Chapter 2

THE IMPACT OF SAN FRANCISCO'S DEVELOPMENT ON THE BAY BRIDGE MORNING COMMUTE

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Introduction

San Francisco has attracted businesses for years with its regionally accessible location, proximity to a large skilled labor force, cultural allure and pleasing landscapes. In the last twenty years the city has become a national center of finance and commerce and has achieved this, in part, by allowing downtown office space to increase at a phenomenal rate. During the 1960s, 10.3 million square feet of space was added to the existing 15.9 million and an additional 15.6 million followed in the next decade (Association of Bay Area Governments [ABAG], 1981). While San Francisco's possibly over-zealous commitment to office space development has indeed strengthened the economy of the region, this continual increase has also produced some negative side-effects, chief among which is congestion on the roadways entering the city.

To anyone traveling the highways during the morning commute hours, it is particularly evident that the Bay Area is now battling the same problem that has plagued Los Angeles for years, serious traffic congestion. It is considered to be, as a recent poll revealed, the most pressing problem facing this region today, before crime, pollution, housing or unemployment (Bay Area Council, 1985). Commute-traffic levels today are threatening to overwhelm portions of the regional roadway system, causing major delays for those traveling to and from work. The Bay Bridge is one of these trouble-some roadways, and its expansion limitations make it a particularly worrisome one.

Implementation of various alternatives to the traditional, single-passenger commute trip has appeared to have postponed the traffic problem seen on the Bay Bridge today. The Bay Area Rapid Transit System (BART) has been most important in terms of reducing the number of actual commuters using this roadway. Car and van pooling and commercial bus services such as the Alameda and Contra Costa County Transit Authority (AC Transit) have also helped to combat the problem. Special incentives for car and van pooling, including reserved high occupancy vehicle (HOV) lanes and a toll-free trip, have contributed to the success of the pooling commute alternatives (Markowitz, 1984). However, popular opinion seems to be that these current means of accommodating the large volume of East Bay-San Francisco commuters are unsatisfactory and that the problem needs immediate attention. It appears that the point has been reached where further roadway expansions and alternative modes of commuting will not be sufficient to keep the traffic flowing at a desirable level. Only together with a thorough examination of the fundamental causes of the problem can solutions be properly sought.

This paper presents a case that San Francisco's dramatic increases in office space over the past two decades have been a primary cause of the present traffic congestion associated with the Bay Bridge, and the consequent increases in travel delays. First, yearly increases in San Francisco's office space are correlated with annual increases in Bay Bridge commuter volumes. Future commuter volumes are then estimated as a function of proposed office-space development and translated into vehicle volumes from average vehicle occupancies. The sums of present and projected vehicle volumes are in turn compared with the roadway's theoretical capacity. It will be suggested that continued substantial increases in San Francisco's office space will further worsen the traffic congestion, resulting in even lengthier delays for Bay Bridge commuters.

Background

Past Metropolitan Traffic Survey Series reports for the Bay Bridge provide an insight into the changes that the morning commute traffic has experienced over the years and how additional vehicle volumes might affect the roadway in the future. The planned theoretical capacity for the five-lane bridge is 4,500 vehicles per half hour, which is based on the assumption that each lane can accommodate 900 cars every half hour (Markowitz, 1984). The peak commute time for the Bay Bridge has been estimated at between 0630 and 0900. In the early 1970s, the bridge was reaching its maximum capacity only between 0700 and 0800. Since that time, this capacity has been achieved for every additional half hour period between 0630 and 0900, and now the periods 0600-0630 and 0900-0930 are approaching the maximum volume. It appears that as the number of commuters having to reach work by 0700, 0800 and 0900 have increased, adjustments have been made to deal with the delays caused by the additional vehicles. Some commuters have compensated for the delay by leaving home earlier, filling in the 0630-0700 time period. Others have the option to start work earlier or later, which also serves to lengthen the peak commute time in each direction. The increases in average occupancy per vehicle indicated in the traffic reports suggest that ride-sharing has been another means of coping with traffic congestion. Some foreseeable problems are that the peak commute time cannot continue to expand indefinitely; the point will be reached where a work day cannot start any earlier or any later, and people's tolerance of increasing commute times will ultimately reach a limit.

Partially as a response to worsening traffic congestion on the roadways entering the city, the San Francisco Board of Supervisors passed a growth management plan in 1985. The Downtown Plan put an approval limit of 950,000 square feet on additional office space per year for the next three years, 1986-1988. Just a year later, however, the residents of San Francisco passed an even stricter growth control measure, Proposition M. This measure cuts in half the approval limit of additional office space set by The Downtown Plan and extends the limit for ten years or until the backlog of approved development projects are completed (San Francisco Chamber of Commerce, 1987). Both growth management plans are not without their shortcomings and the political battles between developers, city officials and slow-growth proponents make future revisions or entirely new plans likely (Halstead, 1987).

Methodology

Bay Bridge traffic statistics for the estimated peak commute period of 0630-0900 are gathered from the 1970-1986 Fall Traffic Survey Series (Bay Bridge) (Metropolitan Transportation Commission [MTC], 1984). Examination of the total vehicle volumes (commercial trucks, buses, private vehicles), makes it apparent that any correlation using these annual volumes would be meaningless, since they have remained essentially unchanged for the past four years. The volume that does see a consistent annual increase is the number of commuters traveling by private vehicles (pooling and single-passenger cars and vans). These annual increases and those for San Francisco office space are used to calculate a correlation coefficient and a regression line.

Yearly increases in square footage of San Francisco office space for 1971-1979 are collected for the downtown area roughly bound by Van Ness Avenue, Folsom Street and the Bay (Nelson, 1980). The increases from 1980-1986, for the same approximate area, are obtained from the San Francisco City Planning Office (Blazej, 1987, pers. comm.). Projected increases in office space are tabluated using the designated approval limitations of The Downtown Plan and Proposition M. After 1988, the approval limitations of The Downtown Plan are unspecified, so the average annual increase over the past 17 years is used from 1989 to 1996. In addition to the maximum approvals set by these two growth management plans, increases from development projects already approved and expected to be completed in the next one to four years are also included to make up the total projected annual increases in office space (Blazej, 1987, pers. comm.). With the projected yearly increases in office space, future increases in commuters traveling by private vehicle are obtained from the regression line equation constructed from the past annual increases in office space and commuter volumes.

Annual projections of the total volume of vehicles traveling the Bay Bridge during the peak commute period are determined using the projected increases in commuters traveling by private vehicles and the average occupancy of these private vehicles. Two average occupancy scenarios are examined for 1987-1996. The first maintains a constant average occupancy rate throughout the ten year period, while the second increases the average occupancy yearly, at a rate equal to the average yearly increase experienced over the past 17 years. The addition of these private vehicles to the total vehicle volume of the previous year produces the projected total vehicle volumes. These in turn are compared to the theoretical capacity of the roadway and the impact on the peak commute time is evaluated.

Data

Annual morning commute statistics for the Bay Bridge from 1970 to 1986 are shown in Table 1. Vehicle volumes have remained fairly constant over the past eight years. The total vehicle volume (commercial trucks, buses, commuter vehicles) has fluctuated between 22,000 and 23,000 since 1978, and the total private vehicle volume (pooling and single passenger vehicles, not including buses) has remained between 19,500 and 20,500. Unlike these vehicle volumes, however, the number of

commuters traveling by private vehicle has increased continually for the past 17 years, rising from 25,300 to 38,100. The average number of persons per private vehicle has also increased from 1.42 to 1.82.

YEAR	TOTAL VEHICLE VOLUME (0630-0900)	TOTAL PRIVATE VEHICLE VOLUME (0630-0900)	AVERAGE NUMBER OF COMMUTERS IN PRIVATE VEHICLES (0630-0900)	TOTAL NUMBER OF COMMUTERS IN PRIVATE VEHICLES (0630-0900)
1970	19,891	17,708	1.42	25,300
1971	20,735	18,286	1.36	24,900
1972	20,904	18,322	1.44	26,500
1973	21,091	18,375	1.43	26,500
1974	19,812	17,239	1.43	24,800
1975	20,236	17,555	1.44	25,300
1976	19,923	17,746	1.50	26,600
1977	19,269	17,001	1.57	26,700
1978	21,237	19,225	1.56	30,100
1979	21,808	18,956	1.67	31,900
1980	23,912	20,666	1.64	34,000
1981	21,591	19,292	1.60	31,000
1982	20,949	19,353	1.73	33,700
1983	22,384	20,540	1.74	35,900
1984	22,352	20,477	1.71	35,000
1985	22,584	20,044	1.68	33,500
1986	22,978	20,879	1.82	38,100

Table 1. Vehicle Volumes, Occupancy, and Commuter Totals, 1970-1986
Source: MTC, 1970-1986

Table 2 presents the annual increases in office space that San Francisco has experienced over the past 16 years. Annual increases in the 1970s averaged about 1.5 million square feet, while increases during the 1980s are substantially higher, averaging about 2.5 million per year. Projected annual increases in San Francisco office space are presented in Table 3 as a combination of three separate factors: office space which has been approved and is under construction but not yet completed; office space which has been approved but is not yet under construction; and the maximum potential new approvals under the policies of The Downtown Plan and Proposition M. Proposition M is seen here to limit

increases in approvals of additional office space to about half that of The Downtown Plan, allowing a maximum increase of 475,000 square feet per year compared to the latter's 950,000 to 1,400,000 square feet per year.

YEAR	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
ANNUAL INCREASE IN OFFICE SPACE (MILLION SQ.FT.)	1.8	1.4	1.8	2.0	1.8	1.4	1.5	1.6	1.3	1.3	2.6	3.2	3.5	0.9	1.8	3.5

Table 2. Actual Annual Office Space Increases in San Francisco, 1970-1986
Source: Nelson, 1980; Blazej, 1987

From the past annual increases in total commuters traveling by private vehicle and in downtown office space in San Francisco, a correlation coefficient of .41 and the regression line equation of $Y = (-1.2) + (1)X$ are derived. Figure 1 displays the regression line graphically, suggesting that for annual increases in volume of San Francisco office space greater than 1.2 million square feet, proportional annual increases in commuters traveling by private vehicles occur.

The 1987-1996 projected values for the data categories presented on Table 1 are displayed in Table 4. The total commuters traveling in private vehicles are shown to increase continually over the next ten years, from approximately 40,000 to 47,000. The vehicle volumes (total and private) are determined for two different average occupancy rates per private vehicle scenarios (constant and increasing). With the occupancy held constant at 1.82, the total vehicle volume and the private vehicle volume increase by almost 4,000 in 1996 to roughly 28,000 and 26,000, respectively. However, increases of only about 1,000 vehicles are reached in 1996, if the average occupancy is increased by .02 each year from 1.84 in 1987, resulting in a total vehicle volume of about 25,000 and a private vehicle volume of around 23,000. Figure 2 illustrates the annual increases in the total vehicle volume (actual and projected), showing that volumes during the peak commute time of 0630-0900 could increase to almost 28,000 in the next ten years, from the 23,000 level of today.

Discussion

It is apparent from the past total vehicle volumes presented in Table 1 that for the peak commute period 0630-0900 the Bay Bridge can accommodate a maximum vehicle volume of between 22,000 and 23,000. Any volume over this will increase the time necessary for all the vehicles to pass, resulting in a delay. Also evident from the annual increases in the average vehicle occupancy and total

YEAR	APPROVED OFFICE SPACE UNDER-CONSTRUCTION (MILL. SQ.FT.)	APPROVED OFFICE SPACE NOT UNDER-CONSTRUCTION (MILL. SQ.FT.)	MAXIMUM POTENTIAL OFFICE SPACE APPROVALS (MILL.SQ.FT.)		PROJECTED ANNUAL OFFICE SPACE INCREASE (MILL.SQ.FT.)	
			DOWNTOWN PLAN	PROP M	DOWNTOWN PLAN	PROP M
1987	2.5	-	.95	.475	3.45	2.98
1988	2.5	.93	.95	.475	4.38	3.91
1989	-	.93	1.4	.475	2.33	1.41
1990	-	.93	1.4	.475	2.33	1.41
1991	-	-	1.4	.475	1.4	.475
1992	-	-	1.4	.475	1.4	.475
1993	-	-	1.4	.475	1.4	.475
1994	-	-	1.4	.475	1.4	.475
1995	-	-	1.4	.475	1.4	.475
1996	-	-	1.4	.475	1.4	.475
1997	-	-	1.4	.475	1.4	.475

Table 3. Projected Annual Office Space Increases in San Francisco, 1987-1996
Source: Blazej, 1987; San Francisco Downtown Plan, 1985; Proposition M, 1986

number of commuters traveling by private vehicles is that until 1986, this maximum vehicle volume had accommodated more and more commuters each year. However, the projections in Table 4 indicate that even if the average number of communters in private vehicles continues to increase at the same rate as it has during the last 17 years, additional vehicles will be required to transport all the commuters. Because the bridge has already reached capacity, this increase in vehicles can only result in a lengthening of the commute period or the travel time per vehicle, in other words, by further delays and increased congestion.

The projected total vehicle volumes are determined for two different scenarios, under both of which the maximum potential new approvals of office space outlined in The Downtown Plan are assumed to

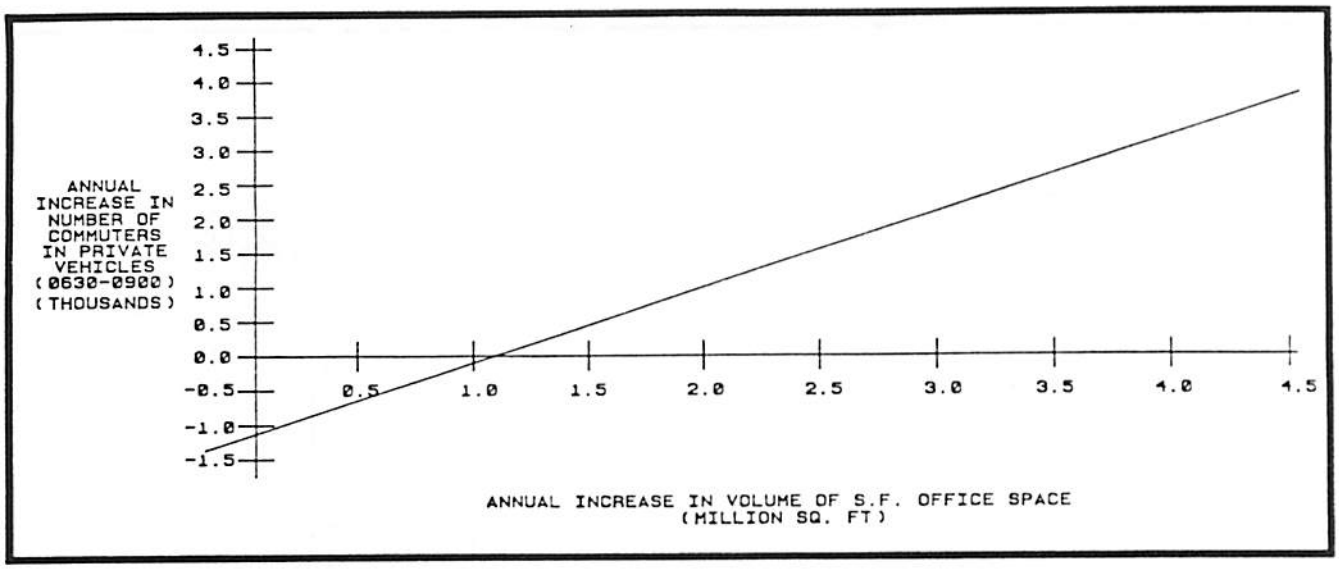

Figure 1. Correlation between Annual Increases of Commuters and Office Space, 1970-1986

Source: MTC, 1970-1986; Blazej, 1987; Nelson, 1980

YEAR	TOTAL VEHICLE VOLUME (0630-0900)	TOTAL PRIVATE VEHICLE VOLUME (0630-0900)	AVERAGE NUMBER OF COMMUTERS IN PRIVATE VEHICLES (0630-0900)	TOTAL NUMBER OF COMMUTERS IN PRIVATE VEHICLES (0630-0900)
	CONSTANT/INCREASING OCCUPANCY	CONSTANT/INCREASING OCCUPANCY	CONSTANT/INCREASING OCCUPANCY	
1987	24,269/24,028	22,170/21,929	1.82/1.84	40,350
1988	26,017/25,502	23,918/23,403	1.82/1.86	43,530
1989	26,638/25,854	24,539/23,755	1.82/1.88	44,660
1990	27,258/26,199	25,159/24,100	1.82/1.90	45,790
1991	27,368/26,052	25,269/23,953	1.82/1.92	45,990
1992	27,478/25,908	25,379/23,809	1.82/1.94	46,190
1993	27,588/25,767	25,489/23,668	1.82/1.96	46,390
1994	27,698/25,629	25,599/23,530	1.82/1.98	46,590
1995	27,808/25,494	25,709/23,395	1.82/2.00	46,790
1996	27,918/25,361	25,819/23,262	1.82/2.02	46,990

Table 4. Projected Traffic Impacts of the Downtown Plan under Two Different Occupancy Scenarios

Source: Blazej, 1987; San Francisco Downtown Plan, 1985

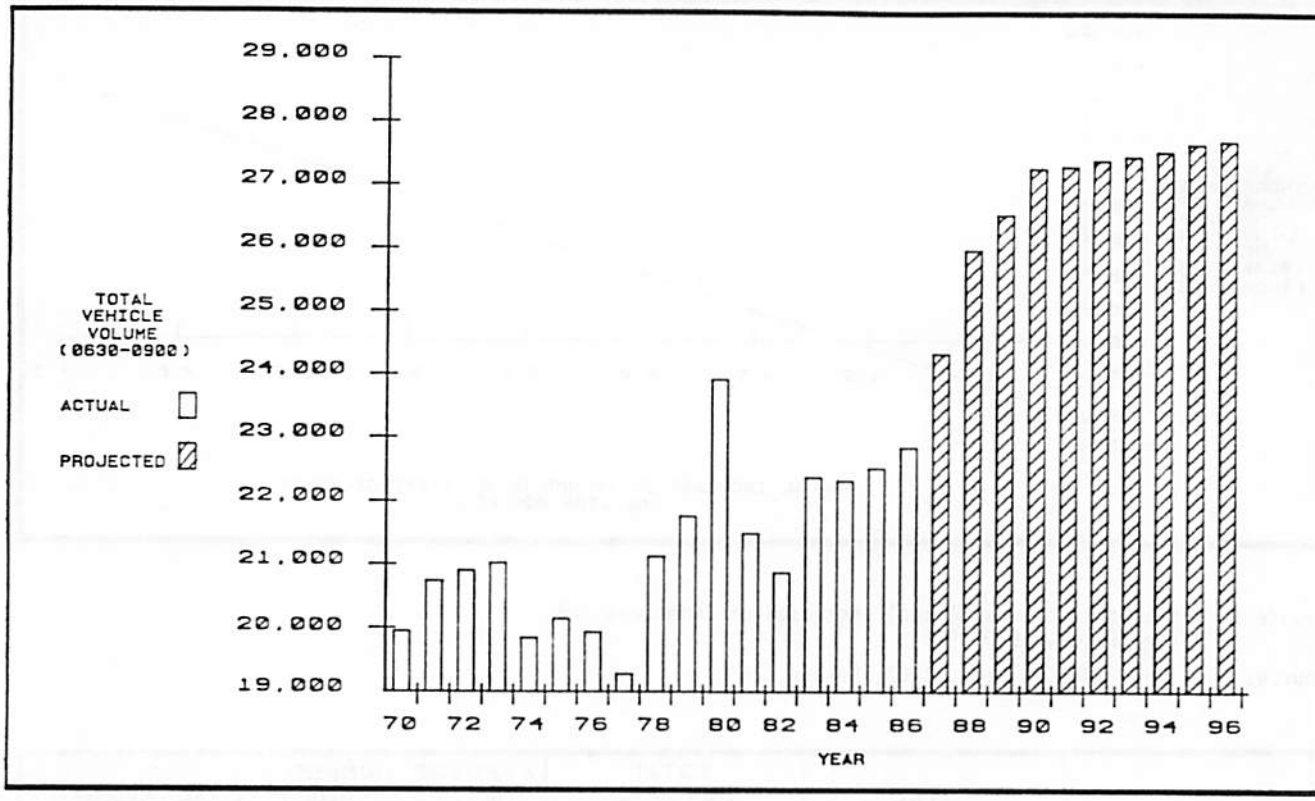

Figure 2. Total Morning Commute Vehicle Volumes on the Bay Bridge, Actual and Projected, 1970-1997

Source: MTC, 1970-1986

have occurred. The first scenario holds the average vehicle occupancy constant, while the second increases the average occupancy each year. The total vehicle volumes exceed the capacity of the bridge by between 1,500 (with occupancy increasing) and 5,500 (occupancy held constant) vehicles in every year over the next ten years. If the theoretical bridge limit of 4,500 per half hour is assumed to hold true, then an additional 1,500 vehicles would translate into an increased delay of ten minutes for every commuter. Therefore, over the period from 1987 to 1996, a potential additional delay of between ten and forty minutes exists for those commuting across the Bay Bridge.

The actual total vehicle volumes for the next ten years will probably not reach these projected levels. These vehicle volumes are derived from using the projected office increases associated with The Downtown Plan, which must be considered a worst case scenario. Proposition M, the current growth control measure, allows increases of only about half that of The Downtown Plan. These lower increases in office space would have a substantially lower traffic generating impact.

The regression line on Figure 1 indicates that for annual increases in office space of less than approximately 1.2 million square feet, a decrease in the number of commuters occurs. This may be explained by the fact that only a fraction of the total commuters generated by office space increases in San Francisco is included in the correlation (many arrive by BART and bus). It is possible that for increases in office space of below 1.2 million, the commuters generated are absorbed by the other commute modes. This same fact may be responsible for the relatively low correlation coefficient of .41, which gives an estimate of the strength of the relationship between the two data sets. Had the annual increases in commuters from all modes been used, this value would probably have been higher, and the regression line would have been positive everywhere for values of X greater than zero.

Conclusions

The data indicate that if San Francisco's growth follows the course projected by The Downtown Plan, the demand on the Bay Bridge during the morning commute could increase by anywhere from 1,500 to 5,500 vehicles in the next ten years, translating into an increased delay of as much as forty minutes for the morning commuter traveling within this time period. If, on the other hand, the limits set by Proposition M are adhered to, substantially lower delays will be experienced, ranging from about five to fifteen minutes.

Car and van pooling and public transit will become more appealing to commuters as the delays over the Bay Bridge reach crippling proportions. The data in this paper clearly show that increased vehicle occupancy has occurred over the past 16 years; it may increase at an even greater rate as the congestion situation worsens. Widening of the approach roadways to the Bay Bridge will only move the delay closer to the bridge toll plaza. The unavoidable fact is that the bridge will be only five lanes wide and will be unable to accommodate greater traffic flow per unit time than it handles today. The addition of reserved HOV lanes extending out past the point where congestion begins will further increase the appeal of pooling and transit systems. Other, more costly alternatives are to increase the number of BART trains and track extensions and introduce more ferry services from the East Bay.

Addressing the root cause is always the logical step to take in solving any environmental problem, and traffic congestion is no different. This paper supports the idea that substantial increases in office space development in San Francisco will lead to further congestion of the Bay Bridge morning commute. The passage of San Francisco's Proposition M came at a time when the growth of the city indeed needed to be checked. Fortunately for the commuter, in passing the measure San Franciscans have simultaneously benefitted future commuters on the Bay Bridge. The proposition's survival, however, is uncertain, due mostly to ardent opponents and some widesweeping stipulations it contains (San Francisco Chamber of Commerce, 1987). However, even a super-conservative growth control measure such as Proposition M must be supported in order to avoid regional roadway gridlock.

Regionally planned growth is the ultimate solution to the problem of crippling traffic congestion in the future. As people eventually realize that they are affected by the actions of surrounding communities and vice versa, this concept will increase in popularity. It is clear that the past practice of addressing only the symptoms of the traffic congestion problem has not worked. In the meantime, growth control measures like Proposition M offer the best immediate hope to reduce the traffic congestion problem and guard against it ever becoming unmanageable.

REFERENCES CITED

Association of Bay Area Governments (ABAG), 1981. Bay Area office growth, pre-1945--1979; Oakland, California, pp. 27-30.

Bay Area Council, 1985. The fortieth annual report: an agenda for action; San Francisco, 12 pp.

Blazej, Lou, Chief of Special Projects, San Francisco City Planning Department. Personal communication, February 1987.

Halstead, Richard, 1987. San Francisco at the economic crossroads: What does the curtaining of new construction portend?; in The Executive (Umberto Tosi), Los Angeles, James C. Clark, pp. 32-36.

Huntsberger, D.V., 1981. Elements of statistical inference; fifth edition, Allyn and Bacon, Inc., Boston, Massachusetts, 505 pp.

Markowitz, J.E., 1984. BART impact report; prepared for the 64th annual meeting of the Transportation Research Board 1985; Oakland, California, pp. 6-9.

Metropolitan Transportation Commission, 1970-1986. Fall Traffic Survey Series (Bay Bridge), Oakland, California.

Nelson, Kristen, 1980. San Francisco office space inventory; Working Paper no. 80-20, Center for Real Estate and Urban Economics, U.C. Berkeley, Berkeley, California, pp. 8-9.

San Francisco Chamber of Commerce, 1987. San Francisco business (S.F. Chamber of Commerce Annual Report), v. 22, no. 1, p. 8.

San Francisco Downtown Plan, 1984. Prepared for the City of San Francisco, Mayor's Office.