

THE EFFECTS OF THE JANUARY 17, 1994 NORTHRIDGE EARTHQUAKE ON TRAVEL BEHAVIOR IN THE SANTA MONICA FREEWAY (I-10) CORRIDOR

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ABSTRACT

On January 17, 1994, the Northridge Earthquake shook the greater Los Angeles area with a power of 6.8 on the Richter scale. In addition to other damage, the earthquake destroyed the La Cienega, Venice, Washington and Fairfax over crossings of the I-10 (Santa Monica Freeway) disrupting travel patterns along one of Los Angeles' most heavily traveled corridors. Two primary detours, HOV and all purpose, were established along the Santa Monica Freeway corridor in each direction to divert traffic around the damaged sections. Within days of the earthquake, Caltrans began gathering data to study these traffic effects of the earthquake's damage. Traffic volumes, travel times and auto occupancy rates were monitored and telephone interviews were conducted on households directly affected by the closure.

Of the 434,000 person trips made each weekday on this segment of I-10 prior to the earthquake, 208,000 remained on I-10, and used the primary detours; 159,000 trips shifted to city streets; 7,000 shifted to the recently completed I-105 freeway; 2,000 shifted mode to transit; and, 58,000 trips were eliminated altogether.

On an average weekday during the freeway reconstruction period, trips using the HOV detour averaged six minutes longer than before the earthquake, and the all purpose detour averaged 12 minutes longer. These numbers varied by time of day and direction of travel. The greatest delay, 17 minutes, was recorded eastbound during the p.m. peak period.

BACKGROUND

On January 17, 1994, the Northridge Earthquake destroyed the bridges carrying the I-10 (Santa Monica Freeway) over Washington Boulevard, Venice Boulevard, La Cienega Boulevard and Fairfax Avenue. This section of Interstate 10 is 5.6 km. (3.5 miles) east of the I-405 along a 15.1 km. (9.4 mile) long section joining I-405 (San Diego Freeway) on the west and I-110 (Harbor Freeway) on the east. The Los Angeles Central Business District (CBD) is immediately northeast of the I-10/I-110 interchange.

The 1993 traffic volumes along I-10 just east of the break were 294,000 vehicles (7 day average) and 310,000 vehicles (5 day average). The route had five lanes in each direction east of the break, and four lanes in each direction to the west. The peak period traffic was split roughly 50 percent in each direction. The a.m. peak was two to three hours long with an average speed of 43 kph (27 mph) for the period of congestion over the 15.13 km (9.4 mile) area. The p.m. peak was three hours in each direction with an average speed of 50 kph (31 mph).

The Detours

After the earthquake, Caltrans and the City of Los Angeles Department of Transportation (LADOT), in conjunction with the California Highway Patrol, the Los Angeles County Metropolitan Transportation Authority (LACMTA) and other affected local agencies, took immediate steps to restore traffic capacity within the I-10 (Santa Monica Freeway) corridor. Two detours, HOV and all purpose, were established along the corridor in each direction to divert traffic around the damaged sections. These primary detours were initially established within a week after the earthquake. On February 1, 1994, both sets of detours were shortened and improved.

Westbound Detours

Westbound HOV traffic exited the freeway via the Washington Boulevard off-ramp as before; then, followed Apple Street, a little used frontage road, across Washington and Venice Boulevards at signalized intersections. Finally, the westbound HOV traffic reentered the freeway ingeniously using the temporarily unused eastbound ramps to move under the I-10 (under reconstruction), and over Ballona Creek. This HOV bypass required only 0.8 km. (0.5 miles) of city streets!

The mixed flow traffic exited the freeway at La Brea Avenue, as before, then used Venice Boulevard, Cadillac Avenue, briefly crossing La Cienega Boulevard to reenter the freeway at that westbound on ramp. The

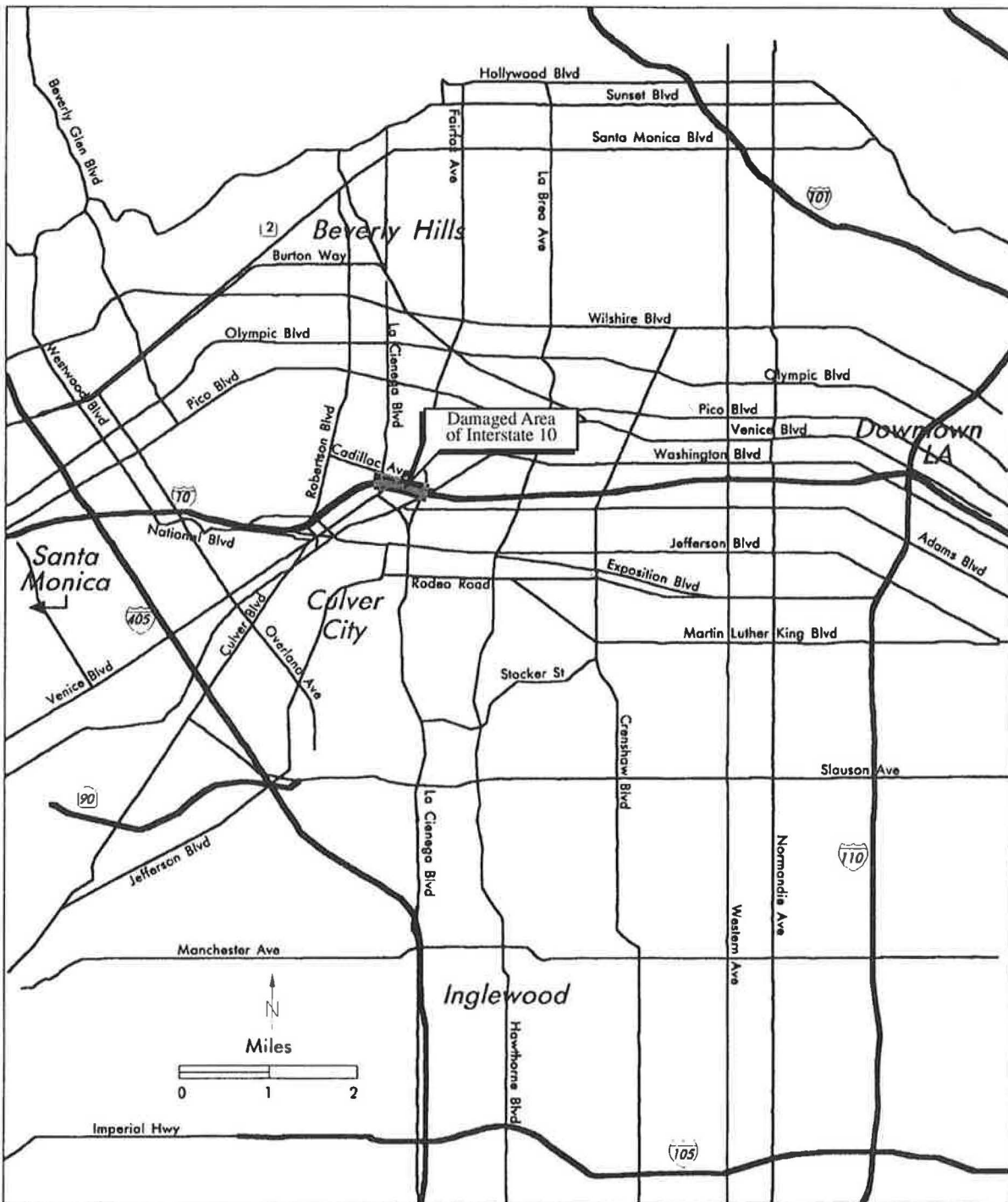


FIGURE 1 Areawide network of roadways.

TABLE 1 AVERAGE ADDITIONAL TRAVEL TIME DELAYS ON I-10 PRIMARY DETOURS DURING MARCH, 1994

| Periods of Delay | I-10 Mixed-Flow and HOV Detours | | | |
|------------------|---------------------------------|--------|--------|--------|
| | EB HOV | EB SOV | WB HOV | WB SOV |
| AM Peak Period | 3 | 8 | 4 | 11 |
| Midday | 5 | 9 | 3 | 11 |
| PM Peak Period | 15 | 17 | 3 | 10 |
| Evening | 8 | 9 | 3 | 9 |
| Weekday Average | 8 | 12 | 4 | 11 |
| Weekend | 7 | 8 | 4 | 8 |

Notes:

- Delay is calculated based on an assumed pre-quake speed of 45 miles per hour.
- Westbound detour travel time runs performed from Crenshaw Boulevard Overcrossing to the vicinity of Robertson Boulevard.
- Eastbound travel time runs performed from the I-405 to the Washington Boulevard on-ramp.

Source: Caltrans travel time runs prior to March 3; Wittec runs after March 3.

westbound mixed flow bypass used 4.8 km. (3 miles) of city streets.

Eastbound Detours

The eastbound HOV lane was not as neat and tidy as the westbound. It had to share very scarce roadway space with local traffic. HOV traffic exited the freeway at La Cienega Boulevard, used La Cienega Boulevard to Washington Boulevard, and reentered I-10 at the eastbound on ramp. The eastbound HOV detour used 1.3 km. (0.8 miles) of city streets.

The eastbound mixed flow traffic exited the freeway at Robertson Boulevard, traversing Venice Boulevard to National Boulevard, then to Jefferson Blvd., and followed Jefferson Boulevard to La Brea Avenue where it reentered the freeway. The eastbound mixed flow detour used about 4.8 km. (3 miles) of city streets.

Delay on the Detours

The average delay experienced along these four detours are summarized in Table 1. As you can see, the delay is not closely related to congestion (Eastbound p.m. peak

period excepted). Most of the delay is associated with travel on city streets with their slower speed limits and intersection delays.

HOME INTERVIEW SURVEY

Applied Management and Planning Group (AMPG), a sub-consultant to Barton-Aschman and Associates, conducted a telephone survey of households within the I-10 corridor to examine changes in travel characteristics brought about by the January 17, 1994 earthquake. Respondents in the 792 household sample were asked if they or someone in their households was a regular user of the damaged section of I-10 prior to the earthquake. If respondents answered yes, they were then asked a series of questions concerning trips made before the earthquake, during reconstruction, and after reopening. In addition to I-10 trip information, basic questions were asked regarding household size, auto ownership and so forth. A follow up survey was conducted in October 1994. Four hundred of the original 792 households were contacted and asked to clarify their response to trip discontinuation, changing trip origin & destination and changing trip start times. The follow up survey results are shown in Figure 3.

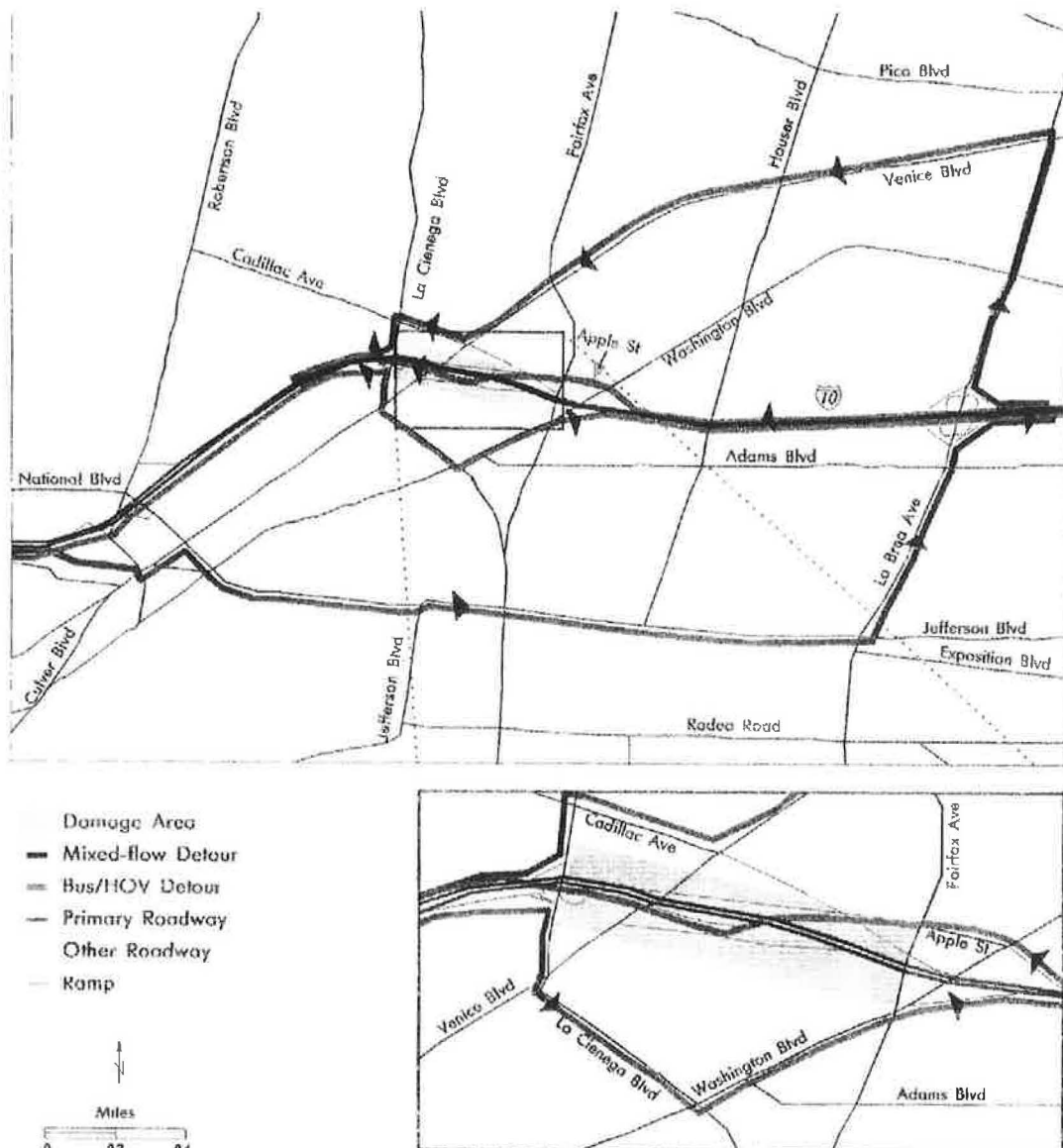


FIGURE 2 Primary HOV and mixed-flow detours in effect from February 1, 1994 until the reopening of I-10 on April 12, 1994.

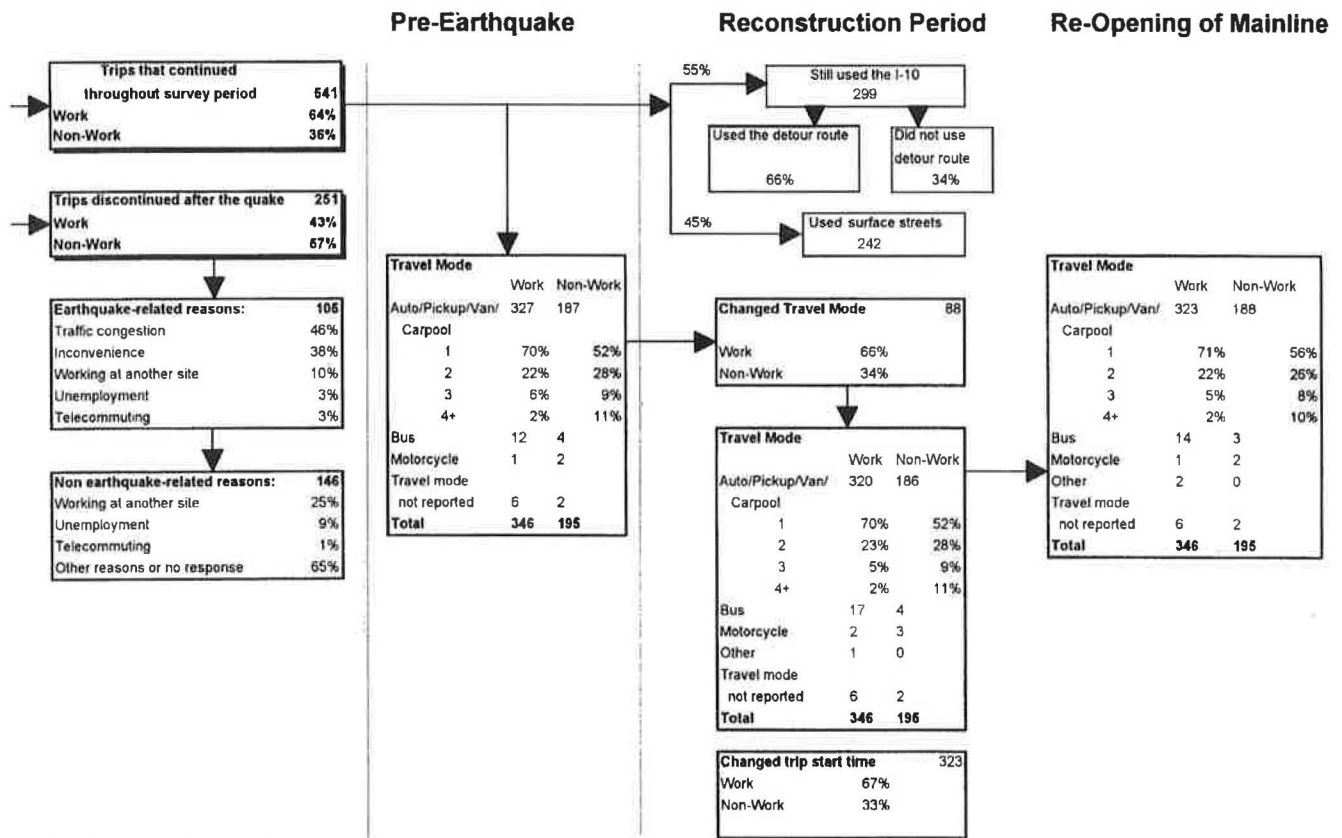


FIGURE 3 I-10 corridor sample travel behavior flowchart.

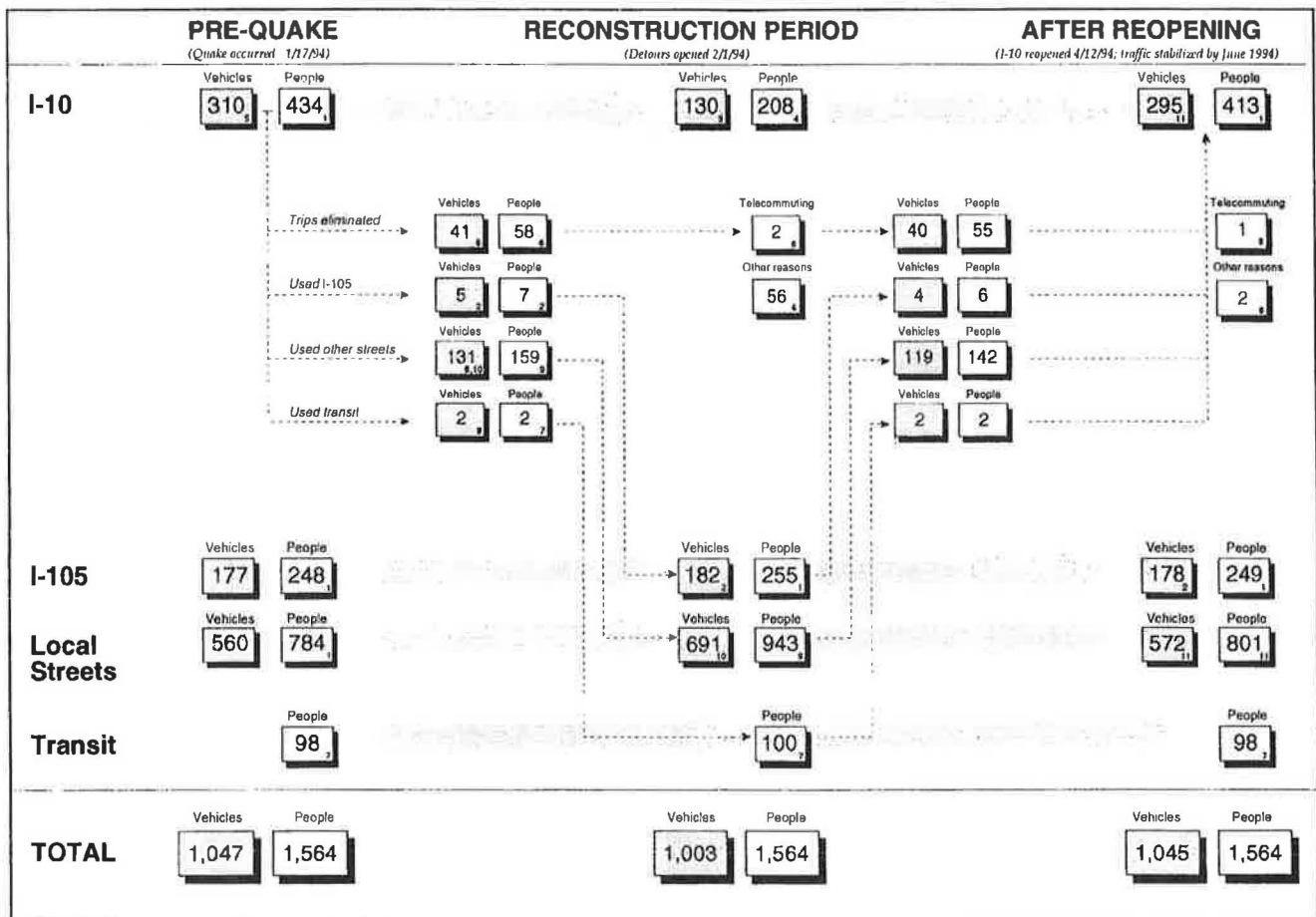


FIGURE 4 I-10 corridor travel behavior flowchart (daily trips in thousands).

Sources of Information for I-10 Corridor Travel Behavior Trends

Footnotes:

1. Daily average vehicle occupancy for all trip purposes combined is 1.4 persons per vehicle for Los Angeles County, based on the 1991 *Regional Home Interview Survey*, Southern California Association of Governments (SCAG).
2. Note: Traffic volumes on the newly opened I-105 continued to grow during the period of analysis. The January, 1994 (pre-quake) volumes of 177,000 grew to approximately 210,000 by June 1994. First source for the change in I-105 volumes associated with the diversion from I-10 is the *Home Interview Survey* of I-10 users conducted by Applied Management & Planning Group. The second source is the weekly traffic volumes recorded on I-105 by Caltrans in April, 1994 before and after the reopening of I-10.
3. Average of weekday vehicle counts for I-10 mixed flow and HOV detour from Caltrans and Wiltec field counts.
4. Vehicle occupancies for the I-10 mixed-flow and HOV detours were calculated from the weekly vehicle classification counts. Vehicles in the mixed-flow detour averaged approximately 1.10 to 1.15 persons per vehicle. Vehicles in the HOV detour averaged approximately 2.10 to 2.30 persons per vehicle. A composite I-10 detour vehicle occupancy of 1.6 persons per vehicle is used in this analysis.
5. The 310,000 is a five-day AADT count as derived from the 1993 Caltrans Traffic Count Book. This count location is between La Brea and Venice/La Cienega. A 294,000 AADT seven-day average corresponds to this count at the same location.
6. Source: *Home Interview Survey* of I-10 corridor travelers (AMPG), which indicates that 13.3 percent of I-10 pre-quake users eliminated or modified trips for earthquake related reasons. Less than one percent of total respondents indicated that they telecommuted following the earthquake.
7. 1994 Weekly transit ridership data from LACMTA, City of Los Angeles, Culver City Transit, and Santa Monica Municipal Bus Lines. A second source for the shift to transit is the *Home Interview Survey* of I-10 corridor travelers.
8. Based on the *Home Interview Survey*, between one and two percent of pre-quake I-10 users shifted from driving alone to ridesharing or transit. This led to the assumption that approximately 2,000 I-10 pre-quake vehicle trips were eliminated by shifts to transit and 1,000 vehicle trips by shifts to carpooling.
9. Assumes a vehicle occupancy of 1.21 persons per vehicle for trips diverted from I-10 to arterials, based on assuming that carpools generally used the I-10 HOV primary detour to gain a time savings, while other vehicles were shifted to arterials.
10. As discussed in Chapter 4, a screenline count in the I-10 corridor during the freeway reconstruction in March 1994 identified 107,000 additional vehicles on six major arterials, two of which (Jefferson and Venice) were on the primary mixed-flow detour, carrying 52,000 of the additional vehicles. The remaining four arterials were carrying 55,000 additional vehicles. Assumption: an additional 76,000 vehicles used other city streets not included in the screenline counts for a total of 121,000 daily vehicle trips diverted to arterials.
11. I-10 daily counts just east of I-405 remain approximately 10 percent below 1993 pre-quake counts for comparable months, while I-110 counts just west of the I-10 returned to pre-quake levels in June 1994. Based on this and other information, it was assumed that approximately five percent of pre-quake I-10 trips have not reappeared on I-10 in the vicinity of where the damage occurred.
12. Estimate of total corridor trips from *emme/2* model simulation. Traffic counts on freeways and primary I-10 detours: Caltrans prior to March 3; Wiltec after March 3. Arterial traffic counts from the City of Los Angeles (ATSAC) and County of Los Angeles.

FIGURE 5 Sources of information for I-10 corridor travel behavior trends.

| | | | | | |
|--|--|---|--------------------------------------|------------------------------|--|
| Pre-quake daily vehicle volumes | <u>I-10 Mainline</u> 310,000 ² | <u>Parallel Arterials</u> 560,000 ³ | <u>I-105</u> 177,000 | <u>Transit Riders</u> N/A | <u>Total Trips Made</u> 1,047,000 |
| Daily vehicle volumes during reconstruction | <u>I-10 Primary Detours</u> 130,000 | <u>Parallel Arterials</u> 691,000 | <u>I-105</u> 182,000 ⁴ | <u>Transit Riders</u> N/A | <u>Total</u> 1,003,000 ⁵ |
| Conversion to person trips ⁶ | 208,000 ⁶ | 943,000 ⁶ | 255,000 | 100,000 | 1,506,000 |
| Average delays for weekdays (in minutes) | 9 ⁷ | 6 ⁸ | 0 | 6 | -- |
| Daily person hours of delay | 31,200 | 93,900 | 0 | 10,000 | 135,100 |
| Daily truck traffic estimates | 5,200 ⁹ | 27,520 ¹⁰ | 7,280 ¹⁰ | N/A | 40,000 |
| Daily truck hours of delay | 780 | 2,752 | 0 | N/A | 3,532 |
| Person-hours/truck-hours of delay | | <u>Trucks</u> 3,532 | | <u>Persons</u> 135,100 | |
| Value of vehicle time for persons and trucks (cost per hour) | | \$19.20 ¹¹ | | \$6.00 ¹¹ | |
| Cost of delay | | \$68,000 | | \$811,000 | |
| Excess fuel used: total vehicle hours of delay x \$1.10 per gallon | | 100,000 hours x \$1.10 = \$110,000 ¹² | | | |
| Cost of the I-10 closure for an average weekday | | \$990,000 | | | |

1. Based upon travel simulation utilizing the City of Los Angeles Framework Model.
2. Source: Derived from the 1993 Traffic Volumes, Caltrans for the I-10 between La Brea and Venice/La Cienega.
3. The emma/2 model simulation results validated by counts from the City of Los Angeles ATSAC, County of Los Angeles and Wittec.
4. Volumes on the newly opened I-105 Freeway have continued to grow from the time of the earthquake and surpassed 200,000 daily vehicle trips soon after it occurred. The volume of 182,000 represents the relative change in volume assumed to be associated with the damage on I-10. Source: Home Interview Survey of I-10 travelers and Caltrans traffic count trends during March and April 1994.
5. Based on the Home Interview Survey of I-10 travelers, approximately 15 to 16 percent of I-10 pre-quake trips either shifted to other travel modes or were eliminated or modified during the reconstruction period on I-10.
6. Conversion of vehicles to persons based on daily occupancy factor of 1.4 persons per vehicle from the 1991 Regional Home Interview Survey, except for arterial streets where a daily occupancy of 1.36 is used to reflect additional drive-alone trips diverted from I-10. For I-10 primary detours: 1.6 persons per vehicle from field counts of vehicle occupancies during March.
7. Approximation based on factoring from delays recorded from travel time runs performed on I-10 traffic detours.
8. Based on a composite average delay for all time periods during weekdays from field travel time runs; March 1994.
9. Based on field vehicle mix counts in March 1994.
10. Derived from Caltrans pre-quake information on percent trucks.
11. California Department of Transportation Policy and Procedure Circular P78-5 Revised February 26, 1990.
12. From the Economic Benefits of Reopening I-10, Governor's Office of Planning and Research, State of California.

FIGURE 6 I-10 corridor: cost of daily areawide delay during reconstruction.