THE 1994 NORTHRIDGE EARTHQUAKE — A TRANSPORTATION IMPACT OVERVIEW

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ABSTRACT

The January 1994 Northridge earthquake caused extensive damage throughout the Los Angeles area, closing highways for several months that carried some of the highest daily traffic volumes in the world. Although catastrophic travel conditions were widely predicted, except for the first few days after the quake, excessive delays were not experienced and the transportation system continued to function throughout the reconstruction period. Detours were quickly established to take traffic around the closed freeway sections, utilizing city streets and sections of freeways that were not damaged by the quake. New carpool lanes were established to encourage ridesharing in an effort to reduce vehicular demand. Rail and bus enhancements were also implemented. This report discusses the impacts of the freeway closures, the effectiveness of the various mitigation measures, and how commuter behavior changed in the corridors that were most directly affected. On the affected corridors in which convenient local street detours were available (I-10 and SR-118), motorists appeared content to continue driving. On the corridors where alternate routes were few or nonexistent (I-5 and SR-14), rail ridership increased substantially. Bus utilization did not appear to have a major effect in any of the corridors. Users of the newly established carpool lanes experienced some time savings, but interestingly, overall carpool volumes did not appear to be much higher than pre-quake volumes, indicating that few new carpools were formed to take advantage of the lanes.

INTRODUCTION

The magnitude 6.8 earthquake that occurred in Southern California on the morning of January 17, 1994 resulted in widespread damage throughout the Los Angeles area. Of the variety of structure types that sustained major damage, the collapse of several highway facilities were among the most visible to the rest of the world. Substantial disruptions to areawide travel occurred during the first few days after the quake, but the catastrophic traffic conditions that were widely predicted never materialized. Although unfortunate, the prolonged closures of several major transportation links provided a unique opportunity to examine motorist response to traffic disruptions of this magnitude and whether certain traffic management strategies are more effective than others under these circumstances.

This report describes the types of traffic management and mitigation measures that were implemented, how motorists responded to the commute choices that were available to them, and the traffic conditions that resulted. Recommendations on the types of actions and measures which worked well and could be successfully applied to similar situations in other areas are presented.

BACKGROUND

Setting

The freeway system in and around the Los Angeles area of Southern California is considered to be the most extensive, if not necessarily the most modern, in the world. The area is criss-crossed by 27 freeways totaling 615 miles. The freeway system is further supplemented within the Los Angeles basin by a comprehensive local roadway network, which for the most part is on a grid system.

The Los Angeles basin area is physically separated from central and northern California by the San Gabriel and San Bernardino Mountain ranges. Access over the mountains is provided via Interstate 5, which runs the length of the state from the Oregon to Mexican borders, and also by State Route 14, providing access to the Antelope Valley communities of Lancaster and Palmdale. Except for these two freeways, there are no other convenient major public roadways that provide access over the mountains.

Public transit service in the Los Angeles area is provided primarily by the Los Angeles County Metropolitan Transportation Authority, with additional service available from a number of other operators. The Metrolink commuter rail system, in operation since 1992, provides train service connecting Ventura, Los Angeles, San Bernardino, and Riverside Counties.

Pre-Quake Traffic Management Facilities

The freeway system and state highway system is operated by the State of California Department of Transportation (Caltrans) out of their Los Angeles

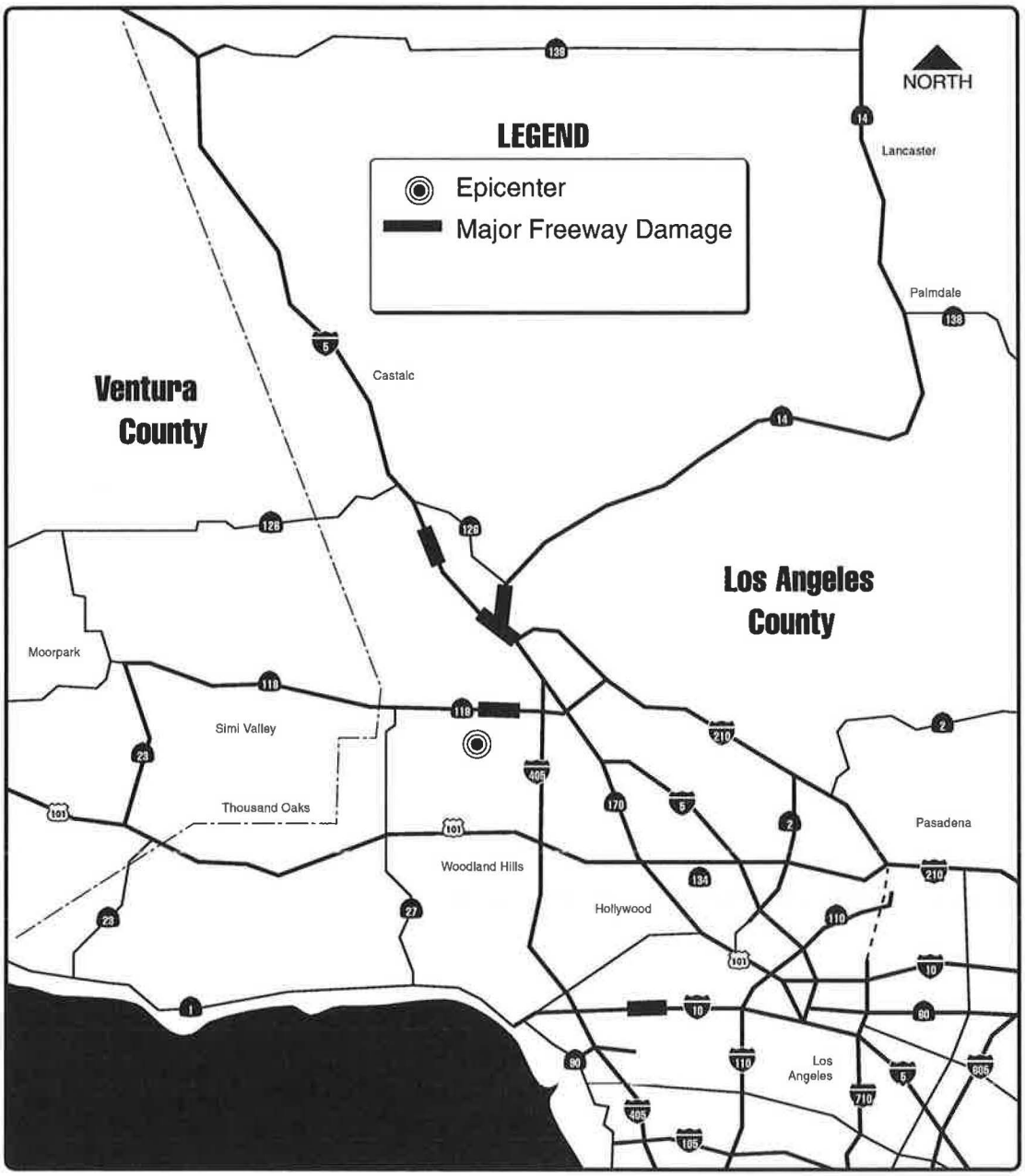

FIGURE 1 Location map.

"District 7" office. Traffic management activities are coordinated through the Traffic Management Center (TMC) in the Caltrans office in downtown Los Angeles. The TMC is staffed 24 hours a day, every day of the year by Caltrans traffic operations and maintenance and California Highway Patrol personnel. Extensive traffic monitoring and management capabilities were already in place on most of the major freeways well before the quake, including loops capable of monitoring speeds and flows, closed-circuit television cameras, and meters at most on-ramps. Permanently mounted overhead changeable message signs were also already in place approaching key freeway junctions. Emergency response Traffic Management Teams also are deployed out of the downtown Los Angeles Caltrans office, providing the capability to fine-tune the traffic management response to individual incidents or closures.

The City of Los Angeles operates its Automated Traffic Surveillance and Control System, which was constructed in 1984. The system, consisting of a network of traffic signals that can automatically adjust signal timing in response to real-time traffic conditions, video

surveillance of key intersections, and changeable message signs, is housed in the city's Department of Transportation headquarters a short distance from the Caltrans TMC in downtown Los Angeles.

DAMAGED FACILITIES

Major damage affecting transportation facilities was confined to four major highways and interchanges (see Figure 1). The Santa Monica Freeway section of Interstate 10, connecting the westerly cities of Santa Monica, Beverly Hills and Culver City with downtown Los Angeles, suffered major damage at two overcrossings. Two of the connectors at the 5/14 interchange in Sylmar collapsed, severing the only freeway link over the mountains to Lancaster and Palmdale, as well as causing damage to the through-movement on Interstate 5. Except for the extensive damage at the interchange, Route 14 to the north was unaffected. Interstate 5, however, also suffered damage at several locations north of the 5/14 interchange, effectively closing the only other major highway link over the mountains. State Highway 118 in Granada Hills was closed when the eastbound roadway collapsed at two locations. Additional damage at other locations resulted in the closure of the entire section of Route 118 from I-405 to I-210 (about 4 miles) in both directions. At all of these locations, closures were immediate and total, with no freeway traffic able to pass through the damaged zones.

At a fifth location, State Route 1 (the Pacific Coast Highway), closures occurred during the first few weeks after the quake. However, repairs on Route 1 were completed by mid-February. Minor damage also occurred at many other highway locations. However, except for the locations described above, none of the closures lasted more than a few weeks.

The local street network was, for the most part, not significantly affected by the quake. Temporary closures were implemented at freeway overcrossings where major damage occurred and at locations where the structural integrity of nearby buildings was in question. This is similar to the experience after the 1989 Loma Preita earthquake in Northern California, where the only sustained damage to transportation facilities was on freeways. Outside of Los Angeles County there was relatively little damage to any roadways. In Orange County to the southeast of Los Angeles, the highway network remained relatively unscathed, although some damage occurred to other types of structures. Airports were also unaffected.

INITIAL RESPONSE

The primary effort within the first hours after the quake consisted of assessing the extent of damage to the roadway system and the provision of basic detours around the affected areas. This function was performed by all available and qualified personnel, but was handled mainly by Caltrans maintenance, construction, and structures staff. Traffic operations TMTs were dispatched to provide assistance in diverting traffic around the closures. Coordination of these efforts, as well as the dissemination of traffic closure information to the public, was handled through the TMC.

Power outages were widespread immediately after the quake, disabling traffic signals on the street system and hindering communications throughout the region. Electrical service to the Caltrans TMC was out, but backup generators and telephones continued to work.

The earthquake occurred very early on a Monday morning, when most of the population was still at home. Furthermore, that Monday was also Martin Luther King's birthday, a national holiday, and thus, many work trips would not have occurred anyway. As expected, areawide traffic volumes were substantially lower than normal in the first few days following the quake, which aided the recovery effort. By the week after the quake, however, workers began returning to their jobs and volumes increased dramatically, although overall volumes were still lower than normal. By mid-March, traffic conditions had generally stabilized throughout the area such that there were only minor day to day variations in peak period travel time.

Early rough estimates indicated that repairs would take from six months to a year. Interstate 5 was expected to reopen in August, Interstate 10 would reopen the month after, and State Route 118 and the 5/14 interchange would reopen towards the end of the year. Incentive clauses were incorporated into the repair contracts in order to encourage contractors to complete the work as quickly as possible. Nevertheless, throughout the reconstruction period, there was considerable uncertainty as to when each of the freeways could be reopened.

Once a determination was made as to which facilities would remain closed for extended periods, the task confronting traffic operations personnel was essentially the same as the underlying problem to congestion problems of any size: *how to best balance capacity and demand.*

MITIGATION MEASURES IMPLEMENTED

Initially, motorists that were originating or were destined for areas outside of the Los Angeles basin were

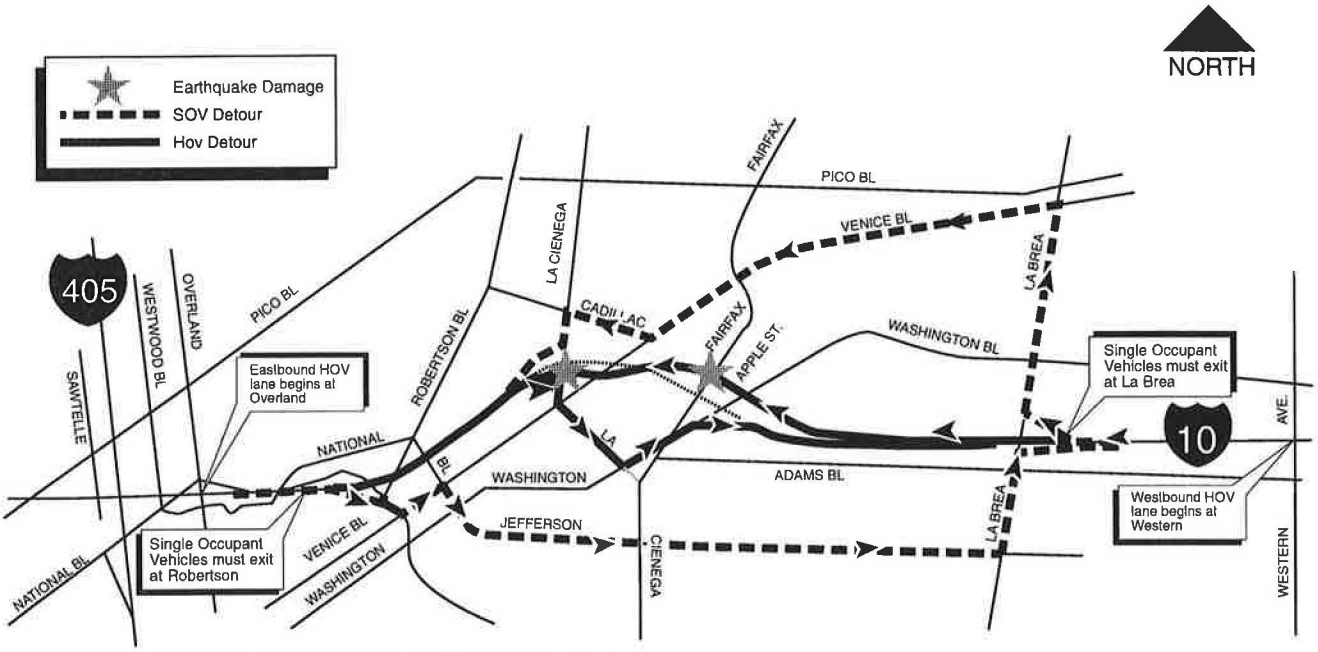

FIGURE 2 Detours implemented on Interstate 10.

encouraged to circumvent the area completely. Recommended routes were Route 101 to the west and Interstate 15 to the east. Use of these long distance detours added as much as 50 miles and several hours to trips. Although this was reasonable and would probably have been acceptable for a relatively short period of time, it was obvious that additional measures would be needed to handle traffic through the duration of the reconstruction period.

Capacity Increasing Measures

Alternate Routes & Detours

The use of local street detours was the mitigation measure that was implemented immediately after the quake and was the measure that ultimately proved to be the most effective. The Los Angeles Department of Transportation estimates that signals were re-timed at 300 intersections, and 1,000 directional signs and 7,500 parking signs were installed on the detour routes.

Interstate 10: Separate detours were implemented for High Occupancy Vehicle (HOV) and single occupant vehicles (see Figure 2). A two-or-more definition was instituted for the HOV detour. HOVs were given preferential treatment by allowing them to stay on the freeway as far as the interchange closest to the closure site and to reenter the freeway immediately past the closure. Single occupant vehicles, on the other hand, were required to exit the freeway two interchanges upstream of the closure and reentered the freeway further downstream of the closures than HOVs. Moreover, once on local streets, the HOV detour utilized streets that were significantly closer to the freeway than the streets utilized by the single occupant vehicles. As a result, the single occupant vehicle detour was about 5 miles longer than the HOV detour. In each direction on the freeway leading up to the detour off-ramps, one lane was designated as an HOV lane to permit HOVs to bypass some of the freeway congestion. This detour scheme was implemented on January 25th, and was revised on February 1st to increase efficiency.

5/14 Interchange: Southbound traffic through the interchange was diverted onto local streets, which were initially converted to one-way operation during peak periods. Northbound traffic through the interchange used the undamaged truck lanes, which were modified to provide two mixed flow and one HOV lane. HOV lanes were opened on the southbound and northbound approaches to the interchange from State Route 14. By the end of January, the southbound local street detours were restriped to provide additional capacity without having to resort to one-way operation.

Interstate 5: A detour utilizing the Old Road, a high capacity local street paralleling the freeway, was implemented by January 29. All traffic was taken off of the freeway, onto the Old Road which accommodated two lanes in each direction, and then directly back onto the freeway downstream of the closure.

State Route 118: Initially, detours were established on local streets, which was relatively easily

accommodated by the comprehensive street network in the area. Signal timing and phasing changes, lane restriping, and detour signing were implemented to support this detour. By February 21st, repairs had been sufficiently completed on the westbound roadway to allow it to be reopened to traffic. The roadway was then striped to provide three lanes in each direction, with a concrete barrier separating the two directions of traffic.

Other Traffic Management Activities

In the week after the quake, Caltrans personnel established a list of strategies that made up the earthquake relief Traffic Management Plan (TMP). These strategies were refined and implemented rapidly in the following weeks. Tow trucks, which had been assigned as part of the Freeway Service Patrol program to some of the routes that were damaged, were re-deployed to patrol the detour routes. Highway Patrol enforcement was also increased through the COZEEP (Construction Zone Enhanced Enforcement Program) to provide traffic control support to expedite repair operations. Peak period helicopter service was leased from the Los Angeles Police Department to provide more rapid and accurate traffic surveillance capabilities. A public awareness campaign was instituted, focusing on providing information on alternative transportation options. Communications equipment, such as cellular phones, pagers, and two-way radios, were leased to facilitate contacts with field units.

EpiCenter: An Earthquake Planning and Implementation Center was constructed and field instrumentation was installed where traffic surveillance and motorist information systems were critically needed but were not available. This included the installation of changeable message signs, highway advisory radio systems, closed-circuit television cameras, vehicle detector systems, and a video image processing system—all operated from the EpiCenter at the Caltrans district office. Satellite linkups were installed to permit communications with equipment at remote sites where conventional linkups could not be implemented quickly enough.

Demand Reduction Measures

Transit Enhancements

Six of the bus transit systems operating in Los Angeles County added new emergency service, which consisted of the implementation of new routes and extension and revision of the schedules of existing service. Most of the bus service changes were implemented on routes on or near Interstate 10. Metrolink added extra trains and line extensions into the Antelope Valley to provide additional capacity for commuters isolated by the closures of Interstate 5 and Route 14. Within the first week, seven new trains were added, and service began operating out of new stations in Lancaster and Palmdale. Numerous shuttles were also put in service to connect Metrolink and Amtrak lines with major employment centers.

Park & Ride Lots

Three new park and ride lots were created at strategic locations in order to encourage the formation of carpools or use of transit. These lots were either newly constructed or made use of leased space on existing lots, and were located in the vicinity of the 5/14 interchange.

TRAFFIC CONDITIONS DURING THE RECONSTRUCTION PERIOD

Fortunately, because of the distance separating the damaged facilities and because of their geographical locations, the effects of each of the closures were generally independent of each other. The closure of the through-movement on Interstate 5 was, of course, closely inter-related with the closure of the 5/14 interchange. The Interstate 10 and State Route 118 closures, however, operated independently of each other and from the Interstate 5 and 5/14 interchange closures. Thus, there was no compounding effect which would have substantially exacerbated the already serious impacts of the individual closures.

Interstate 10

The two-way average daily traffic (ADT) on Interstate 10 prior to the quake was approximately 310,000 at the point of the closure. Based on an average vehicle occupancy of 1.4 persons per vehicle, this translates to 434,000 people typically using the freeway on any given weekday, all of whom had to make decisions about how their trips would be made during the reconstruction period. The closure of the Santa Monica Freeway has been the most thoroughly studied of the closures to date, and in many respects, provided the most diverse spectrum of opportunities for commuters to choose from during the reconstruction period. Motorists could:

1. Continue to drive their automobiles and use the freeway, and then divert to the primary designated detour route.
2. Continue to drive, but divert to parallel freeways, such as the recently opened Interstate 105 (the Century Freeway) located about 8 miles to the south.

3. Continue to drive, but divert to other city streets or arterials that were not officially designated as alternate routes.

4. Form a carpool to take advantage of the new HOV lane and HOV detour.

5. Shift to transit, utilizing existing bus routes or one of the new routes implemented in response to the quake.

6. Change the time of day of travel.

7. Eliminate trips altogether.

Not unexpectedly, daily volumes dropped drastically in the first few weeks until the primary detours were established. ADTs were down by about two-thirds within the first week. Once the detours opened, volumes began climbing steadily, stabilizing at about 130,000, which accounts for 42 percent of the pre-quake ADT.

Extensive traffic counts were performed on parallel local arterials and freeways and a home interview survey was conducted in order to determine where the remaining trips had diverted to. Of the 310,000 daily vehicle trips that occurred on this section of Interstate 10 prior to the quake, 47,000 (about 15 percent) were eliminated altogether during the reconstruction period. Distribution of vehicle and person-trips are summarized in Table 1.

TABLE 1 CHANGES IN TRAVEL ROUTE OR MODE ON I-10

	Vehicles	People
Pre-Quake	310,000	434,000
Reconstruction		
Primary I-10 Detour	130,000	208,000
I-105	5,000	7,000
Other streets	128,000	155,000
Transit		2,000
Telecommuting		2,000
Trip eliminated		60,000
Reconstruction totals	263,000	434,000

Non-HOVs using the primary mixed flow detour during the peak commute periods experienced average delays of only 10 minutes compared to pre-quake travel times. Travel times on the HOV detour were even less, ranging from 3 to 5 minutes more than pre-quake travel times. In fact, once back on the freeway downstream of the closure, travel conditions were better than prior to the quake, since the output of the detours was approximately one-half of the pre-quake demand. As a result, in many cases the total trip travel time for HOVs was less than prior to the quake.

The number of vehicles that diverted to local streets other than the designated primary detour was virtually the same as the number that used the primary detour. Use of the most easily accessible alternate freeway, Interstate 105, was minimal, representing less than 2 percent of the total pre-quake vehicle trips. The low increase in volume was probably directly related to the high levels of delay on the north-south freeways that would have been used to take motorists from Interstate 10 to Interstate 105. Both Interstate 405 (the San Diego Freeway) and Interstate 110 (the Harbor Freeway) are heavily congested during peak periods.

Transit Utilization

Because of the relative ease of use of the local street detours and the comparatively minor delay associated with their use, increases in transit ridership in the Interstate 10 corridor were minimal. Daily boardings increased by about 2,000 passengers immediately after the quake, and then stayed at virtually the same level throughout the reconstruction period. By mid-March, transit operators began consolidating some of the new lines because ridership levels were not sufficient to justify the operating costs.

Effect on Ridesharing

Of particular interest on Interstate 10 was whether or not there would be a noticeable increase in ridesharing in response to the availability of the HOV detour. Prior to the quake, the number of vehicles carrying two or more occupants during the peak hour ranged from 1,000 to 1,400 vehicles. During the reconstruction period, HOV volumes ranged from 1,000 to 1,300 vehicles, although HOVs represented a much larger proportion of the total traffic flow because of the lower overall volume. After the reopening of Interstate 10 on April 12th, peak hour HOV volumes ranged from 1,200 to 1,500.

Thus, although it appears that there was an increase in ridesharing as a result of the HOV detour strategy, the increase was relatively minor. Several factors may have contributed to this. The time savings offered to users of the HOV lane and HOV detour may not have been large enough to instigate a significant change in travel mode. Moreover, the time saved on the HOV detour may not have been large enough to offset the additional time it would have taken to form a carpool each day. In addition, the amount of time savings may have been relatively small in relation to what the total trip times were. Nevertheless, the implementation of the

HOV detour was clearly successful in reducing overall person-delay in the corridor.

Interstate 5 and the 5/14 Interchange

The closures of Interstate 5 and the 5/14 interchange presented a substantially different set of travel options to commuters. At this time, however, the home interview survey and traffic performance data are still being analyzed and only preliminary conclusions can be made.

With few, if any, alternative roadways to use instead of the closed freeways, motorists had a much smaller set of choices to select from compared to Interstate 10. Motorists could:

1. Continue to drive on the freeway in single-occupant autos.
2. Form carpools to take advantage of the State Route 14 HOV lanes.
3. Shift to one of the new Metrolink rail lines.
4. Change the time of day of travel.
5. Eliminate trips altogether.

Travel patterns on Interstate 5 and State Route 14 are highly directional. The primary flow during the morning commute period is southbound, heading towards the Los Angeles basin, and is reversed in the afternoon commute period. In the off-peak direction during commute periods, and during most other times of the day, demands are low enough that virtually no recurrent congestion occurred in spite of the reduced freeway capacity.

Conditions on Interstate 5

The capacity of the two lanes in each direction on the Old Road was generally adequate to handle all but the peak period demands. Peak period travel times were extremely variable during the first month after the quake, with motorists experiencing individual delays as high as one hour. By early March, conditions had generally stabilized, with 10 to 15 minutes of delay in the southbound morning peak and 5 to 10 minutes in the northbound afternoon peak. Vehicles using the detour at times other than the peak period experienced no congestion at all, and use of the detour at those times added only about 2 minutes to trips.

Conditions on State Route 14

The combined capacity of the freeway lanes and improved parallel local streets was also adequate to handle traffic demands, except during the commute periods. Peak period individual delays in the days following the quake were as high as 40 minutes. By early February, after the detours had been improved, delays through the interchange decreased significantly, stabilizing at about 10 minutes in the southbound morning peak and about 20 minutes in the northbound afternoon peak. During the off-peak, there was no congestion on State Route 14 or on the local street detours. At these times of the day, use of the detour added virtually no time to trips.

Time savings for users of the HOV lanes ranged from 5 to 20 minutes during peak periods. HOV lane volumes were approximately 1,500 vehicles during the peak hour. Violation rates varied widely, ranging from 1 to 14 percent dependent on the level of Highway Patrol enforcement.

Transit Utilization

Prior to the quake, the northerly terminus of Metrolink service was at the Santa Clarita station near the 5/14 interchange. Daily ridership was about 1,000 boardings per day. The extensions into Lancaster and Palmdale opened on Friday, January 21st. By the following Tuesday, daily ridership peaked at almost 22,000 boardings, fueling hopes that the rail line would relieve much of the expected freeway congestion and that these ridership levels could be sustained over a long term period. A week later, however, ridership had dropped off to about 13,000, steadily declining through the reconstruction period as shown in Figure 3.

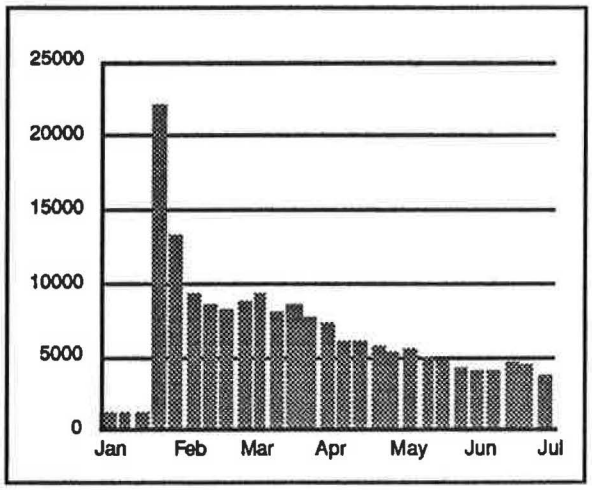

FIGURE 3 Ridership on the Santa Clarita Metrolink line during reconstruction.

By the time the through-movement on Interstate 5 opened in mid-May, daily boardings were less than 5,000. Just before the major connectors at the 5/14 reopened in early July, ridership was at about 4,300 per day. In spite of the inability to sustain the very high ridership levels immediately following the quake, the Metrolink extensions still proved vital in reducing demand on the freeway.

State Route 118

The two-way average daily traffic volume on State Route 118 immediately to the east of the closure was about 123,000 prior to the quake. Until the freeway detour was opened on February 21st, all traffic was being diverted onto the local street detours. As a result, daily volumes on the adjacent freeway sections were less than 50 percent of the pre-quake volume. Some of the local streets were carrying as much as an additional 30,000 vehicles per day. Peak period delays using the designated local street detours were as high as 30 minutes.

Once the freeway detour opened with three lanes in each direction, virtually all delay was eliminated. Daily freeway volumes are still slightly below pre-quake levels, with the local street system absorbing the difference.

Impacts to Truck Travel

The closures of Interstate 5 and State Route 14 raised considerable concern with respect to impacts to commercial truck traffic and commodities movements. Truck intercept surveys were conducted in May at truck inspection facilities at entry points to the Los Angeles area. Telephone surveys were conducted during May and June with 300 shipping companies in the Los Angeles basin. At this time, the survey data is still being analyzed. However, these preliminary conclusions can be made:

- Between 30 to 50 percent of the truck trips into the Los Angeles area were canceled immediately following the quake.
- Until the detours were firmly established, long distance detours via State Routes 58 and 138 and Interstate 15 were used by about one-fourth of the truckers to enter and leave the area. Truck rerouting was the most common action taken by shippers in response to the closures.
- Once the detours were in place, truck volumes returned to pre-quake levels and virtually all trucks returned to their normal routes.
- Rescheduling of shipments was employed by almost one-half of the firms surveyed, with one-fourth reporting less frequent deliveries and pickups.
- Estimated increases in operating costs were estimated to be about 8 percent. A more detailed review of the economic impacts on these firms is currently being conducted by the University of California, Irvine.

Cost of Delay

Motorist delay costs associated with the closure of Interstate 10 are conservatively estimated to be about $990,000 per weekday. Delays due to closures at the 5/14 interchange were about $436,000 per weekday. This correlates very closely with the independent estimate by the Governor's Office of Planning and Research and with the early-completion incentives offered to the repair contractors. These estimates do not include the economic impact of disruption to commercial traffic movements, loss of business due to trips being eliminated, and loss of jobs.

Delay cost estimates were developed by establishing screenlines across the affected corridors, determining the daily volume of traffic that crossed the screenline prior to the quake, and then calculating the aggregate increase in delay based on data collected on the detour routes. Costs were based on standard factors established by the State of California.

FINDINGS AND RECOMMENDATIONS

A. Providing immediate transportation solutions takes precedence over the opportunity to change motorist behavior.

Although the opportunity clearly presents itself to use disasters affecting transportation facilities as an opportunity to make long term changes in driver behavior by establishing new HOV lanes or new and increased use of transit, undeniable political realities must be considered. Whether it is truly feasible to provide "less" vehicular capacity than can actually be provided in order to encourage a modal shift needs to be carefully considered in the context of whether the alternative measures will be able to provide congestion relief, whether they will be adequately used, and whether the benefits of sustained mode shifts compensate any long term negative perceptions that may develop.

B. Stabilization of traffic conditions can take several weeks to several months.

Large fluctuations in traffic conditions can be expected during the initial period following the disaster. Depending on the magnitude of impacts to the system, it may take weeks or months before conditions stabilize into a regular pattern. Consequently, it may not be feasible, nor would it be necessarily cost effective, to attempt to develop the initial traffic mitigation strategies on a real-time basis. A more efficient approach would be to develop large-scale strategies based on known pre-disaster travel patterns, and then make adjustments based on data collected over a reasonable period of time.

C. Where sufficient alternate routes existed, motorists continued driving; where convenient detours were not available, transit options became much more attractive.

The difference in response to the Interstate 10 closure compared to the Interstate 5 and 5/14 closures indicate that where alternate routes are available, motorists were content to continue driving. Increases in bus ridership in the Interstate 10 corridor were very minor. The magnitude of the time savings offered to HOV lane users was probably insufficient to generate any substantive degree of modal shift. Moreover, the closures were not sustained over a long enough period to elicit major mode shifts.

The dramatic increase in Metrolink ridership in the Interstate 5 and State Route 14 corridors immediately following the quake clearly point to the importance of providing transit options on corridors where alternate routes are limited or unavailable. However, once the freeway detours were opened and overall traffic conditions stabilized, ridership decreased sharply. What this means with respect to the long term viability of transit in the Los Angeles area will be the subject of much debate in the future. Whether this experience can realistically be applied to other areas is another important question that cannot be answered at this time.

D. A review is needed of isolated communities that are currently served by a single transportation facility.

Although the detours that were established were successful in providing access to the Antelope Valley, traffic handling could have been substantially more difficult had there been more damage to the highway system or if the Metrolink extensions were not feasible. A review is needed to determine to what extent additional capacity is needed over the San Gabriel and San Bernardino Mountains, if nothing else, to be able to respond to emergencies such as this one. This review could be expanded to include a search for other similarly isolated communities and to provide an estimate of what the economic impacts of prolonged closures might be.

E. Availability of accurate transportation data is critical in developing emergency response.

A database of information should be developed in anticipation of such disasters, integrating data from all transportation providers. Data concerning traffic volumes, travel times, origin & destination information, and transit ridership & schedules should be compiled and stored at a single accessible location. Computer modeling may be useful for this purpose.

After the disaster, a comprehensive data collection effort should begin immediately in order to provide timely and accurate information to the public, to develop mitigation measures, and to determine delay costs with which repair contract incentive clauses my be based.

F. Emergency response procedures need to be expanded to handle major disasters.

"Standard" emergency response measures were already in place and worked well. These include the availability of emergency response teams, widespread use of communications devices such as cellular phones & pagers, and fully-equipped remote field offices. A variety of interagency agreements were already in place which expedited the work between transportation providers.

However, the magnitude of this disaster revealed several areas that require improvement. Detailed procedures should be established in advance to determine how personnel from other locations can be transferred rapidly to the disaster site. These procedures should include a quick approval process for renting or leasing equipment. Media relation training should be given to key staff who will be on the front lines of the recovery effort. Hiring of public relations consultant firms can be extremely beneficial in satisfying the insatiable thirst for disaster information, freeing up personnel to expedite recovery work. Earthquake drills involving all agencies could also be expanded.

G. Areas with well-developed traffic management centers are able to accommodate sudden changes easily.

Properly equipped and well-staffed traffic management centers are an invaluable tool in dealing with transportation emergencies of this magnitude. The availability of devices such as closed-circuit television cameras and roadway detection loops were critical in being able to monitor freeway conditions quickly and frequently. This resulted in more accurate information being given to the public, either via the freeway changeable message signs or through the media. However, the availability of traffic management equipment is by no means a substitute for engineers with the necessary training and experience to develop appropriate operational solutions quickly.