locomotive based upon several analyses performed by and for Conrail and its predecessors. The GF6C electric locomotive is comparable in weight to a six axle 3,000 horsepower diesel locomotive and is rated at 6,000 HP (5093 HP at the rail.) BC Rail operates 2 electric units in place of 3 diesels on the basis of their their train horsepower-per-ton requirements. On this basis BC Rail adjusts their diesel maintenance costs upward by 50 percent to make comparison with electric units consistent on a motive power assigned per train basis. (It is almost, but not exactly, consistent on a horsepower per ton basis.)

BC Rail identifies maintenance costs for a typical 3,000 HP diesel locomotive in 1985 to be $0.96C per km ($1.62 per mile in current U.S. dollars), increased to $1.44C per km ($2.44 per mile in current U.S. dollars) to compensate for horsepower differences when comparing diesels to the GF6C electric locomotive. Electric Locomotive maintenance costs are identified to be $0.71 per km for 1985 ($1.20 per mile in current U.S. dollars) and $88,790 annually ($93,600 in current U.S. dollars) based on an average of 125,000 km/yr (77,688 miles per year). This cost excludes traction power facility maintenance costs. Maintenance covered by the BC Rail figure includes the following tasks:

- Daily, 45-day, and annual inspections
- 6, 12, and 24 month air brake inspections
- Repair and servicing
- Shopping.

As with diesel locomotives, differences between maintenance costs will also depend on duty cycles and operating environments. Maintenance costs, based on the Amtrak figure, are higher for the AEM-7 than the those reported by BC Rail for the GF6C. It seems intuitive that an electric passenger locomotive such as the AEM-7 (ALP-44) would have lower maintenance costs than than an electric freight locomotive such as the GF6C, since the passenger locomotive are typically not subject to the wear and tear associated with high-tonnage freight service. Alternatively, passenger units carry HEP equipment, not found on freight units, and which have maintenance costs associated with them.

Also, the AEM-7 (ALP-44), being strictly a passenger locomotive, typically operates at higher speeds and lower loadings than an electric freight locomotive. However, due to its lighter weight, the AEM-7 (ALP-44) is not suitable for freight service and is not directly comparable to an electric freight unit such as the E44, E60, or GF6C.

As with diesel freight units, higher maintenance costs are expected for electric freight locomotives that are operated under higher loading conditions (drag service and mountain territory) than for units that are operated at higher speeds on trains with higher horsepower-to-ton ratios.

6.5.2 Traction Power System Maintenance

The most current data available for maintenance costs associated with a North American main line freight railroad comes from the Tumbler Ridge Branch of the British Columbia Railway (BCR), located in its namesake province in Canada. Recognizing that additional data should also be considered from the former Pennsylvanian Railroad electrification now operated and maintained by Amtrak, as well as other sources such as the Black Mesa and Lake Powell and other smaller electrified lines, the BCR data has been applied to the Candidate network as a preliminary cost estimating exercise only.

The methodology be which the BCR data was applied to the Accelerated Electrification Program routes consisted of three steps.

- Calculate Catenary maintenance labor requirements on a man-hour per track-mile per year basis
- Calculate Substation maintenance labor requirements on a man-hour per track-mile per year basis
- Calculate per track mile catenary material costs and per substation materials costs.

The calculations by which the BCR data was transformed into unit costs and by which the resultant unit costs were applied to the Candidate network, are summarized on Table 6-16. As shown in the table, using BCR unit costs as a basis, the annual cost of maintaining the traction power system for the entire candidate network is $7.96 million. Because the estimate is not all inclusive of relevant cost factors the figure is likely near the low end of a range of cost estimates.

6.5.3 Other Facilities Maintenance

Due to the proposed catenary contact wire height of 22' 3", necessitated by the operation of double-stack container trains on the Candidate Network, it is anticipated that track maintenance costs may increase. This is because of the need to more stringently preserve cross-level to prevent a locomotive pantograph from sliding out from under the contact wire and tearing down the catenary. The level of effort associated with the hypothesized additional maintenance requirement has not been quantified.

In addition to the potential impact on track maintenance standards, electrification has an impact on the cost of the on-track equipment used to perform track maintenance. Costs of as much as double the costs of conventional track maintenance equipment have been cited. Due to the variability associated with estimating the quantities of such equipment required, the possible impact of additional track maintenance requirements and the lack of definitive cost data, no estimate is provided of the additional cost of track maintenance equipment designed for use in electrified territory.

TABLE 6-16

Traction Power System Maintenance Cost Estimate
Based on British Columbia Railway Data

Expressed in 1991 U.S. Dollars

LABOR

Catenary Maintenance:

Open: 53.6 man hours/year/track mile

Tunnel: 129.2 man hours/year/track mile

Substation Maintenance[1]:

605 man hours/year/substation

Other:

Unscheduled Maintenance	410 man hours/year
Overhead[2]	1032
	1442 man hours/year

Assume 80% (1154) applies to Catenary Maintenance

(1154 man hours/year ÷ 82.9 miles = 13.9 man hours/year/track mile)

Assume 20% (288) applies to Substation Maintenance

Summary:

Catenary Maintenance:

Open: 53.6 + 13.9 = 67.5 man hours/year/track mile

Tunnel: 129.2 + 13.9 = 143.1 man hours/year/track mile

Substation Maintenance:

605 + 288 = 893 man hours/year/substation

Cost Estimate[3]:

Catenary Maintenance

Open: 67.5 man hours/year/track mile
x $ 35.47/hour
$2,394.23/year/track mile (open), Say $2,400

$2,400 x 1,452.5 track miles = $3,486,000 per year

Tunnel: 129.2 man hours/year/track mile
x $ 35.47/hour
$4,582.72/year/track mile (tunnel), Say $4,600

$4,600 x 3.2 track miles = $14,720 per year

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1 Based on one 50kV substation

2 Includes training, vehicle servicing

3 Based on Amalgamated Transportation Union rate for traction power inspector on Metro Blue Line, including 45% fringe rate.

TABLE 6-16 (continued)

Substation Maintenance:

893 man hours/year/substation		
x $ 35.47/hour		
$31,674.71/year/substation, Say $32,000		
$32,000 x 19 substations =		$608,000 per year
TOTAL LABOR COST:		$4,108,720

MATERIALS

Catenary Maintenance:	
$2,085 per track mile x 1455.7 track miles =	$3,035,000
Substation Maintenance:	
$43,000 per substation x 19 substations =	817,000
TOTAL	$3,852,000

SUMMARY

Labor Cost	$4,108,720
Materials Cost	$3,857,000
Total Annual Cost	$7,960,720

6.5.4 Energy Costs

In the absence of useable utility rate estimates, the positive or negative cost impact of electrification on railroad energy costs cannot be determined or quantified.

6.5.5 O&M Cost Summary

In summary, Locomotive maintenance costs cannot be concluded definitively to favor electric or dual locomotives on the proposed candidate network. Similarly, Other Facilities Maintenance costs and energy costs must be assumed, at this point, to have a neutral impact. Only the cost of maintenance of the traction power system can be definitively stated to favor one mode over the other and the magnitude of this input be roughly quantified.

6.5.6 Allocation of O&M Costs

Although all three of the Class I freight railroads in the Basin share track at some location, and Amtrak operates over all three, the interrelationships which would be created by electrification and/or the Consolidated Corridor would be far more complex than any extant in the Basin today. In light of the extent of disagreements which developed between Amtrak, Conrail and several commuter agencies regarding shared costs in the North East Corridor, the basis upon which shared costs are to be allocated should be established early in the electrification program. Cost categories which require such attention include:

- Energy – To resolve disagreements about energy charges in the North East Corridor it was necessary for Conrail to apply meters to a number of electric locomotives. This approach might be cost effective if a sampling plan can be agreed upon which limits the number of meters required.
- Track Maintenance – Freight railroads could logically share the cost of track maintenance by "taking turns" for periods of a year or two, or by allocating costs on a ton-mile basis. Allocation of track maintenance costs between passenger and freight can be more complicated, as freight typically carries a disproportionate share of the burden because track damage is primarily a function of tonnage. However, if passenger trains require higher maximum speeds the incremental cost to maintain the track to a higher FRA Class would be wholly attributable to passenger, as would be the cost to maintain any tracks solely dedicated to passenger operation.
- Train Dispatching – A variety of solutions might be applied here, including variable formulas based on train miles or train hours in the shared territories.

6.6 OTHER CONSIDERATIONS

6.6.1 Locomotive Ownership

The freight railroads are adamantly opposed to participating in a pooled fleet of electric locomotives. The differences in operating practices and philosophies between the three carriers, suggest that a shared locomotive pool would cause significant disagreement on issues of maintenance cost allocations and responsibility. Accordingly the analysis provided in section 6.4 assumed separate locomotive fleets.

6.6.2 Maintenance Facilities

For the purposes of this study, the consultant team has made two primary assumptions regarding maintenance of the electric locomotive fleet:

- The three freight railroads, Amtrak and SCRRA, would each perform light maintenance and running repairs on their own units. This would primarily include periodic inspections and change out of small components such as pantograph shoes, brake shoes, air hoses and head lamp bulbs. These inspections and repairs are expected to be performed at locomotive change facilities and existing diesel locomotive servicing facilities.
- All of the electric locomotive fleets would share a common maintenance facility for heavy repairs, such as wreck repairs and periodic heavy overhauls. The cost estimates provided in Section 7.0 include $40 million for a single, heavy maintenance facility, to be built in a yet undetermined location.

6.6.3 Diesel Operation in Electrified Territory

There are two categories of circumstances in which trains are expected to operate with diesel locomotives in electrified territory:

- Selected Through Trains – Through trains which do not originate or terminate on the route and pass through one of the route end points will continue to be operated using diesel locomotives. For example Southern Pacific trains operating between West Colton Yard and the Coast Route, West Colton-Bakersfield service and between Delores Yard and Bakersfield are anticipated to continue operating with diesel locomotives. The reasons for this are the location of crew division points and the projected low equipment utilization and the resultant diseconomies associated with electric operation of such services.
- Yard and Local Service – It is anticipated that local switching, industrial service and some pickup and delivery of cars will continue to be performed using diesel locomotives, due to the cost of electrifying a great many secondary and industrial tracks, and due to the complex property ownership and safety issues associated with electrifying every industrial delivery track along every candidate route.

6.6.3.1 Selected Through Routes

In the Consolidated Corridor, Candidate Route 1, each railroad would operate some trains in the electrified corridor with diesel power. This is required so customers on non-electrified portions of each railroad's lines could be served as they are today.

In the case of the Southern Pacific, there would be trains that operate from Oakland, Sacramento and even Bakersfield that terminate at several locations in the South Coast Air Basin. Some of these trains operate to the City of Industry yard and may operate over various routes including the Coast Line, the Saugus Line or the Bakersfield Line. Alternatively, all SP through trains could be electrified if the electrification were extended to Bakersfield and San Louis Obispo as discussed in Section 2.1.2.

Santa Fe Trains that would be diesel operated in the Consolidated Corridor scenario would include the trains that handle traffic to San Bernardino, Fullerton and points along the San Bernardino Subdivision as well as the San Diego trains to and from Barstow. Additionally the ATSF main line between San Bernardino and Keenbrook is not included in the Consolidated Corridor or on any commuter routes.

Union Pacific trains that would not be electrified in the Consolidated Corridor scenario would be trains serving the Mira Loma to West Riverside portion of the UP main line as well as the San Bernardino – Riverside area. This is due to the portion of the ATSF main line between San Bernardino and Keenbrook which is not planned to be electrified and which is not included in the Consolidated Corridor or any of the candidate commuter routes.

6.6.3.2 Yard and Local Service

It is technically infeasible to electrify intermodal container and piggyback terminal facilities without interfering with loading/unloading equipment. Accordingly, provision must be made for propulsion of intermodal trains within intermodal terminal facilities.

A solution which was considered and abandoned was the operation of stand-by yard locomotives in intermodal terminals to spot trains at unloading locations. The freight railroads oppose such an approach because of the associated increase in labor costs. (Operation of intermodal trains within terminals is presently accomplished with road crews.) An alternative solution to which the freight railroads may be receptive in spite of its disadvantageous utilization of motive power, is the retention of one diesel locomotive on each train, in addition to electric locomotives hauling the train. The diesel unit would be shut down except for briefly propelling the train at low speed within the intermodal terminal. This would have minimal operational impact presuming the electric and diesel locomotives were capable of multiple-unit operation.

7.0 CAPITAL COST ESTIMATING METHODOLOGY

7.0 CAPITAL COST ESTIMATING METHODOLOGY

7.1 UNIT COST DEVELOPMENT

At project start-up in October 1991, the consultant team met with key staff members of Southern California Edison (SCE), the South Coast Air Quality Management District (AQMD), and the California Transportation Commission (CTC) to discuss the scope of work and project schedule. One finding of these meetings was that an impression existed among some members of the involved agencies that the railroads in the Los Angeles Basin could be electrified for approximately $600,000 per mile. This opinion was fostered by an electrification report prepared for Riverside County that projected a per track mile cost of $588,000 to electrify the Santa Fe Railway from Riverside to LAUPT. The cost estimate was based upon 1991 constant dollars and did not include locomotives.

In these early meetings, the consultant team mentioned numerous times that a $600,000 per mile cost to electrify existing railroads seemed low and inconsistent with recent experience in New York and New Jersey. During the mid to late 1980s, Metro North electrified a portion of their system using third rail technology at an average cost of four to five million dollars per route mile. Similarly, New Jersey Transit electrified sixteen double track miles using catenary technology at an average cost of six million dollars per route mile.

It was subsequently agreed that the cost estimates for the electrification of the Los Angeles Basin freight and commuter rail lines would be developed with assistance from the involved agencies, railroads, other consultants, construction contractors, the Federal Railroad Administration (FRA) and other parties experienced with electrification. Estimates were prepared using typical unit costs for the various aspects of construction and were divided into two groups; costs related to electrification and costs related to railroad improvements such as the construction of the UP/SP consolidated corridor.

The Southern California Regional Railroad Authority (SCRRA) is currently constructing several commuter rail lines in the Los Angeles area. Construction bid costs, based upon bids taken by SCRRA in 1991, were used as the basis for track and track related unit costs. Structural costs for overhead bridge modifications and railroad bridge construction were based upon the consultant teams' California and other related railroad project experience. Signal and communications unit costs were based upon the cost of converting existing signal and communication systems from diesel to electrified rail operations on the Northeast Corridor, the Florida East Coast Line and other potential electrification projects. Traction electrification unit costs were based upon SCE's experience and the costs of electrifying numerous Northeast United States railways.

Draft Unit Price Schedules were prepared containing costs related to electrification, and costs related to railroad improvements. Then, a two day workshop was held with SCE and their electrification consultant to review the draft unit costs and to agree on the value of the unit costs to be used in preparing the estimates. At the conclusion of the workshop, all parties were in agreement regarding the values of the unit costs to be used.

The unit cost schedules were next distributed to the members of the Electrification Task Force Steering Committee and the members of the Planning, Engineering Analysis, Operations and Maintenance Committee (PEAO&M). Membership in these committees includes all Los Angeles Basin railroads, SCE, Southern California Gas Company (SCG), AQMD, the SCRRA participating jurisdictions, environmental interest groups, the Alameda Corridor Transportation Authority, and various consulting firms. The committees reviewed the unit cost schedules and made several suggestions for revisions to the unit cost values.

Finally, the unit cost schedules were reviewed by Federal Railroad Administration personnel and were found to be reasonable and prudent based upon the level of effort expended by the consultant team and amount of relevant information available.

Table 7-1 and Table 7-2 contain the unit costs used to develop the estimates for electrifying the freight railroads and the commuter lines of the Los Angeles Basin.

TABLE 7-1

Estimate of Capital Costs – Unit Price Schedule

Costs Related to Railroad Improvements

	Units	Unit Cost	Specifications
New Track Construction			
(Mainline, sub-ballast up)			
Single Track	T.F.	120	Rails 136RE CWR, wood tie 7" x 9" x 9' @19&1/2, 2 tie plates, 4 track spikes, 4 anchors, 0.50 CY ballast, 0.65 CY sub-ballast
Double Track	T.F.	230	Single track requirements x 2
New Track Construction			
(Yard, sub-ballast up) Single Track	T.F.	105	Rails #1 relay 115 RE CWR, wood tie 7" x 9" x 9' @ 19&1/2", 2-14" relay tie plates, 4 track spikes,4 anchors, 0.70CY ballast
Upgrading Siding to Mainline			
Single Track	T.F.	85	Replace all rails 136 RE CWR with same OTM as new track, replace 50% of ties, add 4" ballast
Track Removal			
Single Track	T.F.	7	Remove rails, ties, ballast. Disposal of removed material excludes environmental requirements
InterLockings			
Crossover #34	L.S.	260,000	2 x Turnout Unit Cost
Crossover #24	L.S.	190,000	2 x Turnout Unit Cost
Crossover #20	L.S.	160,000	2 x Turnout Unit Cost
Crossover #14	L.S.	120,000	2 x Turnout Unit Cost
Crossover #10	L.S.	90,000	2 x Turnout Unit Cost

TABLE 7-1 (continued)

	Units	Unit Cost	Specifications
Turnouts #34	L.S.	130,000	All work sub-ballast up from stock rail joint to last common tie along normal and reverse sides
Turnouts #24	L.S.	95,000	All work sub-ballast up from stock rail joint to last common tie along normal and reverse sides
Turnouts #20	L.S.	80,000	All work sub-ballast up from stock rail joint to last common tie along normal and reverse sides
Turnouts #14	L.S.	60,000	All work sub-ballast up from stock rail joint to last common tie along normal and reverse sides
Turnouts #10	L.S.	45,000	All work sub-ballast up from stock rail joint to last common tie along normal and reverse sides
Turnouts # 7	L.S.	40,000	All work sub-ballast up from stock rail joint to last common tie along normal and reverse sides
Mainline Drainage			
New Drainage	L.F.	10	Side ditch
Restored Drainage	L.F.	5	Regrade side ditch
Grading	T.F.	4	Overall width 15' @ 6" average depth
Right-of-Way Acquisition	A.C.	800,000	Actual acquisition from SP: $45 m for 180 miles R/W approximately 30' wide or $690,000 acre
Earthwork			
Excavate	C.Y.	10	Ordinary Soil
Embankment	C.Y.	6	Ordinary Soil
Retaining Walls 4" High	L.F.	160	Complete
Grade Crossings			
Remove & Lay new crossing	T.F.	250	Demolish and remove existing crossing pavement complete, lay new precast concrete paving complete (no track)
Add second crossing along – side existing crossing	T.F.	170	Add new precast concrete paving for new single track alongside existing crossing (no track)
Eliminate existing crossing	E.A.	3,000	Demolish and remove existing crossing, close both sides to traffic by guard rails
Culvert Extension	L.F.	150	Concrete or CMP circular culvert 12" to 48"
Railroad Bridge for Additional Trackage	T.F.	5,200	Additional bridge 20' wide alongside existing bridge for new track
Grade Separations			
Highway Underpass	L.S.	14,000,000	Assumed bridge 35' x 90' with structural work, approaches and all utilities
Flyover viaduct structure	T.F.	1,750	Assumed bridge 35' x 5000' double track structure

TABLE 7-2
Estimate of Capital Costs – Unit Price Schedule
Costs Related to Electrification

	Units	Unit Cost	Specifications
Stabilize Track for Electrification			
Single Track	T.F.	6	Add 2" ballast, compact shoulder with lining and surfacing
Mainline Drainage			
Restored Drainage	L.F.	5	Regrade side ditch
Overhead Utility Relocations	L.S.	16,000	UP TO 16kV line at each grade crossing
Underground Utility Relocations	L.F.	0	Utilities to relocate at their own expense
Right-of-Way Acquisition	A.C.	800,000	Actual acquisitions from SP: #450M for 180 miles R/W approximately 30' wide or $690,000 acre
Relocation Costs, Legal Fees, Other ROW Costs		20%	% of ROW
Site Demolition	C.Y.	80	Demolition and removal
Shops & Ancillary	L.S.	40,000,000	Based on adequate component replacement at a separate facility for each railroad
Locomotive Change Facilities	L.S.	4,000,000	Consists of selected double ended through tracks and engineer service areas at Yermo, Barstow, 3 facilities at the port and two Amtrak facilities. Indio will be priced at $6,000,000.
Electric Locomotives	L.S.		
Passenger	EA	5,250,000	7000hp, 60Hz units
Freight	EA	4,000,000	6000hp, 60Hz units
Crossing Warning Systems	EA	100,000	Enclosures, signal system, gates – upgrading/repairs
Communications SCADA (Supervisory Control)	R.F.	30	
Control Center	L.S.	10,000,000	Total allotment for SCRRA& 3 railroads including SCADA

TABLE 7-2 (continued)

	Units	Unit Cost	Specifications
Overhead Bridge Clearance Improvements (Including Approaches)			
Raise Bridge supported on bearings	L.S.	600,000	Approaches 1000' utility relocation, abutments, wing walls, bearings, fixation
Raise Monolithic Bridge	L.S.	700,000	Approaches 1000' utility relocation, abutments, wing walls, bearings, fixation
Replace Bridge	L.S.	1,000,000	Approaches 1000' utility relocation, abutments, wing walls, bearings, fixation
Track Lowering 12' AV			
Single Track	T.F.	40	Based on two 4-hour occupancies in 24 hours 1000' – 1200'
Earthwork			
Excavate	C.Y.	10	Ordinary Soil
Embankment	C.Y.	6	Ordinary Soil
Tunnel Modifications			
Track Lowering	T.F.	500	Tunnels 25, 26, 28 on the SP
Structural Modifications	L.S.	3,000	SP Tunnel 27
Signals (Wayside)			
Phase Sel & Tru-II	T.F.	55	Average cost based upon 114 mile sample analysis
Cab Signals	T.F.	7	Average cost based upon 114 mile sample analysis
Utility Provisions			
One Transformer Substation	L.S.	497,000-1,842,000*	Includes bus extension, circuit breakers, metering and 1 mile of transmission line
Two Transformer Substation	L.S.	833,500-3,216,500*	Includes bus extension, circuit breakers, metering and 1 mile of transmission line
Traction Power Substations			
One Transformer	L.S.	1,296,500-3,630,500*	25kV system uses 20MVA transformer, 50kV & 25kVA systems use 30MVA transformers. Cost includes HV & LV breakers, signal power supply and sitework
Two Transformers	L.S.	1,296,500-3,169,750*	25kV system uses 20MVA transformer, 50kV & 25kVA, systems use 30MVA transformers. Cost includes HV & LV breakers, signal power supply and sitework
* Varies by input voltage and electrification voltage			

TABLE 7-2 (continued)

	Units	Unit Cost	Specifications
Switching Station			
25kV	L.S.	962,500	5 circuit breakers, signal power, sitework
50kV	L.S.	1,012,500	5 circuit breakers, signal power, sitework
Paralleling Station			
25kV	L.S.	892,500	4 circuit breakers, signal power, sitework
50kV	L.S.	932,500	4 circuit breakers, signal power, sitework
Autotransformer Station	L.S.	2,342,500	2 autotransformers, LV switchgear, sitework
Simple Catenary System			
25kV	T.M.	401,625-427,425	Poles, foundations, 4/0 cu contact wire, 4/0 cu messenger wire, fittings
50kV	T.M.	413,674	Poles, foundations, 4/0 cu contact wire, 4/0 cu messenger wire, fittings
Tunnel Catenary System			
25kV	T.M.	209,625-235,425	Flexible arms, fittings, 4/0 cu contact wire, 4/0 cu messenger wire
50kV	T.M.	215,914-242,488	Flexible arms, fittings, 4/0 cu contact wire, 4/0 cu messenger wire
Crossover			
25kV	L.S.	56,075-	Poles, foundations, conductors, fittings
50kV	L.S.	57,757	Poles, foundations, conductors, fittings
Turnout			
25kV	L.S.	46,625-47,825	Poles, foundations, conductors, fittings
50kV	L.S.	48,024-49,260	Poles, foundations, conductors, fittings

7.2 PROJECT ADD-ONS

In order to estimate the total cost of electrification, numerous cost elements other than raw construction costs must be considered. These elements are referred to as Project Add-Ons. The Railroad Construction Corporation (RCC) utilizes a system whereby these add-ons are calculated as a percentage of construction. The percentages are based upon actual RCC costs incurred during the planning, design and construction of the Red, Blue and Green Lines in metropolitan Los Angeles. Table 7-3 presents the range of percentages encountered by RCC on their projects. Table 7-4 presents the Project Add-Ons percentages recommended by the consultant team. In general, the electrification project will utilize Add-On percentages at or near the bottom of the range experienced by RCC.

TABLE 7-3

Rail Construction Corporation Project Capital Cost Estimate Experience

ITEM DESCRIPTION:
1. Guideway Costs 2. Stations Costs 3. Maintenance Facilities and Shops 4. Vehicles 5. System-Wide Equipment.
SUBTOTAL A – ITEM 1 THROUGH 5:
6. Testing and pre-operations Costs (2.5% to 3.5% of Subt. A) 7. Owners Insurance Program (7.5% to 8.5% of Subt. A) 8. Master Agreements (3% to 10% of Subt. A).
SUBTOTAL B – ITEM 6 THROUGH 8:
9. Right-of-way (See Real Estate Division).
SUBTOTAL C – ITEM 9:
10. Professional Services (25% to 35% of Subt. A+B+C) 11. Contingency Allowances: A. On subtotal A +B (7% to 12%) B. On item 9 right-of-way (32% to 47%) C. On item 10 professional services (19% to 25%) 12. Total Estimated Cost.

TABLE 7-4

Electrification Project Estimated Add-Ons

A.	Construction Costs
B.	Locomotive Costs
C.	Contracts Mobilization/Demobilization (5% of A)
D.	Testing and Operations Mobilization (2% of A)
E.	Owners Insurance (8% of A)
F.	Mitigation (2% of A)
G.	Right-of-way
H.	Force Account (8% of A)
I.	Employee Training (3% of A)
J.	Construction Change Orders (12% of A&F, 2% of B)
K.	Project Services (25% of A&F, 1% of B, 10% of J)
L.	Subtotal (A thru K)
M.	Project Reserve (20% of L)
N.	Total Cost in 1992 dollars (L&M)

7.3 ESTIMATE DEVELOPMENT

Estimates were prepared for 13 separate routes including each of the nine commuter lines, the Consolidated UP/SP/ATSF Corridor, and the existing main lines of the Union Pacific, Southern Pacific and Santa Fe Railroads. In all, over 800 route miles of railroad were analyzed.

The analysis was begun by collecting data from the railroads, SCRRA, the PUC and local jurisdictions. Then, the various lines were divided into 72 geographical segments. The limits of the segments were set at connections to branch lines, entrances to yards and major sidings, the ends of commuter lines, and interlockings.

An inventory was then made of the existing facilities and train operations in each of the 72 segments. The facility inventory was taken from track charts, time tables, bridge inventories, clearance charts, and grade crossing lists. The facilities inventory was then increased to reflect ongoing railroad construction projects and the additional facilities required by the Southern California Commuter Rail 1991 Regional System Plan. Field trips were made with UP and SP railroad personnel on the Consolidated Corridor from Keenbrook to Redondo Junction to generally ascertain the feasibility of a consolidated corridor. Later, consultant team personnel performed a general inspection of the Corridor west of Colton and photographs were taken of the overhead bridges.

The train operations inventory was taken from seven consecutive 24 hour days of operations in October 1991. This period was recommended by the railroads as typical of their operations throughout the year. Then, based upon discussions with the railroads, future traffic increases were calculated to the year 2000. The year 2000 projected traffic volumes were then used to size the traction electrification system. Next the quantities from the inventory were multiplied by the unit costs to produce a total estimate of cost for each of the thirteen commuter and freight rail lines. Table 7-5, Summary of Costs by Route – Costs Related to Electrification, shows the total cost for electrifying each of the thirteen rail lines. The costs in this figure are duplicated (i.e., if segment one appears in five different rail lines, its cost is counted five times).

Table 7-6, Total Costs Related to Electrification, presents the non-duplicated costs for constructing the commuter and freight lines. The cost of each segment is counted only once and, as such, the costs shown reflect the total costs (excluding locomotives) to electrify the rail lines. Detailed cost estimates are contained in Appendix 7-1.

TABLE 7-5

SUMMARY OF COSTS BY ROUTE* COSTS RELATED TO ELECTRIFICATION
25kV, Minimum Vertical Clearance
***Locomotives, Shops & Ancillary Facilities, Locomotive Change Facilities and Control Center not included**

Commuter Only

Route	Description	Route Miles	Unduplicated Route Miles	Duplicated Construction Costs (A)	Duplicated Total Cost (N)
1	UP/SP Corridor	394	394	$63,766,458	$139,280,434
2	Baldwin Park Commuter	57	57	$93,454,320	$189,546,085
3	Moorpark Commuter	48	46	$91,795,256	$186,222,037
4	Santa Clarita Commuter	35	24	$68,264,880	$137,925,329
5	Lossan Corridor	134	133	$248,469,820	$502,434,180
6	Riverside Via Ontario	59	24	$108,899,602	$220,491,757
7	Riverside – Laupt via Fullerton	62	35	$126,768,720	$256,293,750
8	Hemet – Riverside	39	39	$54,387,174	$110,120,401
9	San Bernardino – Irvine	53	13	$105,997,534	$214,677,267
10	Redlands Commuter	12	12	$18,917,216	$39,053,928
11	Southern Pacific Routes Ports to Yuma	282	16	$7,474,685	$15,576,039
12	Santa Fe Ports to Barstow	176	0	$133,593,390	$273,423,441
13	Union Pacific Ports to Yermo	187	0	$117,114,448	$239,254,760

TABLE 7-5 (continued)

SUMMARY OF COSTS BY ROUTE* COSTS RELATED TO ELECTRIFICATION
25kV, Minimum Vertical Clearance
*Locomotives, Shops & Ancillary Facilities, Locomotive Change Facilities and Control Center not included

Commuter & Freight

Route	Description	Route Miles	Unduplicated Route Miles	Duplicated Construction Costs (A)	Duplicated Total Cost (N)
1	UP/SP Corridor	394	394	$744,585,526	$1,513,715,733
2	Baldwin Park Commuter	57	57	$93,454,320	$189,546,085
3	Moorpark Commuter	48	46	$91,795,256	$186,222,037
4	Santa Clarita Commuter	35	24	$68,264,880	$137,925,329
5	Lossan Corridor	134	133	$276,862,300	$562,776,444
6	Riverside Via Ontario	59	24	$124,703,922	$253,308,787
7	Riverside – Laupt via Fullerton	62	35	$142,581,496	$289,127,722
8	Hemet – Riverside	39	39	$54,387,174.	$110,120,401
9	San Bernardino – Irvine	53	13	$126,635,550	$257,178,935
10	Redlands Commuter	12	12	$18,917,216	$39,053,928
11	Southern Pacific Routes Ports to Yuma	282	16	$511,363,224	$1,040,678,991
12	Santa Fe Ports to Barstow	176	0	$369,135,726	$748,804,528
13	Union Pacific Ports to Yermo	187	0	$394,749,044	$801,274,552

TABLE 7-6

TOTAL COSTS* RELATED TO ELECTRIFICATION
(NO SEGMENTS DUPLICATED)
25kV, Minimum Vertical Clearance

Elements	Commuter Only		Commuter & Freight	
	Construction Cost	Total Cost	Construction Cost	Total Cost
	(A)	(N)	(A)	(N)
Civil, Structural & Signal Costs	$338,784,212	$678,777,206	$629,250,944	$1,260,747,055
System-wide Traction Electrification Costs	$371,306,000	$758,912,819	$888,988,000	$1,831,835,909
Shops & Ancillary Facilities	$0	$0	$40,000,000	$80,142,720
Locomotive Change Facilities	$0	$0	$34,000,000	$68,121,312
Control Center	$5,000,000	$10,017,840	$10,000,000	$20,035,680
Total	**$715,090,212**	**$1,447,707,865**	**$1,602,238,944**	**$3,260,882,676**

*(Locomotives not included)

The average cost per route mile is calculated by dividing the total cost for electrification by the total route miles. Table 7-7, Average Costs Related to Electrification, presents the average cost per track mile and route mile for electrifying commuter rail only and for electrifying the commuter and freight lines.

TABLE 7-7

Average Costs Related to Electrification

25kV Electrification System, Minimum Clearances

	Commuter Only ($000)	Commuter and Freight ($000)
Total Cost	$1,448,000	$3,261,000
Route Miles	417.8	805.5
Track Miles	671.3	1,452.5
Avg. Cost/Route Mile	3,466	4,048
Avg. Cost/Track Mile	2,157	2,245

7.4 ESTIMATES OF COST FOR VARYING CLEARANCES AND VOLTAGES

As mentioned in Section 5.2.1.1, there is a considerable difference between the clearances desired by the railroads and the clearances deemed adequate by the consulting team. In order to minimize the cost of electrification, the project teams' main effort was spent preparing estimates based upon minimum clearances and a 25kV electrification system. This combination results in the least impact to overhead bridges, minimizes track lowering requirements, and has the least impact on tunnels and thru truss railroad bridges.

Estimates were also prepared for a 25kV electrification system using American Railroad Engineering Association (AREA) recommended clearances, and for a 50kV electrification system with minimum clearances.

Details of these estimates are included in Appendix 7-2. A comparison of the total costs related to electrification of each alternative is shown in Table 7-8.

TABLE 7-8

Comparison of Total Electrification Costs

Various Alternatives

Alternative	Commuter Only ($000)	Commuter and Freight ($000)
25kV, Minimum Clearance	$1,448,000	$3,261,000
25kV, Desirable Clearance	1,541,000	3,354,000
50kV, Minimum Clearance	1,514,000	3,250,000

As shown in Table 7-8 above, the use of minimum clearances with 25kV electrification reduces the total cost by approximately $90 million as compared to the cost using desirable clearances, and minimizes adverse impacts to adjacent communities and ongoing railroad operations.

Similarly, the use of 50kV electrification with minimum clearances increases the cost of electrifying commuter rail by approximately $66 million above the 25kV minimum clearance scenario.

In the case of combined commuter and freight electrification, the estimates indicate that a slight savings of ten million could be achieved by using 50kV electrification with minimum clearances in lieu of 25kV electrification with minimum clearances. This is due to the fact that fewer substations are required with a 50kV system. This potential saving ignores the negative impacts caused by the additional 18 inches of vertical clearance required to construct a 50kV electrification system. It is thought that as designs progress, the small cost advantage of the 50kV system will be overtaken by the costs of providing additional clearance.

7.5 TRACTION ELECTRIFICATION SYSTEM COST ESTIMATE

7.5.1 General Approach

The traction electrification costs are estimated in 1992 U.S. dollars. Unit cost estimates are developed first for the various components of the power supply system and for one typical route mile of the power distribution system. Subsequently, the unit costs are used to develop cost estimates for each considered route and for the entire network of railroads under consideration.

7.5.2 Unit Costs

The unit costs of substations, switching stations, paralleling stations and autotransformer stations and the overhead distribution system are developed by summing the costs of various items of equipment required for each installation. The individual equipment costs include:

- Utility System Provision – Cost includes bus extension, line position and circuit breakers at the utility substation. Further, the cost includes the utility system and traction electrification system interface area of approximately 7500 sq. ft. with utility dead-end structures, revenue metering, cables, duct banks, grounding, concrete, steelwork and all other necessary equipment. Utility system voltages of 69kV, 115kV and 230kV are considered.
- Transmission Lines – The transmission line costs are developed using the actual voltage rating. In the absence of actual substation locations and transmission line requirements for each facility, an average transmission line length of one mile per substation is assumed.
- Traction Power Substations, Switching Stations, Paralleling Stations and Autotransformer Stations – For the purpose of estimating the site work and grounding system, the area requirements for each facility type are shown in Table 7-9.
- High Voltage Disconnect Switches and Circuit Breakers – Costs of disconnect switches and circuit breakers at various voltage ratings is considered. One high voltage disconnect switch and circuit breaker is included with each traction transformer.
- Traction Power Transformers – Cost is dependent, to a first order, on the power rating. The costs of appropriately rated transformers are considered, including protective relay equipment.
- Low Voltage Circuit Breakers – Cost includes vacuum bottles, closing and tripping mechanisms, control and protective equipment, instrumentation, bushings, current and voltage transformers, and the housing located on its own concrete slab foundation.
- Signal Power Supply Equipment – Cost includes a motor-generator set in a separate housing located on its own concrete slab foundation.
- Cable and Duct Bank – Cost includes an allowance for a typical length of high voltage cables, electrification feeders, and duct banks.
- Other Equipment – Cost includes auxiliary power equipment, auxiliary transformers, AC and DC distribution panels, battery and charger, low voltage disconnect switches, power transfer switches, fuses, insulators, duct banks, conduits, wiring, tubing, connector and other miscellaneous equipment. Cost of SCADA remote terminal unit (RTU) is also included. However, no communication between the RTU's and central control facility is included.

TABLE 7-9

Approximate Area Requirements for Traction Power Supply System Facilities

Facility Type	Number of Traction Transformers	Approximate Area Requirement (sq. ft.)
Traction Power Substations	1	15,000
	2	22,500
Switching Station, Paralleling Station, Autotransformer Station	None	5,000

The equipment is typically located in a switchgear annex housing located on a concrete slab foundation , the cost of which is also included.

- Autotransformers – Cost includes 50kV/25kV autotransformers rated at 10MVA.
- Site Work – Cost includes clearing, grubbing, excavation, filling, grading, top soil placement, seeding, mulching, crushed stone, gravel, drainage system, access road and fencing.
- Grounding System – Cost includes copperweld mat, grounding rods and copper connecting wire.
- Concrete and Structural Steel – Costs cover the foundation and supports for bus-bars, circuit breakers, potential transformers and power transformers.
- Power Factor and Harmonic Filters – Assumed to be installed on the locomotives. The cost of locomotives may be affected depending on the actual requirements.
- Real Estate Costs – The power supply system facility costs do not include any real estate costs.
- At-Grade Overhead Distribution System – Auto-tensioned simple catenary system is considered with an average span length of approximately 176 feet. Wide flange steel supporting poles are to be located on the outside of the tracks. Pole face to centerline of track is 15 feet. The contact wire height above top of rail varies from 22'-3" to 25'-1" depending upon voltage and clearance option selected.
- Tunnel Overhead Distribution System – Fixed-termination contact wire system with an overhead feeder. An average span length is approximately 40 feet.

Unit costs for traction power supply system facilities and power distribution are developed in Appendix 7-3 for systems without autotransformers and in Appendix 7-4 for autotransformer systems.

7.5.3 Overall Traction Power System Cost Estimates for Individual Routes

The overall traction power system cost for each route combines the cost of the appropriate number of traction power substations, switching stations, paralleling stations and autotransformer stations with the cost of the overhead distribution system for the tracks to be electrified. The schedule of quantities for both the traction power supply system and the length of tracks is presented in Appendix 7-5.

The overall electrification system cost estimates for each considered route and for the whole network of railroads are developed in Appendix 7-6 for a traction power system without autotransformers and in Appendix 7-7 for the autotransformer system. The results are summarized in the following tables. First, Table 7-10 presents the traction power supply system costs. Table 7-11 shows the distribution system costs and finally Table 7-12 presents the overall electrification costs combining the power supply and distribution systems. It should be understood that the route costs are developed for each route independently. If several routes utilizing common portions of track are electrified, care should be taken to avoid duplication of segment costs.

7.5.4 Locomotive Cost Estimates

7.5.4.1 Freight Locomotive Base Price

The history on the procurement of electric freight locomotives in the U.S. is not very extensive. Only a few have been built for use in North America in the recent past. The last locomotive to be built was the GM/ASEA GF 6 C. Seven units were built for the British Columbia Railway during 1983-1984. They are 6000 HP, 50kV, 60Hz units. Another relevant locomotive is the General Electric E 60C-2 which are 6000 HP, 25kV, 60Hz units; thirty nine of these locomotives were built for the National Railways of Mexico in 1982-1983.

The two leading locomotive manufacturers were contacted in order to obtain current pricing information. They advised that to build the exactly same unit as built for the BCR would cost $U.S. 4.0 million in 1992 dollars and the Mexican unit would cost $U.S. 4.2 million in 1992 dollars. Any change to the propulsion or power conditioning systems, transformer coolant or other modifications would alter the price.

Since little is known of railroad requirements at this time, we recommend using the $4.0 million estimate. No contingency is included in this estimate.

7.5.4.2 Passenger Locomotive Base Price

The most recent order for new electric passenger locomotives took place during 1988-90. An order was placed by New Jersey Transit for 15 ABB APL-44's for use on its North Jersey Coast Line. The units are 7000 HP, 12.5kV/25kV, 60Hz.

The average cost for the 15 NJT units was $4.6 million each. To arrive at a 1992 cost estimate for an electric passenger locomotive, we escalated the NJT average purchase price two ways:

- Method # 1 uses the Bureau of Labor Statistics Producers Price Index for Railroad Equipment – Code P3743.
- Method # 2 uses the L.A. Green Line formula for escalation.

TABLE 7-10

Power Supply System Cost Estimate by Route

POWER SUPPLY SYSTEM COST ESTIMATE (Add-on 12.00%)						
Route No.	Route Name	Route Miles	Traffic Type	Power Supply System Cost (in $000's)		
				25kV	50kV	25kV AT
1	SP/UP Corridor	34.7	Commuter	10,812	6,360	10,935
		393.5	Commuter & Freight	104,781	61,578	86,355
2	Baldwin Park	57.0	Commuter	8,413	7,829	20,810
3	Moorpark	47.5	Commuter	8,413	7,829	15,563
4	Santa Clarita	34.9	Commuter	5,326	5,740	15,563
5	Lossan	133.7	Commuter	22,338	18,848	32,826
		133.7	Commuter & Freight	38,200	20,293	41,579
6	Riverside via Ontario	59.1	Commuter	8,413	7,829	15,563
		59.1	Commuter & Freight	12,660	9,029	16,734
7	Riverside via Fullerton	61.8	Commuter	8,413	7,829	15,563
		61.8	Commuter & Freight	12,660	9,029	16,734
8	Hemet to Riverside	39.1	Commuter	5,945	6,360	16,182
9	San Bernardino to Irvine	52.8	Commuter	14,549	10,941	19,358
		52.8	Commuter & Freight	27,397	15,613	26,555
10	Redlands	12.2	Commuter	2,347	2,493	6,757
11	Southern Pacific (Yuma to Ports)	281.7	Freight	74,932	32,434	52,571
12	Santa Fe (Barstow to Ports)	68.3	Commuter	10,193	10,966	16,003
		176.1	Commuter & Freight	40.579	21,389	38,954
13	Union Pacific (Yermo to Ports)	65.7	Commuter	10,193	15,144	16,003
		186.8	Commuter & Freight	42,406	27,064	34,630
	Entire Network	418.0	Commuter	60.079	37,040	60,263
		805.7	Commuter & Freight	206,873	134,721	276,854

TABLE 7-11

Distribution System Cost Estimate by Route

DISTRIBUTION SYSTEM COST ESTIMATE (Add-on 12.00%)

Route No.	Route Name	Route Miles	Traffic Type	Distribution System Cost (in $000's)		
				25kV	50kV	25kV AT
1	SP/UP Corridor	34.7	Commuter	26,591	27,389	28,239
		393.5	Commuter & Freight	353,910	364,527	376,033
2	Baldwin Park	57.0	Commuter	40,548	41,765	42,950
3	Moorpark	47.5	Commuter	39,859	41,054	42,292
4	Santa Clarita	34.9	Commuter	30,310	31,219	32,148
5	Lossan	133.7	Commuter	109,452	112,775	129,108
		133.7	Commuter & Freight	121,635	125,284	129,108
6	Riverside via Ontario	59.1	Commuter	50,327	51,837	64,854
		59.1	Commuter & Freight	61,122	62,956	64,854
7	Riverside via Fullerton	61.8	Commuter	65,086	67,038	74,201
		61.8	Commuter & Freight	69,989	72,088	74,201
8	Hemet to Riverside	39.1	Commuter	20,959	21,587	22,272
9	San Bernardino to Irvine	52.8	Commuter	48,145	49,589	52,574
		52.8	Commuter & Freight	49,494	50,979	52,574
10	Redlands	12.2	Commuter	6,003	6,183	6,384
11	Southern Pacific (Yuma to Ports)	281.7	Freight	236,717	243,818	251,461
12	Santa Fe	68.3	Commuter	66,415	68,408	187,316
		176.1	Commuter & Freight	176,340	181,630	187,316
13	Union Pacific	65.7	Commuter	53,122	54,716	209,750
		186.8	Commuter & Freight	197,368	203,289	209,750
	Entire Network	418.0	Commuter	311,227	320,564	330,468
		805.7	Commuter & Freight	682,115	702,578	724,565

TABLE 7-12

Overall Traction Electrification System Cost Estimate by Route

OVERALL TRACTION ELECTRIFICATION SYSTEM COST ESTIMATE						
Route No.	Route Name	Route Miles	Traffic Type	Overall System Cost (in $000's)		
				25kV	50kV	25kV AT
1	SP/UP Corridor	34.7	Commuter	37,403	33,748	39,174
		393.5	Commuter & Freight	458,691	426,105	462,389
2	Baldwin Park	57.0	Commuter	48,961	49,594	63,760
3	Moorpark	47.5	Commuter	48,271	48,883	57,854
4	Santa Clarita	34.9	Commuter	35,636	36,959	47,711
5	Lossan	133.7	Commuter	131,791	131,623	161,934
		133.7	Commuter & Freight	159,835	145,577	170,687
6	Riverside via Ontario	59.1	Commuter	58,739	59,666	80,417
		59.1	Commuter & Freight	73,783	71,985	81,588
7	Riverside via Fullerton	61.8	Commuter	73,498	74,867	89,764
		61.8	Commuter & Freight	82,649	81,117	90,936
8	Hemet to Riverside	39.1	Commuter	26,904	27,947	38,454
9	San Bernardino to Irvine	52.8	Commuter	62,693	60,530	71,932
		52.8	Commuter & Freight	76,891	66,592	79,130
10	Redlands	12.2	Commuter	8,350	8,676	13,141
11	Southern Pacific (Yuma to Ports)	281.7	Freight	311,649	276,252	304,033
12	Santa Fe (Barstow to Ports)	68.3	Commuter	76,609	79,374	203,319
		176.1	Commuter & Freight	216,919	213,019	226,270
13	Union Pacific (Yermo to Ports)	65.7	Commuter	63,315	69,859	225,753
		186.8	Commuter & Freight	239,774	230,354	244,380
	Entire Network	418.0	Commuter	371,306	357,604	390,732
		805.7	Commuter & Freight	888,988	837,299	1,001,419

Work sheets for both methods are presented in Appendix 7-8. Method # 1 provides an estimated cost of $5.25 million while Method # 2 gives an estimate of $4.84 million.

After researching the indices used in both methods, we recommend using the $5.25 million estimate because the components of the Producers Price Index for Railroad Equipment – Code P3743 relate more specifically to locomotives than the indices used for the Green Line transit vehicle. We have confirmed the estimate within the industry and verified that for planning purposes the $5.25 million is reasonable. As in the case with the freight locomotive estimate no contingency is included in this estimate and any major change from the NJT design will alter the price.

7.5.4.3 Locomotive Cost Additions

The base prices of the freight and passenger locomotives were increased by adding costs for the following equipment:

- Double Cab – Any electric locomotive of 6,000-7,000 diesel equivalent horsepower will require double cab to allow for operational flexibility. The single GM/ASEA GF6C was built for BCR to operate in two unit back-to-back sets on large coal trains. We estimate that it would cost $200,000 to add a second cab to the GF6C.
- Transformer Coolant – It is estimated that it would cost $40,000 to change the coolant on oil cooled transformers from oil to silicone to reduce the fire hazard. Part of the cost involves pump equipment to handle the viscosity change.
- Cab Signals – Cab signal equipment costs are estimated at $30,000 per locomotive. This includes speed control which is becoming mandatory in certain applications.
- Cab Air Conditioning – The cost of air conditioning (R22) is estimated to be $20,000 per cab.
- Power Conditioning Equipment – In the absence of power factor and harmonic distortion limits is difficult to estimate the cost of this equipment. However, $50,000 is allocated for the power factor correction equipment and $50,000 for harmonic filters.

Appendix 7-8 presents the locomotive cost summaries.

7.5.4.4 Volume Discounts

Volume discounts for large quantities of locomotives would be possible if large number of locomotives were ordered at one time and to a uniform design. However, due to staged nature of electrification projects and the desire of different parties to require different design features, it is doubtful that such large orders will happen. As an example, Amtrak may not be satisfied with the performance of the AEM-7 with heavy trains on western grades. They may require a heavier locomotive to avoid stalling on grades such as Cajon pass.

7.6 LIFE CYCLE ISSUES

Total costs related to the electrification of the railroads and commuter lines in the Los Angeles Basin include the capital cost for designing and constructing the electrification system and purchasing electric locomotives, the ongoing costs of operating and maintaining the electrification system and electric locomotives, and the cost of periodic replacement of facilities and systems at the end of their useful service life.

Consideration of life cycle issues could possibly increase the cost effectiveness of electrification because electric locomotive operation and maintenance costs are thought to be considerably less than the operations and maintenance costs for diesel locomotives. Additionally, electric locomotives are thought to have a considerably longer effective service life than diesel locomotives. Conversely, the electrification systems and facilities require continuous operating and maintenance expenditures which are not incurred with diesel service.

Popular opinion is that electric locomotives last twice as long as diesels and cost half as much to maintain. While this may be true in parts of Europe where electrified railroads are the norm, United States experience, which is limited to the Northeast Corridor from Washington, D.C. to New Haven, Connecticut and Conrails' Main Line from Philadelphia, Pennsylvania to Harrisberg, Pennsylvania does not support this opinion. Amtraks' experience is that their electric locomotives cost 50% more to maintain than diesels and do not achieve a longer service life. This is no doubt at least partially caused by the higher speeds and additional mileage travelled by the electric locomotives on the Northeast Corridor (110 mph max) as apposed to that required of diesel service, which is only 79 mph nominal maximum speed.

Also, Conrail has eliminated their entire electric locomotive fleet and runs only diesel freight service on the Northeast Corridor and their mainline between Philadelphia and Harrisberg. At present, there are no electrified freight railroads in the United States.

A life cycle cost analysis ascertaining the cost effectiveness advantage (if one exists) of an electrified railroad as compared to a diesel powered railroad would consider the life cycle costs of the following elements:

- Track and roadbed
- Signals
- Communications/SCADA
- Bridges and tunnels
- Maintenance facilities
- Locomotives
- Traction power substations
- Power supply
- Catenary system.

Table 7-13, Life Cycle Costing Comparison Matrix, presents the generally expected service life of each of the above elements and a cost effectiveness comparison of electrified and diesel power railroads.

TABLE 7-13

Life Cycle Costing Comparison Matrix

		Electrified Railroad			Diesel Power Railroad		
	Service Life (Years)	Service Life*	Annual M&O Costs*	Cost Effective-ness	Service Life**	Annual M&O Costs**	Cost Effective-ness**
Track and Roadbed	20	0	--	--	0	+	+
Signals	40	0	0	0	0	0	0
Communications/SCADA	40	--	--	--	+	+	+
Bridges and Tunnels	80	0	0	0	0	0	0
Maintenance Facilities	50	0	0	0	0	0	0
Locomotives	E D	+	+	?	--	--	?
Traction Power Substations	50	--	--	--	+	+	+
Power Supply	70	--	--	--	+	+	+
Catenary System	70	--	--	--	+	+	+

Legend
+ = More Advantageous
0 = Neutral
-- = Less Advantageous
? = Unknown

* = Electrified Compared to Diesel
** = Diesel Compared to Electrified

A review of the matrix reveals that the only potential life cycle cost advantage of the Electrified Railroad is the electric locomotives themselves. However, this is greatly minimized, as electric locomotives cost more than twice as much as diesel locomotives, but do not provide double the tractive effort. In addition, conversion to electrification requires a very large capital investment not required by the diesel powered railroads. Life cycle costing computations generally show an economic advantage to minimizing initial capital expenditures.

7.7 PROJECT IMPLEMENTATION SCHEDULE

The preparation of a realistic schedule for electrifying the commuter lines and freight railroads of the Los Angeles Basin is dependent upon realistic consideration of the following parameters:

- Time frame for performing preliminary engineering, environmental work, final design, design coordination and the approval process
- Funding limitations
- Contract or availability
- Governmental management and administrative limitations
- Maintenance of adequate railroad operations during construction.

Exhibits 7-1 through 7-7 present several alternative design and construction schedules and cash flow diagrams. These alternatives are discussed separately in the following subsections.

7.7.1 Simultaneous Implementation of All Routes

Exhibit 7-1 presents the design and construction schedule, and Exhibit 7-2 and 7-3 present the cash flow requirements, for the simultaneous implementation of all routes. The purpose of this set of exhibits is to determine the earliest date that any individual route could be converted to electrified operation, and to determine the cash flow requirements to support such a schedule. The time frames for completing the various portions of the implementation plan were developed using the following assumptions.

- A 12 month minimum time frame for environmental/preliminary engineering. The minimum time frame is determined by the environmental approval process. The time frame increases with route length and complexity. A 24 month maximum time frame was projected for the UP/SP/ATSF Consolidated Corridor.
- A 10 month minimum time frame for final design, determined by the design review and approval process. A 28 month maximum time frame was projected for the UP/SP/ATSF Consolidated Corridor.
- A 3 month construction contract bid and award cycle determined by the approval process.
- A 16 month minimum construction contract period based upon the electrification of the 12 route miles of the Hemet Line. A 54 month maximum construction contract period was projected for the UP/SP/ATSF Consolidated Corridor.
- A 4 month minimum pre-operations testing period. A 6 month maximum testing period was projected for the UP/SP/ATSF Consolidated Corridor.

Exhibits 7-2 and 7-3 present cash flow projections in constant 1992 dollars and inflated dollars (3.46% annual rate) for combined commuter and freight operations, and commuter only operations, respectively. The maximum expenditures in any one year are projected to be:

	$1992 (millions)	$Inflated (millions)
Commuter and freight	726	861
Commuter only	474	544

This funding amount is considered unattainable based on other existing demands for public works funds. In addition, it is considered impossible to manage or construct this amount of work in any one year. Accordingly, prioritized implementation schedules and cash flows were developed for commuter and freight, and commuter-only scenarios.

7.7.2 Prioritized Implementation Plan – Commuter and Freight

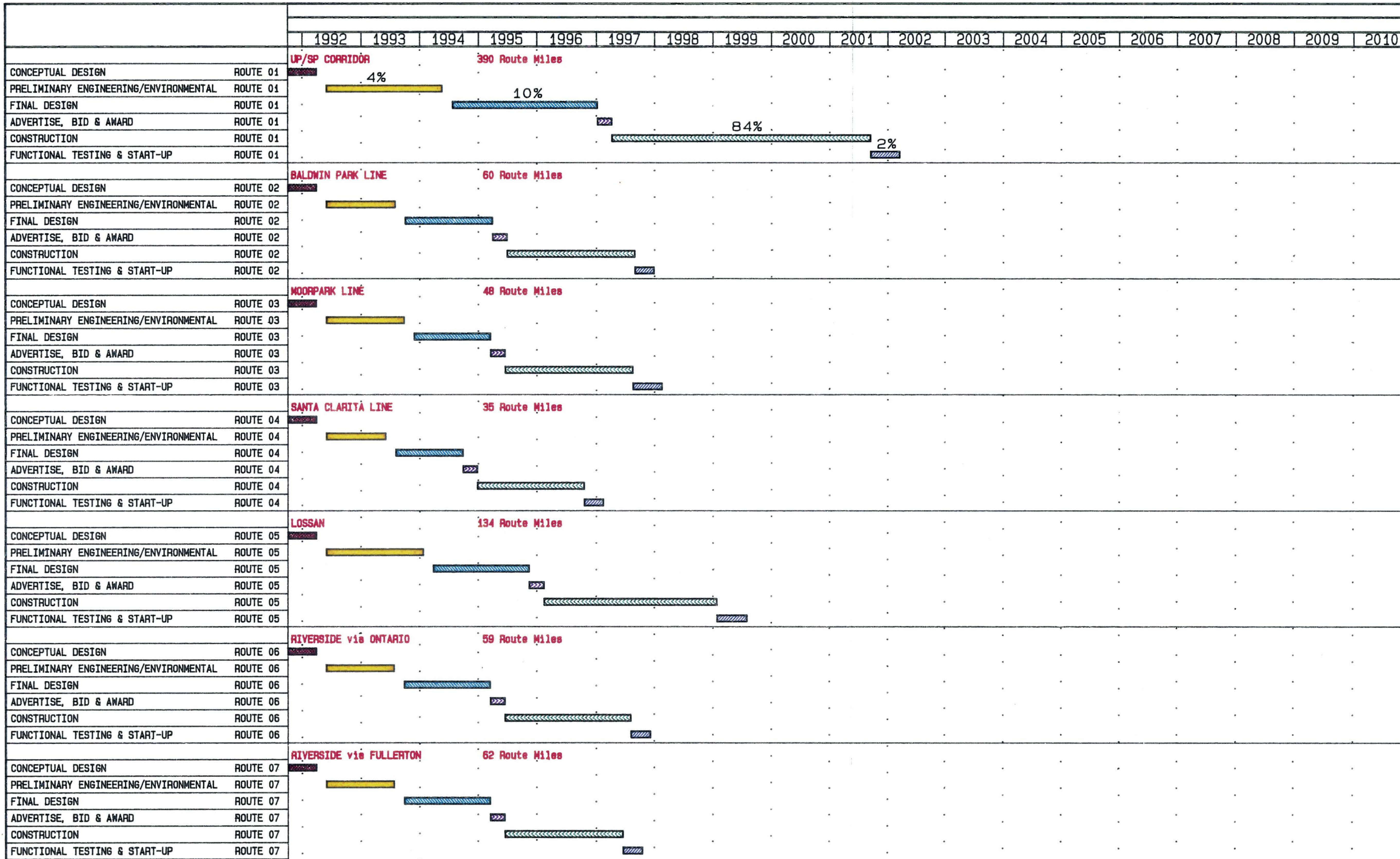
Exhibits 7-4 and 7-5 present the design and construction schedule and cash flow requirements, respectively, for the orderly implementation of all routes. Priorities were developed based upon the analyses presented in Section 3.0. An amount of $300 million per year, in constant 1992 dollars, was chosen as the maximum amount of work which could be constructed, managed and funded in any one year, while maintaining adequate freight railroad operations. Construction schedules for the various lines were then adjusted to keep spending below the $300 million cap. Using this scenario, the electrification projected could be completed by the beginning of 2010.

7.7.3 Prioritized Implementation Plan – Commuter Only

Exhibits 7-6 and 7-7 present the design and construction schedule and cash flow requirements, respectively, for the orderly implementation of the nine commuter rail lines only. (i.e., no freight routes.). A spending limit of $300 million per year, in constant 1992 dollars, was chosen for this scenario as well. With this limitation, electrification of all nine commuter rail candidate routes could be completed by the end of 2004.

7.8 COSTS OF CONSOLIDATED CORRIDOR RAILROAD IMPROVEMENTS

Section 6.3 describes the additional facilities required to support the operations of the three freight railroads in the Consolidated Corridor. The estimated cost of these railroad improvements were developed following the same procedures used to determining the costs for electrification. The estimated cost of the required additional facilities is $1.848 billion in constant 1992 dollars. This cost is above the amount required for electrification and is not contained in the average cost per mile calculations. A detailed estimate for the Consolidated Corridor Railroad Improvements is presented in Appendix 7-3.



Activity Bar/Early Dates
Critical Activity
Progress Bar

WBS LEVEL 5
CONCEPTUAL DESIGN
PRELIMINARY ENGINEERING / ENVIRONMENTAL
FINAL DESIGN
ADVERTISE, BID & AWARD
CONSTRUCTION
FUNCTIONAL TESTING / START-UP

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Commuter & Freight Sheet 1 of 2

Project Start : 1JAN91
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Data Date: 1OCT91
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EXHIBIT 7-1

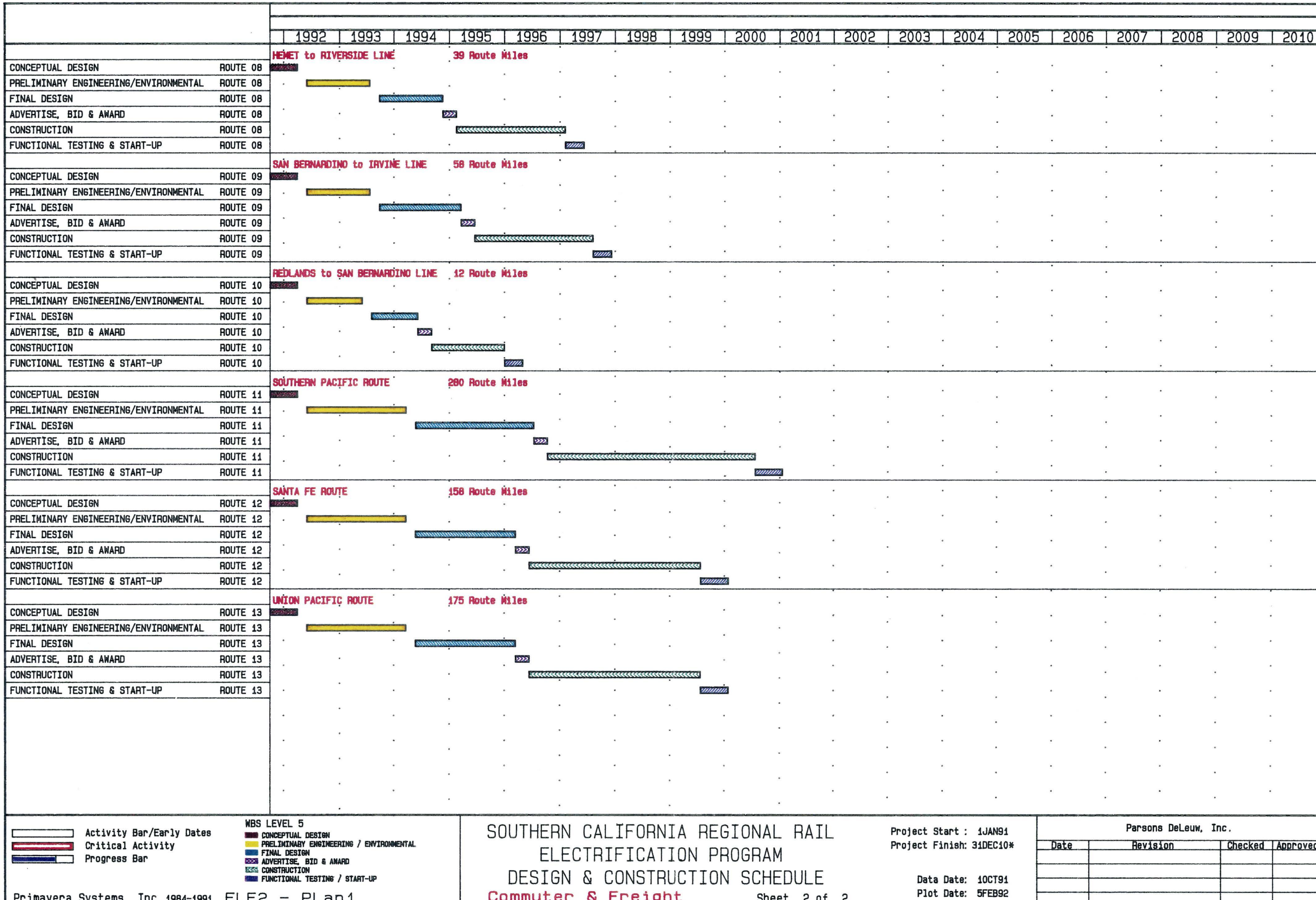
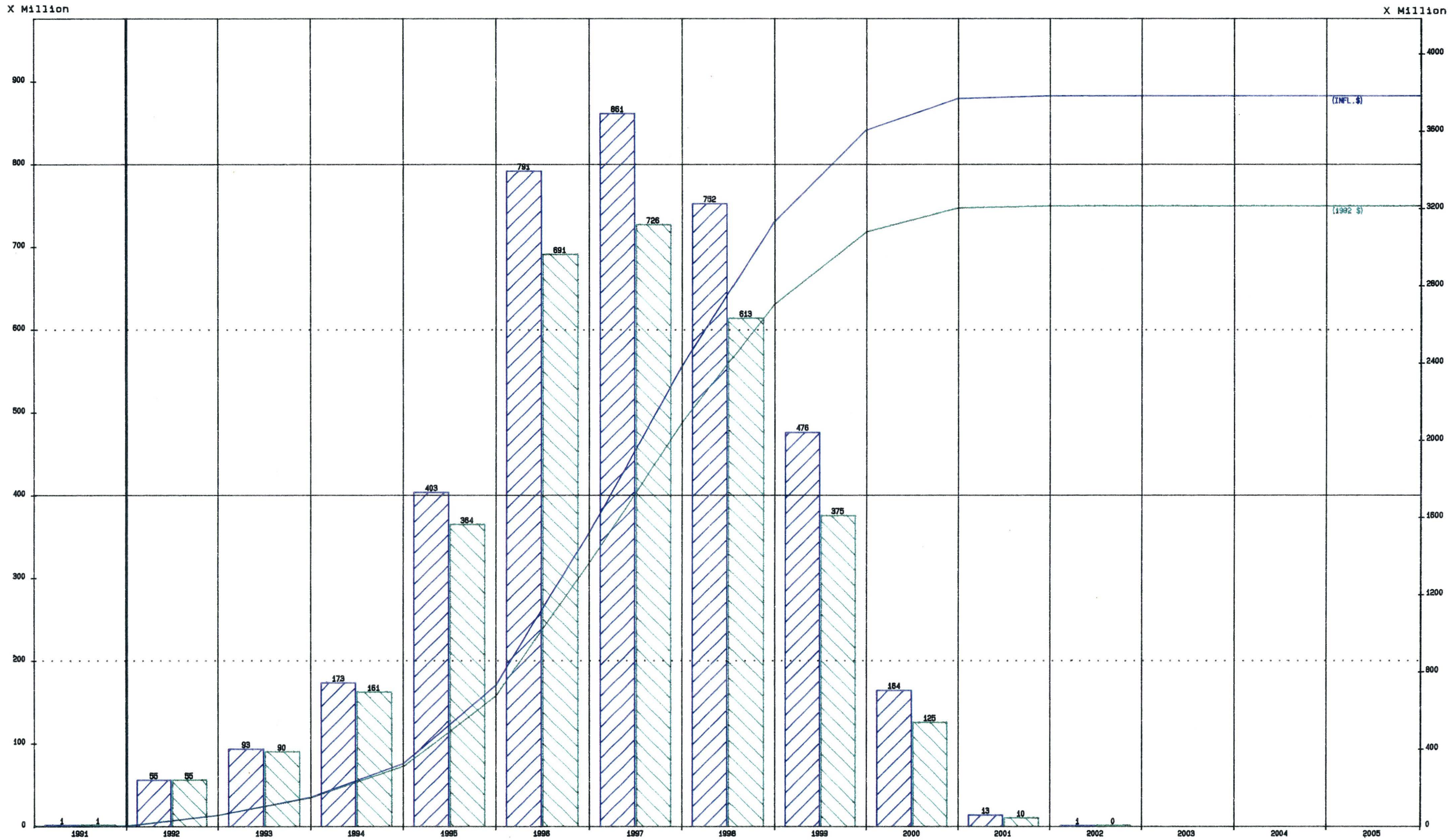


EXHIBIT 7-1, CONTINUED



Inflated using 3.46% annual rate.

Constant 1992 dollars.

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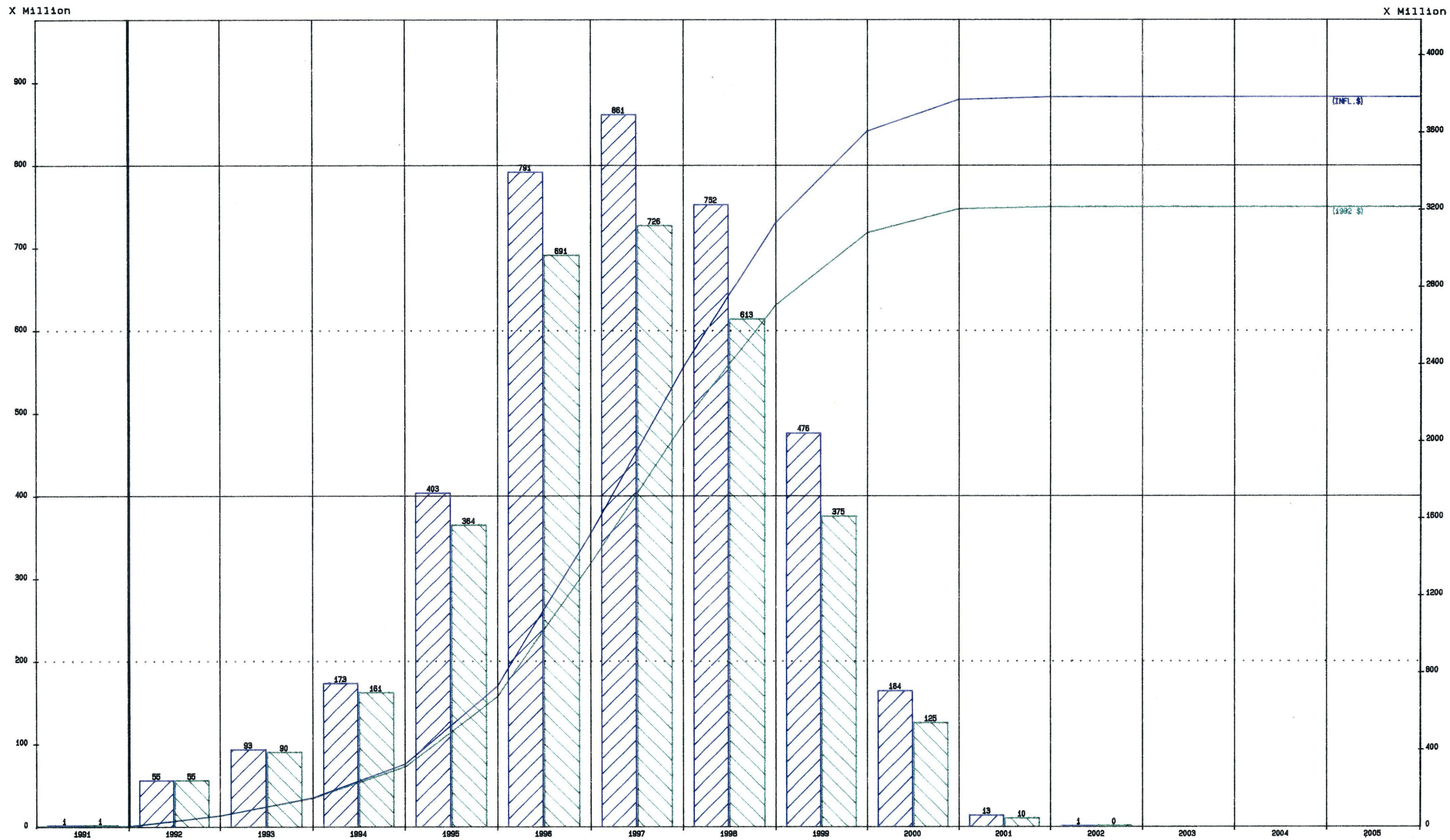
EXHIBIT 7-2



Inflated using 3.46% annual rate.
Constant 1992 dollars.

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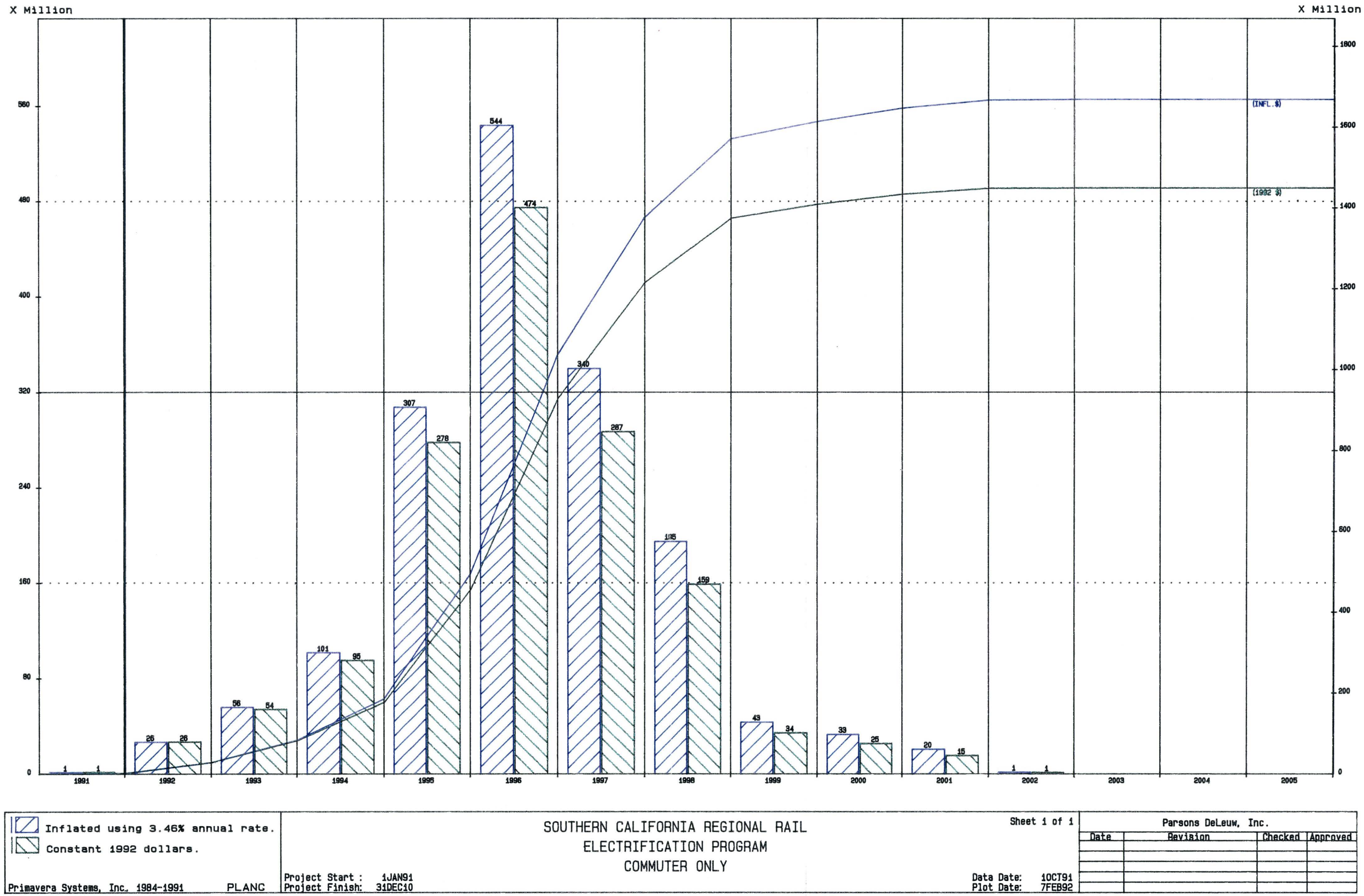
EXHIBIT 7-2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Inflated using 3.46% annual rate.
Constant 1992 dollars.
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SOUTHERN CALIFORNIA REGIONAL RAIL
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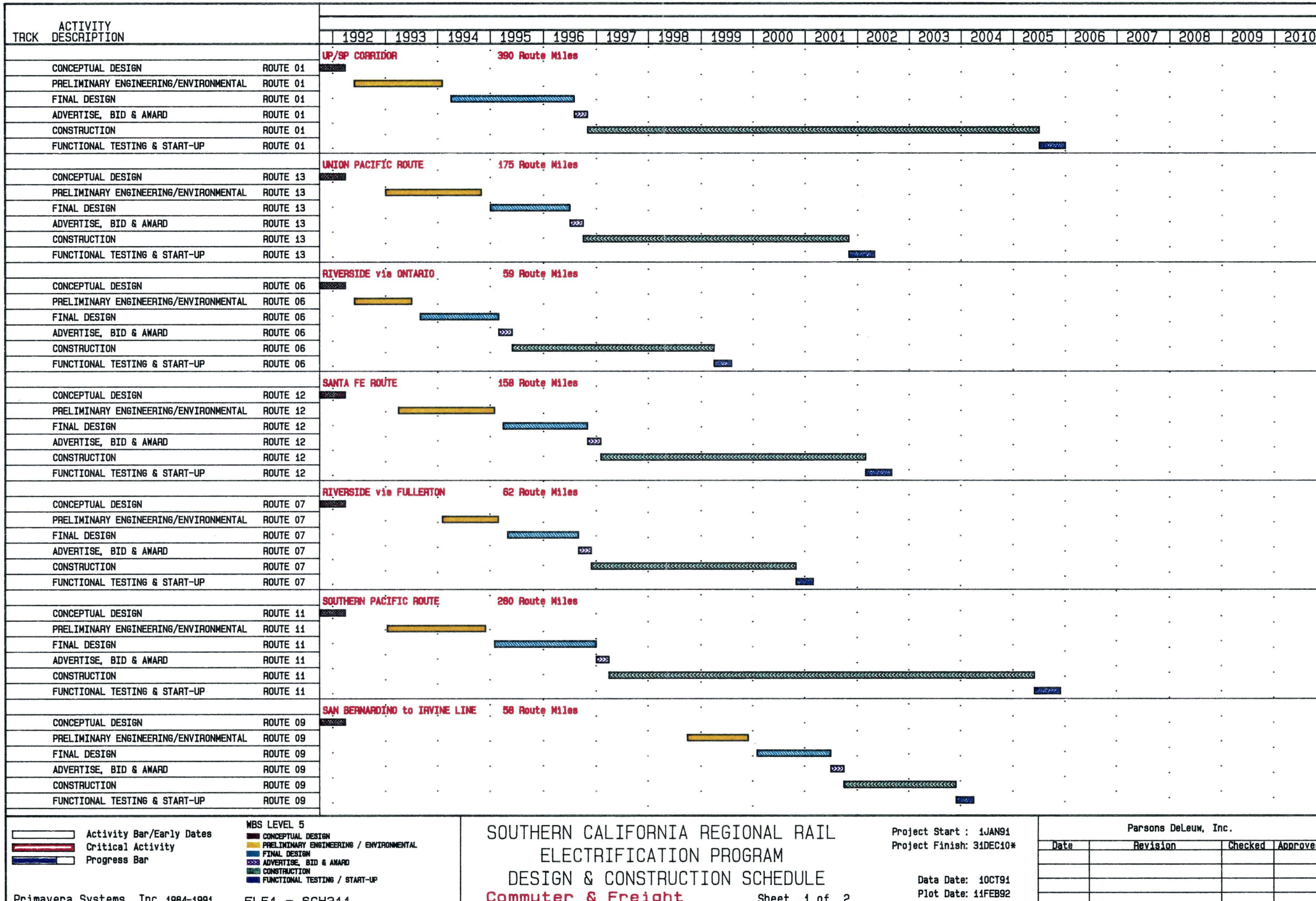
EXHIBIT 7-3



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ELE1 - SCH211

SOUTHERN CALIFORNIA REGIONAL RAIL ELECTRIFICATION PROGRAM DESIGN & CONSTRUCTION SCHEDULE

Commuter & Freight

Sheet 1 of 2

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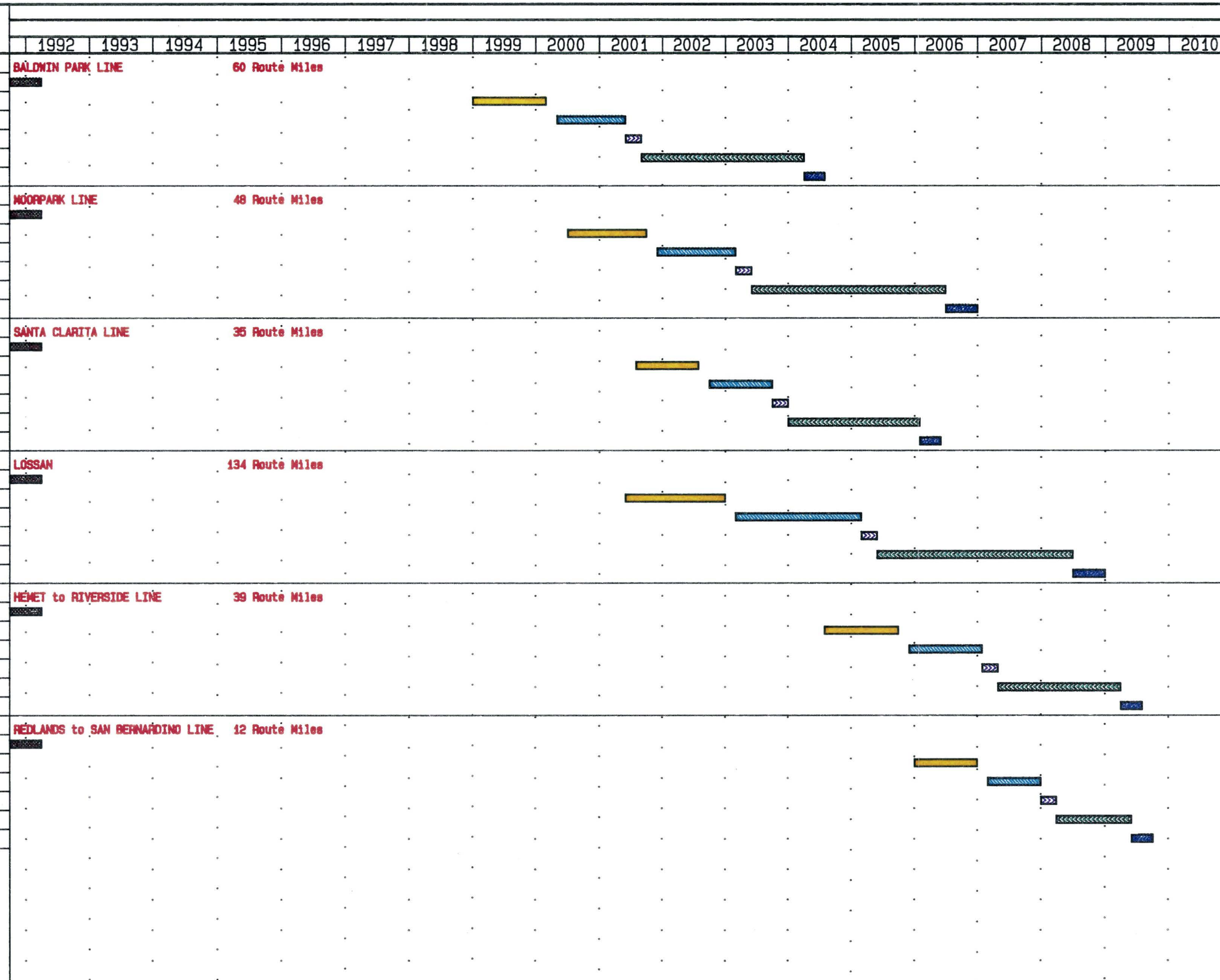
EXHIBIT 7-4

TRCK	ACTIVITY DESCRIPTION	
	BALDWIN PARK LINE — 60 Route Miles	
	CONCEPTUAL DESIGN	ROUTE 02
	PRELIMINARY ENGINEERING/ENVIRONMENTAL	ROUTE 02
	FINAL DESIGN	ROUTE 02
	ADVERTISE, BID & AWARD	ROUTE 02
	CONSTRUCTION	ROUTE 02
	FUNCTIONAL TESTING & START-UP	ROUTE 02
	MOORPARK LINE — 48 Route Miles	
	CONCEPTUAL DESIGN	ROUTE 03
	PRELIMINARY ENGINEERING/ENVIRONMENTAL	ROUTE 03
	FINAL DESIGN	ROUTE 03
	ADVERTISE, BID & AWARD	ROUTE 03
	CONSTRUCTION	ROUTE 03
	FUNCTIONAL TESTING & START-UP	ROUTE 03
	SANTA CLARITA LINE — 35 Route Miles	
	CONCEPTUAL DESIGN	ROUTE 04
	PRELIMINARY ENGINEERING/ENVIRONMENTAL	ROUTE 04
	FINAL DESIGN	ROUTE 04
	ADVERTISE, BID & AWARD	ROUTE 04
	CONSTRUCTION	ROUTE 04
	FUNCTIONAL TESTING & START-UP	ROUTE 04
	LOSSAN — 134 Route Miles	
	CONCEPTUAL DESIGN	ROUTE 05
	PRELIMINARY ENGINEERING/ENVIRONMENTAL	ROUTE 05
	FINAL DESIGN	ROUTE 05
	ADVERTISE, BID & AWARD	ROUTE 05
	CONSTRUCTION	ROUTE 05
	FUNCTIONAL TESTING & START-UP	ROUTE 05
	HEMET to RIVERSIDE LINE — 39 Route Miles	
	CONCEPTUAL DESIGN	ROUTE 08
	PRELIMINARY ENGINEERING/ENVIRONMENTAL	ROUTE 08
	FINAL DESIGN	ROUTE 08
	ADVERTISE, BID & AWARD	ROUTE 08
	CONSTRUCTION	ROUTE 08
	FUNCTIONAL TESTING & START-UP	ROUTE 08
	REDLANDS to SAN BERNARDINO LINE — 12 Route Miles	
	CONCEPTUAL DESIGN	ROUTE 10
	PRELIMINARY ENGINEERING/ENVIRONMENTAL	ROUTE 10
	FINAL DESIGN	ROUTE 10
	ADVERTISE, BID & AWARD	ROUTE 10
	CONSTRUCTION	ROUTE 10
	FUNCTIONAL TESTING & START-UP	ROUTE 10



Activity Bar/Early Dates
Critical Activity
Progress Bar

WBS LEVEL 5
CONCEPTUAL DESIGN
PRELIMINARY ENGINEERING / ENVIRONMENTAL
FINAL DESIGN
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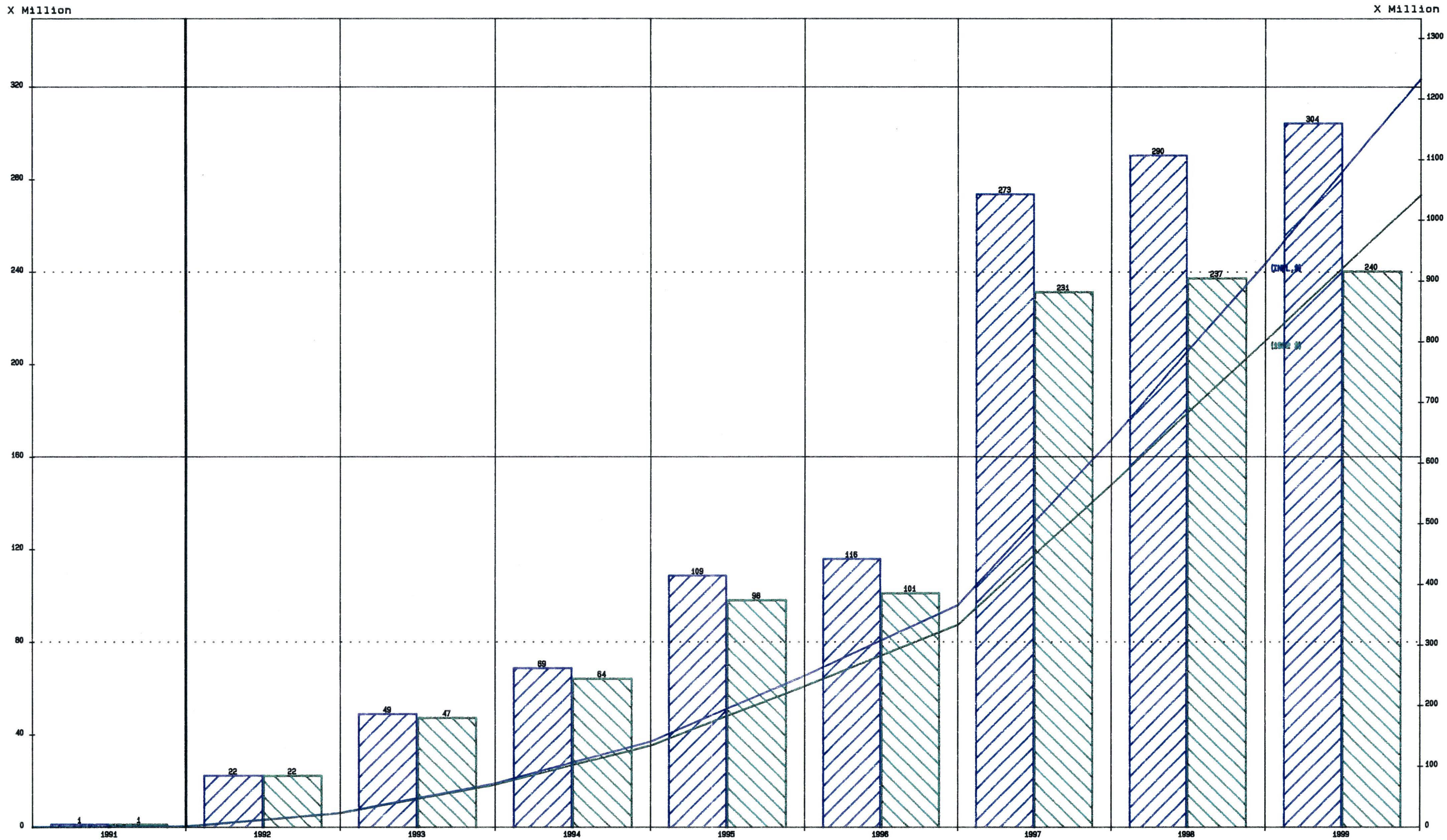
EXHIBIT 7-4, CONTINUED



Inflated using 3.46% annual rate. Constant 1992 dollars. Primavera Systems, Inc. 1984-1991 CFRCONX	SOUTHERN CALIFORNIA REGIONAL RAIL ELECTRIFICATION PROGRAM COMMUTER & FREIGHT Project Start : 1JAN91 Project Finish: 31DEC10	Sheet 1 of 1 Data Date: 1OCT91 Plot Date: 11FEB92	Parsons DeLeuw, Inc.

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EXHIBIT 7-5

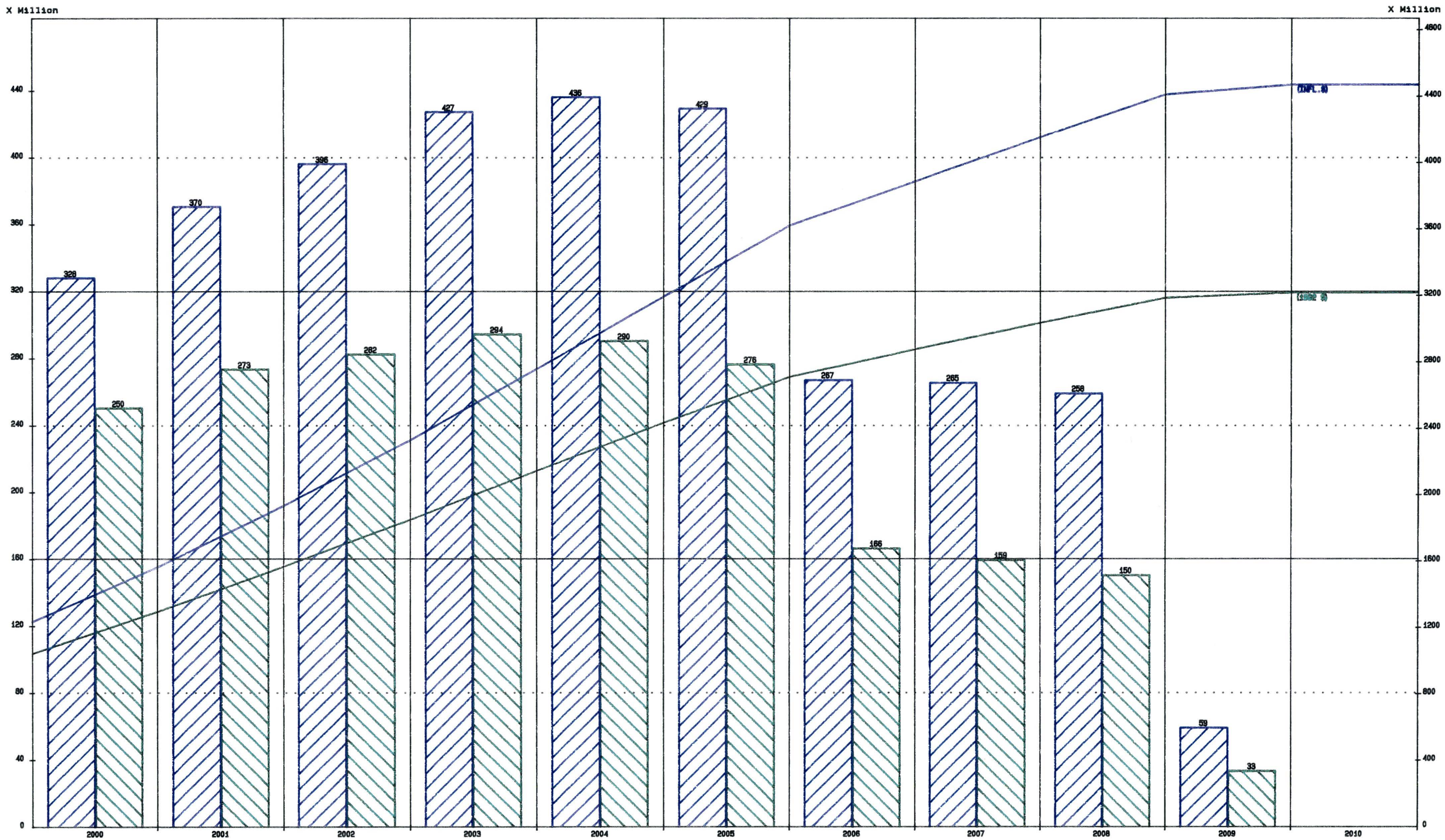

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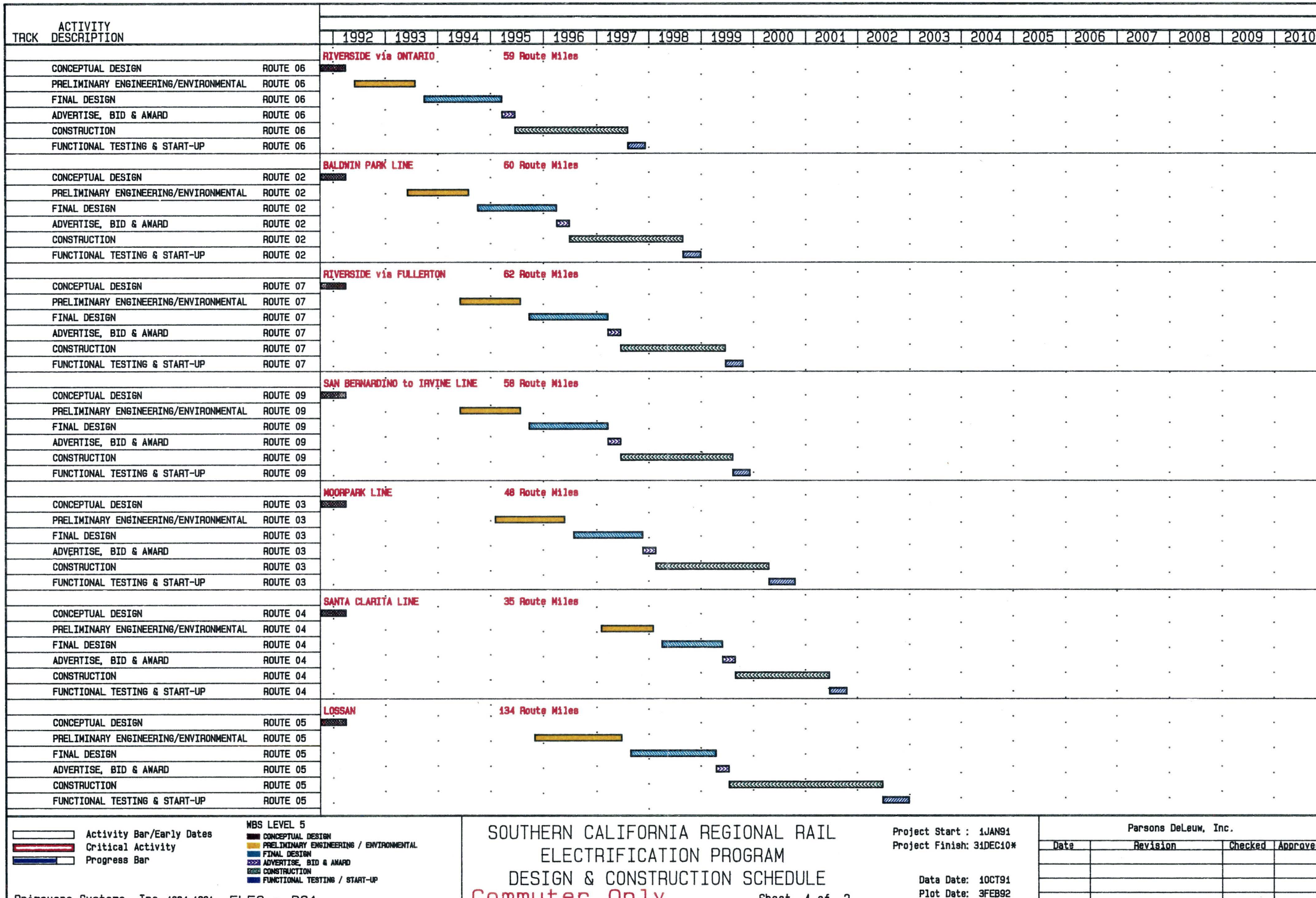
EXHIBIT 7-5, CONTINUED



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SOUTHERN CALIFORNIA REGIONAL RAIL
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Commuter Only

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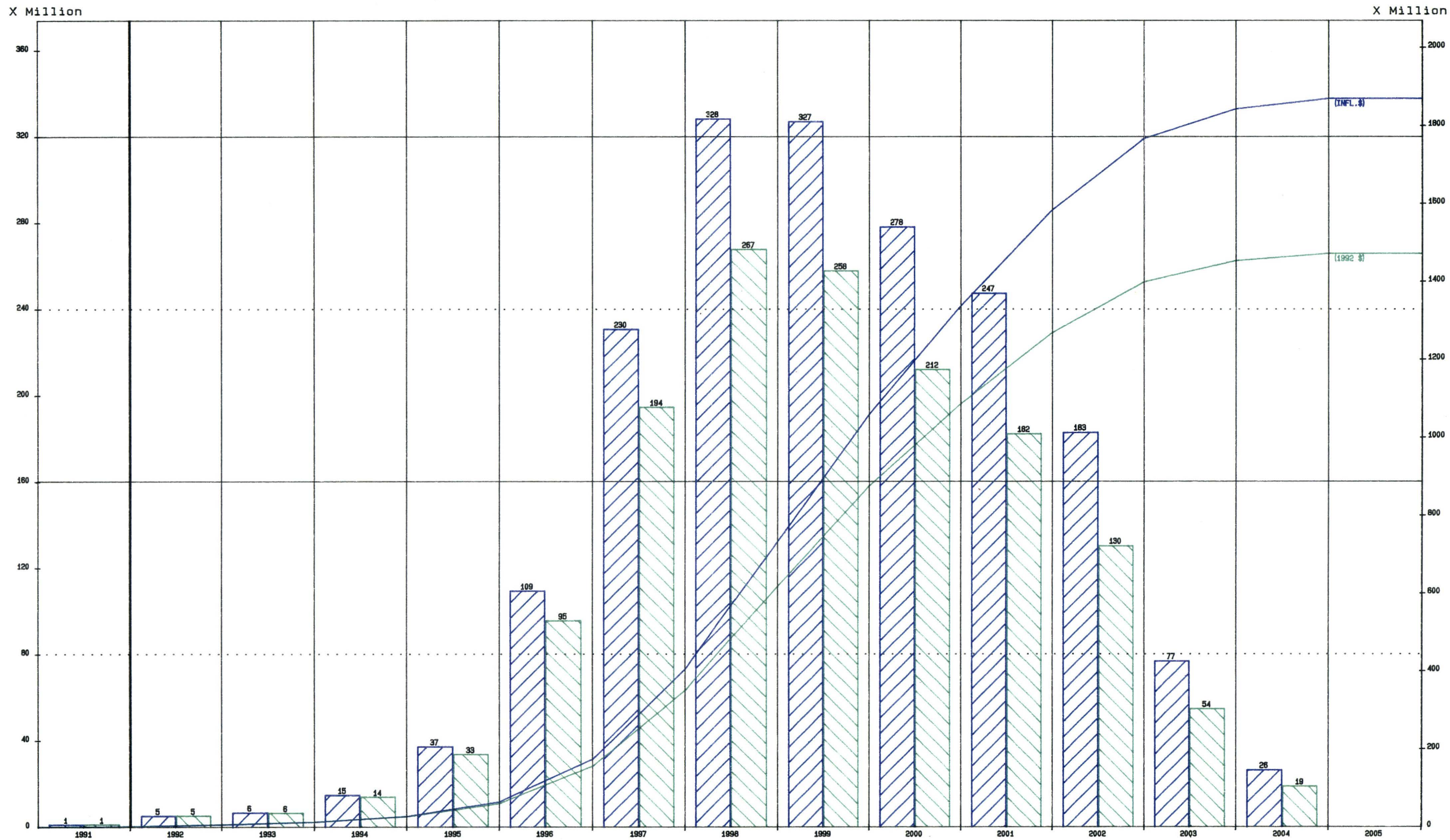
EXHIBIT 7-6



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Constant 1992 dollars.

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SOUTHERN CALIFORNIA REGIONAL RAIL
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EXHIBIT 7-7

8.0 ALTERNATIVE FUELS

8.0 ALTERNATIVE FUELS

8.1 PURPOSE OF SECTION

There are parts of the rail network in Southern California which have been excluded from consideration as candidates for electrification. These include yard and terminal operations, some of which are technically infeasible for electrification (such as intermodal container terminals) and local/light density freight lines. Alternative fuels has been included in this report to provide a means by which to reduce emissions on those portions of the rail network not planned for electrification. In addition, alternative fuels offer a viable opportunity to reduce emissions in the South Coast Air Basin as an interim strategy on commuter rail and freight lines to be electrified in the future.

Natural gas, methanol, clean diesel, and after-treatment devices are discussed in this section regarding their potential toward reducing railroad emissions in the South Coast Air Basin. Supporting technical data and a detailed list of assumptions used in preparing this chapter are included as Appendix 8-1.

8.2 NATURAL GAS

Natural gas is an abundant and secure energy source in the U.S. In addition to these positive attributes, natural gas is relatively inexpensive compared with other conventional fuels and offers the opportunity to reduce exhaust emissions when properly applied to reciprocating engines. The purpose of this section of the report is to discuss the potential for natural gas to provide emissions benefits on railroad applications not being considered for electrification.

8.2.1 Technology

This section discusses the technologies available for converting diesel locomotives to natural gas operation.

8.2.1.1 Design and Operating Characteristics

Locomotive engines operate very differently from highway trucks. This is important to understand since typical conversion techniques for converting diesel truck or bus engines to natural gas operation cannot be applied to locomotive engines directly.

Locomotives are designed with such features as very high output engines, long engine configurations (such as V12, V16, or even V20) and very narrow "V" angles between banks to accomplish their tasks.

In addition to being designed differently from truck engines, locomotives also have much different operating characteristics. They do not operate under transient conditions in the same way on-highway vehicles operate, but rather at eight discrete operating throttle positions (plus idle and dynamic braking modes).

Current railroad engines are optimized for economy not emissions. For example, the 1991 emissions specifications for on-highway trucks requires NOx emissions be below approximately 5 gm/bhp-hr as measured on the Federal Test Procedure (FTP) transient test cycle. By comparison, today's railroad engines provide approximately 9.5 gm/bhp-hr of NOx at full power. Thermodynamically, high engine efficiency comes from providing high combustion temperatures. Unfortunately, these high temperatures produce high NOx emissions.

8.2.1.2 Locomotive Engines and Technology Options

Engines – Two manufacturers produce locomotives in the United States: Electro-Motive Division of General Motors (EMD) and General Electric Transportation Company of General Electric (GE). Both manufacturers build the entire locomotive, including the engine. The locomotive engines produced by these manufacturers generally have a displacement in excess of 10 liters per cylinder. Some of the characteristics of these engines are listed in Table 8-1 below:

TABLE 8-1

U. S. Locomotive Engine Characteristics

Manufacturers	EMD	GE
Cycle	2	4
CID/cylinder	567,645,710	668
Hp/cylinder	200-270	same as EMD
Rated Speed (rpm)	900	1050
Configuration	V8, V12, V16	same as EMD
Cost (approx.)	\$1 – \$2M	same as EMD
Life	500,000 to 1,000,000 miles	same as EMD

Recently, Caterpillar has been reconditioning locomotives used for local yard and switching operations and replacing the original prime movers with 3500 and 3600 series Caterpillar engines.

The EMD locomotive engine is commercially available in diesel configuration only. No commercial natural gas-fueled EMD locomotives have been developed for railroad application. Burlington Northern (BN), one of the four largest railroads in the United States, has recently developed a prototype EMD natural gas burning locomotive. This locomotive uses a small diesel pilot to initiate combustion and reportedly has a very high substitution rate with natural gas. Although no fuel economy or emissions data have been reported for this engine, Burlington Northern has demonstrated the feasibility of running natural gas in a locomotive.

General Electric does not produce natural gas locomotives either. GE recently announced that they are actively pursuing development of a natural gas locomotive and anticipate the first units being available for production within 12 to 24 months. No details on fuel economy or emissions levels have been released from GE at this time.

Technology Options – This portion of the report discusses natural gas engine technology options only. Clean diesel technology options are discussed later in this report. For the purposes of comparison, all emissions reduction in this section and the following sections on clean diesel and after-treatment options are based on the best level of emissions which have been achieved by EMD with the 12-710G3A engine to-date. This is the engine used in the F59PH locomotive. The baseline diesel data which are used throughout this chapter are shown in Table 8-2. These data were obtained from EMD and are believed to represent the lowest achievable emissions levels on today's production locomotives.

TABLE 8-2
Baseline Diesel Emissions and Performance Data

			Emissions (gm/bhp-hr)				Fuel Consumption
Notch	RPM	Bhp	CO	NOx	HC	PM	BSFC (lb_m/bhp-hr)
8	903	3196	1.23	9.51	0.11	0.23	0.35
7	823	2536	1.71	9.36	0.09	0.21	0.35
6	728	1696	0.83	10.71	0.11	0.25	0.36
5	650	1402	0.61	10.93	0.12	0.21	0.36
4	566	1053	0.29	12.01	0.13	0.23	0.36
3	489	717	0.26	13.88	0.17	0.3	0.37
2	342	372	0.34	15.04	0.22	0.31	0.38
1	342	209	0.54	15.94	0.40	0.17	.5
Idle	197	7.8	6.94	114.03	7.02	4	7
DB6	728	64.3	5.02	56.22	3.95	4	3
DB4	566	24.8	9.21	112.96	7.69	4	3
DB1	343	12.3	7.71	114.88	5.72	4	3

There are numerous technologies available for converting diesel truck engines to natural gas operation. Some of the results of these technologies have been reported by various researchers. These results are not directly transferrable to locomotive engines due to the differences in engine design and operating conditions described in the previous section of this chapter.

Data is available regarding the use of natural gas as a fuel in locomotive engines. Perhaps the best available source is SAE paper #87204, referred in Appendix 8-1. Unfortunately, emissions data has not yet been made available from the BN project.

Therefore, the projections for fuel economy and exhaust emissions contained in this report should be considered as preliminary estimates of the effect of converting diesel locomotives to natural gas operation. These estimates are based on published truck engine data and Southwest Research Institute's understanding of the difficulty in applying truck engine data directly to locomotive engines.

Five techniques could be used to convert diesel locomotives to natural gas fuel:

- Dual-fuel (with gas injection after valve or port closure)
- 100 percent gas conversion (with spark ignition)
- Medium pressure, early cycle injection of natural gas
- High pressure, late cycle injection of natural gas
- Re-engine the locomotive with a gas engine.

Dual-Fuel – Dual-Fuel engines are expected to provide approximately 80 percent of full diesel power when operated on pipeline quality natural gas. The power is limited by detonation of the natural gas fuel. Dual-fuel operation also increases fuel consumption by approximately 10 percent while providing 20 percent reduction in NOx emissions. Visible smoke will be reduced significantly with a well-designed dual-fuel system.

100 Percent Gas Conversion – This approach has the potential to reduce NOx by 80 percent from the current diesel baseline. Fuel consumption will be increased a minimum of 20 percent due to the high flow-through characteristics of the fuel which is premixed with the air. The main disadvantage of this approach is a 30 to 40 percent decrease in power and a corresponding penalty on fuel economy.

Medium Pressure, Early-Cycle Injection – This conversion is similar to the dual fuel approach except at a lower compression ratio is used and the diesel pilot is not used as a source of ignition. By reducing the compression ratio and using a natural gas flame as a source combustion, NOx emissions could be reduced by as much as 75 percent compared with baseline diesel. A 25 percent power loss and 5 to 10 percent fuel economy penalty will likely accompany this reduction in NOx. Particulate matter and visible smoke emissions should be reduced at least 80 percent with this system regardless of the power level.

High Pressure, Late-Cycle Injection – The most promising near term technology for converting diesel locomotives is high pressure, late-cycle injection of natural gas. This technology uses gas injection to "make gas burn like diesel fuel." This approach allows the engine to make the same power as the original diesel engine. Fuel consumption penalty is only minor and NOx reductions of 40 percent compared with the original diesel have been reported using this approach. If properly designed, the engine could readily revert back to full power diesel operation if required.

Re-Engine – The option may exist to repower with smaller dedicated natural gas engines from other applications and use these locomotives strictly for yard switcher and local trains which require lower power. Since these engines are now fully developed for natural gas, the expected performance is similar to the 100 percent gas conversion option, except no fuel economy penalty would be expected.

The following assumptions have been made for the purposes of calculating the air quality benefits and cost-effectiveness of natural gas-powered trains. First, the early-cycle injection, precombustion chamber gas engine was chosen for further comparison with the baseline diesel engine since it represents the full potential for emissions reduction with natural gas. The relative differences in fuel economy and emissions of the gas locomotive compared with the diesel baseline are shown below:

TABLE 8-3

Assumptions for Gas Locomotive Performance

Compared with Baseline Diesel Locomotive

Emissions	Reduction with Gas
NOx	75 percent
PM	80 percent
Fuel Economy	(5 percent)*

* Increase in fuel economy over gas engine assumed to be 5 percent of diesel baseline.

Power for the gas locomotive was assumed to be equal to the baseline diesel locomotive for the purposes of this study.

8.2.1.3 Fueling Logistics

Several scenarios have been studied for refueling and storing natural gas fuel for alternative fueled trains. These scenarios include storing the fuel as compressed natural gas (CNG) or as liquified natural gas (LNG). Within the categories of CNG and LNG, numerous strategies are possible to improve fueling logistics and reduce capital and operating costs. The options available for each of the various scenarios are discussed in detail in Appendix 8-1, a report entitled "Feasibility of Natural Gas Powered Commuter Trains in the L.A. Basin."

Based on the study included in the referenced appendix, it appears that CNG offers the most cost effective approach for storing gas on trains and refueling them when the operating range of the train is less than 150 miles per day. In other terms, daily fuel consumption of less than 500 gallons of diesel fuel should allow sufficient CNG tanks to be stored on a locomotive to provide a full day's operation without refueling.

If additional operating range is required, a switch from CNG to LNG fuel storage will probably be required. LNG plants could be located at strategic points within the railroad system in order to provide maximum refueling access to alternative fueled trains.

8.2.1.4 Compressed Natural Gas (CNG) and Liquified Natural Gas (LNG) Technologies

Compressed Natural Gas – One method for storing the fuel on-board locomotives is as a compressed gas.

Tank Requirements – Comdyne I, Inc. (located in West Liberty, Ohio) manufactures a CNG tank with a capacity of 2,800 standard cubic feet (SCF) of gas at 3,600 psi. This tank has a length of 8.5 feet and a diameter of 19 inches. After studying the dimensions for an EMD F40PH locomotive (which is smaller than the F59PH), it appears that 24 tanks can be installed on the locomotive. This quantity of CNG tanks would allow the locomotive to carry 480 gallons diesel equivalent of natural gas on-board the locomotive.

Compressor Requirements – Two scenarios exist for refueling the trains with CNG. For road operations, passenger or freight, two compressors could be located on each route. For switching operations one refueling compressor station could be located at a central location within a switching yard. The required capacity and costs of these compressors are included in the study provided Appendix 8-1.

Liquified Natural Gas – Maintaining the fuel in its liquid state is a second fuel storage method. For liquified natural gas (LNG), the energy density is substantially better than CNG. Moreover, the LNG tank volume capacity requirements are only half that of the CNG scenario. Therefore, it is apparently possible to increase operating range by storing the fuel as LNG.

8.2.1.5 Safety-Related Issues

SwRI recently conducted a worldwide literature search and industry survey to determine the safety record of natural gas vehicles (NGVs). Data was collected which represented over 7,100 NGVs that had traveled a total of over 434 million miles and compared with the National Fleet Average for Gasoline Vehicles in the U.S. The results of this study indicate a remarkable safety record for natural gas. Not one single incident was identified where natural gas contributed to the death of even one person. On the other hand, there were a large number of deaths which were attributed to gasoline as an on-board fuel.

The primary safety issue with natural gas as a railroad fuel is not a technical issue, though certain guidelines must be followed for equipment design and fuel handling. The big problem is public perception. Although natural gas is widely accepted for use in homes where leaking gases cannot escape as easily as in the case of vehicles, there is a public resistance to placing CNG on vehicles.

Los Alamos National Laboratory has recently completed an in-depth safety study addressing natural gas as a railroad fuel. The Los Alamos study has just reached the public domain and is referenced in Appendix 8-1. Further, the Los Alamos study is expected to provide a more scientific basis for evaluating the safety-related issues of gas as a railroad fuel.

8.2.1.6 Implementation Schedule

SwRI is currently working to develop a natural gas fueled locomotive engine. Based on the status of technology with that engine in the laboratory, and information on other natural gas locomotive engine programs, we anticipate a limited number of gas fueled locomotive engines will be available in mid-1993, with substantial numbers of locomotive engines being available for implementation in 1994.

8.2.2 Air Quality

8.2.2.1 Emission Characteristics

Due to the very low levels of HC and CO emissions on the baseline diesel locomotive (see Table 8-2), no reduction in these pollutants is expected from conversion to natural gas. Non-methane hydrocarbons will be equal to, or greater than, the baseline diesel HC emissions depending on the gas engine technology used. CO emissions should be approximately equal for the natural gas and diesel engines.

The emphasis of the air quality analysis is on NOx emissions. Particulate emissions will be reduced dramatically with natural gas, but their overall contribution to the South Coast Air Basin air pollution problem is considered negligible compared with NOx emissions. HC and CO emissions are not discussed any further due to the small difference between natural gas and diesel locomotives.

As mentioned before, natural gas locomotives have the potential to reduce NOx emissions by as much as 75 percent and particulate emissions by approximately 80 percent. Fuel economy penalties of approximately 5 percent would be experienced by the natural gas locomotive compared with the baseline diesel locomotive.

8.2.2.2 Emissions Reduction (Tons/Passenger)

Actual emissions reduction in terms of NOx tons per year (or cumulative tons NOx) have not been estimated due to the uncertainty of which switching and local yard operations would be candidates for natural gas fuel. However, the data in the Appendix 8-1 provide detailed information on the effect of converting diesel locomotives to natural gas with regard to emissions reduction for commuter train operations.

8.2.3 Cost Analysis

This study addresses two primary costs: the capital cost required to install natural gas rail service in the South Coast Air Basin, and the associated operating and maintenance costs. Due to the relatively simple planned commuter rail operating patterns and the relatively complex current yard and local freight operating patterns in the South Coast Air Basin, a cost analysis is prepared for commuter rail applications only.

8.2.3.1 Capital Costs

Diesel

The primary capital cost associated with diesel commuter rail service is the cost of the locomotives themselves. These locomotives are estimated to cost approximately $2M each when purchased from the Electro-Motive Division (EMD) of General Motors in a quantity of 17 locomotives (such as those to be delivered in mid-1992). These locomotives will be rated at 3000 hp and used to initially establish three commuter rail routes. Current plans call for 12 of these locomotives to be used on three commuter lines, which will allow three locomotives to be used for back-up service (one each for each commuter line). Two spare locomotives will be available for miscellaneous requirements.

The required servicing/refueling facilities are the only capital cost, in addition to the locomotive itself, which would be different for diesel and gas. All other capital items are identical and accordingly, are omitted from the analysis.

Natural Gas

When natural gas is used as a means of reducing the emissions from trains, additional capital costs will be incurred compared with the diesel baseline. Additional capital costs for the natural gas trains include the following:

(1) New engine (or combustion systems) to allow the locomotive to operate on natural gas fuel

(2) CNG or LNG fuel storage tanks on-board the train

(3) New refueling infrastructure (CNG or LNG).

Several combustion systems could be applied to the diesel engine to operate on natural gas. These combustion systems are discussed in more detail in the Technology section, but will also be discussed here for the purposes of the cost analysis.

The least expensive gas combustion system would be a dual-fuel system. SwRI estimates that a dual-fuel system could be designed and installed on the EMD12-710G3A locomotive engines for approximately $250,000 per locomotive.

The next level of complexity would include the removal of the diesel fuel injection system and replacement with a spark ignition combustion system. This type of combustion system should be achievable using existing gas engine technology at a cost of approximately $500,000 per locomotive depending on the level of sophistication of the engine control system.

A third option to convert the diesel locomotive to natural gas is early-cycle injection of the gas. This system will require a reduction in compression ratio and retrofit with an ignition system and precombustion chamber. This type of combustion system will require substantial development on a locomotive engine and is expected to increase the original diesel locomotive cost by approximately $500,000.

Finally, the most promising near term natural gas combustion system involves the direct injection of natural gas into the cylinder under very high pressure similar to the diesel fuel injection system. This combustion system is currently under research and has been applied to large bore engines, but has not yet been commercially used in locomotives. This combustion system will require optimization of the fuel injection system and combustion process. Once this technology is available, an estimated retrofit cost of $150,000 to $300,000 per locomotive is considered possible for this combustion system.

One other possibility exists for the use of natural gas as a fuel in trains. Generation II Locomotive (Minneapolis, Minnesota) has developed a successful engine retrofit for GP-15 through GP-30C locomotives. This retrofit includes the complete renovation of the locomotive and re-engining with a Caterpillar 3516 diesel engine rated at just over 2,000 horsepower. Retrofitted locomotives from Generation II Locomotive range in cost from $800,000 to $900,000 in diesel configuration. However, since low emissions, lean-burn, natural gas combustion and control systems already exist for the 3500 series Caterpillar stationary engines, a remanufactured locomotive could be obtained from Generation II Locomotive operating on natural gas at an estimated cost of approximately $1.5M.

Several options exist for locating fuel storage tanks on the trains to store liquified natural gas (LNG) or compressed natural gas (CNG). For LNG, the existing diesel fuel tank can be removed and replaced with a 600 gallon capacity LNG fuel system. This fuel system would include three LNG tanks. Each tank would have a capacity of over 200 gallons LNG at a cost of approximately $7,500 each. Thus, the LNG fuel tank costs for each train would be in the range of $25,000. This fuel storage approach allows fuel to be stored on the locomotive and does not require a fuel tender or additional rail car for carrying fuel. For CNG, roughly twice the storage volume of LNG will be required which will make storage of CNG on a locomotive more difficult. The cost for an equivalent on-board fuel storage capacity using CNG tanks is approximately $48,000 per train.

Please note that CNG is considered a viable option for fuel storage on local yard and switching operations. However, due to the operating range required, LNG appears to be the only feasible choice for rail freight applications. Air Products & Chemicals, Inc. has recently designed and built a prototype 20,000 gallon LNG fuel tender for rail applications. The purchase price of similar LNG tenders is expected to be in the range of $275,000 – 325,000.

In today's fast moving alternative fuels environment, the options for buying or leasing refueling stations is virtually unlimited. For LNG, several options are available. One option includes shipping LNG from existing liquefaction plants in Sacramento, Reno, or Las Vegas. The capital costs associated with this approach include the purchase of on-highway tankers which are expected to cost $350,000 each for a capacity of 10,000 gallons of LNG. An alternative approach toward LNG fuel supply would be to install one or more central liquefaction plant(s) in the Los Angeles Basin to supply LNG for the natural gas trains. The capital cost to install a reliable liquefaction plant is on the order of $5M to $50M.

For CNG, relatively inexpensive slow-fill compressor stations could be installed at each rail yard to fill the locomotive's fuel tanks overnight. This would be viable for local freight or commuter rail locomotives which are not utilized for long periods of time, often at night. It is less viable for yard locomotives which may operate at any hour. The cost of a 150 SCFM CNG compressor is in the range of $225,000 and could be expected to provide a sufficient gas supply for five or more locomotives.

A comparison of the capital costs applicable to interim use on SCRRA commuter trains is provided in Table 8-4.

TABLE 8-4

Capital Cost Assumptions

SCRRA Commuter Trains		
Fuel	**Locomotive (each)**	**Refueling (per Route)**
Diesel	$2M	n/a
Gas*	$2.5M	$1.1M (LNG) $300,000 (CNG)

* Natural gas fuel tanks will also be required for gas. LNG tanks are estimated to be approximately $25,000 per train. CNG tanks are expected to be approximately $48,000 per train.

8.2.3.2 Operations and Maintenance Costs (O&M)

Diesel

Diesel locomotives have three major operating costs. The first cost is diesel fuel and oil consumption. Today's low sulphur diesel fuel costs approximately $0.75 per gallon in the South Coat Air Basin. The future cost of low aromatic diesel fuels is uncertain. The second cost is operating labor, which should be approximately the same for each of the rail services whether it be diesel or gas. Accordingly, labor costs will not be addressed in this analysis. The third cost is maintenance. The maintenance characteristics of the diesel and gas locomotive are expected to be different and are identified in the cost comparison.

CALTRAIN operates a diesel commuter rail service from San Jose to San Francisco. This commuter service is considered to be very similar to the service planned for the South Coast Air Basin. CALTRAIN officials indicate that their annual maintenance costs are approximately $37,500 per locomotive. On average, each of these locomotives travels 35,000 miles per year, resulting in an average maintenance cost of $1.07/mile. This cost includes all service and repair of the diesel locomotives.

Based on the CALTRAIN data an annual diesel maintenance cost of $37,500 per commuter locomotive was assumed.

Natural Gas

The natural gas fuel costs depend on whether LNG or CNG fuels are used. The refueling station will also have an impact on the cost to refuel the trains. For example, if LNG is brought in by tractor trailer from a remote location (e.g., Sacramento) it will cost about $0.52 per gallon (i.e., $0.91 per diesel equivalent gallon). In the case of CNG, there are many different scenarios which could be considered.

SoCal Gas has recently obtained preliminary approval of their NGV fuel rates. These fuel rates differ dramatically depending upon whether or not SoCal Gas supplies the refueling station at the operator's facility. Other factors include whether the user purchases its own gas from the field and contracts with SoCal Gas to transmit the fuel or whether it leaves the purchase of the gas and transmission up to SoCal Gas. Looking at the two extremes, if the train operator depends on SoCal Gas to procure and transmit the gas to their location and compress the gas to approximately 3,000 to 3,600 psi for refueling operations, then the operator can expect to pay approximately $5.50 per MCF of natural gas. On the other hand, if the operator decides to go out and purchase the gas from the field and contract with SoCal Gas to transmit the fuel, they will only be charged $0.50 per MCF by SoCal Gas. The operator will then be faced with a fuel origination cost of abut $2.00/MCF and the responsibility of installing its own compressor at its site for refueling the CNG storage tanks. Preliminary calculations indicate that the pay back period for an operator-owned compressor station is about two to three years compared with buying fully compressed gas from SoCal Gas. Therefore, we based the cost analysis on the assumption that the operator will purchase the refueling station and pay a delivered cost of $3.50/MCF for the gas. The gas cost could be reduced to $2.00/MCF for long-term contracts, but $3.50/MCF has been used for all CNG calculations.

Additional maintenance costs will be incurred for the LNG fuel system to assure that the fuel composition in the LNG tanks does not change over extended periods of time. These issues and the relevant costs used in this analysis are discussed in the Fueling Logistics section of Appendix 8-1. The additional maintenance cost to periodically drain and otherwise maintain the LNG tanks is estimated to be in the range of $17,500 per train per year. The maintenance costs will be lower for the CNG fuel system than for LNG. An additional $7,500 per train per year is expected to maintain the refueling stations for CNG compared with diesel maintenance costs. The locomotive engine maintenance costs for the CNG and LNG are expected to be approximately the same as the diesel-fueled locomotives in terms of major failures and engine rebuilds. This cost assumes that the spark plug and ignition system maintenance for the gas engine will be offset by the reduced number of engine rebuilds due to a cleaner burning engine (i.e., fewer carbonaceous deposits) and the elimination of the diesel fuel injection system.

Basic assumptions for calculating operating and maintenance (O&M) costs for the two fuels are summarized in Table 8-5.

TABLE 8-5

O&M Cost Assumptions

Fuel	Fuel Cost	Annual Maintenance Cost (per Locomotive)
Diesel	$0.75/gallon	$37,500
Gas	$0.52/gallon (LNG) $3.5/MCF (CNG)*	$55,000 $45,000

* Does not include compression costs.

8.2.3.3 Financial Cost Effectiveness

The financial cost effectiveness was calculated for SCRRA Commuter Rail trains operating on diesel and natural gas. Financial cost effective calculations were based on intermediate service for each fuel. For the purposes of cost comparisons, operation on 100 percent diesel and 100 percent natural gas was assumed. All financial calculations were based on the assumptions for capital costs and O&M costs outlined in Tables 8-4 and 8-5.

Table 8-6 shows the average financial cost effectiveness for diesel and natural gas trains based on capital costs.

TABLE 8-6

Financial Cost Effectiveness for

South Coast Air Trains Based on Capital Costs

Fuel	($) Capital Cost/Passenger	($) Capital Cost/Passenger-Mile
Diesel	0.98	0.013
Gas	1.27	0.017

As Table 8-6 illustrates, the financial cost effectiveness is approximately 30 percent worse for natural gas compared with diesel trains on a capital cost per passenger basis. Likewise, the capital cost per passenger-mile cost effectiveness is about the same amount higher for natural gas.

Table 8-7 shows the calculated financial cost effectiveness for natural gas and diesel trains based on operating and maintenance costs.

TABLE 8-7

Financial Cost Effectiveness for

South Coast Air Basin Commuter Trains Based on O&M Costs

Fuel	($) O&M Cost/Passenger	($) O&M Cost/Passenger-Mile
Diesel	0.36	0.004
Gas	0.37	0.004

The data in Table 8-7 illustrates that natural gas is equally cost effective as diesel on an operating and maintenance cost basis.

8.2.3.4 Air Quality Cost Effectiveness

Based on results of this study natural gas has the potential to achieve a positive air quality cost effectiveness. Our calculations indicate an average NOx emissions reduction cost of approximately $6,500 per NOx ton per year for natural gas.

8.2.4 Environmental

Natural gas is expected to offer several advantages regarding general environmental characteristics compared with diesel. For example, combustion noise from a natural gas engine is typically lower than that of the original diesel engine, thereby, reducing overall engine noise. Likewise, engine vibration is normally reduced to some extent when converting from diesel fuel to natural gas fuel. A visual improvement in using natural gas will also occur due to the virtual elimination of visible smoke from the engine's exhaust.

8.2.5 Funding

8.2.5.1 Level of $ Required

A minimum of $1M is likely to be necessary to demonstrate the feasibility of natural gas on a small commuter rail, local yard, or switching train operation. As mentioned above, this level of funding may be available through the Petroleum Violation Escrow Account combined with RCTC or other local sources.

8.2.5.2 Funding Opportunities

Funding from DOE, SCAQMD, the utilities, railroads, and locomotive manufacturers are possibilities for the demonstration of an alternative fueled train.

8.2.5.3 Potential for Rate Treatment

The potential for recovery of an investment in the increased capital cost of natural gas-fueled locomotives, through rate treatment, is uncertain at this time.

8.2.6 Key Issues

One of the main issues regarding natural gas trains includes safety and regulatory approvals which may be required at the state and federal level. Several key safety studies will be available in the very near future to help evaluate these issues. Additional studies need to be made regarding regulatory requirements for fueling locomotives with CNG and LNG both as an on-board fuel for the locomotive and in the form of an LNG fuel tender for freight applications. Burlington Northern and Air Products, Incorporated have overcome many of these obstacles but additional study will be required for application of natural gas to railroad use in California.

8.3 METHANOL/AVOCET

As a liquid fuel made from natural gas, methanol has two attributes which make it of special interest to both LACTC and railroad companies.

- It offers a cost effective clean fuel technology very similar to diesel fuel in terms of infrastructure and operations, so that potentially disruptive and costly changes to engine and fuel storage/supply systems are minimized.
- With ignition improvers such as Avocet, existing diesel locomotives can be converted to clean efficient operation on methanol, so that the entire rolling stock can be operated on the same fuel system-wide.

8.3.1 Technology

8.3.1.1 Design and Operating Characteristics

Converting an internal combustion diesel engine to operate on methanol with a cetane improver utilizes current design internal combustion compression ignition engines with modifications to cylinder components, fuel and air systems. These modifications are based on the requirement for twice as much fuel delivery, and to increase cylinder temperature and reduce air flow to operate on as little Avocet as possible. Although neither EMD nor GE locomotive prime movers have yet been tested with Methanol as a fuel, a program demonstrating similar technology is underway at the Southern California Rapid Transit District (SCRTD) on twelve transit buses. This project (acronym MASSCAR) has demonstrated the feasibility of using ignition improver technology to retrofit an existing fleet of transit buses to operate on a blend of Methanol/Avocet as fuel.

8.3.2 Locomotive Engines and Technology Options

8.3.2.1 Conversion of a 12/710G3A EMD Engine

An EMD engine would require the following modifications to operate on methanol:

- <u>Pistons</u> – Change compression ration from 16:1 to 18:1; reduces Avocet percentage required.
- <u>Fuel System</u> – Modify fuel injectors from 9/16" to 5/8" plungers and harden components for methanol exposure. Install electric fuel transfer pump and methanol filters with fuel cooler.
- <u>Air System</u> – Turbocharger clutch ratio changes required.

9.0 LEGAL/LEGISLATIVE ISSUES

9.0 LEGAL/LEGISLATIVE ISSUES

The context within which electrification of regional rail services would occur is complex, involving a multiplicity of public and private agencies and organizations, and responding to a variety of procedural requirements. This chapter reviews the key legal and institutional factors which would have to be considered in the electrification of regional rail services. Five types of factors are discussed:

- Roles and Responsibilities of Participating Agencies, Utilities, and Railroads
- Rights for Access to Privately Owned Rights-of-Way (Existing and Future)
- Environmental Documentation Requirements
- Federal, State, and Local Control over Railroad Emissions
- Potential Institutional Structures.

In addition, pending and potential future legislation is considered.

9.1 ROLES OF PARTICIPATING AGENCIES, UTILITIES, AND RAILROADS

A variety of participating agencies, utilities, and railroads could be involved in electrification of regional rail service. Included are local, regional, state, and federal agencies, investor-owned and municipal utilities, and the private railroads.

In the sections below, the key roles and responsibilities of 22 entities or types of entities are reviewed. These agencies are involved in a variety of functions, including planning, funding, and regulatory reviews and approvals related to safety, rail operating access, financing, and environmental and air quality conformance.

Improvement of air quality in the Basin is the primary impetus for rail electrification. The federal Clean Air Act (CAA) requires that states develop state implementation plans (SIPs) which identify the measures the state will use to meet air quality standards mandated by the CAA. Under the CAA, regional agencies (SCAG and SCAQMD), must develop the required measures to be followed to attain air quality standards. These regional air quality management plans (AQMPs) are incorporated into the SIP and submitted to the EPA for approval. Rail electrification is one of the measures included in the AQMP.

Table 9-1 summarizes the areas of responsibility related to railroad electrification. Those agencies considered to be of key interest are:

- Southern California Regional Rail Authority
- Southern California Association of Governments
- South Coast Air Quality Management District
- California Transportation Commission
- California Air Resources Board
- California Public Utilities Commission
- California Department of Transportation

TABLE 9-1

Agency Roles and Responsibilities in Rail Electrification

Agency	Planning	Funding	Regulatory: Safety	Regulatory: Operating Access	Regulatory: Financial (1)	Regulatory: Environmental
Southern California Regional Rail Authority	X	X				
Southern California Association of Governments	X				X	X
South Coast Air Quality Management District		X				X
California Transportation Commission					X	
California Air Resources Board						X
California Public Utilities Commission			X		X	X
California Department of Transportation	X	X			X	X
California Environmental Protection Agency						X
California Coastal Commission						X
U.S. Environmental Protection Agency						X
Interstate Commerce Commission				X	X	X
Federal Railroad Administration			X		X	
Federal Transit Administration		X			X	X
National Railroad Passenger Corporation (Amtrak)		X				
Private Railroads	X	X	X	X		
Investor-Owned Utilities	X	X				
Municipal Utility Districts	X	X				
Los Angeles-San Diego Rail Corridor Agency	X				X	
San Diego Association of Governments	X	X			X	X
Metropolitan Transit Development Board	X	X		X		
North San Diego County Transit Development Board	X	X				
Local Jurisdictions			X	X	X	X

1. Includes regulation of the issuance of securities by the private railroads, review and approval of applications for rate-based financing, and review and approval of applications for federal and state funds.

- California Environmental Protection Agency
- California Coastal Commission
- U.S. Environmental Protection Agency
- Interstate Commerce Commission
- Federal Railroad Administration
- Federal Transit Administration
- National Rail Passenger Corporation (Amtrak)
- Private Railroads
- Investor-Owned Utilities (Southern California Edison)
- Municipal Utility Districts
- Los Angeles-San Diego Rail Corridor Agency
- San Diego Association of Governments
- Metropolitan Transit Development Board
- North San Diego County Transit Development Board
- Local Jurisdictions.

As electrification of rail services in the South Coast Air Basin could potentially extend to areas outside the Basin, a variety of other agencies and organizations would likely be involved as well. To the north, these include the Ventura Air Pollution Control District, Santa Barbara Air Pollution Control District, and Santa Barbara City-County Association of Governments. To the east are the desert areas of San Bernardino County that are within the Southeast Desert Air Basin, as well as the Arizona Environmental Protection Agency. Agencies to the south in San Diego County are currently participating in this study, and have been included in the descriptions below. In addition, a wide range of agencies have statutory authority for particular resources. For example, U.S. Fish and Wildlife Service and the Department of Fish and Game would have statutory authority over projects involving endangered species; the Corps of Engineers would have authority over wetlands; while other projects could involve agencies including the State Historic Preservation Office, the Bureau of Indian Affairs, the U.S. Forest Service; the U.S. Air Force, Navy or Marines; and the Bureau of Land Management.

9.1.1 Southern California Regional Rail Authority

The Southern California Regional Rail Authority (SCRRA) is a 5-county joint powers authority (JPA) comprised of the Los Angeles County Transportation Commission (LACTC), Orange County Transportation Authority (OCTA), Riverside County Transportation Commission (RCTC), San Bernardino Associated Governments (SANBAG), and Ventura County Transportation Commission (VCTC), with ex-officio membership by the San Diego Association of Governments (SANDAG), Southern California Association of Governments (SCAG), and State of California.

SCRRA's purpose is to advance the planning, design and construction, and then administer the operation of the Metrolink regional passenger rail lines serving the multi-county area. A main objective of the SCRRA is to improve regional mobility through provision of commuter rail service, while enhancing air quality. Nine initial commuter rail routes are proposed, with the first three lines to begin operation by October 1992. Lines scheduled to begin operation in October 1992 are:

- San Bernardino to Los Angeles
- Moorpark (Ventura County) to Los Angeles
- Santa Clarita to Los Angeles.

SCRRA member counties secured the rights to own and/or operate commuter rail service on these lines from the Southern Pacific Transportation Company in 1991. Construction of the regional maintenance facility and capital improvements on these lines is presently underway; rolling stock will begin delivery in the spring of 1992; and the operator of the system has been selected.

The six commuter lines to follow shortly thereafter are:

- Riverside to Los Angeles via Ontario (UP)
- Orange County to Los Angeles
- Riverside to Los Angeles via Fullerton (ATSF)
- San Bernardino-Riverside-Irvine
- Hemet to Riverside
- Redlands to San Bernardino.

These lines are proposed to operate over rights-of-way presently owned by the Union Pacific Railroad and Santa Fe Railway Company. Negotiations have been completed with the Union Pacific and are in progress with the Santa Fe.

SCRRA is staffed by LACTC's Commuter Rail section. In addition, LACTC provides administrative functions for the SCRRA, including processing of applications for state funding. The SCRRA is funded by its five member counties based on multi-county cost sharing formulas for capital, as well as operating and maintenance costs.

9.1.2 Southern California Association Of Governments

The Southern California Association of Governments (SCAG) is responsible for planning of long-term transportation, housing, and land use within the region. SCAG prepares the Regional Mobility Plan, the Transportation Control Measures (Appendix IV-G) of the Air Quality Management Plan (AQMP), and the Regional element of the State Transportation Improvement Plan (STIP). SCAG's responsibilities include making conformity determinations of transportation programs with the SIP.

In the 1989 and 1991 AQMPs, SCAG prepared two measures pertaining to railroads and electrification:

- Transportation Control Measure 14, dealing with electrification of rail operations, and
- Transportation Control Measure 2g, which calls for implementation of commuter rail service as part of a larger transit strategy.

The former is considered a "Tier 2" measure in the 1991 AQMP, for which technological, financial, and institutional constraints must be overcome to proceed with implementation over the long term. The latter is a "Tier 1" measure, considered capable of being implemented currently.

The 1979 Plan included railroad electrification as Measure H-11, Electrify Railroad Switching Yards. This measure would have replaced most diesel locomotives in railroad classification and switching yards with electric locomotives powered by overhead wires; to be included were yards at Colton, East Los Angeles, and in Wilmington/Carson; and terminal railways including the Ventura County Railway (Pt. Hueneme) and the Harbor Belt Line in the Ports of L.A. and Long Beach. It was estimated that railroad emissions in these yard areas would be reduced by 75%; 1987 emissions reduced by category would have been 4.4 tons/day for hydrocarbons, 7.3 for CO, and 17.7 for NOx.

The 1982 Plan included Measure M8, Electrification of Railroad Line Haul Operations. The implementation date was to have been 1985. The measure was to have reduced NOx, ROG, and CO by 17.7, 4.7, and 7.3 tons/day, respectively, in 1987. At that time, in anticipation of a major increase of coal traffic through the ports, and in an effort to implement Measure M8, the SCAQMD proposed to consolidate all rail freight traffic from the Ports of L.A. and Long Beach through East Los Angeles and Colton to the Cajon Pass on a single electrified rail line.

9.1.2.1 Role in Railroad Electrification and Air Quality Management

The 1989 Air Quality Management Plan (AQMP) included Railroad Electrification as Transportation Control Measure (TCM) 14. This measure requires reduction of 90% of the rail emissions in the Basin through electrification by 2010. Under Tier 1, SCAG and the South Coast Air Quality Management District (SCAQMD) are to conduct a detailed feasibility study of railroad electrification in 1991 – 1992, and the railroads are to proceed with engineering, environmental clearance, and funding for a pilot project from 1993 – 1995. Under Tier II, the railroads are to construct a pilot project from 1996 – 1998, and expand electrification to other lines from 1999 – 2010. This measure could reduce Reactive Organic Gases (ROG) by 8.9 tons/day and NOx emissions by 34.9 tons/day by 2010.

Even though Measure 14, Railroad Electrification, still remains a part of the 1991 AQMP, the measure has been modified to involve additional agencies. Specifically, the AQMP proposes that the Environmental Protection Agency (EPA) and Federal Railroad Administration (FRA) conduct a detailed study of railroad electrification by 1995; and consistent with Environmental Protection Agency (EPA) direction, that the FRA require electrification by 2010 of 90% of rail freight operations in the Basin, including railroad main lines and the Alameda Corridor. These proposed roles for EPA and FRA have not yet been accepted by these agencies. This could reduce Reactive Organic Gases (ROG) by 0.2 tons/day by 2000, and 1.17 tons/day by 2010 (17% of the 90% emissions reduction would be achieved by 2000). In addition, NOx emissions would be reduced by 5.4 tons/day in 2000 and 28.7 tons/day in 2010.

Ten lines are listed in the 1991 AQMP as candidates for electrification, but it is not specified whether all would actually be electrified. Achievement of air quality goals is based on electrification of 90% of railroad freight ton-miles, and not on conversion of all of the candidate lines listed. Alternative fuels are mentioned as a candidate for replacing diesel fuel for terminal, switching, and branch line operations. The detailed feasibility study of railroad electrification will include commuter rail operations.

9.1.2.2 Role in Transportation Planning

As the federal and state designated transportation planning agency for the region, SCAG prepares the Regional Mobility Plan (RMP), also known as the Regional Transportation Plan. The most recent RMP, adopted in 1989, provides short and long range strategies and actions to address transportation problems. Commuter rail, as part of a larger transit strategy (TCM 2g), was included for the first time in the 1989 RMP and earmarked for early implementation.

State and federal law also mandate that SCAG has responsibility for the development, in cooperation with the county transportation commissions, and approval of a 5 – 7 year Transportation Improvement Program (TIP). The TIP identifies federal, state, and locally financed transportation programs for the specified time period. The 1991 – 1997 TIP calls for the development of five commuter rail lines.

9.1.2.3 SCAG and Conformity Findings

As the federally designated Metropolitan Planning Organization (MPO) for the region, SCAG is responsible for determining conformity of the RMP, the TIP, and other transportation plans and programs with the SIP. Conformity is the process by which SCAG ensures that implementation of the transportation control measures of the SIP is on schedule. SCAG made its conformity determination of the 1991 – 1997 TIP on September 5, 1991. Federal approval of the TIP was given on November 15, 1991.

Under EPA guidelines, SCAG is required to examine the emission impacts of the projects in the TIP and determine whether they conform to the emissions reduction for all relevant pollutants identified in the SIP. In this conformity analysis SCAG included estimates of temporary short-term increases in oxides of nitrogen (NOx) from the interim use of diesel locomotives on commuter trains, as well as reductions in carbon monoxide and hydrocarbon which will result from people changing their mode of transit. The analysis showed that the program met the required reductions and conforms under federal guidelines.

Once a TCM is promulgated in an applicable State Implementation Plan (SIP), the statute requires the MPO and federal agencies to determine the conformity of any project or plan with the applicable SIP.

9.1.2.4 Expeditious Implementation of Transportation Control Measures

Implementation of TCMs is required to demonstrate conformity of transportation plans, programs and projects with the SIP. If conformity of transportation plans, programs and projects cannot be demonstrated, they will not receive financial assistance, licenses or other approvals from any department or agency of the federal government. To date, SCAG, in its capacity as MPO, has found that the regional commuter rail program identified in the 1989 Regional Mobility Plan and in the 1989 AQMP as Transportation Control Measure 2g is on schedule as is the rail study required under TCM 14 of the 1989 AQMP. The fiscal year 1991 – 1997 TIP has recently been found to be in conformance by SCAG, EPA and DOT. SCAG states that delaying implementation of commuter rail for electrification could subject the region to federal sanctions for failure to expeditiously implement TCM 2g. These sanctions may include disapproval of the RTIP and withholding of federal transportation funds for the region and/or the state.

9.1.3 South Coast Air Quality Management District

The South Coast Air Quality Management District (SCAQMD) was statutorily created in 1976. The legislative intent in forming the District was to integrate the responsibilities of local and regional authorities with respect to air pollution control and air quality management plan adoption into one agency with Basin wide authority. This agency, governed by representatives of county and city governments and the State Legislature and the Governor, was charged with implementing a comprehensive program for achieving and maintaining state and federal ambient air quality standards in the South Coast Air Basin. (Health and Safety Section 40402(f))

The Legislature further empowered the SCAQMD to "take a leadership role to sponsor, coordinate, and promote projects which increase the use of clean-burning fuels in the transportation and stationary source sectors, and to establish voluntary programs to accelerate the utilization of clean-burning fuels within the South Coast Air Basin." (Health and Safety Section 40404)

As a means of carrying out the AQMP, the District is empowered to adopt rules and regulations that are not in conflict with state and federal laws, rules, and regulations.

With respect to rail electrification, the SCAQMD has two major roles:

- Adopting an AQMP in cooperation with SCAG which addresses electrification and introduction of commuter rail service; and
- Adopting and enforcing specific emission regulations. In this regard, however, the Health and Safety Code states that the SCAQMD cannot mandate types of equipment or technology to be used to control emissions from locomotives.

A full public process, including public notices and workshops, is required for the District to adopt a rule or revise the AQMP. Currently, the District enforces rule 402 which applies to opacity of locomotive smoke. The District has not adopted any specific emission limitations which apply to locomotives.

According to SCAQMD District Counsel, the SCAQMD is not prohibited from developing more restrictive emission standards, which would replace the standards currently included in the AQMP.

SCAQMD's view of its role in the Los Angeles Basin electrification project called for in AQMP Measure 14 was summarized in a September 10, 1991 memo from its District Counsel to Hank Wedaa (provided in Appendix 9-1). The following legal conclusions drawn from that memo relate to the District's and CARB's authority to regulation emissions from locomotives and contain his interpretation of Health and Safety Code Sections 40702, 43013, 43018, 40000, 39002 and 40001:

- Under state law, the District and the California Air Resources Board (CARB) have the authority to establish emission limitations applicable to locomotives.
- State law prohibits the District from specifying the "design of equipment, type of construction, or particular method to be used" in reducing the release of air contaminants from locomotives. The District thus could not explicitly mandate a particular control technology such as electrification. CARB is not subject to this limitation and, under state law, could likely mandate specific control technologies, including the use of locomotives powered solely by electricity.
- Under state law, the District could encourage, or potentially even mandate, electrification by establishing a low emissions limit applicable to locomotives or a low mass emissions cap applicable to rail systems.

- Under the federal Clean Air Act Amendments of 1990, neither the District nor CARB may establish "any standard or other requirement relating to the control of emissions from" new locomotives or new engines used in locomotives. While the exact impact of this prohibition has not been defined by the courts, there is a reasonable basis to conclude that a District regulation imposing a mass emissions cap applicable to a rail system would be permissible.
- Under the federal Clean Air Act Amendments of 1990, the federal EPA must provide authorization before California may enforce standards or other requirements relating to the control of emissions from locomotives (other than state regulations applicable to new locomotives where such regulations are prohibited.) Such authorization should be obtained if the District demonstrates a need for locomotive emission limitations and coordinates its rule-making actions with other local jurisdictions and the state to prevent conflicting locomotive emission control requirements.
- Under the United States Constitution, any regulation of locomotives must be crafted to avoid undue interference with interstate commerce. EPA authorization for District locomotive regulations should help assure compliance with this requirement.

The District recently adopted a resolution which calls for the establishment of a legally enforceable mechanism for the early phase-out of diesel locomotives on the initial three commuter rail routes. Further, the Board recommended that the CTC not fund or allocate any funds for the purchase of diesel locomotives beyond those required for the first three routes. The AQMD Board will reconsider this resolution on March 6, 1992 following completion of the Electrification Task Force report.

9.1.4 California Transportation Commission

The California Transportation Commission (CTC) was statutorily created in 1977 to advise and assist the Administration and the Legislature in formulating and evaluating state policies and plans for multimodal transportation programs in California. The CTC is a major funding agency which programs and allocates transportation funds from a variety of sources. With regard to rail electrification, funding sources allocated by the CTC include Proposition 108, Proposition 116, Transit Capital Improvement Program (TCI), and Flexible Congestion Relief (FCR).

The CTC has taken a proactive role in support of electrification of rail services in Southern California. CTC is calling for preparation of a schedule and funding plan for rail electrification by the SCRRA by January 31, 1992. It has encouraged electrification of the Metrolink commuter rail system and has, to date, disallowed state funding to be used for the purchase of diesel engines for commuter rail because of concerns over nitrous oxide emissions. However, the determination for technology selection is legally reserved as a function of the county transportation commissions under Public Utilities Code Section 130303(e), and it appears the CTC may not legally mandate technologies, with certain exceptions. For example, Proposition 116 funds may be conditioned on acquisition of rail cars complying with specifications adopted by Caltrans.

With regard to rail electrification, CTC's role is focussed principally on the allocation of funds from state rail bonds. CTC's primary concern is that bonds are allocated in a way that accomplishes the perceived goals of the ballot initiative. According to CTC staff, a long-term goal of the Commission is for the electrification of all rail service. Due to the limited pool of funds, CTC wants to ensure that funded projects will not have to be redone to meet electrification goals. According to staff, some Commissioners feel they can condition grants with respect to mandating the use of electric locomotives. Other Commissioners disagree with the position and believe that current investments are consistent with the goal of total electrification. Formal CTC regulations on this subject are being considered, however, no specific authority has been identified for promulgating such regulations. The CTC is interested to see the Southern California Accelerated Rail Electrification Program Report to ascertain how realistic rail electrification really is. Consideration had been given to attaching electrification-related conditions on grants prior to the creation of the Electrification Task Force.

The CTC is mandated to adopt and update guidelines for the following transportation programs which have potential relevance to rail electrification:

- State Transportation Improvement Program (Gov Code § 14529)
- Flexible Congestion Relief Program (St. and Hwy. Code §§ 164.2 and 164.4)
- Proposition 116 Rail Program
- Proposition 108 Urban and Commuter Rail Program
- Proposition 108 Intercity Rail Program
- Transit Capital Improvement Program.

The CTC is responsible for adoption of the State Transportation Improvement Program (STIP) after approval and adoption by the regional transportation planning agencies. Guidelines for the adoption of the STIP are set forth in the California Code of Regulations, Title 21, Div. 4, § 8100 et. seq. This seven-year program is updated every two years. With regard to rail, the STIP includes an Urban and Commuter Rail Program and a Flexible Congestion Relief Program (FCR). These are prepared by the the local transportation commissions in conjunction with the regional transportation planning agencies, such as SCAG, as well as an Intercity Rail Program prepared by Caltrans. CTC's role relative to the STIP is to:

- Adopt a seven-year fund estimate and a methodology for its preparation
- Adopt policy guidelines for project nominations
- Conduct hearings on projects proposed by the regions and Caltrans
- Assemble CTC staff recommendations, and
- Adopt the STIP.

The CTC also has authority with regard to the review, approval, allocation, and certification of state bond funds under Proposition 116, the Clean Air and Transportation Improvement Act of 1990. This voter-approved initiative authorizes the sale of $1.99 billion in state bonds for projects specifically enumerated in the act. The CTC is responsible for establishing the guidelines to be used to review applications for Proposition 116 funds. It conducts project-by-project review and approval for recipients specified in the Proposition for intercity, urban and commuter rail stations, rolling stock, and right of way. Regarding the SCRRA's Metrolink system, six Proposition 116 applications were submitted to the CTC, of which two have been approved (L.A. – Ventura and Shared Facilities) and four are pending (San Bernardino – L.A., Fullerton – L.A., Oceanside – Fullerton, and San Bernardino – Riverside – Fullerton).

With regard to Proposition 108, the CTC allocates funds for individual projects programmed in the STIP for the regions' Urban and Commuter Rail Program and the Caltrans Intercity Rail Program. Proposition 108, which was approved by the voters in 1990, authorizes the expenditure of $1 billion in state bond funds for urban, commuter, and intercity rail purposes. The $1 billion approved by the voters under Proposition 108 is one of three such measures authorized by the Legislature; two additional $1 billion measures will go before the voters in 1992 and in 1994 respectively. While the application of these funds to specific projects was not detailed in the act (as was the case with Proposition 116), the $3 billion in funds from all three bond measures has already been programmed by the CTC in the adopted 1991 – 1997 STIP.

The CTC is also responsible for approving the annual Transit Capital Improvement Program (TCI) (Public Utilities Code S99317). Unlike the state rail bond fund programs under Propositions 108 and 116, which are limited in duration, TCI is the State's only on-going funding program exclusively reserved for rail and other forms of guideway transit. The other on-going program, Flexible Congestion Relief, is for both highway and transit purposes. The TCI program is roughly on the order of $100 million annually statewide, with half of the funds allocated to eligible counties under county minimum formulas and the other half allocated at the discretion of the CTC. Of the funds awarded annually, 15% is targeted for intercity rail. The CTC adopts TCI guidelines, conducts hearings on projects proposed by Caltrans and the counties, and adopts the TCI Program. SCRRA county recipients of TCI funds generally reserve these limited funds for use by the local jurisdictions for station projects.

9.1.5 California Air Resources Board

The California Air Resources Board (CARB) is a state agency responsible for setting air quality standards that protect public health and for adopting state emission standards to limit pollution from motor vehicles. CARB also monitors air quality, provides technical expertise to help local pollution control officials set stationary source emission limits, and operates a broad air pollution research program. In addition, CARB reviews and approves the regional AQMP's prepared by regional agencies across the state and adopts the STIP. CARB is also responsible for adopting and implementing the California Clean Air Act pursuant to Health & Safety Code § 40910. This act is more stringent in some respects than the Federal Clean Air Act. Under the California CAA and the Federal CAA, CARB is also required to demonstrate reasonable further progress in achieving state and national ambient air quality standards.

With respect to locomotive emissions, the Health and Safety Code generally requires CARB to "endeavor to achieve the maximum degree of emissions reduction possible from vehicular and other mobile sources in order to accomplish the attainment of the state standards at the earliest practicable date." (Health and Safety Code Section 43013(a)). The CARB has the authority under Section 43013(b) of this code to adopt "standards and regulations" for off-road and nonvehicle engine categories, including locomotives. The code requires CARB to conduct hearings to consider the adoption of regulations applicable to several types of off-road and nonvehicular sources, including locomotives, not later than November 15, 1991.

The code provides that CARB may not adopt any standard or regulation affecting locomotives until a final study, required by AB 234 which was adopted in 1987, has been completed and submitted to the Governor and the Legislature. The required study, which was directed by a Locomotive Emission Advisory Committee (LEAC), has been completed and was approved by CARB in August 1991. At that time, CARB adopted a plan for the control of locomotive exhaust emissions from existing locomotives. This plan, which is to be followed up by specific rule-making actions currently scheduled for August 1992, proposes a number of control strategies, including:

- Emission standards
- Requirements for engine modifications and operational limits
- Requirements for alternate fuels

- Requirements for emission control devices, and
- Market-based controls defining mass emission caps with marketable emissions permits.

While state law establishes CARB's authority to adopt and implement engine modifications and operational limits as a means to reduce locomotive emissions for both new and in-use locomotives, federal law limits this authority to new locomotives. 1990 Amendments to the Federal Clean Air Act reserve the authority to establish emission standards for new locomotives exclusively to the U.S. Environmental Protection Agency. Prior to these amendments, there could have been state regulations requiring that a locomotive meet certain emission standards before it could be sold; now that power has been pre-empted and lies with the EPA. In addition, any state emission standards for existing locomotives must first be approved by the EPA.

CARB also has the authority to adopt and implement regulations that affect the quality of fuels used by locomotives operating in California. However, the full extent of this authority has not yet been determined.

According to CARB staff, the next step for CARB is to develop an expeditious schedule for achieving locomotive air emissions reduction, and to understand how that schedule relates to elements of previous plans. CARB would then work toward the modification of existing plans to provide further air emissions reduction. In addition, staff noted that CARB and SCAQMD will work with the federal government to define the District's power to act in terms of rail-related emissions.

9.1.6 California Public Utilities Commission

The California Public Utilities Commission (CPUC) is an agency of the state government. By law, the CPUC sets the rates and standards of safety and service for more than 500 privately-owned utilities and more than 22,000 freight and passenger carriers within the state. The CPUC does not regulate city or district-operated utilities or cooperatively-owned water companies.

The CPUC acts in both a judicial and a legislative capacity. Like a court, it may take testimony, issue decisions and orders, cite for contempt, and subpoena witnesses and records. Its major legal duty, however, is the regulation of transportation companies and utilities, including gas, electric, water, steam, sewer, pipeline,telephone and telegraph, and cellular and radio-telephone companies.

In the area of safety, the CPUC oversees safety standards and procedures for: overhead power and communication lines, gas facilities, rapid transit systems, light rail transit systems, and common carrier railroads. In some cases, the CPUC requires an environmental impact report before it can approve the construction of certain utility facilities or operations.

In setting utility rates, the CPUC estimates a utility's reasonable expenses and revenues, and adds to this a "fair and reasonable" return on investment. No utility, however, is guaranteed a profit, merely a reasonable opportunity to earn one. Utilities must have authorization from the Commission to transfer property, issue stocks and bonds, and in some cases, construct or extend plant or other facilities.

Transportation utilities regulated by the CPUC include railroads, bus companies, trucking companies, and marine vessels transporting passengers or freight within the state. The Commission requires regulated truck and bus companies to maintain a minimum amount of public liability and property damage insurance.

Under Public Utilities Code § 740.2, which is in effect through January 1, 1997, the CPUC is required to encourage gas and electric corporations to pursue research, development, and demonstration activities to further the legislative goal of establishing substantial market penetration of electric and compressed natural gas fueled vehicles. Electric vehicles are defined as being powered by either batteries or other on-board means of generating electricity.

Public Utilities Code § 740.3 requires the CPUC, in cooperation with the State Energy Conservation and Development Commission, and CARB, air quality management districts and air pollution control districts, regulated electrical and gas corporations, and the motor vehicle industry, to evaluate and implement policies to promote the development of equipment and infrastructure needed to facilitate the use of electric power and natural gas to fuel low-emission vehicles. Policies to be considered include:

- The sale-for-resale and rate-Basing of low-emission vehicles and supporting equipment such as batteries for electric vehicles and compressor stations for natural gas fueled vehicles.
- The development of statewide standards for electric vehicle charger connections and compressed natural gas vehicle fueling connections, including installation procedures and technical assistance to installers.

While the CPUC's primary role regarding railroads pertains to safety requirements, the principal role of the CPUC in relation to railroad electrification would pertain to rate applications from Southern California Edison (SCE) and other investor-owned utilities participating in the electrification program. While consideration of such applications can last a very long time, the CPUC has made a commitment to attempt to process any electrification-related SCE application within six months. It is important to note, however, that the clock does not begin on the six-month period until the CPUC determines that the application is complete in all respects.

Once this occurs, the approval process continues as follows:

- After the date the application is deemed complete, there would be 30 days period for protests, after which a public hearing may be held.
- The CPUC Administrative Law Judge (ALJ) then would issue draft decision, subject to a 20 day comment period.
- The Commission would then issue a final decision and establish an effective date.
- The final decision of the CPUC is subject to a re-hearing before the CPUC and then is appealable only to the California Supreme Court. Appeals can only be made with regard to points of law or errors in the record.

9.1.7 California Department of Transportation

California Department of Transportation (Caltrans) is a statutorily created state agency responsible for development and implementation of a multimodal transportation system, including highways, rail, and aeronautics.

The intent of the Legislature in creating Caltrans included the following objectives related to rail transportation:

- To encourage and stimulate the development of urban mass transportation and interregional high speed transportation where found appropriate as a means of carrying out the policy of providing balanced transportation in the state.
- To develop a rail passenger network consistent with the needs and desires of the public, and in which the location of rail corridors and their service characteristics are compatible with statewide and regional goals and objectives, without discouraging the development of passenger rail service by privately-owned carriers.
- Encourage research and development of technological innovation in all modes of transportation, in cooperation with public agencies and the private sector.

Through its Division of Rail, Caltrans is involved in the planning, funding, and regulating of intercity rail services across the state and of the San Francisco Peninsula commuter rail service. The Department's responsibilities germane to rail electrification include:

- Provide staff support to the California Transportation Commission in the review of requests for state rail funding under the Transit Capital Improvement Program (TCI), Proposition 108 state rail bonds, and Proposition 116 state rail bonds. Caltrans programs TCI and Proposition 108 funds subject to approval by the CTC. It prepares allocating resolutions for state funding, conducts bond certification for Proposition 108 rail bonds, and evaluates the financial management capability of state funding recipients through a process known as Section 580 review.
- Caltrans is the recipient or co-recipient of Proposition 116 funds for two of the corridors within the proposed electrification study area: the Los Angeles-San Diego (LOSSAN) Corridor and the Los Angeles/Ventura/Santa Barbara Corridor. On the former, it shares this responsibility with the LOSSAN Rail Corridor Agency, the designated recipient. On the latter, it must work in conjunction with the Southern California Regional Rail Authority.
- Under Government Code Section 14035, Caltrans may enter into contracts with the National Railroad Passenger Corporation (Amtrak) under Section 403(b) of the Rail Passenger Services Act of 1970 to provide commuter and intercity rail passenger services. These contracts may include, but are not limited to, the extension of intercity passenger rail services or the upgrading of commuter rail services. Amtrak presently operates six basic system routes in California. In addition to these basic system routes, Caltrans supplements them with funding to provide additional intrastate services. The State supports four of the eight Amtrak passenger trains operated daily between Los Angeles and San Diego and two between Los Angeles and Santa Barbara. The State also supports three trains on the San Joaquin route through the Central Valley.
- Caltrans may construct, acquire, lease, improve, and operate rail passenger terminals along various corridors, including the San Diego-Los Angeles-Santa Barbara corridor, the Los Angeles-Santa Barbara-Oakland-Sacramento-Redding corridor, and the Los Angeles-Bakersfield-Fresno-Stockton-Sacramento-Oakland corridor.

- Under Government Code Section 14036, Caltrans prepares a biennial Rail Passenger Development Plan. This plan provides an overview of the development of intercity and commuter rail passenger service in California. It describes the service on various individual routes, both existing and proposed, and presents the Department's recommendations concerning state-supported service on specific routes. The plan also includes the identification and costs of capital facilities necessary to enhance competitiveness of rail passenger services, and provides a performance evaluation of all services in operation.
- Under Government Code Section 14035.6, Caltrans has prepared a work plan for a feasibility study for developing an integrated publicly or privately operated high-speed ground transportation system which includes specified commuter and intercity rail corridors, some of which are included in the electrification study area.
- Under Government Code Section 99603 of the Clean Air and Transportation Improvement Act of 1990 (Proposition 116), Caltrans is developing specifications for standard state-of-the-art California commuter and intercity rail cars and locomotives.

9.1.8 California Environmental Protection Agency

In 1991, Governor Wilson issued an Executive Order establishing the California Environmental Protection Agency (Cal-EPA) in expectation of enabling legislation from the state legislature. The legislation did not pass in the 1991 session, but will be reconsidered in the 1992 session. The organization and integration of the new department is moving forward in expectation of the passage of the legislative charter. Portions of the Governor's plan were based on a National Academy of Sciences report.

The new Cal-EPA will incorporate the following existing state agencies:

- Air Resources Board
- Integrated Waste Management Board
- State Water Resources Control Board
- Department of Toxic Substances Control (transferred intact from the Department of Health Services)
- Department of Pesticide Regulation (transferred intact from the Department of Food and Agriculture)
- Office of Environmental Health Hazard Assessment (specified environmental functions of the Health Hazard Assessment division transferred from DHS).

In terms of the structure of Cal-EPA's basic powers, the air,waste, and water boards will maintain their independent status despite their absorption within Cal-EPA; the governor described his plan as a "core" organization to which other agencies could be added. The addition of more agencies to this core, however, could result in longer debate and possibly stronger opposition to the Governor's plan.

The impact of the new department on the electrification program is not immediately apparent. There is a likelihood that the authority of the various environmental agencies may be significantly altered over the next few years during the period in which rail electrification would potentially occur.

9.1.9 California Coastal Commission

The California Coastal Commission (Coastal Commission) is a state agency which generally controls development of California's coastal resources in cooperation with local governments. The California Coastal Act of 1976 (Coastal Act) requires local governments within the California Coastal Zone to prepare Local Coastal Programs (LCP) which are to be implemented through the issuance of coastal development permits. The coastal zone encompasses 1.3 million acres, extends 3 miles out to sea and varies from a few blocks to several miles inland. It may not extend more than 5 miles inland from the mean high tide line.

Until a local jurisdiction's LCP is certified by the Coastal Commission, the Coastal Commission has the authority to issue all coastal development permits in the LCP area. After LCP certification, the Coastal Commission has only appellate power over permits, although it retains primary permit authority over development on tidal and public trust lands, and certain other lands.

To the extent that any of the rights-of-way proposed for electrification or support structures are located within the Coastal Zone, compliance with the Coastal Act and local ordinances adopted pursuant to an LCP may be required. The Coastal Act generally requires that any development within the Coastal Zone conform with certain policies expressed in the statute. These policies include maintenance and enhancement of public access to the sea, promotion of marine recreation use, protection and restoration of marine resources and environmentally sensitive habitat, and maintenance and enhancement of scenic and visual qualities of coastal areas. Portions of the LOSSAN Corridor are potentially within the coastal zone, as are portions of the Ventura-Los Angeles Metrolink line north of the City of Ventura.

9.1.10 U.S. Environmental Protection Agency

The U.S. Environmental Protection Agency (U.S. EPA) was established in the executive branch as an independent agency in 1970 to permit coordinated and effective governmental action on behalf of the environment. EPA endeavors to abate and control pollution systematically by proper integration of a variety of research, monitoring, standard setting, and enforcement activities. As a complement to its other activities, EPA coordinates and supports research and antipollution activities by State and local governments, private and public groups, individuals, and educational institutions. EPA also reinforces efforts among other federal agencies with respect to the impact of their operations on the environment, and is responsible for publishing its determinations when a proposal is considered unsatisfactory from the standpoint of public health or welfare, or environmental quality.

The EPA is the federal agency responsible for review and approval of the State Implementation Plans implementing the Federal Clean Air Act. Under the 1990 Federal Clean Air Act, the EPA reviews the SIP submissions that include the criteria and procedures for assuring conformity of the Transportation Department Plan. The EPA is also required to develop regulations for new locomotive emissions by November 1995 pursuant to 42 USCA § 7547.

9.1.11 Interstate Commerce Commission

The Interstate Commerce Commission (ICC) was created in 1887 as an independent federal regulatory agency for the regulation of commerce by an act of Congress now known as the Interstate Commerce Act. The ICC's responsibilities include regulation of carriers engaged in interstate commerce and in international commerce to the extent that it takes place within the United States. Surface transportation under the Commission's jurisdiction includes railroads, trucking companies, bus lines, freight forwarders, water carriers, transportation brokers, and a coal slurry pipeline. With regard to railroads, the enactment of the Railroad Revitalization and Regulatory Reform Act of 1976 and the Staggers Rail Act of 1980 substantially lessened the ICC's jurisdiction over railroads.

In broad terms and within prescribed legal limits, Commission regulations encompass transportation economics and service. The economic matters regulated by the Commission with regard to railroads include:

- Rates and charges controversies
- Mergers, consolidations, and acquisitions of control
- Accounting rules
- The issuance of securities
- Administration of bankruptcy laws relating to railroads
- Prevention of unlawful discrimination, destructive competition, and rebating
- Virtually all aspects of the use and supply of railroad equipment.

In the area of railroad service, the ICC grants operating rights and approves applications to construct and abandon rail lines.

The ICC's authority to regulate railroad economics and service generally restricts the jurisdiction of the states in the same fields, except for purely intrastate movements of freight and passengers in those states which retained their regulatory power by complying with certain provisions of the Staggers Rail Act of 1980. CPUC has retained such jurisdiction over passenger service but not over freight.

9.1.12 Federal Railroad Administration

The Federal Railroad Administration (FRA) is an agency of the U.S. Department of Transportation that:

- Promulgates and enforces rail safety regulations
- Conducts research and development in support of improved railroad safety and national rail transportation policy
- Provides for the rehabilitation of Northeast Corridor rail passenger service
- Participates, with the Army Corps of Engineers, in the National Magnetic Levitation Initiative Program
- Administers a program of high-speed ground transportation planning grants for selected states, and
- Consolidates government support of other rail transportation activities.

FRA's safety responsibilities are potentially of significance to electrification in the Los Angeles Basin, in regard to issues of the design, purchase, or construction of electrification facilities and equipment; and railroad operation in an electrified environment. FRA's safety jurisdiction is conferred through the Rail Safety Act of 1970, which encompasses all areas of rail safety including track maintenance, inspection standards, equipment standards, and operating practices. The agency also administers and enforces regulations resulting from railroad safety legislation for locomotives, signals, safety appliances, power brakes, hours of service, transportation of explosives and other dangerous articles, and reporting and investigation of railroad accidents. In the 1991 AQMP, SCAG and SCAQMD have suggested that the FRA, with direction form the EPA, should require implementation of rail electrification.

9.1.13 Federal Transit Administration

Until recently known as the Urban Mass Transportation Administration (UMTA), the Federal Transit Administration (FTA) is the federal agency responsible for programs of funding and research in the fields of passenger transit technology, economics, planning, investment, and operations. Its specific missions are: to assist in the development of improved mass transportation facilities, equipment, techniques, and methods; to encourage the planning and establishment of area wide urban mass transportation systems where they are cost-effective; to provide assistance to state and local governments in financing such systems; and to encourage private sector involvement in local mass transportation systems.

In addition to FTA's other roles, the agency also participates in an extensive system of regulatory or administrative review. In this role, FTA serves as an active participant at the federal level in transportation planning, Clean Air Act conformity, and environmental impact review processes affecting transit.

In terms of both its funding and regulatory review functions, FTA is important to the electrification program. Pursuant to the new Intermodal Surface Transportation Efficiency Act (ISTEA) of 1991, FTA has funding authority over the next six fiscal years in the amount of $31.5 million, an increase of 40 percent over the authorized levels of the past six years, and 60 percent over the appropriated levels of the same period. Large urbanized areas will receive $14.6 billion of these funds through the Section 9 block grant programs, the major transit formula program distributed to all urbanized areas. The Act also authorizes $5 billion new transit systems and system extensions, and $5 billion to upgrade aging transit systems through rail modernization program.

The ISTEA represents a conscious effort to break away from traditional highway bias at the federal level and approach transportation policy and funding decisions with a new perspective. Transit benefits from this new perspective through the much-heralded "flexible" programs that provide much more latitude at the state and local level in the use of federal transportation dollars; through the removal of disincentives in federal law that make development of transit projects more difficult than highway projects; and through a revised transportation planning and decision-making process that encourages a more comprehensive examination of the benefits and potential effects of transportation alternatives.

9.1.14 National Railroad Passenger Corporation

The National Railroad Passenger Corporation—popularly called "Amtrak"—is a U.S. government corporation established in 1971 to take over the operation of intercity rail passenger services from the private railroads that desired to abandon passenger services. At that time, all of the private railroads except the Rock Island, the Southern, and the Rio Grande terminated their intercity rail passenger services and turned them over to Amtrak. Under Amtrak's enabling legislation, the corporation operates a national network of services (a "basic system") at a service level substantially less than that offered by the private railroads prior to Amtrak's creation. Its system comprises both federally-funded and state-and-federally-funded passenger services.

Amtrak derives the greatest share of its capital funding from federal monies that are administered through the Federal Railroad Administration of the U.S. Department of Transportation. Over the years, federal capital funds well in excess of $3 billion have been provided to purchase new locomotives and rolling stock, upgrade the Northeast Corridor, and improve passenger stations, maintenance facilities, and other assets.

In California, Amtrak operates six basic system routes, five of which utilize all or part of some of the commuter lines that could potentially be electrified under the proposed electrification program, including:

- The San Diegans (Santa Barbara-Los Angeles-San Diego), which operate over the Los Angeles-San Diego and the Los Angeles-Moorpark commuter lines;
- The Coast Starlight (Los Angeles-Sacramento-Seattle), which operates in part over the San Diego and Moorpark commuter lines;
- The Desert Wind (Los Angeles-Salt Lake City), which operates over the San Bernardino-Riverside-LAUPT via Fullerton commuter line;
- The Southwest Chief (Los Angeles-Chicago), which operates on the San Bernardino-L.A. commuter line via Pasadena (on the Santa Fe); and
- The Sunset Limited (Los Angeles-New Orleans), operating over the Southern Pacific's Sunset Route, part of the consolidated corridor, which is being considered for electrification.

The principal effects of the electrification program on Amtrak would be a requirement to purchase electric locomotives for use in the Basin, with attendant investments in maintenance facilities and personnel training. In addition, depending on the level of shared use between intercity, commuter, and freight services, Amtrak could also be a potential funding contributor to electrification of selected rail lines.

9.1.15 Private Railroads

Of the 800 miles of rail line in the Electrification Study Area, 750 miles—or 90 percent—are owned and operated by three private, for-profit freight railroads, the Union Pacific, the Atchison, Topeka & Santa Fe, and the Southern Pacific. They are regulated at the federal level in their commercial dealings by the Interstate Commerce Commission, and in safety matters by the Federal Railroad Administration. At the state level, residual regulatory powers of both a commercial and safety nature reside with the California Public Utility Commission.

The role of the private freight railroads in the commercial and industrial life of the Los Angeles Basin is extensive. On a daily basis, these three railroads operate some 100 through freight trains, plus numerous local and switching freight trains carrying approximately 10,000 carloads of freight, and serving hundreds of industrial and commercial customers. If this freight were moving by truck, it would add an additional 15,000 to 20,000 truckloads daily to the Basin's already overcrowded road system.

Regarding the proposed electrification program and its air quality objectives, total oxides of nitrogen (NOx) emissions in the Basin are currently 1208 tons per day as estimated by SCAG. Railroad emissions are estimated to generate approximately 2.6 percent of this amount, or 30.9 tons of NOx emissions per day. The freight railroads are estimated to generate roughly 90 percent of the 30.9 tons of NOx emissions or 30.2 tons per day. This factor, together with their ownership and operation of more than 90 percent of the Basin's rail line miles, makes their participation in the electrification program essential. Their participation would facilitate program implementation for the rail passenger commuter system and ensure achievement of any substantial measure of the air quality improvement objectives that electrification is intended to secure.

The potential impact of the electrification project upon the operations of the Basin's freight railroads will be immense, whether or not they ultimately run electrified services of their own. The electrification of the commuter system cannot be completed without a massive construction effort that will involve not only the installation of the actual electrification system itself, but also many changes to track and civil structures along the rail lines to accommodate the electrification infrastructure. This construction program will likely cause significant adverse effects on rail freight operations on many of the involved lines during the construction period.

Over the course of this study, specific concerns raised by the railroads regarding electrification of freight lines owned or used by Metrolink have included the coordination of train movements, the impact on and reaction of unions, engineering compatibility, capital costs, and other economic impacts. Some of the railroads expressed the view that the freight railroads need to consider whether heavy rail electrification is compatible with the railroads' existing long-term goals. The railroads also questioned the ability of the State to regulate the freight railroads.

In the sections below, brief descriptions are provided of the three freight railroads operating within the electrification study area.

9.1.15.1 Union Pacific Railroad

Union Pacific Railroad is a subsidiary of Union Pacific Corporation, which is headquartered in Bethlehem, Pennsylvania. The railroad is headquartered in Omaha.

Union Pacific operates 19,000 miles of track in 19 states, ranging from Chicago south to New Orleans and Houston and west to Los Angeles, Oakland, Portland and Seattle.

The company has 29,500 employees and generated $4.6 billion in operating revenues and $534 million in net income in 1990. As of December 31, 1990 UP's total assets were $9.5 billion. In the state of California, UP employs 1,500 people, and operates 900 miles of track. The company carries a wide variety of freight such as coal, chemicals, grain, lumber, automobiles and manufactured goods. Union Pacific also has the world's most centralized dispatching center located in Omaha, where 700 trains are dispatched daily throughout the 19-state system. In addition, Union Pacific operates a national customer service center in St. Louis, where thousands of customers are handled daily through an 800 telephone number system.

9.1.15.2 Atchison, Topeka and Santa Fe Railway Company

The Atchison, Topeka, and Santa Fe Railway (Santa Fe) is one of the nation's major freight railroads, owning and operating approximately 10,770 miles of track extending from Chicago to the Gulf of Mexico and California. It operates a network of railroad lines and related facilities in 12 states. Its total operating revenues in 1990 were $2.1 billion, and it had total assets of $4.5 billion. In 1990, Santa Fe showed a loss in net income of $162.2 million, due in large part to a $342 million litigation settlement expense for the ETSI Coal Slurry Project. Santa Fe serves primarily manufacturing, agricultural and natural resource markets with intermodal, coal, agricultural, and chemicals making up the bulk of their rail traffic.

9.1.15.3 Southern Pacific Transportation Company

Southern Pacific Transportation Company, one of the nation's largest privately held companies and its fifth largest railroad, has been a major factor in Western history and development for 128 years.

Philip Anschutz of Denver transformed SP into a larger and more geographically diverse railroad system on October 11, 1988, when Rio Grande Industries, a subsidiary of the closely held Anschutz Corporation, bought Southern Pacific Transportation Company and combined it as a privately held company with the Denver and Rio Grande Western Railroad. The combined railroad system has operated under the SP banner, with headquarters at One Market Plaza in San Francisco.

In California, SP is also the largest railroad in the state, with 3,740 operating miles of track. The company has 9,757 employees with an annual payroll of $416,065,963. It has major yard facilities throughout the state and is the largest intermodal/container carrier among U.S. railroads, with major facilities located at Los Angeles, Oakland, and Long Beach.

In addition to the transportation business, SP is quite actively involved in the real estate business and has a major subsidiary (SP Environmental Systems) involved in the environmental clean-up business.

Total operating revenues for SP are approximately $2.5 billion, and total assets are approximately $4.8 billion.

9.1.16 Investor-Owned Utilities

There are three investor-owned utilities within the areas under consideration for rail electrification: Southern California Edison (SCE), San Diego Gas and Electric (SDG&E), and Arizona Public Service. Of these three, the vast majority of the route miles under consideration for electrification are within the service area of Southern California Edison. On eight of the thirteen corridors under consideration, SCE services over 75% of the route miles; on an additional three routes, SCE services roughly 50% of the route miles of territory. On one of the two remaining corridors, SCE and SDG&E combined service over 90% of the route mile area.

The investor-owned utilities potentially have two roles with respect to rail electrification. First, as providers of electric service, they could potentially be required to construct, operate and maintain an electrical support system for an electrified rail service. In addition, the utilities could be potential sources of financial support if the utilities elect to request approval from their respective governing boards and are allowed to construct, own, operate and maintain, and recover through rates (assuming CPUC approval) portions of the costs of the electrification system.

Investor-owned utilities in California are under the jurisdiction of the California Public Utilities Commission (CPUC). The CPUC is vested with broad powers and regulatory authority to oversee the business activity of the investor-owned utilities and ensure that the interests of the utility rate payers are served.

By virtue of the exclusive operating franchise granted to a utility within its defined service area, each utility has the obligation to provide electric service to customers within this service area. To meet this obligation, the utility constructs, owns, operates, and maintains sufficient electric plants to provide reliable electric service to its customers. A utility is allowed to recover the reasonable cost of facilities that are determined by the CPUC to be "used and useful" in the performance of its duty to the public, through electric rates charged to the utility's customers.

9.1.17 Municipally-Owned Utilities

Local jurisdictions are involved in electrification in two key ways: through municipally-owned utilities in selected jurisdictions, and through enforcement of local land use regulations.

In addition to the investor-owner utilities, there are nine municipally-owned utilities within the area under consideration for rail electrification, including:

- City of Anaheim
- City of Banning
- City of Burbank
- City of Colton
- City of Glendale
- Imperial Irrigation District
- Los Angeles Department of Water and Power
- City of Riverside
- City of Vernon.

Like the investor-owned utilities, the municipally-owned utilities represent potential sources of electricity, as well as potential sources of funding. Within the municipalities, agency approvals for investment and ultimately recovery of that investment through customer rates would be secured through local city councils, not by the PUC, and decisions concerning the rate-Basing of electrification costs would require approval by those bodies.

9.1.18 Los Angeles-San Diego Rail Corridor Agency

The Los Angeles-San Diego Rail Corridor Agency (LOSSAN RCA) is a joint powers authority comprised of Los Angeles County Transportation Commission, Orange County Transportation Authority, North San Diego County Transit Development Board, Metropolitan Transit Development Board, and Caltrans, with San Diego Association of Governments and Southern California Association of Governments serving as ex-officio non-voting members.

The LOSSAN RCA was formed in 1988 to plan, recommend programs, promote, and identify funding sources for improvements to intercity and commuter passenger rail services and facilities in the LOSSAN Corridor. The agency has an adopted capital program and budget calling for over $450 million in capital improvements, exclusive of the costs associated with acquisition of right of way from the Santa Fe Railway Company.

LOSSAN RCA is the designated recipient of $202 million in Proposition 116 funds reserved for the LOSSAN Corridor under the Clean Air and Transportation Act of 1990. Thus, any proposed expenditure of Proposition 116 funds in the corridor must be approved by the LOSSAN Board. LOSSAN RCA has also been designated in the federal Intermodal Surface Transportation Efficiency Act of 1991 as the recipient of $20 million in Section 3 capital funds from the Federal Transit Authority (formerly Urban Mass Transportation Administration) for initiating a grade separation program in the corridor.

9.1.19 San Diego Association of Governments

Electrification of rail services within the South Coast Air Basin could potentially affect counties such as San Diego which are linked to the region through the Los Angeles-San Diego (LOSSAN) Rail Corridor. The significance of this linkage is reflected in the fact that San Diego, through the San Diego Association of Governments (SANDAG) is a member of both the Southern California Regional Rail Authority (SCRRA) and the Los Angeles-San Diego Rail Corridor Agency (LOSSAN RCA).

SANDAG, legally organized as a joint powers agency, is the association of governments and regional planning agency for San Diego County. Through this voluntary Association, the 18 incorporated cities and the county government work together to solve current problems and plan for the future. The agency serves as the Regional Transportation Commission, Integrated Solid Waste Task Force, the Regional Planning and Growth Management Review Board, and the Airport Land Use Commission. SANDAG administers the region's transportation sales tax, known as TransNet, passed by county voters in 1988. SANDAG also serves as the technical and informational resource for the region's cities, the county government, as well as other local public agencies.

SANDAG's monthly meetings provide a public forum and decision point for significant regional issues such as growth, transportation, environmental management, housing, open space, air quality, energy, fiscal management, economic development, recycling and solid waste management, and criminal justice.

Each May, the SANDAG Board adopts an overall work program and budget comprised of federal, state and local funds to support the Association's regional responsibilities. Like the Southern California Association of Governments, SANDAG is the regional transportation planning agency responsible for preparation of the Regional Transportation Plan and the Regional Transportation Improvement Program for the San Diego region.

9.1.20 Metropolitan Transit Development Board

The Metropolitan Transit Development Board (MTDB) was statutorily created in 1975. The Board is responsible for planning, design, construction, and operation of San Diego's light rail system; for preparation, in conjunction with other transit operators, of the Short Range Transit Plan and the transit component of the 5 – 7 year regional Transportation Improvement Program; administration of fund claims made by local transit operators for Transit Development Act (TDA) and State Transit Assistance (STA) funds to operate transit in the MTDB area; for provision of service, either directly or by contract with public or private operators; licensing and regulation of jitneys, taxis, and other transportation services by contract for the City of San Diego; and for policy coordination with other operators.

In conjunction with North San Diego County Transit Development District, MTDB is presently completing engineering for the commuter rail service proposed to operate between Oceanside and downtown San Diego. This 43-mile service will utilize the San Diego subdivision right-of-way presently owned by the Santa Fe Railway Company. Also within this right of way but on a separate track, MTDB will be operating a light rail line between Old Town and downtown San Diego.

9.1.21 North San Diego County Development Board

Electrification of rail service within the Los Angeles-San Diego Corridor would potentially affect the proposed commuter rail service of the North San Diego County Transit Development Board (NSDCTDB). NSDCTDB, in conjunction with the Metropolitan Transit

Development Board, is presently completing engineering on a commuter rail service that would operate between Oceanside and downtown San Diego on the Santa Fe Railway Company's San Diego subdivision. Oceanside will also be the terminus for the Oceanside to Los Angeles Metrolink commuter rail service, currently under design by Orange County Transportation Authority.

NSDCTDB was statutorily created in 1975 to plan, construct, and operate itself, or through a contractor, public transit systems in its area of jurisdiction. In 1976, the Board formed the North County Transit District (NCTD) for the purpose of providing integrated public transit services within the North San Diego County region.

The Transit Development Board's area of jurisdiction is 1,020 square miles located in the northern portion of San Diego County. The area includes the cities of Carlsbad, Del Mar, Encinitas, Escondido, Oceanside, Solana Beach, San Marcus and Vista, Camp Pendleton, the unincorporated communities of Fallbrook and Ramona, and other unincorporated portions of northern San Diego County.

In addition to its interest in the proposed commuter rail services that will operate out of Oceanside, NSDCTDB is also a member of the Los Angeles-San Diego Rail Corridor Agency. As such, it has actively been involved in the development and implementation of the LOSSAN capital improvement program and in other efforts to enhance intercity rail service in the corridor.

As discussed above, electrification of the LOSSAN Corridor could potentially effect the commuter rail service proposed for operation by MTDB and NSDCTDB.

9.1.22 Local State Jurisdictions

Local jurisdictions have a variety of regulations governing land use including zoning, undergrounding of utility lines, and preservation of view corridors, noise levels and public health. With regard to the siting of substations, installation of overhead catenary wires and poles, and provision of transmission lines, electrification may or may not be compatible with such regulations.

In some of the potentially affected counties within the Southern California Regional Rail Authority, notably Los Angeles and Orange Counties, the county transit authorities have franchise rights and/or an exemption from building and zoning ordinances .

Within Los Angeles County, Public Utilities Code Sections 30631 and 30633 grant to the Southern California Rapid Transit District, and therefore to the LACTC, a legislative franchise to use the public streets in order to construct transit facilities. Pursuant to Section 30633, LACTC has a franchise in public ways "to the same extent that those rights and privileges ... are granted to municipalities ...."

LACTC is also exempt from building and zoning ordinances of a city. Government Code Sections 53090 and 53091, which regulate intergovernmental applicability of building and zoning ordinances and regulations, apply only to "local agencies". Section 53090 defines "local agency" to exclude " a rapid transit district whose board of directors is appointed by public bodies or officers or elected from election districts within the area comprising the district.

Among the four other SCRRA member counties, Orange County Transportation Authority appears to be exempt from city building and zoning ordinances, and has a franchise right to develop a transit system, subject to individual city approval. San Bernardino

Association of Governments, Riverside County Transportation Commission, and Ventura County Transportation Commission show no evidence of a franchise right in public ways of the type held by either LACTC or OCTA.

Preliminary legal analysis indicates that the extent to which the building and zoning exemptions and franchise rights applicable to LACTC would apply to the SCRRA as an independent agency, and to areas outside of Los Angeles County, appears to be limited.

9.2 RIGHTS FOR ACCESS TO PRIVATELY OWNED RIGHTS-OF-WAY

9.2.1 Electrification Under Existing Ownership and Trackage Rights Agreements

The over 800 miles of rail line comprising the thirteen routes under consideration for electrification are owned by four major parties: Southern Pacific Transportation Company, Santa Fe Railway Company, Union Pacific, and the Southern California Regional Rail Authority and its member counties. Appendix 9-2 summarizes current ownership and mileage within each route, by individual component segments.

Depending on which of the specific corridors are advanced for implementation, electrification of regional rail services will potentially require the acquisition of additional rights within privately owned rights-of-way. The rights of Southern California Regional Rail Authority and/or its member counties to electrify the railroad rights-of-way acquired from Southern Pacific, Union Pacific and the Santa Fe Railway Company, can be determined only after an analysis of engineering plans and topographical issues.

LACTC and the SCRRA member counties of Ventura and San Bernardino acquired either the fee interest or the easement interest owned by Southern Pacific in the following lines:

- Baldwin Park Line
- Azusa Line
- State Street Line
- Burbank Line
- Santa Ana Line
- Santa Monica Line
- Alla Line.

In addition, these counties acquired a forty-foot corridor along SP's Saugus and Ventura Lines together with trackage rights over a portion of the Saugus-Ventura Lines retained by SP. A forty-foot easement was also acquired over a portion of SP's Yuma Main Line. Shared Use Agreements were entered into to permit Southern Pacific to use some lines for local freight service.

The relevant SCRRA counties clearly have the right to electrify the lines purchased by them. Where they have acquired the fee estate or easement rights, poles and lines may be constructed. The easement rights owned by SP and sold to the counties are also broad enough to justify such construction. However, before such construction could occur there are several practical issues which would need to be considered:

- Bridges located over tracks may not be a height which would permit electrification.

- Many rights-of-way are very narrow, particularly the Baldwin Park Line, and may not be sufficiently wide to permit construction of the poles. In addition, there are drainage ditches, fiber optic cables and other such interests along the right-of-way which could interfere with construction or make it expensive.
- There may not be suitable sites for substations and other similar installations required for electrification. In general the purchase of the rights-of-way only included the railroad right-of-way plus certain non-operating property to be used for stations.
- There are several hundred license and easement agreements for lines and other overhead encroachments over the rights-of-way.
- The lines cross numerous city streets, where SCRRA and/or its member counties may need a franchise or license from the city for its rail crossing as well as any electrification lines crossing the street.

Any construction undertaken on the rights-of-way would need to be managed in a way which would not interfere with the railroad freight operations. Such management would add additional expense to the project as discussed in Section 7.0.

In contrast to lines acquired in fee or through easement rights, lines which are to be operated over existing freight lines under trackage rights agreements could not be electrified under the terms of the existing agreements. Therefore, SCRRA could not electrify SP's retained portion of the Saugus-Ventura Line or the Riverside Line to be operated on Union Pacific tracks without acquiring the rights to do so from the respective railroads.

In summary, SCRRA has sufficient legal authority to electrify the lines acquired in fee or through existing easement rights. However, a thorough analysis of easement and license rights would need to be undertaken together with an engineering study to ascertain if any property rights held by third parties would conflict. Lines operating under trackage rights could not be electrified without obtaining additional agreement with the railroad.

9.2.2 Potential Third-Party Impacts and Mitigations of Electrification on Utilities/Facilities Along Railroad Right-of-Way

As noted above, additional issue that would have to be considered with regard to electrification concerns third party rights. A variety of facilities and installations exist in, and adjacent to, the railroad right-of-way. These include public and private utilities, including electric, sewer, water, communications equipment and a variety of pipelines, as well as miscellaneous facilities which may or may not be affected by electrification.

The most numerous and prominent type of facilities within railroad right-of-way are the various types of utilities and communications transmission facilities that transport materials, information or power in linear form. In general, there are two basic categories of utility transmission facilities, which are defined in terms of their physical proximity to the rail line. These are:

- Longitudinal facilities, which run generally parallel with the rail line, and
- Crossing facilities, which enter the right-of-way only to cross the rail line at a specific point, either along the route of a street, or else at a non-street location.

The variety of facilities which may be affected, along with potential impacts of electrification and mitigation approaches, are shown on the accompanying Summary Matrix (Table 9-2). These facilities are owned and operated by a wide range of public and private

TABLE 9-2
Additional Potential Impacts and Mitigations of Electrification
Summary Matrix

Type of Utility/Facility	Potential Impact	Mitigation
1. Electrical utility power supply and transmission system	Large reactive power flows, particularly in areas where electric power transmission system consists primarily of long rows of overhead transmission lines.	Shunt capacitors, which are installed on board of locomotives, at the catenary distribution system wayside or at the traction power substation. Another option involves technology to improve the power factor of the electric utility transmission system through rearrangement of the locomotive's propulsion circuit.
	Utility system voltage flicker, due to a partial failure of power supply (flickering of lights, loss of power to computers, etc.) caused by shifting power demand of locomotives.	Ramping circuits installed on locomotives to reduce rapid voltage fluctuation. Also, overall power distribution system can be designed to allow for voltage fluctuations.
	Integrity of power supply affected through distortion of harmonic current, caused by locomotive control equipment.	Filters applied on board of locomotives or at wayside.
2. Computers and electric machinery served by power transmission system.	Electric machinery overheating and computer malfunction, due to distortion of harmonic current.	Filters applied on board of locomotives or at wayside.

TABLE 9-2 (continued)

Additional Potential Impacts and Mitigations of Electrification

Summary Matrix

Type of Utility/Facility	Potential Impact	Mitigation
3. Above-ground and below-ground communications equipment along rail ROW (phone and other communications equipment, signaling and communications circuits for rail operation).	Electrical interferences (both electromagnetic and electrostatic) can create operational problems for computers. Overvoltages created by excess electrical currents can cause electromagnetic fields (EMFs), which have the potential to damage computers and cause health risk to humans through long-term exposure.	Electromagnetic interference can be reduced by grounding, shielding, isolating transformers, booster transformer system, neutralizing wire system, and autotransformer system. Electrostatic induction can be eliminated by shielding and grounding. Overvoltages caused by ground potential rise to safe levels by adequate grounding and application of protective process or possible relocation of the facility. Studies focusing on the potential effects of EMFs have been initiated by the California Public Utilities Commission and the Federal Railroad Administration. Results from these studies will be monitored by SCRRA.
	Electrification of existing rail lines is incompatible with signal systems currently in use.	Replacement of existing signal systems would be required, and has been included in electrification cost estimates.
4. Long metal fences, outdoor signage and metal roofs.	Large metal objects can pick up electric charge due to overvoltages, posing potential hazard to humans or animals coming in direct contact with objects.	Overvoltages can be reduced to safe levels by adequate grounding and application of protective process or possible relocation of the facility.

TABLE 9-2 (continued)
Additional Potential Impacts and Mitigations of Electrification
Summary Matrix

Type of Utility/Facility	Potential Impact	Mitigation
5. Fiber optic cable.	Because of materials used, fiber optic cable is not generally vulnerable to either electrical interference of stray current corrosion. Only potential impact is at repeater stations, where interference could possibly occur.	Normal grounding at repeater stations should eliminate any potential negative impact.
6. Any type of partly metal-constructed underground pipe or cable (telephone and other hardware communications cable, as well as pipes carrying a variety of materials, such as water, steam, oil, gasoline, liquid natural gas, etc.)	Stray current corrosion of pipes, which causes loss of metal material in pipes (and early replacement), and can pose potential health hazards to workers carrying out maintenance. Note: Because AC current flows in both directions, the potential for stray current is significantly less than with DC current, and is not considered a major consideration in system design.	Pipe or cable can be shielded with protective metal layer. Another option is to develop a corrosion control system, using a "replacement anode" to which the stray current is directed.
	Return electrical current can leak off rails into ground and intrude upon pipe or cable in immediate vicinity of substations, posing potential hazard to workers.	Shield pipeline or cable. Also, provide specialized training and procedures for workers in electrified ROW.
7. TV airwaves communications/reception.	Potential for disruption of TV signal/reception due to icing on catenary in high-elevation locations (mountain passes), causing shorts in electrical system.	Installation of radio frequency grounding devices in immediate vicinity of problem, on an as-needed basis.

interests, as shown on the attached chart, titled Types of Utilities and Facilities Potentially Affected by Electrification (Table 9-3). While some of these agreements would permit the freight railroads to make alterations without compensating third parties, others do not. In any case, SCRRA would have to make such compensation.

TABLE 9-3

Types of Utilities and Facilities Potentially Affected by Electrification

Type of Facility	Owner
1. Electrical Utility Power Supply and Transmission System	Private and Public Utilities
2. Computers and Electric Machinery Served by Power Transmission System	Private and Public Owners
3. Above- and Below-ground Communications Equipment, Signaling Equipment	Private and Public Utilities and Freight Railroads
4. Large Metal Structures (Long Fences, Roofs, Large-scale Outdoor Signage, Etc.)	Various Public and Private Owners
5. Fiber Optic Cable and Stations	Communications Companies
6. Various Pipelines and Cables (Phone/Communications Cable, Pipelines Carrying Variety of Materials)	Communications Companies, Private/Public Utilities, Variety of Private/Public Owners
7. Television Sets (Airwaves Reception)	Individual Owners

The issue of defining financial responsibility for mitigating potential effects of electrification upon utilities and related facilities needs to be investigated further. In general, the freight railroads have separate agreements for each specific public or private installation or facility within the railroad-owned right-of-way. Each of these agreements has a defined set of responsibilities and conditions which allows a public or private utility to install and operate a specified type of facility within the right-of-way. While some of these agreements would permit the freight railroads to make alterations without compensating third parties, others do not. In any case, SCRRA would have to compensate.

9.3 ENVIRONMENTAL DOCUMENTATION REQUIREMENTS

California and federal law, under similar but different statutory schemes, require that public agencies evaluate the environmental impacts of a project before they exercise discretion in approving that project. The federal law is known as the National Environmental Policy Act, or "NEPA." The California statute is known as the California Environmental Quality Act, or "CEQA."

Both NEPA and CEQA provide for basically two different levels of environmental review. If an initial analysis of a project's potential environmental impacts shows that it will have no impact on the environment, CEQA permits the public agency to prepare a "negative declaration" which essentially states that the project will have no significant impact in the environment. The analogous environmental document in NEPA is the Finding of No Substantial Impact, or "FONSI."

If the initial environmental analysis concludes that there will be significant environmental impacts, then a more comprehensive evaluation and a greater opportunity for public comment is required. Under NEPA, the document is an environmental impact statement, or "EIS." CEQA requires an environmental impact report, or "EIR." Preparation and certification of an EIS and/or an EIR can take a great deal of time, including a significantly longer and more costly process than the negative declaration or FONSI procedures.

NEPA and CEQA also provide exemptions for limited types and categories of projects which are by their nature (1)not felt to have significant environmental impacts or (2)the legislative body has determined for other reasons that the project should not be subject to NEPA or CEQA. Such exemptions, however, are rare and are generally interpreted very narrowly by the California and federal courts.

The flow chart contained in Exhibit 9-1 shows the general analysis used to determine what compliance, if any, is required under CEQA and/or NEPA for a given project.

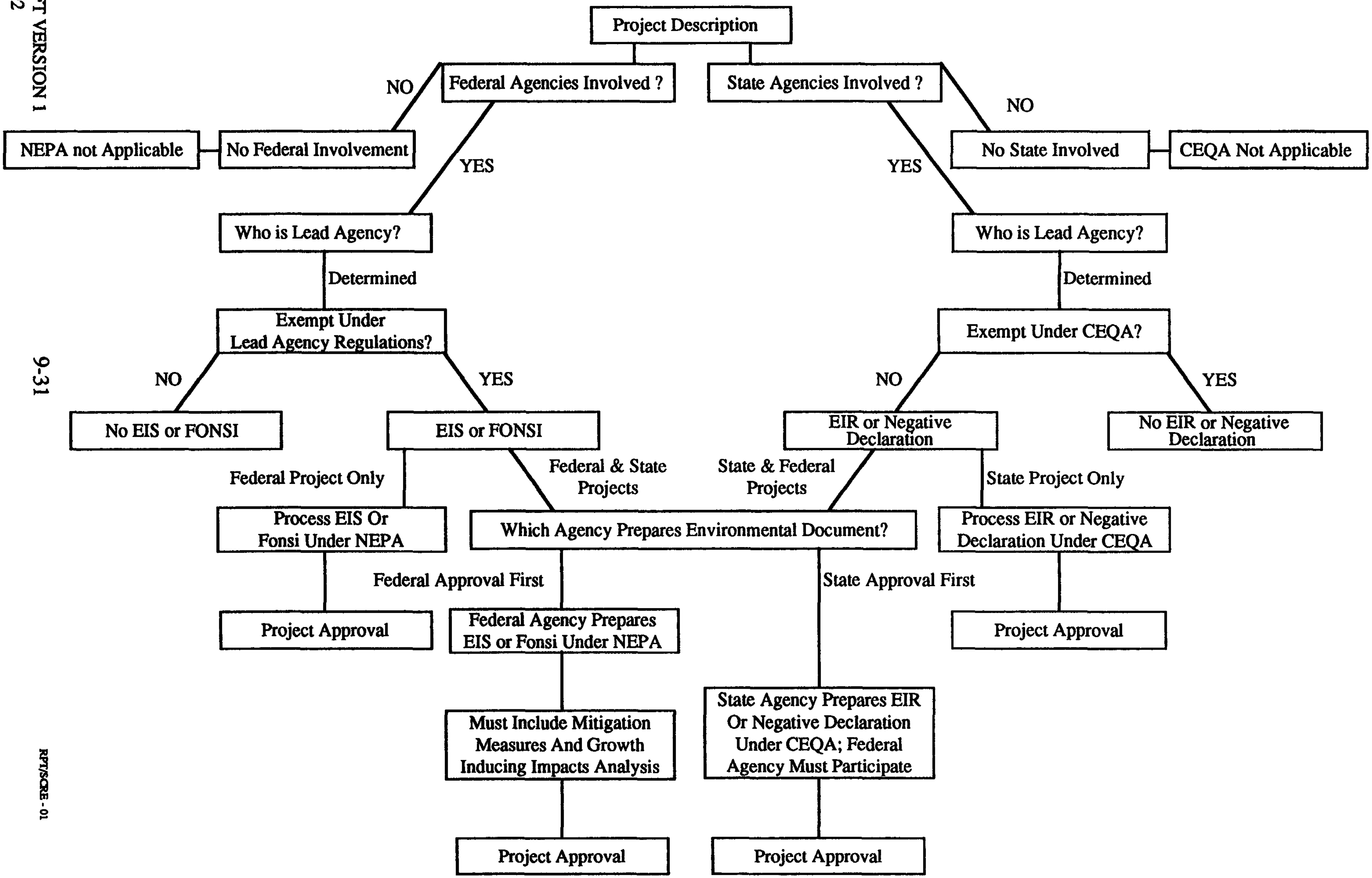
More specifically, four different types of commuter/freight rail electrification projects may currently be implemented, and the project description will likely dictate the level of environmental review the project must receive under NEPA and/or CEQA. The project types are:

- Commuter Rail Only, Within Existing Rail Rights-of-Way
- Commuter Rail Only, with Some Project Components Located Outside the Existing Rail Rights-of-Way
- Commuter Rail and Freight
- Freight Only.

9.3.1 Commuter Rail Only, within Existing Rights-of-Way

The first project type would be electrification of a commuter rail system only, with all project components located entirely within the boundaries of existing freight railroad rights-of-way. It appears that this type of project will be exempt under CEQA (Public Resources Code Section 21080(b)(11)), which provides a specific exemption for the institution or increase of passenger or commuter services on rail or highway rights-of-way already in use, including modernization of existing stations and parking facilities. It is important to note that since diesel commuter rail service has already been approved, SCRRA would have to demonstrate that conversion to electricity will amount to an "increase" in such service for the CEQA exemption to apply. If this project type is exempt, SCRRA would not have to comply with CEQA in approving the project. The clear benefit is that there would be no significant delay or expense in approving the project due to compliance with CEQA. This project type may, however, still be subject to NEPA requirements if federal funding or approvals are involved.

EXHIBIT 9-1
Agency Jurristiction Flow Chart



9.3.2 Commuter Rail Only, with Components Outside Right-of-Way

The second type represents what appears to be the more likely scenario for a commuter rail electrification project. In this project version, only electrification of commuter rail service would occur, but some project components would be located outside of the existing railroad rights-of-way. While California law is not entirely clear on this point, the strongest argument seems to be that a CEQA environmental evaluation will have to be performed at least on those project components located outside of existing right-of-way boundaries. This conclusion reflects CEQA's clear preference for construing exemptions as narrowly as possible, as stated in many California appellate court decisions.

Depending on the project's impacts and the amount of public controversy, this review process could take from five months, if the impacts are small and a negative declaration is appropriate, to one or more years, if the impacts are numerous and an environmental impact report is required. Similar to the first project type, it is also possible that this project type will require NEPA compliance as well.

The Legislature could eliminate any uncertainty as to how broadly the exemption will be construed by the courts by passing new legislation stating that (a) electrification of existing commuter rail service is exempt from CEQA, and (b) the exemption applies whether or not certain ancillary components needed for the electrification, such as electrical power substations and transmission facilities, are located outside of existing railroad rights of way.

9.3.3 Commuter and/or Freight

The third and fourth project types would involve electrification of a commuter and/or freight rail system on the existing rights-of-way. This project has two subparts: (1)an integrated commuter-freight rail project; or (2)a commuter rail project which anticipates electrification of freight rail service. Since freight rail projects do not fall within the limited class of projects exempted from CEQA, CEQA would require at least an evaluation of the freight components of the project, even if all project components are located entirely within the existing railroad rights-of-way. In an integrated commuter-freight rail project, it may be impossible to segregate project components into strictly "commuter" or "freight" categories. If so, the practical effect of the CEQA exemption for commuter rail projects may be lost if freight rail electrification is part of the project. Consequently, integration of freight service into the electrification project could result in a long and costly CEQA environmental evaluation, which may be avoided if the project was limited to commuter service.

The risk of losing the CEQA exemption option is also present in a commuter rail project which, by its design, anticipates eventual electrification of freight rail as a "foreseeable consequence." Under those conditions, current law strongly suggests that a CEQA review will be required since the freight portion of the project is not exempt. Like the second project type, CEQA environmental review could take from five months to one year or more, although it seems likely that a freight rail electrification would require the longer EIR process due to the likelihood of greater environmental impacts.

As mentioned previously, the Legislature could eliminate any uncertainty about the scope of the exemption by adopting legislation which provides an exemption not only for electrification projects involving commuter service but for combined commuter/freight service projects as well.

9.3.4 Potential Federal Agency Involvement

Finally, depending on the level of federal agency involvement, either in terms of regulation or funding (for example, Federal Highway Authority involvement in necessary highway improvements), all three project types may also have to comply with NEPA. While both NEPA and CEQA require cooperation between the state and federal agencies in complying with their respective environmental acts, it can be expected that NEPA compliance will add further delay and expense to the CEQA environmental review periods discussed above.

9.4 FEDERAL, STATE, AND LOCAL CONTROL OVER EMISSIONS FROM RAILROAD LOCOMOTIVES

The Environmental Protection Agency (EPA), the California Air Resources Board (CARB) and the South Coast Air Quality Management District (SCAQMD) are the primary environmental regulatory agencies empowered to regulate emissions of air contaminants from railroad operations including locomotive engines. The legal provisions authorizing these agencies to regulate locomotive emissions by requiring electrification or other means are set forth below. The exact nature and extent of each agency's authority is somewhat unclear due to conflicts between provisions of the federal Clean Air Act (CAA) and California statutes and local regulations. This problem is exacerbated by the fact that California has not had a federally approved SIP since 1979. Currently, California is required to submit a SIP to EPA by November 15, 1992.

9.4.1 U.S. Environmental Protection Agency

EPA's jurisdiction to regulate emissions from locomotives is found in the Clean Air Act (CAA). CAA § 209(e)(1) states, in relevant part that "[N]o state or any political subdivision thereof shall adopt or attempt to enforce any standard or other requirement relating to the control of emissions from new locomotives or new engines used in locomotives" (emphasis added). CAA § 213 goes on to direct the Administrator of EPA to promulgate emission standards for such new locomotives and new engines used in locomotives (hereinafter referred to collectively as "locomotives") by November 15, 1995.

On September 6, 1991, EPA published in the Federal Register proposed amendments to 40 CFR Part 85 ("Control of Air Pollution From Motor Vehicles and Motor Vehicle Engines") which, among other things, interpret the scope of federal preemption of the regulation of emissions from new locomotives. EPA defines "new" locomotive to mean a locomotive to which the equitable or legal title has never been transferred to an ultimate purchaser. "Ultimate purchaser" is defined as the first person who in good faith purchases such locomotive. EPA contends that the preemption does not apply to in-use engines which were manufactured before, on, or after November 15, 1990.

Thus, it is clear that only EPA has the power to establish emission limitations for new locomotives. EPA may also have the authority to regulate emissions from existing locomotive engines either directly through federal regulation or indirectly through approval of SIPs (CAA § 110) or special state authorizations under CAA § 209 (e)(2). To date, EPA has not expressed any intention of promulgating specific regulations to control emissions of existing locomotive engines.

9.4.2 California Air Resources Board

CARB is the agency charged with implementing air quality regulation within the state. In general, CARB regulates mobile sources emissions and delegates stationary source regulation to the local air pollution control district throughout the state retaining a supervisory role.

Under Health & Safety Code 43013(b) and 43018(a), CARB may adopt emission standards and regulations for locomotives after (1) a final study concerning locomotive exhaust has been completed and submitted to the Governor and the legislature and (2) the effect of the standards and regulations on the economy of the state has been considered. On August 8, 1991, CARB adopted and submitted its plan for control of locomotive exhaust emissions. CARB is currently in the process of proposing specific implementing rules and control strategies for locomotives based on its study and has scheduled adoption of such rules for summer 1992.

Under the CAA amendments, CARB may not regulate emissions from new locomotives. Assuming that existing locomotives are considered to be nonroad vehicles or engines, CAA § 209 (e)(2) requires CARB to first obtain EPA authorization before adopting or enforcing any emission standards for existing locomotives. The EPA Administrator can withhold such authorization if he finds that (1) the determination of California is arbitrary or capricious, (2) California does not need such regulation to meet compelling and extraordinary conditions, or (3) California's regulation is not consistent with CAA § 209. Thus, if CARB receives appropriate authorization from EPA, it appears that CARB can regulate emissions from existing locomotives within the state. These regulations could include installation of specific control technologies such as electrification.

9.4.3 South Coast Air Quality Management District

SCAQMD is the local air quality regulatory agency for the counties of Los Angeles, Orange, Riverside and the non-desert portions of San Bernardino. Health & Safety Code Section 40702, which outlines the general powers and duties of SCAQMD, states in part that, "No order, rule, regulation of any district shall, however, specify the design of equipment, types of construction, or particular method to be used in reducing the release of air contaminants from railroad locomotives." Thus, SCAQMD is prohibited from adopting regulations which specify installation of a particular control technology such as electrification. At the same time, the District has historically regulated opacity (smoke) from locomotives (Health & Safety Code Section 41701).

The SCAQMD, however, has raised the issue of whether it has authority to establish low emission limits or a low mass emissions cap for rail systems. The District has indicated that it can establish such limits under its general rule-making authority. Thus, the District would not require any particular type of control technology, but would set emission limits which could only be met through use of certain technology such as electrification. SCAQMD is currently studying the viability of regulating rail systems.

Measure 14 of the 1991 AQMP proposes electrification of 90% of rail operations in the South Coast Air Basin by 2010. The measure proposes that by 1995 the federal EPA and the Federal Railroad Administration (FRA) conduct a feasibility study of railroad electrification. It is proposed that EPA and FRA direct installation by 2010 of overhead or third rail electrical distribution systems applicable to 90 percent of rail operations in the Basin, totalling approximately 571 route miles. It is projected that this measure would result in a 90 percent reduction in railroad emissions. (See 1991 AQMP, Appendix IV-E, p.I-197)

Measure 14 in the 1991 AQMP proposes implementation by federal agencies. Measure 14 in the 1989 AQMP proposed implementation by SCAG and the SCAQMD. EPA, however, proposed to take no action to approve Measure 14 for inclusion in the State Implementation Plan (SIP) when California submitted the measure to EPA as part of the 1989 AQMP. 55 Fed.Reg.36490 (September 5, 1990). EPA's stated reason for taking no action was that the description of the measure required additional detail. To date, EPA has taken no final action on the 1989 AQMP, primarily due to extensions of planning deadlines and changes in SIP approval criteria made by the 1990 amendments to the Clean Air Act. It is also not known when EPA will approve the 1991 AQMP.

Thus, Measure 14 has not been approved by EPA as a part of California's SIP. The last California SIP approved by EPA was the 1979 SIP. Even if Measure 14 were currently part of an approved SIP, SCAQMD (or EPA if it assumes implementation) would still need to adopt regulations before this measure could be enforced.

9.4.4 Impact on Interstate Commerce

Agencies seeking to regulate locomotive emissions must also consider the additional issue of the impact of and compliance with Article I, Section 8 of the United States Constitution, which grants authority to "regulate commerce...among the states" to Congress. Commonly known as the "Commerce Clause," this provision of the Constitution prohibits states from enacting regulations which unreasonably interfere with national concerns, including the free flow of interstate commerce. The extent to which individual states can regulate locomotive emissions to address local concerns such as air pollution if the regulation may impact interstate commerce has not yet been determined.

9.5 POTENTIAL INSTITUTIONAL STRUCTURES

9.5.1 Rail Operations and Construction

In developing an approach to the electrification of rail services in Southern California, careful consideration must be given to the institutional framework for carrying out the planning, design, construction, and operation of the project, for the structure itself will have important implications for funding, tax consequences, and timing. The discussion of institutional alternatives below is divided between two elements: the three-step planning, engineering design, and construction element; and the operations element. These two elements are discussed separately due to the likelihood that different institutional approaches would be appropriate for each of these elements of the program.

Before describing individual institutional alternatives, however, it is important to understand the California law that enables various governmental entities to cooperate in the pooling of powers, funding, and authority by creating organizations that carry out specific purposes—called joint powers authorities ("JPA's") have their legal basis in the Joint Exercise of Powers Act. The JPA Act authorizes two or more public agencies, by agreement, to jointly exercise powers common to the contracting parties.

The JPA authorizes either the members of the agency to delegate the exercise of the common powers identified in the joint powers agreement to an individual entity or to exercise their common power through the authority. The California Supreme Court has ruled that the Joint Powers Act does not create new authority for JPA's; however, the Marks-Roos Act provides independent and supplemental powers to JPA's. A JPA must designate an entity to establish the manner in which the JPA will exercise its authority. The JPA Act refers to public agencies, but separate agreements with private entities could be made as authorized by the Marks-Roos Act or the joint powers agreement.

The question of whether a JPA such as the Southern California Regional Rail Authority could become a member of another JPA would also have to be considered. The 1990 amendment to the JPA Act expanded the list of public agencies authorized to form a JPA to include any public agency. This appears to authorize an existing JPA to join another JPA. The ability of an existing JPA to become a member of a new entity would depend upon the terms of the original agreement. It would also be possible to amend the original Southern California Regional Rail Authority agreement to allow the JPA to join another JPA in both cases. With this legal instrument in mind, the following section examines institutional alternatives that might be used to implement the electrification program.

9.5.1.1 Institutions to Conduct Planning, Engineering Design, and Construction

9.5.1.1.1 A Broadly-Based Joint Powers Authority

One potential structure would be to develop a broadly-based joint powers authority including the various public agencies with jurisdiction over the planning, financing and operation of passenger rail services. Under this approach, the various public agencies would enter into a joint powers agreement to jointly exercise their common powers relative to the planning and implementation of an electrification program. Given the multiplicity of agencies with jurisdiction over the electrification of regional rail service, a broadly-based joint powers authority could streamline and simplify the development and implementation of an electrification program. Although the Joint Exercise of Powers Act does not authorize private parties (such as the private railroads and private utilities) to become members of a JPA, a joint powers agency could enter into agreements with private entities to implement various aspects of an electrification program.

9.5.1.1.2 SCRRA

As a joint powers authority that is the planner and ultimate operator of commuter rail services in the Basin, SCRRA is one logical candidate to carry out this three-step element of the program. The charter of the SCRRA's JPA agreement could potentially be amended to incorporate other essential powers and agencies or firms.

9.5.1.1.3 RCC

With the skills it has acquired in supervising facilities planning, engineering design, and construction, RCC should be considered for this element of the program. It is also important to consider other agencies that might be affiliated through a joint powers agreement or other mechanism to provide the full range of powers needed for project implementation.

9.5.1.1.4 Joint Venture of Basin Freight and Passenger Railroads

The railroads themselves, public and private, might create one or more subsidiaries through which a joint venture could be formed to organize and manage this element of the program. This joint venture arrangement could encourage and enable all owners of rail lines in the Basin to become participants in the project. Such arrangement could eventually be converted into a joint operating company comprising all or most of the rail lines in the Basin.

9.5.1.2 Operation

9.5.1.2.1 Independent Operators

One obvious and logical approach is for each rail service provider to operate its own electrified services and maintain its own equipment. SCRRA for commuter rail; Amtrak for intercity passenger service; private railroads for freight. Operations control could be provided by SCRRA on all commuter and publicly-owned lines and by the freight railroads on the lines they own, or one entity could be established to provide operational control in the Basin.

9.5.1.2.2 Joint Operating Company

The entity established to provide overall operational control would logically be a part of a joint operating company established to coordinate all Basin rail operations. Such entity could potentially be responsible for providing, allocating and maintaining the motive power for all Basin operations as well. This would hinge upon the legal ability of the entity to bear the debt burden for the system and to be the recipient of federal and state grant monies.

9.5.1.2.3 SCRRA and the Freight Railroads

As a JPA, SCRRA might serve as the agency to control, provide and maintain the motive power for all commuter and intercity passenger operations in the Basin. Freight railroads would then control and provide motive power for all freight rail operations in the Basin, either individually or on a coordinated basis through the joint operating company.

9.5.2 Inter-Utility Arrangements

It is clear from the structure of the public and investor-owned utilities in the Electrification Study Area that cooperative arrangements among the utilities will be needed for construction, power-sharing, funding, and the like. It is fortunate that cooperative agreements of these types are common among utilities.

Such agreements can range in scope from the multi-state Pacific Intertie Facilities, which span the West Coast from the Pacific Northwest to Southern California, to small projects that involve as few as two local municipal utilities.

As an electrification project moves forward, the utilities involved, whether investor-owned (such as Southern California Edison) or municipal, should encounter little difficulty in making appropriate cooperative arrangements, once the scope of the project is determined.

9.6 PENDING AND POTENTIAL FUTURE LEGISLATION

Electrification of regional rail services may require new legislation to address certain issues. The sections below discuss legislative issues identified to date. Future legislative needs may appear as implementation actions are specifically defined.

9.6.1 Pending Legislation

The Senate Transportation Committee approved Senate Bill 1167 (Killea) on January 13, 1992. This bill mandates that financial analysis be done to determine the impact that rate-Basing of electrification would have on the rate-payers over the 5, 10, and 15 year period on a regionwide and county-by-county basis. This bill is an urgency bill that would go into effect upon signature by the Governor.

9.6.2 Potential Future Legislation

To date, consideration has been given to the potential need for legislation to exclude rail electrification costs from the calculation of operating costs for purposes of complying with the State's mandated farebox recovery of 40% for commuter rail operations.

9.6.3 Exemption for Electrified Rail Service

Also under consideration is possible legislation exempting any projects which involve the electrification of commuter/freight rail service along existing rail service routes from the requirements of CEQA, as discussed in Section 9.3.

10.0 REGULATORY REQUIREMENTS

10.0 REGULATORY REQUIREMENTS

10.1 INTRODUCTION

10.1.1 Regional Rail Electrification Task Force Objectives

The California Transportation Commission on August 20, 1991, convened a meeting to address the topic of railroad electrification in the Los Angeles Basin. It was agreed that the Southern California Regional Rail Authority would establish a Task Force to include representatives of transportation agencies, private railroads, utilities, and regulatory agencies in the five county area. The objective of the Task Force was to develop by January 31, 1992, a specific plan defining a process, schedule and financing plan for accelerated railroad electrification. The Task Force organization is presented in Exhibit 10-1.

10.1.2 Role of Electric Utilities on the Task Force

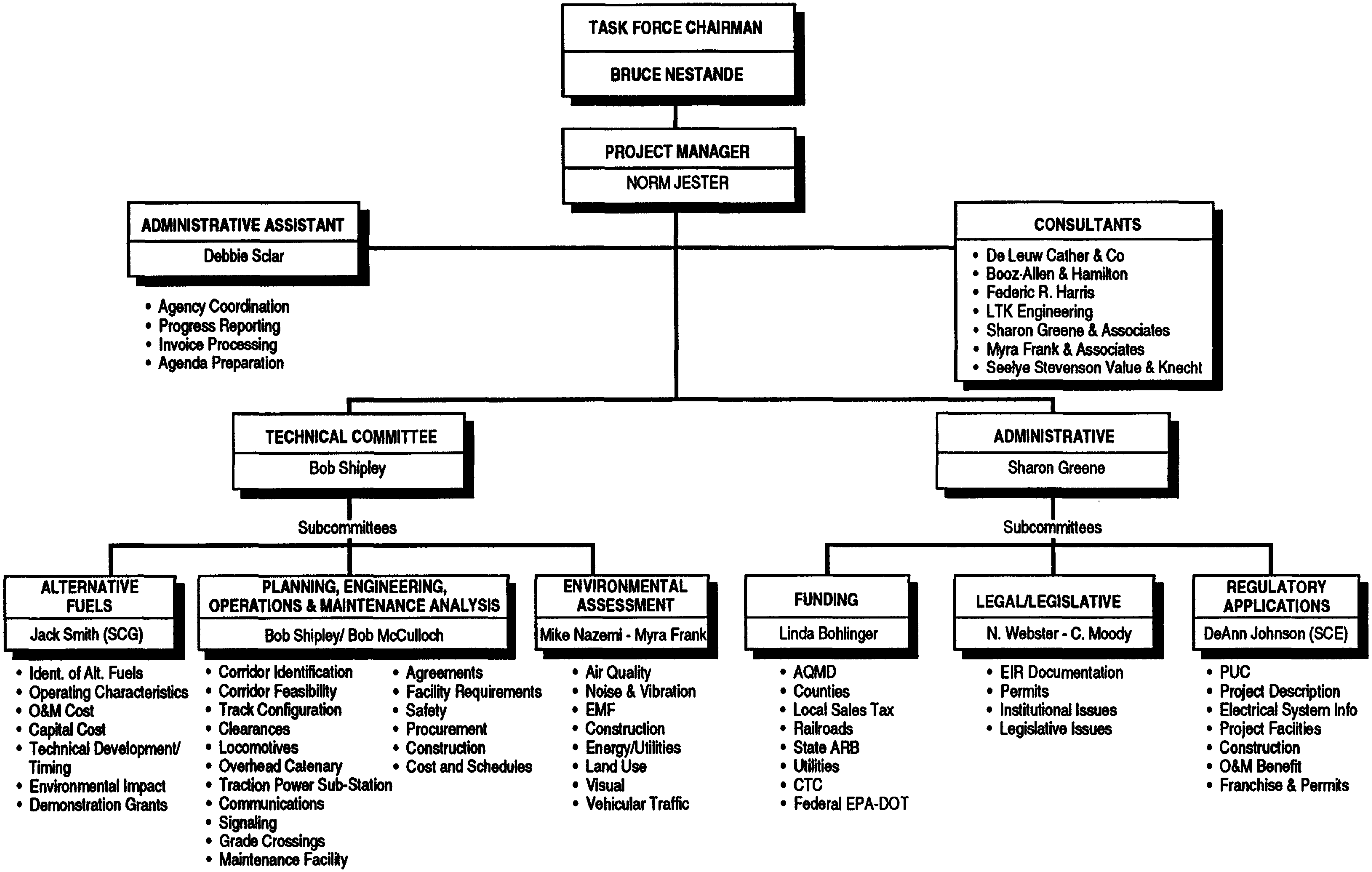
Two investor-owned and nine municipal electric utilities in the Southern California region are potentially effected by the electrification of rail corridors in Southern California. These utilities include:

Investor-owned Utilities	Municipal Utilities
Southern California Edison	City of Anaheim
San Diego Gas & Electric	City of Banning
	City of Burbank
	City of Colton
	City of Glendale
	Imperial Irrigation District
	Los Angeles Department of Water and Power
	City of Riverside
	City of Vernon

These electric utilities have two potential roles with respect to rail electrification: 1) as providers of electric service required to operate and maintain an electrified rail system, and 2) as potential sources of financial support if the utilities elect to request approval from their respective governing bodies and are allowed to construct, own, operate and maintain, and recover through rates, portions of the costs of the electrified rail system.

Because of the importance of both of these potential roles, the electric utilities were requested to participate on the Regional Rail Electrification Task Force through the activities of the various Subcommittees. The Task Force requested Southern California Edison (SCE) to chair the Regulatory Applications Subcommittee. The purpose of this subcommittee was to focus on the role of the electric utilities as possible sources of financial support for rail electrification. Additionally, the subcommittee was to identify the information requirements

EXHIBIT 10-1
Regional Rail Electrification Task Force



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necessary to enable the affected utilities to submit applications to their governing authorities requesting approval to construct, own, operate and maintain, and ultimately recover through rates, some portion of the costs for rail electrification within their respective service areas.

Although a number of the potentially affected electric utilities have participated on this Subcommittee work effort, their participation does not represent a commitment that the utilities would elect to seek such approval from their governing authorities.

10.1.3 Purpose of Regulatory Applications Subcommittee Report

This section of the report focuses on the potential role of the electric utilities as equity participants in rail electrification and presents the following Subcommittee work products:

- A listing of potential rail corridors noting mileages within each electric utility service area.
- Location maps of potential rail corridors with electric utility service areas highlighted.
- A listing of regulatory application information needs, including environmental compliance requirements for both investor-owned and municipal utilities.
- A discussion of the regulatory review process for both investor-owned and municipal utility participation and potential review timeframes

10.2 IDENTIFICATION OF ELECTRIC UTILITY SERVICE AREAS BY RAIL CORRIDORS

10.2.1 Table of Candidate Routes

The Regional Rail Electrification Task Force identified 13 potential rail lines for consideration of accelerated electrification of freight, intercity, passenger and commuter rail lines in Southern California (candidate routes). These candidate routes, route lengths, and mileages within affected electric utility service areas are presented in Table 10-1.

10.2.2 Location Maps

Location maps of the 13 candidate routes are presented in Exhibits 10-2 through 10-15. Affected electric utility service areas have been highlighted on each route.

TABLE 10-1
CANDIDATE ROUTES FOR ELECTRIFICATION

ROUTE #	ROUTE NAME	MILES OF LINE*
1 (Freight)	**Union Pacific/Southern Pacific Corridor**	**394.0**
	Edison Territory	220.0
	Imperial Irrigation District (IID)	148.6
	Arizona Public Service	6.0
	City of Los Angeles	6.0
	City of Vernon	4.5
	City of Colton	4.5
	City of Banning	4.4
2 (Commuter)	**Baldwin Park Branch (San Bernardino to L.A.)**	**57.0**
	Edison Territory	53.1
	City of Los Angeles	2.4
	City of Colton	1.5
3 (Commuter)	**Moorpark Line (Moorpark to L.A.)**	**48.0**
	Edison Territory	23.5
	City of Los Angeles	16.0
	City of Burbank	4.5
	City of Glendale	4.0
4 (Commuter)	**Saugus Line (Santa Clarita to L.A.)**	**35.0**
	City of Los Angeles	17.4
	Edison Territory	9.1
	City of Burbank	4.5
	City of Glendale	4.0
5 (Commuter)	**Lossan Line (National City to L.A.)**	**134.0**
	San Diego Gas & Electric	75.0
	Edison Territory	48.5
	City of Anaheim	5.6
	City of Los Angeles	2.5
	City of Vernon	2.4

TABLE 10-1 (continued)
Candidate Routes for Electrification

ROUTE #	ROUTE NAME	MILES OF LINE*
6 (Commuter)	**Riverside to Los Angeles (via Ontario)**	**59.0**
	Edison Territory	45.0
	City of Riverside	8.4
	City of Los Angeles	3.3
	City of Vernon	2.3
7 (Commuter)	**Riverside to Los Angeles (via Fullerton)**	**62.0**
	Edison Territory	45.9
	City of Riverside	9.0
	City of Los Angeles	2.5
	City of Vernon	2.4
	City of Anaheim	2.2
8 (Commuter)	**Hemet Line (Hemet to Riverside)**	**39.0**
	Edison Territory	32.8
	City of Riverside	6.2
9 (Commuter)	**San Bernardino to Irvine**	**53.0**
	Edison Territory	38.4
	City of Riverside	9.0
	City of Anaheim	3.0
	City of Colton	2.6
10 (Commuter)	**Redlands Line (San Bernardino to Redlands)**	**12.0**
	Edison Territory	12.0
11 (Freight)	**Southern Pacific -Ports to Yuma**	**282.0**
	Imperial Irrigation District (IID)	149.0
	Edison Territory	110.6
	Arizona Public Service	6.0
	City of Colton	4.5
	City of Banning	4.4
	City of Los Angeles	4.0
	City of Vernon	3.5

TABLE 10-1 (continued)

ROUTE #	ROUTE NAME	MILES OF LINE*
12 (Freight)	**Santa Fe – Ports to Barstow**	**176.0**
	Edison Territory	143.5
	City of Riverside	11.5
	City of Los Angeles	9.5
	City of Vernon	4.5
	City of Anaheim	4.0
	City of Colton	3.0
13 (Freight)	**Union Pacific – Ports to Yermo**	**187.0**
	Edison Territory	158.0
	City of Los Angeles	12.5
	City of Riverside	10.5
	City of Vernon	3.0
	City of Colton	3.0

* From Station to Station

TABLE A

CANDIDATE ROUTES FOR ELECTRIFICATION

ROUTE #	ROUTE NAME	MILES OF LINE*
1 **(Freight)**	**Union Pacific/ Southern Pacific Corridor**	**394.0**
	Edison Territory	221.0
	Imperial Irrigation District (IID)	147.6
	Arizona Public Service	6.0
	City of Los Angeles	6.0
	City of Vernon	4.5
	City of Colton	4.5
	City of Banning	4.4
2 **(Commuter)**	**Baldwin Park Branch (San Bernardino to L.A.)**	**57.0**
	Edison Territory	54.0
	City of Los Angeles	1.5
	City of Colton	1.5
3 **(Commuter)**	**Moorpark Line (Moorpark to L.A.)**	**48.0**
	Edison Territory	23.5
	City of Los Angeles	16.0
	City of Burbank	4.5
	City of Glendale	4.0
4 **(Commuter)**	**Saugus Line (Santa Clarita to L.A.)**	**35.0**
	City of Los Angeles	15.4
	Edison Territory	11.1
	City of Burbank	4.5
	City of Glendale	4.0
5 **(Commuter)**	**Lossan Line (National City to L.A.)**	**134.0**
	San Diego Gas & Electric	75.0
	Edison Territory	48.5
	City of Anaheim	5.6
	City of Los Angeles	2.5
	City of Vernon	2.4

* From Station to Station

TABLE A (con't)

CANDIDATE ROUTES FOR ELECTRIFICATION (Continued)

ROUTE #	ROUTE NAME	MILES OF LINE*
6	**Riverside to Los Angeles**	
(Commuter)	**(via Ontario)**	**59.0**
	Edison Territory	44.1
	City of Riverside	9.0
	City of Los Angeles	3.5
	City of Vernon	2.4
7	**Riverside to Los Angeles**	
(Commuter)	**(via Fullerton)**	**62.0**
	Edison Territory	45.9
	City of Riverside	9.0
	City of Los Angeles	2.5
	City of Vernon	2.4
	City of Anaheim	2.2
8	**Hemet Line**	
(Commuter)	**(Hemet to Riverside)**	**39.0**
	Edison Territory	36.5
	City of Riverside	2.5
9	**San Bernardino to Irvine**	
(Commuter)		**53.0**
	Edison Territory	39.7
	City of Riverside	9.0
	City of Anaheim	2.3
	City of Colton	2.0
10	**Redlands Line**	
(Commuter)	**(San Bernardino to Redlands)**	**12.0**
	Edison Territory	12.0
11	**Southern Pacific - Ports to Yuma**	**282.0**
(Freight)		
	Imperial Irrigation District (IID)	145.0
	Edison Territory	114.6
	Arizona Public Service	6.0
	City of Colton	4.5
	City of Banning	4.4
	City of Los Angeles	4.0
	City of Vernon	3.5

* From Station to Station

TABLE A (Con't)

CANDIDATE ROUTES FOR ELECTRIFICATION (Continued)

ROUTE #	ROUTE NAME	MILES OF LINE*
12 (Freight)	**Santa Fe - Ports to Barstow**	**176.0**
	Edison Territory	155.2
	City of Riverside	9.0
	City of Los Angeles	4.0
	City of Vernon	3.5
	City of Anaheim	2.3
	City of Colton	2.0
13 (Freight)	**Union Pacific - Ports to Yermo**	**187.0**
	Edison Territory	162.8
	City of Riverside	9.0
	City of Los Angeles	6.2
	City of Vernon	4.5
	City of Colton	4.5

* From Station to Station

COLOR INDEX

COMMUTER/FREIGHT LINES

NAME	*COLOR*
Los Angeles	Yellow
Glendale	[illegible]
Anaheim	Red
Burbank	Virdian (Green-Blue)
Vernon	Purple
Riverside	Brown
Banning	Light Blue
San Diego Gas & Electric	Green
Colton	Apple Green
I.I.D.	Rose
Arizona	Orange
SCE Territory	White

Note: All area that the freight and commuter lines run through on the maps and are not colored but remain white is Edison Territory.

All Freight and Commuter Lines are mapped in **Dark Blue**.

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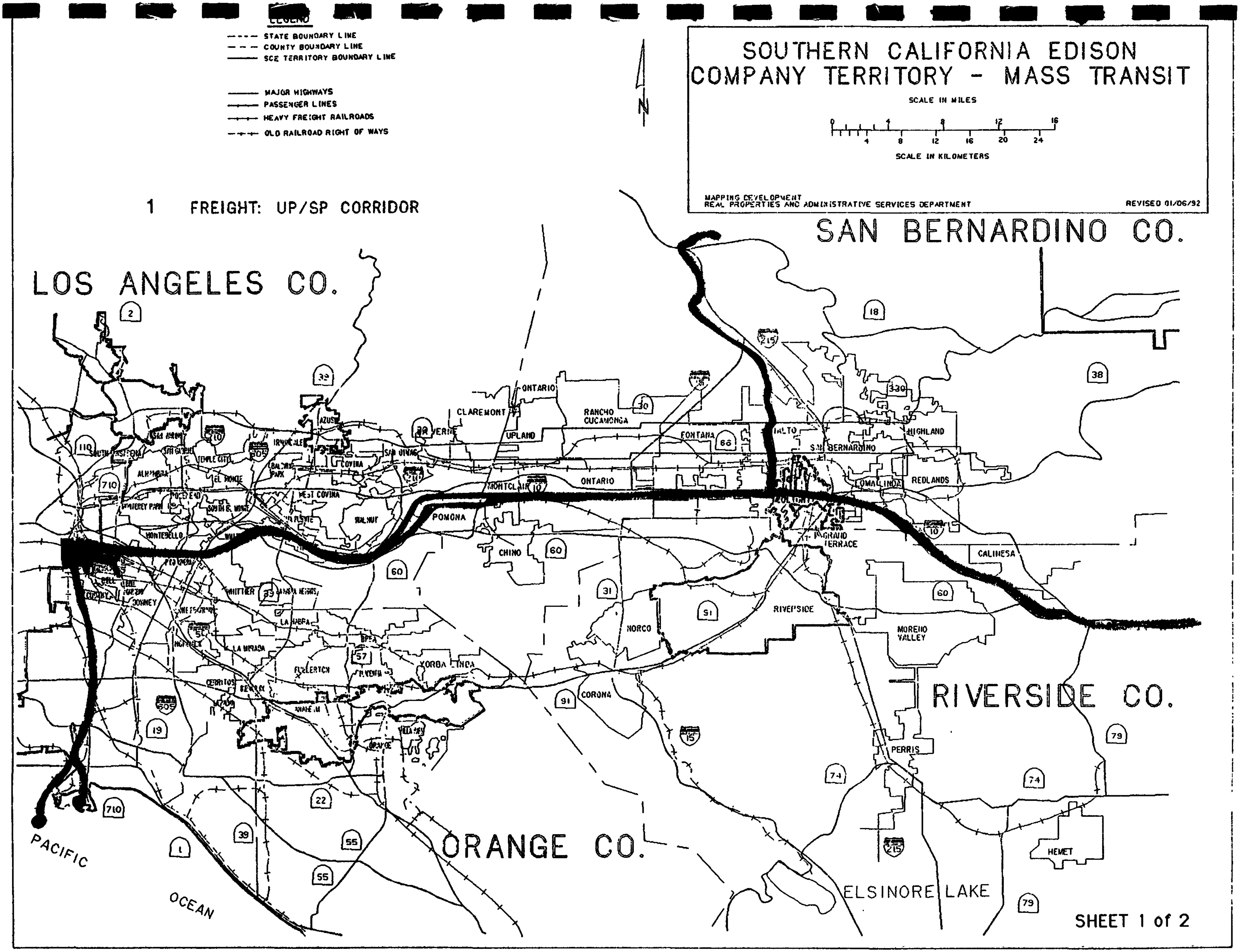

LEGEND
STATE BOUNDARY LINE
COUNTY BOUNDARY LINE
SCE TERRITORY BOUNDARY LINE
MAJOR HIGHWAYS
PASSENGER LINES
HEAVY FREIGHT RAILROADS
OLD RAILROAD RIGHT OF WAYS
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COMPANY TERRITORY - MASS TRANSIT
SCALE IN MILES
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4 8 12 16 20 24
SCALE IN KILOMETERS
MAPPING DEVELOPMENT
REAL PROPERTIES AND ADMINISTRATIVE SERVICES DEPARTMENT
REVISED 01/06/92
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LOS ANGELES CO.
RIVERSIDE CO.
ORANGE CO.
PACIFIC
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ELSINORE LAKE
CLAREMONT
ONTARIO
UPLAND
RANCHO CUCAMONGA
FONTANA
SAN BERNARDINO
HIGHLAND
REDLANDS
LOMA LINDA
MONTCLAIR
POMONA
CHINO
GRAND TERRACE
CALIMESA
RIVERSIDE
NORCO
CORONA
MORENO VALLEY
PERRIS
HEMET
AZUSA
COVINA
WEST COVINA
WALNUT
EL MONTE
TEMPLE CITY
ALHAMBRA
MONTEBELLO
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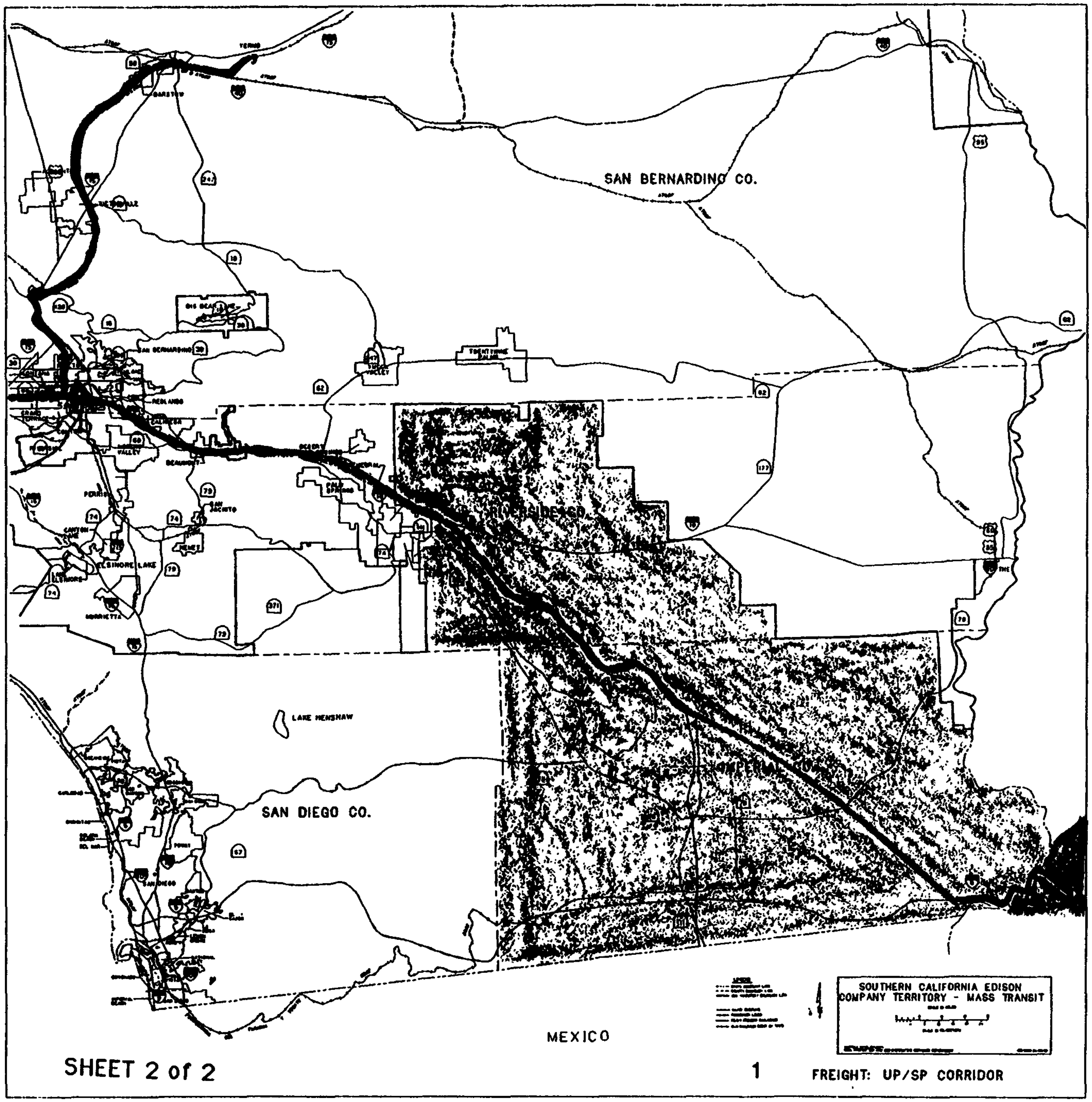
ANAHEIM
ORANGE
DOWNEY
SHEET 1 of 2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SAN DIEGO CO.
LAKE HENSHAW
MEXICO
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COMPANY TERRITORY - MASS TRANSIT
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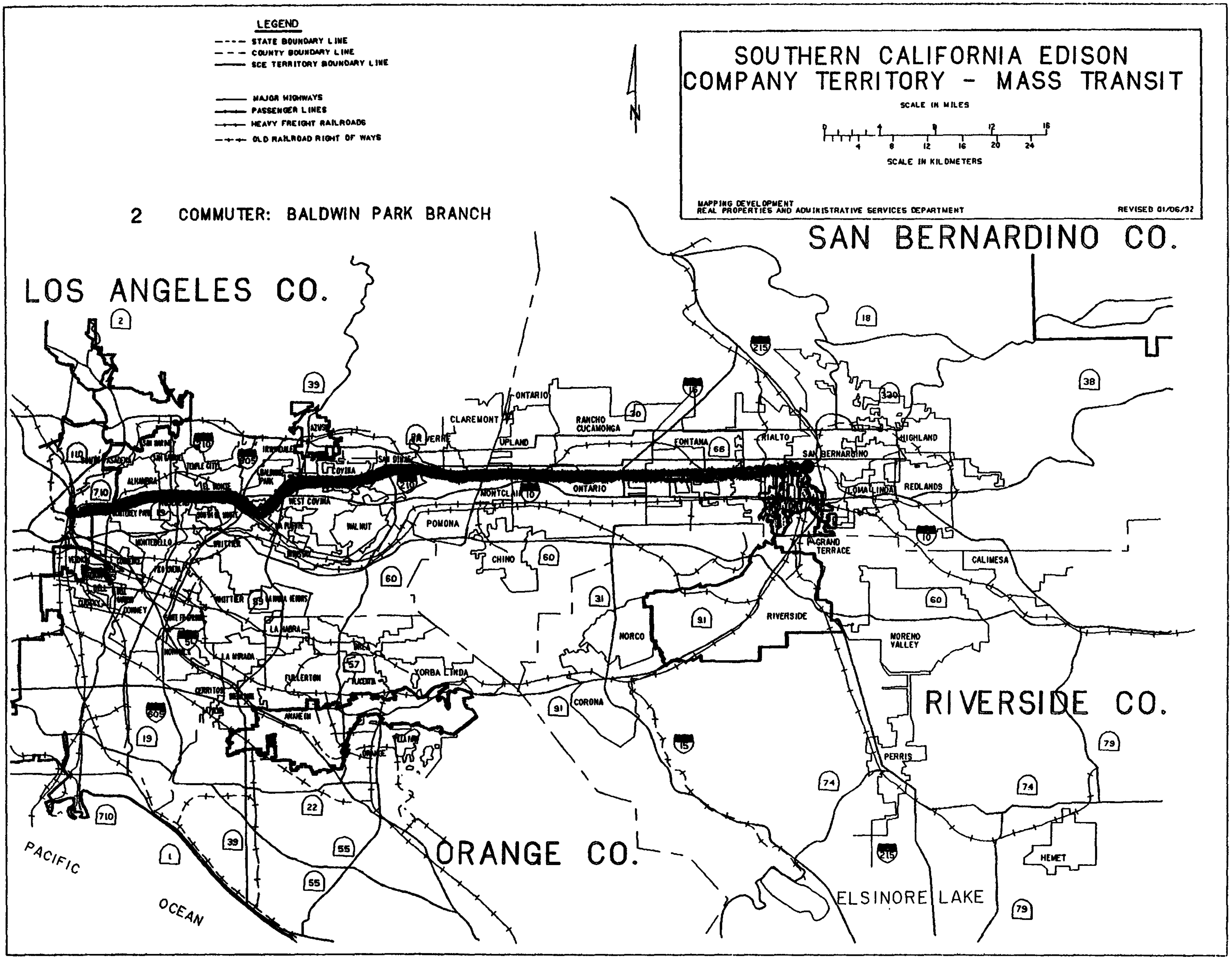
FREIGHT: UP/SP CORRIDOR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PASSENGER LINES
HEAVY FREIGHT RAILROADS
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SOUTHERN CALIFORNIA EDISON
COMPANY TERRITORY - MASS TRANSIT
SCALE IN MILES
SCALE IN KILOMETERS
MAPPING DEVELOPMENT
REAL PROPERTIES AND ADMINISTRATIVE SERVICES DEPARTMENT
REVISED 01/06/32
2 COMMUTER: BALDWIN PARK BRANCH
LOS ANGELES CO.
SAN BERNARDINO CO.
RIVERSIDE CO.
ORANGE CO.
PACIFIC
OCEAN
ELSINORE LAKE
ONTARIO
CLAREMONT
UPLAND
RANCHO CUCAMONGA
FONTANA
RIALTO
SAN BERNARDINO
HIGHLAND
REDLANDS
LOMA LINDA
MONTCLAIR
POMONA
WALNUT
WEST COVINA
COVINA
CHINO
GRAND TERRACE
CALIMESA
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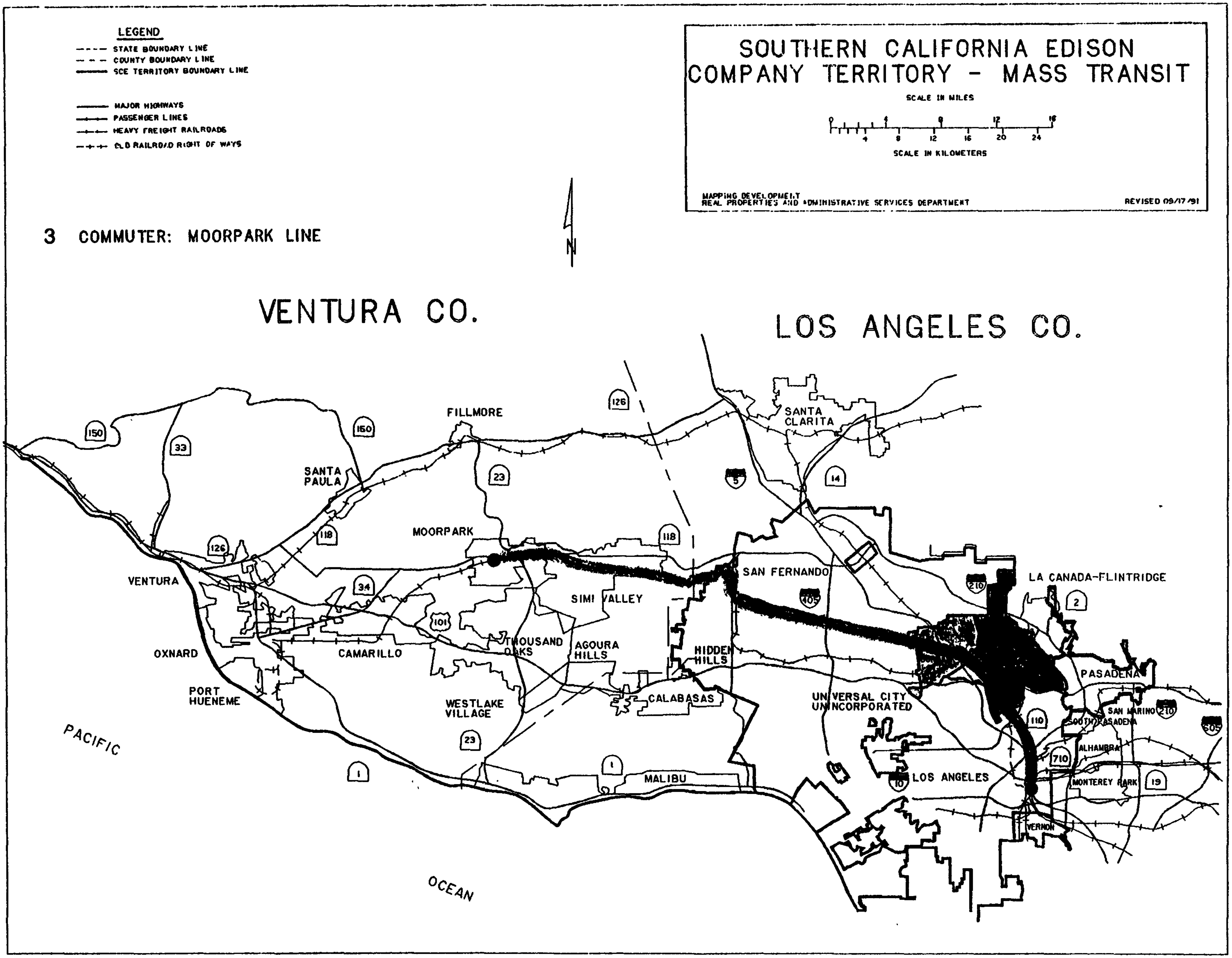
NORCO
CORONA
MORENO VALLEY
YORBA LINDA
FULLERTON
LA HABRA
LA MIRADA
WHITTIER
PERRIS
HEMET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HEAVY FREIGHT RAILROADS
OLD RAILROAD RIGHT OF WAYS
SOUTHERN CALIFORNIA EDISON
COMPANY TERRITORY - MASS TRANSIT
SCALE IN MILES
0 4 8 12 16
4 8 12 16 20 24
SCALE IN KILOMETERS
MAPPING DEVELOPMENT
REAL PROPERTIES AND ADMINISTRATIVE SERVICES DEPARTMENT
REVISED 09/17/91
3 COMMUTER: MOORPARK LINE
N
VENTURA CO.
LOS ANGELES CO.
FILLMORE
SANTA CLARITA
SANTA PAULA
MOORPARK
SAN FERNANDO
LA CANADA-FLINTRIDGE
VENTURA
SIMI VALLEY
OXNARD
CAMARILLO
THOUSAND OAKS
AGOURA HILLS
HIDDEN HILLS
PASADENA
PORT HUENEME
WESTLAKE VILLAGE
CALABASAS
UNIVERSAL CITY UNINCORPORATED
SAN MARINO
SOUTH PASADENA
ALHAMBRA
LOS ANGELES
MONTEREY PARK
MALIBU
VERNON
PACIFIC
OCEAN
150
33
126
118
23
34
101
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14
405
210
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110
710
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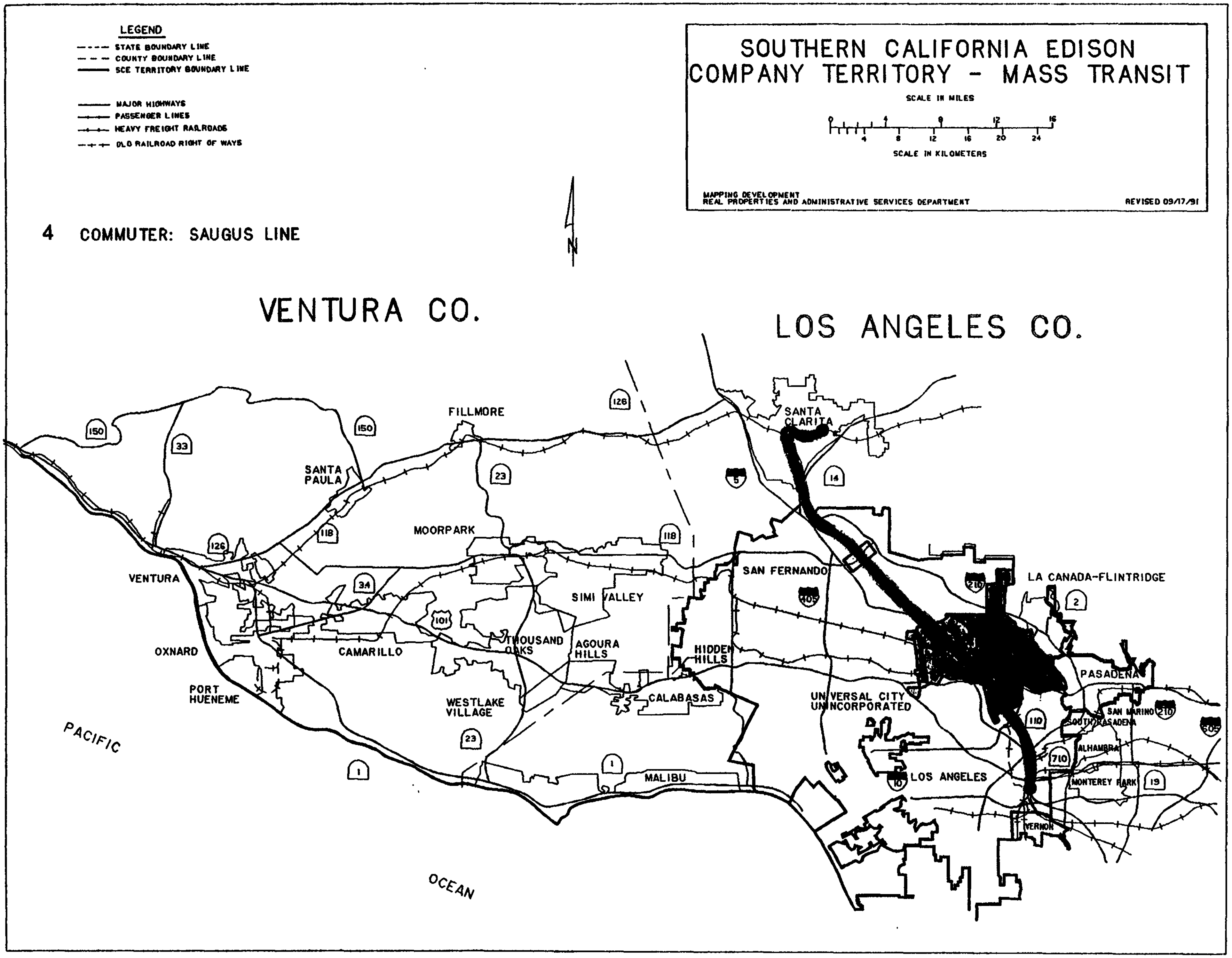
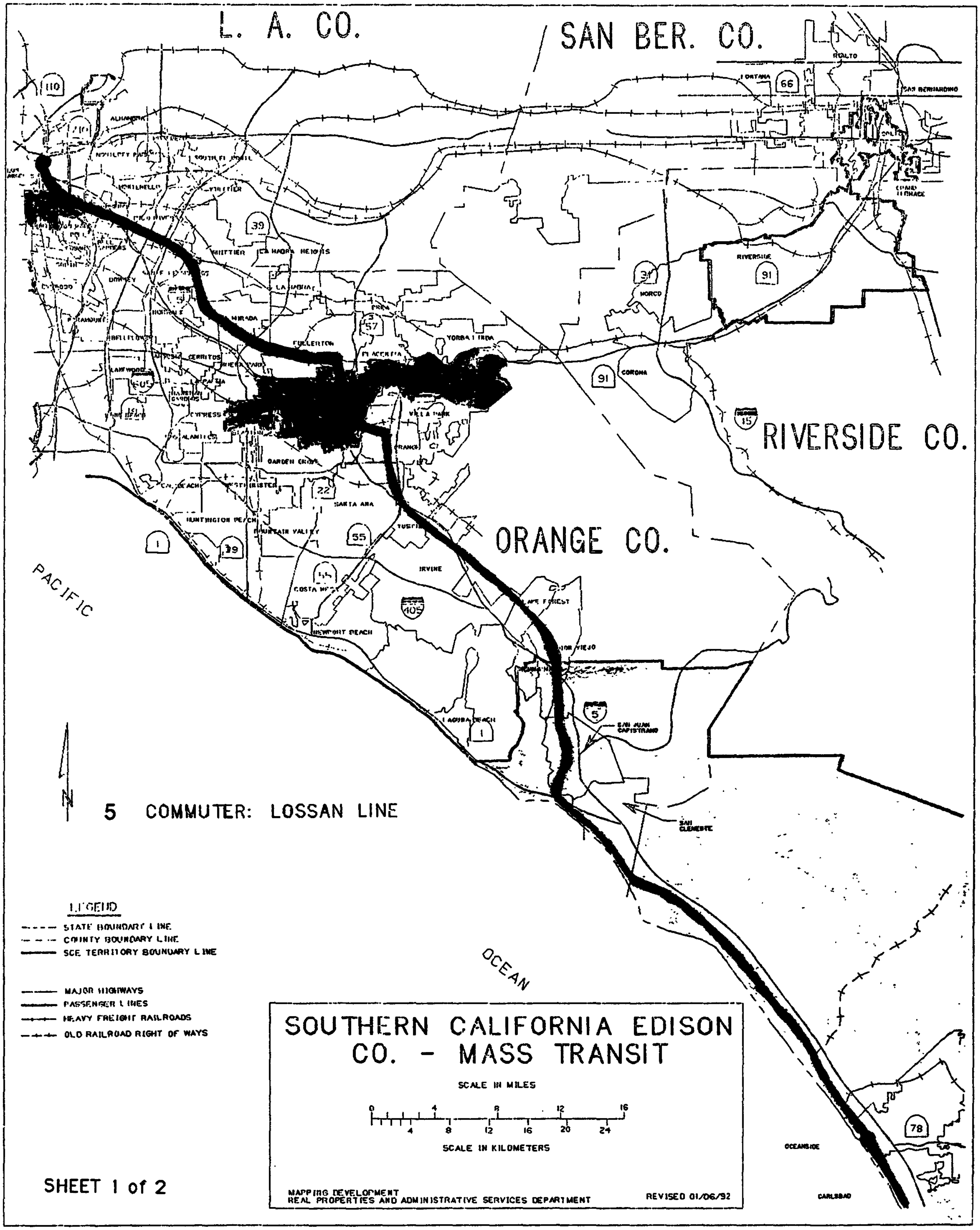
1

4 COMMUTER: SAUGUS LINE




L. A. CO.
SAN BER. CO.
RIVERSIDE CO.
ORANGE CO.
PACIFIC
OCEAN
5 COMMUTER: LOSSAN LINE
LEGEND
STATE BOUNDARY LINE
COUNTY BOUNDARY LINE
SCE TERRITORY BOUNDARY LINE
MAJOR HIGHWAYS
PASSENGER LINES
HEAVY FREIGHT RAILROADS
OLD RAILROAD RIGHT OF WAYS
SOUTHERN CALIFORNIA EDISON
CO. - MASS TRANSIT
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SHEET 1 of 2
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WHITTIER
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CYPRESS
GARDEN GROVE
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HUNTINGTON BEACH
FOUNTAIN VALLEY
IRVINE
COSTA MESA
NEWPORT BEACH
LAGUNA BEACH
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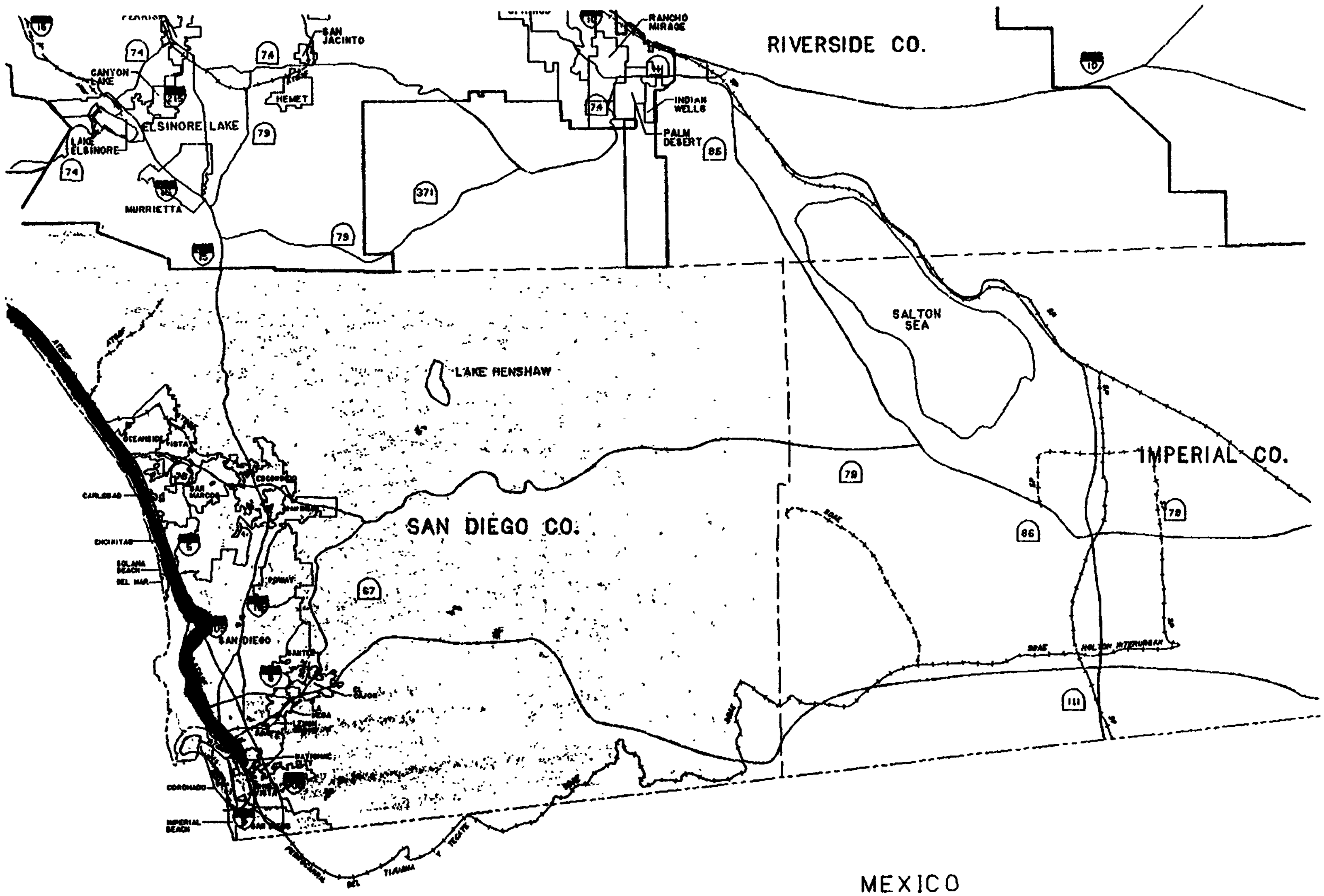
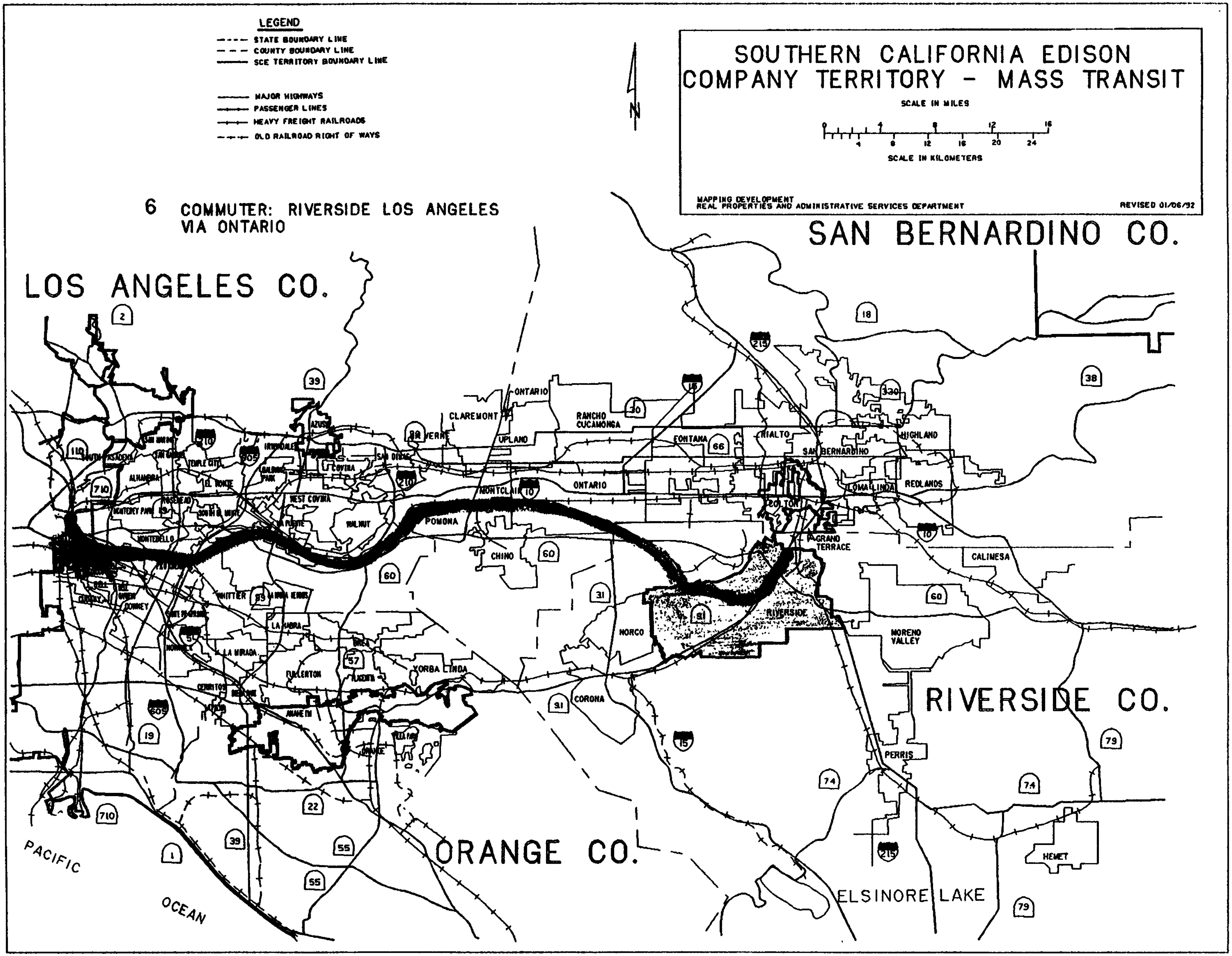


SOUTHERN CALIFORNIA EDISON
COMPANY TERRITORY - MASS TRANSIT

5 COMMUTER: LOSSAN LINE

SHEET 2 of 2



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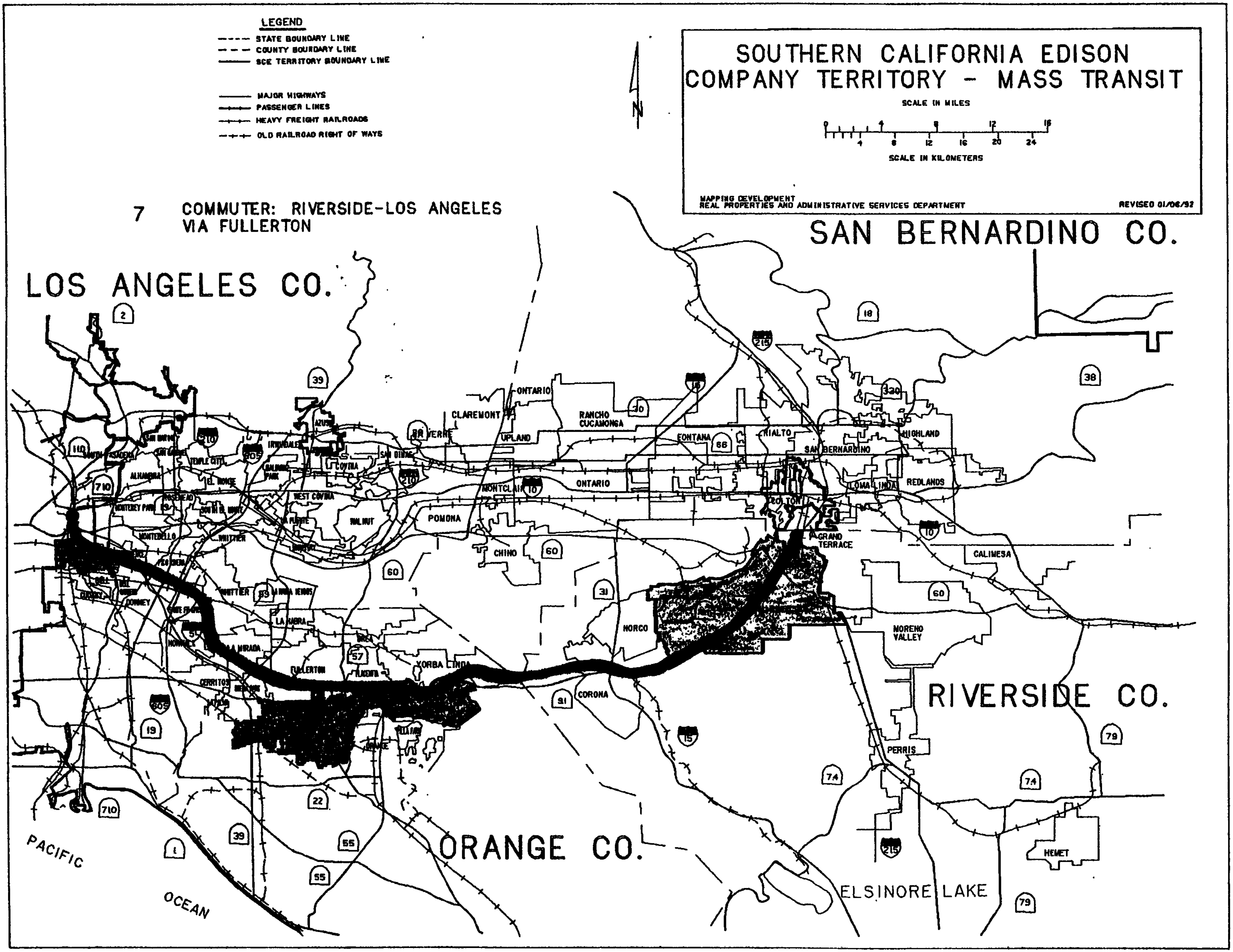

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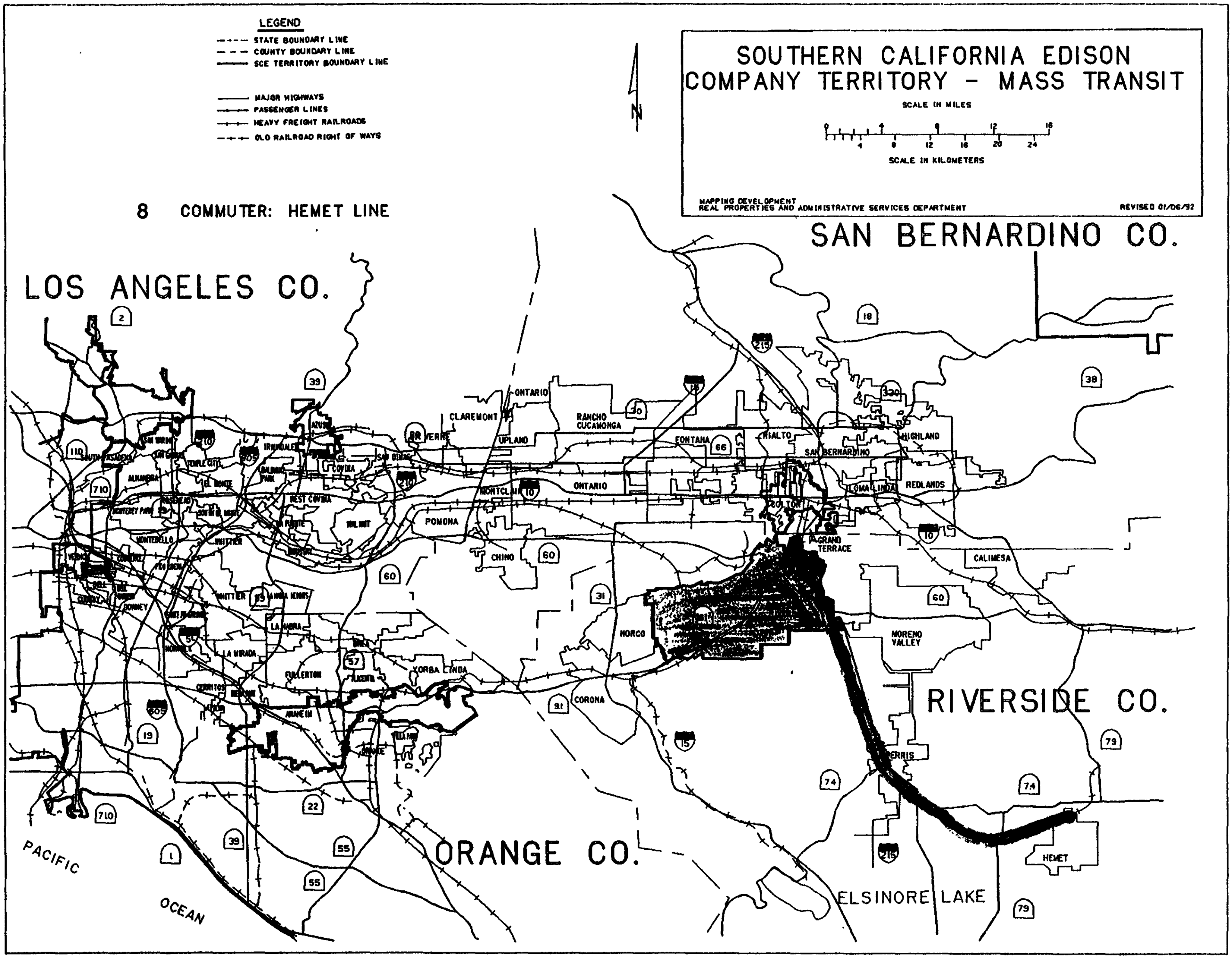

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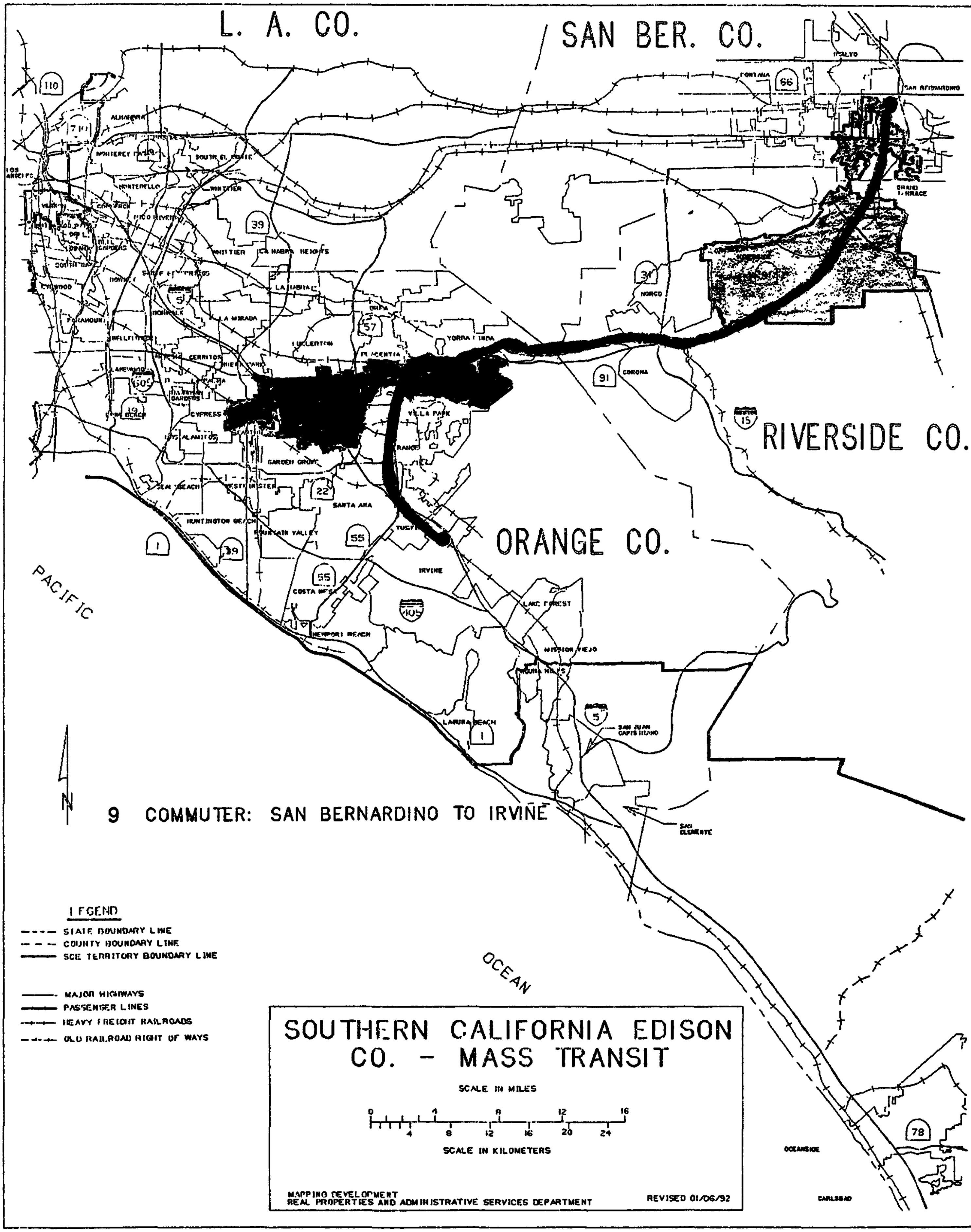
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ORANGE CO.
PACIFIC
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9 COMMUTER: SAN BERNARDINO TO IRVINE
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REVISED 01/06/92
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PLACENTIA
YORBA LINDA
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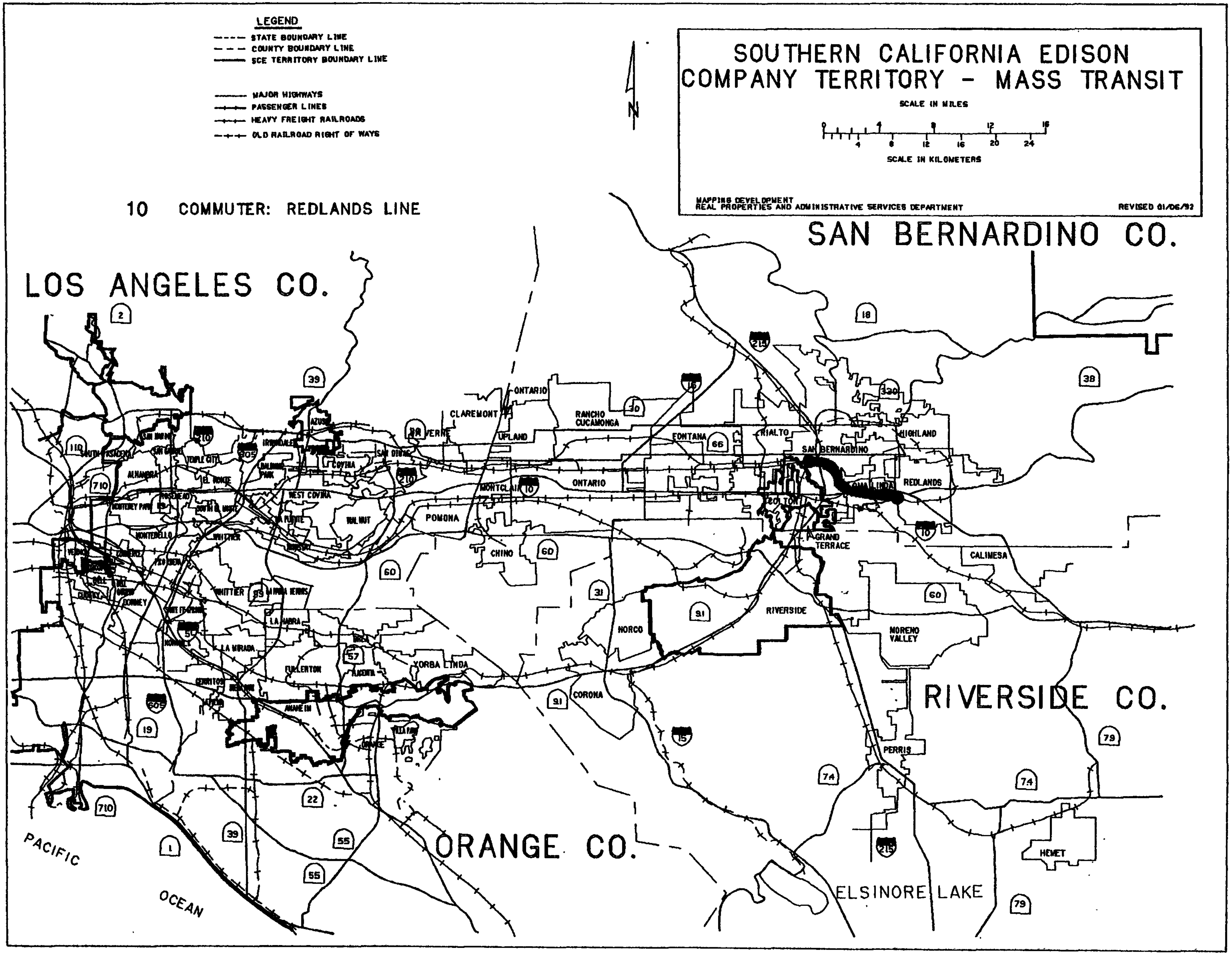

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REVISED 01/06/92
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10 COMMUTER: REDLANDS LINE
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CERRITOS
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MORENO VALLEY
PERRIS
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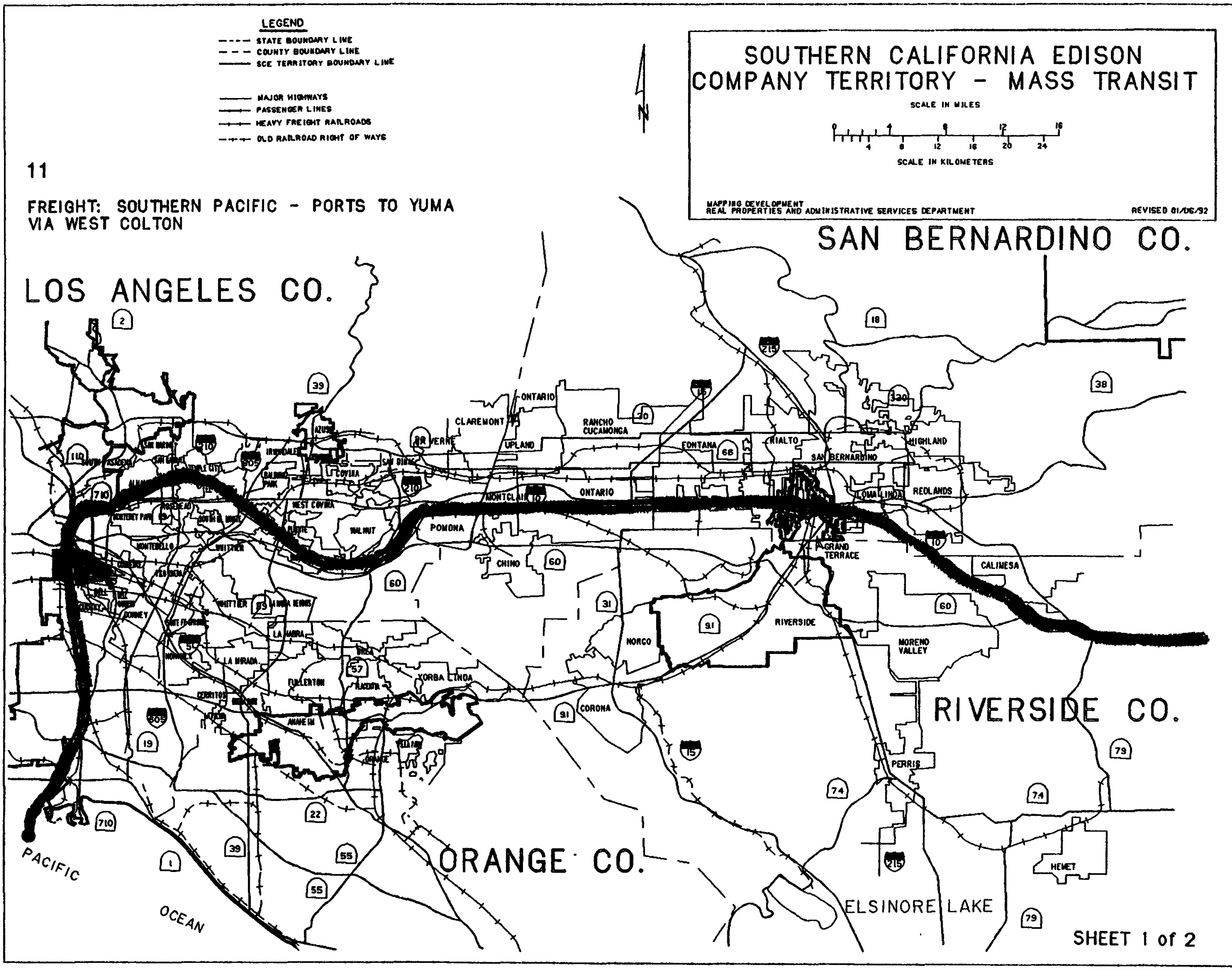
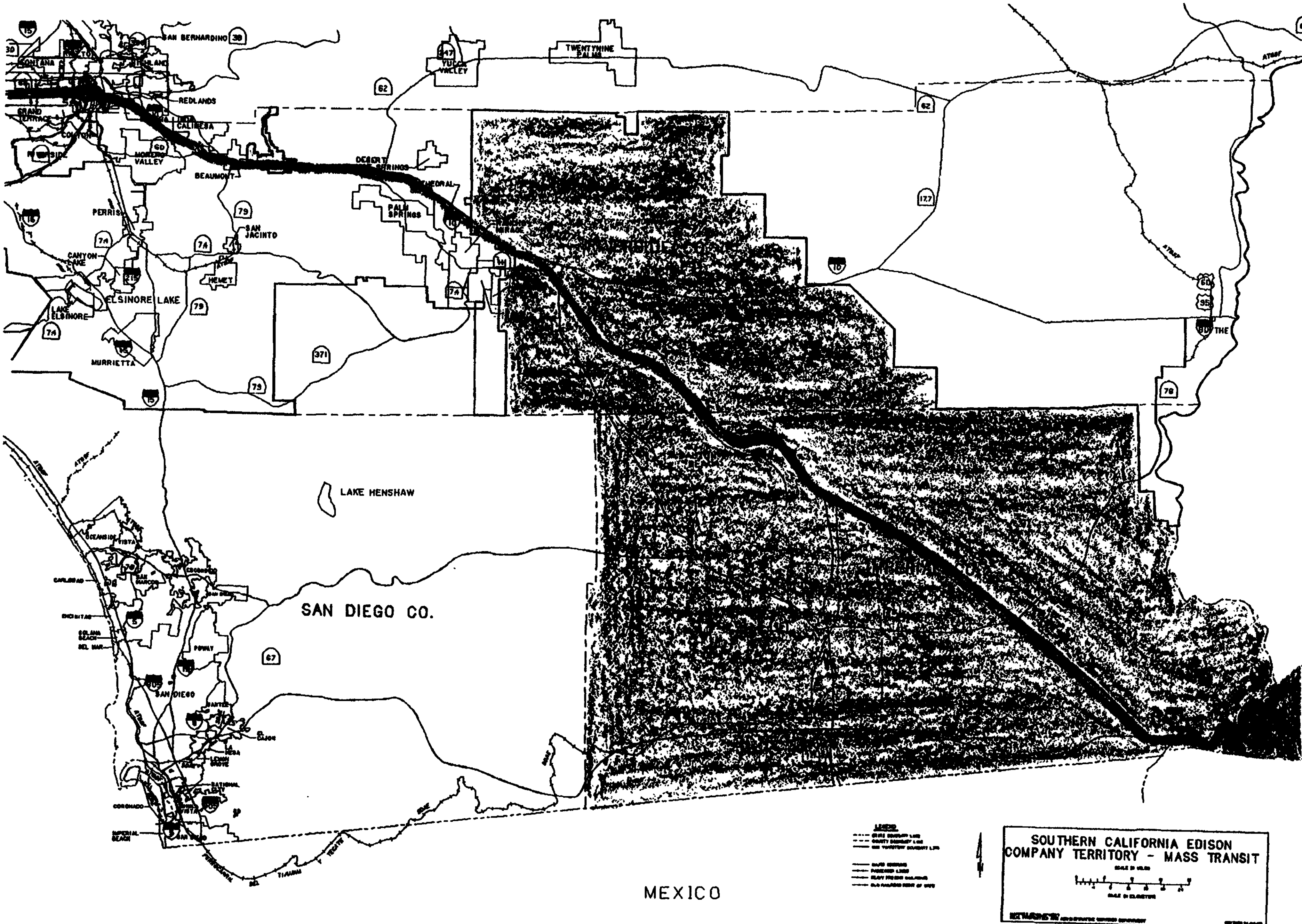
11

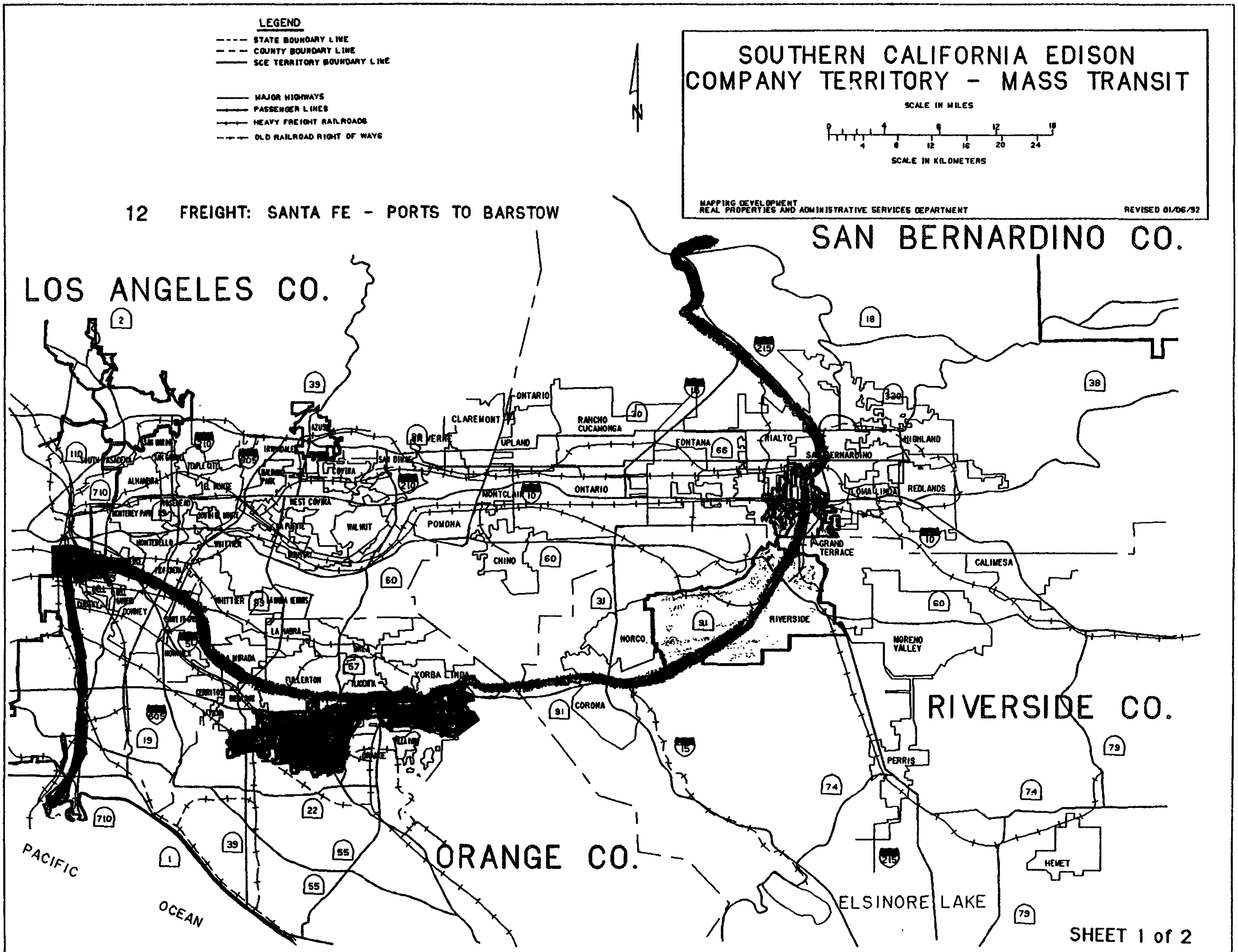
FREIGHT: SOUTHERN PACIFIC - PORTS TO YUMA VIA WEST COLTON





11 FREIGHT: SOUTHERN PACIFIC - PORTS TO YUMA VIA WEST COLTON

SHEET 2 of 2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REVISED 01/06/92
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ORANGE CO.
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CLAREMONT
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RANCHO CUCAMONGA
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RIALTO
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REDLANDS
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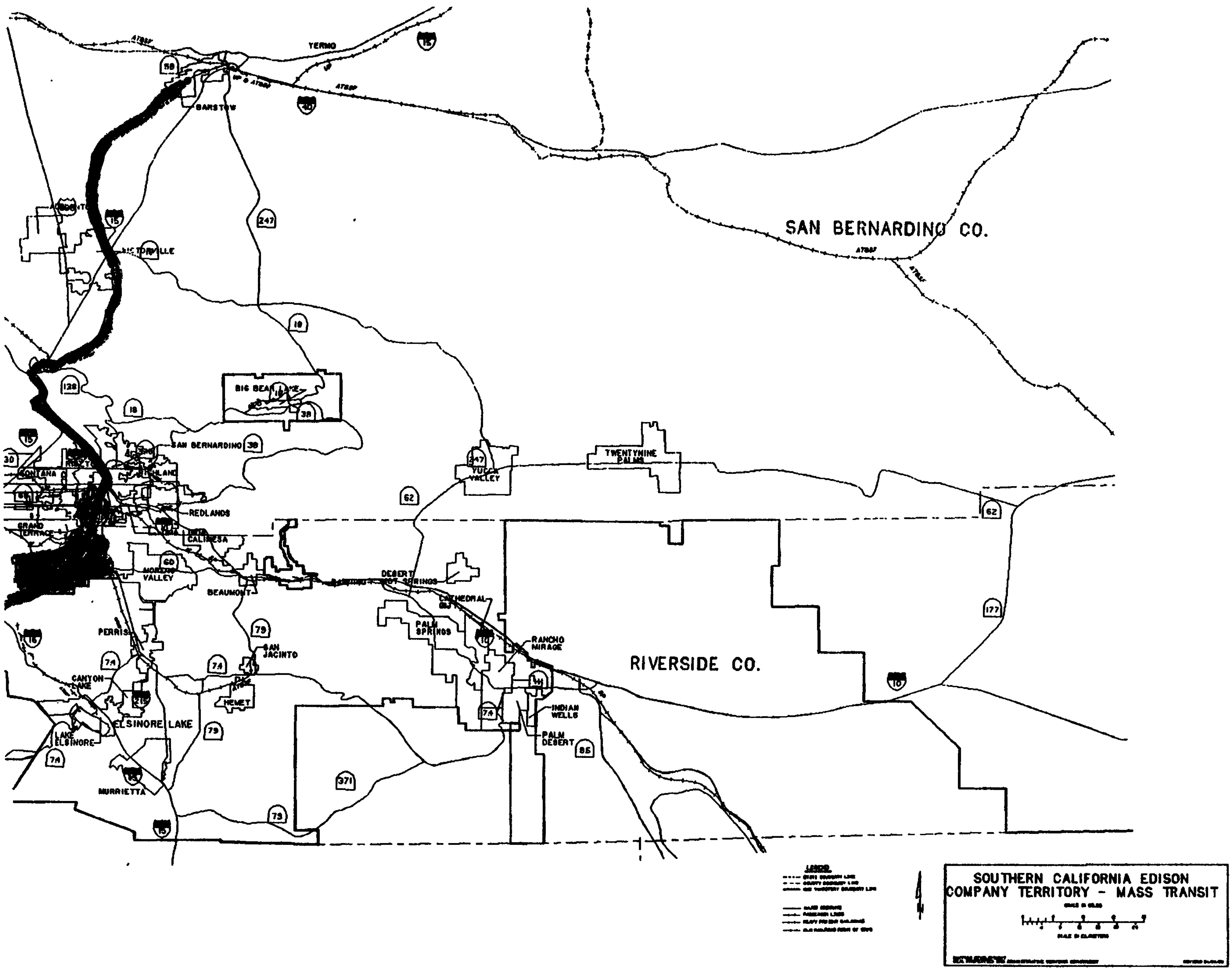
SHEET 1 of 2



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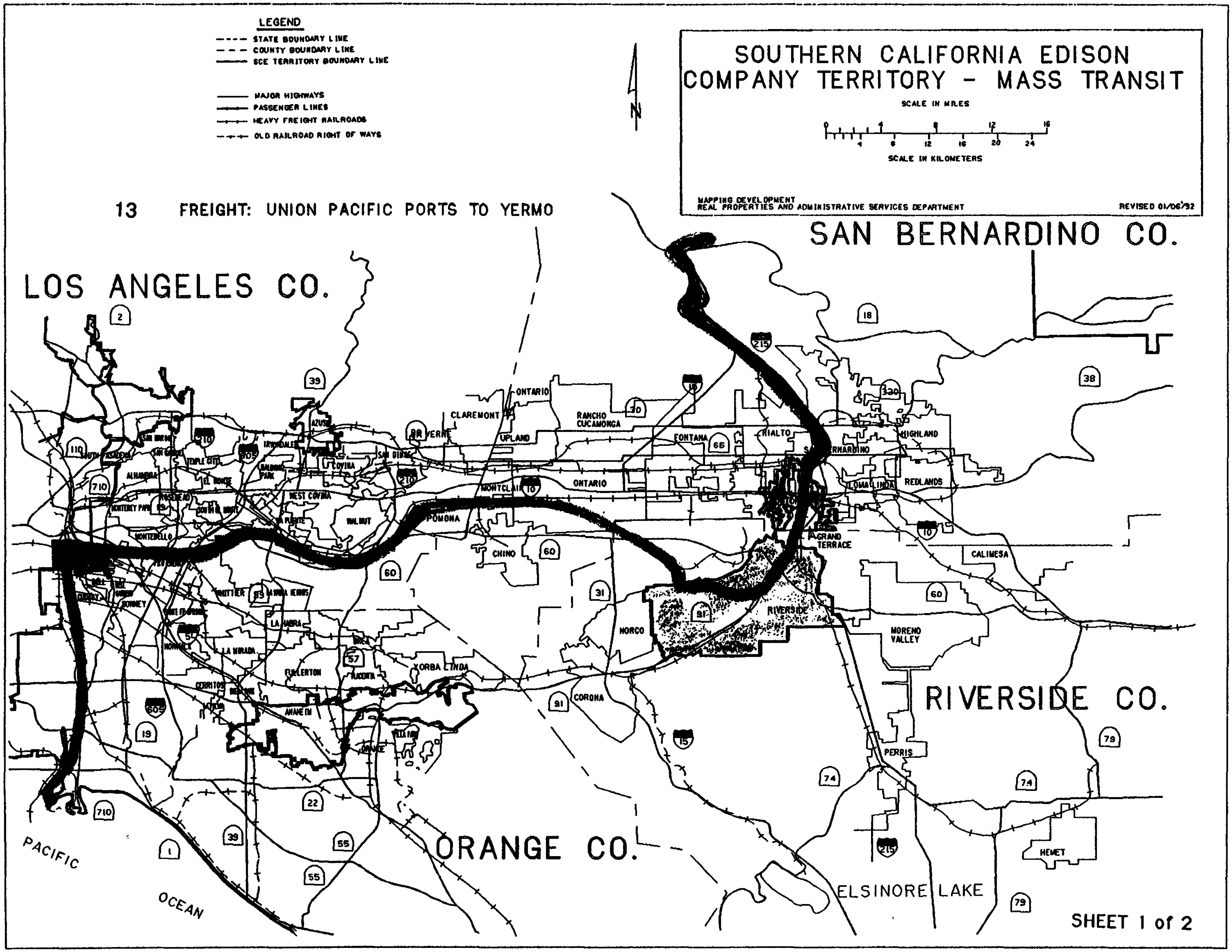
FREIGHT: SANTA FE -
PORTS TO BARSTOW

SHEET 2 of 2



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REVISED 01/06/92
13 FREIGHT: UNION PACIFIC PORTS TO YERMO
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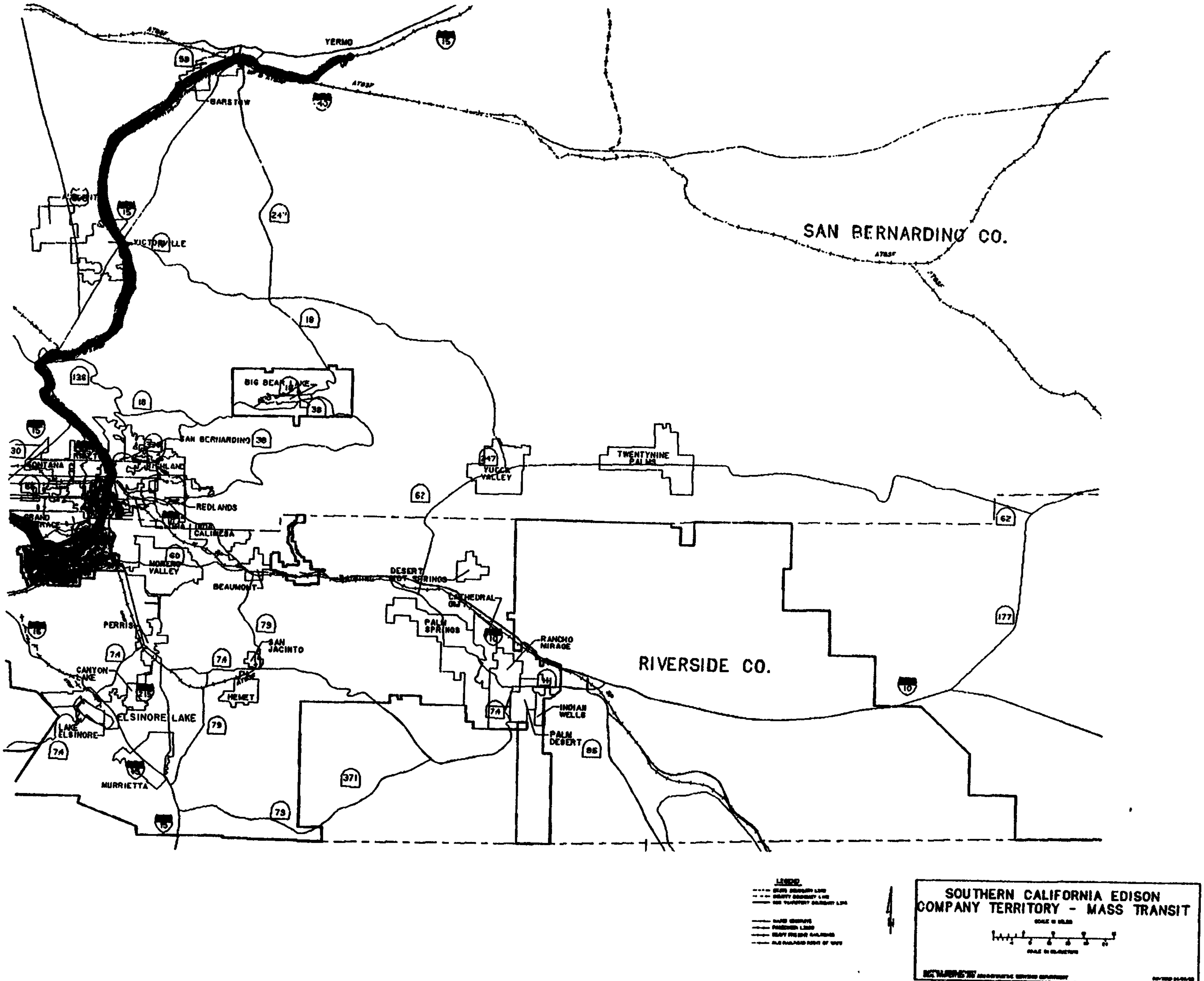
SHEET 1 of 2



SHEET 2 of 2

FREIGHT: UNION PACIFIC - PORTS TO YERMO

10.3 ELECTRIC UTILITY PARTICIPATION

10.3.1 Investor-owned Electric Utilities

10.3.1.1 General

Investor-owned utilities in California are under the jurisdiction of the California Public Utilities Commission (CPUC). The CPUC is vested with broad powers and regulatory authority to oversee the business activity of the investor-owned utilities and ensure that the interests of the utility ratepayers are served.

By virtue of the exclusive operating franchise granted to the utility within its defined service area, the utility has the obligation to provide electric service to customers within this service area. To meet this obligation to serve, the utility constructs, owns, operates and maintains sufficient generation, transmission, distribution, substation and other necessary electric system facilities (electric plant) to provide reliable electric service to its customers. The utility is allowed to recover, through electric rates, the reasonable costs of facilities that are deemed necessary by the CPUC for the utility to perform its duty to the public.

10.3.1.2 Construction of Facilities to Serve New Customers

There are typically four principal ways that an investor-owned electric utility might construct, own, operate and maintain electric facilities on behalf of its customers. These four methods are addressed below.

10.3.1.2.1 Utility Rate – Base

When a system need is identified and there are sufficient anticipated revenues to support investment, electric utilities invest in new electric plant by financing the cost of the new construction and requesting recovery of those costs, including the utility's total cost of owning, operating, and maintaining these facilities, (e.g., the revenue requirement) through customer rates. This method generally applies to an electric plant which is constructed to serve the needs of utility customers on a system-wide basis, satisfies traditional utility tests of cost-effectiveness and regulatory criteria of being "used and useful." The impact on customer rates and the availability of capital must be considered.

10.3.1.2.2 Customer Funded Facilities

When there are insufficient anticipated revenues to support an investment, utilities require the applicant to fund the portion of the investment anticipated to be unsupported by revenues. The applicant is also required to advance an ownership fund for the period of time that there may be insufficient revenue. This ensures that the utility's other ratepayers do not unfairly subsidize any single customer. The customer provides the required funds to the utility in advance of construction. The utility constructs, owns, operates and maintains the facility. The customer pays for electric service at a standard tariffed rate.

10.3.1.2.3 Utility Financed Added Facilities [1]

On a utility financed Added Facilities basis, the serving electric utility finances and constructs the facilities and recovers the cost of owning, operating, and maintaining the added facilities from the customer through a monthly added facilities payment.

10.3.1.2.4 Customer Financed Added Facilities [1]

On a customer financed Added Facilities basis, the customer finances the installed cost of the facilities and pays a monthly added facilities payment through which the utility recovers its ongoing costs of ownership. In other respects, this procedure is similar to utility financed added facilities in that the utility owns, operates, and maintains the facilities.

10.3.1.3 Rate Treatment for Rail Electrification Facilities

An argument may be made that the benefits of an electrified public rail system accrue to the general public through reduced traffic congestion and improved air quality. The CPUC could determine that the facilities required for rail electrification are appropriately constructed, owned, operated and maintained by the utility and recovered through a utility's rates. Traditional electric utility regulation is based on charging customers rates that are based on the cost of providing electric service to each customer. Therefore, argument may also be made that the facilities required for rail electrification are non-standard facilities required to serve a single customer and that these facilities will not provide system benefits to other utility ratepayers. It can therefore be argued that these facilities are appropriately Customer Funded.

The facilities for rail electrification will require a significant investment and will require a CPUC finding that the expenditure of funds would be cost-effective and the facilities determined used and useful in the performance of the utility's duty to the public. If the utility elects to construct, own, operate and maintain electrification facilities, and seek recovery of associated costs through rates, the utility will have to file an Application with the CPUC prior to construction to determine if these costs are eligible for such rate treatment.

The CPUC will carefully examine any extension of the traditional electric utility function, the costs to the utility's ratepayers of electrification and the range of economic, environmental and other public benefits that may be realized. Although the CPUC has never been asked to review facilities required to electrify a rail system and determine if those facilities, or portions of those facilities, can be deemed "used and useful" and therefore incorporated into a utility's rate base, the broad public benefits of rail electrification may provide the CPUC a basis for determining that costs be appropriately charged to all utility ratepayers.

10.3.1.4 Rate Recovery

Although the CPUC may determine eligibility for rate treatment in rendering its decision on the utility's initial Application, the CPUC will not, at this time, approve collecting the estimated costs through rates. After the facility is constructed and in-service, the utility must request recovery of the recorded costs. This usually occurs through a utility's General Rate Case(GRC) proceeding. Currently, a utility may file a GRC every three years. Recovery may

---

1 The purpose of both applicant and utility financed Added Facilities mechanism is for the utility to recover its costs of owning capacity and maintaining facilities which are, in addition to, or in substitution for, facilities normally necessary to provide electric service.

The information requirements identified in Appendix 10-1 do not represent the entire range of information that may be contained in a utility application, but do represent the baseline data required to evaluate specific proposals. Additional work will be required of the utilities to customize their individual applications and ensure that all requirements of their respective agencies are met.

10.4.2 Environmental Compliance

If rail electrification is determined to be a development project subject to the requirements of the California Environmental Quality Act (CEQA), and determined not to be exempt from that provision, environmental documentation in compliance with that statute will be required in conjunction with any state agency's discretionary action approving or disapproving a project.

10.4.2.1 Investor-owned Utilities

If the CPUC is determined to be the lead state agency for CEQA application review for rail electrification on behalf of an investor-owned utility, the utility is required to also submit a Proponent's Environmental Assessment (PEA). The CPUC provides guidance for informational contents of PEAs in the "State of California Public Utilities Commission Information and Criteria List – Appendix B" Relevant portions of that Appendix are provided in this document as Appendix 10-2. Provided in Appendix 10-3 are the State guidelines for preparing the Proponent's Environmental Assessment (i.e., instructions for completing the form in Appendix 10-2).

If a state agency other than the CPUC is determined to lead the CEQA review, the CPUC could jointly prepare environmental documentation or participate as a responsible agency in the other agency's review process. The CPUC would be required to consider the state prepared Environmental Impact Report or Negative Declaration in approving or disapproving the utility's Application. In this circumstance, a PEA need not be filed with the utility's Application. The Negative Declaration or EIR would be incorporated by reference in the utility's Application.

10.4.2.2 Municipal Utilities

If rail electrification is subject to CEQA review, Municipal utilities will also be required to comply with CEQA concerning any applications they might file. For rail electrification, it is not expected that the municipalities will assume the lead agency role in the CEQA process. They will be directly involved in the process as a responsible agency and must consider the state prepared Environmental Impact Report or Negative Declaration in approving or disapproving the Application.

Examples of environmental checklists required to be submitted with municipal applications are included in Appendix 10-2. These checklists are representative of the environmental review generally required by municipal utilities.

10.5 REGULATORY REVIEW PROCESS/SCHEDULE

10.5.1 Investor-Owned Utilities

10.5.1.1 Utility Application

As previously noted, if an investor-owned utility elects to construct, own, operate and maintain portions of an electrified rail system and seek recovery of the associated cost through rates, the utility must seek CPUC approval prior to construction. The CPUC review process commences with the filing of a utility-prepared Application setting forth the utility's request. The Application must contain supporting testimony and documentation which will enable the CPUC to determine:

- If the utility may construct, own, operate and maintain the electrification facilities
- If the costs are eligible to be recovered through rates
- The allocation of such costs to the appropriate customer (i.e., solely to the rail electrification customer, or to other groups of customers).

The Application and supporting exhibits must contain complete project information including project description, cost and benefit information and, where required, environmental compliance data. (Project information needs and environmental compliance requirements are presented in Appendix 10-1 through 10-3. The burden of proof rests with the Applicant.

A flow chart of the expected CPUC review process is shown in Exhibits 10-16A and 10-16B.

10.5.1.2 CEQA Compliance

10.5.1.2.1 CPUC as State Lead Agency

Based on the assumption that rail electrification is to the provisions of CEQA, with the CPUC acting as the state lead agency, the Commission's Advisory and Compliance Division (CACD) has 30 days to determine if a utility Application is complete and acceptable for processing. If there are deficiencies in the information provided, the Applicant must be notified of these deficiencies in writing. When all deficiencies are remedied, the Application may be re-submitted.

Upon acceptance of the application, the CACD initiates preparation of an initial study to determine the need for required environmental documentation, in particular, a Negative Declaration or an Environmental Impact Report (EIR). A Negative Declaration (a finding that a project will result in no significant environmental impact) may be prepared by the CACD staff. In instances when an EIR is required, a contractor is usually employed to prepare the environmental document.

Public scoping meetings, which serve to identify public concerns, are generally held early in the process. The draft EIR is circulated for public review and comment for a statutorily mandated period of 45 days. Although hearings are not mandated by CEQA, the CPUC generally conducts both public and evidentiary hearings. Parties to the proceeding may present testimony during these hearings. A final EIR is than prepared which responds to questions raised during the review process.

At the conclusion of hearings, the case is submitted to the presiding Administrative Law Judge (ALJ). The ALJ then writes a proposed decision. The ALJ proposed decision must be issued for a 30 day review period for correction of fact or legal error. The ALJ's proposed decision and the Final EIR are then submitted for the CPUC's consideration. The CPUC may adopt all or any part of the ALJ's proposed decision or prepare a decision of its own. The final EIR must be considered by the CPUC during its decision-making process and certified as complete. Upon approval or disapproval of the project, the CPUC issues a Notice of Determination which triggers the 30-day statutorily mandated period for legal challenge of the decision.

10.5.1.2.2 CPUC as Responsible Agency

If a state agency other than the CPUC is the designated lead agent for CEQA purposes, the CPUC can jointly prepare environmental documentation, or participate as a responsible agency in the other agency's environmental process. In this circumstance, a PEA need not be filed with the utility Application, but the CPUC must consider the other agency's Negative Declaration or EIR in its decision making process.

10.5.1.3 Timeframes for Regulatory Review

Upon acceptance of the utility's Application as complete, the time limits specified under Government Code Section 65950, et. seq., (the Permit Streamlining Act or PSA) pertaining to development projects subject to CEQA compliance are enacted.

The PSA establishes maximum timeframes for agencies to approve or disapprove a project. Lead agencies are generally required to act within one year from Application acceptance. The law does provide for limited extensions. The timeframes specified by the PSA are maximum timeframes. Agencies may act in shorter time periods, so long as the statutorily mandated time periods for public review are observed. Since failure to act within the maximum time periods specified by law renders a project to be unacceptable, mandated deadlines are carefully observed.

From the time the utility's Application is accepted as complete, a responsible agency has 6 months, or 90 days from certification of the other agency's final EIR, in which to act. The law does provide for limited extensions.

From the time a utility Application concerning rail electrification is accepted as complete, review and approval is expected to take between 6 and 12 months, depending on public input and political support/or opposition, and the role of the CPUC pursuant to CEQA.

10.5.2 Municipal Utilities

Typically, approval to participate in a project by a municipal utility is based on the results of a review process and recommendations by several municipal organizations to the City Council. A relatively complete project description including project, facility, location and cost information is initially provided to the municipality's Planning Commission. The Planning Commission's staff will review the project information, conduct an initial environmental review, assess the completeness of the information and develop a recommendation for the Planning Commission. When necessary, environmental documentation for compliance with CEQA must be prepared. As noted earlier, municipal utilities are expected to act a responsible agencies in the CEQA review process.

The Planning Commission focuses primarily on zoning and land use compatibility issues. Usually, Planning Commission meetings occur every two weeks and are open to the public. Concurrently or, usually successively, an assessment of the project cost, ratebase, revenues, and public benefits will be made by a separate organizations such as the municipality's Utility Commission or Board of Supervisors. These organizations' meetings are usually held once a month and are also open to public input.

Both the Planning Commission and Utility Commission recommendations (which include public input) are provided to the City Council. The City Council can approve or disapprove the project by resolution or refer it back to the Commission(s) staff for further review. Review and approval of a rail electrification application is expected to take between 3 and 9 months depending on completeness of project description, public input and political support and/or opposition.

A flow chart of the general municipal process is shown in Exhibit 10-17.

EXHIBIT 10-16A

Investor-Owned Utility Review Process

CPUC as Lead Agency

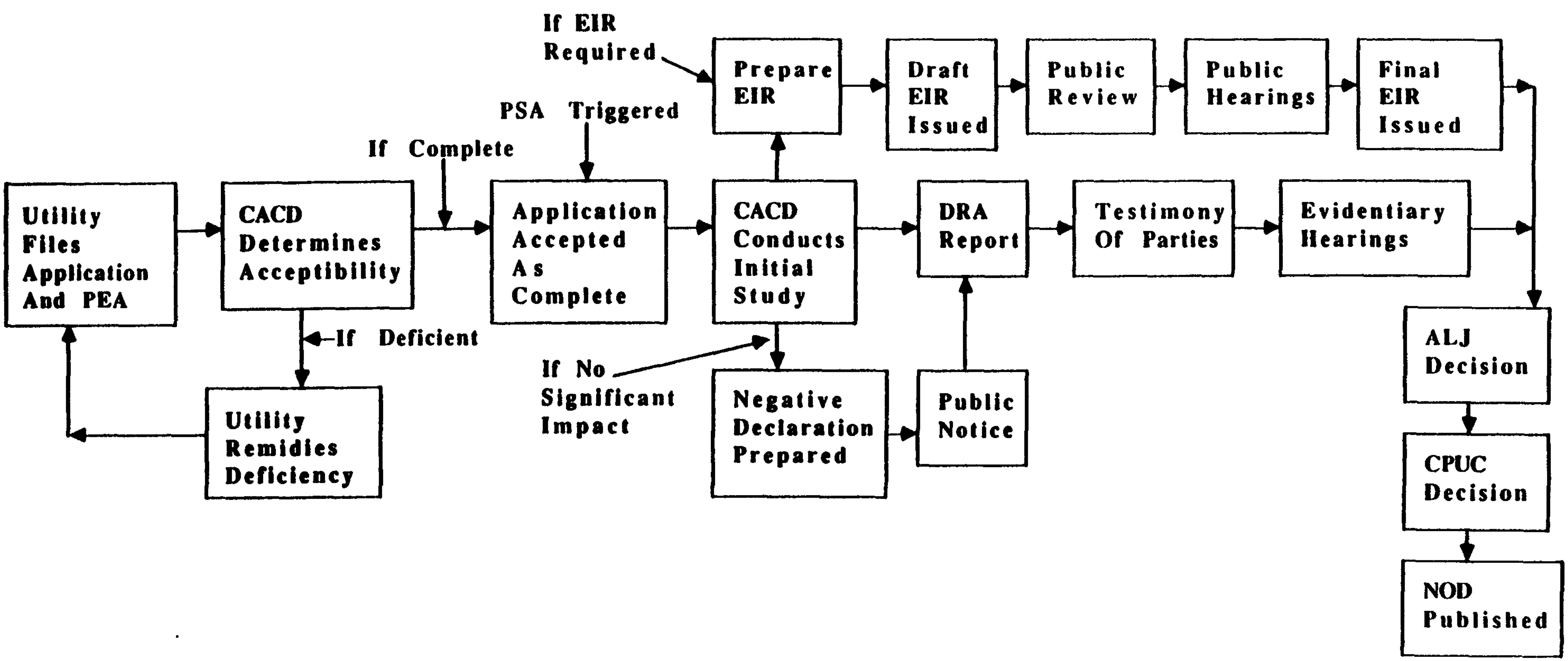


EXHIBIT 10-16B
Investor-Owned Utility Review Process
CPUC as Responsible Agency

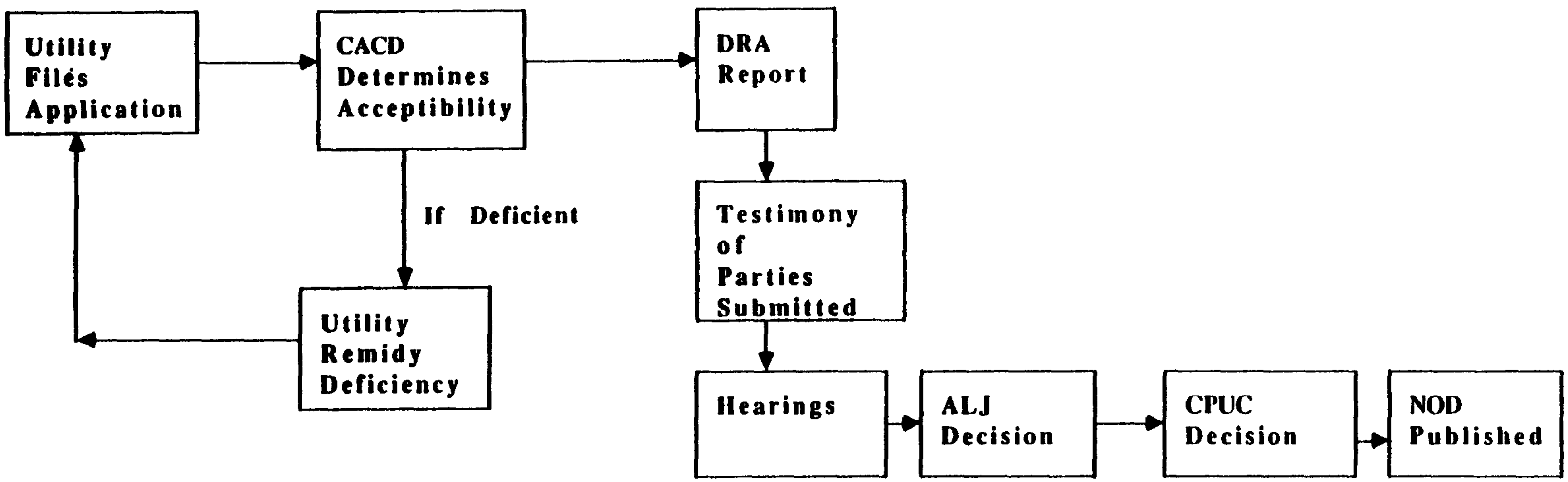
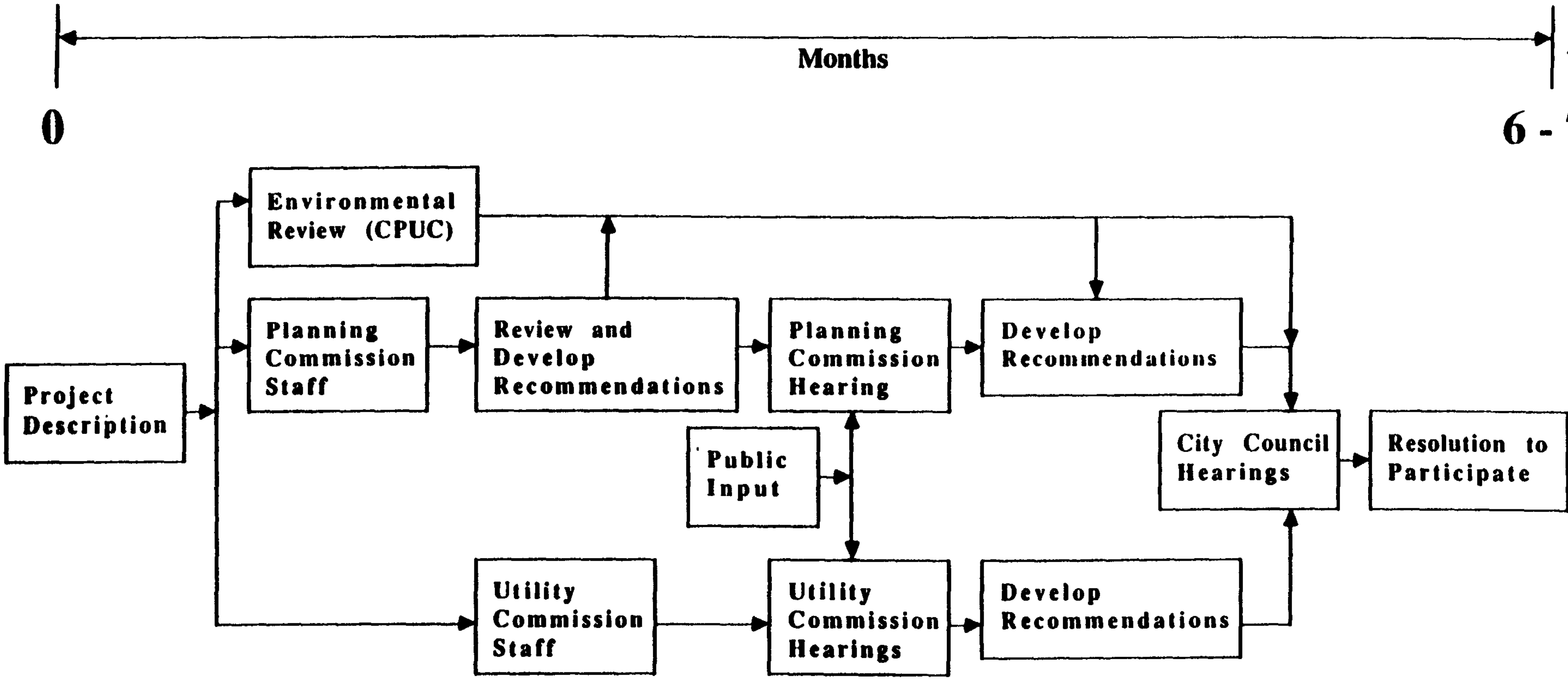


EXHIBIT 10-17
Municipal Utility Review Process



11.0 ENVIRONMENTAL ISSUES

11.0 ENVIRONMENTAL ISSUES

11.1 AIR QUALITY

In September 1991, the South Coast Air Quality Management District (SCAQMD) was requested by the Southern California Regional Rail Authority (SCRRA) to participate in the Regional Rail Electrification Task Force. SCAQMD co-chaired the Environmental Committee, whose purpose was to assess emission benefits and to perform cost effectiveness analysis based on cost data provided by the Planning, Engineering, Operations & Maintenance Analysis Committee. Sections 11.1 and 11.2 have been prepared by SCAQMD to fulfill these purposes.

Major aspects of the emissions assessment included within the scope of the Environmental Committee's activities were:

- Candidate routes 2 through 13 were studied. This included SCRRA's planned nine route commuter train system, Amtrak passenger rail service, and freight rail operations. However, the SP/UP/ATSF Consolidated Corridor was not included.
- The year 2010 in-Basin emissions impacts for each corridor were evaluated for both diesel and electric train scenarios. All rail passengers and line haul freight operations were considered for electrification. In addition, the avoided vehicle emissions for SCRRA's planned commuter train system were determined.
- The capital cost effectiveness of reducing NOx emissions through rail electrification in the Basin was evaluated systemwide as well as for each corridor. (O&M cost impacts and the capital cost of electric locomotives were not included).

Principal air quality findings are:

- For the rail electrification scenario studied, (all train operations electrified except local and switching trains), Basinwide year 2010 train NOx emissions would be reduced by 27 tons per day, corresponding to a 76 percent decrease in Basinwide train NOx emissions. (This assumes 1992 locomotive technology in the year 2010).
- Because of the shortfall in the percentage of NOx emissions decreased as a result of rail electrification, compared to the 90 percent AQMP reduction goal, other strategies may be needed to attain the goal. These strategies could include implementation of alternative-fueled locomotives for rail operations not targeted for electrification.
- Using a cost to electrify rail operations in the Basin ranging from \$2.5 to \$4.05 million per route mile, as well as Discounted Cash Flow (DCF) and Levelized Cash Flow (LCF) methodologies, the overall cost effectiveness for this control strategy is estimated to range from \$3,900 to \$10,900 dollars per ton of NOx reduced (Based on \$1.2 to \$1.9 billion to electrify 467.5 route miles in the Basin—the Capital Cost to electrify the candidate network was estimated by the Task Force to be \$1.9 billion, or an average of \$4.05 million per mile. The lower figures represent a dissenting opinion held by SCE.). This analysis does not include incremental rail electrification operation and maintenance costs or the capital costs associated with purchasing electric locomotives.

- Implementation of a diesel commuter rail system (in the absence of an electric system) for all nine planned commuter routes would result in an overall emissions reduction compared to the vehicles that would be taken off the road. However, there would be an estimated 520 tons per year (or 2.04 tons per operating day) increase in NOx emissions in the year 2010. (This is based upon 1992 locomotive technology as well as advances in automotive technology such as electric cars in 2010.)
- Without electrification, trains would be expected to increase their share of Basinwide NOx emissions from less than 3% currently to more than 10% in the year 2010 assuming no change in 1992 diesel locomotive technology and implementation of electric and other low-emissions rubber tired vehicles.

The purpose of the air quality analysis is to assess the emission impacts and cost effectiveness of Basinwide rail electrification. The basis of this analysis is the 1991 revision of the South Coast Air Basin Air Quality Management Plan (AQMP). Control Measure 14, which is contained in Appendix IV-E of the AQMP, targets 90 percent electrification of rail operations in the Basin.

The following steps have been taken in generating this analysis:

- An Environmental Assessment Committee was formed as part of the Electrification Task Force. (A list of committee members is provided in Appendix 11-1.)
- The Environmental Assessment Committee approved methodologies to perform the air quality impact and cost effectiveness analyses using a calculation approach which required detailed activity data from the Planning, Engineering, Operations & Maintenance Analysis (PEO&MA) Committee.
- Limited activity data were submitted to the Environmental Committee; therefore, a modified calculation approach was utilized to ensure consistency between the activity data that were used to develop cost estimates of rail electrification and corresponding emission benefits.
- The cost effectiveness portion of the analysis is only based on the capital costs of electrification facilities, because of the limited cost data submitted to the committee. Specifically, operations and maintenance data and the capital cost of locomotives were not included in the analysis. SCE has expressed a dissenting opinion regarding the capital cost of rail electrification; therefore, a range of costs is included.

Section 11.1 presents the detailed methodological approach, assumptions, and findings on commuter and freight separately. The commuter rail section is limited to SCRRA's proposed nine route commuter rail system. The freight rail section includes Amtrak rail service (due to the formatting of the freight train and Amtrak data) as well as those rail operations that are typically classified as freight, including, local, switching, and line haul trains. Cost effectiveness for both commuter and freight rail electrification is combined due to route overlap among freight and commuter rail operations, and is presented separately in its own section.

11.1.1 Commuter Rail Emissions Impact Analysis

11.1.1.1 Scope

The purpose of the commuter rail emissions analysis is to estimate the quantities of pollutants associated with a diesel locomotive-powered system, as compared to the emissions produced by electric power plants to meet the requirements of an electrified system. In addition, motor vehicle emissions reduction expected as a result of commuters traveling by train rather than passenger car are quantified. Emissions of carbon monoxide (CO), hydrocarbons (HC), oxides of nitrogen (NO_X), particulate matter (PM), and oxides of sulfur (SOx) have been determined by route, for the years 1992 through 2000 and 2010. Emissions for each route have been analyzed for three service level scenarios as explained below. Results are shown in Appendix 11-2.

The Southern California Regional Rail Authority has developed a plan for a nine route commuter rail network. The planned routes are listed in Table 11-1, as are details on projected year of start-up for each route and the peak and off-peak numbers of trains assumed for various levels of service.

TABLE 11-1

SCRRA Proposed Commuter Rail System (1)(2)

	Route	Date	Number of Trains [a]		
			Start Up	Intermed.	Mature
1	Moorpark to L.A.	1992	4 (0)	8 (4)	9 (10)
2	Santa Clarita to L.A.	1992	3 (0)	4 (0)	6 (6)
3	San Bernardino to L.A.	1992	5 (0)	8 (6)	9 (10)
4	Riverside to L.A. (via Ontario)	1993	3 (0)	5 (2)	6 (6)
5	Oceanside to L.A.	1993	8 (0)	8 (4)	10 (10)
6	Riverside to L.A. (via Fullerton)	1995	2 (0)	4 (3)	5 (14)
7	San Bern./Riverside to Irvine	1995	4 (0)	8 (3)	10 (14)
8	Hemet to Riverside	1995	2 (0)	4 (0)	5 (0)
9	Redlands to San Bernardino	1995	2 (0)	4 (2)	5 (5)

Note: [a] Numbers of off peak trains shown in parentheses. Some off-peak traffic levels have been estimated by SCAQMD staff based on data for other routes. A detailed description of service level assumptions used in this analysis is contained in Appendix 11-2.

Following is a discussion of the methodology and a summary of the emissions analysis for the nine commuter rail routes. Several general assumptions have been made in developing this analysis. They are as follows:

1. Projected service levels are, for the most part, contained in the Southern California Commuter Rail 1991 Regional System Plan (1). In instances where service levels have not been specified, values have been estimated by factoring up or down the known Plan data.
2. Total emissions for each route, by scenario, are assumed to be the sum of emissions for both peak and off-peak train operations. However, peak and off-peak emissions are considered separately in Appendix 11-2.
3. In peak service during the start up phase, each train consists of four passenger coaches. This increases to seven coaches during intermediate and mature operation. In the start up and intermediate phases, each coach is assumed to have 119 riders on average. This value has been calculated by averaging Southern California Association of Governments data supplied for routes 1, 2, 3, and 5. (2)(3) It is anticipated that coach capacity will be 140 seated passengers with additional room for 60 standing passengers. Peak ridership data for the mature scenario were not supplied; A level of 200 passengers per train car has been assumed for the mature scenario.
4. In off-peak service the number of passenger coaches for each phase is assumed to be the same as for peak service. Off-peak ridership level was not supplied for this analysis; A level of 35 passengers per coach has been assumed for the start up, intermediate, and mature levels.
5. Commuter trains are assumed to operate five days per week, 52 weeks per year, less 6 holidays per year, for a total of 254 days per year.

11.1.1.2 Commuter Rail Findings

The results of the emissions analysis for the year 2000 and 2010, assuming an intermediate level of commuter train service, are summarized in Tables 11-2 and 11-3. Detailed spreadsheets containing 1992 through 2000, as well as 2010 findings where they differ from the 1992-2000 data, are included in Appendix 11-2 for start-up, intermediate, and mature levels of service.

It is clear that an electric commuter rail system would lead to emission benefits over one based on diesel locomotives. Similarly, the electric commuter rail scenario results in lower emissions than would be achieved if passengers traveled by car. This analysis also suggests that a diesel locomotive based commuter rail system would result in lower emissions of CO, HC, and PM relative to passenger cars. However, the data indicate that more NO_X and SOx would be produced by diesel locomotives, relative to passenger cars.

11.1.1.2.1 Potential Sources of Error

Several potential sources of error which could affect the accuracy of this emissions analysis have been identified. Additional work in these areas is needed:

- Ridership estimates for four of the nine proposed commuter rail routes have been supplied by the Southern California Association of Governments. Estimates for the other rail routes have been derived by factoring, rather than actual information. Thus, estimates of avoided emissions due to commuter rail should be considered rough.
- Similarly, estimates of vehicle miles avoided for five of the routes are not based on route-specific information. This is another potential source of error.
- It is not possible to precisely estimate future locomotive emissions. The Air Resources Board staff is in the process of developing regulations for in-use diesel locomotives. However, given the early stage of regulatory development, the scope and extent of Air Resources Board control can only be estimated at this time. Accordingly, 1992 locomotive technology has been assumed to be in use in the year 2010.

TABLE 11-2

2000 Commuter Rail Emissions Summary – Tons Per Year

Peak Plus Off-Peak Emissions, Intermediate Level of Service

NOx EMISSIONS							
	Route	Diesel Scenario	Electric Scenario	Vehicle Emissions Avoided	Difference (Diesel – PC)	Difference (Electric – PC)	Difference (Electric – Diesel)
1	Ventura to L.A.	84.57	0.71	42.44	42.13	-41.73	-83.86
2	Santa Clarita to L.A.	25.41	0.22	15.13	10.28	-14.91	-25.19
3	SB to L.A.	133.54	1.14	95.98	37.56	-94.84	-132.40
4	Riverside to L.A. (Ontario)	69.48	0.59	39.93	29.55	-39.34	-68.89
5	Oceanside to L.A.	173.30	1.47	84.30	89.00	-82.83	-171.83
6	Riverside to L.A. (Fullerton)	74.22	0.63	37.25	36.97	-36.62	-73.59
7	SB/Riverside to Irvine	109.56	0.93	63.69	45.87	-62.76	-108.63
8	Hemet to Riverside	26.74	0.23	19.25	7.49	-19.02	-26.51
9	Redlands to SB	12.15	0.10	6.69	5.46	-6.59	-12.05
	Total NOx (tons/year)	708.97	6.02	404.66	304.31	-398.64	-702.95
	Total NOx (tons/day)	2.79	0.02	1.59	1.20	-1.57	-2.77

TABLE 11-2 (Continued)

PM EMISSIONS *

Route	Diesel Scenario	Electric Scenario	Vehicle Emissions Avoided	Difference (Diesel – PC)	Difference (Electric – PC)	Difference (Electric – Diesel)
1 Ventura to L.A.	3.35	0.12	23.89	-20.54	-23.77	-3.23
Santa Clarita to L.A.	1.01	0.03	5.51	-4.50	-5.48	-0.98
3 SB to L.A.	5.27	0.18	34.97	-29.70	-34.79	-5.09
4 Riverside to L.A. (Ontario)	2.74	0.10	14.55	-11.81	-14.45	-2.64
5 Oceanside to L.A.	6.87	0.24	30.71	-23.84	-30.47	-6.63
6 Riverside to L.A. (Fullerton)	2.93	0.10	13.57	-10.64	-13.47	-2.83
7 SB/Riverside to Irvine	4.33	0.15	23.20	-18.87	-23.05	-4.18
8 Hemet to Riverside	1.06	0.04	7.01	-5.95	-6.97	-1.02
9 Redlands to SB	0.48	0.02	2.44	-1.96	-2.42	-0.46
Total PM (tons-year)	28.04	0.98	155.85	-127.81	-154.87	-27.06
Total PM (tons/day)	0.11	0.00	0.61	-0.50	-0.61	-0.11

* Roughly 95 percent of passenger car PM is from tire wear.

HC EMISSIONS

Route	Diesel Scenario	Electric Scenario	Vehicle Emissions Avoided	Difference (Diesel – PC)	Difference (Electric – PC)	Difference (Electric – Diesel)
1 Ventura to L.A.	1.38	0.39	42.18	-40.80	-41.79	-0.99
2 Santa Clarita to L.A.	0.41	0.12	15.03	-14.62	-14.91	-0.29
3 SB to L.A.	2.17	0.63	95.37	-93.20	-94.74	-1.54
4 Riverside to L.A. (Ontario)	1.13	0.33	39.67	-38.54	-39.34	-0.80
5 Oceanside to L.A.	2.82	0.82	83.76	-80.94	82.94	-2.00
6 Riverside to L.A. (Fullerton)	1.21	0.35	37.02	-35.81	-36.67	-.0.86
7 SB/Riverside to Irvine	1.79	0.52	63.28	-61.49	-62.76	-1.27
8 Hemet to Riverside	0.44	0.13	19.13	-18.69	-19.00	-0.31
9 Redlands to SB	0.20	0.06	6.65	-6.45	-6.59	-0.14
Total HC (tons/year)	11.55	3.35	402.09	-390.54	-398.74	-8.20
Total HC (tons/day)	0.05	0.01	1.58	-1.54	-1.57	-0.03

TABLE 11-2 (Continued)

CO EMISSIONS						
Route	**Diesel Scenario**	**Electric Scenario**	**Vehicle Emissions Avoided**	**Difference (Diesel – PC)**	**Difference (Electric – PC)**	**Difference (Electric – Diesel)**
1 Ventura to L.A.	11.16	0.67	396.72	-385.56	-396.05	-10.49
2 Santa Clarita to L.A.	3.53	0.21	141.39	-137.86	-141.18	-3.32
3 SB to L.A.	18.67	1.08	897.07	-878.40	-895.99	-17.59
4 Riverside to L.A. (Ontario)	9.72	0.56	373.15	-363.43	-372.59	-9.16
5 Oceanside to L.A.	23.77	1.40	787.85	-764.08	-786.45	-22.37
6 Riverside to L.A. (Fullerton)	10.38	0.60	348.15	-337.77	-347.55	-9.78
7 SB/Riverside to Irvine	15.32	0.89	595.14	-579.82	-594.25	-14.43
8 Hemet to Riverside	3.74	0.22	179.92	-176.18	-179.70	-3.52
9 Redlands to SB	1.70	0.10	62.52	-60.82	-62.42	-1.60
Total CO (tons-year)	97.99	5.73	3781.91	-3683.92	-3776.18	-92.26
Total CO (tons/day)	0.39	0.02	14.89	-14.59	-14.87	-0.36

SOx EMISSIONS						
Route	**Diesel Scenario**	**Electric Scenario**	**Vehicle Emissions Avoided**	**Difference (Diesel – PC)**	**Difference (Electric – PC)**	**Difference (Electric – Diesel)**
1 Ventura to L.A.	6.73	0.04	3.39	3.34	-3.35	-6.69
2 Santa Clarita to L.A.	2.05	0.01	1.21	0.84	-1.20	-2.04
3 SB to L.A.	10.80	0.06	7.68	3.12	-7.62	-10.74
4 Riverside to L.A. (Ontario)	5.61	0.03	3.20	2.41	-3.17	-5.58
5 Oceanside to L.A.	13.93	0.08	6.74	7.19	-6.66	-13.85
6 Riverside to L.A. (Fullerton)	6.00	0.03	2.98	3.02	-2.95	-5.97
7 SB/Riverside to Irvine	8.86	0.05	5.10	3.76	-5.05	-8.81
8 Hemet to Riverside	2.16	0.01	1.54	0.62	-1.53	-2.15
9 Redlands to SB	0.98	0.00	0.54	0.44	-0.54	-0.98
Total SOx (tons/year)	57.12	0.31	32.38	24.74	-32.07	-56.81
Total SOx (tons/day)	0.22	0.00	0.13	0.10	-0.13	-0.22

TABLE 11-3

2010 Commuter Rail Emissions Summary – Tons Per Year

Peak Plus Off-Peak Emissions, Intermediate Level of Service

NOx EMISSIONS *

	Route	Diesel Scenario	Electric Scenario	Vehicle Emissions Avoided	Difference (Diesel – PC)	Difference (Electric – PC)	Difference (Electric – Diesel)
1	Ventura to L.A.	84.57	0.71	20.11	64.46	-19.40	-83.86
2	Santa Clarita to L.A.	25.41	0.22	7.17	18.24	-6.95	-25.19
3	SB to L.A.	133.54	1.14	45.48	88.06	-44.34	-132.40
4	Riverside to L.A. (Ontario)	69.48	0.59	18.92	50.56	-18.33	-68.89
5	Oceanside to L.A.	173.30	1.47	39.94	133.36	-38.47	-171.83
6	Riverside to L.A. (Fullerton)	74.22	0.63	17.66	56.56	-17.03	-73.59
7	SB/Riverside to Irvine	109.56	0.93	30.17	79.39	-29.24	-108.63
8	Hemet to Riverside	26.74	0.23	9.12	17.62	-8.89	-26.51
9	Redlands to SB	12.15	0.10	3.17	8.98	-3.07	-12.05
	Total NOx (tons/year)	708.97	6.02	191.74	517.23	-185.72	-702.95
	Total NOx (tons/day)	2.79	0.02	0.75	2.04	-0.73	-2.77

PM EMISSIONS *

	Route	Diesel Scenario	Electric Scenario	Vehicle Emissions Avoided	Difference (Diesel – PC)	Difference (Electric – PC)	Difference (Electric – Diesel)
1	Ventura to L.A.	3.35	0.12	23.75	-20.40	-23.63	-3.23
2	Santa Clarita to L.A.	1.01	0.03	5.48	-4.47	-5.45	-0.98
3	SB to L.A.	5.27	0.18	34.76	-29.49	-34.58	-5.09
4	Riverside to L.A. (Ontario)	2.74	0.10	14.46	-11.72	-14.36	-2.64
5	Oceanside to L.A.	6.87	0.24	30.53	-23.66	-30.29	-6.63
6	Riverside to L.A. (Fullerton)	2.93	0.10	13.50	-10.57	-13.40	-2.83
7	SB/Riverside to Irvine	4.33	0.15	23.07	-18.74	-22.92	-4.18
8	Hemet to Riverside	1.06	0.04	6.97	-5.91	-6.93	-1.02
9	Redlands to SB	0.48	0.02	2.42	-1.94	-2.40	-0.46
	Total PM (tons-year)	28.04	0.98	154.94	-126.90	-153.96	-27.06
	Total PM (tons/day)	0.11	0.00	0.61	-0.50	-0.61	-0.11

* More than 95 percent of passenger car PM is from tire wear.

TABLE 11-3 (Continued)

HC EMISSIONS							
	Route	**Diesel Scenario**	**Electric Scenario**	**Vehicle Emissions Avoided**	**Difference (Diesel – PC)**	**Difference (Electric – PC)**	**Difference (Electric – Diesel)**
1	Ventura to L.A.	1.38	0.39	13.69	-12.31	-13.30	-0.99
2	Santa Clarita to L.A.	0.41	0.12	4.88	-4.47	-4.76	-0.29
3	SB to L.A.	2.17	0.63	30.97	-28.80	-30.34	-1.54
4	Riverside to L.A. (Ontario)	1.13	0.33	12.88	-11.75	-12.55	-0.80
5	Oceanside to L.A.	2.82	0.82	27.20	-24.38	-26.38	-2.00
6	Riverside to L.A. (Fullerton)	1.21	0.35	12.02	-10.81	-11.67	-0.86
7	SB/Riverside to Irvine	1.79	0.52	20.55	-18.76	-20.03	-1.27
8	Hemet to Riverside	0.44	0.13	6.21	-5.77	-6.08	-0.31
9	Redlands to SB	0.20	0.06	2.16	-1.96	-2.10	-0.14
	Total HC (tons/year)	11.55	3.35	130.56	-119.01	-127.21	-8.20
	Total HC (tons/day)	0.05	0.01	0.51	-0.47	-0.50	-0.03

CO EMISSIONS							
	Route	**Diesel Scenario**	**Electric Scenario**	**Vehicle Emissions Avoided**	**Difference (Diesel – PC)**	**Difference (Electric – PC)**	**Difference (Electric – Diesel)**
1	Ventura to L.A.	11.16	0.67	198.52	-187.36	-197.85	-10.49
2	Santa Clarita to L.A.	3.53	0.21	70.75	-67.22	-70.54	-3.32
3	SB to L.A.	18.67	1.08	448.91	-430.24	-447.83	-17.59
4	Riverside to L.A. (Ontario)	9.72	0.56	186.74	-177.02	-186.18	-9.16
5	Oceanside to L.A.	23.77	1.40	394.26	-370.49	-392.86	-22.37
6	Riverside to L.A. (Fullerton)	10.38	0.60	174.22	-163.84	-173.62	-9.78
7	SB/Riverside to Irvine	15.32	0.89	297.82	-282.50	-296.93	-14.43
8	Hemet to Riverside	3.74	0.22	90.03	-86.29	-89.81	-3.52
9	Redlands to SB	1.70	0.10	31.29	-29.59	-31.19	-1.60
	Total CO (tons/year)	97.99	5.73	1892.54	-1794.55	-1886.81	-92.26
	Total CO (tons/day)	0.39	0.02	7.45	-7.07	-7.43	-0.36

TABLE 11-3 (Continued)

SOx EMISSIONS							
	Route	Diesel Scenario	Electric Scenario	Vehicle Emissions Avoided	Difference (Diesel – PC)	Difference (Electric – PC)	Difference (Electric – Diesel)
1	Ventura to L.A.	6.73	0.04	3.11	3.62	-3.07	-6.69
2	Santa Clarita to L.A.	2.05	0.01	1.11	0.94	-1.10	-2.04
3	SB to L.A.	10.80	0.06	7.03	3.77	-6.97	-10.74
4	Riverside to L.A. (Ontario)	5.61	0.03	2.93	2.68	-2.90	-5.58
5	Oceanside to L.A.	13.93	0.08	6.18	7.75	-6.10	-13.85
6	Riverside to L.A. (Fullerton)	6.00	0.03	2.73	3.27	-2.70	-5.97
7	SB/Riverside to Irvine	8.86	0.05	4.66	4.20	-4.61	-8.81
8	Hemet to Riverside	2.16	0.01	1.41	0.75	-1.40	-2.15
9	Redlands to SB	0.98	0.00	0.49	0.49	-0.49	-0.98
	Total SOx (tons/year)	57.12	0.31	29.65	27.47	-29.34	-56.81
	Total SOx (tons/day)	0.22	0.00	0.12	0.11	-0.12	-0.22

11.1.1.3 Diesel Locomotive System Scenario

The following methodology has been used to determine the emissions impact for diesel locomotive commuter rail operation.

1. Diesel locomotive operation is based on throttle notches. Locomotives typically have eight distinct throttle notches, each corresponding to a constant load and speed. Therefore, diesel locomotive emissions estimates calculated for this analysis have been generated using emission rate versus throttle notch and time-in-throttle-notch data.
2. The Los Angeles County Transportation Commission and the Southern California Regional Rail Authority, have supplied time in throttle notch data for routes 1, 2, and 3. (4) Values for routes 4, 6, 7, 8, and 9 are based on those for route 3, weighted by respective mileages. This approach has been selected because the terrain in these routes is similar. However, because of its varied terrain, route 5 time in throttle notch is based on a mileage weighted composite of routes 1, 2, and 3 data. (5)
3. CO, HC, NO_X, and SOx emission factors for a General Motors Electro-Motive Division (EMD) commuter locomotive engine (model 12-710G3A) have been used in the analysis. PM emission factors for this engine were not available. Instead, factors for EMD model 16-710G3 have been used. (6)(7)
4. NO_X emission factors have been adjusted by 25 percent to account for reductions expected for 1992 locomotives due to the use of retarded injection timing, low sulfur fuel (0.02 percent), and improved operational efficiencies. (2)

5. Retarded injection timing also results in increased PM emissions. However, it is assumed that the use of low sulfur fuel will mitigate this factor to some extent.

6. Emissions per train have been calculated for each route by multiplying time in throttle notch data by throttle notch emission factors.

11.1.1.4 Electric Locomotive System Scenario

The methodology used to calculate the emissions impact associated with the electrification scenario is based on power plant emission levels as governed by SCAQMD rules. A summary of the methodology and assumptions is as follows:

1. Horsepower by throttle notch data for a General Motors Electro-Motive Division (EMD) commuter locomotive engine (model 12-710G3A) have been used in the analysis. (6)

2. Megawatt-hours per train power consumption has been calculated by summing the product of time in throttle notch by route (same data which are used in the diesel scenario) and horsepower by throttle notch. Total daily train power consumption by route is the product of per train power consumption and number of trains.

3. Line losses of 7 percent and a catenary efficiency of 83 percent have been assumed in calculating the total power requirement by route. (8)

4. CO, HC, PM, and SOx emission levels used in the analysis are representative of typical power plants in the Basin and were obtained from the District's Engineering Division and Office of Planning and Rules. The levels are: (9)

Rate (lb/MW-HR)	Pollutant
0.143	CO
0.084	HC
0.024	PM
0.008	SOx

5. Power plant NO_x emission levels are based on the requirements of District Rule 1135, Emissions of Oxides of Nitrogen from Electric Power Generating Systems (amended July 19, 1991), as they apply to the Southern California Edison Company. (Similar emission limits apply to other electric utilities in the Basin.) The emission factors (in lb/MW-HR) are listed in Table 11-4. (10)

6. In-Basin generation plants are assumed to supply all power requirements of an electrified rail system. This is a conservative assumption since only twenty to forty percent of current South Coast Air Basin electricity requirements are supplied in-Basin. Appendix 11-2 also contains power plant emissions assuming that only forty percent of the electricity is generated in-Basin.

TABLE 11-4

Power Plant NOx Emissions

(LBS/MW-HR)

Beginning December 31, 1991	0.91
Beginning December 31, 1992	0.82
Beginning December 31, 1993	0.72
Beginning December 31, 1994	0.63
Beginning December 31, 1995	0.53
Beginning December 31, 1996	0.44
Beginning December 31, 1997	0.34
Beginning December 31, 1998	0.25
Beginning December 31, 1999	0.15

Vehicle Emissions Avoided

Vehicle emissions avoided are a function of train ridership, the number of trains in operation, and the number of passenger coaches pulled per train. As mentioned previously in this analysis, it has been assumed that for the start up level of service trains will consist of four passenger coaches. During the intermediate and mature phases of operation, seven passenger coaches are assumed. The emissions methodology is as follows:

- Round trip passengers per train by route has been calculated by multiplying the number of trains by the number of passenger coach by the number of passengers per coach.
- One-way per passenger vehicle miles avoided for routes 1, 2, 3, and 5 have been supplied by the Southern California Association of Governments. Using these data and the track lengths for routes 1, 2, 3, and 5, mileage weighted values for the remaining routes have been calculated. (3)
- Daily vehicle miles avoided by route is the product of round trip per passenger vehicle miles avoided and the number of round trip passengers.
- Passenger car emission factors by year in pounds per mile have been calculated using the Air Resources Board's EMFAC7E/BURDEN7C emission inventory. (11) In addition, emission factors have been adjusted to account for reductions expected as a result of emission standards to be in effect in future years (e.g., electric and other low-emission vehicles). (12)(13)
- Emissions avoided by route is the product of daily vehicle miles avoided by route and the passenger car emission factors for each pollutant.

11.1.2 Freight Train Emissions Impact Analysis

11.1.2.1 Scope

The freight rail air quality emissions impact analysis is based on current rail operations in the South Coast Air Basin, extrapolated to the year 2010. Specific pollutants analyzed include CO, HC, NOx, PM, and SOx. Only the in-Basin capital cost of electrifying trackage and emission benefits of electrified train operation are included in this analysis (i.e., portions of the candidate network north of the Cajon Pass and east of Beaumont Hill are excluded because they are located in adjacent air quality management districts, not the South Coast District).

Freight train types specifically analyzed for electrification include bulk, mixed, and intermodal, (collectively known as line haul trains) as specified by the PEO&MA Committee. Local and switching trains were not identified as candidates for electrification. Amtrak service was considered for electrification, and included in this portion of the report because the calculation approach and data formatting used to assess the emission benefits of Amtrak and freight train were equivalent.

In order to evaluate the emission benefits from electrification of freight rail operations and Amtrak, detailed activity data were requested from the PEO&MA Committee. These data requirements included the following:

- Number of trains per route;
- Number and types of locomotives for each train consist;
- Time in throttle for each locomotive;
- Emissions and power output by throttle notch; and
- Forecast of anticipated changes in train activity levels and consist makeup for future years.

Our purpose in requesting these data was to develop an accurate assessment of train electrification emission benefits, and to ensure consistency with the information used to develop train electrification costs and their associated emission benefits.

Ultimately, the Environmental Committee only received data regarding number of trains per route for current train operations and the year 2010, as well as several intermediary years. Therefore, a modified calculation approach was employed utilizing the year 2010 trains per route data together with the Locomotive Emission Study activity data (prepared by Booz Allen & Hamilton for the AB 234 Locomotive Emission Advisory Committee), in an effort to ensure maximum consistency between the emissions and cost estimate work.

11.1.2.2 Freight Rail Findings

The results of the train electrification emissions analysis for the year 2010 are summarized in Table 11-5. Detailed spreadsheet calculations, which form the basis for this summary table are shown in Appendix 11-3.

TABLE 11-5

2010 Freight Rail Emissions Summary – Tons Per Year

NOx EMISSIONS			
	Diesel Scenario	**Electric Scenario**	**Difference (Electric – Diesel)**
1) Line Haul	9460	280	-9180
2) Local Trains	1,431	1,431 *	-0
3) Yard Operations	1,303	1,303 *	-0
4) Amtrak	264	2	-262
Total NOx (tons/year)	12,458	3,016	-9,442
(tons/day)	34	8	-26

* Not Electrified

PM EMISSIONS			
	Diesel Scenario	**Electric Scenario**	**Difference (Electric – Diesel)**
1) Line Haul	291	10	-281
2) Local Trains	44	44 *	0
3) Yard Operations	42	42 *	0
4) Amtrak	9	0	-9
Total PM (tons/year)	386	96	-290
(tons/day)	1.1	0.3	-0.8

* Not Electrified

HC EMISSIONS			
	Diesel Scenario	**Electric Scenario**	**Difference (Electric – Diesel)**
1) Line Haul	546	37	-509
2) Local Trains	93	93 *	0
3) Yard Operations	108	108 *	0
4) Amtrak	5	1	-4
Total HC (tons/year)	752	239	-513
(tons/day)	2.1	0.7	-1.4

* Not Electrified

TABLE 11-5 (Continued)

CO EMISSIONS			
	Diesel Scenario	**Electric Scenario**	**Difference (Electric – Diesel)**
1) Line Haul	1,390	62	-1,328
2) Local Trains	296	296 *	0
3) Yard Operations	272	272 *	0
4) Amtrak	42	2	-40
Total CO (tons/year)	2000	632	-1,368
(tons/day)	5.5	1.7	-3.8

* Not Electrified

SOx EMISSIONS			
	Diesel Scenario	**Electric Scenario**	**Difference (Electric – Diesel)**
1) Line Haul	943	4	-939
2) Local Trains	150	150 *	0
3) Yard Operations	101	101 *	0
4) Amtrak	23	0	-23
Total SOx (tons/year)	1217	255	-962
(tons/day)	3.3	0.7	-2.6

* Not Electrified

Similar to commuter rail, electrification of freight rail operations would lead to substantial emission benefits over one based on diesel locomotives. Depending on pollutant, emissions reduction generally range from 93 percent to 99 percent.

The 90 percent NOx reduction as specified in the 1991 AQMP will not be achieved by electrification of the candidate network. To achieve the equivalent of this goal in terms of air quality benefit, additional electrification or use of alternative fuels (if they can reduce NOx) should be considered for those train applications such as local and switching trains.

11.1.2.2.1 Need for Additional Analysis

There are several potential areas of refinement which would impact the results of this emissions analysis.

- Enhancement of train activity data
- Inclusion of Consolidated Corridor
- Inclusion of ARB's final in-use locomotive emission regulations.

11.1.2.3 Diesel Locomotive Scenario

The following methodology and assumptions were used to determine the emissions impact for diesel locomotive operation:

- Line haul freight, local, switching and Amtrak train NO_X emissions were assumed to decrease by 5 percent per year (30 percent cap) based on anticipated ARB in-use locomotive regulations, beginning in 1995. (15)
- Line haul freight train emissions were assumed to decrease based on train fleet turnover to lower emitting locomotives. Specifically, a locomotive mix of 50 percent EMD 16-710 (new technology) and 50 percent EMD 16-645E3 (old technology) engines are assumed for future years. (2)(7) Emissions by throttle notch for each of these engine models is shown in Appendix 11-3.
- The same locomotive emission data used for SCRRA's commuter train system was also assumed for Amtrak trains (i.e., emissions data based on EMD models 12-710G3A and 16-710G3).
- The following activity data were used from the Locomotive Emission Study:
  - The number of trains per route (baseline)
  - Number of locomotives per train
  - Time in throttle notch for each locomotive
- The emission data and number of trains per route, as contained in the Locomotive Emission Study, were modified to be consistent in format to the data that was submitted by the PEO&MA Committee. Essentially, all activity data were disaggregated by segment, as defined by the PEO&MA Committee. Emissions per segment were determined for 2010 by multiplying the baseline emissions by the ratio of the number of trains per segment for baseline (Locomotive Emission Study Data) divided by the corresponding PEO&MA Committee data for 2010. Total emissions per route were determined by adding up the emissions for each segment included in each route.

11.1.2.4 Electric Locomotive Scenario

Essentially, a two step methodology was utilized to derive power plant emissions. First, the methodology described in the commuter rail section was used to determine power plant emissions from electric locomotive operation based on the Locomotive Emission Study activity data. Equivalent assumptions were made regarding power plant system and catenary line losses, as well as power plant emission rates. Second, these power plant emission data were modified to be consistent in format with the activity data that was submitted by the PEO&MA Committee, and multiplied by the same multiplication factor used to determine year 2010 diesel locomotive emissions. Total emissions per route were determined by adding up the emissions for each segment included in each route.

11.1.3 Capital Cost Effectiveness

Two different methodologies have been used by SCAQMD for determining estimated cost effectiveness — Discounted Cash Flow (DCF) and Levelized Cash Flow (LCF). The LCF method calculates annualized costs by first multiplying a capital recovery factor (CRF) by the capital costs exclusive of locomotives. Cost effectiveness is then determined by summing the annualized costs (capital cost multiplied by the CRF plus annual operations and maintenance costs) and dividing by the annual emissions reduced. The DCF method calculates the cost effectiveness by first determining the present value of the costs of buying and operating the control equipment over the equipment life, and then dividing this value by the emissions reduced over that period. For the Air Quality Management Plan, DCF is used to determine cost effectiveness for control measures.

DCF and LCF methodologies yield different cost effectiveness values. To take these differences into account, a cost effectiveness range has been developed. Another reason for presenting a cost effectiveness range is the dissenting opinion held by SCE that the capital cost estimate prepared by the Task Force ($4.05 million per route mile on average) is too high, and that $2.5 million per route mile should be used. Using these cost assumptions, a capital cost effectiveness range for both the DCF and LCF methodologies has been determined for twelve rail corridors as well as for overall Basinwide rail electrification, as shown in Table 11-6. Detailed calculations upon which the data in Table 11-6 are based, are provided in Appendix 11-4.

It is anticipated that these calculations will be repeated in a subsequent phase of the Accelerated Electrification Program, too incorporate the impacts of O&M costs and the capital costs of electric locomotives.

TABLE 11-6

Cost Effectiveness of Rail NOx Emissions Regulation by Electrification ($/ton of NOx)**

Corridor	Cost Effectiveness Range (DCF)	Cost Effectiveness Range (LCF)	Emission Reduction* (ton/d)
San Bernardino to L.A.	20,120 - 32,600	34,900 - 56,550	0.66
Ventura to L.A.	6,970 - 11,190	11,980 - 19,400	1.06
Santa Clarita to L.A.	5,830 - 9,450	10,120 - 16,390	1.37
Oceanside to L.A.	8,310 - 13,470	14,420 - 23,360	1.84
Riverside to L.A. (Ontario)	3,850 - 6,230	6,670 - 10,810	3.51
Riverside to L.A. (Fullerton)	3,510 - 5,690	6,090 - 9,870	4.02
Hemet to Riverside	54,920 - 88,970	95,230 - 154,270	0.16
San Bern./Riverside to Irvine	3,540 - 5,730	6,130 - 9,930	3.41
Redlands to San Bernardino	82,990 - 134,440	143,900 - 233,120	0.03
Southern Pacific Routes (Ports to Beaumont)	2,190 - 3,540	3,790 - 6,140	11.44
Santa Fe (Ports to Summit)	2,180 - 3,530	3,780 - 6,120	12.54
Union Pacific (Ports to Summit)	2,250 - 3,650	3,900 - 6,320	11.97
OVERALL	3,900 - 6,300	6,700 - 10,900	27

* Emissions Reduction are not additive, due to common segments.

** Subject to change. Does not include O&M Cost Impacts or Capital Costs of locomotives.

Other major assumptions used to develop these cost effectiveness values are as follows:

- Corridor cost effectiveness is based on the capital cost to electrify the corridor (regardless of the overlapping that occurs among the corridors) and emission benefits that would accrue from all freight, Amtrak, and SCRRA commuter trains operating on that corridor.
- Incremental operations and maintenance costs associated with rail electrification, as well as the capital costs associated with purchasing electric locomotives were not provided, and therefore have not been utilized in the analysis.
- Simplifying assumptions have been made regarding the application of the DCF cost effectiveness procedure. Due to lack of data regarding capital outlay and emission benefits as a function of time (implementation of rail electrification would occur over a multi-year period) the total emission benefits and capital outlay are assumed to occur at the beginning of the project.
  - Only the capital cost and emission benefits for in-Basin electrification are included.
  - Real interest rate is assumed to be 4%.
  - Project lifetime is assumed to be 30 years.
  - For commuter routes, intermediate levels of service are assumed.

It should be noted that the San Bernardino to Los Angeles, Hemet to Riverside, and Redlands to San Bernardino commuter routes show relatively high cost effectiveness values due to low rail activity levels. For these routes in particular, there is a minimum amount of overlap with freight rail operation, thus resulting in the high cost effectiveness values.

11.1.4 References

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By comparison, the cost effectiveness values for other SCAQMS NOx emissions control rules are summarized on Table 11-7.

TABLE 11-7

Cost-Effectiveness of Various SCAQMD NOx Rules

Rule	Title	Cost-Effectiveness in 1991 $/ton
1109	Refinery Boilers & Heaters	9,800 – 22,250
1134	Gas Turbines	3,700 – 21,200
1146.1	Small Industrial Boilers	11,100 – 36,200
1146	Large Industrial Boilers	2,200 – 52,700
1135	Electrical Generation	6,500 – 46,400
	Train Electrification	3,900 – 10,900

11.2 RAIL ELECTRIFICATION AND HEALTH EFFECTS ASSOCIATED WITH ELECTROMAGNETIC FIELDS

11.2.1 Introduction

In recent years there has been growing concern that exposure to the electric and magnetic fields produced by electrical systems may present a risk to health. Concerns have been raised specifically with regard to the 1991 AQMP's electrification strategies and, in particular, rail electrification.

The purpose of this paper is to provide a brief overview of the current state of knowledge with respect to the electric and magnetic fields and their potential health effects. In sum, the report concludes that there is currently insufficient evidence to determine whether low-level electromagnetic field exposure presents a health risk.

In preparation of this paper, a number of reports on the health effects of electromagnetic fields sponsored by various agencies and institutions were reviewed. A brief summary of each report's conclusion is presented in Appendix 11-5.

11.2.2 Background

Electric and magnetic fields are invisible forces that exist wherever electricity occurs. The forces of attraction and repulsion among positive and negative charges create electric fields. Magnetic fields are created when charges are in motion. These fields are collectively referred to as electromagnetic fields (EMF).

The strengths of the electric and magnetic fields are dependent on the voltage of the circuit and the magnitude of the current flowing through the system, respectively (DHS, 1990). Electric fields are generally measured in units of volts/meter (V/m) whereas magnetic fields are generally expressed in milli-Gauss (mG). The strength of electromagnetic fields is greatest near the source and falls off rapidly with distance (U.S. Congress, 1989).

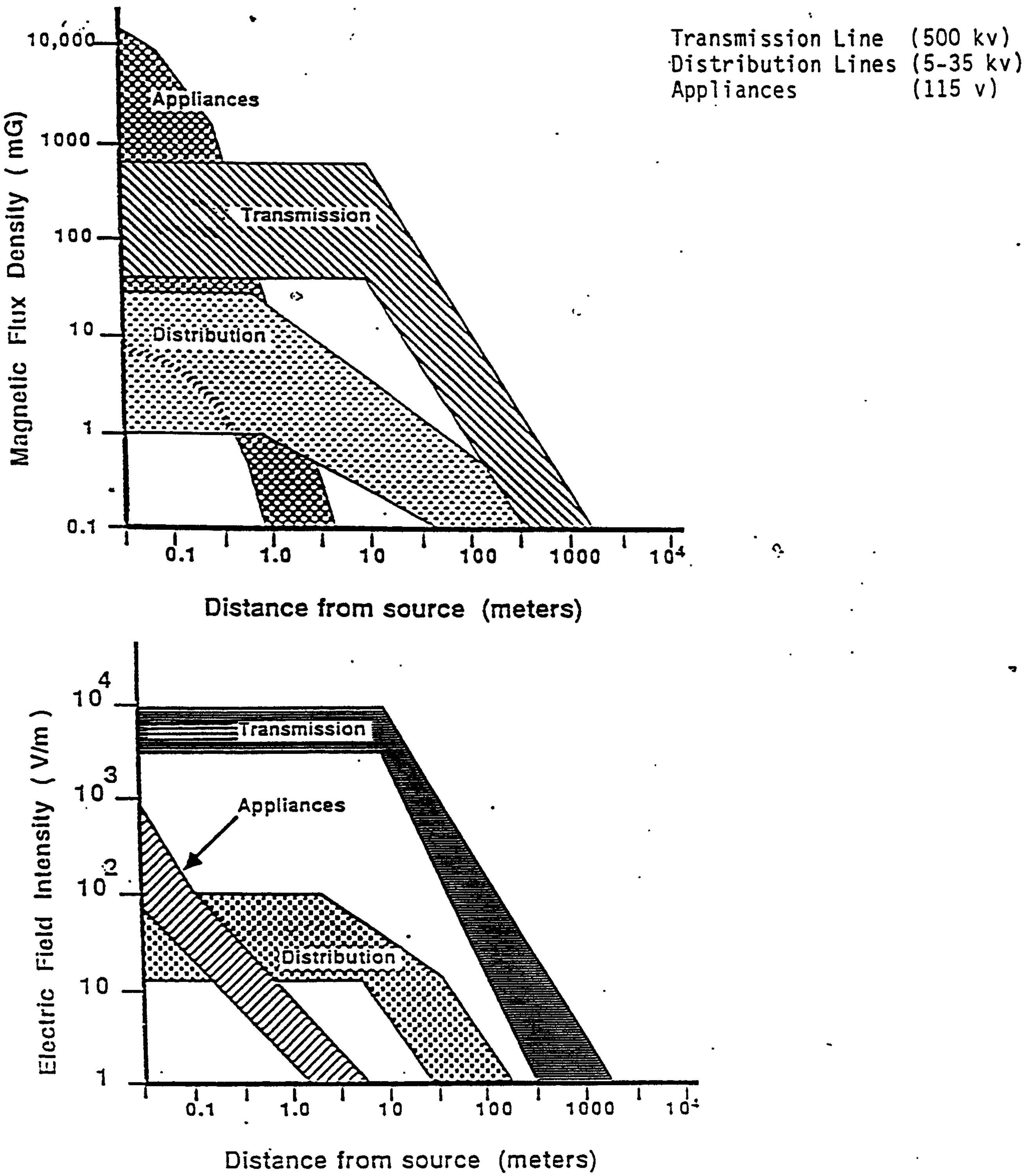
Electromagnetic fields are associated with all electrical systems including electrical appliances, lighting, wiring, distribution power lines, high voltage transmission lines, transformers and other electrical equipment. We are constantly exposed to EMF during our daily activities. At home and work, fields are generated from the use of electric appliances as well as from inside wiring and outside distribution lines. Outdoors, exposure is dominated by the fields generated from power distribution and transmission systems including power lines, substations, and transformers.

Electric fields can be effectively blocked by the earth, buildings, trees, or other means. Magnetic fields, however, can only be shielded by structures containing large amounts of ferrous or other special metals (U.S. Congress, 1989).

Exhibit 11-1 illustrates typical electric and magnetic field intensities from high voltage transmission lines (500 kv), distribution lines (5-35 kv), and household appliances. Table 11-8 contains some electric and magnetic field measurements for several types of transmission lines (500 kv, 230 kv, and 66 kv) and distribution lines (12 kv and 35 kv) as well as several electrical appliances (U.S. Congress, 1989; SCE, 1991). There have not been any studies specifically conducted to determine the magnitude of the electromagnetic fields associated with 25 and 50 kv electric rail systems (FRA, 1992).

EXHIBIT 11-1

Variation in Electric and Magnetic Field Intensities at Ground Level as a Function of Distance from the Source



(Source: U.S. Congress, 1989)

TABLE 11-8

Typical Electric and Magnetic Field Measurements from Transmission and Distribution Power Lines and Household Appliances

Source	Voltage	Electric Field (kv/m)	Magnetic Field (MG)
Transmission Line [1] (on right-of-way)	500 kv	0.7-18	15-650
Transmission [1] (edge of right-of-way)	500 kv	0.001-0.15	9-150
Transmission Line [2]	500 kv	4.8	88
Transmission Line [2]	230 kv	0.07	25
SubTransmission Line [2]	66 kv	0.03	6.3
Distribution Line [1]	35 kv	0.007-0.15	0.5-30
Distribution Line [2]	12 kv	0.02	8.7
Electric Blanket [1]	115 v	0.2-3	4-25
Electric Shaver [1]	115 v	0.007-0.15	11-700
Hairdryer [3]	115 v	0.04	3-1400

Note [1] U.S. Congress, Office of Technology Assessment, Carnegie Mellon University. May 1989.

Note [2] Southern California Edison, 1992. Field strengths are measured at 50 feet from Centerline and represent one-time measurements.

Note [3] Department of Health Services, 1990.

11.2.3 Interaction of EMF with Biological Tissue

EMF from power systems affect biological tissue in a unique way. Fields from electrical systems are different from other types of electromagnetic energy such as x-ray and microwaves. X-rays have so much energy that they can "ionize" or break up molecules such as DNA and cause mutations. Microwaves are absorbed by water in body tissues and thereby heat them up. Electromagnetic fields from power systems (often called "power-frequency EMF") neither ionize molecules nor heat tissues. Instead, EM fields interact with electric charges in the tissues of biological organisms. Electric charges in the body move in response. This movement of charge inside the body in turn creates currents and fields inside the body.

Some experimental results are consistent with a possible role in promoting the development of existing cancers by, for example, stimulating cancer cells to grow and divide. The interpretation of findings such as these is limited by the fact that in most cases effects have been observed only in cell cultures -- not whole animals, in which the effects can be quite different -- and only at field strengths much higher than typical exposures.

11.2.5 EMF and Other Health Effects

A number of experiments have exposed human volunteers to power-frequency EMF under controlled conditions then looked for changes in measures of health status such as heart activity, brain activity, blood chemistry, and performance on neurological tests. These studies have found no obvious physiological or behavioral effects.

The nervous system has been considered a prime candidate for EMF effects because of its reliance on electrical signals. Experiments have evaluated the effect of EMF on the nervous systems of a variety of lower animals. There have been some scattered reports of subtle effects, but no consistent pattern has emerged. The most comprehensive and well-conducted studies have not found effects. Health surveys of electrical workers have not found any effect on nervous system function.

The possibility that EMF may cause birth defects or other reproductive problems has also been studied. A few preliminary epidemiological studies have been conducted. One study reported that women who used electric blankets or electrically heated beds had longer pregnancies and a higher rate of miscarriage. Another study reported a higher miscarriage rate during seasons when EMF exposure from ceiling cable heating would be high. Both of these studies have methodological limitations that put these associations in doubt. Experimental studies with lower mammals have produced inconsistent results.

Many organizations, including the Department of Energy, the Electric Power Research Institute, and the California Department of Health Services, are currently sponsoring studies on the health effects of EMF. Many other countries also have active EMF research programs. Many of these studies are expected to be completed within the next several years (DHS, 1990; PUC, 1989; NCI, 1990; U.S. Congress, 1989).

11.2.6 Measuring a Dose of EMF

Electromagnetic fields are complex phenomena. It is not known what aspects of EMF, if any, are harmful to health. Scientists do not know whether we should be concerned with the strength of the field, the current it induces in the body, the duration of exposure, the peak level of exposure, the orientation of the body towards the field, or any number of other characteristics of electromagnetic fields. Contrary to intuition, stronger fields may not always pose a greater risk than weaker fields. The question of what aspects of EMF may cause health effects is a central issue which remains to be resolved.

11.2.7 Rail Electrification

The 1991 AQMP calls for the electrification of 90 percent of the Basin's rail operations. Replacement of diesel locomotives with electric units will reduce the emissions associated with the production, distribution, and combustion of locomotive diesel fuel. In addition, rail electrification will significantly reduce human exposure to diesel fuel components (e.g., polycyclic aromatic hydrocarbons, PM10, benzene, and formaldehyde) which have known health effects.

The electrification of commuter and freight rail operations will result in increased residential, occupational, and transportation-related exposures to EMF. It is expected that rail electrification will increase exposure to EMF primarily by increasing the demand for electricity in areas along the routes. This will be compounded by expected increases in electricity demand resulting from population growth.

In order to meet the additional electricity demand from the commuter and freight rail projects, new electricity distribution system components such as electricity supply lines and substations could be required. This could result in increased residential exposure to EMF. In addition, rail electrification projects could lead to greater current transmission through existing power lines, resulting in more frequent and intense exposure to EMF for people in the existing vicinity of power distribution routes and facilities.

Rail electrification will also require the construction of a rail power infrastructure (e.g., overhead catenary wires, catenary supply lines, and route substations). EMF exposures could increase where people live in close proximity to these facilities along rail routes. Residential exposures could also increase where new routes are constructed through residential areas or where existing right-of-ways through residential areas are electrified.

Occupational EMF exposures could also increase with implementation of electrified commuter and freight rail line projects. Rail workers responsible for maintaining and repairing trackage and crossings as well as locomotive engineers and mechanics, and other yard maintenance personnel will experience greater exposure to the EMF. Transportation-related exposures would increase for persons riding the electric commuter trains, as well as for anyone in close proximity to locations where electric trains are in operation.

The Federal Railroad Administration (FRA) has recently initiated an Environmental Impact Statement (EIS) for the proposed electrification of the 150-mile New Haven to Boston (25 kv, 60 Hz) rail line. As part of the EIS analysis (including the EMF impact analysis), the EMF exposure levels measured from existing electric rail systems in the U.S. and Europe would be compared with the EMF exposure levels expected from the proposed project to determine whether similarities exist. The EIS is expected to be completed by the end of 1992. (FRA, 1992).

11.2.8 Conclusion

Researchers do not yet understand which aspect or aspects of EMF exposure, if any, may be responsible for health effects. Stronger fields may not always pose a greater risk than weaker fields. With the scientific information now available, it is not possible to set an exposure standard or determine whether any particular exposure is safe or harmful (DHS, 1990, PUC, 1989, U.S. Congress, 1990). It is not possible to determine the health effects of EMF exposure from any application, including rail electrification, based on the current state of knowledge. Additional studies on the health effects of EMF must be completed.

It is clear that electrification of the commuter and freight rail operations in the Basin will reduce criteria and toxic pollutants associated with diesel fuel as well as their proven health effects. It is also clear that rail electrification will increase human exposure to EMF. However, since the health implications of exposure to these fields have not been determined, the risk associated with rail electrification also cannot be determined. It is hoped that research currently in progress will provide more definitive answers to questions about the potential health effects of EMF.

11.2.9 References

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11.3 ENVIRONMENTAL IMPACTS

A preliminary review was performed of the potential environmental impacts due to the construction and operation of the proposed electrified railroad lines. Potential impacts in 12 categories (air quality and electromagnetic field impacts are described in detail in previous sections) were considered for the UP/SP/ATSF Consolidated Corridor and 12 other railroad routes (nine commuter and three existing freight) under study. Given the conceptual level of detail developed for this study, the discussion is primarily qualitative. Where qualitative analyses are provided, the reader is cautioned that the numbers are preliminary estimates that at best serve to illustrate the order of magnitude of potential impacts. The objective was to highlight potential issues and provide a preliminary evaluation of their potential significance. As individual projects are developed, additional significant impacts may be identified which will require substantial mitigation.

In the discussion that follows, the information is grouped by subject area. Within each of the 12 areas are three subheadings: UP/SP Consolidated Corridor; Other Rail Electrification Corridors; and System-wide Facilities. Within the UP/SP Consolidated Corridor the discussion is broken down into two subheadings: a) Impacts Associated with Consolidation and; b) Impacts Associated with Electrification. Within each subheading, the potential environmental issues are bulleted with accompanying text. Each impact subheading closes with a preliminary estimate of the potential level of significance.

The 12 routes (excluding the consolidated UP/SP corridor) were considered as a group rather than individually due to the similarity of issues and the difficulty in discriminating among the corridors based on the conceptual level of detail provided. Where possible, differences in environmental impacts among the corridors are noted.

The system-wide facilities are components that are considered common to the entire rail electrification system and are not necessarily associated with any specific route. They include shops/ancillary facilities, a control center and locomotive change facilities. Three shops, one for each railroad company, eight locomotive change facilities and one control facility are proposed.

11.3.1 Land Use/Right-of-Way Acquisition

11.3.1.1 UP/SP Consolidated Corridor

Impacts Associated with Consolidation

Acquisition of additional right-of-way (ROW) – New tracks would be required to accommodate the increase in freight traffic due to consolidation. The new tracks would include 24 new bridges and 9 river crossings. Additional tracks and bridges may require acquisition of new right-of-way.

To mitigate potential traffic impacts at grade crossings, it is estimated that 43 crossings between East L.A. yard and West Colton would have to be grade separated (this estimate excludes the grade separations which will be constructed as part of the Alameda Corridor Consolidation project). These grade separations could require a substantial amount of additional right-of-way.

The acquisition of right-of-way to accommodate the facilities and structures identified above may result in the displacement of a significant number of residences and businesses. Displacement impacts would be mitigated by compensating owners for the fair market value of their property and providing relocation assistance and benefits.

Potential level of significance: **Significant.**

Impacts Associated with Electrification

Compatibility of proposed facilities with adjacent sensitive land uses – The proposed rail electrification facilities, including traction power substations and switching stations, access roads, and new transmission lines would be constructed partially or entirely outside the existing railroad right-of-way. The traction power substations and switching stations would be located along the existing railroad right-of-way. The new transmission lines, which would require a dedicated right-of-way, would connect existing power system substations with the traction power substations.

The compatibility of these facilities with sensitive land uses such as residential areas, hotel/motels, schools, hospitals, parks or churches is a potential issue. Although the locations of the proposed facilities have not been identified, it is estimated that as many as 19 substations, 19 new transmission lines, and 20 switching stations (assuming a 25kV system) may be necessary to accommodate rail operations on an electrified UP/SP corridor.

To determine the general land uses along the corridor that could be affected by proposed facilities, aerial photos of the corridor (from Long Beach to Colton) were reviewed. The results are presented in Table 11-9. As shown, the predominant land use immediately bordering the UP/SP ROW is commercial/industrial (see Table 11-9). Residential land uses occupy less than five percent of the adjacent land uses.

TABLE 11-9

Land Uses Bordering The Consolidated Corridor

SECTION	MILES	RESIDENTIAL		OPEN SPACE OR VACANT		COMMERCIAL OR INDUSTRIAL	
		%	Miles	%	Miles	%	Miles
1. Alameda Corridor	20 mi	3%	0.5 mi	3%	0.6 mi	94%	18.9 mi
2. East Los Angeles to City of Industry	14 mi	6%	0.9 mi	9%	1.2 mi	85%	12.1 mi
3. City of Industry to San Bernardino County	18 mi	2%	0.2 mi	21%	4.3 mi	77%	13.9 mi
4. San Bernardino County Line to City of Colton	19 mi	4%	0.8 mi	24%	4.6 mi	72%	13.6 mi
5. City of Colton to Yermo	—	NA	—	NA	—	NA	—
4. City of Colton to Yuma	—	NA	—	NA	—	NA	—
TOTAL (Ports to Cotton)	71 mi	4%	2.5 mi	16%	11.5 mi	81%	57.9 mi

Note: Only land uses adjacent to the railroad right-of-way were identified. In areas where a highway or street bordered the rail right-of-way, land uses adjacent to the street or highway were not considered. Streets or highways were included in the industrial/commercial category. The land use data were based on a review of aerial photos. Aerial photos were not available for areas north and east of Colton.

Source: Myra L. Frank & Associates, Inc., 1992.

Potential impacts could be mitigated by locating facilities in compatible commercial/industrial areas, or shielding facilities from adjacent sensitive uses by fencing and landscaping.

Consistency of proposed facilities with local land use plans and zoning – Proposed facilities constructed outside the existing railroad right-of-way may be inconsistent with the land uses designated in the local general plan or uses permitted by the zoning code. Zone changes or amendments to the local general plans may be required in order to accommodate proposed facilities.

Acquisition of additional right-of-way – Additional ROW would be necessary to accommodate the traction power substations, switching stations and new transmission lines. The substations would cover an area roughly 150 by 250 feet in size; the switching stations would encompass an area approximately 50 by 100 feet. Each transmission line would require a dedicated right-of-way. For costing purposes, the average length of each transmission line was assumed to be one mile. It is estimated that as many as 19 substations, 19 new transmission lines and 20 switching stations could be required for a consolidated UP/SP corridor.

The acquisition of right-of-way to accommodate the facilities and structures identified above may result in the displacement of residences and businesses. Displacement impacts would be mitigated by compensating owners for the fair market value of their property and providing relocation assistance and benefits.

Potential level of significance: **Not Significant.**

11.3.1.2 Other Rail Corridors

Compatibility of proposed facilities with adjacent sensitive land uses – The issues would be similar to those described above for an electrified UP/SP corridor. The extent of potential impacts would depend upon the number of facilities that would be constructed outside the existing railroad right-of-way and the land uses adjacent to the proposed locations of the facilities. Although the locations have not been identified, estimates of the number of facilities that would be required for each corridor have been provided and are shown in Table 11-10.

Consistency of proposed facilities with local land use plans and zoning – The issues would be similar to those described above for an electrified UP/SP corridor.

Acquisition of additional right-of-way – Additional ROW may be necessary to accommodate the traction power substations, switching stations and transmission lines. The substations would require an area roughly 150 by 250 feet; the switching stations would encompass an area approximately 50 by 100 feet. The transmission lines, which would require a dedicated right-of-way, are assumed to average one mile in length. The estimated number of substations and switching stations required for each of the corridors is shown in Table 11-10. The acquisition of additional right-of-way for these facilities could result in the displacement of existing land uses.

Potential level of significance: **Not Significant.**

TABLE 11-10

Traction Power Supply System By Route For A 25kV System

ROUTE	TRAFFIC TYPE	SUB. 66kV UTILITY	SUB. 115kV UTILITY	SUB. 230kV UTILITY	SWITCH. STATION
1. UP/SP Corridor	Commuter		2		3
	Commuter & Freight	5	7	7	20
2. Baldwin Park Commuter	Commuter	2			3
3. Moorpark Commuter	Commuter	2			3
4. Santa Clarita Commuter	Commuter	1			2
5. Lossan Corridor	Commuter	2		2	5
	Commuter & Freight	4		3	8
6. Riverside Via Ontario	Commuter	2			3
	Commuter & Freight	3			4
7. Riverside-LAUPT Via SF	Commuter	2			3
	Commuter & Freight	3			4
8. Hemet-Riverside	Commuter		1		2
9. San Bern. – Irvine	Commuter	1	1		3
	Commuter & Freight	1	1	1	4
10. Redlands Commuter	Commuter		1		
11. Southern Pacific Yuma to Ports	Commuter & Freight	5	3	6	15
12. Santa Fe Ports to Barstow	Commuter	1	1		3
	Commuter & Freight	5	2	1	9
13. Union Pacific Ports to Yermo	Commuter	1	1		3
	Commuter & Freight	4	5		10
TOTAL	Commuter	7	4	2	15
	Commuter & Freight	22	12	10	45

Source: LTK, 1992

11.3.1.3 Systemwide Facilities

These facilities are components that are part of the entire rail electrification project and are not route specific. They include shops/ancillary facilities, a control center, and locomotive change facilities. Three shops are proposed, one for each railroad company. Each shop would occupy an area of about 100 feet by 200 feet. An estimated eight locomotive change facilities and one control facility would also be necessary. Although most of these facilities may be located within existing railroad right-of-way, some additional right-of-way may be necessary. If any facilities were constructed outside the existing railroad right-of-way, compatibility with adjacent land uses, consistency with local zoning and general plans, and potential displacement of existing land uses would be potential land use issues.

Potential level of significance: **Not Significant**

11.3.2 Noise and Vibration

11.3.2.1 UP/SP Consolidated Corridor

Impacts Associated with Consolidation

Construction noise and vibration – Activities associated with the construction of proposed facilities, including the operation of construction equipment and vehicles, could result in temporary and intermittent high noise levels and increased vibration that could adversely affect adjacent sensitive land uses. Traffic generated by construction workers to and from the project site could also increase noise levels in the community. Consolidation would require construction of new track, reconstruction of 24 bridges, 9 new river crossings, and new grade separations at 43 existing grade crossings.

Measures to mitigate construction noise could include limiting construction to daytime hours, routing truck traffic away from residential areas, or use of temporary noise barriers.

Operation noise and vibration – The increase in freight rail traffic on a consolidated UP/SP corridor could result in significant adverse increases in noise levels in the surrounding community. The major sources of noise due to rail freight operations include the locomotive engines, wheel-rail noise, warning bells at grade crossings and train horns. The frequency of each of these noise events would increase with the increase in rail traffic on the consolidated corridor. Noise levels in the community and at noise-sensitive land uses adjacent to the ROW could also increase due to the relocation of existing tracks or construction of new tracks closer to adjacent noise-sensitive uses. The increase in rail traffic could also increase vibration levels in the community.

New grade separations which include elevated automobile travel lanes could also result in an increase in noise levels at adjacent land uses.

Although it is beyond the scope of this study to quantify the potential increase in noise levels at sensitive uses along the corridor, population estimates for the area within a 1,000 feet of the corridor give some of indication of the number of residents that could be adversely affected by the project. Table 11-2 shows the population within a 1,000 feet of the corridor. The estimates are based on data provided in a 1988 SCAG study using 1980 census information. The average population per mile is also presented in Table 11-11. The data show that population density along the corridor is greatest along the segments extending from the Port of Los Angeles to J Yard near downtown Los Angeles (1,310 persons per mile within 1,000 feet). The population density is also high in the east Los Angeles area (954 persons per mile). Population densities decrease significantly in the outlying desert areas of San Bernardino and Riverside Counties with fewer than 50 persons and as few as 2 persons per mile along some segments.

TABLE 11-11

Population Within 1000 Feet of UP/SP Corridor

SECTION	LENGTH IN MILES	POP. WITHIN 1000 FT.[1]	POP/MILE
1. Ports to J Yard (Alameda Corridor)	20 mi.	26,199	1,310
2. East L.A. to Industry	14 mi.	13,551	954
3. Industry to San Bernardino County line (near Montclair)	18 mi.	3,858	214
4. Los Angeles County Line to Colton	19 mi.	8,013	422
5. Colton to San Bernardino[1]	3 mi	590	197
6. San Bernardino to Hesperia[1]	28 mi	6,476	231
7. Hesperia to Victorville	11 mi	502	46
8. Victorville to Barstow	37 mi	1,611	44
9. Colton to Beaumont	22 mi	3,171	144
10. Beaumont to Indio	51 mi	2,339	46
11. Indio to Niland	50 mi	83	2
12. Niland to Glamis	30 mi	56	2
13. Glamis to Yuma	35 mi	unknown	---

Note: 1 Population figures cited for the Colton to Hesperia segment are for the Santa Fe Railroad route, which is approximately two to three miles east of the consolidated route. Because there are slightly fewer residential areas along the Southern Pacific route, population surrounding the consolidated corridor would be somewhat less.

Source: *Southern California Association of Governments, "The Feasibility of Hauling Solid Waste by Railroad from the San Gabriel Valley to Remote Disposal Sites," April, 1988.*

Within 1,000 feet of the UP/SP right-of-way, there are 26,199 persons from the Port of Long Beach to J Yard (20 miles), 25,422 persons from East Los Angeles to Colton (51 miles), 9,179 persons from Colton to Barstow (79 miles) and 5,649 persons from Colton to Glamis (153 miles).

It should be noted that consolidation of rail traffic on the UP/SP corridor would have a beneficial noise and vibration impact along those routes that would experience a reduction or elimination of rail freight traffic (segments of Routes 7, 11, 12, and 13). Also, improvements to existing track may tend to slightly reduce the potential increase in community noise levels along the UP/SP corridor. In addition, a reduction in the number of at-grade crossings (i.e., new grade separations, street closures) would reduce the number of occurrences of train horn noise. However, the resultant noise impacts due to consolidation are still expected to be significant and adverse.

In order to mitigate potential noise impacts on noise-sensitive uses near the UP/SP corridor, sound walls may be required along sections of the railroad right-of-way that are adjacent to noise-sensitive uses. Sound walls could have adverse impacts on community identity and aesthetics and could constitute a maintenance and security problem.

Potential level of significance: **Significant.**

Impacts Associated with Electrification

Construction noise and vibration – Activities associated with the construction of proposed facilities, including the operation of construction equipment and vehicles, could result in temporary and intermittent high noise levels and increased vibration that could adversely affect adjacent sensitive land uses. Traffic generated by construction workers to and from the project site could also increase noise levels in the community. The proposed facilities, which would be constructed over an estimated 4.5 year period include: catenary poles, as many as 19 substations and 20 switching stations, and 19 new transmission lines.

Measures to mitigate construction noise could include limiting construction to daytime hours, routing truck traffic away from residential areas, or use of temporary noise barriers.

Operation noise and vibration – The noise characteristics of electric locomotives differ from those of diesel locomotives. At speeds generally lower than 40 mph, the noise from a diesel locomotive engine is lower in frequency and substantially higher in volume than noise from an electric locomotive. At higher speeds (70 mph and above), wheel/rail noise rather than engine noise is the predominant noise source and both electric and diesel locomotives generate similar noise levels. Therefore, conversion to electrically powered locomotives could result in a beneficial noise impact to areas adjacent to slow moving trains. In addition, electric locomotives can be manufactured with significantly higher horsepower ratings than the most powerful diesel locomotives. Where one electric locomotive is used in place of two diesel locomotives, additional noise reductions could occur. Improvements to the rail track as a result of electrification may result in a slight but noticeable reduction in noise levels.

Noise from transformers at substations may have a minor adverse impact on adjacent land uses.

Potential level of significance: **Beneficial/Not Significant.**

11.3.2.2 Other Rail Corridors

Construction noise and vibration – Construction noise and vibration impacts would be similar to those described above. However, Table 11-10 shows the number of switching stations and substations for each of the corridors. Estimates of the length of the construction periods for all of the corridors are shown in Table 11-12.

TABLE 11-12

Construction Periods By Route

ROUTE	DURATION (Years)
1. UP/SP Corridor	4.50
2. Baldwin Park Commuter	2.25
3. Moorpark Commuter	2.25
4. Santa Clarita Commuter	1.75
5. Lossan Corridor	3.00
6. Riverside Via Ontario	2.00
7. Riverside – LAUPT Via SF	2.00
8. Hemet – Riverside	2.00
9. San Bern. – Irvine	2.00
10. Redlands Commuter	1.25
11. Southern Pacific Rts. – Yuma to Ports	3.75
12. Santa Fe – Barstow to Ports	3.00
13. Union Pacific – Ports to Yermo	3.00

Source: De Leuw, Cather & Co., 1992.

Operation noise and vibration– The operational noise and vibration impacts would be similar to those for an electrified UP/SP corridor described above.

Potential level of significance: **Beneficial/Not Significant.**

11.3.2.3 Systemwide Facilities

Construction noise and vibration – Activities associated with the construction of shops, locomotive change facilities and control centers could result in temporary intermittent high noise levels and increased vibration that could adversely affect adjacent sensitive land uses.

Operation noise and vibration – Activities at the system facilities, in particular the vehicle shops, could increase noise levels in the surrounding community.

Potential level of significance – **Not Significant.**

11.3.3 Visual Quality/Aesthetics

11.3.3.1 UP/SP Consolidated Corridor

Impacts Associated with Consolidation

Visual compatibility with adjacent land uses – Consolidation would require construction of additional structures to accommodate track, including 24 new bridges and 9 new river crossings. An additional 43 grade separations would also be required to separate auto/truck traffic from rail traffic. These structures could present visual incompatibilities and obstructions to views. If noise walls were required, they could also be incompatible with adjacent land uses and block views or vistas.

Potential level of significance: **Not Significant.**

Impacts Associated with Electrification

Visual compatibility with adjacent land uses – The following structures may be intrusive visual elements incompatible with the scale and/or character of adjacent land uses: catenary poles and wires; power transmission lines; substations; and switching stations. The catenary will be strung 22 to 24 feet above the railroad track; the wires will be supported by catenary poles along the route, located about 12 to 15 feet from the track and spaced every 200 feet (about 26 poles per mile). New transmission lines would include utility poles roughly 60 to 70 feet in height.

Potential level of significance: **Not Significant.**

11.3.3.2 Other Rail Corridors

Visual compatibility with adjacent land uses – The following structures may be intrusive visual elements incompatible with the scale and/or character of adjacent land uses: catenary poles and wires; power transmission lines; substations; and switching stations. The catenary will be strung 22 to 24 feet above the railroad track; the wires will be supported by catenary poles along the route, located about 12 to 15 feet from the track and spaced every 200 feet (about 26 poles per mile).

Potential level of significance: **Not Significant.**

11.3.3.3 Systemwide Facilities

The visual impact of locomotive change facilities, shops/ancillary facilities, and the control center would be lessened if they were constructed within the existing railroad ROW. Any facilities constructed outside the railroad ROW could be visually intrusive and incompatible with adjacent uses and may obstruct views or cast additional shade and shadow on adjacent uses. However, these impacts are not expected to be significant because these types of facilities are most likely to be sited in industrial or commercial areas in order to be consistent with adjoining uses and to meet local code requirements.

Potential level of significance: **Not Significant.**

11.3.4 Transportation/Circulation

11.3.4.1 UP/SP Consolidated Corridor

Impacts Associated with Consolidation

Additional vehicle delay at grade crossings – Consolidating freight rail traffic along this corridor would increase vehicle delays at grade crossings. The additional delay would depend on factors such as the frequency and volume of automobile and freight rail traffic, the length of the trains and the train speeds. The cross-streets along the corridor and Average Daily Traffic Volumes (ADT) are shown in Table 11-13. Although the additional delay at cross streets has not been quantified as part of this study, it is expected that the impacts to traffic flow and circulation could be significant. Consequently, it is expected that 43 grade crossings along the corridor would have to be grade separated. Grade separations may displace some turning movements on to parallel and crossing streets, creating new impacts at those intersections. They may also be visually intrusive, require right-of-way and create noise impacts.

TABLE 11-13

Grade Crossings And ADT By Route

ROUTE	# GRADE CROSSINGS	ADT (in thousands)
1. UP/SP Corridor	95	343
2. Baldwin Park Commuter	77	459
3. Moorpark Commuter	33	236
4. Santa Clarita Commuter	34	186
5. Lossan Corridor	101	1,141
6. Riverside Via Ontario	52	381
7. Riverside-LAUPT Via SF	54	324
8. Hemet-Riverside	61	112
9. San Bern. – Irvine	71	426
10. Redlands Commuter	42	170
11. Southern Pacific Rts. – West Colton to Ports	97	485
12. Santa Fe Barstow to Ports	84	393
13. Union Pacific – Ports to Yermo	82	450
TOTAL	883	5,106

Source: Frederic R. Harris, Inc., 1992; Average Daily Traffic Volumes (ADT) from PUC.

It should also be noted that the consolidation of traffic on the UP/SP Corridor would result in a corresponding decrease in freight traffic along segments of several routes including Route 7 (Riverside - LAUPT via SF), Route 11 (Southern Pacific – West Colton to Ports), Route 12 (Santa Fe Barstow to Ports), and Route 13 (Union Pacific – Ports to Yermo). Reduction in rail traffic along those routes would have a beneficial impact on vehicle delay at grade crossings.

Potential level of significance: **Significant.**

Impacts Associated with Electrification

Electrification of the consolidated corridor would not create additional traffic impacts.

Potential level of significance: **Not Significant.**

11.3.4.2 Other Rail Corridors

Since electrification of the other corridors would not result in an increase in rail traffic, no adverse impacts to vehicle delay are anticipated. Segments of routes 7, 11, 12 and 13 that would experience a decrease in freight traffic due to consolidation on the UP/SP corridor would benefit as a result of the corresponding reduction in vehicle delay at grade crossings.

Potential level of significance: **Not Significant/Beneficial.**

11.3.4.3 Systemwide Facilities

The vehicle shops and the control center would generate employee traffic that may adversely affect the local street system. These impacts, which are not expected to be significant, would depend on the number of employees at each facility, the location of the facility and the level of congestion on local streets and intersections.

Potential level of significance: **Not Significant.**

11.3.5 Construction

11.3.5.1 UP/SP Consolidated Corridor

Impacts Associated with Consolidation

Major construction activities associated with consolidation of the UP/SP corridor would include the installation of new track and signals, reconstruction of 24 bridges, and construction of 9 new river crossings and 43 new grade separations. These activities could result in adverse construction impacts in the areas of noise/vibration, air quality, transportation/circulation, utilities and public services. Grading activities at the project sites could generate fugitive dust and construction vehicles would emit pollutants which would adversely affect air quality. Construction equipment and vehicles would also generate intermittent high noise levels. Temporary detours or lane or road closures, which could adversely affect local circulation, may be required during the construction period. Detours, lane and road closures may also diminish access to local community facilities and result in additional delay for emergency vehicles. Construction activities within the existing railroad right-of-way could adversely affect rail service along the alignment. Temporary disruption of service provided by public utilities is also possible during construction.

Given the length of the corridor and the number and complexity of the structures proposed, consolidation of the UP/SP corridor could result in significant construction impacts.

Potential level of significance: **Significant.**

Impacts Associated with Electrification

Construction activities associated with electrification would include the erection of the catenary system including substations and switching stations, construction of new transmission lines connecting the existing lines with the traction power substations, the raising of 3 bridges to accommodate the catenary, and the lowering of 16 sections of track (minimum clearance requirements) to achieve required vertical clearances. These activities could result in adverse impacts similar to those described above. Track lowerings could require the reconstruction of adjacent grade crossings and the drainage system within the railroad ROW.

Construction would proceed in phases along the rail corridor, and it is expected that no one site would be affected by the construction activities for the duration of the construction period. Adverse construction impacts would be reduced if construction activities for consolidation and electrification were conducted simultaneously in the UP/SP corridor.

Potential level of significance: **Not Significant.**

11.3.5.2 Other Rail Corridors

The construction impacts for the other corridors would be similar to those described above for an electrified UP/SP corridor. Construction activities within the right-of-way could adversely affect freight and commuter rail service. In particular, construction within the single-track tunnels along routes 3 and 4 may pose special problems which would make it difficult to avoid temporary disruptions of freight and commuter rail service. The estimated construction period for each of the corridors is shown in Table 11-12. Table 11-14 shows the number of bridges that would have to be raised or replaced.

Potential level of significance: **Not Significant.**

11.3.5.3 Systemwide Facilities

Construction of the vehicle shops, the control center and locomotive change facilities could also result in construction impacts including air quality (fugitive dust and construction equipment and vehicle emissions), noise and vibration, transportation/circulation, and public services and utilities impacts. These impacts would be temporary and are not expected to be significant.

Potential level of significance: **Not Significant.**

11.3.6 Risk of Upset/Hazardous Waste

11.3.6.1 UP/SP Consolidated Corridor

Impacts Associated with Consolidation

Risk of upset – The increase in rail traffic due to consolidation of the UP/SP corridor could increase the potential for conflicts between trains, or between trains and vehicles or pedestrians at grade crossings. Hazardous materials, including diesel fuel, that are released as a result of a derailment or accident could expose persons to potential health hazards. Grade separating existing at-grade crossings would eliminate potential conflicts between trains and vehicles.

Hazardous Waste – Soil and ballast within the existing railroad right-of-way may have been contaminated as a result of years of railroad operations. A determination of the extent of soil contamination is beyond the scope of this study. However, contaminated soil and ballast disturbed or displaced as a result of construction activities may expose construction workers to potential health hazards. To minimize the risk of exposure, contaminated soil would have to properly handled, transported and disposed of in accordance with existing regulations.

TABLE 11-14

Number Of Structural Modifications Required By Route (25kV)

Route	Number Of Structures Based On Minimum Clearance Requirement			Number Of Structures Based On Desired Clearance Requirement			Grade Separated Crossings
	Replace	Raise	Lower Track	Replace	Raise	Lower Track	
1. UP/SP Corridor	0	3	16	0	5	26	43[1]
2. Baldwin Park Commuter	0	1	2	0	1	3	0
3. Moorpark Commuter	0	2	3	0	5	1	0
4. Santa Clarita Commuter	0	1	2	0	3	23	0
5. Lossan Corridor	0	2	22	0	3	36	0
6. Riverside Via Ontario	0	2	8	0	3	9	0
7. Riverside-LAUPT Via SF	0	1	4	0	2	9	0
8. Hemet-Riverside	0	0	6	0	0	8	0
9. San Bern. – Irvine	0	1	5	0	2	10	0
10. Redlands Commuter	0	0	1	0	0	2	0
11. Southern Pacific Yuma to Ports	0	1	11	0	2	14	0
12. Santa Fe Barstow to Ports	0	1	11	0	4	22	0
13. Union Pacific Ports to Yermo	0	2	12	0	10	33	0
TOTALS	0	14	103	0	40	196	43
UNDUPLICATED TOTALS	0	8	62	0	17	95	43

1 – Excludes Alameda Corridor Crossings. Assumes Crossings in the Alameda Corridor will be grade separated as part of the Alameda Corridor Project rather than the electrification project.

Source: Frederic R. Harris, Inc., 1992.

Construction of facilities located outside the railroad the right-of-way (e.g., substations, switching stations and transmission lines) could also disturb or displace contaminated soil. Since the locations of these proposed facilities are not known at this time, it is impossible to predict the likelihood of uncovering any hazardous materials or waste.

Potential level of significance: **Significant.**

Impacts Associated with Electrification

Risk of Upset – The placement of additional fixed objects within the railroad ROW, including catenary poles and electrical substations and switching stations, would slightly increase risks in an accident. There are potential increased risks associated with maintenance of the catenary structure in an active railroad ROW.

Hazardous Waste – The impacts would be similar to those described above.

Potential level of significance: **Not Significant.**

11.3.6.2 Other Rail Corridors

Risk of upset – The risk of upset may increase as a consequence of electrification. The construction activities associated with converting the existing railroad lines to electrified lines, may interfere with concurrent rail operations increasing the risk of upset or accident. Increased risk may also persist after the system is converted due to required ongoing maintenance of the electrified facilities. Several routes could experience a decreased risk due to the diversion of rail traffic to the consolidated UP/SP corridor.

Hazardous Waste – The potential issues are similar to those described above.

Potential level of significance: **Not Significant.**

11.3.6.3 Systemwide Facilities

Contaminated soil could be encountered as a result of the construction of system facilities within the existing railroad rights-of-way. Since the locations of proposed facilities have not been identified, the potential for uncovering hazardous substances can not be determined.

Potential level of significance: **Not Significant.**

11.3.7 Cultural Resources

11.3.7.1 UP/SP Consolidated Corridor

Impacts Associated with Consolidation

Historic structures – Although a survey has not been completed as part of this study, it is possible that structures within or near the UP/SP right-of-way, including control towers, maintenance buildings, bridges and passenger or freight depots, could have historic or architectural merit. The removal or demolition of any historic buildings or structures to accommodate a consolidated UP/SP corridor would be an adverse impact.

Archaeological Resources – The presence of surface artifacts within the railroad right-of-way, which has been developed and disturbed by railroad operations, is unlikely. However,subsurface artifacts may be uncovered during construction of proposed facilities. It is also possible that artifacts may be uncovered or an archaeological site disturbed as a result of activities associated with the construction of facilities at sites outside the right-of-way.

Potential level of significance: **Not Significant.**

Impacts Associated with Electrification

The issues due to electrification of a consolidated UP/SP corridor may be similar to those described above.

Potential level of significance: **Not Significant.**

11.3.7.2 Other Rail Corridors

The impacts for the other corridors would be similar to those described above for the UP/SP corridor.

Potential level of significance: **Not Significant.**

11.3.7.3 Systemwide Facilities

The impacts as a result of construction of the systemwide facilities would be similar to those described above.

Potential level of significance: **Not Significant.**

11.3.8 Energy

11.3.8.1 UP/SP Consolidated Corridor

Impacts Associated with Consolidation

Significant increases in energy consumption or the wasteful use of fuel are not anticipated as a result of consolidation.

Potential level of significance: **Not Significant.**

Impacts Associated with Electrification

Consumption of Electricity – Although the electricity consumed by electrified trains operating along this corridor has not been calculated, it is expected that the amount may be substantial given the number of freight trains and miles travelled. However, electrification would result in a corresponding decrease in diesel fuel consumption. An additional benefit of electrification is derived from the fact that electricity can be generated from a variety of fuel or energy sources, including renewable resources, rather than a single fuel, i.e, diesel fuel. This flexibility provides opportunities for more efficient management of energy resources and consumption.

Potential level of significance: **Not Significant.**

11.3.8.2 Other Rail Corridors

Consumption of Electricity – Electrification of the rail corridors could result in potentially significant increases in the consumption of electricity. The cumulative amount of electrical energy consumed by the 12 corridors was obtained from data supplied by the SCAQMD in its air quality impact analysis. In the year 2010, approximately 568,000 megawatt-hours would be consumed as a result of electrification of the candidate corridors. This amount represents slightly less than one percent of the energy sold by Southern California Edison (SCE) in 1989. SCE services all of Southern California (including Riverside and San Bernardino Counties) with the following exceptions: the Cities of Los Angeles, Burbank, Glendale, and Pasadena; and San Diego County. It should also be noted that conversion to electrically powered locomotives would save an estimated 29.3 million gallons of diesel fuel in the year 2010.

Potential level of significance: **Not Significant.**

11.3.8.3 Systemwide Facilities

The systemwide facilities would consume minimal amounts of energy in the context of the energy consumed by the electrified rail corridors.

Potential level of significance: **Not Significant.**

11.3.9 Biology

11.3.9.1 UP/SP Consolidated Corridor

Impacts Associated with Consolidation

Proposed facilities constructed outside the existing railroad right-of-way may have an adverse effect on biological resources. Since the locations of the facilities are not known, the extent and significance of any potential impacts cannot be determined at this time. However, it should be noted that the corridor and adjoining areas for the section of the corridor from the ports to Colton and San Bernardino are generally intensely developed urban, suburban areas. A greater potential for impacts to biological resources may exist where the rail routes pass through the undeveloped open space and desert areas of San Bernardino and Riverside Counties (segments 58,59,60, 61 and 44 and 45).

Potential level of significance: **Not Significant.**

Impacts Associated with Electrification

The potential issues would be similar to those described above for consolidation.

Potential level of significance: **Not Significant.**

11.3.9.2 Other Rail Corridors

The impacts would be similar to those described above for the UP/SP corridor. There is a potential for impacts to biological resources if the routes pass near or through large open areas, local, state or national parks, national forest, and areas designated as habitat for endangered or threatened species of plant or animal.

Potential level of significance: **Not Significant.**

11.3.9.3 Systemwide Facilities

The proposed system facilities are likely to be located in or near the existing railroad rights-of-way. The potential for significant impacts to biological resources is expected to be minimal. Identification of the locations of the facilities and further review is required before the significance of potential impacts can be evaluated with any degree of certainty.

Potential level of significance: **Not Significant.**

11.3.10 Soils and Geology

11.3.10.1 UP/SP Consolidated Corridor

Impacts Associated with Consolidation

Soil displacement, movement and compaction – Displacement of significant amounts of soil or substantial fill work may be required in order to construct new tracks, bridges and grade separations. Displaced soil may be contaminated with toxic materials as a result of railroad operations or by other uses in the vicinity of the project sites.

Exposure of persons and property to seismic hazards – Proposed facilities may also be located in the vicinity of active earthquake faults exposing persons or property to seismic hazards in the event of any earthquake.

Potential level of significance: **Not Significant.**

Impacts Associated with Electrification

Construction of the facilities required for electrification would result in impacts similar to those described above.

Potential level of significance: **Not Significant.**

11.3.10.2 Other Rail Corridors

Soil displacement, movement and compaction – Construction of the electrification facilities including substations, switching stations, catenary system and new transmission lines could also result in the displacement of significant amounts of soil or substantial fill work. Soil displaced during construction may be contaminated with toxic materials as a result of railroad operations or by other uses in the vicinity of the project sites.

Exposure of persons and property to seismic hazards – Proposed facilities may also be located in the vicinity of active earthquake faults exposing persons or property to seismic hazards in the event of an earthquake.

Potential level of significance: **Not Significant.**

11.3.10.3 Systemwide Facilities

The systemwide facilities include new shops, locomotive change facilities and the control center. Construction of these facilities may require some grading and cut and fill work. Soil within the railroad rights-of-way may also be contaminated with hazardous materials. Any contaminated soil displaced as a result of construction activities would have to be properly handled and disposed in accordance with existing regulations.

Potential level of significance: **Not Significant.**

11.3.11 Public Services

11.3.11.1 UP/SP Consolidated Corridor

Impacts Associated with Consolidation

Access to public services and facilities – Construction activities may require temporary detours, and lane or road closures diminishing access to community services and facilities and resulting in additional delay to emergency vehicles. The construction of 43 grade separations could significantly affect access to community facilities and services along the corridor. Access could be temporarily diminished during construction or permanently denied and diminished as a result of road closures.

Emergency vehicle delay at grade crossings – The consolidation of freight traffic on the UP/SP corridor could also increase emergency vehicle delay at grade crossings. However, eliminating the conflicts between rail and auto by grade separating cross streets would reduce vehicle delay. Given the large number of crossings that may have to be grade separated to mitigate potential traffic impacts, the overall impact to emergency vehicle delay may be beneficial.

Potential level of significance: **Significant.**

Impacts Associated with Electrification

Electrification would have little effect on public services.

Potential level of significance: **Not Significant.**

11.3.11.2 Other Rail Corridors

The construction of new facilities along the other corridors could affect access to community services and facilities and result in increased delay for emergency vehicles.

Potential level of significance: **Not Significant.**

11.3.11.3 Systemwide Facilities

It is expected that the systemwide facilities would be mostly constructed within the existing railroad rights-of-way, therefore, impacts to community services and facilities would be minimal.

Potential level of significance: **Not Significant.**

11.3.12 Public Utilities

11.3.12.1 UP/SP Consolidated Corridor

Impacts Associated with Consolidation

Temporary disruptions to utility service – Construction activities associated with consolidation could require the relocation of existing utilities (e.g., sewers, power lines, phone/communication lines, fiber optic cables, water, natural gas and other underground pipelines used to transport materials) and could result in temporary disruptions of service.

Potential level of significance: **Not Significant**

Impacts Associated with Electrification

Temporary disruptions to utility service – The potential impacts would be similar to those described above for consolidation.

Alterations to utility systems and facilities – Alterations to the existing electrical utility system and facilities would be required to accommodate the proposed electrified UP/SP corridor. New transmission lines would have to be constructed to connect proposed traction power substations with existing utility substations. For costing purposes, it was assumed that each transmission line would average one mile in length. Since an estimated 19 substations may be necessary along the UP/SP corridor, 19 miles of transmission lines may be required.

Increased demand for utilities – Operation of an electrified UP/SP corridor would also result in an increased demand for electricity. This increase, though substantial, may not be significant in the context of the regional consumption or the electrical generating capacities of the major suppliers to the region, SCE and the Los Angeles Department of Water and Power.

Operational impacts to power systems – The power demands of electric locomotives could create fluctuations or flicker problems in power system voltage. Locomotive control equipment could also create electrical current flow problems which could adversely affect computers or other electrical equipment served by the power transmission system. These impacts can be mitigated through proper design and installation of electrical filters. Above and below ground communications equipment could also be adversely affected by electromagnetic and electrostatic interference from the traction power supply system. These impacts could be mitigated by proper grounding and shielding.

Potential level of significance: **Not Significant.**

11.3.12.2 Other Rail Corridors

Disruptions and alterations to utility service and systems – Construction activities required to electrify the other corridors could also require alterations to the existing electrical power system and the relocation of utilities, potentially disrupting utility service. The potential for impacts would depend on the proximity of existing utilities to the rail rights-of-way and the proposed construction sites in addition to the level of proposed construction activity. Substations, switching stations, the catenary system and new transmission lines would have to be constructed for each of the corridors in addition to the track that would have to be lowered.

Increased demand for utilities – The cumulative amount of electricity consumed by the rail operations in the year 2010 for the 12 corridors is estimated to be 568,000 megawatt-hours or slightly less than 1 percent of the amount of energy sold by SCE in 1989.

Operational impacts to power systems – Operational impacts to the electrical system, e.g, interference, voltage problems, would be similar to those described above.

Potential level of significance: **Not Significant.**

11.3.12.3 Systemwide Facilities

Construction of the systemwide facilities may also affect existing service or require alterations to the existing utilities; however, the impacts are not expected to be significant or extensive due to the fact the facilities are relatively small in number and size and would probably be constructed within existing rail rights-of-way.

Potential level of significance – **Not Significant**

12.0 FUNDING ANALYSIS

12.0 FUNDING ANALYSIS

12.1 INTRODUCTION

The successful completion of any rail electrification program in the Southern California Region will require a complex arrangement of different financing techniques, and funding sources. The successful array of financing techniques and funding sources will necessarily include utility financing by both investor-owned, and municipal utilities, public sector participation at the state, federal and local levels, and financial participation by the freight railroads. In addition, other sources of innovative funding will need to be pursued.

To facilitate such a complex financing package, important public policy choices must be made, and priorities reconsidered among competing transportation infrastructure needs in the region. In addition, it will be necessary to reach consensus as to how the substantial costs of improving the air quality in the Southern California Air Basin through means such as rail electrification, should be absorbed.

This section reviews potential funding sources, discusses funding issues and strategies, and explores the following potential funding scenarios for rail electrification (For Commuter Rail only, and Commuter Rail and Freight):

Scenario One

100% Rate Based: SCE Customer Paid

Locomotives And Control Center Costs Financed By Other Funding Partners

Scenario Two

40% Rate Based: SCE Customer Paid

Scenario Three

40% Rate Based: Southern California Regional Rail Authority (SCRRA) Paid

12.2 POTENTIAL FUNDING SOURCES

12.2.1 Utility Financing

At the present time, utility financing may appears to offer the most viable method of funding a significant portion of the cost of rail electrification. Although the overall cost of utility financing can be high in comparison to other methods of public sector financing, the distribution of a substantial portion of the costs of rail electrification over a utility's customer base reduces the effective cost of the project to the direct users such as the SCRRA, the freight railroads, and Amtrak.

Southern California Edison (SCE) has expressed its willingness to pursue an application to the California Public Utilities Commission (CPUC) to participate financially in the funding of rail electrification. The City of Los Angeles Department of Water and Power (LADWP) has also expressed its willingness to participate financially in rail electrification. In addition, several other locally owned municipal utilities have expressed their interest in participating financially in any rail electrification project which may proceed within their service territory.

Southern California Edison's financial participation is subject to a CPUC finding that SCE's financial participation is in the best interest of it customers.

In addition, SCE has stated that from its perspective, any financial participation through utility financing includes constructing, owning, operating, and maintaining rail electrification facilities in which it invests.

Local municipal utilities including the LADWP are not required to seek CPUC approval for their financial participation but must instead seek approval from their local governing bodies, including their local boards and city councils.

While utility financing may offer the most viable method of funding a portion of the costs of rail electrification, it is unlikely that utility financing alone can bear the entire financial burden of electrification. Other funding sources must be sought to fill the gap between the utility financed share of the costs and the total costs of electrification.

12.2.1.1 Investor-Owned Electric Utilities

As an Investor-owned utility in California, SCE is under the jurisdiction of the CPUC. The CPUC is vested with broad powers and regulatory authority to oversee the business activity of investor-owned utilities and ensure that the interests of the utility ratepayers are served.

By virtue of the exclusive operating franchise granted to the utility within its defined service area, the utility has the obligation to provide electric service to customers within this service area. To meet this obligation to serve, the utility constructs, owns, operates and maintains sufficient generation, transmission, distribution, substation, and other necessary electric system facilities (electric plant) to provide reliable electric service to its customers. The utility is allowed to recover the reasonable cost of facilities that are determined by the CPUC to be used and useful in the performance of its duty to the public, through electric rates charged to the utility's customers.

There are four principal ways that an investor-owned electric utility would typically construct, own, operate, and maintain electric facilities (plant) on behalf of its customers. These four methods are:

1) Utility Rate Based – When a system need is identified and there are sufficient anticipated revenues to support investment, electric utilities invest in new electric plant by financing the cost of the new construction and requesting recovery of those costs, including the utility's total cost of owning, operating, and maintaining these facilities, (e.g., the revenue requirement) through customer rates. This method generally applies to the electric plant which is constructed to serve the needs of utility customers on a system-wide basis, and satisfies traditional utility tests of cost-effectiveness and regulatory criteria of being "used and useful." The impact on customer rates as well as the availability of capital must be considered.

2) Customer Funded Facilities – When there are insufficient anticipated revenues to support an investment, utilities require the applicant to fund the portion of the investment unsupported by revenues and also require them to advance an ownership fund for the period of time that there may be insufficient revenue. This ensures that the utility's ratepayers do not unfairly subsidize any single customer. The customer provides the required funds to the utility in advance of construction. The utility constructs, owns, operates and maintains the facility. The customer pays for electric service at a standard tariff rate.

3) Utility Financed Added Facilities – On a utility financed Added Facilities basis, the serving electric utility finances and constructs the facilities and recovers the total cost of owning, operating, and maintaining the added facilities (the utility's revenue requirement) from the customer through a monthly added facilities payment. Added Facilities contracts are not generally subject to CPUC approval prior to construction.

4) Customer Financed Added Facilities – On a customer financed Added Facilities basis, the customer finances the installed cost of the facilities and pays a monthly added facilities payment through which the utility recovers its ongoing costs of ownership. In other respects, this procedure is similar to utility financed in that the utility owns, operates, and maintains the facilities.

Rail electrification in the Southern California Air Basin involves potential electrification of freight and/or commuter rail operations. Although certain routes are solely freight rail routes, of the thirteen potential routes for electrification, nine of the routes involve shared freight and commuter rail operations. Electrification for freight operations requires higher levels of power delivery and some additional operational improvements. To date SCE has focused its interest in financial participation on electrification of commuter rail operations (although it has not ruled out financial participation in electrification of freight rail operations). SCE has also focused its interest in financial participation on construction and ownership of the catenary and power traction portions of any rail electrification project. It is believed that the electrification elements (traction power stations system) represent between 40% to 50% of the total project costs.

It is very important to note that the total costs of SCE investment which must be recovered from SCE customer(s) under any of the four approaches include a return on investment, taxes paid on the SCE return on investment, allocated overhead costs, and operating and maintenance costs.

12.2.1.1.1 Southern California Edison

Southern California Edison (SCE) is an investor owned utility with total annual operating revenues in 1990 of $6.99 billion, and total assets of $14.6 billion. SCE's net income in 1990 was $736.8 million. Its activities are closely regulated by the California Public Utilities Commission (CPUC).

Southern California Edison has expressed its interest in participating in the funding of rail electrification. Any SCE decision to participate financially in rail electrification is subject to a management finding of substantial public benefit to SCE ratepayers, and a subsequent approval by the CPUC. A complete description of the regulatory relationship between SCE and the CPUC, and the CPUC application process is found in Section 10.0 of the report. Generally speaking, the CPUC must make a finding that rail electrification is in the best interest of SCE's customers. In doing so the CPUC will consider the impact SCE's financial participation will have on its customer's rates.

SCE's proposed financial participation in rail electrification differs substantially from the typical utility investment made by SCE. Therefore it is likely that the CPUC application process will focus on the balance between the costs to SCE's customers and the benefits these customers will receive from rail electrification. Whether SCE will receive CPUC approval to participate financially, and how the costs of participation will be shared among SCE's customers, including the Southern California Regional Rail Authority (SCRRA), will largely depend on how strong a public benefit argument is made in the application. To date the question of public benefit has focused on the potential for rail electrification to provide improvements to air quality in the California South Coast Air Basin.

12.2.1.2 Public Utilities

12.2.1.2.1 The Los Angeles Department of Water and Power

The City of Los Angeles Department of Water and Power (LADWP) is one of the largest municipally owned utilities in the country. The Power System has annual revenues of $1.86 billion and book value assets of $4.7 billion. LADWP is exempt by State statue from regulation by the CPUC but is under the oversight of its Board of Water and Power Commissioners, and the Los Angeles City Council. In addition, in some cases it is subject to regulation by the Federal Energy Regulatory Commission (FERC). The LADWP is also interested in pursuing financial participation in any rail electrification project which may occur in the California South Coast Air Basin, to the extent that the rail line(s) to be electrified traverse LADWP's service territory. Like investor-owned utilities, LADWP also finances its utility investments through rate-Basing or customer facility charges. Any decision on the part of LADWP management and its Board to pursue rate based financial participation in rail electrification will be subject to approval by the Los Angeles City Council. While the LADWP remains open to the possibility of rate-Basing its investment, a decision to allocate the costs of LADWP's investment to LADWP's customers through rate increases would face the political hurdle of obtaining the Los Angeles City Council's approval. Customer facility charges, whereby the LADWP invests its funds and the customer pays a surcharge to repay that investment, does not require Los Angeles City Council approval.

It should also be noted that the LADWP possesses a superior credit rating and by extension, a favorable cost of capital. Any investment decision on the part of LADWP will be made with full consideration of the impact of the investment on LADWP's financial position and high bond rating. By extension, project scope and total costs will be weighed heavily against potential revenue streams available to cover the costs of electrification.

12.2.1.2.2 Other Municipal Utilities

The thirteen freight and commuter rail routes under consideration for electrification run through twelve different utility districts:

MUNICIPALLY OWNED	INVESTOR OWNED
LADWP	Southern California Edison
Imperial Irrigation District	Arizona Public Service
City of Banning	San Diego Gas & Electric
City of Colton	
City of Burbank	
City of Glendale	
City of Riverside	
City of Vernon	
City of Anaheim	

Of the twelve utility districts, only SCE, Arizona Public Service and San Diego Gas and Electric are private investor-owned utilities. The remaining utility districts, with the exception of the City of Anaheim, are members of the Southern California Public Power Authority (SCPPA).

12.2.1.2.3 The Southern California Public Power Authority (SCPPA)

The Southern California Public Power Authority (SCPPA) is a Joint Powers Agency (JPA) created for the purpose of the planning, financing, development, acquisition, construction, operation and maintenance of projects for the generation or transmission of electric energy.

Members cast votes weighted according to their respective shares, with the LADWP as the largest shareholder with 67% of the shares. Although the charter and the by-laws of the SCPPA inhibit its financial participation in any rail electrification project directly, several of the member municipal utilities including the LADWP have expressed an interest in participation in a Joint Powers Authority for the purpose of coordinating municipal utility investment in rail electrification, pointing to the SCPPA as a model JPA.

12.2.2 Public Agency Funding of Rail Electrification

It is likely that utility financing of electrification will only provide 40% to 50% of the total cost of rail electrification. Assuming that SCE and the other municipal utilities decide to seek regulatory and local governmental approval for rate based financial participation in rail electrification, and are successful in obtaining the necessary approvals, there is still approximately 50% to 60% of the remaining total project cost to fund. Policy makers will be looking at state, federal and local agencies as possible sources of funding for much of the remaining project costs.

While attention has focused on the Regional Transportation Agencies as potential funding sources given their recent access to local sales tax revenues, the Regional Transportation Agencies have already programmed available funds to existing rail transit, highway, and congestion management projects. Any current sales tax or state grant funds which might be programmed into rail electrification would come at the expense of other local and regional transportation projects.

At the state level, Proposition 108 and 116 funds, including funds potentially available with voter approval of 1992 and 1994 Transportation Bonds, are already programmed through the State Transportation Improvement Program (STIP). State Funds for rail electrification from these funding sources would come at the expense of other state transportation projects. The one source of currently unprogrammed State funds would be 1994 STIP Flexible Congestion Relief Program for Fiscal Years 1999/2000 and 2000/2001. Without the passage of a new gas tax, voter approval of a dedicated rail electrification bond issue, or cancellation/deferral of currently programmed STIP transportation projects, state allocation of 1994 STIP Flexible Congestion Relief Program funds appears to be the only viable state funding mechanism for rail electrification.

At the federal level, The 1991 Intermodal Surface Transportation Efficiency Act offers potential new sources of funding with the creation of two new programs: The Surface Transportation Program, and The Congestion Mitigation and Air Quality Improvement Program. These two programs offer the most viable source of unprogrammed government funds available for rail electrification to date. It should be noted that rail electrification will compete with currently unprogrammed and unfunded transportation projects for access to these federal funds.

12.2.2.1 Local Funding

12.2.2.1.1 Southern California Regional Rail Authority

The Southern California Regional Rail Authority (SCRRA) is a 5 county Joint Powers Authority (JPA) comprised of the following member counties:

1) The Los Angeles County Transportation Commission
2) The Orange County Transportation Authority
3) The Riverside County Transportation Commission

4) The San Bernardino Associated Governments

5) The Ventura County Transportation Commission.

The San Diego Association of Governments, and the Southern California Association Governments are both ex-officio members.

SCRRA's purpose is to advance the planning, design, construction, and then administer the operation of the Metrolink regional Commuter rail service in the multi-county area. It receives its funding from its member agencies, who in turn receive local sales tax, and state and federal grant funds. Funding by the five member counties is based on multi-county cost sharing formulas for capital as well as operating and maintenance costs. All of its member agencies with the exception of the Ventura County transportation Commission have sales tax authority.

The SCRRA is staffed by the LACTC Commuter Rail Section. In addition, the LACTC provides administrative functions for the SCRRA including the processing of applications for state funding.

12.2.2.1.2 Los Angeles County Transportation Commission

The Los Angeles County Transportation Commission (LACTC) was created by the California Legislature in 1976 to function as the primary transportation authority in Los Angeles County. The Commission sets public transit policies and funds mobility solutions, such as the County's streets and highways, rail transit, buses, shuttles, dial-a-rides, social service transportation, bikeways and other public transit systems. In addition, the LACTC coordinates activities between the various transportation operators and agencies in the County and State.

In 1990, the Los Angeles County Transportation Commission (LACTC) unveiled its Metro System concept with the goal of improving mobility in the county and the surrounding Southern California area. The program -- an integrated transportation network called the METRO System -- will be implemented over a thirty-year period.

The Integrated Transportation System is described in the LACTC Draft 30 –Year Integrated Transportation Plan. This plan, which embodies the mission of the LACTC, provides a framework for strategizing the most effective combination of programs and resources to achieve the objectives underlying this mission. This plan is accompanied by a mechanism for assessing the relative merit of alternative programs and a mechanism for allocating limited resources to the selected programs. The LACTC Draft 30 –Year Integrated Transportation Plan is a tool to guide Commission decision–making. It is more than a simple accounting of programs, projects, costs, and revenues for the next 30 years. It challenges the Commission to pursue strategies required to deliver a balanced program of transportation improvements as quickly and efficiently as possible.

The system's integrated transportation network coordinates four major components: (1) approximately 150 miles of light rail and heavy rail, called the Metro, combined with a commuter rail system of over 250 miles of routes called Metrolink; (2) an expanded bus system; (3) highway and freeway improvements and (4) Transportation Demand Management strategies..

The LACTC's Governing Board has 11 members:

- All five Los Angeles County Supervisors
- The Mayor of Los Angeles
- Two Mayor appointed members: a member of the Los Angeles City Council and, traditionally, a private citizen

- A member of the Long Beach City Council
- Two city council members from among the other 84 cities in the county
- A non-voting member: a Governor-appointed member from the California Department of Transportation.

Congestion Management Agency – LACTC is the Congestion Management Agency charged with implementing the state-required Congestion Management Program for the Los Angeles County area.

Local Funds: Proposition A – In 1980, the LACTC proposed that the county increase the sales tax from six to six and one-half cents on each dollar to pay for public transit improvements. Voters approved the one-half cent tax increase under a measure called Proposition A. The tax began to be collected in mid-1982, and currently brings between $350 and $400 million each year. This tax does not sunset.

Proposition C – In November, 1990, Los Angeles County voters approved another one-half cent sales tax increase to pay for public transit-related improvements by passing Proposition C. Beginning in April, 1991, this measure provides between $350 and $400 million per year in funds. Funds from Proposition C are currently held in escrow pending the outcome of litigation challenging the right of the LACTC to levy the additional sales tax increase. This tax does not sunset.

12.2.2.1.3 Orange County Transportation Authority

In June of 1991, six formerly separate transportation agencies consolidated into the Orange County Transportation Authority (OCTA). The agencies were: the Orange County Transportation Commission, the Orange County Transit District, The Consolidated Transportation Services Agency, the Service Authority for Freeway Emergencies, the Orange County Local Transportation Authority, and the Orange County Congestion Management Agency.

The new OCTA is governed by a single 11 member board of directors consisting of four members of the Orange County Board of Supervisors, six city representatives, and one public member selected by the other ten members.

The consolidation allows Orange County to coordinate its approach to regional transportation planning, and take full advantage of revenues generated by State Propositions 111 (Fuel Tax), 116, 108 (Rail Bonds) and Measure M, the County's one-half cent sales tax for transportation. Measure M approved by the voters in November 1990, is projected to generate 3.1 billion for transportation projects in Orange County. It sunsets in 20 years.

The OCTA is responsible for implementing Measure M programs, coordinating the planning of the county's first light/monorail system, operating and expanding commuter rail service, allocating funds for freeway widening and street and road improvements, administering Orange County's freeway call box system, and overseeing a county-wide growth management program to assist cities in fulfilling their Measure M responsibilities.

In addition, OCTA serves as the lead Congestion Management Agency, oversees and operates local and express bus routes, and Dial-A-Ride services.

12.2.2.1.4 Riverside County Transportation Commission

The Riverside County Transportation Commission was created by the State Legislature in 1976. Its responsibilities include coordinating state highway planning, adopting short range transit plans, coordinating transit service, allocating Transportation Development Act funds, identifying projects for state and federal grant funds, and coordinating county highway and transit plans with regional and state agencies.

It received approval from the voters in 1988 for Measure A, its one-half cent sales tax authority. Measure A sunsets in 20 years. In Fiscal Year 1990/91 RCTA funding sources totaled 192 million: 28% from Measure A, 57% from debt proceeds, and 15% from DMV user fees.

The RCTC Board is composed of eight members, three of whom are members of the County Board of Supervisors, two elected official from cities selected by the City/County selection Committee, one elected official from the City of Riverside, and one public member appointed by the other Commission members. In addition, the governor appoints an ex-officio member, who is currently the District 8 Caltrans Director.

12.2.2.1.5 San Bernardino Associated Governments

The San Bernardino Associated Governments (SANBAG) was formed in 1973 as a subregional council of governments under a Joint Powers Agreement (JPA). As of 1991 the JPA included the 22 cities within the County of San Bernardino as represented by the Board of Supervisors. The JPA serves as a forum for:

1) Serve as the subregional transportation planning, fiscal programming and coordinating agency.
2) The consideration, study and preparation of recommendations on county-wide, subregional and regional problems.
3) Assemble information helpful in the consideration of problems peculiar to the various sections included in the collective area of the association membership.

In 1976, SANBAG became the County Transportation Commission, and in 1986 SANBAG was named the Service Authority for Freeway Emergencies (SAFE). With the passage of Measure I in 1989, SANBAG added the duties of County Transportation Authority. In 1990, SANBAG was named the Congestion Management Agency. The SANBAG Board is made up of one elected member from each city and all five members of the County Board of Supervisors.

Until Measure I, SANBAG's revenue came from 2 percent of the county-wide Local Transportation Fund (LTF) monies which were a portion of the overall six cent (.06) sales tax. In 1989 AB 2184 increased the amount to 3% of the LTF funds. Measure I provided for a one-half cent sales tax to fund transportation projects in San Bernardino County. As the Transportation Authority, SANBAG receives 1% of the Measure I monies for administrative purposes. The sales tax sunsets after 20 years.

12.2.2.1.6 The Ventura County Transportation Commission

The Ventura County Transportation Commission was created by Senate Bill 1880 (Davis), Chapter 1136 of the Public Utilities Code, in September of 1988. On January 1, 1989 VCTC became operational and assumed the resources and transportation responsibilities of the Ventura County Association of Governments (VCAG).

12.3 FUNDING ISSUES AND STRATEGIES

12.3.1 Utility Financing

12.3.1.1 Investor-Owned Utilities

12.3.1.1.1 CPUC Criteria for Approval

An argument can be made that the benefits of electrification accrue to the general public through reduced traffic congestion and improved air quality. The California Public Utilities Commission (CPUC) could determine that the facilities required for rail electrification are appropriately constructed, owned, operated, and maintained by a utility and recovered through utility rates to all customers.

Traditional electric utility regulation is based on charging the customers rates that are based on the cost of providing electric service to each customer. Thus it may also be argued that the facilities required for rail electrification are non-standard facilities required to serve a single customer and that these facilities will not provide system benefits to other utility ratepayers.

The facilities required for rail electrification will require a significant investment and will require a CPUC finding that the expenditure of funds would be cost effective and the facilities are "used and useful" in the performance of the utility's duty to the public. If the utility, for example, the Southern California Edison (SCE), elects to own, operate, and maintain electrification facilities, and seek recovery of the associated costs through rates charged to all or a single customer, the utility will have to file an application with the CPUC prior to construction to determine if these costs are eligible for such rate treatment.

The CPUC will carefully examine any extension of the traditional electric utility function, the costs to the utility's ratepayers of electrification, and the range of economic, environmental and other public benefits that my be realized. Although the CPUC has never been asked to review facilities required to electrify a rail system and determine if those facilities or portions of those facilities can be deemed "used and useful" and therefore incorporated into a utility's rate base, the broad public benefits of rail electrification may provide the CPUC with a basis for determining that the costs are appropriately charged to all of the utility's ratepayers.

In the public policy discussion surrounding rail electrification, the issue of public benefit has focused on the potential for improvements to the air quality in the California South Coast Air Basin. What may be problematic about the focus on air quality from the perspective of a potential CPUC application is that, on a cost/benefit basis, the air quality improvements may or may not be significant enough to justify adding the cost of SCE's investment to its rate base. Further complicating the CPUC evaluation of the air quality benefits, and the cost/benefits of rail electrification, is that, in order to obtain substantial air quality improvements from electrification, freight rail as well as commuter rail must be electrified. To date, SCE has focused its interest in financial participation on commuter rail.

It should be clearly understood that in order for the CPUC to make a determination approving a utility rate base application which spreads the cost of the SCE's investment in rail electrification among all of its customers, the CPUC must make a finding that such an investment provides substantial benefit to SCE's customers.

12.3.1.1.2 Utility Rate Based vs. Utility Financed Added Facilities

The two utility financing approaches primarily considered by the Funding Committee were utility rate Basing vs. utility financed added facilities change. As previously discussed in Section 12.1 of this section, utility rate based financing involves SCE investment in new electric plant and recovery of that investment through customer rates. Utility financed added facilities charge financing involves SCE financing, constructing and operating an electric facility on behalf of a particular customer who pays a monthly percentage of the cost of the investment back to SCE. The payment theoretically continues in perpetuity.

In addition, when considering utility financing for rail electrification, it is important to note that it is unlikely that utility financing would be able to cover the total costs of construction. It is not clear whether the CPUC would allow SCE to fully cover the costs of the total rail electrification project, or that SCE management is interested in an investment of that nature.

An analysis performed by SCE (see Exhibit 12-2) comparing the costs of investment by utility financing of commuter rail electrification per $100 million indicates that the cost of utility rate based financing is less than the cost under utility financed added facilities charge. Although SCE cautions that the results of the analysis are preliminary only, and subject to refinement with additional project definition and cost information, they are indicative of the relationship between the costs of "rate Basing" vs. "added facilities charges."

Utility Rate Base

The analysis for utility rate base financing was conducted in such a manner that the cost per $100 million represented the amount needed to be collected to fully recover the total costs of the additional investment. This total cost could then be allocated subject to CPUC authorization for investment and recovery, among SCE customers.

This total cost includes:

1) The 1992 authorized rate of return of 10.59%
2) Income taxes at 40%, other taxes at 1.08%
3) Operations and maintenance charges fixed at 1.5% of capital costs, allocated overhead costs at 1.3% of capital costs
4) Depreciation charges in excess of capital costs.

The Net Present Value, discounted at 7%, of the total costs per $100 million of investment needed to be collected in rates would be $216 million dollars over thirty-three years.

Added Facilities

The cost of an added facilities charge investment to the SCE customer for whom the facility is built is currently 1.7% monthly (on an indefinite basis) of the total investment. In this case the cost of a $100 million dollar investment expressed in Net Present Value over thirty-three years would be $260 million to either the Southern California Regional Rail Authority, or some other entity created for the purpose of implementing rail electrification. All other costs, with the exception of the costs of the electricity, are included.

EXHIBIT 12-2
Southern California Edison
Commuter Rail Electrification
Annual Cost per $100 Million of Investment
(Millions of Dollars)

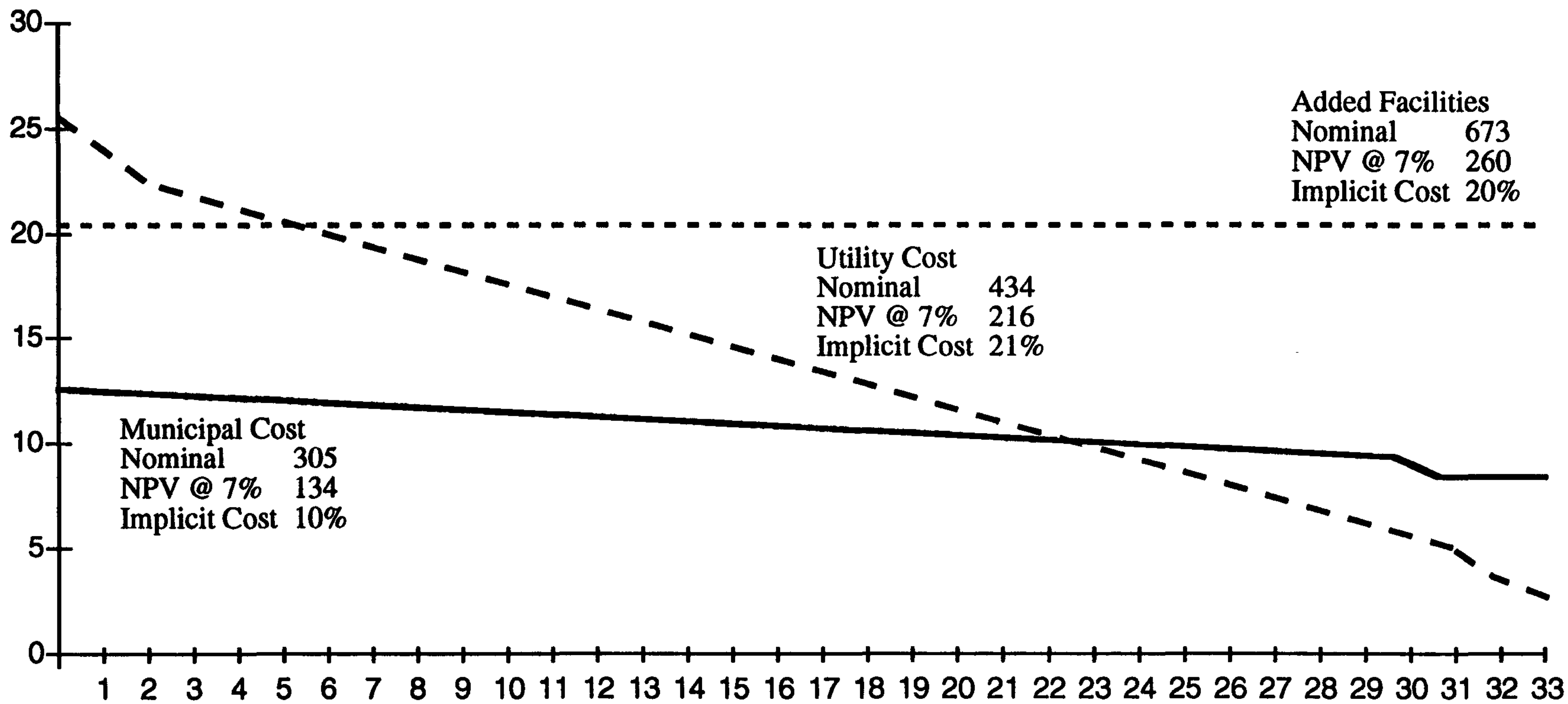

EXHIBIT 12-2 (continued)
SOUTHERN CALIFORNIA EDISON COMPANY
Commuter Rail Electrification
Cost Per $100 Million Of Investment

Disclaimers	All projections are preliminary and subject to change. Need final project definition and cost to refine projections. Need operating and maintenance cost projections. Tax and accounting assumptions need to be verified once project definition and costs are known.
Added Facilities	NPV @ 7% over 33 years is $260 million. Payments are 1.7% per month on capital cost. Contributions in Aid of Construction (CIAC) not considered . No Income Tax consequences associated with CIAC . Covers all costs except replacement; replacement costs are capitalized and monthly payments increase. Existing Tariff authorized by CPUC.
Utility Cost	NPV @ 7% over 33 years is $216 million. Costs represent amount needed to be collected through rates to make ratepayers neutral to additional investment. If investment is added to rate base and costs are allocated to all customers, no Income Tax consequences associated with CIAC . If investment is added to rate base and costs are allocated to a single customer, possibility of Income Tax on CIAC. Covers all costs except replacement: – 1992 Authorized Rate of Return at 10.59% – Income Taxes at 40%, Other Taxes at 1.08% – Depreciation charges are in excess of capital cost – Operating & Maintenance fixed at 1.5% of capital cost – Allocated Overhead fixed at 1.3% of capital cost Need CPUC authorization for investment and recovery.
Municipal Cost	Rough estimate of cost to public entity. NPV @ 7% over 33 years is $134 million. All capital costs financed with debt at 7%. Interest accrued on undepreciated capital cost. Same maintenance and overhead allocations as in other cases. Covers all costs except replacement. Depreciation charges equal to capital cost. No taxes assumed.

It should be noted that any replacement costs would require additional capitalization causing the monthly payment to increase. In addition, SCE is at some degree of financial risk since if the customer for whom the facility has been built becomes insolvent, SCE has no recourse by which to recover its investment.

Benefits of Rate Basing Over Added Facilities Charge

In addition to the lower costs of utility rate Basing ($216 million vs. $260 million respectively) over added facilities charge financing, there are two important benefits to utility rate Basing. First, unlike added facilities financing, it is possible to pay off the cost of the investment over time. Secondly, utility rate Basing offers the opportunity to spread the cost of the investment among SCE rate payers.

If it is believed that the CPUC will not approve a utility rate based application which allocates the costs of the SCE investment to all SCE customers on the basis on the air quality or other public benefits, then it may be possible to submit an utility rate base application which allocates the costs to a sole customer, the SCRRA or other entity created for that purpose. In this manner, utility rate Basing serves as a financing technique by which rail electrification may be accomplished by spreading the costs of rail electrification over thirty-three years. Dependant upon project scope and costs, it may then be easier for the SCRRA or other entity created for this purpose to absorb the costs of rail electrification on a year by year basis.

Two additional issues remain if this approach is attempted. First, this approach-- utility rate Basing of rail electrification facilities, with the costs allocated to a single customer, is untested at the CPUC level. Thus it is uncertain how the CPUC would react to such a proposal. Secondly, there may be negative tax implications for SCE, as the Internal Revenue Service (IRS) may view this approach as a Contribution in Aid of Construction, and assess income taxes on the amount of the contributed capital. SCE would then pass this tax on to the single customer. A ruling from the IRS should probably be sought in advance.

The Funding Committee believes that if utility financing for rail electrification is to be pursued, it should be done as a form of utility rate Basing, most optimally with the costs allocated to all utility customers on the basis of its air quality or other benefits. Potentially feasible as a financing technique, but less preferable as a funding mechanism would be utility rate Basing with the costs allocated to a single customer, the SCRRA or other entity created for that purpose. For the purpose of the hypothetical financing scenarios included in Section 12.4, the Funding Committee has chosen these two approaches.

12.3.1.2 Public Utilities

12.3.1.2.1 LADWP and Other Municipal Utility Participation: The Approval Process, and Rate Basing vs. Added Facilities Charge Financing

Unlike SCE, LADWP and the other eight municipal utilities in the region are not regulated by the CPUC. They are governed by their respective boards and their local City Councils. As such the decision to participate financially in rail electrification and the type of financial participation possible are constrained by political considerations at the local level.

While it is possible for a municipal utility to propose a utility rate base approach to financing its participation in rail electrification, the municipal utility would have to secure both Board and local City Council approval before passing on the costs of the investment to the residents of the locality, which may be difficult.

On the other hand, LADWP's analysis of the costs of utility financing of rail electrification per $100 million dollars of investment indicates that a customer facilities charge to cover municipal utility investment in electrification is promising.

Under a municipal utility financing scenario prepared by the LADWP using itself as an example, the Net Present Value of a $100 million investment over thirty-three years, utilizing a 7% discount rate is $134 million (including operations and maintenance, and allocated overhead costs). This assumes all capital costs are financed with tax-exempt debt at 7% interest accrued on undepreciated capital costs. The LADWP or a JPA formed for this purpose could finance their portion of the total project costs at a favorable cost of capital and recover the costs of its investment from the SCRRA or other entity created for that purpose.

The operations and maintenance, and allocated overhead assumptions are the same as for the SCE utility rate base and utility financed added facilities charge alternatives. The primary difference lies in the rate of return required by SCE, and depreciation schedules used by the two utilities. LADWP assumes that it would depreciate at 100% of its capital costs over the thirty-three years, while SCE utilizes a depreciation rate between 140% and 145% over the same period.

However, if the CPUC allows rate Basing of investment in rail electrification, it makes it more likely that the governing body of these municipal utilities would support these utilities' participation. While the opportunity available under a rate based approach to spread the costs among a utility's customers may require the support of many local political bodies, the opportunity to utilize the tax-exempt status and outstanding credit worthiness of a municipal utility such as LADWP makes municipal utility participation attractive. This is especially true in light of the limited amount of debt capacity available to other regional agencies concerned with electrification.

12.3.2 Public Agency Funding

12.3.2.1 Project Deferral and Capacity for Debt

While the regional transportation agencies have independent sources of funds (with the exception of Ventura County Transportation Authority) in their local sales tax authorizations, the regional transportation agencies have already programmed virtually all available funds to address the pressing transportation problems of the Southern California region.

For the regional transportation agencies, the issue of funding rail electrification is one of project deferral or cancellation. Investment of funds in rail electrification would come at the expense of other transportation projects. Despite the amount of sales tax funds available to the regional transportation agencies, the total number of dollars is finite. All of the regional transportation agencies which have sales tax authority, with the exception of the LACTC, have sunset clauses on their sales tax authority. This makes very real the trade off between the substantial investment required for rail electrification and the pressing capital requirements required for other specific transportation projects.

In addition, the measures authorizing counties like Orange and San Bernardino to impose a sales tax have proscribed projects which must be funded with the sales tax revenues generated. Finally, financial participation by the regional transportational agencies is constrained by timing. An accelerated rail electrification program requires substantial amounts of cash in exactly the years when the regional transportation agencies require significant amounts of cash to fund other major, capital-intensive heavy, light and commuter rail projects.

The prospect for the issuance of long term debt to finance rail electrification supported by the sales tax revenues of the regional agencies is also problematic. The sunset clauses of the regional transportation agencies make the issuance of long term debt beyond 2008 to 2010 difficult. In addition, although the LACTC does not have a sunset clause on its sales tax authority, it is at the limitation of its debt capacity with its rail program under construction and planned in its draft 30 Year Plan.

The very real question facing policy makers is the degree to which the funding of rail electrification should take precedence over transportation projects already in the planning and development stages. If a regional consensus develops which is committed to the electrification of rail in the Southern California region, then perhaps approval for new additional sources of funding such as a regional utility or sales tax could be sought.

12.3.3 Strategies to Obtain State Funds

With Proposition 108 and 116 funds already committed to transportation projects statewide, 1994 STIP Flexible Congestion Relief funds offer the best hope for securing state participation in rail electrification.

In order for rail electrification to obtain 1994 STIP Flexible Congestion Relief funds, the member regional transportation agencies of the SCRRA must nominate rail electrification for funding through the Regional Transportation Improvement Program (RTIP) process. The RTIP would be submitted to Southern California Area Governments (SCAG) by November of 1993. SCAG would have to approve the RTIP by December of 1993, with the California Transportation Commission reviewing the nominations for inclusion into the STIP and allocating Flexible Congestion Relief funds by March of 1994.

With the recent passage of Proposition 111, which authorized the imposition of $0.01 (one cent) per gallon gas taxes in 1991, 1992, 1993, and 1994, additional gas tax increases for the purpose of funding rail electrification may not be a near term funding strategy.

Two transportation bond measures are already scheduled to go before the voters in 1992 and 1994. Whether or not the Legislature and the voters will be sympathetic to additional transportation bond measures for transportation is difficult to assess. One potential source of funds is the Governor's recent $6 billion Economic Recovery Bond Program. If the Governor's proposal moves forward it may provide an additional source of funds which could be used for rail electrification.

12.3.4 Strategies to Obtain Federal Funds

Although funding for rail electrification through the Federal Transit Agency (FTA) (formerly UMTA) Section 3 and Section 9 programs seems unlikely, two new programs created by the 1991 Intermodal Surface Transportation Efficiency Act (1991 ISTEA) offer some promise as potential funding sources.

The Surface Transportation Program (STP) and the Congestion Mitigation and Air Quality Improvement Program (CM & AQIP) are two new flexible programs which provide the State and regional agencies with new sources of currently unprogrammed funds.

At the present time it is unclear how funds for either of the two programs will be allocated within California. Discussions are ongoing over whether funding through these two new programs will be allocated through the regular STIP process with the CTC action in March 1994, or whether funds will be programmed through a mid year STIP process in 1993. There is also the possibility that the funds will distributed by formula to the Metropolitan Planning Organizations across the State who would in turn program the funds.

In addition, it may be possible to seek an direct congressional appropriation earmarked for rail electrification in the Southern California region which would be programmed through the Department of Transportation (DOT), the Federal Railroad Administration, or the Environmental Protection Agency (EPA).

12.3.5 Private Financing by the Freight Railroads

12.3.5.1 Willingness to Participate and Cost of Capital

What is driving the acceleration of rail electrification in the Southern California region is the SCAQMD requirement that 90% of all rail operations be electrified by the year 2010. The motivation for the SCAQMD requirement is centered on improved air quality, a general benefit which accrues to all in the Southern California Region (including business entities) but which is difficult to quantify in economic terms.

In piecing together the elements of a funding strategy for rail electrification, a question certain to be asked is what will be the financial role of the freight railroads. As owners and operators of the majority of the rail mileage to be electrified, there is a perception that the freight railroads should also participate financially in the costs of rail electrification. However, the regulatory authority of the SCAQMD over the freight railroads is uncertain. Therefore the freight railroads view investment in electrification not as a economic cost of operating in a regulated environment but as a bottom line investment decision which must generate certain rates of return.

The railroads themselves assert that they have little discretionary capital to invest in rail electrification. Their willingness and ability to participate financially is hampered by their high cost of capital in the financial markets.

The extent to which the freight railroads are likely to willingly participate in rail electrification will thus be proportional to the incremental net benefits they expect to receive as a result of any rail electrification project. For the railroads these benefits are expressed in terms of a rate of return on investment (ROI).

The Interstate Commerce Commission (ICC) has established an industry-average pre-tax cost of capital of 17.4% as the minimum rate of return needed to insure railroad revenue adequacy. On a $100 million dollar investment, the Net Present Value cost to the freight railroad (33 years, 7% Discount Rate) is $191 million (excluding operating and maintenance costs, allocated overhead, and depreciation).

This creates the threshold which internal investment decisions by the railroads must overcome. Unless dramatic life cycle cost savings accrue from rail electrification, the railroads assert it is difficult for the railroads to justify an investment decision to fund a portion of the cost of rail electrification.

As owners and operators of the majority of the mileage to be electrified, freight railroads have a significant level of investment already in place, and a vested interest to protect. Two factors should be noted; 1) that the freight railroads control access to the rights-of-way which would be necessary to construct and operate the electric power distribution system for rail electrification, and 2) that the SCRRA commuter lines operate all or in part over freight railroads.

Given the freight railroads view of financial participation in rail electrification as an investment decision subject to a required rate of rate of return, and not as the cost of operating in a regulated environment, the freight railroad's willingness to ultimately participate financially in the cost of rail electrification may be determined by the resolution of the uncertainty surrounding the SCAQMD regulatory authority over their operations.

12.3.6 Institutional Arrangements For Funding Rail Electrification

12.3.6.1 Collective Action

Given the size, scope and complexity of the planning, design, construction, operation and most importantly the financing and funding of rail electrification in Southern California, some form of institutional arrangement will be necessary to both govern the activities of the various agencies, utilities, and private sector companies participating electrification, and to coordinate the activities necessary to implement electrification. This collective action problem is addressed in Section 9.0.

At this time it is unclear what the preferred mode of institutional arrangement should be for governing and coordinating the electrification of freight and commuter rail in Southern California. Among possible alternatives are the establishment of a Joint Powers Authority (JPA), a series of Memorandums of Understandings, possible Joint Ventures, or the designation of a lead organization. One question which must be answered is whether or not investor owned organizations (private sector) can participate as members of a JPA.

Negotiations on financial, legal and regulatory issues among the various agencies and organizations will determine the form of institutional arrangement which ultimately arises. Settlement of the issue of the preferred form of institutional arrangement is important because any SCE application to the CPUC for the purpose of utility rate Basing must include a carefully defined project and a complete funding package.

In order to gain access to the private capital markets at favorable rates, it is desirable to establish some form of a JPA for coordinating the financial participation of those municipal utilities which desire to participate in the financing of rail electrification. A JPA along the lines of the Southern California Public Power Authority (SCPPA) would be appropriate for coordinating the financial participation of the municipal utilities.

If a JPA is created for the purpose of coordinating the financing and funding activities of the local municipalities, two additional questions arise. First, may one JPA be a member of a second JPA? In other words, could a JPA created for the purpose of coordinating the tax exempt debt financing of the municipal utilities be a member of another JPA created for the purpose of governing and implementing rail electrification? Secondly, would the first JPA jeopardize its tax exempt status if the membership of the second JPA included investor owned organizations, particularly if the debt issued by the first JPA is in connection with the goals and tasks of the second JPA? These questions should be addressed as part of the next steps to be taken in response to this report, as discussed in Section 4.0.

12.4 FINANCING SCENARIOS FOR RAIL ELECTRIFICATION

12.4.1 Rail Electrification Financing Scenarios

The Funding Committee has prepared three differing funding scenarios. It should be noted that the scenarios presented in no way reflect any agreements to participate in funding rail electrification, nor does the percentage allocated to individual agencies or industries represent any agreements by participants as to future levels of financial participation.

Electrification costs per route were provided by the Planning, Engineering, Operations and Maintenance Committee assisted by the consulting engineering firm of De Leuw Cather.

The first step in preparing the electrification financing scenarios was the definition of a "project." Due to engineering, construction, operational, and funding constraints, it would not be possible to electrify all lines simultaneously. Furthermore, since various lines share segments, in order to more accurately determine the cost of the total "project," only by determining a sequence for construction is it possible to present a "project" in which the costs represent the non-duplicated costs (of individual segments) for specific routes. A consensus was reached that construction engineering, operation and funding constraints were such that no more that $300 million could be expended in any one year. This $300 million constraint was then applied to the route sequencing to determine a project phasing. For a more detailed description of the route selection and sequencing process, please see Section 3.0.

For each scenario, two alternatives are provided:

1) Electrification to commuter rail operational standards

2) Electrification to commuter and freight operational standards.

While there are certain routes which are freight routes only, the majority of routes under discussion are subject to shared commuter and freight operations. Electrification of freight lines requires higher levels of power delivery, and additional operational improvements. The difference between the two alternatives is cost of electrifying to the operational standards necessary to run commuter rail operations only, and the cost of electrifying to the operational standards necessary to run freight operations. In addition, it should be noted that the cost scenarios include the costs for electric locomotives.

The three financing scenarios are provided for the electrification of commuter rail operations only, and three for the electrification of commuter and freight rail operations. The scenarios are based on non-duplicated costs which assume construction according to a preferred sequence. In addition, the projects are escalated using an inflation factor of 3.46%. The costs of electrifying the UP/SP Consolidated Corridor is not included. The scenarios do include the costs of locomotives, and other system wide facilities such as a Control Center.

The electrical components (polls, catenary, substations) represent between 40% to 50% of the total project costs. For Scenarios Two and Three, Southern California Edison's allocated funding share of 40% represents a conservative view of the percentage of the total project costs which will be attributable to the electrical components of any rail electrification project.

The three scenarios are as follows:

12.4.1.1 SCENARIO ONE – 100% Rate Based – SCE Customer Paid

Total project costs are financed by SCE using customer-paid rate-based utility financing. The locomotive and control center costs are financed by the other funding partners.

12.4.1.2 SCENARIO TWO – 40% Rate Based – SCE Customer Paid

Total project costs allocated to various organizations and agencies as follows:

- 40% SCE Rate Based: CUSTOMER PAID
- 30% State and Federal Funding
- 10% Local Transportation Agency: Cash Contribution
- 10% Local Municipality/JPA Financed: Local Transportation Agency Funded
- 10 % Freight Railroad Participation.

12.4.1.3 SCENARIO THREE – 40% Rated Based – SCRRA Paid

Total project costs allocated to various organizations and agencies as follows:

- 40% SCE Rate Based: LOCAL TRANSPORTATION AGENCY (e.g., SCRRA)
- 30% State and Federal Funding
- 10% Local Transportation Agency: Cash Contribution
- 10% Local Municipality/JPA Financed: Local Transportation Agency Funded
- 10 % Freight Railroad Participation.

12.4.1.4 Electric Locomotives

In all three scenarios, electric locomotive costs are allocated as follows:

- 50% State and Federal Funding
- 16.6% Local Transportation Agencies
- 16.7% Municipal Utility/JPA Financed: Local Transportation Agency Funded

16.7% Freight Railroad Funding.

12.4.1.5 Construction Sequencing

The following sequence illustrates one possible phased construction scenario. This sequencing was utilized for the financing scenarios. Other sequencing orders may provide slightly differing funding requirements on a year to year basis, however, the overall scale of funding requirements on a year to year basis, and the total project costs will remain similar.

12.4.1.5.1 Commuter Rail Only

1) Riverside to Los Angeles (via Ontario)
2) San Bernardino-Irvine
3) Riverside to Los Angeles (via Fullerton)
4) The Baldwin Park Branch
5) The Moorpark Line
6) The Santa Clarita Line
7) Lossan Corridor (National City/L.A.)
8) Hemet-Riverside
9) Redlands Commuter Line.

12.4.1.5.2 Commuter And Freight

1) Union Pacific: Ports to Yermo
2) Riverside to Los Angeles (via Ontario)
3) Santa Fe: Ports to Barstow
4) Southern Pacific: Ports to Yuma
5) San Bernardino-Irvine
6) Riverside to Los Angeles (via Fullerton)
7) The Baldwin Park Branch
8) The Moorpark Line
9) The Santa Clarita Line
10) Lossan Corridor (National City/L.A.)
11) Hemet-Riverside
12) Redlands Commuter Line.

12.4.1.6 Exhibit 12-3

Exhibit 12-3 is a summary chart of total costs and total funding shares for each of the three scenarios for the electrification of commuter rail, and commuter and freight rail operations. In addition, it shows the actual costs to the local transportation agencies of the three scenarios.

12.4.1.6.1 Chart A and Chart D

Charts A and D show Scenario One, which illustrates the costs of electrifying the five selected routes for commuter rail operations (Chart A), and commuter and freight operations (Chart D). Under Scenario One, the total project costs are fully utility rate base financed by SCE. Recall that under utility rate base financing, SCE recovers the full cost of its investment at an approximate rate of $216 million per every $100 million dollars invested (NPV over 33 years discounted at 7%, including a rate of return, taxes paid, O &M costs, and allocated overhead expenses) from its customers.

In Scenario One, SCE invests $1.828 billion to electrify commuter rail operations, or $ 4.462 billion to electrify to commuter and freight operations (excluding locomotives). It recovers from its customers, $3.949 billion for commuter, or $9.638 billion for commuter and freight rail operations respectively.

The costs of electric locomotives are allocated to state and federal participation, local transportation agencies, municipal utilities/JPA financing paid by the local transportation agencies, and the freight railroads. Their shares are $255 million, $84.7 million, $85.2 million, and $85.2 million respectively.

This scenario represents in a general sense, a best but unrealistic case. It is unlikely that the CPUC would grant approval to utility rate base the total costs of the project. Nor is it clear that SCE is interested in pursuing such an approach.

EXHIBIT 12-3
Summary

(MILLIONS $'S)

SCENARIO ONE: 100% RATE BASED -- SCE CUSTOMER PAID	TOTAL COSTS	REVENUES SCE 100%	STATE & FEDERAL 50%	RAILROADS 16.7%	LOCAL CASH 16.6%	JPA BOND POOL 16.7%	SUBTOTAL LOCAL 33.4%
Commuter Rail Only (Line by line costs)	3,949	3,949					
Commuter Rail Only (Locomotives and the Control Center)	539		255	85	85	114	199
Commuter & Freight Rail (Line by line costs)	9,638	9,638					
Commuter & Freight Rail (Locomotives and the Control Center)	2,361		1,117	373	371	500	871

SCENARIO TWO: 40% RATE BASED -- SCE CUSTOMER PAID	TOTAL COSTS	REVENUES SCE 40%	STATE & FEDERAL 30%	RAILROADS 10%	LOCAL CASH 10%	JPA BOND POOL 10%	SUBTOTAL LOCAL 20%
Commuter Rail Only	2,988	816	804	268	268	833	1,100
Commuter & Freight Rail	8,270	1,812	2,456	819	817	2,366	3,183

SCENARIO THREE: 40% RATE BASED -- SCCRA PAID	TOTAL COSTS	REVENUES SCE/SCCRA 40%	STATE & FEDERAL 30%	RAILROADS 10%	LOCAL CASH 10%	JPA BOND POOL 10%	SUBTOTAL LOCAL 60%
Commuter Rail Only	2,988	816	804	268	268	833	1,916
Commuter & Freight Rail	8,270	1,812	2,456	819	817	2,366	4,994

NOTES:

1. Total costs assume unduplicated sequencing of projects (see Ch. 3), escalated at 3.46% FY 1992 $'s.

EXHIBIT 12-3
Chart A
Commuter Rail Only

SCENARIO ONE: 100% RATE BASED – SCE CUSTOMER PAID

INFLATION ESCALATION				COST IN 1992 (MILLIONS $'S)																		
Route	Seq/ Unit	Total 1992 Cost	Total Inflated Cost	1991 1992	1992 1993	1993 1994	1994 1995	1995 1996	1996 1997	1997 1998	1998 1999	1999 2000	2000 2001	2001 2002	2002 2003	2003 2004	2004 2005	2005 2006	2006 2007	2007 2008	2008 2009	2009 2010
FUNDING SHARES																						
SCE (100% of costs, less locos, control center)			1,828.2	2.8	15.2	32.6	91.5	160.9	258.8	312.9	269.3	223.3	201.6	152.9	63.6	22.9	0.0	0.0	0.0	0.0	0.0	0.0
State & Federal (50% cost of locos, control center)			255.2	0.0	0.0	0.0	69.5	2.9	3.0	0.0	0.0	82.3	0.0	0.0	0.0	0.0	97.6	0.0	0.0	0.0	0.0	0.0
Railroads (16.7% cost of locos, control center)			85.2	0.0	0.0	0.0	23.2	1.0	1.0	0.0	0.0	27.5	0.0	0.0	0.0	0.0	32.6	0.0	0.0	0.0	0.0	0.0
Local (16.6% costs of locos, control center)			84.7	0.0	0.0	0.0	23.1	1.0	1.0	0.0	0.0	27.3	0.0	0.0	0.0	0.0	32.4	0.0	0.0	0.0	0.0	0.0
JPA – Bond Pool (16.7% cost of locos, control center)			85.2	0.0	0.0	0.0	23.2	1.0	1.0	0.0	0.0	27.5	0.0	0.0	0.0	0.0	32.6	0.0	0.0	0.0	0.0	0.0
TOTAL SHARE			2,338.6	2.8	15.2	32.6	230.4	166.7	264.7	312.9	269.3	388.0	201.6	152.9	63.6	22.9	195.2	0.0	0.0	0.0	0.0	0.0
FINANCING REQUIREMENTS (incremental costs)																						
SCE	2.16		2,120.7	3.2	17.6	37.8	106.1	209.9	300.2	363.0	312.4	259.0	233.6	177.3	73.6	26.5	0.0	0.0	0.0	0.0	0.0	0.0
JPA – Bond Pool	1.34		29.0	0.0	0.0	0.0	7.9	0.3	0.3	0.0	0.0	9.3	0.0	0.0	0.0	0.0	11.1	0.0	0.0	0.0	0.0	0.0
TOTAL REQUIREMENTS			4,488.2	6.0	32.9	70.3	344.4	396.9	565.3	675.9	581.6	656.4	435.4	330.2	137.4	49.4	206.3	0.0	0.0	0.0	0.0	0.0
SEGMENT SPECIFIC COST																						
2 Baldwin Park Commuter	4	172.6	202.8	0.0	3.6	7.4	13.4	41.5	77.7	59.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3 Moorpark Commuter (Los Angeles/Moorpark)	5	166.5	209.4	0.0	0.0	0.0	5.6	9.7	14.0	70.2	81.2	28.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4 Santa Clarita Commuter (Los Angeles/Santa Clarita)	6	82.7	107.6	0.0	0.0	0.0	0.0	0.0	3.9	7.1	21.0	49.9	25.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5 Lossan Corridor (Oceanside/Los Angeles)	7	354.3	468.4	0.0	0.0	0.0	0.0	8.1	12.6	26.1	71.9	130.2	134.7	84.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6 Riverside Via Ontario (Los Angeles/Riverside – Union Pacific)	1	212.1	241.2	0.0	8.8	15.9	56.4	94.8	65.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7 Riverside – LAUPT via Fullerton (LA/San Bernardino/Riverside/Fullerton)	3	117.3	142.2	0.0	0.0	2.5	5.2	9.4	33.4	60.4	31.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8 Hemet – Riverside (Riverside/Hemet)	8	102.5	142.5	0.0	0.0	0.0	0.0	0.0	0.0	1.3	3.9	10.6	34.6	62.0	29.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9 San Bernardino – Irvine	2	178.0	216.1	0.0	0.0	3.8	7.9	14.3	48.5	85.1	56.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10 Redlands Commuter	9	44.7	65.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.4	6.3	33.6	22.9	0.0	0.0	0.0	0.0	0.0	0.0
Locomotives		376.3	496.8				136.9					164.7					195.2					
Control Center		10.0	11.7					5.7	5.9													
Shared Costs		27.6	32.4	2.8	2.9	3.0	3.1	3.2	3.3	3.4	3.5	3.6	3.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL COSTS		1,846.7	2,338.6	2.8	15.2	32.6	230.4	166.7	264.7	312.9	269.3	388.0	201.6	152.9	63.6	22.9	195.2	0.0	0.0	0.0	0.0	0.0
FINANCING (incremental costs)																						
SCE			2120.7	3.2	17.6	37.8	106.1	209.9	300.2	363.0	312.4	259.0	233.6	177.3	73.6	26.5	0.0	0.0	0.0	0.0	0.0	0.0
JPA – Bond Pool			29.0	0.0	0.0	0.0	7.9	0.3	0.3	0.0	0.0	9.3	0.0	0.0	0.0	0.0	11.1	0.0	0.0	0.0	0.0	0.0
TOTAL REQUIREMENTS			4,488.2	6.0	32.9	70.3	344.4	396.9	565.3	675.9	581.6	656.4	435.4	330.2	137.4	49.4	206.3	0.0	0.0	0.0	0.0	0.0

NOTES:

1. This funding summary is hypothetical and in no way represents an agreement by any parties as to potential funding.
2. The total funding cost (less locomotives and the control center), which must be recovered from SCE customers is 2.16 times greater than the total costs and reflects SCE's estimated rate of return, taxes, depreciation, overhead, and operations and maintenance costs.
3. The Control Center and the Locomotives funding is 50% State, 16.6% Local, 16.7% Railroads, and 16.7% JPA.
4. The cost of locomotives represents 56 commuter and 15 Amtrak engines at $5.3M each.
5. Locomotive costs are split equally over three years and the Control Center costs are split evenly over two years.
6. The Joint Powers Authority (JPA) is solely a financing entity that is responsible for 10% of the total costs, plus the difference that SCE is not financing (mileage outside of SCE territory). Their allocated share is multiplied by 1.34, which represents the total amount which must be recovered to fully fund the JPA's investment costs (1.34 is the net present value, at a 7% discount rate, of $1 invested over 33 years, including the cost of funds, depreciation, operations and maintenance, and allocated overhead).
7. JPA funding will be 100% financed (assuming 33 year, 7% bonds). LA's share of the total costs each year include 40% of the Local Share, plus 40% of the JPA financed total. The Other Jurisdictions fund 60% of these amounts.
8. Project costs escalated assuming FY 1992 $'s, at 3.46%.
9. SCCRA stands for the Southern California Commuter Rail Authority.

EXHIBIT 12-3
Chart B
Commuter Rail Only

SCENARIO TWO: 40% RATE BASED – SCE CUSTOMER PAID

INFLATION ESCALATION				COST IN 1992 (MILLIONS $'S)																		
Route	Seq/ Unit	Total 1992 Cost	Total Inflated Cost	1991 1992	1992 1993	1993 1994	1994 1995	1995 1996	1996 1997	1997 1998	1998 1999	1999 2000	2000 2001	2001 2002	2002 2003	2003 2004	2004 2005	2005 2006	2006 2007	2007 2008	2008 2009	2009 2010
FUNDING SHARES																						
SCE (40%)			377.6	0.6	3.1	6.7	18.9	37.4	53.5	64.7	55.6	48.1	41.7	31.6	13.1	4.7	0.0	0.0	0.0	0.0	0.0	0.0
State & Federal (30%)			803.7	0.8	4.6	9.8	96.9	57.1	80.6	93.9	80.8	149.3	60.5	45.9	19.1	6.9	97.6	0.0	0.0	0.0	0.0	0.0
Railroads (10%)			268.1	0.3	1.5	3.3	32.3	19.0	26.9	31.3	26.9	49.8	20.2	15.3	6.4	2.3	32.6	0.0	0.0	0.0	0.0	0.0
Local (10%)			267.5	0.3	1.5	3.3	32.2	19.0	26.9	31.3	26.9	49.7	20.2	15.3	6.4	2.3	32.4	0.0	0.0	0.0	0.0	0.0
JPA -- Bond Pool (10%)			621.5	0.8	4.5	9.6	50.0	54.0	76.9	91.6	79.0	93.0	59.1	44.8	18.7	6.7	32.6	0.0	0.0	0.0	0.0	0.0
TOTAL SHARE			2,338.6	2.6	15.2	32.6	230.4	186.7	264.7	312.9	269.3	388.0	201.6	152.9	63.6	22.9	195.2	0.0	0.0	0.0	0.0	0.0
FINANCING REQUIREMENTS																						
SCE	2.16		438.2	0.7	3.6	7.8	21.9	43.4	62.0	75.0	64.6	53.5	48.3	36.6	15.2	5.5	0.0	0.0	0.0	0.0	0.0	0.0
JPA – Bond Pool	1.34		211.3	0.3	1.5	3.2	17.0	18.4	26.1	31.2	26.9	31.6	20.1	15.2	6.3	2.3	11.1	0.0	0.0	0.0	0.0	0.0
TOTAL REQUIREMENTS			2,988.1	3.7	20.4	43.6	269.4	248.4	352.9	419.1	360.7	473.1	270.0	204.8	85.2	30.6	206.3	0.0	0.0	0.0	0.0	0.0
SEGMENT SPECIFIC COST																						
2 Baldwin Park Commuter	4	172.6	202.8	0.0	3.6	7.4	13.4	41.5	77.7	59.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3 Moorpark Commuter (Los Angeles/Moorpark)	5	168.5	209.4	0.0	0.0	0.0	5.6	9.7	14.0	70.2	81.2	28.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4 Santa Clarita Commuter (Los Angeles/Santa Clarita)	6	82.7	107.8	0.0	0.0	0.0	0.0	0.0	3.9	7.1	21.0	49.9	25.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5 Lossan Corridor (Oceanside/Los Angeles)	7	354.3	468.4	0.0	0.0	0.0	0.0	8.1	12.6	26.1	71.9	130.2	134.7	84.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6 Riverside Via Ontario (Los Angeles/Riverside – Union Pacific)	1	212.1	241.2	0.0	8.8	15.9	56.4	94.8	65.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7 Riverside – LAUPT via Fullerton (LA/San Bernardino/Riverside/Fullerton)	3	117.3	142.2	0.0	0.0	2.5	5.2	9.4	33.4	60.4	31.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8 Hemet – Riverside (Riverside/Hemet)	8	102.5	142.5	0.0	0.0	0.0	0.0	0.0	0.0	1.3	3.9	10.8	34.8	62.0	29.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9 San Bernardino -- Irvine	2	178.0	216.1	0.0	0.0	3.8	7.9	14.3	48.5	85.1	56.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10 Redlands Commuter	9	44.7	65.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.4	6.3	33.8	22.9	0.0	0.0	0.0	0.0	0.0	0.0
Locomotives		376.3	498.8				138.9					164.7					195.2					
Control Center		10.0	11.7					5.7	5.9													
Shared Costs		27.6	32.4	2.6	2.9	3.0	3.1	3.2	3.3	3.4	3.5	3.6	3.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL COSTS		1,846.7	2,338.6	2.6	15.2	32.6	230.4	186.7	264.7	312.9	269.3	388.0	201.6	152.9	63.6	22.9	195.2	0.0	0.0	0.0	0.0	0.0
FINANCING (incremental costs)																						
SCE			438.2	0.7	3.6	7.8	21.9	43.4	62.0	75.0	64.6	53.5	48.3	36.6	15.2	5.5	0.0	0.0	0.0	0.0	0.0	0.0
JPA -- Bond Pool			211.3	0.3	1.5	3.2	17.0	18.4	26.1	31.2	26.9	31.6	20.1	15.2	6.3	2.3	11.1	0.0	0.0	0.0	0.0	0.0
TOTAL REQUIREMENTS			2,988.1	3.7	20.4	43.6	269.4	248.4	352.9	419.1	360.7	473.1	270.0	204.8	85.2	30.6	206.3	0.0	0.0	0.0	0.0	0.0

NOTES:

1. This funding summary is hypothetical and in no way represents an agreement by any parties as to potential funding.
2. Total funding allocated to SC Edison represents 40% of the total costs, multiplied by 51.7% (the weighted average % of miles in SC Edison territory).
3. Railroad contribution does not include their average cost of capital of 17.4%. The cost of their contribution is not passed to the SCCRA.
4. Local agency contribution may require project cancellation or deferal.
5. The Joint Powers Authority (JPA) is solely a financing entity that is responsible for 10% of the total costs, plus the difference that SCE is not financing (mileage outside of SCE territory) Their allocated share is multiplied by 1.34, which represents the total amount which must be recovered to fully fund the JPA's investment costs (1.34 is the net present value, at a 7% discount rate, of $1 invested over 33 years, including the cost of funds, depreciation, operations and maintenance, and allocated overhead)
6. SCCRA stands for the Southern California Commuter Rail Authority.
7. The Control Center and the Locomotives funding is 50% State, 16.6% Local, 16.7% Railroads, and 16.7% JPA.
8. The cost of locomotives represents 56 commuter and 15 Amtrak engines at $5.3M each.
9. Locomotive costs are split equally over three years and the Control Center costs are split evenly over two years.
10. JPA funding will be 100% financed (assuming 33 year, 7% bonds). LA's share of the total costs each year include 40% of the Local Share, plus 40% of the JPA financed total The Other Jurisdictions fund 60% of these amounts.
11. Project costs escalated assuming FY 1992 $'s, at 3.46%.

EXHIBIT 12-3
Chart C
Commuter Rail Only

SCENARIO THREE: 40% RATE BASED – SCCRA PAID

INFLATION ESCALATION Route	Seq/ Unit	Total 1992 Cost	Total Inflated Cost	1991 1992	1992 1993	1993 1994	1994 1995	1995 1996	1996 1997	1997 1998	1998 1999	1999 2000	2000 2001	2001 2002	2002 2003	2003 2004	2004 2005	2005 2006	2006 2007	2007 2008	2008 2009	2009 2010
				COST IN 1992 (MILLIONS $'S)																		
FUNDING SHARE																						
SCE/SCCRA (40%)			377.8	0.6	3.1	6.7	18.9	37.4	53.5	64.7	55.8	46.1	41.7	31.8	13.1	4.7	0.0	0.0	0.0	0.0	0.0	0.0
State & Federal (30%)			803.7	0.8	4.6	9.8	96.9	57.1	60.6	93.9	60.8	149.3	60.5	45.9	19.1	6.9	97.6	0.0	0.0	0.0	0.0	0.0
Railroads (10%)			268.1	0.3	1.5	3.3	32.3	19.0	26.9	31.3	26.9	49.8	20.2	15.3	6.4	2.3	32.6	0.0	0.0	0.0	0.0	0.0
Local (10%)			267.5	0.3	1.5	3.3	32.2	19.0	26.9	31.3	26.9	49.7	20.2	15.3	6.4	2.3	32.4	0.0	0.0	0.0	0.0	0.0
JPA – Bond Pool (10%)			621.5	0.8	4.5	9.6	50.0	54.0	76.9	91.8	79.0	93.0	59.1	44.6	18.7	6.7	32.6	0.0	0.0	0.0	0.0	0.0
TOTAL SHARE			2,338.6	2.8	15.2	32.6	230.4	186.7	264.7	312.9	269.3	388.0	201.6	152.9	63.6	22.9	195.2	0.0	0.0	0.0	0.0	0.0
FINANCING REQUIREMENTS (incremental costs)																						
SCE	2.16		438.2	0.7	3.6	7.8	21.9	43.4	62.0	75.0	64.6	53.5	48.3	36.6	15.2	5.5	0.0	0.0	0.0	0.0	0.0	0.0
JPA – Bond Pool	1.34		211.3	0.3	1.5	3.2	17.0	18.4	26.1	31.2	26.9	31.6	20.1	15.2	6.3	2.3	11.1	0.0	0.0	0.0	0.0	0.0
TOTAL REQUIREMENTS			2,988.1	3.7	20.4	43.6	269.4	248.4	352.9	419.1	360.7	473.1	270.0	204.8	85.2	30.6	206.3	0.0	0.0	0.0	0.0	0.0
SEGMENT SPECIFIC COST																						
2 Baldwin Park Commuter	4	172.6	202.8	0.0	3.6	7.4	13.4	41.5	77.7	59.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3 Moorpark Commuter (Los Angeles/Moorpark)	5	168.5	209.4	0.0	0.0	0.0	5.6	9.7	14.0	70.2	81.2	28.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4 Santa Clarita Commuter (Los Angeles/Santa Clarita)	6	82.7	107.8	0.0	0.0	0.0	0.0	0.0	3.9	7.1	21.0	49.9	25.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5 Lossan Corridor (National City/Los Angeles)	7	354.3	468.4	0.0	0.0	0.0	0.0	6.1	12.6	26.1	71.9	130.2	134.7	84.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6 Riverside Via Ontario (Los Angeles/Riverside – Union Pacific)	1	212.1	241.2	0.0	8.8	15.9	56.4	94.8	65.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7 Riverside – LAUPT via Fullerton (LA/San Bernardino/Riverside/Fullerton)	3	117.3	142.2	0.0	0.0	2.5	5.2	9.4	33.4	60.4	31.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8 Hemet – Riverside (Riverside/Hemet)	8	102.5	142.5	0.0	0.0	0.0	0.0	0.0	0.0	1.3	3.9	10.8	34.8	62.0	29.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9 San Bernardino – Irvine	2	178.0	216.1	0.0	0.0	3.8	7.9	14.3	48.5	85.1	56.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10 Redlands Commuter	9	44.7	65.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.4	6.3	33.8	22.9	0.0	0.0	0.0	0.0	0.0	0.0
Locomotives		376.3	498.8				138.9					164.7					195.2					
Control Center		10.0	11.7					5.7	5.9													
Shared Costs		27.8	32.4	2.8	2.9	3.0	3.1	3.2	3.3	3.4	3.5	3.6	3.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL COSTS		1,846.7	2,338.6	2.8	15.2	32.6	230.4	186.7	264.7	312.9	269.3	388.0	201.6	152.9	63.6	22.9	195.2	0.0	0.0	0.0	0.0	0.0
FINANCING (incremental costs)																						
SCE			438.2	0.7	3.6	7.8	21.9	43.4	62.0	75.0	64.6	53.5	48.3	36.6	15.2	5.5	0.0	0.0	0.0	0.0	0.0	0.0
JPA – Bond Pool			211.3	0.3	1.5	3.2	17.0	18.4	26.1	31.2	26.9	31.6	20.1	15.2	6.3	2.3	11.1	0.0	0.0	0.0	0.0	0.0
TOTAL REQUIREMENTS			2,988.1	3.7	20.4	43.6	269.4	248.4	352.9	419.1	360.7	473.1	270.0	204.8	85.2	30.6	206.3	0.0	0.0	0.0	0.0	0.0

NOTES:

1. This funding summary is hypothetical and in no way represents an agreement by any parties as to potential funding.
2. Total funding allocated to SC Edison represents 40% of the total costs, multiplied by 51.7% (the weighted average % of miles in SC Edison territory).
3. Railroad contribution does not include their average cost of capital of 17.4%. The cost of their contribution is not passed to the SCCRA.
4. Local agency contribution may require project cancellation or deferal.
5. The Joint Powers Authority (JPA) is solely a financing entity that is responsible for 10% of the total costs, plus the difference that SCE is not financing (mileage outside of SCE territory). Their allocated share is multiplied by 1.34, which represents the total amount which must be recovered to fully fund the JPA's investment costs (1.34 is the net present value, at a 7% discount rate, of $1 invested over 33 years, including the cost of funds, a rate of return, depreciation, operations and maintenance, and allocated overhead).
2. Total funding allocated to SCE is financed by SCE and funded by the SCCRA. This represents 40% of the total costs, multiplied by the % of miles in SC Edison territory, multiplied by 2.16 which represents the total amount which must be recovered to fully fund SCE's investment costs (2.16 is the net present value, at a 7% discount rate, of $1 invested over 33 years, including the cost of funds, depreciation, taxes, operations and maintenance, and allocated overhead).
7. SCCRA stands for the Southern California Commuter Rail Authority.
8. The Control Center and the Locomotives funding is 50% State, 16.6% Local, 16.7% Railroads, and 16.7% JPA.
9. The cost of locomotives represents 56 commuter and 15 Amtrak engines at $5.3M each.
10. Locomotive costs are split equally over three years and the Control Center costs are split evenly over two years.
11. JPA funding will be 100% financed (assuming 33 year, 7% bonds). LA's share of the total costs each year include 40% of the Local Share, plus 40% of the JPA financed total. The Other Jurisdictions fund 60% of these amounts.
12. Project costs escalated assuming FY 1992 $'s, at 3.46%.

EXHIBIT 12-3
Chart D
Commuter and Freight Rail

SCENARIO ONE: 100% RATE BASED – SCE CUSTOMER PAID

INFLATION ESCALATION				COST IN 1992 (MILLIONS $'S)																		
Route	Seq/ Unit	Total 1992 Cost	Total Inflated Cost	1991 1992	1992 1993	1993 1994	1994 1995	1995 1996	1996 1997	1997 1998	1998 1999	1999 2000	2000 2001	2001 2002	2002 2003	2003 2004	2004 2005	2005 2006	2006 2007	2007 2008	2008 2009	2009 2010
FUNDING SHARES																						
SCE (100% of costs, less loco's, control center)			4,462.0	13.8	47.1	50.2	130.0	137.8	278.1	308.6	317.1	332.3	376.7	409.7	397.0	434.3	402.5	250 9	256 9	237.3	83.8	0 0
State & Federal (50% cost of locos, control center)			1,117.3	0.0	0.0	0.0	309.5	2.9	3.0	0.0	0.0	366.9	0.0	0 0	0.0	0.0	435.0	0.0	0 0	0.0	0.0	0.0
Railroads (16.7% cost of locos, control center)			373.2	0.0	0.0	0.0	103.4	1.0	1.0	0.0	0.0	122.6	0.0	0.0	0.0	0.0	145.3	0 0	0.0	0.0	0.0	0 0
Local (16.6% costs of locos, control center)			370.9	0.0	0.0	0.0	102.8	1.0	1.0	0.0	0.0	121.6	0.0	0.0	0.0	0 0	144.4	0.0	0.0	0.0	0.0	0 0
JPA – Bond Pool (16.7% cost of locos, control center)			373.2	0.0	0.0	0.0	103.4	1.0	1.0	0.0	0.0	122.6	0.0	0.0	0.0	0.0	145.3	0.0	0.0	0.0	0.0	0.0
TOTAL SHARE			6,696.6	13.8	47.1	50.2	749.1	143.3	282.0	308.6	317.1	1,066.2	376.7	409.7	397.0	434.3	1,272.4	250 9	256.9	237.3	83.8	0.0
FINANCING REQUIREMENTS (incremental costs)																						
SCE	2.16		5,176.0	16.0	54.7	58.3	150.8	159.6	320.3	358.0	367.9	385.5	436.9	475.2	460.6	503.6	466.9	291.1	298 0	275.3	97.2	0.0
JPA – Bond Pool	1.34		126.9	0.0	0.0	0.0	35.2	0.3	0.3	0.0	0.0	41.7	0.0	0.0	0.0	0.0	49.4	0.0	0.0	0.0	0.0	0.0
TOTAL REQUIREMENTS			11,999.4	29.8	101.8	106.5	935.0	303.2	602.7	666.6	665.0	1,493.3	813.6	884.9	857.6	938.2	1,786.6	542.0	554.9	512.6	181.0	0 0
SEGMENT SPECIFIC COST																						
2 Baldwin Park Commuter	7	193.3	279.6	0.0	0.0	0.0	0.0	0 0	0.0	0.0	2.5	7.6	23 6	59.8	87.1	93.0	6.0	0 0	0 0	0.0	0.0	0 0
3 Moorpark Commuter (Los Angeles/Moorpark)	8	203.2	310.2	0 0	0.0	0.0	0.0	0.0	0.0	0 0	0.0	0 0	8.3	11.4	20.7	103.9	123.3	42 5	0 0	0.0	0 0	0 0
4 Santa Clarita Commuter (Los Angeles/Santa Clarita)	9	99 7	151 5	0.0	0.0	0.0	0.0	0 0	0.0	0 0	0.0	0.0	2.7	7.0	10 2	60 0	63.6	8 0	0 0	0 0	0.0	0 0
5 Lossan Corridor (Oceanside/Los Angeles)	10	427.6	686.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0 0	5 8	16.0	24.9	38 6	119.6	179 0	192.3	110 5	0.0	0 0
6 Riverside Via Ontario (Los Angeles/Riverside – Union Pacific)	2	31 8	37.0	0.6	1.3	2 4	4 9	8.0	8 3	8.6	2.8	0.0	0 0	0.0	0 0	0 0	0 0	0.0	0 0	0 0	0 0	0.0
7 Riverside – LAUPT via Fullerton (LA/San Bernardino/Riverside/Fullerton)	6	14 6	17.9	0.0	0.0	0.5	1.0	1.2	3 5	3 8	3.9	3.8	0.4	0 0	0.0	0.0	0.0	0.0	0.0	0 0	0.0	0 0
8 Hemet – Riverside (Riverside/Hemet)	11	123 7	210 6	0 0	0 0	0 0	0.0	0.0	0.0	0.0	0.0	0 0	0.0	0.0	0.0	1 9	5.6	17.9	55.6	83 1	46.3	0 0
9 San Bernardino – Irvine	5	57 2	80.6	0 0	0.0	0 0	0.0	0 0	0.0	0.7	2.2	4.5	8 5	31.3	31.6	1.7	0.0	0 0	0 0	0 0	0.0	0 0
10 Redlands Commuter	12	53 9	93.6	0 0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.5	9.0	43.7	37.5	0 0
11 Southern Pacific Routes Ports to Yuma	4	899 0	1,165.2	0 0	18.6	19.2	59.7	61.8	85.3	110.3	114.1	118.0	122.1	126.3	130.7	135.2	83.9	0.0	0 0	0.0	0 0	0 0
12 Santa Fe Ports to Barstow	3	270 2	336.0	6.1	5.6	5.8	15.0	15.5	51.3	53.0	54.9	56.8	58.7	11.4	0.0	0.0	0.0	0 0	0.0	0.0	0.0	0.0
13 Union Pacific Ports to Yermo	1	790 6	1,011 5	0.0	16.4	16 9	43.8	45 3	121.8	126.1	130.4	134.9	139 6	144.4	92.0	0.0	0.0	0 0	0 0	0 0	0 0	0.0
Locomotives		1,677.1	2,222.9				619.1					733.9					869.9					
Control Center		10 0	11.7					5.7	5.9													
Shared Costs		50.7	59.4	5.1	5.2	5.4	5.6	5.6	6.0	6.2	6.4	6.7	6.9	0.0	0.0	0 0	0.0	0 0	0.0	0.0	0.0	0 0
TOTAL COSTS		4,902.7	6,696.6	13.8	47.1	50.2	749.1	143.3	282.0	308.6	317.1	1,066.2	376.7	409.7	397.0	434.3	1,272.4	250.9	256 9	237.3	83.8	0.0
FINANCING (incremental costs)																						
SCE			5176.0	16.0	54.7	58.3	150.8	159.6	320.3	358.0	367.9	385.5	436.9	475.2	460.6	503.6	466.9	291 1	298.0	275.3	97.2	0.0
JPA – Bond Pool			126.9	0.0	0.0	0.0	35.2	0.3	0.3	0.0	0.0	41.7	0.0	0.0	0.0	0.0	49.4	0.0	0.0	0.0	0.0	0.0
TOTAL REQUIREMENTS			11,999.4	29.8	101.8	106.5	935.0	303.2	602.7	666.6	665.0	1,493.3	813.6	884.9	857.6	938.2	1,786.6	542.0	554.9	512.6	181.0	0.0

NOTES:

1. This funding summary is hypothetical and in no way represents an agreement by any parties as to potential funding.
2. The total funding cost (less locomotives and the control center), which must be recovered from SCE customers is 2.16 times greater than the total costs and reflects SCE's estimated rate of return, taxes, depreciation, overhead, and operations and maintenance costs.
3. The Control Center and the Locomotives funding is 50% State, 16.6% Local, 16.7% Railroads, and 16.7% JPA.
4. The cost of locomotives represents 56 commuter and 15 Amtrak engines at $5.3M each, plus 271 freight engines at $4.8M each.
5. Locomotive costs are split equally over three years and the Control Center costs are split evenly over two years.
6. The Joint Powers Authority (JPA) is solely a financing entity that is responsible for 10% of the total costs, plus the difference that SCE is not financing (mileage outside of SCE territory). Their allocated share is multiplied by 1.34, which represents the total amount which must be recovered to fully fund the JPA's investment costs (1.34 is the net present value, at a 7% discount rate, of $1 invested over 33 years, including the cost of funds, a rate of return, depreciation, operations and maintenance, and allocated overhead).
7. JPA funding will be 100% financed (assuming 33 year, 7% bonds) LA's share of the total costs each year include 40% of the Local Share, plus 40% of the JPA financed total. The Other Jurisdictions fund 60% of these amounts.
8. Project costs escalated assuming FY 1992 $'s, at 3.46%.
9. SCCRA stands for the Southern California Commuter Rail Authority.

EXHIBIT 12-3
Chart E
Commuter and Freight Rail

SCENARIO TWO: 40% RATE BASED – SCE CUSTOMER PAID

INFLATION ESCALATION Route	Seg/ Unit	Total 1992 Cost	Total Inflated Cost	COST IN 1992 (MILLIONS $'S) 1991 1992	1992 1993	1993 1994	1994 1995	1995 1996	1996 1997	1997 1998	1998 1999	1999 2000	2000 2001	2001 2002	2002 2003	2003 2004	2004 2005	2005 2006	2006 2007	2007 2008	2008 2009	2009 2010
FUNDING SHARES																						
SCE (40%)			638.7	2.6	8.9	9 4	24.4	25.9	51.9	56.0	59.6	62.5	70.6	77.0	74.6	81.6	75.6	47.2	48 3	44.6	15.6	0.0
State & Federal (30%)			2,455.9	4.1	14.1	15 1	348.5	44.1	86.6	92.6	95.1	466.6	113.0	122.9	119.1	130.3	555.7	75.3	77 1	71.2	25.1	0 0
Railroads (10%)			819.4	1.4	4.7	5.0	116.4	14.7	28.6	30.9	31.7	155.6	37.7	41 0	39.7	43.4	165.5	25.1	25.7	23.7	8.4	0.0
Local (10%)			817.1	1.4	4.7	5.0	115.8	14.7	28.6	30.9	31 7	155.1	37.7	41.0	39.7	43.4	164.7	25.1	25.7	23.7	8.4	0.0
JPA – Bond Pool (10%)			1,765.5	4.3	14.7	15.7	144.0	43.9	87.1	96.3	99.0	226.2	117.5	127.8	123.9	135.5	270.9	78 3	80.2	74.1	26.1	0.0
TOTAL SHARE			6,696.6	13.8	47.1	50.2	749.1	143.3	262.0	306.6	317.1	1,066.2	376.7	409.7	397.0	434.3	1,272.4	250 9	256.9	237.3	83 6	0.0
FINANCING REQUIREMENTS (incremental costs)																						
SCE	2.16		972.9	3.0	10.3	11.0	28.3	30.0	60.2	67.3	69.1	72.5	82.1	89.3	86.6	94.7	87.6	54.7	56.0	51.7	18.3	0.0
JPA – Bond Pool	1.34		600.3	1.5	5.0	5.3	48.9	14.9	29.6	32.7	33.6	76.9	40.0	43.5	42.1	46.1	92.1	26 6	27 3	25.2	8.9	0.0
TOTAL REQUIREMENTS			8,269.7	18.3	62.4	66 5	826.4	188.2	371.9	406.6	419.9	1,215.5	498.8	542 5	525.7	575.1	1,452.2	332.3	340.2	314.3	111.0	0.0
SEGMENT SPECIFIC COST																						
2 Baldwin Park Commuter	7	193 3	279.6	0.0	0.0	0 0	0.0	0.0	0.0	0.0	2 5	7.6	23 6	59 8	87.1	93 0	6.0	0 0	0 0	0 0	0 0	0 0
3 Moorpark Commuter (Los Angeles/Moorpark)	8	203 2	310 2	0.0	0.0	0.0	0.0	0 0	0.0	0.0	0 0	0.0	8 3	11.4	20.7	103.9	123.3	42 5	0 0	0 0	0.0	0 0
4 Santa Clarita Commuter (Los Angeles/Santa Clarita)	9	99 7	151.5	0.0	0 0	0 0	0 0	0 0	0.0	0.0	0 0	0.0	2.7	7 0	10.2	60 0	63.6	8 0	0 0	0 0	0 0	0 0
5 Lossan Corridor (Oceanside/Los Angeles)	10	427.6	688.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0 0	0 0	5.8	18 0	24.9	38.6	119.8	179 0	192 3	110.5	0.0	0 0
6 Riverside Via Ontario (Los Angeles/Riverside – Union Pacific)	2	31.8	37.0	0.6	1.3	2.4	4.9	8.0	6.3	6.6	2 8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0 0	0 0	0.0	0 0
7 Riverside – LAUPT via Fullerton (LA/San Bernardino/Riverside/Fullerton)	6	14.6	17.9	0 0	0 0	0 5	1.0	1.2	3.5	3.8	3.9	3.8	0.4	0.0	0 0	0.0	0 0	0 0	0 0	0 0	0.0	0 0
8 Hemet – Riverside (Riverside/Hemet)	11	123 7	210.6	0 0	0 0	0 0	0 0	0.0	0.0	0 0	0 0	0 0	0 0	0 0	0 0	1.9	5 8	17 9	55 6	83.1	46.3	0 0
9 San Bernardino – Irvine	5	57 2	80 6	0 0	0 0	0 0	0.0	0 0	0 0	0 7	2 2	4 5	8.5	31 3	31.6	1.7	0 0	0 0	0 0	0 0	0 0	0 0
10 Redlands Commuter	12	53 9	93.6	0.0	0 0	0 0	0 0	0.0	0.0	0.0	0 0	0.0	0 0	0 0	0.0	0.0	0.0	3 5	9 0	43 7	37.5	0.0
11 Southern Pacific Routes Ports to Yuma	4	899.0	1,185.2	0.0	18 6	19.2	59.7	61.8	85.3	110.3	114 1	118.0	122.1	126 3	130.7	135.2	83.9	0 0	0 0	0.0	0 0	0 0
12 Santa Fe Ports to Barstow	3	270 2	336.0	8.1	5 6	5.8	15.0	15.5	51.3	53.0	54 9	56 6	58.7	11 4	0.0	0.0	0 0	0 0	0 0	0.0	0 0	0 0
13 Union Pacific Ports to Yermo	1	790.6	1,011.5	0.0	16 4	16 9	43.8	45.3	121.8	126.1	130 4	134.9	139 6	144 4	92.0	0.0	0.0	0.0	0.0	0.0	0.0	0 0
Locomotives		1,677.1	2,222.9				619 1					733.9					869.9					
Control Center		10.0	11.7					5 7	5.9													
Shared Costs		50.7	59.4	5.1	5 2	5.4	5.6	5.8	6.0	6.2	6.4	6.7	6.9	0.0	0.0	0.0	0.0	0.0	0 0	0.0	0.0	0 0
TOTAL COSTS		4,902.7	6,696.6	13.8	47.1	50.2	749.1	143.3	262.0	306.6	317.1	1,066.2	376.7	409.7	397.0	434.3	1,272.4	250 9	256 9	237.3	83.6	0.0
FINANCING (incremental costs)																						
SCE			972.9	3.0	10.3	11.0	28.3	30.0	60.2	67.3	69.1	72.5	82.1	89.3	86.6	94.7	87.6	54.7	56.0	51.7	18.3	0.0
JPA – Bond Pool			600.3	1.5	5.0	5.3	48.9	14.9	29.6	32.7	33.6	76.9	40.0	43.5	42.1	46.1	92.1	26.6	27.3	25.2	8.9	0.0
TOTAL REQUIREMENTS			8,269.7	18.3	62.4	66.5	826.4	188.2	371.9	406.6	419.9	1,215.5	498.8	542.5	525.7	575.1	1,452.2	332.3	340 2	314.3	111.0	0.0

NOTES:

1. This funding summary is hypothetical and in no way represents an agreement by any parties as to potential funding.
2. Total funding allocated to SC Edison represents 40% of the total costs, multiplied by 47% (the weighted average % of miles in SC Edison territory).
3. Railroad contribution does not include their average cost of capital of 17.4%. The cost of their contribution is not passed to the SCCRA.
4. Local agency contribution may require project cancellation or deferral.
5. The Joint Powers Authority (JPA) is solely a financing entity that is responsible for 10% of the total costs, plus the difference that SCE is not financing (mileage outside of SCE territory). Their allocated share is multiplied by 1.34, which represents the total amount which must be recovered to fully fund the JPA's investment costs (1.34 is the net present value, at a 7% discount rate, of $1 invested over 33 years, including the cost of funds, a rate of return, depreciation, operations and maintenance, and allocated overhead).
6. SCCRA stands for the Southern California Commuter Rail Authority.
7. The Control Center and the Locomotives funding is 50% State, 16.6% Local, 16.7% Railroads, and 16.7% JPA.
8. The cost of locomotives represents 58 commuter and 15 Amtrak engines at $5.3M each, plus 271 freight engines at $4.6M each.
9. Locomotive costs are split equally over three years and the Control Center costs are split evenly over two years.
10. JPA funding will be 100% financed (assuming 33 year, 7% bonds). LA's share of the total costs each year include 40% of the Local Share, plus 40% of the JPA financed total. The Other Jurisdictions fund 60% of these amounts.
11. Project costs escalated assuming FY 1992 $'s, at 3.46%.

EXHIBIT 12-3
Chart F
Commuter and Freight Rail

SCENARIO THREE: 40% RATE BASED – SCCRA PAID

INFLATION ESCALATION				COST IN 1992 (MILLIONS $'S)																		
Route	Seq/ Unit	Total 1992 Cost	Total Inflated Cost	1991 1992	1992 1993	1993 1994	1994 1995	1995 1996	1996 1997	1997 1998	1998 1999	1999 2000	2000 2001	2001 2002	2002 2003	2003 2004	2004 2005	2005 2006	2006 2007	2007 2008	2008 2009	2009 2010
FUNDING SHARES																						
SCE (40%)			836.7	2.6	6 9	9.4	24.4	25.9	51 9	56 0	59.6	62.5	70.6	77.0	74.6	81.6	75.6	47.2	48 3	44.6	15 6	0 0
State & Federal (30%)			2,455 9	4 1	14.1	15 1	348.5	44.1	85.6	92.6	95.1	466.6	113.0	122.9	119.1	130.3	555.7	75.3	77 1	71.2	25.1	0 0
Railroads (10%)			819.4	1.4	4 7	5.0	116 4	14.7	28 6	30.9	31.7	155 6	37.7	41 0	39.7	43.4	185.5	25.1	25 7	23 7	8 4	0.0
Local (10%)			617.1	1.4	4.7	5 0	115.6	14.7	28.6	30.9	31.7	155.1	37.7	41.0	39.7	43.4	164.7	25 1	25.7	23.7	6.4	0.0
JPA – Bond Pool (10%)			1,765.5	4.3	14.7	15.7	144.0	43.9	87.1	96.3	99.0	226.2	117.5	127.8	123.9	135.5	270.9	78 3	80.2	74.1	26.1	0.0
TOTAL SHARE			6,696.6	13.6	47.1	50.2	749.1	143.3	282.0	306.6	317.1	1,066.2	376.7	409.7	397.0	434.3	1,272.4	250.9	256.9	237.3	83.6	0.0
FINANCING REQUIREMENTS (incremental costs)																						
SCE	2.16		972.9	3.0	10.3	11.0	28.3	30.0	60.2	67.3	69 1	72.5	82.1	89 3	86.6	94.7	87.8	54.7	56.0	51.7	18.3	0.0
JPA – Bond Pool	1.34		600.3	1.5	5.0	5.3	48.9	14.9	29.6	32.7	33.6	76.9	40.0	43 5	42.1	46.1	92.1	26.6	27.3	25 2	8.9	0.0
TOTAL REQUIREMENTS			8,269.7	18.3	62.4	66.5	826.4	188.2	371.9	408.6	419.9	1,215.5	498.6	542 5	525.7	575.1	1,452.2	332.3	340.2	314.3	111.0	0.0
SEGMENT SPECIFIC COST																						
2 Baldwin Park Commuter	7	193.3	279.6	0 0	0 0	0 0	0.0	0.0	0 0	0.0	2.5	7.6	23.6	59 8	87.1	93 0	6.0	0.0	0 0	0 0	0.0	0 0
3 Moorpark Commuter (Los Angeles/Moorpark)	8	203.2	310 2	0 0	0.0	0 0	0.0	0 0	0.0	0 0	0 0	0 0	8 3	11 4	20 7	103 9	123 3	42 5	0 0	0 0	0 0	0 0
4 Santa Clarita Commuter (Los Angeles/Santa Clarita)	9	99.7	151 5	0 0	0 0	0 0	0 0	0.0	0 0	0.0	0 0	0.0	2 7	7 0	10 2	60.0	63 6	8 0	0 0	0 0	0 0	0 0
5 Lossan Corridor (National City/Los Angeles)	10	427 6	688 9	0 0	0 0	0.0	0 0	0 0	0 0	0 0	0 0	0.0	5 8	18 0	24.9	38.6	119.8	179.0	192 3	110 5	0 0	0 0
6 Riverside Via Ontario (Los Angeles/Riverside – Union Pacific)	2	31 8	37 0	0 6	1 3	2 4	4.9	8.0	8.3	8 6	2 8	0.0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0
7 Riverside – LAUPT via Fullerton (LA/San Bernardino/Riverside/Fullerton)	6	14 6	17 9	0 0	0 0	0 5	1 0	1.2	3 5	3 8	3 9	3 8	0 4	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0
8 Hemet – Riverside (Riverside/Hemet)	11	123 7	210 6	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	1 9	5.8	17 9	55 6	83 1	46 3	0 0
9 San Bernardino – Irvine	5	57 2	80.6	0 0	0 0	0 0	0 0	0.0	0 0	0.7	2 2	4 5	8 5	31 3	31 6	1.7	0 0	0 0	0 0	0 0	0 0	0 0
10 Redlands Commuter	12	53 9	93.6	0 0	0 0	0 0	0 0	0.0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0.0	0.0	3 5	9.0	43 7	37.5	0 0
11 Southern Pacific Routes Ports to Yuma	4	899.0	1,185.2	0.0	18 6	19 2	59 7	61.8	65 3	110.3	114 1	118 0	122 1	126 3	130.7	135.2	83.9	0 0	0.0	0 0	0 0	0 0
12 Santa Fe Ports to Barstow	3	270 2	336 0	8 1	5 6	5 8	15.0	15.5	51 3	53.0	54.9	56.8	58 7	11 4	0.0	0.0	0.0	0.0	0.0	0 0	0.0	0.0
13 Union Pacific Ports to Yermo	1	790 6	1,011 5	0.0	16 4	16 9	43 8	45 3	121.6	126 1	130.4	134 9	139 6	144 4	92.0	0.0	0 0	0 0	0.0	0 0	0 0	0.0
Locomotives		1,677 1	2,222 9				619.1					733.9					869 9					
Control Center		10.0	11 7					5.7	5 9													
Shared Costs		50.7	59.4	5 1	5.2	5.4	5.6	5 8	6 0	6.2	6.4	6.7	6.9	0 0	0 0	0.0	0.0	0.0	0 0	0 0	0.0	0 0
TOTAL COSTS		4,902.7	6,696.6	13.6	47.1	50.2	749.1	143.3	282.0	306.6	317.1	1,066.2	376.7	409 7	397.0	434.3	1,272.4	250.9	256.9	237.3	83 6	0 0
FINANCING (incremental costs)																						
SCE			972.9	3.0	10.3	11.0	28.3	30.0	60.2	67.3	69 1	72.5	82 1	89 3	86 6	94.7	87.8	54.7	56.0	51.7	18.3	0 0
JPA – Bond Pool			600.3	1.5	5.0	5.3	48.9	14.9	29.6	32.7	33.6	76.9	40.0	43.5	42.1	46.1	92.1	26.6	27.3	25.2	8.9	0.0
TOTAL REQUIREMENTS			8,269.7	18.3	62.4	66.5	826.4	188.2	371.9	408.6	419.9	1,215.5	498.8	542.5	525.7	575.1	1,452.2	332.3	340.2	314.3	111.0	0 0

NOTES:

1. This funding summary is hypothetical and in no way represents an agreement by any parties as to potential funding.
2. Total funding allocated to SC Edison represents 40% of the total costs, multiplied by 47% (the weighted average % of miles in SC Edison territory).
3. Railroad contribution does not include their average cost of capital of 17.4%. The cost of their contribution is not passed to the SCCRA.
4. Local agency contribution may require project cancellation or deferal.
5. The Joint Powers Authority (JPA) is solely a financing entity that is responsible for 10% of the total costs, plus the difference that SCE is not financing (mileage outside of SCE territory). Their allocated share is multiplied by 1.34, which represents the total amount which must be recovered to fully fund the JPA's investment costs (1.34 is the net present value, at a 7% discount rate, of $1 invested over 33 years, including the cost of funds, a rate of return, depreciation, operations and maintenance, and allocated overhead).
6. SCCRA stands for the Southern California Commuter Rail Authority.
7. The Control Center and the Locomotives funding is 50% State, 16.6% Local, 16.7% Railroads, and 16.7% JPA.
8. The cost of locomotives represents 56 commuter and 15 Amtrak engines at $5.3M each, plus 271 freight engines at $4.8M each.
9. Locomotive costs are split equally over three years and the Control Center costs are split evenly over two years.
10. JPA funding will be 100% financed (assuming 33 year, 7% bonds). LA's share of the total costs each year include 40% of the Local Share, plus 40% of the JPA financed total. The Other Jurisdictions fund 60% of these amounts.
11. Project costs escalated assuming FY 1992 $'s, at 3.46%.

12.4.1.6.2 Chart B and Chart E

Charts B and C show Scenario Two, which also represents the costs for electrifying the five representative routes at the both the commuter, and the commuter and freight levels of operations.

<u>SCE:</u>

40% Rate Base Customer Paid

Under Scenario Two, 40% of the costs are allocated to SCE. This represents the approximate share of the total project cost of the power distribution system (power traction stations, catenary, and poles). This 40% percent share is then multiplied by the weighted average of the percentages of the SCE territory through which each individual route passes (51.7%). The resultant is multiplied against the total project cost to determine SCE's allocated share of the total project costs.

Under Scenario Two, SCE finances its investment through utility rate Basing recovering the costs of its investment from its customers.

SCE's share of the allocated costs is $377.8 and $838.7 million for commuter, and commuter and freight operations respectively. The costs to its customers is $816 million, or $1.816 billion respectively.

<u>State/Federal:</u>

30% Share

30% of the total project costs are allocated to come from State and Federal sources. Although this may represent an optimistic assessment of the prospects for obtaining state and federal dollars, the 1991 ISTEA Surface Transportation Program,and Congestion Mitigation & Air Quality Improvement Program, and the 1994 STIP Flexible Congestion Relief Program are among the only unprogrammed fund sources potentially available for rail electrification without the deferral of other federal, state or local transportation projects.

The State and Federal share of the total project costs would be $804 million and $2.456 billion for commuter, and commuter and freight operations respectively.

<u>Local:</u>

10% Share

10% of the total project costs would be allocated to the regional transportation agencies: LACTC, OCTA, RCTC, SANBAG, VCTC, and SANDAG/MTDB/ NSDCTDB. This allocation would be subject to further negotiation among the regional transportation agencies as to their respective shares of the 10% allocation. Although the percentage of the allocation may appear to be low, it is further increased by local transportation agency (the SCRRA) repayments to a JPA composed of the municipal transportation utilities under both Scenarios Two and Three.

The local agency share of the total project costs would be $268 million and $817 million for commuter and commuter and freight operations respectively.

<u>Railroads:</u>

10% Share

10% of the total project cost would be allocated to the freight railroads. The cost to each individual railroad would be subject to negotiation dependent on the ownership of the routes to be electrified.

The railroad share of the total project costs is $268 and $819 million for commuter rail and commuter and freight rail operation respectively.

<u>JPA:</u>

10% Share

Both Scenario Two and Scenario Three contemplate the creation of a JPA to coordinate the financial participation of the municipal utilities. Under both Scenarios, the JPA investment is repaid by the local transportation agencies (the SCRRA), as opposed to the customers of the municipalities.

To determine the JPA allocated share of the investment, a base allocation of 10% was established. To this base share of costs is added the difference between the 40% share allocated to SCE, and the weighted average of the percentages of the SCE territory through which each individual route passes.

This resulting municipal utility share is multiplied by a factor of 1.34 representing the amount needed by the JPA to recover the full costs of its investment (the NPV over 33 years of a 100 million dollar investment discounted at 7% including O & M costs, and allocated overhead).

The cost of the project allocated to the municipal utility JPA, and repaid by local transportation agencies (the SCRRA) is $833 million and $2.366 billion for commuter, and commuter and freight rail respectively.

12.4.1.6.3 Chart C and Chart F

<u>SCE:</u>

40% SCE Rate Base
SCRRA Paid

As under Scenario Two, in Scenario Three 40% of the costs are allocated to SCE. This represents the approximate share of the total project cost of the power distribution system (power traction stations, catenary, and poles). This 40% percent share is then multiplied by the weighted average of the percentages of the SCE territory through which each individual route passes (51.7%). The resultant is multiplied against the total project cost to determine SCE's allocated share of the total project costs.

In Scenario Three, SCE provides utility financing through a rate based approach in which it recovers the costs of its investment from the local transportation agencies (the SCRRA).

The cost to the local transportation agencies (the SCRRA) is $816.0 million and $1.812 billion for commuter rail and commuter and freight rail operations respectively.

State/Federal:

30% Share

As in Scenario Two, in Scenario Three 30% of the total project costs are allocated to come from State and federal sources. Although this may represent an optimistic assessment of the prospects for obtaining state and federal dollars, the 1991 ISTEA Surface Transportation Program and Congestion Mitigation & Air Quality Improvement Program, and the 1994 STIP Flexible Congestion Relief Program are among the only unprogrammed fund sources potentially available for rail electrification without the deferral of other federal, state or local transportation projects. The state and federal share of the total project costs would be $804.0 million and $ 2.456 billion for commuter, and commuter and freight operations respectively.

Local:

10% Share

10% of the total project costs would be allocated to the regional transportation agencies: LACTC, the OCTA, RCTC, SANBAG, VCTC, and SANDAG/MTDB/ NSDCTDB. This allocation would be subject to further negotiation among the regional transportation agencies as to their respective shares of the 10% allocation. Although the percentage of the allocation may appear to be low, it is further increased by SCRRA repayments to a JPA composed of the municipal utilities under Scenario Two and Three. Furthermore, in Scenario Three, it is greatly increased by SCRRA payments to SCE in order for SCE to recover the full costs of its investment.
The local agency share of the total project costs would be $268 and $817 million for commuter and commuter and freight operations respectively.

Railroads:

10% Share

10% of the total project cost would be allocated to the freight railroads. The cost to each individual railroad would be subject to negotiation dependent on the ownership of the routes to be electrified.

The railroad share of the total project costs is $268 and $819 million for commuter rail and commuter and freight rail operation respectively.

JPA:

10% Share

Both Scenario Two and Scenario Three contemplate the creation of a JPA to coordinate the financial participation of the municipal utilities. Under both Scenarios, the JPA investment is repaid by the local transportation agencies (the SCRRA), as opposed to the customers of the municipalities. To determine the JPA allocated share of the investment, a base allocation of 10% was established. To this base share of costs is added the difference between the 40% share allocated to SCE, and the weighted average of the percentages of the SCE territory through which each individual route passes.

This resulting municipal utility share is multiplied by a factor of 1.34 representing the amount needed by the JPA to recover the full costs of its investment (the NPV over 33 years of a 100 million dollar investment discounted at 7% including O & M costs, and allocated overhead).
The cost of the project allocated to the municipal utility/JPA, and repaid by the local transportation agencies (the SCRRA) is $833 million and $2.366 billion for commuter, and commuter and freight rail respectively.

12.5 CONCLUSION

The total cost of rail electrification in the Southern California Region will be substantial. Rate based utility financing, if CPUC approval can be obtained, will spread the costs among SCE customers and offer a base to which many other fund sources must be added. State, federal and local sources must be utilized, as should financial participation of the freight railroads, in order to successfully accomplish the goal of rail electrification in Southern California.

To the extent that electrification costs are not offset by easily quantified economic benefits, decisions on funding participation levels among various public, private and commercial entities must attempt to spread the costs of rail electrification as widely and as equitably as possible.

DISCLAIMER

All participants in the Electrification Task Force identified on the previous page have contributed in some measure to the preparation of this Southern California Accelerated Rail Electrification Program report. However, not every participant is in agreement with the analysis and findings contained herein. Accordingly, identification of a participant on the previous page does not indicate acceptance of, or agreement with, the entirety of the information provided in the report.