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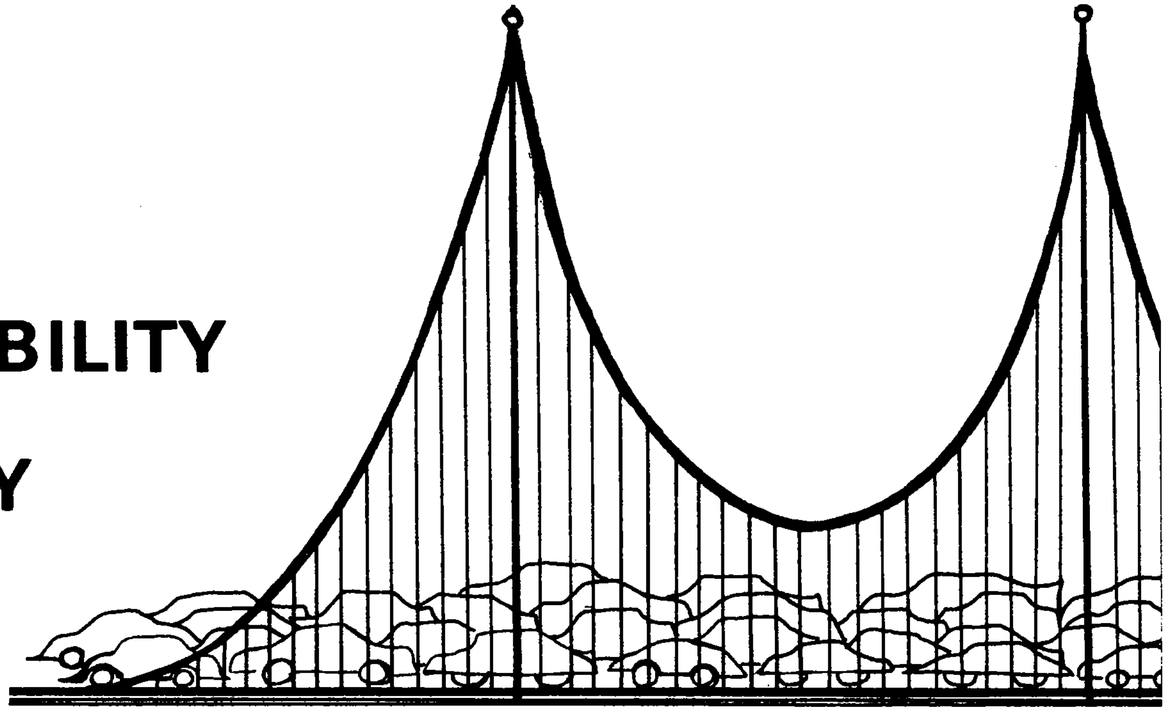

SAN FRANCISCO - MARIN FERRY SYSTEM

Arthur D. Little, Inc.
SAN FRANCISCO

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for

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FEASIBILITY STUDY OF SAN FRANCISCO - MARIN FERRY SYSTEM

Report to

SAN FRANCISCO - MARIN WATER TRANSPORTATION STUDY COMMITTEE

July 1969
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Arthur D. Little, Inc.

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Hundreds of business firms permitted their employees to complete the interviews utilized in this study. We owe a particular debt to the Harbor Tour Co., the Pacific Telephone & Telegraph Co., the Bank of America and the Bechtel Corp. for aiding us and permitting us to pre-test our survey on their boats and business premises. The Bell Aerosystems Co., the Aerojet General Corp. and the Hydrodyne Marine Corp. were among the firms which provided us with information on advanced technology vessels.

Finally, we wish to give particular thanks to the more than 1600 individuals who answered our questionnaires and gave us the benefit of their thoughts.

While this study was greatly enhanced by these many contributions, Arthur D. Little, Inc. accepts responsibility for the analysis and conclusions of this study.

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I. SUMMARY OF FINDINGS, CONCLUSIONS, AND RECOMMENDATIONS

A. PRINCIPAL FINDINGS

The San Francisco-Marin Water Transportation Study Committee authorized this study by Arthur D. Little, Inc. (ADL) to answer two primary questions. First, they asked whether a modern, technologically advanced system of ferries, with proper, closely coordinated feeder services at each end, can substantially reduce the present peak hour highway congestion of the Golden Gate Bridge "corridor" by diverting a significant number of automobiles from it. Second, they asked whether it would be feasible to institute such a system. The results of the study summarized in this report lead to the conclusion that the answer to both these questions is a firm "yes."

The traffic projections and commuter origin/destination research presented in Chapter III indicate that the presently severe highway and bridge congestion problems will worsen dramatically in the future. If a significant percentage of commuters is not diverted from the use of road-requiring vehicles, the number of commuters trying to cross the Golden Gate Bridge during the commute period will increase by at least 61% by 1985. The traffic congestion which would result both on the bridge and the roadways of the two counties is obviously unacceptable.

In order to estimate the number of commuters who would utilize a modern water transportation system under alternative conditions, we conducted the extensive survey and analysis of commuter behavior and expected response to ferry availability described in Chapter IV. To be acceptable to commuters a ferry system must include dependable and convenient feeder links and water transportation equipment connected by conveniently located terminals with ample parking facilities. If these basic requirements are met, daily round-trip ferry service patronage will vary with the cost and speed of using the ferry system.

At current price levels maximum ferry revenue can be obtained by charging $1.50 for a round-trip commute ride that would include bus feeder service in Marin County or a parking slot plus a two-way ferry ride to a terminal located just to the north or south of the Ferry Building. During midday and on weekends a second San Francisco terminal in the Fisherman's Wharf area could be used. If good road access, feeder systems, and an appropriate terminal off Paradise Drive in Marin were available and serviced by new high-speed but conventional displacement ferries cruising at approximately 26 miles per hour, approximately 8500 commuters, or 26% of all present commute traffic, would avoid the present level of road congestion and switch to the ferry service. Since their removal from the road would lower the present congestion level, some of them might switch back until the commuter population growth once again built up close to the present level. Once this congestion level is reached about 5% more round trips per day will be made each year.

If all the basic feeder systems and terminal facilities were provided at three terminals in Marin County and serviced by hydrofoil boats or air cushioned vehicles cruising at approximately 40 knots per hour, 11,000 commute round trips per day would be made on such a service. That is, more than one third of today's commuters would avoid the existing level of congestion by traveling on ferryboats leaving from terminals relatively near their homes which get them to San Francisco in less time than the majority of all Marin commuters are now taking to make the morning or afternoon commute trip. The proportion of commuters who would switch under this or the longer time single terminal alternative would be highest among the 43.7% of all Marin County commuters who work in the San Francisco Central Business District.

In Chapter V the experiences of other ferry services and the potential naval hardware and Marin County terminal options are reviewed. The demands of the Marin commuter are also detailed in terms of specific requirements. A one terminal ferry system initially capable of carrying the 8500 commuters who would use this service on conventional ferryboats from the Corte Madera site is described. This chapter also presents a conceptualized system that would use hydrofoils or air cushioned vehicles with terminals initially provided at Gallinas Creek, off Paradise Drive, and in North Sausalito.

The three terminal advanced design vessel system would offer faster more convenient service than the single terminal site which would be optimum for a system placing total reliance on conventional vessels. If the fast boat three terminal site we considered is developed, average North Marin County commuters would get from their home to San Francisco in 54 minutes, the average Central Marin commuter in 32 minutes, and the average South Marin commuter in 26 minutes. Boat travel time would be approximately 25 minutes from the North Marin site, 14 minutes from the Central site, and 11 minutes from the Sausalito site. While the vessels required for such systems are not now being used in the United States, the successful experiences in other countries suggest the testing of such vessels in the Bay before such a superior system is rejected and exclusive reliance placed on the more fully historically tested displacement craft.

Chapter VI simulates the financial operation of the hypothesized single terminal displacement craft system and two three terminal systems, one with hydrofoil vessels and the other with 1000-passenger air cushioned vehicles. Since no final design work or engineering was done in this five-month study, the results of this evaluation should not be used to make a selection between the vessel options. However, this financial analysis suggests that both the displacement vessel and perhaps one of the more technologically advanced vessel-using systems could be self-supporting. Utilizing our pre-design cost approximations, the single terminal displacement vessel system would require an initial investment of $36 million and a total investment of $51 million in constant value dollars over the next 25 years. It seems capable of supporting itself with bonds amortized over 25 years at 6½% interest. The financial evaluation of a hypothesized three terminal hydrofoil system suggests an initial investment of $26 million climbing to $35 million in constant dollars which would also require no subsidy if funded by 6½% debt. The third analysis suggests that a subsidy would be required if air cushioned vehicles were used exclusively. It is important to remember that our estimate of hydrofoil costs is extremely tentative and could easily turn out to be as high as the air cushioned vehicle system. One way of summarizing the financial analysis is to note that a ferry system appears to be at least as feasible when considered in 1969 as the Golden Gate Bridge did while it was being considered in the 1930's. Since many advanced technological craft are still in the development stage, initial costs might be higher than estimated but final costs might drop before the system were completed.

No attempt was made to develop an optimum system. But the parameters for a system design and implementation effort have been laid out in terms of what the commuter will use and pay for. A final financial evaluation should be made in the course of designing and implementing an integrated ferry-bus-highway system. However, as discussed in Chapter VII, the benefits of a ferry service are great enough to warrant the inclusion of ferries as a major component of such a system.

B. CONCLUSIONS

The magnitude of the transportation needs which will be posed by the development of Marin, Sonoma, and Napa counties suggests the eventual need for an advanced and rapid transit system above and beyond what can be provided by any ferry system. A ferry service can be a keystone component of the integrated system needed to serve the transportation needs of the Golden Gate corridor for the many years which will be required to efficiently program design and build a rapid transit system that will fully utilize all available technology in an environmentally beneficial manner.

While many benefits could be cited, the main benefits of designing and developing a ferry system now seem to include the following:

1. Diversion of Marin commute traffic from the Golden Gate Bridge. If the three terminal fast service ferry were instituted, by 1971 approximately 6380 fewer cars and 36 fewer buses would cross the bridge each day. The public's existing investment in the bridge would be preserved as the bridge is allowed to operate more beneficially.

2. Achievement of San Francisco goals. The encouragement of commute travel on ferries would help free San Francisco from pressing demands on the vehicular capacity of its streets and garages.

3. Buying of time required to build a modern fixed rail or other advanced rapid transit system.

4. Alleviation of intermediate time span transport problems without a large taxpayer-supplied subsidy.

C. RECOMMENDATIONS

The findings and conclusions of this study suggest the advisability of taking the following steps:

1. One authority should be assigned the responsibility of providing an integrated bridge-ferry-bus system serving the Golden Gate corridor as soon as possible while it begins to plan for the provision of a rapid transit system to meet long-range needs. The Golden Gate Bridge and Highway District seems the logical candidate for this job, but they must be supported by San Francisco and Marin public officials in this effort. It is important that the San Francisco Municipal Railway system be included in this effort so that the commuter will buy tickets for one system.

2. A system design and development effort should start immediately in a program aimed at creating a ferry service. The first task of this effort should include vessel testing and the design of an optimum integrated ferry-bus system. After this task is completed contracts should be let and the system developed. The parameters of a long-range solution should begin to be established as the elements of the ferry-bus system are being developed.

3. The Federal Government should be contacted by the City of San Francisco and the County of Marin in an attempt to gain financial support in this pilot effort to develop and use modern waterborne technology to alleviate the intermediate-range transportation problems of growing urban areas located on waterways.

II. HISTORICAL DEVELOPMENT

A. THE BEGINNING

Ferry service between Marin County and San Francisco began May 10, 1868, with the "Princess" plying daily between Sausalito and San Francisco. The inauguration of ferry service was part of a real estate development venture of the Sausalito Land and Ferry. This company was organized to sell lots to people seeking a "quiet, rural home in a lovely place," and included the service as part of its promotion. The promoter, General Patrick Connor, was also one of the incorporators of the San Francisco and Humboldt Bay Railroad Co., which eventually pushed connecting tracks as far as Eureka. The "Princess" docked in Sausalito at the foot of Princess St. and in San Francisco at Meigg's Wharf near the foot of Powell St.--the latter requiring quite a walk to downtown Montgomery and Kearny Sts. for the commuter.

In 1869, another ferry service, from San Francisco to San Quentin Point, was begun by the San Quentin and San Rafael Railroad. It was soon tied into a four-mile railroad trip from San Quentin to San Rafael, thus becoming the first combined rail-ferry service in the country. Two ferryboats operated on this line.

In 1875 both the Sausalito and San Quentin Point services were absorbed by the North Pacific Coast Railroad, which also began rail operations on a narrow gauge track from Sausalito to Tomales with a branch to San Rafael. Four boats were operated on these two runs until 1881.

In 1883 the ferryboat "Saucelito" burned at her San Quentin terminal taking with it the entire wharf to the water's edge. After this, ferry service to San Quentin Point was discontinued, leaving only the Sausalito run. In 1887, seven round trips daily were operated by North Pacific Coast between San Francisco and Sausalito. The fare was 25 cents round trip and monthly commuter tickets sold for $3.

B. A RIVAL SYSTEM TO TIBURON

The ensuing years of ferry operation were marked by internal rivalries and a series of financial deals among competing companies. Soon after North Pacific Coast Railroad took over the Sausalito run, a rival railroad, the San Francisco & North Pacific, began to push southward from Sonoma County to Tiburon with lines to San Rafael, Cloverdale, and later, Willits and Eureka. In 1884 this new competition started its own connecting ferry service from San Francisco to Tiburon and for years the Sausalito and Tiburon services were steady rivals.

In the very early 1900's the Sausalito service experienced a series of deaths on its system caused by the sinking of the "San Rafael" and by several train wrecks. As a result of these accidents and the lawsuits that followed, the management of the North Pacific Coast Railroad in 1902 sold out to a new owner, the North Shore Railroad. At the head of this new company was John Martin, the "father" of long-distance high-voltage, high-transmission lines; his object was to electrify the inter-urban rail service. This was completed in 1905 and electric lines ran from Sausalito to Mill Valley; another line ran to San Anselmo and Fairfax Manor, and a third ran to San Rafael either by San Anselmo or Greenbrae. At Fairfax Manor electric trains connected with steam trains for Point Reyes. The electric train system spurred the biggest land boom in Marin County to that time.

C. MERGING OF RIVAL SERVICES

In 1907 six railroad lines in Marin County, including the San Francisco & North Pacific and the North Shore Railroad, consolidated to form the Northwestern Pacific Railroad, a creation of the Santa Fe and Southern Pacific companies.

Under the auspices of this new owner the passenger terminal and all passenger traffic were shifted to Sausalito. Tiburon became the main freight and mechanical terminal. There was a connecting ferry service established between Tiburon, Belvedere Point, and Sausalito. This ferry run was so unproductive of business that use of a regular size ferry proved uneconomical. Thus in 1909 a small boat, only 97 feet overall, was re-built to make the run.

The Northwestern Pacific company carried on under the auspices of the Santa Fe and the Southern Pacific Railroads until 1929, when the Santa Fe bowed out. After this it was run by the Southern Pacific until the diversion of traffic to the Golden Gate Bridge eventually caused discontinuation of ferry service in 1941. At its inception the Northwestern Pacific had five passenger ferries and two automobile ferries. Later, as the fleet began to age, the number was reduced. From 1922-32 there were only four passenger ferries and after that only three. Late in the 1920's the company did build three ferries exclusively for automobile traffic. However, its ferry operation was devoted principally to passenger traffic.

D. A NEW AUTO FERRY COMPANY

In 1920, as a result of the increasing demand for auto ferry passage and the unresponsiveness of the Northwestern Pacific to this demand, a new ferry company, the Golden Gate Ferry Co., was inaugurated. This company operated auto ferries on the bay between San Francisco's Hyde St. pier and Sausalito--much to the dismay of Sausalito residents who felt they had enough auto traffic in their narrow streets already. The company was so successful that even though the Northwestern Pacific and other Southern Pacific-related lines finally built auto ferries, they could not lure back the auto business. Negotiations were subsequently undertaken between the Southern Pacific and the auto ferry company to form a new ferry company, the Southern Pacific Golden Gate Ferries, Ltd. This new company's business increased steadily until the building of the Golden Gate Bridge.

E. EFFECTS OF THE BRIDGE

The opening of the Golden Gate Bridge in 1937 began a period of competition between the Golden Gate Bridge and Highway District and the ferries--and a period of financial difficulties for both. Soon after the bridge opened, the ferry company asked for and received permission from the State Railroad Commission to cut its round-trip fares to equal a one-way passage on the bridge. With ferry fares so low, commuters returned to them by the thousands. The bridge district in turn, recognizing potential disaster, cut its truck fares in half--a sound move on its part, for trucks comprised only 3% of the bridge's business but accounted for 36% of ferry traffic.

At this point, in September 1937, both the bridge and the ferries were in financial trouble. The ferries were losing about $500 a day and the bridge revenues were more than $600 a day short of the amount needed for operating expenses and interest charges, leaving nothing to apply toward retiring bridge bonds. Though both bridge and ferries had reserve funds to fall back on, the ferry company was the first to break under the strain and, in 1938, the Southern Pacific Golden Gate Company offered to sell out to the bridge district for $1.250 million. Soon after, however, the State Railroad Commission decided that retention of the ferries was no longer in the public interest, and thus the Southern Pacific Golden Gate service instead of being sold was abandoned.

This left only one ferry service running between San Francisco and Marin County--the primarily passenger oriented Northwestern Pacific. However, this company's losses had skyrocketed to $94,000 in 1938 and they soon asked the State Railroad Commission for permission to abandon service. Permission granted, the last Marin ferry crossed the bay February 28, 1941.

F. GROWTH OF BRIDGE TRAFFIC

As competition was eliminated and the bridge came to monopolize transportation across the Golden Gate, it began to make money. Traffic grew at a rate unforeseen by the bridge planners, engineers and architects, who had predicted that the six-lane bridge would meet traffic requirements throughout its lifetime. Between fiscal 1940-41 and fiscal 1950-51, average number of vehicles per day increased from 13,054 to 27,701, an increase of 112%. During the next 10 years average daily traffic increased by 98% to 54,825 and by fiscal 1967-68, 84,444 vehicles were crossing the bridge daily. This was 55,814 more vehicles every day than the planners had estimated for 1970. With a volume of traffic this heavy the inadequacy of bridge capacity not only has become evident, but has become a serious problem demanding immediate consideration and action. San Francisco and Marin Counties have rejected any solution which encourages increased vehicular traffic leading to more freeway construction.

A statement in 1930 by the Golden Gate Bridge project's chief engineer Joseph B. Strauss and quoted in the Jenkins report* is relevant here: "Thus the capacity of the Golden Gate Bridge is from six to eight times greater than the maximum traffic over the heaviest trafficked toll bridge in the United States, i.e., the Delaware River Bridge .... These figures dispose of the question of the adequacy of the Golden Gate Bridge for <u>all the traffic the future may bring</u>."

In fact traffic levels of three and a half times his estimate for 1970 have already been reached. Numerous changes in traffic control methods and modification of physical structures have been made by the bridge district to deal with traffic problem. The Jenkins report documents twenty of these changes and concludes:

"The Golden Gate Bridge, as a structure, has reached its ultimate capacity during commuter hours...The result of more traffic during commuter hours will inevitably be to increase congestion, with greater delay for all."**

*Jenkins, Arthur C., <u>Prospective Participation in a Public Transit Bus System</u>, report to the Golden Gate Bridge and Highway District, 1968.

** Op. Cit.

CHAPTER III

PRESENT AND FUTURE TRAFFIC VOLUME ESTIMATES

A. PAST AND PRESENT TRAFFIC FLOWS ACROSS THE GOLDEN GATE CORRIDOR

1. Vehicle Flow

Since the opening of the Golden Gate Bridge in 1937, total vehicle travel across this link has grown from 3.5 million cars per year to 30.3 million cars for fiscal 1968. Here is the history of the commute period vehicle flow which is most pertinent to this study: between 1960 and 1968 total vehicular traffic grew at an average annual rate of 6.2%, while the purchase of commute books increased by 11% annually for the same period (Table 1). More detailed statistics for March in various years give a better idea of the components of bridge traffic (Table 2). In that month, from 1964-69, total vehicle flow grew an average of 6% per year. Commute auto traffic increased at a rate of 7% and bus traffic at a rate of 2%. Thus in March of 1969 commute autos represented 37% of total vehicular traffic, up from 35% in 1964.

The "Morning Commute Record," a tabulation kept for an average day in October for various years, gives one more indication of the commute period problem: vehicular traffic between 6 a.m. and 9 a.m. has grown from 7560 vehicles in 1958 to 15,707 in 1968--an average annual growth rate of almost 8% (Table 3).

People have adjusted their schedules to cross the bridge to San Francisco earlier, as evidenced by the dramatic growth in the 6-7 a.m. period, or to cross during the 8-9 a.m. period. Thus where the commute period was formerly two hours it has expanded to about three and a half hours.

2. Passenger Traffic During Peak Commute Periods

This study concerns itself with the feasibility of a ferry service that would carry people, not vehicles. Therefore, we required estimates of the number of commuters in the vehicles that cross the bridge. Passenger movement across the bridge is more difficult to measure than vehicular traffic. Typically a standard ratio of persons per type of vehicle is multiplied by the number of that type of vehicle which crosses the toll plaza. The standard ratio for private automobiles is 1.5 persons per car and 40-45 persons per bus.

Little direct information on passenger traffic is available for past years. During the 1960 census, households were asked where the head of the household worked within the Standard Metropolitan Statistical Area (SMSA). Census data indicates that approximately 18,000 Marin

TABLE 1

VEHICLE MOVEMENTS ON THE GOLDEN GATE BRIDGE
(millions)

	1960	1961	1962	1963	1964	1965	1966	1967	1968	Average Annual Growth Rate
Total Vehicles	18.7	20.0	21.2	22.4	24.0	25.2	27.0	28.0	30.3	6.2%
Commute Autos	4.6	5.3	6.6	7.3	7.9	8.7	9.4	10.0	10.7	11.2

TABLE 2

COMPARATIVE RECORD OF TRAFFIC FOR MONTH OF MARCH
(vehicles)

	1964	1965	1966	1967	1968	1969	Average Annual Growtl 1964-1969
Total Vehicles	1,961,953	2,075,722	2,195,041	2,364,032	2,525,902	2,629,210	6.1%
Commute Autos	698,604	797,113	853,429	899,956	925,729	977,900	7.0%
Buses - Total	13,032	14,372	14,838	15,101	14,398	14,370	2.0%
Buses-Greyhound	n.a.	n.a.	n.a.	12,666	11,809	11,664	-4.0% (1967-69)

n.a. = Not available.

Source: Office of the Auditor, Golden Gate Bridge and Highway District, various years.

TABLE 3

MORNING COMMUTE RECORD
(Number of Vehicles)

	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968
6-7	843	930	1,011	1,129	1,373	1,413	1,606	1,743	2,336	2,794	3,174
7-8	3,704	4,141	4,473	4,287	4,804	5,137	5,622	5,895	5,971	6,260	6,394
8-9	3,013	3,420	3,794	4,308	4,471	4,783	5,411	5,583	5,930	6,158	6,139
Totals	7,560	8,491	9,278	9,724	10,648	11,333	12,639	13,221	14,237	15,212	15,707

Average Annual Increase (1958-68): 7.6% - 815 Vehicles

Source: Office of the Auditor, Golden Gate Bridge and Highway District.

County residents commuted to San Francisco in 1960; about 200 commuted to San Mateo County. This estimate served us as a base which we projected to 1969 by utilizing additional data furnished us by the Golden Gate Bridge and Highway District.

The bridge district provided a head count for a "typical" weekday during 1968 for southbound traffic (Table 4). An evaluation of this count, census data, and available information on bus travel suggests that an average of 4200 people currently cross the bridge by bus during the 6-10 a.m. commute period. Slightly more than 28,000 people cross the bridge via private automobile during this commute period. Considering that some of these people are commuters from Sonoma and Napa Counties and that a few unlucky noncommute travelers are caught in peak travel times, it appears that some 31,000 commute trips originated in Marin County on an average weekday in early 1969. This represents an average annual increase of 7% over the 18,000 from Marin County in 1960.

B. PAST, CURRENT, AND PROJECTED ORIGINS AND DESTINATIONS OF COMMUTER TRAFFIC BETWEEN MARIN COUNTY AND SAN FRANCISCO

Any assessment of potential changes in commuter travel mode requires information concerning the specific origins and destinations of the relevant commuters. Several data sources were utilized to estimate the origins of today's 31,000 commuters. ADL conducted a survey of commuters that will be discussed in the next chapter. The Marin County Transit District (MCTD) distributed a survey postcard in November 1968 at the bridge toll plaza with a response rate of 57%. It was also possible to apply the 1960 ratio of commuters per household contained in census data to the 1968 household population. All three of these data sources yielded closely similar results (Table 5). These results suggested the appropriateness of utilizing the origin data taken from the ADL survey as a reliable estimate of commuter origins.

Three data sources were evaluated in order to derive a final estimate of the commuter destination pattern. The Bay Area Transportation Study Commission (BATSC) conducted a survey of approximately 31,000 commuters from a list of randomly selected Bay Area households which enabled them to assign auto and transit riding commuters to 13 San Francisco zones. The MCTD postcard survey resulted in an estimate of commuter desginations of 16 San Francisco zones. Finally, the City of San Francisco and the State of California conducted a block-by-block Downtown Parking and Traffic Survey in 1965, the results of which were made available to us.

The MCTD data was aggregated into BATSC zonal classifications. This aggregation permitted a comparison of these two data sources with the Downtown Parking and Traffic Survey. The comparison lent confidence to the use of the MCTD figures as our final estimate of the percentage of commuters destined to each of the San Francisco zones (Figure 1 and Table 6).

TABLE 4

HEAD COUNT - GOLDEN GATE BRIDGE
SOUTHBOUND ONLY - TYPICAL WEEKDAYS - 1968

	Via Bus		Via Private Automobile	
Beginning Midnight				
12-1	8		600	
1-2	5		275	
2-3	0		180	
3-4	0		150	
4-5	0		250	
5-6	0		550	
6-7	150	6-10 commute period	4,800	6-10 commute period
7-8	2,199	4,166	9,800	28,150
8-9	1,609		9,000	
9-10	208		4,550	
10-11	130		3,080	
11-12	156		2,725	
Beginning Noon				
12-1	149		2,300	
1-2	124		2,560	
2-3	101		2,550	
3-4	85		2,970	
4-5	108		3,250	
5-6	129		3,150	
6-7	37		2,900	
7-8	27		2,330	
8-9	13		1,310	
9-10	12		950	
10-11	18		1,250	
11-12	10		1,130	

Source: Golden Gate Bridge and Highway District.

TABLE 5

COMPARISON OF COMMUTER DISTRIBUTIONS IN MARIN COUNTY

Census Tract	ADL Survey	MCTD Survey November 68	Distribution Based on 1960 Census Ratio[1]
1	1.47	0.60	0.74
2	2.93	2.03	1.23
3	3.02	2.70	2.02
4	5.24	3.63	3.61
5	0.09	0.07	0
6	1.19	1.26	1.54
7	4.22	3.73	4.24
8	6.97	7.46	8.10
9	3.03	3.16	2.31
10	4.96	5.29	4.71
11	1.65	1.30	0.95
12	3.58	3.10	2.77
13	0.83	0.86	0.75
14	3.03	3.73	3.48
15	3.49	3.56	3.83
16	1.01	1.43	1.53
17	1.56	1.66	1.97
18	2.11	2.50	2.62
19	6.33	5.49	6.43
20	2.94	3.10	3.41
21	5.05	6.36	7.86
22	0	0	0
23	1.83	2.46	2.07
24	7.43	7.39	6.30
25	1.28	1.60	2.22

TABLE 5 (Continued)

Census Tract	ADL Survey	MCTD Survey November - 68	Distribution Based on 1960 Census Ratio[1]
26	5.87	5.73	5.63
27	3.67	3.70	3.69
28	6.88	7.42	7.12
29	0.09	0.17	0.18
30	8.26	7.96	8.52
31	0	0.20	0
32	0	0.30	0.27
33	0	0	0.07
	100.01	99.95	100.17

1. This distribution was obtained by applying the ratio of commuters from Marin County to San Francisco by census tract in 1960 to housing units by census tract in 1960 and applying this ratio to an estimate of housing units by census tract in 1968 obtained from the Marin County Planning Department.

FIGURE 1 BAY AREA TRANSPORTATION STUDY COMMISSION ZONES INTO WHICH MCTD DESTINATION DATA WAS AGGREGATED

TABLE 6

COMPARISON OF BATSC AND MCTD DISTRIBUTIONS

BATSC Zone	BATSC % of Person Trips for Work Purpose - All Modes	MCTD Final Results % Distribution of Respondents	
1 2	19.6) 40.6) 60.2	61.6	(MCTD Zones 1,2, 3, 4, 5, 15, ½7)
3	6.3	4.5	(MCTD Zones ½7, 6, 8)
4	1.2	2.5	(MCTD Zones 12, 13)
5	8.9	4.3	(MCTD Zones 10, 11)
6	9.2	8.9	(MCTD Zones 16, ½9)
13	0.2	2.0	(MCTD Zone 14)
Rest of San Francisco	14.0	16.2	
	100.0%	100.0%	

These separate origin and destination estimates were utilized as control totals in conjunction with the ADL survey to link commuter origins to destinations. A variety of such links were calculated at various stages in our research. A final estimate was made of bus and auto flows from three Marin County superzones to three San Francisco superzones.

The 33 Marin County census tracts were finally aggregated into the following three categories: North and West Marin, comprising census tracts 1-5, 13, 32, and 33; Central Marin comprising census tracts 6-12 and 14-20; and Southern Marin, comprising census tracts 21-31 (Figure 2). We found that 13.5% of all Marin County commuters come from North and West Marin, 46% come from Central Marin, and 40.5% come from Southern Marin (Table 7).

San Francisco was divided into the following three zones: Central Business District (CBD) consisting of MCTD zones 3, 4, and 15; Outer CBD with MCTD zones 5-8; and all the remainder of San Francisco including MCTD zones 1, 2, 9-14, 16, and the largely residential areas of the city not covered in the MCTD survey (Figure 3). Of all Marin County commuters, 43.7% worked in the CBD, 14.5% in the outer CBD and 41.8% in the rest of San Francisco, which includes the south of Market area, the Presidio, and the U.C. Medical Center among its major employment generating areas (Table 7).

The zone-to-zone daily commute flow distribution calculated by ADL is presented in Table 8. These flow estimates were developed after an analysis of the ADL survey data and the control totals derived from the previously mentioned other sources. It is important to notice that these estimates demonstrate that the distribution of Marin County commuters in San Francisco is not random. Table 9 presents a breakdown of the total average 1968-69 commute pattern on a zone-by-zone basis separating those who currently ride the bus from those who ride in private automobiles. Note that these estimates suggest that the proportion of bus ridership is higher for those commuters who reside in North and West Marin, with close to 14% of all these commuters riding the bus to work. Slightly less than 8% of all Central Marin County commuters now ride the bus to work, while close to 13% of all South Marin commuters (which includes Mill Valley) currently ride the bus. Total current bus ridership accounts for almost 13% of all commuter trips.

The Marin County Planning Department predicts that Marin County population will grow at an annual rate of 3.6% between 1960 and 1990. The 1960-68 growth rate has been approximately 5.1%. We think that this growth rate may drop even more dramatically than the planning department has forecast

* A working paper which details derivations of Tables 8 and 9 is on file in the ADL office.

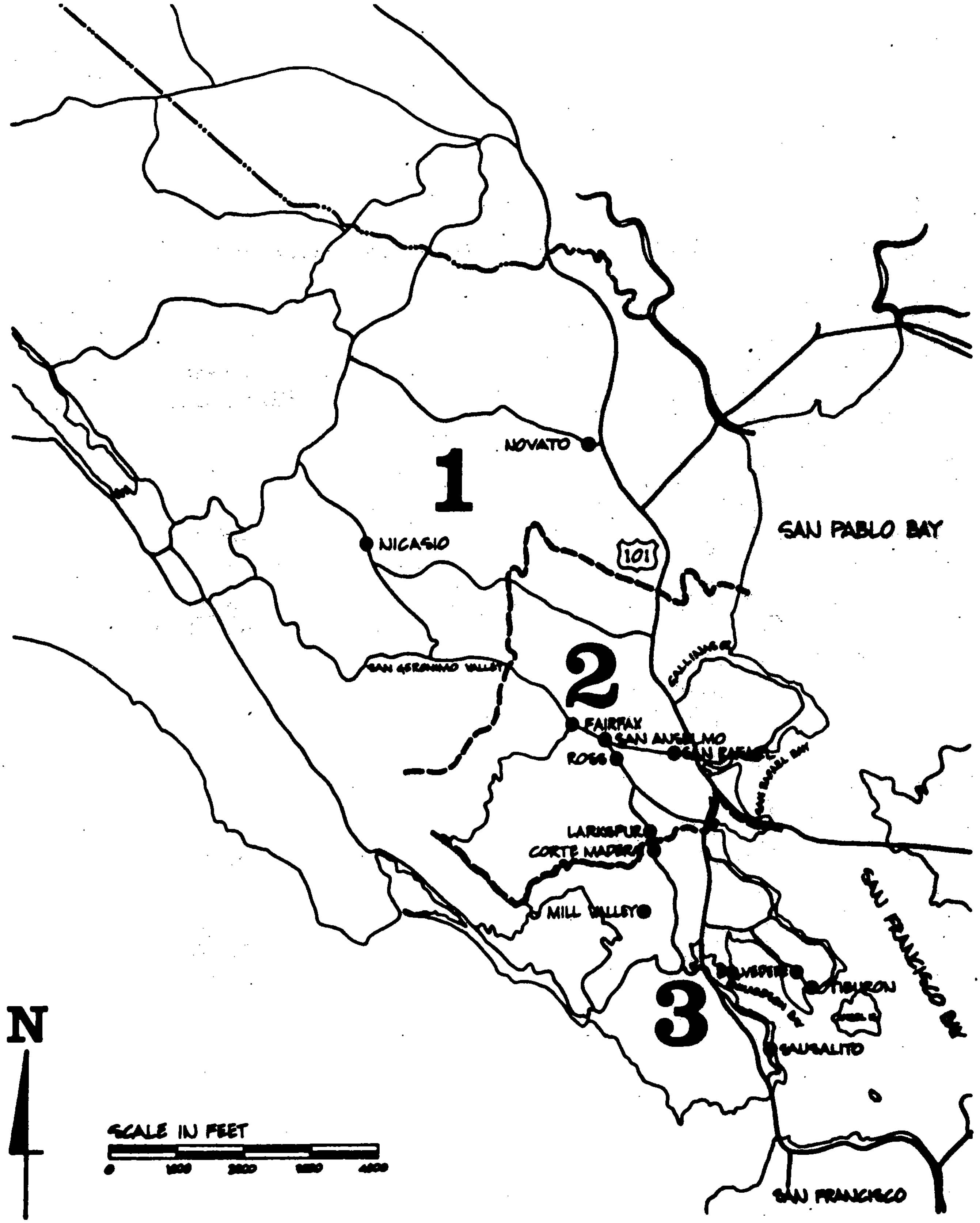

FIGURE 2 THREE MARIN SUPERZONES

TABLE 7

MARIN COMMUTERS - ORIGINS AND DESTINATIONS

	Coming from Marin Zone	Percent Distribution
1	North and West	13.5
2	Central	46.0
3	Southern	40.5
		100.0%
	Going to San Francisco Zone	
A	Central Business District	43.7
B	Outer CBD	14.5
C	Rest of City	41.8
		100.0%

Source: ADL estimates.

FIGURE 3 THREE SAN FRANCISCO SUPERZONES

TABLE 8

ZONE-TO-ZONE DAILY COMMUTER
FLOW DISTRIBUTION BY MODE*
(%)

Automobile

Marin/San Francisco		CBD (A)	Outer CBD (B)	Rest of San Francisco (C)
1	North and West	4	2	8
2	Central	19	6	22
3	Southern	17	7	15

Bus

Marin/San Francisco		(A)	(B)	(C)
1	North and West	12	2	1
2	Central	36	7	3
3	Southern	26	8	5

Total

Marin/San Francisco		(A)	(B)	(C)
1	North and West	5	2	8
2	Central	21	6	19
3	Southern	18	7	14

* Each figure represents percent of total commuters by the identified mode.

Source: ADL estimate.

TABLE 9

ZONE-TO-ZONE DAILY COMMUTER ROUND TRIPS BY MODE - 1968-69

A. AUTOMOBILE COMMUTERS

From Marin Zones		CBD A	Outer CBD B	Rest of San Francisco C	Total
1	North and West	1,050	450	2,300	3,800
2	Central	5,030	1,500	6,100	12,630
3	Southern	4,520	1,850	4,200	10,570
	Total	10,600	3,800	12,600	27,000

B. BUS COMMUTERS

From Marin Zones		To San Francisco Zones A	B	C	Total
1	North and West	460	70	60	590
2	Central	1,400	290	130	1,810
3	Southern	1,040	340	210	1,590
	Total	2,900	700	400	4,000

C. TOTAL COMMUTERS

From Marin Zones		To San Francisco Zones A	B	C	Total
1	North and West	1,510	520	2,360	4,300
2	Central	6,430	1,790	6,230	14,400
3	Southern	5,560	2,190	4,410	12,300
	Total	13,500	4,500	13,000	31,000

if the congestion remains unrelieved. Table 10 presents a population forecast utilizing the Marin County Planning Department's growth rates broken down by the census tract groupings used in the County of Marin Balanced Transportation Program. These census tract groupings vary only slightly from our own three superzone categorization of Marin County.

TABLE 10

POPULATION ESTIMATES - MARIN COUNTY

					Annual Average Growth Rate		
Area	1960	1968	1980	1990	1960-68	1960-80	1960-90
North[a] and West Marin	21,705	50,800	96,100	151,400	7.8%	6.4%	5.8%
Central[b] Marin	82,695	119,800	154,900	176,800	4.8	3.2	2.6
Southern[c] Marin	36,341	48,300	85,300	101,300	3.6	4.4	3.5
Total	146,820	218,900	336,300	429,500	5.1%	4.2%	3.6%

a. Census Tracts 1-5, 13, 32, 33
b. Census Tracts 6-12, 14-22
c. Census Tracts 23-31

Sources: 1960 population from 1960 Census of Population. Zone data by County of Marin Balanced Transportation Program 1980 and 1990 projections from County of Marin Planning Department.

We used this basic population forecast to make three commuter projections which differ as a function of the following assumptions (Table 11):

TABLE 11

DAILY COMMUTER PROJECTIONS BETWEEN MARIN AND SAN FRANCISCO 1980, 1985, 1990

Assumption Concerning Proportion of Commuters in Marin Population		1980	1985	1990
Extrapolation of Current Trend	(1)	69,000	98,000	137,000
Today's Proportions	(2)	50,000	60,000	73,000
Current Trend	(3)	57,000	67,000	78,000

Source: ADL estimates.

(1) We have assumed that the current trend toward a higher percentage of commuters in the population will continue. If this happens the present commute traffic will increase 220% by 1980. This appears unlikely but not impossible.

(2) We assumed that the proportion of commuters in the population will remain constant. Under this assumption the commuting traffic will increase 161% by 1980. This assumption would, of course, result in an annual growth in commuter traffic equal to the population growth.

(3) We assumed that the present trend toward more commuters in the population will level off at the present rate of 2% higher than it was in 1968. Under this assumption, which seems most likely if the congestion problem is alleviated, commute traffic will increase 5% each year.

The following chapter summarizes the results of the study of commuter behavior and attitude that permitted us to estimate the proportion of Marin County commuters who would use various types of ferry services if they were available.

IV. SURVEY OF COMMUTER ATTITUDES AND FERRYBOAT USE FORECAST

The initiation of an advanced water transportation system between Marin and San Francisco Counties would offer a new choice of ways to cross the Golden Gate. Two kinds of information about the people now traveling this corridor are required in order to evaluate the feasibility of starting such a system: first, their attitudes and preferences, which would suggest what features the new system would have to incorporate to be competitive with present means of travel; and second, the basis of their selection of transportation, so that the number of riders who would use ferry systems of various types can be estimated.

The experience of other ferry services could, of course, be used to deduce the required information. But our analysis of other regions suggests that none is sufficiently like the area we are concerned with for their experience to be directly applicable. Thus, while we considered such findings (see Chapter V), the bulk of the required information was derived from ADL's extensive survey research effort, whose results are summarized in this chapter.

The main research effort was an investigation of commuter behavior and attitudes. A less extensive study of other bridge users was also undertaken.

A. THE ORIGINS AND DESTINATIONS OF COMMUTER RESPONDENTS

We questioned 1237 Marin County commuters about their present commuter patterns, reasons for their transportation choice, and reactions to various ferryboat system alternatives. Of that total, 147 were interviewed in a pilot study. The final version of the commuter questionnaire, which was administered to 1090 Marin County residents employed in San Francisco, was based upon the responses to the pilot survey. The relevant results drawn from the survey responses are discussed below; a more complete explanation of the sampling and survey methodology is contained in Appendix A.

We interviewed commuters at their places of employment. Because our commuter sample was based on preliminary origin and destination patterns, the Central Business District (CBD) zones were somewhat overrepresented while the remainder of San Francisco was underrepresented. (The zone-to-zone commuter distributions presented in the previous chapter were used to adjust the sample results before the demand schedules were calculated.)

Almost 60% of the sampled commuters work in the CBD. Eighteen percent were employed in what we denote as the outer CBD while 23% work in the western areas of the city. Residential distribution of respondents was: 46% in Central Marin (north of Corte Madera and south of Ignacio), 41% in Southern Marin (south of Corte Madera), and 13% in Northern Marin (north of Ignacio). (See Table 12 and Figures 3 and 4.)

TABLE 12

THE MARIN COUNTY ORIGIN - SAN FRANCISCO DESTINATION OF SURVEY RESPONDENTS

From	To							
	S.F. Central Business District		Outer CBD		West San Francisco		Total	
	#	%	#	%	#	%	#	%
Southern Marin County	260	24	98	9	83	8	441	41
Central Marin County	305	28	78	7	118	11	501	46
Northern Marin County	79	7	22	2	47	4	148	13
Total	644	59	198	18	248	23	1,090	100

B. THE MODAL SPLIT AND COMMUTE TIMES OF THE RESPONDENTS

Of the Marin County commuters surveyed, 49% drive their own car to work. Another 21% ride with someone else, including spouses who drive together, and car pool arrangements. Twenty-seven percent regularly ride the bus to work and 3% ride the Tiburon ferry. The 48% which comprises the bus riders and those who ride to work with others would no doubt have been lower if the San Francisco destination sample did not contain an overrepresentation of CBD employees. The 3% use of the Tiburon ferry is also overstated because this commuter was frequently more desirous of being included in the survey than was the general commuting population. However, the 34 questionnaires containing the responses of those currently riding the ferry were not used in the calculations of future ferryboat use.

FIGURE 4. ADL SURVEY - SAN FRANCISCO DESTINATION ZONES

Table 13 summarizes the means of transportation used (technically, the modal split) by total number of responses. Table 14 shows the percent distribution of those using a particular mode 1-3 days and 4-5 days per week. Bus riders have the most consistent commute patterns: 81% ride the bus to work 4-5 days a week. Those who drive their own car or ride with someone else to work show a less consistent pattern, and the least consistent pattern is that of the Tiburon ferry patron.

TABLE 13

THE MODAL SPLIT OF THE MARIN COUNTY COMMUTER

Commuter Mode	No. of Total Responses	% of Total Responses
Drive own car	651	49
Ride with someone else	280	21
Ride bus	358	27
Ride Tiburon ferry	34	2
Total	1,323[1]	99%[2]

1. The number of responses does not equal 1,090 since some persons used more than one mode.

2. Does not equal 100% due to rounding.

TABLE 14

MODAL SPLIT BY NUMBER OF DAYS PER WEEK

Commuter Mode	% Using Mode 1-3 Days/Week	% Using Mode 4-5 Days/Week	Total
Drive own car	27	73	100%
Ride with someone else	31	69	100%
Ride bus	19	81	100%
Ride Tiburon ferry	41	59	100%

Commuter arrival and departure times are also important to an understanding of the commuter transportation crisis.

Eighty-six percent of the survey respondents leave home between 6:16 a.m. and 8:15 a.m. and arrive at their place of employment between 7:16 a.m. and 9:15 a.m. Eighty-eight percent leave work between 4:16 p.m. and 6:15 p.m. Clearly then, the commuter flows are concentrated in these three morning and two afternoon hours. Table 15 presents the actual arrival and departure commuter distributions.

TABLE 15

COMMUTER ARRIVAL/DEPARTURE TIMES
(%)

A.M. Times	Leave Home	Arrive at Work	P.M. Times	Leave Work
Before 5:45	1%	0%	Before 3:15	1%
5:46-6:15	5	<1	3:16-3:45	1
6:16-6:45	23	2	3:46-4:15	4
6:46-7:15	30	6	4:16-4:45	29
7:16-7:45	22	21	4:46-5:15	37
7:46-8:15	11	32	5:16-5:45	15
8:16-8:45	5	23	5:46-6:15	8
8:46-9:15	1	10	6:16-6:45	2
9:16-9:45	1	2	6:46-7:15	1
After 9:46	1	2	After 7:16	1
	100%	99%[1]		99%[1]

1. Does not equal 100% due to rounding.

C. THE COMMUTER'S VIEW

Obviously how and when people commute will affect their attitude toward the status quo. The 6-7 a.m. commuters are less inconvenienced by heavy traffic flows than those who are on the road between 7-8 a.m. Respondents currently riding the Tiburon ferry 4-5 days per week express the greatest satisfaction while bus riders indicated the greatest dissatisfaction. (See Table 16.) Commuters riding with someone else appear to be more satisfied than those driving themselves. (This may be attributed to the fact that a driver undergoes more intense psychological strain than does a passenger.)

TABLE 16

ATTITUDES TOWARD TRAVEL MODE OF PEOPLE
COMMUTING 4-5 DAYS PER WEEK

Degree of Satisfaction	% Drive Own Car	% Ride With Others	% Ride Bus	% Ride Ferry
Satisfied	65	70	58	95
Not Satisfied	35	30	42	5
Total	100%	100%	100%	100%

While there does appear to be some acceptance of alternate methods of transportation, the flexibility and convenience provided by the private automobile are always weighed against the features of competing modes. For example, each respondent was asked how often he/she would participate in a car pool provided the travel requirements of each member were compatible. Fifty-three percent said they would use such a service seldom or never; 17% stated that they would participate sometimes or frequently, and 30% indicated they would commute by car pool all of the time, provided the origins and destinations of the members were compatible. Many of the persons who stated they would not be interested in a car pool claimed that the irregular hours and travel requirements of their jobs precluded such an alternative.

What the commuter thinks about each mode of transportation influences his feelings of basic satisfaction and in the long run will help determine the acceptance or rejection of alternate modes. The major purpose of the survey was to ascertain how the commuter perceives and ranks various attributes and thus obtain a better understanding of how these influence his modal choice. Such an understanding is prerequisite to accurate forecasts of ferryboat ridership. For example, our survey indicates that there is a group of what can be considered basic requirements--those attributes which must be present in any waterborne transportation system if it is to compete successfully with existing modes. Then there are factors which will determine ridership depending upon the degree or extent to which they are provided. The latter serve as basic inputs to our ferry boat demand model.

The survey suggests that convenience--that is, schedule and location--is the most important factor to the commuter. (See Table 17.) Convenience is almost twice as important as travel time, the second ranked factor, while travel time is more than twice as important as cost, the third ranked factor. Comfort, which includes not only riding comfort but protection from inclement weather, was ranked fourth, and privacy was ranked fifth and last by more than 70% of the persons surveyed.

TABLE 17

FACTORS RANKED BY IMPORTANCE TO MODAL CHOICE

Factors	% Ranked 1	% Ranked 2	% Ranked 3	% Ranked 4	% Ranked 5	Total
Convenience	51	24	19	5	<1	99+%
Time	28	41	17	11	2	99%
Cost	11	20	29	21	18	99%
Comfort	5	12	27	47	8	99%
Privacy	4	3	7	15	71	100%

1. Basic Requirements

Convenience, safety, dependability, and comfort were found to be basic requirements of any waterborne system. In analyzing a ferry system, dependability, amenable schedules, feeder system, and terminal locations are all related to convenience.

It may be well to reiterate that in the discussion below we are at all times referring to perceived attributes. For example, respondents presume that a ferryboat system will be safe. Although the automobile has the highest accident rate per passenger mile, accidents involving mass transit vehicles appear to be more intensely feared by the public. Use of the automobile insures that most persons adopt a defense mechanism much like that developed by the soldier in battle which provides a feeling of immunity from disaster. This defense mechanism is apparently not as effective for airplane and boat travel.

There is less discrepancy between the perceived and actual evaluation of dependability of a transportation system. Most of the commuters must arrive at work at a designated time. Therefore a major concern of those commuters contemplating a switch to a ferry system is whether the ferry will arrive in San Francisco at a pre-stipulated time. There is, by the way, much less concern with dependability on the return trip, and consequently a 10-15 minute afternoon time delay would be far less annoying than such a delay on the morning trip.

Comfort in a waterborne system is seen as the provision of comfortable seats, the availability of restrooms for lengthier trips (for example, those taking longer than 30 minutes), and the avoidance of rough or noisy rides. According to our survey, approximately 12% of the commuting public have seasickness tendencies, and would be particularly concerned about the smoothness of the trip.

Other factors which neither are prerequisites nor appreciably alter the number of potential riders are type of vessel and the amenities offered by the respective vessels. However, they are sufficiently important to have been considered in the overall analysis of the ferry system.

Thirty-seven percent of the survey respondents indicated a preference for exotic craft, for example, hydrofoils or air-cushioned vehicles. Speed was the reason offered by 93% of those persons opting for such a craft. Almost half of the 63% who prefer a conventional craft based their choice on the dependability factor and also expressed a strong concern that the newer exotic vessel would be less safe. Forty-three percent also felt that the conventional craft are able to provide greater amenities than the generally smaller exotic vessels: comfortable seats, snack stands, restaurants, and bars were the most frequently cited amenities. Approximately one-third of the survey respondents were totally indifferent to any amenity features.

2. Factors Determining Ferry Ridership

Gradations in time and cost to the commuter are the primary factors which determine the number of commuters who will switch to a ferry system once the prerequisites are met. Time must be subdivided into the following four factors:

a. <u>Marin County Terminal Time</u> - the time it takes from the respondent's place of residence to reach the closest Marin County terminal. Once again we are referring to perceived time and therefore terminal locations which require the commuter to drive away from San Francisco are perceived as taking longer than those in which the respondents drive toward San Francisco.

b. Waterborne Time - the total time the person is on the ferryboat including the time taken to board and disembark.

c. San Francisco Time - the time it takes after disembarking near the Ferry Building or other San Francisco terminal to reach the place of employment.

d. Transfer Time - the greater number of transfers required the longer the perceived time.

The feeder system alternatives, summarized in Table 18, indicate that if parking, a minibus, and a full-sized bus were all provided free to the commuter population, the minibus would be acceptable to 90%, parking to 84%, and a regular bus to 74%. A 50-cent per day charge, for either parking or round-trip bus service, does not alter the order of these preferences. The ordinal ranking of these feeder system alternatives does not vary according to point of origin.

When probing the stated preference for a minibus feeder system, it became apparent that the respondent visualized a convenient and personalized service in terms of scheduling and location of bus stops. Frequency of service was of less importance than the maintenance of time schedules. Many expected the bus to pick up and deliver within a block or two of their homes. These conceptions make it clear that the optimum use of a minibus service would be in highly dense population areas not too distant from the terminal. Adequate parking facilities would still have to be provided to accommodate those persons living in more geographically distant, less dense areas.

Proximity to and the location of the ferry terminal are crucial to the number of riders that the ferry service will obtain. The 939 respondents who did not reject a ferryboat option outright were asked, "What are your first, second, and third choice locations for a ferry terminal?" Fifty-eight percent of those residing in North Marin, 65% in Central Marin, and 70% in Southern Marin volunteered at least one location choice. Many of the respondents were extremely well informed and backed up their choices with discussions on silt conditions, water, and feeder access problems. Few respondents named sites that were obviously unfeasible.

As Table 19 illustrates, only a small percentage of people are willing to drive away from San Francisco to reach a ferry terminal. For example, only 1% of the Southern Marin respondents indicated an

TABLE 18

COMMUTER ATTITUDES TOWARD FEEDER SYSTEM ALTERNATIVES
(%)

Location	Park $1.00	Park $.50	Park Free	Minibus $.50	Minibus Free	Bus $.50	Bus Free
NORTH MARIN							
Often	13%	30	74	53	85	44	71
Sometimes	6	20	10	13	5	11	3
Total: Often and Sometimes	19	50	84	66	90	55	74
Seldom/Never	80	50	14	34	10	45	25
CENTRAL MARIN							
Often	15	32	70	51	80	29	56
Sometimes	8	18	7	18	8	11	6
Total: Often and Sometimes	23	50	77	69	88	40	62
Seldom/Never	76	49	22	31	12	59	38
SOUTH MARIN							
Often	16	29	67	41	72	20	49
Sometimes	7	16	8	13	8	9	9
Total: Often and Sometimes	23	45	75	54	80	29	58
Seldom/Never	79	55	25	46	19	70	42%

TABLE 19

FERRYBOAT TERMINAL PREFERENCES

	% South or Central Sausa-lito	% North Sausa-lito	% Tiburon Belve-dere	% Corte Madera	% Green-brae	% San Rafael except Civic Center	% Civic Center	% North of Gallinas Creek	% Sir Frances Drake Highway	Total*
NORTH MARIN										
1st Choice	0	1	1	11	1	24	0	61	0	99
2nd Choice	0	4	2	11	6	43	9	24	0	99
3rd Choice	19	0	5	19	9	14	14	19	0	99
CENTRAL MARIN										
1st Choice	3	4	1	20	10	52	7	<1	1	99
2nd Choice	4	4	6	43	16	22	2	2	1	100
3rd Choice	25	9	15	20	15	13	1	1	1	100
SOUTH MARIN										
1st Choice	31	32	22	11	2	1	0	0	0	100
2nd Choice	36	26	16	15	2	5	0	0	0	100
3rd Choice	17	14	27	21	4	15	1	0	0	99

* Does not equal 100% due to rounding.

interest in a San Rafael location. Time spent in getting to the ferry terminal is, in fact, perceived as longer than that which is spent on the vessel. Therefore, a commuter who must drive or ride the bus a relatively long time to get to the terminal may stay in his car or bus all the way rather than transfer to the ferry even if such a transfer would effect a total time saving.

The nature of their jobs required 99 respondents (9%) to drive to work every day while 52 other interviewees (5%) were not amenable to a ferry system for a variety of reasons. The responses of these 151 persons were not excluded from the subsequent forecasts of ferryboat ridership, but they were not questioned further concerning possible ferry service use.

In order to gauge the effect of changes in total trip time on ferry ridership each of the remaining 939 respondents was asked how many days a week he/she would ride the ferry to work given a short- and long-time assumption based upon his/her residence--i.e., Marin geographical division.

Each respondent was questioned about his/her ferry usage under the following condition:

Residence	Short Time Assumption	Long Time Assumption
South Marin - south of and including Corte Madera	35 minutes	55 minutes
Central Marin - north of Corte Madera and south of Ignacio	50 minutes	70 minutes
North Marin - Ignacio and northern portions of the county	60 minutes	80 minutes

Which of the two time periods is most realistic will depend upon the type of feeder, terminal, and ferry system that is instituted. For example, if exotic craft are utilized the short time might be the most realistic, while the long time might prove more realistic given conventional craft and a less than optimal feeder/terminal system.

The realism of alternative systems was not the only reason for the selection of these two time periods. We also wanted to determine the type of gradations needed in the calculation of the demand schedules. (See Appendices A and B.)

Although the respondents were not queried as to their reactions to alternate San Francisco feeder systems, they left little doubt that San Francisco feeder time was seen as the "longest" of all. This conclusion can be deduced from the fact that those commuters most amenable to switching to a ferry work in the CBD, in zones 4 and 15, which are closest to the Ferry Building. In general, those commuters who can walk to work rather than transferring on the San Francisco side--e.g., to bus or streetcar--are more likely to be ferryboat riders.

Few appear willing to transfer to a non-express bus to their place of employment. However, some are amenable to direct express bus service to their place of employment, e.g., to the Civic Center or medical center area. There is little question that the number of transfers and ease of transfer are determining factors in the commuters' decision to utilize a waterborne system in preference to their present means of transportation.

Fare Schedules

The second major factor determining probable ferry ridership is the number of days the respondents stated they would be willing to take the ferry under alternate fare schedules. The 939 interviewees were asked, "How many days per week, if any, would you take the ferry if the daily round-trip fare were $2.50, $2, $1.50 and $1 respectively?" Starting with the $2.50 fare, each choice was presented separately so that the respondent would not know the number or gradations of fare schedule options.

This survey procedure was not a problem for the respondents. However, questions which attempted to break out the feeder costs from the total Marin County feeder-ferryboat fares presented in the next series of questions did prove difficult for many of the interviewees. Therefore, we suggested that they should assume that the $2.50 fare schedule encompassed all Marin County feeder costs but that the $2, $1.50 and $1 fares did not. Generally the respondents were only concerned with the expected daily out-of-pocket expenses and indifferent as to how the costs would be apportioned.

D. THE FERRYBOAT DEMAND MODEL

1. Construction of the Model

The ferryboat demand model was built upon the responses to the four fare ($2.50, $2, $1.50 and $1) and two time (short and long) questions.

A computer was programmed to combine the responses to these two sets of questions. For example, for each respondent we ascertained how many days he would take the ferry at $2.50 and at the short time period, always recording the lowest number of the two. Thus, if a person stated he would take the ferry once a week at $2.50 and 3 days a week at the shorter time period, a "1" would be recorded for that particular fare and time combination. This procedure was followed for each of the four fare schedules and the two time periods shown below. Please note that this procedure for developing demand schedules always counted the <u>lowest</u> number of round trips that each respondent indicated for each set of assumptions. It resulted in a schedule that considered the most restrictive impact of either time or price for each respondent as determining his or her use of the service.

Price	Time period
$1.00	short
$1.50	short
$2.00	short
$2.50	short

Price	Time period
$1.00	long
$1.50	long
$2.00	long
$2.50	long

This procedure yielded a printout which stipulated the number of passengers who would use the ferry from 0-5 days a week. The next step was to calculate the number of round trips per week; this was easily done by multiplying the number of passengers by the number of days they would use the ferry. The following example illustrates this procedure assuming a $1 price and the longer time period. (The procedure is of course the same regardless of the combination price and time assumptions used.)

	No. of Persons	No. of Days	No. of Round Trips/Week
	1	1	1
	2	2	4
	3	3	9
	4	4	16
	5	5	25
Total	15	15	55

Table 20 presents the number of passengers, the number of round trips per week, and the total revenue that would be generated under the alternate price and time assumptions. The calculations encompass all sample responses, thus constituting average demand schedules for all Marin County commuters, regardless of specific geographic group. However, the interview findings suggested that all Marin County respondents did not react in a similar manner to the ferryboat alternatives.

TABLE 20

AVERAGE DEMAND SCHEDULES FOR MARIN COUNTY

	Shorter Time Period				Longer Time Period			
No. of	$1.00	$1.50	$2.00	$2.50	$1.00	$1.50	$2.00	$2.50
Passengers	651	573	367	259	352	325	221	162
Round Trips	2,809	2,330	1,275	832	1,423	1,245	719	479
Total Revenue	$2,809	$3,495	$2,550	$2,080	$1,423	$1,867	$1,438	$1,197

Therefore, we next studied the best way to group the Marin County commuters in order to minimize within-group differences and maximize between-group differences--in other words, to aggregate people in terms of commute patterns. We had two main choices: breaking down the Marin County sample by socioeconomic groupings on the basis of income, or into origin/destination categories.

We chose the latter alternative for three reasons. First, as a comparison of Tables 21 and 22 demonstrates, the between-group differences were maximized by grouping people according to San Francisco destination.* The maximum percentage range difference for the income categories is 8% (for the short time period, $1.50 price) while the group categorized by origin and destination displays a variance of 30% for the short time $1.50 fare case.

TABLE 21

PERCENT OF FERRYBOAT USERS GROUPED BY INCOME

	Short Time		Long Time	
	$1.50	$2.00	$1.50	$2.00
Less than $10,000	57	36	36	26
$10,000-$19,999	54	35	30	20
$20,000 and above	49	34	27	19%

*In the interest of clarity, we have omitted the origin zones in the Table 22 example.

TABLE 22

PERCENT OF FERRYBOAT USERS
GROUPED BY SAN FRANCISCO DESTINATION

S.F. Destination	Short Time		Long Time	
	$1.50	$2.00	$1.50	$2.00
Central Business District	59	37	35	23
Outer CBD	43	60	21	30
Western S.F.	29	18	11	11%

In contrast, the maximum and minimum percentage point spreads for the destination groupings are 30 and 12.

The second reason for our choice was that the income factor is implicitly considered in the origin and destination groupings. For example, workers in the financial district earn on the average higher incomes than those working in the Civic Center area.

Finally, the origin/destination groupings both complement and facilitate the geographic decision making, or the spatial allocation of feeder systems, terminal locations, etc.

However, grouping the sample respondents by origin and destination was not sufficient. An additional breakdown which separated those who currently commute by car on a routine basis from those who commute by bus was also necessary.

The following example illustrates the need to make this separation when estimating ferryboat ridership. It points out the greater propensity of present bus riders to switch to a ferry system. The references are to car and bus riders who state that they will ride the ferry at least once a week at $1.50 and the shorter time period:

S.F. Destination	Drive Car	Ride Bus
Central Business District	58%	71%
Outer CBD	46%	41%
Rest of city	28%	43%

2. Calculations and Results

Since it was necessary to look at three origin zones and three destination zones for both bus and car rider groups (9 x 2 = 18) for four fare schedules and two time periods (4 x 2 = 8), a total of 144 (18 x 8) combinations resulted. This large number of required calculations, plus the need to permit the testing of alternative price and time combinations not specifically asked in our market survey, made it mandatory to generalize these demand schedules by the development of demand functions. That is, we developed generalized equations to describe the impact of changes in time and fare on ferryboat patronage. These generalized equations made it possible to obtain answers to questions about "in-between" fares and times so that maximum benefit might be derived from our survey results.* A lengthier exposition on the model and series of equations is contained in Appendix B. The demand schedules for the three Marin County origin and San Francisco destination zones broken down by current bus and automobile riders are presented in Table 23. PERCEN refers to the percentage of theoretical round trips for a particular sample of respondents between two zones and for a particular current mode of transportation that would accrue to the ferry system at a given price and time; if PERCEN equals 100%, then all the respondents indicated they would switch to the ferry system.

The responses vary considerably from zone to zone and by the respondent's current means of transportation. For any given zone-to-zone round trip demand, bus riders are much less responsive to changes in either time or price than automobile riders, indicating that the former attach a certain benefit to public transit and are willing to pay for it while the latter do not necessarily attach the same significance to public transit.

3. A Test of Reasonableness of the Survey Results

Tables 24 and 25 illustrate the significance of required commute time by comparing the responses from three survey questions. Column (1) in each table indicates the percentage of all round-trip commutes that would be taken by ferry if the fare were $1.50 and the home-to-Ferry Building time was as indicated by the "short time" assumption stated in the questionnaire. Column (2) indicates the percentage of all round-trip commutes that would be taken by ferry assuming a longer home-to-Ferry Building time. Columns (3) and (4) indicate the time currently spent by "hard-core" (4-5 days per week) car and bus riders who work in the CBD on the home to workplace journey.

Tables 24 and 25 make it clear that commuting time is a far more

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*This is a case of classical demand analysis from the literature of economics being applied to a public policy question, a little-used approach in transportation problems.

TABLE 23

INTERZONAL DEMAND SCHEDULES DERIVED FROM MARKET SURVEY

Zone to Zone: Marin	Zone to Zone: San Francisco	Current Mode of Transportation	Time to Ferry Building (minutes)	PERCEN Percentage of Total Commuter Round Trips by Ferry at Given Round-Trip Fare: $1.00	$1.50	$2.00	$2.50
North	C.B.D.	Automobile	60	58	52	30	18
		Bus		67	62	35	20
		Automobile	80	29	26	16	13
		Bus		44	41	26	17
North	Outer C.B.D.	Automobile	60	54	38	21	15
		Bus		17	17	0	0
		Automobile	80	19	13	13	6
		Bus		17	17	0	0
North	Rest of S.F.	Automobile	60	21	21	10	8
		Bus		67	33	33	0
		Automobile	80	6	6	6	4
		Bus		33	33	33	0
Central	C.B.D.	Automobile	50	51	44	29	19
		Bus		78	67	27	14
		Automobile	70	23	22	15	11
		Bus		49	43	16	8
Central	Outer C.B.D.	Automobile	50	35	34	21	16
		Bus		41	29	17	2
		Automobile	70	13	13	6	5
		Bus		17	10	3	2
Central	Rest of S.F.	Automobile	50	27	19	13	10
		Bus		80	66	11	0
		Automobile	70	7	6	5	5
		Bus		80	9	9	0
South	C.B.D.	Automobile	35	55	44	24	16
		Bus		81	62	27	17
		Automobile	55	20	18	12	9
		Bus		61	48	20	14
South	Outer C.B.D.	Automobile	35	39	30	18	12
		Bus		61	45	33	19
		Automobile	55	14	13	10	5
		Bus		28	27	19	11
South	Rest of S.F.	Automobile	35	30	23	15	10
		Bus		55	22	2	2
		Automobile	55	13	11	10	8
		Bus		27	0	0	0

TABLE 24

SIGNIFICANCE OF COMMUTE TIME - CBD WORKERS
- FOR CAR RIDERS

Marin County Zones	% of Round Trips by Ferryboat at $1.50 (1)	(2)	Present Commute Time[1] (3)	(4)
Southern Marin	35 minutes from home to Ferry Bldg. 44%	55 minutes from home to Ferry Bldg. 18%	% taking longer[2] than 40 minutes 29%	% taking longer[2] than 60 minutes 3%
Central Marin	50 minutes from home to Ferry Bldg. 44%	70 minutes from home to Ferry Bldg. 22%	% taking longer than 50 minutes 44%	% taking longer than 70 minutes 5%
Northern Marin	60 minutes from home to Ferry Bldg. 52%	80 minutes from home to Ferry Bldg. 26%	% taking longer than 60 minutes 32%	% taking longer than 80 minutes 8%

TABLE 25

SIGNIFICANCE OF COMMUTE TIME - CBD WORKERS
- FOR BUS RIDERS

Marin County Zones	% of Round Trips by Ferryboat at $1.50 (1)	(2)	Present Commute Time[1] (3)	(4)
Southern Marin	35 minutes from home to Ferry Bldg. 62%	55 minutes from home to Ferry Bldg. 48%	% taking longer[2] than 40 minutes 83%	% taking longer[2] than 60 minutes 15%
Central Marin	50 minutes from home to Ferry Bldg. 67%	70 minutes from home to Ferry Bldg. 43%	% taking longer than 50 minutes 81%	% taking longer than 70 minutes 30%
Northern Marin	60 minutes from home to Ferry Bldg. 62%	80 minutes from home to Ferry Bldg. 41%	% taking longer than 60 minutes 82%	% taking longer than 80 minutes 45%

[1] Present commute times consider the average time it takes from place of residence to place of employment while the per cent of round trips by ferryboat times were calculated to the Ferry Building. The Central Business District S.F. destination probably limits this time difference to a 5 or 7 minute differential.

[2] Due to the structure of the 2 survey questions used in this table the times for Southern Marin are not directly comparable. Therefore more significance can be attached to this analysis for North and Central Marin.

significant factor to the car rider than the bus rider. To persuade the car rider to switch to a ferry system, travel time must be at least comparable to if not better than that of the transportation now used. Although the bus rider would prefer a shorter trip, time is of less general consequence than the improved quality of service. Thus the responses given by commuters to a hypothetical ferry system appear compatible with present behavior.

It is important to note that all survey responses were based on the transportation alternatives as they exist today, as compared to a hypothesized ferry system. Needless to say, bus riders who currently show the greatest dissatisfaction with the status quo would reveal less willingness to switch to a ferry system if a much improved bus system were offered.

E. THE NONCOMMUTER: RESIDENT AND TOURIST

1. The Marin County Resident

Because our purpose was to determine if a ferry service would offer a feasible means of alleviating the commuter transportation problem, most of our time and resources were directed toward answering that question.

However, we also believed it important to learn how the Marin County noncommuter resident would react to a Marin County-San Francisco ferryboat service and which aspects of the service would most influence its use or nonuse. To obtain such information, we telephoned 400 Marin County households to ask them about their Marin-San Francisco travel patterns and their degree of willingness to switch from their present transportation to a ferry system. The noncommuter sample was composed primarily of housewives but also included some retired persons and students.

The 400 households, on the average, visit San Francisco 5.4 days per month or an average of 3.5 weekdays and 1.9 weekend days. During the week approximately half travel to San Francisco in the morning while on weekends approximately one fourth leave for San Francisco after 6 p.m.

We calculated the number of weekly noncommuter trips under the following three situations:

1. The number of Marin County noncommuters who would take the ferry to San Francisco if present commute time and cost were unchanged.

2. The number of Marin County noncommuters who would take the ferry to San Francisco if commute time were 10 minutes longer than at present.

3. The number of Marin County noncommuters who would take the ferry to San Francisco if round trip cost 50 cents more than at present.

Table 26 reveals that approximately 4300 Marin County residents would take the ferry daily to San Francisco during noncommute hours provided that the commute cost and time did not increase. This number is reduced only slightly, about 200 daily trips, if time is 10 minutes longer than with their present transportation. Thus time does not appear to be a major factor in the generation of noncommuter trips. However, with a 50-cent increase in perceived fare, the ferry would attract only 350 daily passengers per week.* From currently available calculations it is reasonable to assume that during any average week approximately 35,000 persons travel to San Francisco during noncommute hours daily. This daily rate represents an average of weekday and weekend travel patterns. Therefore, our projections for situations one and two above indicate that between 11-12% of the Marin County noncommuter automobile and bus riders could be induced to switch to a ferry service.

Our survey research shows that the fare is the overriding consideration for the noncommuter and that time is the most influential factor for the commuting population.

2. The Tourist

Although we did not generate new research data on the impact of tourism on ferryboat usage, previous research undertaken in the San Francisco northern waterfront area suggests that a bay cruise was the most preferred activity of both the first time and repeat visitors.** Fifty-seven percent of all first time and 49% of all repeat visitors cited their preference for a boat ride. (Fisherman's Wharf is the number two San Francisco tourist attraction.)

The many proposals to upgrade and expand the facilities of Angel Island promise an additional nonpeak use of an established ferry system. Currently the island attracts approximately 100 people per weekday and about 1000 on weekends. If the existing proposals are implemented, the daily number could increase to 7000, which would necessitate a scheduled waterborne system. Presently the public is served by Harbor Tours, which departs from the Tiburon ferry slip on a nonscheduled basis. Angel Island is also open to private craft.

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*The average automobile driver does not calculate the upkeep of his car as part of his transportation cost. Bridge toll and parking are considered by all respondents and gasoline/oil costs by about three fourths.

**The Port of San Francisco - An in-depth study of its impact on the city, its economic future, the potential of its northern waterfront. Arthur D. Little, Inc., September 1966, page 156.

TABLE 26

NUMBER OF MARIN COUNTY NONCOMMUTERS
AS POTENTIAL FERRY RIDERS

A. IF TIME AND COST FACTORS SAME AS PRESENT MODE

% of Ferry Trips to S.F.	% of Survey Respondents in Each Category	No. of Ferryboat Trips per Month
100% of the time	12%	44,064
75% of the time	11%	30,294
50% of the time	26%	47,736
25% of the time	9%	8,262

Total trips per month: 130,356

No. of trips per day 130,356 ÷ 30 = 4,345

B. IF TIME 10 MINUTES LONGER THAN PRESENT MODE

% of Ferry Trips to S.F.	% of Survey Respondents in Each Category	No. of Ferryboat Trips per Month
100% of the time	11%	40,392
75% of the time	11%	30,294
50% of the time	24%	44,064
25% of the time	10%	9,180

Total trips per month: 123,930

No. of trips per day 123,930 ÷ 30 = 4,131

C. IF TRIP COSTS 50 CENTS MORE THAN PRESENT MODE

% of Ferry Trips to S.F.	% of Survey Respondents in Each Category	No. of Ferryboat Trips per Month
100% of the time	8%	2,937
75% of the time	8%	2,203
50% of the time	22%	4,039
25% of the time	14%	1,285

Total trips per month: 10,464

No. of trips per day 10,464 ÷ 30 = 348

For one month during our study, we installed a taped telephone service to permit the general public to make comments concerning the establishment of a Marin County-San Francisco ferry system. Approximately 150 calls were received, more than 100 of them from Marin commuters. Three fourths of the Marin commuter calls were favorably disposed to the establishment of a ferryboat service, 15% were negative and 10% did not specify. More than 40 San Francisco residents called and indicated an interest in such a ferry service. Many of these people were either young or elderly residents seeking weekend recreation.

There are still other potential users, for example, private groups and organizations, whom we merely note here. In this study we have viewed all visitor and recreational uses of an established ferry system as being an additional financial resource over and above the basic transportation oriented uses. However, there has been no attempt to quantify their contribution in terms of either number of passengers or revenue generation.

V. FERRY SERVICE ALTERNATIVES

A. CONCEPTUALIZING ALTERNATIVE SYSTEMS

Even after the critical demand factors are estimated, the conceptualization of alternative ferry systems is complicated by the fact that each element in the system affects every other element. Alternative terminal locations cannot be fully evaluated except in the light of vessel and feeder system options, nor can vessels be fully evaluated without also considering feeder systems and terminals; the appropriateness of various feeder systems is partially determined by the location of the terminals and the characteristics of the ferries.

Nevertheless, we had to conceptualize possible systems in order to evaluate the feasibility of beginning the design and implementation of a ferry service. The approach taken in this chapter is to first review the experience of some existing ferry services and then summarize the vessel options that confront the designers of a ferry service. We also describe a selected list of relevant terminal options.

The demand factors are then used as parameters to group the terminal and vessel combinations into three ferry system options. The terminal, vessel, and service characteristics of these options are described to provide examples of ferry systems. The demand model derived from the data obtained in our survey was used to forecast the number of passengers that would use each of the services outlined.

The feeder system options that result from the two terminal sets used in the examples are discussed in Section F.

B. EXISTING FERRY SYSTEMS

As already noted the only ferry service currently operating in the bay is offered by a private company which provides commuters two rides in the morning and two in the late afternoon on weekdays only, between Tiburon and the Ferry Building. It carries approximately 300 passengers each way and seems to be operating profitably; its owners have requested permission to serve Sausalito also. However, this operation uses vessels that were primarily designed for sightseeing purposes for which they are used during the day and weekends. But this minuscule use of ferries is not typical of many other regions located next to or around large bodies of water.

The largest ferry system in North America serves the Puget Sound area, centering its service on Seattle. The Washington State Ferry System includes 24 vessels traveling more than 750,000 miles per year and making more than 180,000 landings per year. This system has been consistently adding new ferries, the most recent addition being four car-and passenger-carrying "superferries" built at a cost of slightly more than \$6 million per vessel. It is probably worth noting that the U.S. Department of Housing and Urban Development provided a grant of more than \$11 million for the purchase of these four ferries.

Both passenger and vehicular use of the Washington State Ferry Service has been increasing in recent years. The entire system will carry approximately 6.5 million passengers and 4.8 million vehicles in the 1968-69 fiscal year. Five years ago, in the 1963-64 fiscal year, the system carried approximately 5 million passengers and less than 3 million vehicles. In 14½ years after the state took over the ferries, operating revenue doubled with only modest increases in rates.

The Washington State ferries have been operating under state sponsorship since June 1, 1951. The ferry system is heavily indebted to funds derived from other revenue sources. Approximately \$2 million from the State's Motor Vehicle Fund are added to the revenue collected from the users of the ferry system. However, the revenues generated by the system itself are quite significant. The 1967-68 revenues earned from passengers, vehicles and the terminals amounted to only slightly less than \$11 million, a 6.46% increase from the previous fiscal year. Furthermore, the publicly operated system maintains a level of service that is probably above the level that would be offered if the system were trying to operate solely to maximize profit or minimize financial losses. The existence of vocal commuter clubs tends to make reductions in service or increases in commuter fares politically difficult.

Unfortunately the situations in which the various Washington State ferry routes operate are not extremely similar to the conditions that prevail in the Marin-San Francisco corridor. The Seattle/Bremerton run of about 7½ miles most closely resembles the type of runs that could be made between the two Bay counties. In the six months that ended in December 1968, this route carried 787,821 passengers and 283,490 vehicles; it sustained a loss in net operating revenue of \$180,771.58. The importance of the vehicles they transport makes this system and others in the Pacific Northwest unlike anything that would be considered for the San Francisco Bay. Little would be gained here if vehicles were dumped on San Francisco streets from ferries instead of bridges.

One recent service in Vancouver does appear to deal with problems that are somewhat similar to those in the Golden Gate corridor. It is a small service on a scale similar to the local Tiburon ferry operation which began service on September 9, 1968. The service, operated by a private company, Harbour Ferries, runs between the Vancouver Central

Business District (CBD) and the bedroom communities on the north shore of the Burrand Inlet. The Vancouver CBD is, like San Francisco's, located on a relatively inaccessible peninsula. In both San Francisco and Vancouver bridges were built in the 1930s to open up suburban areas to direct access to the CBD. Large numbers of residents from Vancouver's north shore cross one of two bridges to work and shop in the CBD. Automobile ownership is higher on the north shore and peak hour passenger-vehicle trips over both bridges number approximately 10,000.

The nonsubsidized ferry service that began in September 1968 uses boats that are regularly giving tours of the area. These old boats take about 13 minutes to make the approximately 1½ mile run. The parking lot in North Vancouver is hard to find, unpaved and unmarked. In Vancouver the situation is worse: the passengers must climb a flight of roughly 40 stairs after leaving the ferry, cross the Canadian Pacific Railroad tracks on an elevated viaduct, and then reach the edge of the CBD at Granville and Cordova Streets. It is a formidable walk but the hardy Canadians seem to enjoy it. Between September 1968 and February 1969, 32,700 passengers used this service.

The fare on this service is 50 cents each way or 10 trips for $4. Boats leave Vancouver at 7:10, 7:40, and 8:10 a.m. and about 75% of the passengers get to the boat on the north shore side by driving and parking on the lot. In the evening boats leave Vancouver at 4:50, 5:30, and 6:10. The greatest number of passengers carried by this service on any one day was 596, on September 27, 1968.

No truly significant lessons can be drawn from this interesting new attempt to operate ferry services because its scale is so small. It is reported here for two reasons. First, it represents conditions somewhat similar to the Marin-San Francisco situation and this is extremely unusual. The one thing that has become quite clear from our survey of ferry operations is that they are all unique. No duplicate of the local conditions exists, but Vancouver, B.C., and Sydney, Australia, seem to be the most similar. Second, the recent Vancouver situation does give one of the many indications we have received that ferries can profitably carry commuters <u>if</u> some off peak hour use can be found for them.

The Sydney ferry services are quite extensive with seven full-time services operating in Sydney Harbour. There are 22 conventional displacement hull vessels and two hydrofoils in the various fleets. No North American ferry services are currently using hydrofoil vessels. The Minister of Transport New South Wales estimates that approximately 26,000 passengers are carried on these ferries per weekday. Half of these are carried on the Manly run of about 7½ miles. The Manly service is profitably operated by a private company, the Port Jackson and Manly Steamship Co., Ltd. The Manly ferry does not carry vehicles, only passengers, and is a link between the suburbs north of Manly and the Sydney CBD.

Sydney can also be reached by bridge in private automobiles or by bus. However, parking in the Sydney CBD is not easy to find. Greater Sydney has a population of about 2.485 million (1966). The Manly area has a population of 38,000. Displacement ferries make the trip in about 32 minutes while the hydrofoil vessels make it in about 15 minutes. A very important ingredient in the success of the Manly Ferry Service is the 22 bus lines that serve the Manly ferry terminals.

The Manly service uses four displacement vessels, and their one-way fare is 25 Australian cents. The hydrofoils used carry about one quarter of the Manly traffic and are reported to cost 50 Australian cents each way. No fare reductions are made for commuters or round trips. The Ministry of Transport, which does not subsidize the Manly ferry, wrote to a member of our committee* in 1967:

> "The government is most anxious to encourage greater use of Sydney's waterways. Proposals are currently being examined to introduce combined bus/ferry tickets at reduced rates so as to encourage people who now travel to the city over the Harbour Bridge by bus to travel by feeder bus and ferry--overseas developments in the use of hydrofoils and hovercraft are being watched closely and it could be that these craft will greatly expand the network of ferry services operating on Sydney's waterways in the future."

The Australian situation is certainly not identical to that of the two bay counties, but it is sufficiently similar to make their desire for more ferries of interest to us. Since the receipt of their 1967 letter we have also received information from Australia to indicate that they have ordered one additional hydrofoil.

Many more ferry services are in operation all over the world but we were unable to find many with direct relevance to the local situation. In fact the main conclusion of our review of existing ferry systems was that each local situation is sufficiently unique to demand a unique water transportation solution. Many ferry services in Asia and Europe are very much oriented to tourists or serve areas where no bridges exist. In New England more than 20 offshore islands can be reached by regularly scheduled ferry routes operating along the coast.

Finally, of course, not even the briefest review of ferry services should be concluded without mentioning the world's greatest nickel ride-the Staten Island ferry. This world famous system is still modernizing and adding boats to its fleet. In 1964 when the Verrazzano Narrows bridge was built there was a slight reduction in passengers, but by 1969 the volume is back up to its previous peak.

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*San Francisco-Marin Water Transportation Study Committee

C. VESSEL OPTIONS

Any comprehensive attempt to describe all of the naval hardware that could be built to operate between Marin and San Francisco would result in a list of extraordinary length. Most of the vessels on such a list could be grouped into three general categories: displacement vessels, hydrofoils, and air-cushioned vehicles or hovercrafts. The number of vessel types within these three groups that could successfully divert a significant number of commuters from the Golden Gate Bridge can be greatly reduced by considering the prerequisites imposed by the demand factors discussed in Chapter IV.

We did not attempt to narrow the list of potential vessel options to a single prototype. Instead we first considered the feasibility of utilizing a vessel of the type that would fall within each of the three groups, and selected three tentative prototypes for further evaluation and inclusion in a system package. We are not suggesting that the prototypes we selected for evaluation represent the exact type of vessel that should finally and exclusively be considered for inclusion in a ferry boat system should one be implemented. The definitive selection of the exact vessel that would best serve the corridor should be a part of a final system design effort, not this preliminary feasibility study. However, as will be indicated below, the research we have conducted does permit the specification of certain criteria that must be met by any vessel to be considered. The final selection should screen candidates that can meet these criteria to select the type or types that show superior characteristics above these minimums.

In this section of the report we suggest the kind of schedules, passenger loads and terminals that would result from the use of the three tentative prototypes. In the following chapter hypothetical systems utilizing these vessels will be analyzed in terms of the estimated financial results that would accompany their operation. Before proceeding to this system description the minimum criteria will be summarized and the vessel types discussed briefly.

Our analysis of commuter behavior suggests the following minimum vessel criteria:

1. They must be capable of operating dependably and maintain schedules under fog and other weather conditions which occur in the bay.

2. They must be capable of operating dependably at night to permit trips past peak commute hours.

3. They must operate dependably given the fact that logs and other flotsam are frequently in the bay.

4. They must be capable of avoiding small boats.

5. They must be able to operate economically on relatively short runs.

6. They must present no navigational hazards.

7. Maintenance down time must not be excessive.

8. They must not produce noise pollution problems for the residents and workers located near terminals.

9. The internal facilities of the vessel must be commodious with no noise irritation for passengers.

10. The ride must be smooth and comfortable.

As indicated previously the question of speed is paramount in attracting ridership once these minimum criteria have been met. Sixty percent of the respondents to our survey expressed a preference for relatively conventional displacement hull vessels because they correctly deduced that the above minimum criteria could most easily and assuredly be met by such vessels. However, the speed of any displacement hull vessel is limited because of the drag induced by a hull in the water. Speed can be increased by lengthening the hulls, using lighter material and putting in more powerful propulsion systems. However, the top speeds that can be produced by most displacement vessels fall only slightly above the minimum speeds required to make water transport systems operating from middle and north Marin competitive with the present work trip times of driving an automobile.

A recent example of displacement ferry boats is provided by the four vessels built for The Washington State Ferry Service in 1967. These vessels are faster than any of the older vessels in the Washington fleet. They cruise at 20 knots with an 8000 horsepower diesel-electric power plant and contain both radar and VHF radio equipment. They were built in San Diego with a 382 ft. 2 in. steel hull and 73 ft. 2 in. beam capable of carrying 2067 passengers and 160 automobiles.

Morris Guralnick Associates, a local firm of naval architects, considered various types of displacement concepts for the Marin-San Francisco service. Based on their studies they recommended a catamaran type vessel for the prototype displacement-type vessel to be initially evaluated for the purposes of this study. They indicated the following in a letter to ADL:

> "Based on our studies to date, we recommend catamaran type vessels, driven by diesel engines through controllable pitch propellers. This type of vessel will generate minimum wake, provide ample deck area with minimum stability problems, and permit outstanding maneuverability characteristics which is

vital to the success of this service. A normal speed of about 21 knots and a capability of operating at 23 knots on occasion will be required to maintain the desired schedule. To be sure of maintaining these speeds with reasonable economy, the hulls will have to be long and widely spaced. We have conservatively selected a length of 330 feet and an overall beam of 100 feet. The length of the deckhouse will be much shorter."

The second category of vessels that should be considered and for which a prototype concept was developed are hydrofoil boats. A hydrofoil manufacturer describes it in the following manner:*

"The hydrofoil could be called a cross between an airplane and a boat because this type of boat has hydrofoils on her bottom and sails afloat the same as an ordinary boat at the beginning. With the increase in the boat's speed, the foil produces a lifting force giving the same effect as airfoil on an airplane, pushing the body upwards above the water level finally. Then the boat is supported by hydrofoils and runs about three times as fast an an ordinary boat... it is steered much more easily than ordinary boats."

Few hydrofoils have been used in the United States, even though they have been operating successfully in the Mediterranean, the Baltic Sea, and other gulfs, lakes, and rivers all over the world. Several of the commuters we interviewed in the previously described survey had traveled abroad and ridden hydrofoils in Switzerland, Denmark, Egypt and Hong Kong and they all reported enjoying the ride. Two noncommuters we interviewed had ridden in Russia an approximately 150 passenger capacity hydrofoil which they reported to be fast and commodious.

One reason behind the limited use of hydrofoils in the United States is that the Jones Act, a federal law, prohibits the use of foreign made vessels by privately owned companies operating domestically. To date, no American-made hydrofoil vessels have proved themselves capable of achieving the minimum criteria listed above that would be required for the run. Furthermore, most initial hydrofoil operations involved relatively long runs over water not clogged with flotsam.

The problem of flotsam were emphasized by the recent experience of a hydrofoil service between Victoria, B.C., and Seattle on Puget Sound. One of the foils hit a large submerged log of the type that is very common in the Sound. The damage done by this accident is reported to have cost $250,000 to repair. However, adherents of hydrofoil vessels claim that advances in technology would minimize the danger of

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* Brochure provided by Hitachi Shipbuilding & Engineering Co. Ltd., a licensee of the Swiss Supramar firm.

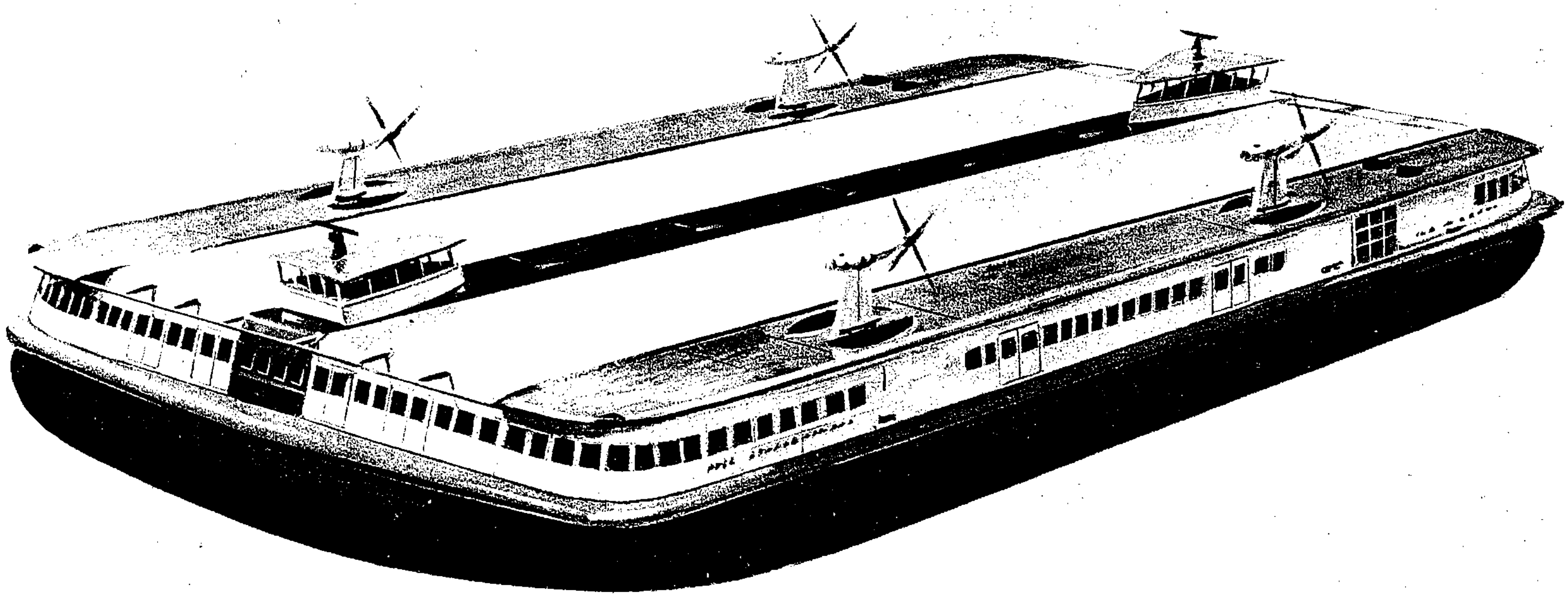
such damage and point out that even in this case the passengers were not harmed in any way as the boat could travel on its hull.

Furthermore, the experiences of Sydney, Australia and Chedori, Japan, and other places suggest the possible feasibility of using hydrofoils on short runs such as those between Marin and San Francisco. The water times that would result from the use of various vessel types from differing terminal locations are in Section D. However, we have not conducted the engineering tests required to prove or disprove the ability of hydrofoil vessels to meet the 10 prerequisites of ferry operation listed above. We do believe that extensive tests are required before this type of vessel is either accepted or rejected for use in a final system. Such tests should be a part of a system design and implementation program that should follow this study if a ferry system is to be placed in operation.

The lack of available information on hydrofoils makes it extremely critical that any use of such vessels be preceded by engineering tests to determine the ability of such craft to meet the critical criteria of dependability and safety. If ADL were seeking to maximize the conservative nature of its report we would exclude consideration of any vessels other than displacement hull craft because more technologically advanced vessels cannot yet be proven to be absolutely reliable. However, the market demand requirements previously discussed suggests that the systems design effort should not exclude the possibility of more advanced vessels. A newly-formed concern, the Hydrodyne Marine Corp., purports to be planning to produce hydrofoils in Southern California that would be suitable for a Marin-San Francisco service. ADL has written this concern a letter questioning the use of hydrofoils on the basis of the 10 criteria. A response to this letter indicating the ability of the craft they propose to manufacture to meet these criteria is included in Appendix C of this report. The vessel they propose to manufacture and deliver under a contract that will guarantee performance would be 80 ft. in length with a passenger capacity of 250. This vessel is purported to cruise between 40 and 50 miles per hour. This conceptualized vessel was utilized as an example prototype for purposes of preliminary feasibility evaluation.

While we do not wish to refuse consideration of the Hydrodyne Marine Corporation's volunteered data, neither were we in a position to make any independent engineering studies of their claims. Thus, we would recommend that the systems design effort consider the craft that are suggested by all reliable sources. In the United States such organizations as the Grumman Aircraft Co. should be contacted and asked whether or not they would have vehicles which they consider suitable and would be willing to have tested. The competitive testing procedure should also be open to foreign firms such as the Swiss Supramar Company who have indicated an interest in this service and report that they are producing a 250 passenger hydrofoil vessel. They have also suggested the appropriateness of their vessel for a Bay ferry service. We believe that

1. 250-PASSENGER CAPACITY HYDROFOIL WHICH HYDRODYNE MARINE CORP. PROPOSES TO OFFER AS A CANDIDATE FOR THE FERRY SERVICE



2. 1,000-PASSENGER CAPACITY AIR CUSHIONED VEHICLE PROPOSED FOR THE FERRY SERVICE BY BELL AERO SYSTEMS

consideration should even be given to the possibility of testing and licensing the advanced hydrofoils now operating in the Soviet Union. It may be that a tested Russian craft could then be built in San Francisco, perhaps at the Bethlehem shipyards, by a yet to be determined American concern. We feel it is critical that the type of vehicle suggested by demand parameters as being most suitable be sought during a period of engineering evaluations. These evaluations should not be restricted to the craft being offered by any one firm but should consider the full spectrum of potential hydrofoil manufacturers.

Surface effect vessels of the type that are called Hovercraft in Great Britain and air cushioned vehicles (ACV) in the United States are the third type of vessel that was considered as an option. These utilize a variety of propulsion systems to force air downward to create an air cushion beneath the craft, over which the craft is then propelled. In 1965 and 1966 a 14-passenger ACV was tested on San Francisco Bay to determine the operational and economic feasibility and public acceptance of using air cushioned vehicles to provide convenient airport access and public transportation in metropolitan areas. The Department of Housing and Urban Development paid two-thirds of the $1,182,944 expended in this test effort, with the remaining third contributed in equal amounts by the City and Port of Oakland, Bell Aerosystems Co., and SFO Helicopter Airlines, Inc. Scheduled service was provided between Oakland and San Francisco International Airports and between Oakland International and downtown San Francisco.

The results of this test did not indicate that the SK-5 would meet the prerequisites of a Marin-San Francisco ferry service. The final report of the demonstration project indicated that,

> "Trip cancellations during the project due to high winds and waves were numerous, especially during summer afternoons when the winds in the San Francisco Bay area frequently exceed 20 knots. However, this is considered due to the characteristics and limitations of the vehicles used, rather than to those of ACVs generally. The use of larger heavier craft probably would not require cancellation under similar conditions."*

The report also indicated that the operating costs of the relatively small vehicle tested were high compared to other types of transportation. However, the report concluded, "The tendency to assign the qualities of the SK-5 to all existing and future ACVs must be avoided. Vehicles which are larger, more comfortable, and more economical are being developed and many of the apparent limitations of the SK-5 may be eliminated."

Some of the very guarded optimism about ACVs that appeared in the above cited final report may be justified. Larger ACVs have been operating in other parts of the world. On August 1, 1968, British Rail Hovercraft Limited began a cross-channel service between Dover, England, and

* Air Cushion Vehicle, Mass Transportation Demonstration Project Cal-MTD-3 Final Report, April 1967 p. 1.

Boulogne, France. This service utilizes the Mountbatten Class SR.N4 hovercraft built by the British Hovercraft Corp. which carries 254 passengers and 30 vehicles. Overall length is 130 ft. 2 in. with a 78 ft. beam. The trip takes slightly less than 40 minutes and the makers of this craft claim it can achieve speeds over 80 miles per hour. The cost of the trip including feeder service from the towns to the terminals is $7.20.

We have interviewed a San Franciscan who recently took this trip. He reported that the noise level was high and the atmosphere more like an early aircraft than what he expects of a ferry service.

Many new ACVs are now being developed for military and commercial uses. Some of these may be able to meet the criteria suggested by this study and a representative of Bell Aerosystems indicated that his company was developing a 1000 passenger capacity vehicle that he thought would be a candidate. We sent him a letter questioning him about requirements, and his reply is included in this report in Appendix C. We did not undertake any more detailed evaluation of any ACV prototype though this could be done in the system design and implementation phase of a ferry boat program should a manufacturer present the relevant data. We have, however, hypothesized the Bell ACV's for use in one of the conceptualized ferry services before operations are simulated in the next chapter.

During this study an innovational scheme for water transportation that does not fit into any of the three categories mentioned was suggested. A local group has designed a ferry that would be pulled across the bay on a cable. They are currently negotiating to build such a system in Vancouver, and suggest that it be further tested for possible use between Tiburon and Fisherman's Wharf. Tests would have to be made before such a system could be seriously considered. Once such tests are made the system could be compared to the other vessel options. However, the inability of such a service to utilize terminals in Central and North Marin would remain a handicap even if current engineering problems were solved.

D. TERMINAL OPTIONS

1. Criteria for Consideration

Water access feasibility requirements include the depth of the water at the terminal site. Both displacement and hydrofoil vessels require a water depth of 12 feet. The ACV, on the other hand, travels on the surface of water or even on land. Present water depth determines the amount of dredging required to make the site serviceable which, along with the site's siltation rate, is significant in determining capital and maintenance costs of terminal sites. The number of nautical miles from terminal site to the San Francisco Ferry Building is necessary information in determining boat travel time. The volume of small boat traffic near the terminal site is important because of its impact on boat running speed.

Land access considerations include number, type and condition of access roads, and present traffic patterns on terminal access roads. Future local and county road improvements are considered to approximate the possible added capital costs of the ferry system. In order to compare the relative suitability of various terminal sites in terms of their accessibility to Marin residents, road travel times were derived to sites from each census tract in Marin County and also from the general areas of North, Central, and South Marin County to each terminal site. A summary of these weighted average travel time estimates is presented in Table 27.

Each terminal site is required to have adequate parking space potential as a service to ferryboat commuters. Each site must be able to provide parking: topographic features were considered in the light of this criterion.

Ferry terminal sites are required to be located near a population center or in a location central to large numbers of people. Centrality is significant because of potential market opportunities.

2. Terminals

The terminal sites selected for detailed study and evaluation were chosen on the basis of several factors. The first criterion came directly from the commuter questionnaire which explicitly asked on question 18: "What are your first, second, and third choice locations for a ferry terminal?" Information from the commuter survey indicated that the preferred ferry terminal sites were located in nine general geographic areas of Marin County:

Area	1st Choice Preference
North or Central Sausalito	15%
North Sausalito	16%
Tiburon - Belvedere	10%
Corte Madera	16%
Greenbrae - San Quentin Point	7%
San Rafael	28%
County Civic Center	4%
North of Gallinas Creek	4%
Sir Francis Drake Highway	1%

The Sir Francis Drake Highway area was deleted from further study because of the negligible computer response (0.4% or 3 of 1090 respondents).

TABLE 27

WEIGHTED AVERAGE TRAVEL TIMES FROM CENSUS TRACTS TO SEVEN POSSIBLE TERMINAL LOCATIONS IN MARIN

Terminals

Census Tract	Point San Quentin	North Sausalito	Tiburon	Corte Madera	Mill Valley Heliport	San Rafael	Gallinas Creek
01	27	40	41	31	35	26	22
02	28	41	42	31	36	27	22
03	28	41	42	32	36	28	23
04	23	36	37	26	31	22	18
05	Hamilton Air Force Base						
06	15	27	29	18	23	14	10
07	18	30	32	21	26	17	10
08	15	28	29	19	23	15	10
09	12	25	26	16	20	11	15
10	13	26	27	16	21	11	15
11	11	24	25	14	19	10	15
12	9	22	24	13	18	8	15
13	29	41	42	32	36	28	43
14	21	33	35	24	29	20	25
15	19	31	33	22	26	18	24
16	17	29	31	20	25	16	21
17	15	26	28	17	22	15	20
18	14	24	25	14	19	17	22
19	9	20	21	10	15	13	18
20	12	19	21	10	15	16	20
21	10	17	18	7	12	15	17
22	San Quentin Prison						
23	19	20	7	16	15	24	26
24	16	17	10	13	13	21	23
25	14	13	13	11	9	19	21
26	15	15	17	12	11	19	21
27	18	18	20	15	13	22	24
28	18	15	20	15	11	22	24
29	16	11	17	13	6	20	22
30	18	8	20	15	8	23	25
31	U.S. Military Reserve						
32	49	54	57	49	50	51	53
33	57	69	71	60	65	56	58

Source: Traffic zone level travel times from Marin Balanced Transportation Program.

For purposes of study, a specific site in each of the eight areas was chosen after a field survey of each general area. Two possible sites were selected for study in the North Sausalito and the Corte Madera general areas because of the strong specific site response of the commuter survey. Figure 5 shows the location of these sites, which are:

General Area	Specific Site
South or Central Sausalito	-Trade Fair (old Berkeley-Sausalito terminal)
North Sausalito	-South of Corps of Engineers Facility
	-Mill Valley Heliport
Tiburon - Belvedere	-Harbors Tours terminal
Corte Madera	-Paradise Drive
	-San Clemente Creek
Greenbrae - San Quentin Point	-San Quentin Point - northwest of Marin Rod and Gun Club
San Rafael	-San Rafael Creek - Harbor Road
County Civic Center	-Gallinas Creek
North of Gallinas Creek	-Bel Marin Keyes

Several political bodies were interested in expressing their preferences for ferry terminal sites in Marin County. The Bay Conservation and Development Council is interested in seeing ferryboat service established and was helpful in defining advantages and disadvantages of several sites. Local government officials and planning personnel were contacted to determine zoning ordinances for parking and public reaction to terminal sites.

Each of the specific sites was evaluated on the basis of our four requirements for a ferry terminal: water access, land access, parking, and centrality. (Table 28).

The Trade Fair site in South Sausalito, once the terminal for the Sausalito-Berkeley ferryboats, has excellent water access. It is 5.5 nautical miles to the San Francisco Ferry Building and would require no dredging. It offers very good market opportunities in the South Marin area. The Trade Fair site has three important disadvantages. Land access is restricted to Bridgeway Ave. in Sausalito which is already heavily strained. The inadequate parking facilities adjacent to the terminal area are a major consideration because local zoning ordinances prohibit any upward expansion of parking areas. Local and civic opposition to the Trade Fair terminal site is another significant factor. The Sausalito Yacht Club has expressed opposition because the ferry service might interfere with children's sailing classes. The Sausalito City Council expressed opposition to this site because it would bring more tourists into the downtown area and because it would not conform to the Sausalito Revised General Plan.

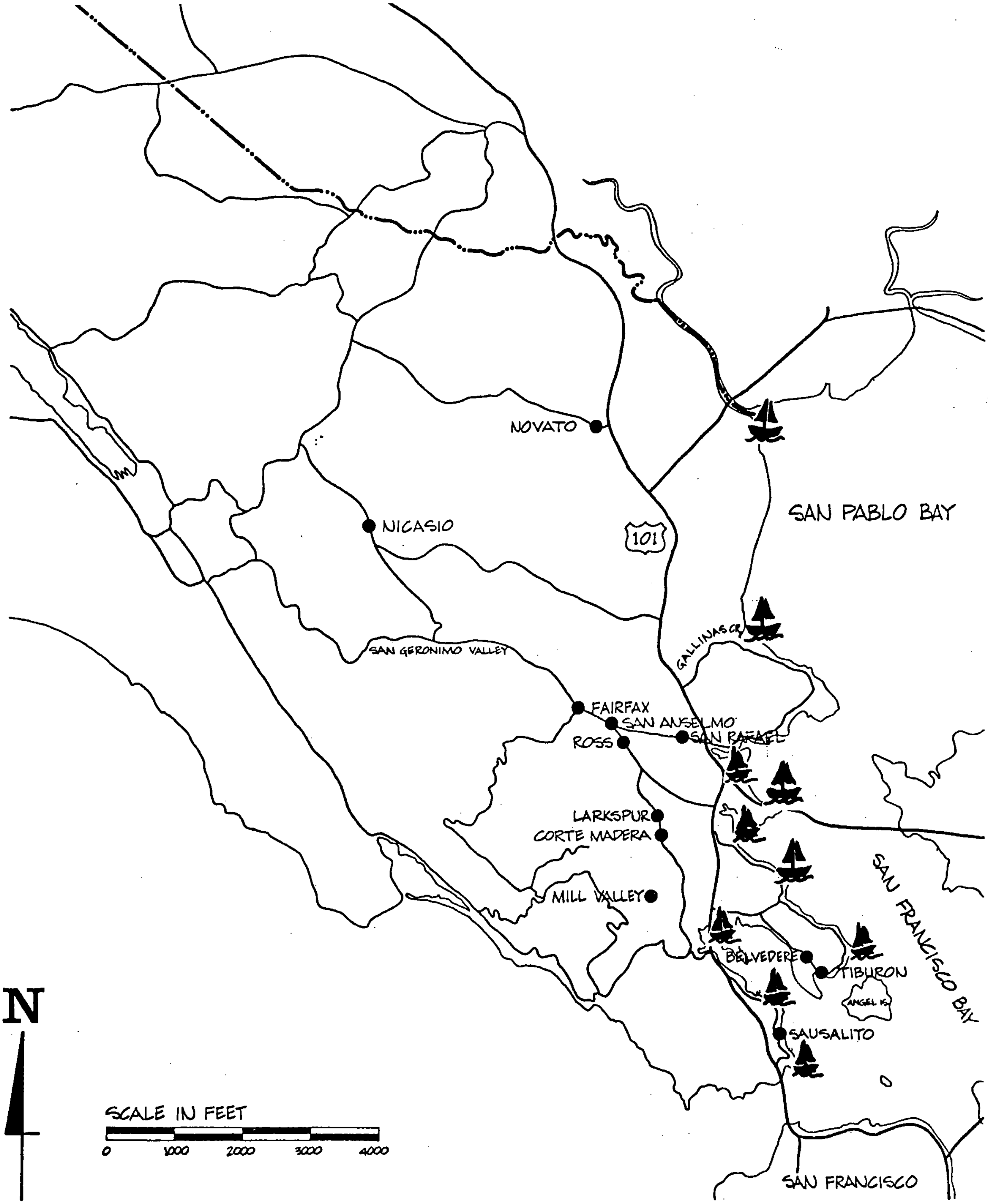


FIGURE 5 LOCATION OF TERMINALS CONSIDERED - MARIN COUNTY

TABLE 28

TERMINAL SITE CRITERIA RANKINGS

Site	Water Access	Land Access	Parking	Market	Advantages	Disadvantages
Trade Fair - Sausalito	Excellent	Very Poor	Very Poor	Very Good	Fast Route	Very Poor Access Local Opposition
South of Army Corps of Engineers Sausalito Site	Very Good	Good	Good	Very Good	Adequate Parking	Long Run
Mill Valley Heliport	Very Poor	Good	Very Poor	Excellent	Good S.M. Market	No Parking Narrow Route
Tiburon (Harbor Tours)	Excellent	Poor	Very Poor	Very Good	Proven Site Nearest to Ferry Bldg.	Poor Land Access - No Parking
Paradise Drive	Very Good	Very Good	Excellent	Excellent	Most Central Site	Small Amount of Dredging
San Clemente Creek	Very Poor	Poor	Very Good	Excellent	Most Central Site	Large Amount of Dredging
San Quentin Point	Fair	Very Good	Excellent	Excellent	Central Market Good Access	Require Dredging
San Rafael Creek	Very Poor	Very Poor	Poor	Very Good	Central Market	Dredging - No Parking
Gallinas Creek	Poor	Very Poor	Excellent	Very Good	Good Parking Close to Civic Center	Dredging-Long Boat Time
Bel Marin Keyes	Good	Fair to Good	Good	Excellent	Local Support	Not Central to All Commuters

Source: Arthur D. Little, Inc. estimates.

The terminal site in North Sausalito, in the area immediately south of the Corps of Army Engineers complex, has good water access. The water depth through the main channel to the terminal site varies between 16 and 18 feet. Because of the moderate to heavy small boat traffic, displacement ferries would have to travel at reduced speeds beyond Sausalito Point, though the low wakes generated by more advanced vessels may mitigate this problem. The land access to the terminal site is also good although heavy automobile traffic might strain road capacity.

The site has excellent parking potential; a large central parking area has been set aside by the City of Sausalito which will be adequate to meet commuter demands. The terminal site is reasonably well situated in terms of market opportunities, although not as well as the other terminal sites located in South Marin.

The Mill Valley Heliport terminal site has very poor water access; it is doubtful whether the Sausalito Canal (once constructed) could accommodate any displacement ferries. During the summer months, heavy small boat traffic can be expected to be a problem. As with the site immediately south of this site, ferries would have to operate at reduced speeds past Sausalito Point. The Mill Valley site does have good land access via Highway 101 and Shoreline Highway. The amount of land available for parking facilities is inadequate to meet commuter demand, and multilevel expansion is doubtful due to local zoning ordinances. The site offers excellent market opportunities and is located in a central position for the majority of commuters from South Marin.

The Tiburon site, currently used by Harbor Tours for two commuter runs per day, has excellent water access. No dredging is necessary because of the depth of the water, the small boat traffic is minimal, and the site is only 5.6 nautical miles from the San Francisco Ferry Building. Land access is poor; Tiburon Blvd. via U.S. 101 is of limited capacity which would be strained by heavy commuter traffic. The parking facilities at the Tiburon site are currently overcrowded and local zoning ordinances prohobit multilevel parking structures. Strong local opposition to traffic congestion and necessary parking improvements can be expected.

The Corte Madera - Paradise Drive ferry terminal site has very good water access to the San Francisco Ferry Building. Some dredging would be necessary unless a pier were constructed over 300 yards of marsh land. Because of deeper water the siltation rate, unlike that at the Corte Madera - San Clemente Creek site, is negligible. The site is 9.4 nautical miles from the Ferry Building. The Paradise Drive site has an immediate disadvantage in terms of land access because Paradise Drive is not a major route. However, a freeway off-ramp from U.S. 101 could be constructed at the Tamalpais Blvd. interchange going directly to the terminal site parking facilities and an adjacent recreational area. The site has excellent parking potential if some bay fill would be permitted. Much of the existing land is zoned for medium-density residential use. The Paradise Drive terminal location is most centrally located in terms of Marin County commuter populations.

The Corte Madera-San Clemente Creek terminal site has very poor water access because of the amount of dredging necessary to make the site adaptable to all types of ferries. The siltation rate of 9-12 inches per year would necessitate costly annual maintenance. Land access to the site is poor; there is no easy or major access into the area. The expansion of Paradise Drive, as proposed in the Corte Madera General Plan, is not expected to be of sufficient capacity to handle heavy commuter traffic. The parking potential of the area is very good because of the amount of flat vacant land and marsh lands adjacent to the site suitable for parking. The site is the most centrally located to the commuter market; it is within 17 minutes road time from Central Marin and 12 minutes to Southern Marin.

The Point San Quentin terminal site, located northwest of the Marin Rod and Gun Club, has fair water access. Some dredging may be necessary because there is no existing channel and the water is fairly shallow. The site has two other water access disadvantages. It is located 11 nautical miles from the San Francisco Ferry Building and boats traveling from it would have to navigate beneath the Richmond-San Rafael Bridge; both of these factors increase boat running time. The site has very good land access from both the north and south on Highway 17 via U.S. 101. The parking potential and market opportunities are both evaluated as excellent at the Point San Quentin terminal site.

The site located near Harbor Road in San Rafael Creek has very poor water access because of shallow water in the channel and also because it is 13.6 nautical miles to the San Francisco Ferry Building. There is also very poor land access; there is no major route to the area and current traffic congestion suggests that additional commute traffic would severely strain roads. There is little adjacent land which could be suitably used for parking. This has the additional disadvantage, as do all sites north of Point San Quentin, of requiring navigating beneath the Richmond-San Rafael Bridge.

The Gallinas Creek terminal site, serving Marin County Civic Center and the northern portion of the county, was evaluated as having poor water access because of dredging requirements and its distance to the Ferry Building (16.3 nautical miles). The land access to the site is currently poor because no major access road serves the area from U.S. 101. The adjacent marshes provide excellent parking potential and the market opportunities appear to be very good. The site has the advantage of being located near the County Civic Center and recreational facilities now are under construction.

Commuters from North Marin (Novato) could greatly benefit from a site located at the mouth of Novato Creek near Bel Marin Keyes. The water access at this site is excellent for the ACV craft, although enormous dredging would be required for any other type of vessel. Brian Mattson, Planning Director for the city of Novato, informs us that the site is readily accessible from Highway 37 which connects directly with U.S. 101 and that sufficient area would be available to accommodate parking. There is a good commuter market residing in the area, some of whom currently use public transit for the journey to work. The use of the area for a ferryboat terminal would be compatible with the Novato General Plan.

E. HYPOTHESIZED VESSEL AND TERMINAL ALTERNATIVES

The vessel and terminal site options just discussed would provide the components for many alternative types of ferry services. We have not tried to list every possible combination. However, three vessel-terminal combinations stand out as being most typical of systems likely to provide practical solutions to the commuter congestion problem. One of these combinations utilizes displacement vessels exclusively, while the other two utilize more exotic craft. This section of the report describes the nature of these combinations and forecasts the number of passengers that they will serve. We discuss the relative advantage of each combination in terms of their ability to satisfy the demands of the commuting market. These alternative combinations determine the most appropriate feeder system that should be developed as an integral part of the system. Therefore, the remaining section of this chapter will summarize the feeder system alternatives. In the next chapter, the financial operation of these systems will be simulated and evaluated.

1. Hypothesized Ferry System Utilizing Displacement Vessels at Single Terminal

Utilization of the displacement prototype dictates a single ferry terminal site in a location which best meets requirements of minimizing travel time for all Marin County commuters. The Corte Madera - Paradise Drive terminal was the best single site available in Marin County. In addition to reducing the travel time for a maximum number of Marin County commuters due to its central location, the site has the further advantages of a low siltation rate, a relatively short nautical distance to San Francisco (9.4 nautical miles), and an excellent potential to provide parking facilities. The primary disadvantage is the present inadequacy of highway access to the site.

In order to evaluate the time advantages which accrue to each location, a weighted average time for each of the three Marin County superzones to the site in question was computed. For the Paradise Drive terminal these weighted averages are: 35 minutes from North Marin, 18 minutes from Central Marin, and 13 minutes from Southern Marin (Table 29). These weighted time estimates are then added to the time it will take to cross from the terminal location to the Ferry Building in San Francisco (Table 30). For a displacement hull vessel traveling at a fast speed of 22 knots the waterborne portion of the trip would take approximately 26 minutes.

Fifteen equations defining these demand functions are derived from the commute times calculated for each of the three superzones in combination with a $1.50 round-trip daily fare. The response to the survey demonstrated that at the $1.50 price a maximum amount of revenue was generated. Calculations were then made to determine the percentage who will switch at this price and time combination (Table 31). For instance, at this time and price structure we estimate that as many as 47% of those currently commuting to San Francisco by car would switch to a ferry system.

Under the one terminal - displacement hull assumption, the demand model forecasts an average of 9500 daily round trips at a $1.50 total cost to the Ferry Building. However, we reduced this estimate by 10% to 8500 (rounded) to take into consideration the relatively long land access time that would be involved for some Marin County residents living in North and South Marin. In the three terminal - exotic craft alternative in which water time was increased but land access time decreased, there was no need to further adjust the estimates derived with the use of the model.

The physical aspects of the site, as summarized in the preceding section, helped make the Corte Madera - Paradise Drive location the best for displacement vessels. The potential parking facilities at this location are quite good due to the adjacent flat undeveloped land. Some of the spoils of dredging might be used for additional parking and recreational areas. As previously mentioned, the site has very poor land access because Paradise Drive is not a major route. Although recommendations to widen the road to four lanes were proposed in the Corte Madera general plan, such improvement would be insufficient to carry large numbers of cars to the terminal site because of cross streets in residential sections requiring signal regulations. A solution to this land access problem could be induced by a freeway off ramp from U.S. 101 at the Tamalpais interchange to go directly to terminal parking areas and adjacent aquatic recreational area.

A sample weekday ferryboat schedule was derived utilizing the displacement vessel - Paradise Drive terminal site package results in the following assumptions concerning this hypothesized system:

Vessels - 4 displacement

Distance to Ferry Building - 9.4 nautical miles

Vessel Speed - approximately 22 knots

TABLE 29

AVERAGE TRAVEL TIMES FROM MARIN SUPERZONES TO TERMINAL

Zone	Point San Quentin	North Sausalito	Tiburon	Corte Madera	Mill Valley Heliport	San Rafael	Paradise Drive	Gallinas Creek
North Marin	31	43	44	34	38	38	35	29
Central Marin	14	26	28	17	22	14	18	17
South Marin	15	15	17	12	11	20	13	22

Source: Arthur D. Little, Inc. estimates based on Marin County Planning Department calculations of travel time between traffic centroids.

TABLE 30

WATER TIMES BY VESSEL TYPE BETWEEN A MARIN TERMINAL AND FERRY BUILDING

	Nautical Miles to Ferry Building	Displacement 22 knots	Hydrofoil 40 knots	ACV 37 knots
North Sausalito	7.5	21	11	13
Tiburon	5.6	15	9	10
Paradise Drive	9.4	26	14	17
Point San Quentin	11.0	30	17	20
Gallinas Creek	16.3	45	25	26

Source: Arthur D. Little, Inc. estimates.

TABLE 31

PERCENT OF COMMUTERS SWITCHING TO FERRYBOAT SYSTEM BASED ON DEMAND FUNCTIONS WITH TERMINAL LOCATION ABOVE PARADISE DRIVE AND A FARE OF $1.50

A. Automobile Commuters

Marin Zone from/to	CBD San Francisco Zone A	Outer CBD San Francisco Zone B	Rest of San Francisco San Francisco Zone C
1 North and West Marin	41	27	14
2 Central Marin	47	39	18
3 South Marin	29	21	16

B. Bus Commuters

Marin Zone from/to	San Francisco Zone A	San Francisco Zone B	San Francisco Zone C
1 North and West Marin	55	17	33
2 Central Marin	73	32	72
3 South Marin	53	38	19

Source: ADL estimates.

Running Time - approximately 26 minutes

Time at Terminal - 4 minutes

Round Trip - 1 hour

Sailing Headway - 15 minutes

Vessel Capacity - 1500 - 2000 passengers

In the peak commute hours, 6:30-9:41 a.m., Corte Madera - Paradise Drive departures would be made every 15 minutes. From 9:41 a.m. to 3:30 p.m. ferry departures would be scheduled on an hourly basis. The homeward bound commute hours, 3:30-5:30 p.m., would again be scheduled every 15 minutes. From 5:30-8 p.m. or the last run to Paradise Drive from San Francisco, trips would be made every half hour. Additional evening runs may be advisable on Friday, Saturday, and Sunday nights.

The displacement hull alternative would permit breakfast service in the mornings with cocktails available on the return trips. The larger exotic craft could also provide these amenities although the smaller ones would be limited to coffee service.

2. Three Terminals with Exotic Craft (Hydrofoil Examples)

The utilization of hydrofoil vessels or air cushioned vehicles in a ferryboat system increases the number of terminal options. The high running speed (40 knots) of the hydrofoil enables us to look at all site options without making water distance to the San Francisco Ferry Building a major consideration. Land access and centrality were judged by the ADL research team as the critical determinants of site options utilizing hydrofoil vessels. Land access requirements included finding the shortest land time to centrally located terminals. In consideration of the demand parameters developed in Chapter IV, in which land time is perceived as long while water time is short, road time has been minimized in selecting hydrofoil sites, although total trip time may in fact be longer.

An example of reducing land time even at the expense of increasing the total trip time by two minutes is illustrated below:

From Census Tract	Area	Gallinas Creek Land Time	Gallinas Creek Sea Time	Gallinas Creek Total	Paradise Drive Land Time	Paradise Drive Sea Time	Paradise Drive Total
4	Novato	20	25	45	29	14	43

The nine-minute reduction in land time more than justifies the selection of this three terminal option even though water time is increased by 11 minutes.

In a similar manner to that described for the single terminal alternative, patronage levels were developed for the three terminal - exotic vessel alternative. The total weighted times to the ferry building from the 3 superzones are as follows: North Marin residents via Gallinas Creek, 54 minutes; Central Marin via the Paradise Drive terminal, 32 minutes; South Marin via the North Sausalito site, 26 minutes. While the above weighted times are less than the short times stipulated in our survey questionnaire for each of the three superzones, we elected to use the latter when predicting ferryboat patronage for this alternative. Table 32 shows patronage estimates for the three terminal- hydrofoil system at a fare of $1.50 per round trip.

TABLE 32

ESTIMATED DAILY PATRONAGE FOR THREE TERMINAL - ADVANCED TECHNOLOGY SYSTEM AT A FARE OF $1.50 PER ROUND TRIP

	San Francisco Zone			
Marin Zone	C.B.D.	Outer C.B.D.	Rest of San Francisco	Total
North Marin	800	200	500	1,500
Central Marin	3,200	600	1,200	5,000
South Marin	2,600	700	1,000	4,300
Total	6,600	1,500	2,700	10,800

There are various reasons for choosing this conservative approach in making our patronage forecast. The primary one is that we have no survey data for trip time alternatives shorter than those that were in the questionnaire. Thus we would have to extrapolate the available data if we were to attempt a forecast of patronage at the exact weighted times calculated for the three terminal - hydrofoil alternative. It would be imprudent to attempt such an extrapolation of commuter behavior. Second, the impact of the shorter ferry times will be offset to some degree by the speedup in automobile time that would result from relief of bridge congestion occasioned by a heavy switch to ferry use. A distribution of patronage according to location of terminal is summarized in Table 33. These distributions are not identical to the three zoned origin estimates because the travel time of some people in the central zone would actually be minimized if they travel to the Gallinas Creek terminal, while some South Marin commuters would find the Paradise Drive terminal most convenient.

TABLE 33

DISTRIBUTION OF PATRONAGE
ACCORDING TO LOCATION OF TERMINAL

Terminal Site	Number of Commuters Per Day (estimates rounded)
Gallinas Creek	3,000
Paradise Drive	5,000
North Sausalito	3,000
Total	11,000

Source: Arthur D. Little, Inc.

The Gallinas Creek site is well situated for the North and a portion of Central Marin commuters. Maximum road travel time for North Marin commuters is 25 minutes, and some road improvements to the site will shorten the land access time. The important point as stated once before is that road travel time is approximately nine minutes faster to this site than to the Paradise Drive site for North Marin commuters. The advantages of the Corte Madera - Paradise Drive terminal have been discussed in the one terminal alternative. The North Sausalito site located north of the Army Engineers Corps's installation in Sausalito has very good water access for hydrofoil vessels. In fact the water is deep enough to require no dredging. The site is only 7.5 nautical miles or 11 minutes running time from the San Francisco Ferry Building. The land access to the North Sausalito site is presently good and is expected to be enhanced with the improvement and extension of Nevada Street to U.S. 101, as proposed in the Proposed Revised General Plan of Sausalito completed in the April 1967 report by William Spargle and Associates. The same plan indicates that the parking potential of the site is very good. A parking area could be developed at the foot of Nevada Street.

The following basic assumptions were made for a hydrofoil vessel using three terminal site package. Figure 6 shows the locations of the three sites.

	Gallinas Creek Terminal	Corte Madera-Paradise Drive Terminal	North Sausalito Terminal
Number of Vessels	4	7	3
Distance to Ferry Building	16.3 naut. miles	9.4 naut. miles	7.5 naut. miles
Approximate Vessel Speed	40 knots	40 knots	40 knots
Approximate Running Time	25 minutes	14 minutes	11 minutes
Time at Terminal	3 minutes	3 minutes	3 minutes
Round Trip Terminal	56 minutes	34 minutes	28 minutes
Sailing Headway During 6:45-8:15 a.m.	19 minutes	8 minutes	20 minutes
Vessel Capacity	250 passengers	250 passengers	250 passengers

In addition to the 14 vessels allocated above there would be a need for two additional hydrofoils alternating between the Corte Madera and Gallinas Creek sites during commute hours if the assumed passenger estimates and schedules are to be maintained.

The patronage estimates for the packages described above assumed a static condition, that is, no interplay between the lessening of traffic congestion from the existence of a ferry system and the subsequent number of ferryboat switchers who elect once more to drive their car to work. We support the realism of these patronage estimates for the following two reasons:

1. Bridge traffic is currently increasing in excess of 1,200 vehicles per year.

2. There would be an approximately two-year time lapse between the date of the initial survey, February 1969, and inauguration of a ferry service.

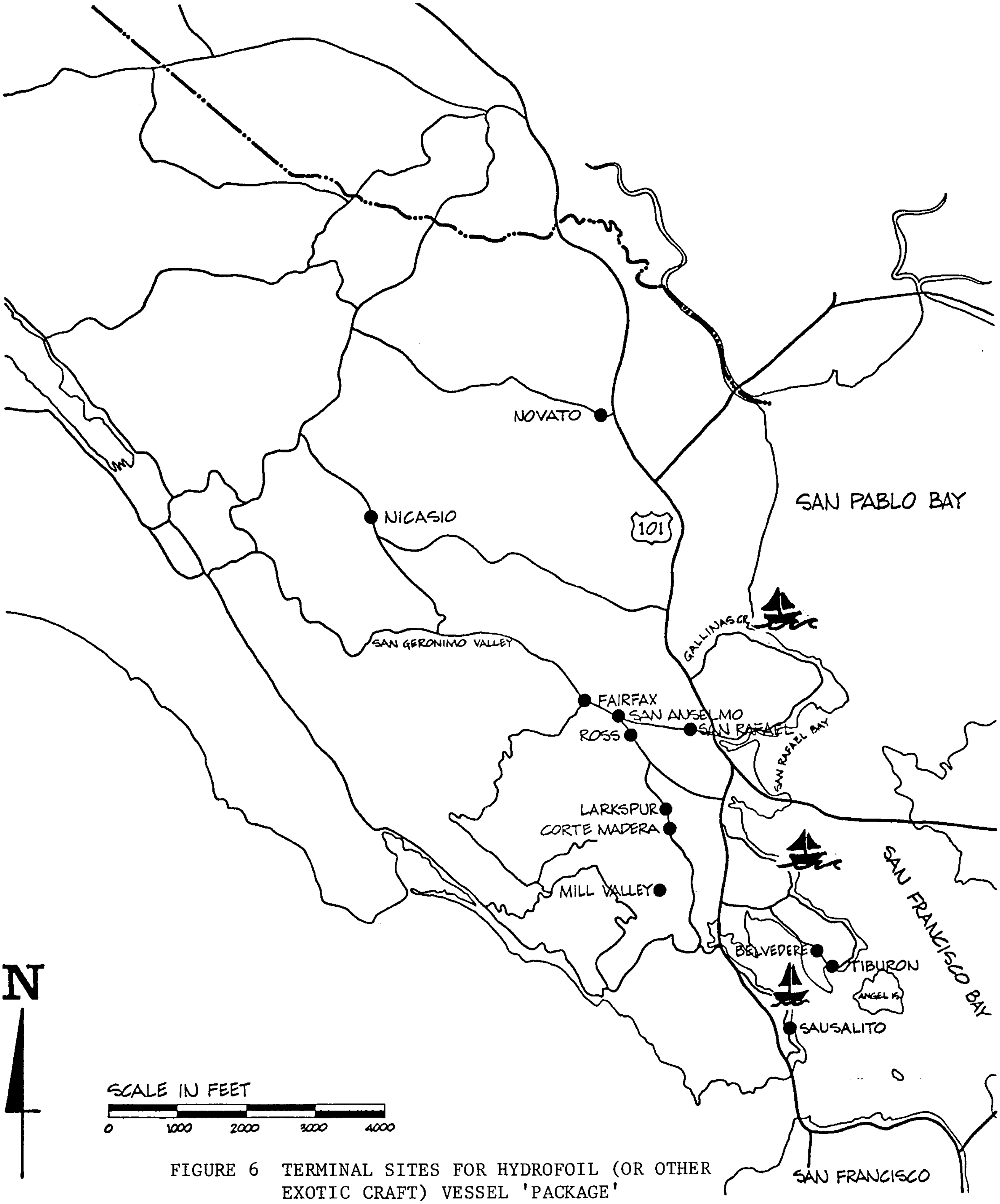


FIGURE 6 TERMINAL SITES FOR HYDROFOIL (OR OTHER EXOTIC CRAFT) VESSEL 'PACKAGE'

*The Corte Madera-Paradise Drive site is also used in the displacement hull single terminal example.

We have not detailed the hypothesized aspects of a three terminal system using air cushioned vehicles because most of its aspects would be similar to the hydrofoil three terminal system described above. However, the ACV using ferry service whose financial operations are simulated in Chapter VI would use four 1000-capacity vehicles instead of 15 hydrofoils with a capacity of 250 each.

F. FEEDER SYSTEM ALTERNATIVES

The success of any ferry service will depend upon the adequacy of the feeder system. Adequacy should be defined in terms of the level of quality and service demanded by today's affluent Marin County commuter rather than type of transportation. Thus, a well designed feeder system can be viewed as a basic requirement of any Marin - San Francisco waterborne transportation system.

Basically, there are two primary feeder options: the automobile and the bus. Each has its advantages and disadvantages. The automobile provides the commuter with the greatest degree of flexibility and convenience. However, it necessitates the construction of adequate parking facilities and appropriate highway access. Without satisfactory road access the commuter induced automobile traffic congestion problem is merely shifted from inter- to intra-regional. The closer the bus feeder option comes to providing the rider with the same degree of flexibility he obtains from driving his own car, the larger the number of potential ferryboat riders who will elect to use mass transit modes from home to place of employment. The obvious advantage of attracting commuters to a feeder bus system is the reduction of traffic congestion and the concomitant resources which have to be allocated to highways and parking structures.

The above discussion does not mean to infer that there should be one type of feeder system. In almost all cases bus and car facilities will have to be offered in order not to lose a large number of potential ferryboat riders. However, the proportion will alter by terminal location depending upon the demand parameters and site specifications. As regards the former, the survey data summarized in Chapter IV suggests that between 14% and 25% of the potential sample commuters would not drive to the ferry terminal even if parking were provided free. Many of these persons, of course, do not have access to a car. Therefore, if automobile related facilities were the <u>only</u> feeder option up to 2000 round-trip fares per day would be lost. Conversely, it would not be prudent to do away with parking facilities because the survey data suggests a loss of as many as 3500 daily round-trip fares.

We want to mention at this juncture a third feeder option on the Marin County side, that is, the possibility of using a rail feeder service. Currently, the right of way to the Northwestern Pacific Railroad line from Tiburon to Meadowsweet (an area near Paradise Drive) still exists although trackage and some trestles have long since vanished. We will not dwell on this feeder alternative because of the expense to restore it to an operating state, the limited number of potential terminal locations it can serve, and most important, its inherent requirement of an additional transfer for the potential ferryboat rider. The survey data demonstrates conclusively the greater the number of transfers, the longer the trip will be perceived as being and the lower the likelihood the commuter will switch to a ferry service. The Marin County feeder opportunities differ appreciably from those in San Francisco. Therefore, the feeder options associated with each of the participating counties will be described separately.

1. Marin County Feeder Options

There has been no attempt made to describe the feeder options in terms of specified routings or time schedules. Such procedures will have to await the final determination of terminal sites. We have delineated the proportion of parking spaces to bus loads that would be appropriate to two illustrative terminal site alternatives. Figure 7 presents the bus and car proportions for a one terminal alternative. This alternative assumes a site somewhere in the Corte Madera area with an estimated daily 8500 total round-trip fares at $1.50; 1000 of these daily round-trip fares were attracted from North Marin, 4800 from Central Marin and the remaining 2700 from South Marin. The proportion of the feeder system modal split was derived from the survey data presented in Chapter IV. The potential ferryboat switchers in South and Central Marin are the most automobile oriented, those in North Marin the least. The number of bus riders versus parkers are calculated separately for each of the three Marin County origin zones and are then combined to provide an estimate of total parking spaces required -- 4000 -- and number of bus loads needed during the commute hours -- 60.

The same procedure is then undertaken for the three terminal site alternative. Since there is a terminal site postulated for all three origin zones we have made the simplifying assumption that each terminal site will only attract commuters from its own zone. Obviously in the real world there would always be a percent of commuters residing in one zone finding it more convenient to use a terminal located in another.

The three terminal site alternative (Figure 8) also tends to promote a larger percentage of "kiss and ride" trips. A terminal closer to the place of residence encourages the wife to drop off her husband in the morning and pick him up again at night. This is not an insignificant consideration if one looks at existing ferry services. In Vancouver, for example, between 20% and 25% of all commuters are driven to the ferry by their spouses, thus reducing parking facility needs.

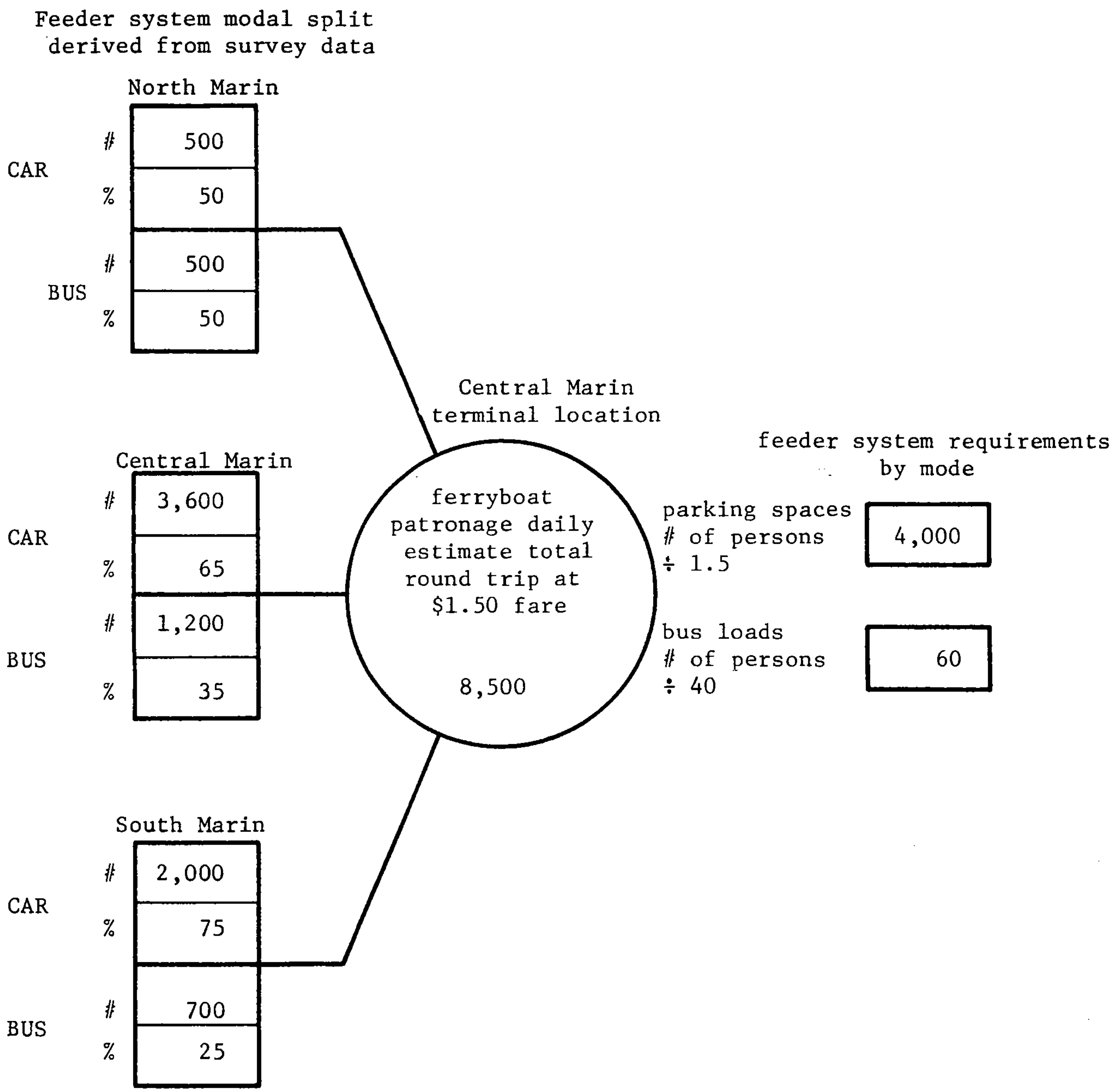
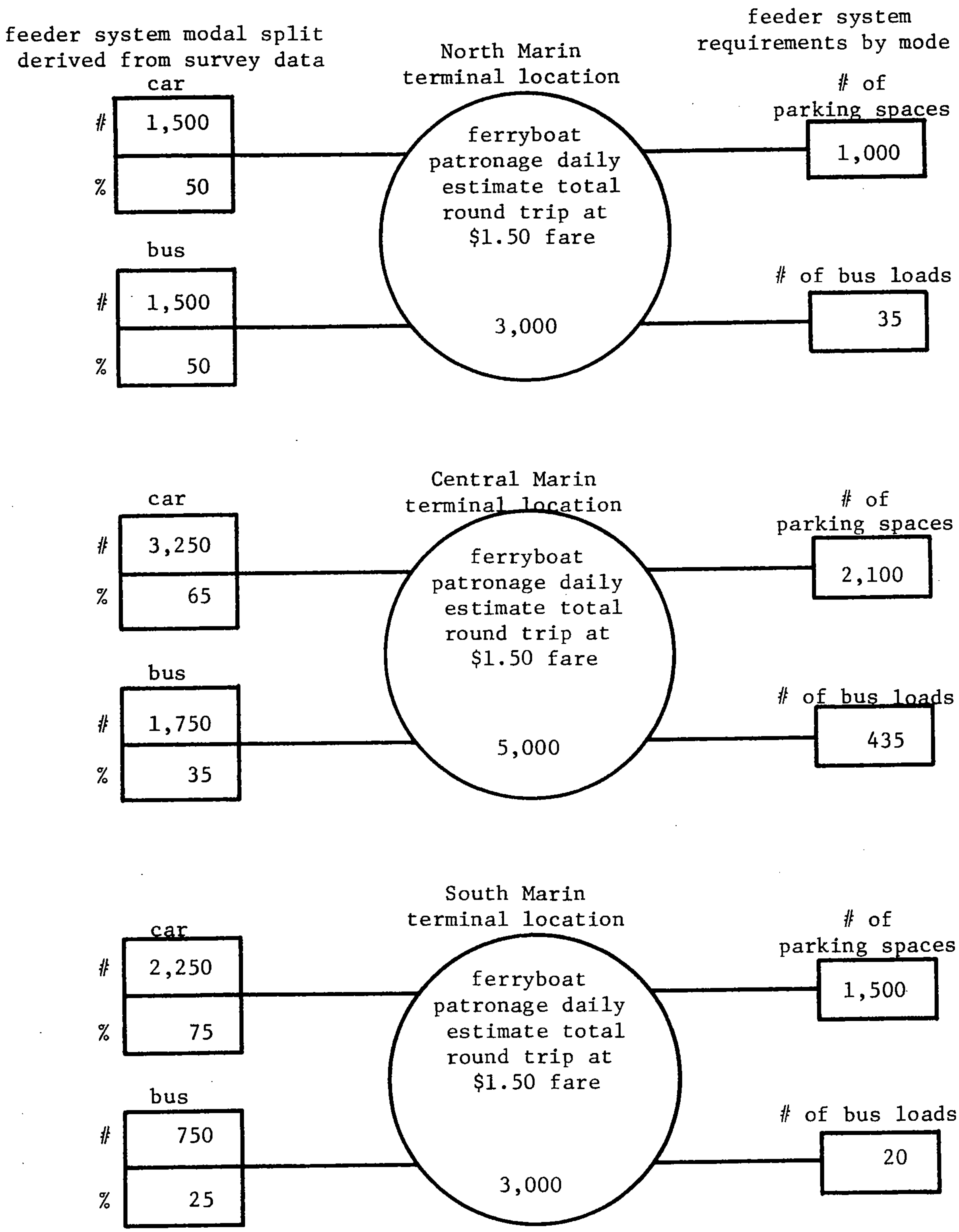


FIGURE 7 ONE TERMINAL SITE ALTERNATIVE



Note: Parking space = # of persons driving car ÷ 1.5
Bus loads = # of persons riding bus ÷ 40

FIGURE 8 THREE TERMINAL SITE ALTERNATIVE

The required number of parking spaces and bus loads during peak commute hours for the three Marin County zones is as follows:

Marin County Zone	Number of Parking Spaces	Number of Bus Loads
North	1,000	35
Central	2,100	43.5
South	1,500	20

We have assumed for both the one and three site terminal location examples a 1.5 car passenger ratio, although this proportion may be somewhat low due to the fact that theoretically many persons from a single neighborhood would be traveling to the same destination, e.g. the ferry terminal. We also calculated a bus load on the basis of 40 passengers per vehicle, assuring a seat to all patrons. The more standard calculations assume that a certain percent will be standing at any one point of time during peak use hours. However, this level of service contrasts sharply with what would have to be offered to successfully attract commuters away from their present mode.

If one bus can handle two loads during peak commute hours then the one terminal site alternative would require 30 or 35 buses while 50 buses would be needed to serve the three terminal site alternatives.

The MCTD in its Summary Presentation of an Optimum Bus System, June 18, 1969, advocates ordering between 132 (Plan II) and 166 (Plan III) buses for that system. If any buses are ordered, flexibility can be maintained if 30-35 of these vehicles are selected on the basis of how well they can serve an intraregional market and thus could meet the needs of a ferryboat commuter system. The immediate integration of a ferry-bus transit system could prevent the investment in inappropriate vehicles. If this integration is not attempted the MCTD might find itself in a position analogous to that of A-C Transit. A-C Transit, for example, now serves between 45% and 55% of the transbay commuter market. This percent is anticipated to be reduced to approximately 5% once BART is operative. However, according to the final report of Northern California Transit Demonstration Project the total adult traffic gain will be in the nature of 21% as a result of increased feeder service.* The report also hypothesizes that more than half of A-C Transit patronage will be BART related.

* Final Report of Northern California Transit Demonstration Project Coordinated Transit for the San Francisco Bay Area - now to 1975 Cal MTD-5 ord Cal MTD-6 October 1967; prepared by Simpson and Civil - Transportation Engineers, Philadelphia and San Francisco, pp. 1-18.

2. San Francisco Feeder Options

More than 60% of the commuters estimated to switch from their present mode to a ferry system are employed in downtown San Francisco. The majority of these will be able to walk to their jobs once they have disembarked. Tables 34 and 35 present the number of daily round-trip fares at $1.50 distributed by origin and destination zones for the one terminal and three terminal alternative. These tables clearly demonstrate the erosion effect of more distant zones. Thus, while approximately 60% of all those willing to switch to a ferry work in the CBD, only 14% work in the outer CBD and between 24% and 25% work in the rest of San Francisco. This decreasing number of persons willing to switch from their present mode to a ferry service in the outer CBD and rest of San Francisco, can be attributed to the perceived attitudes toward Muni's present bus system.

TABLE 34

ESTIMATED DAILY PATRONAGE LEVELS FOR ONE TERMINAL ABOVE PARADISE CAY EAST OF PARADISE DRIVE AT A FARE OF $1.50 PER ROUND TRIP

Marin Zone	San Francisco Zone: Downtown San Francisco	San Francisco Zone: Outer Downtown	San Francisco Zone: Rest of San Francisco	Total
North Marin	600	130	300	1,030
Central Marin	3,040	600	1,120	4,760
South Marin	1,600	470	650	2,720
Total	5,240	1,200	2,070	8,510

TABLE 35

ESTIMATED PATRONAGE LEVELS
FOR THREE - TERMINAL - ADVANCED TECHNOLOGY
AT A FARE OF $1.50 PER ROUND TRIP[a]

Marin Zone	San Francisco Zone: Downtown San Francisco	Outer Downtown	Rest of San Francisco	Total
North Marin	800	200	500	1,500
Central Marin	3,200	600	1,200	5,000
South Marin	2,600	700	1,000	4,300
Total	6,600	1,500	2,700	10,800

a. Number refer to daily round trips

Source: Arthur D. Little, Inc. Estimates

James Carr, General Manager of San Francisco's Public Utilities Commission, has indicated Muni's cooperation in providing special limited or express bus service, should the numbers warrant it for those ferryboat commuters destined to more distant zones, for example, the medical complex, the Southern Waterfront area, the Presidio, San Francisco State or the Civic Center. This would provide a solution to the back haul problem now facing Muni during peak commute hours in which busloads of San Francisco passengers are deposited in the general vicinity of the Ferry Building after which the buses return empty.

In addition, Muni has stated a willingness to provide some specialized shopper service during the noncommute hours. For example, a minibus could meet each noncommute trip and take passengers directly to the Union Square complex or any other heavily trafficked area such as Ghirardelli-Cannery. Naturally, it would be important to publicize these services. In fact, the public relations aspect of both the commute and noncommute feeder service would have to be given prime consideration if the present negative attitudes towards bus services are to be eradicated.

The estimates of persons and round-trip fares which can be expected to use a ferry service under alternate assumptions did not consider an improved bus service either on the Marin County or San Francisco sides. Therefore, the number of Marin County commuters who switch to a ferry may be somewhat overstated if a good Marin - San Francisco line haul bus service were in operation. However, a good San Francisco feeder system would encourage riders who currently state they would not be willing to switch and are thus underrepresented in the demand estimating model.

Since the feeder service is an integral part of any waterborne transportation service it is imperative that all requisite agencies form a joint committee or association to coordinate the system. They may well be able to obtain federal assistance for such an endeavor as did A-C Transit, BARTD and Muni in planning for BART's operation. The collection of fares, routings, schedules, and the handling of public relations can best be handled in a cooperative venture. This step should be built into the system's design and development which we recommend to follow this study.

This report turns now to a financial simulation and evaluation of the three hypothesized systems.

VI. FINANCIAL EVALUATIONS

A. LIMITATIONS OF PRE-SYSTEM DESIGN FINANCIAL EVALUATION

The financial evaluation of any undesigned system cannot be exact. The task of estimating the costs that would be associated with the operation of the three alternative types of ferry systems is made especially difficult because certain system elements could be designed in a variety of ways, without dramatically altering the type of service that can be provided. For example, the terminal sites specified in the previous chapter can be shifted slightly, if real estate costs or as yet unconducted soil test suggest would be appropriate.

This inevitable lack of precision in cost estimating was recognized at the onset of this five-month study. It is noted here to highlight the need for a more in-depth financial evaluation to be accomplished concommitantly with the required engineering work and vessel tests.

Fortunately, the extensive study of commuter behavior reported in Chapter IV and detailed in Appendices A and B does permit us to make reasonably accurate revenue estimates for commuter use of the system. The data we have collected can, if carefully interpreted, be used to gauge what the commuter will buy and what he will pay for it. Noncommuter use of the new systems is more difficult to estimate, since many special trips and vessel uses may be arranged in the future which cannot be projected now. We have included only the midday use by Marin County residents that was indicated by our study. Such use amounted to only about 12% of all trips currently taken by Marin residents during noncommute hours.

B. ANALYSIS OF FINANCIAL FEASIBILITY

It is appropriate here to comment briefly on our approach to analyzing financial feasibility of the three conceptional alternatives for a San Francisco-Marin ferry system. For each alternative we have projected year-by-year estimates of revenue from various sources, such as commuter demand, noncommuters, weekend activities, and parking. Similarly we have projected year-by-year estimates of direct operating costs, that is, those costs that are associated with the boats' operation over the course of the year. In addition to these direct operating costs, we have projected various fixed costs for terminal personnel, administration insurance, and a number of other categories. Once these estimates are made, it is possible to generate year-by-year estimates of operating surplus or deficit for each of the systems.

Each system also has its own unique profile of capital investment required. In addition to the initial cost of purchasing vessels, new vessels are periodically required to handle the increase in number of passengers. Other investments include terminals, land and access roads, buses, dredging, and the cost of systems design and development. In the projection of capital investment costs, we allow for replacement of items as they wear out. For example, buses in each of the systems are replaced every 12 years, so the quality of the overall ferryboat system is maintained. Once the year-by-year operating surplus or deficit and the capital investment program requirements are known, it is possible to determine the amount of bond financing that can be issued against the system and repaid over time through the surplus of the system, and the amount of local subsidy that may be required in addition to bond financing. The results of this analysis enable us to determine whether a given system appears to be financially feasible. For each alternative--displacement hull vessels, hydrofoil craft--and aircushioned vehicles--we have carried out the analysis according to two assumptions: inflation and noninflation. Thus, we can analyze whether a given system's financial feasibility would be jeopardized by rising costs of operations.

Again it should be stressed that while we have great confidence in our revenue projections, which derived from market survey work, we have considerably less confidence in the costs, both operating and capital investment, associated with each of the systems. Costs cannot be estimated with any degree of precision until further system design and development work is undertaken. In terms of financial feasibility, this analysis, therefore, must be considered preliminary. The key question is, "At this stage of analysis, does any, or all of the alternative systems offer enough potential for financial feasibility, so that the system design and development phase is merited?"

C. FINANCIAL ANALYSIS ASSUMPTIONS

The key assumptions behind the financial analysis fall into certain broad categories.

1. Number of Terminals

For the analysis of the displacement hull vessel system, it was assumed that there would be a single terminal location in Marin, as well as a San Francisco terminal. Because of the large capacity of this vessel, approximately 1500 passengers, the judgment was made that this system could not support multiple terminals in Marin at competitive scheduled headways. Both the hydrofoil and the aircushioned vehicle (Hovercraft-ACV) systems are based on three terminal locations in Marin and one in San Francisco.

2. Passengers, Fares, System Revenues and Growth

Market research indicated that if a ferry system were to start in 1972 some 8500 daily commute passengers could be carried in the displacement hull system, as well as 3500 daily noncommuters and 6000 daily passengers on the weekend. The hydrofoil and ACV systems were based on 11,000 commuters and 4000 noncommuters per week day. In addition the 4000 a day noncommuter estimate was augmented by 2000 tourists and San Francisco users on Saturday and Sunday. These latter two systems, operating from three Marin terminals, can be expected to have a greater market pull than the displacement hull vessel. In the financial analysis of all three systems the round-trip ferry fare (including the feeder system) was assumed to be $1.50 per passenger. Each system was projected as generating a 5% per year real growth in number of passengers for the first 15 years of operation. After 1987, the number of passengers is held constant.

Parking revenues are generated by each of the systems. The one Marin terminal alternative includes 4000 parking spaces. The three Marin terminal alternative, used for two of the systems, includes a total of 4600 parking spaces. Parking revenues were based upon a daily 50 cents per space charge, with 10 cents per space going to the operator of the garages. Thus, the parking charge would generate a 40 cents per space contribution to the system or a total of about $500,000-$600,000 a year. Concessions and other sources of revenue were estimated at approximately $300,000 per year.

3. Direct Operating Costs

Direct ferry operating costs, which vary with the number of hours of boat operation, are made up to a large extent of crews, fuel, and maintenance expense. To man the four displacement hull craft requires an estimated eight crews at $115,000 each a year, or a total of approximately $920,000 a year. Fuel and direct boat maintenance costs for this system run to an estimated $140 per operating hour, or some $450,000 a year based on a schedule of slightly more than 11,000 operating hours per year.

For the hydrofoil system, crew costs are estimated at $42,000 a year per three-man crew, or $840,000 a year for 20 crews. Fuel and maintenance costs are estimated at $68.20 per running hour totaling $1.68 million for approximately 24,000 operating hours. Total direct operating cost is therefore estimated at $2.52 million a year.

The ACV vehicle is estimated to require a six-man crew at approximately $71,000 a year, or $568,000 total for 20 crews. Variable operating hourly costs for fuel and maintenance are estimated at $370 per operating hour, or $2.297 million a year for 6200 operating hours. Thus, the total direct operating costs for this system are projected at $2.865 million a year.

All of these operating costs must be increased whenever a new vehicle is placed in the system to handle passenger growth. Appropriate adjustments have been made in the financial analysis for these additional operating costs.

The estimated number of crews required was based upon specific run schedules, worked out to provide appropriate levels of commuter service based upon the market demand. Estimates of direct operating costs per hour for fuel and maintenance were based upon comparable existing systems for the displacement hull vessel system, and upon manufacturers' representation as to the cost of operating both hydrofoils and ACVs. Direct operating costs are partly a function of vehicle size and the number of passengers carried. Since 1000-passenger ACVs and 250-passenger hydrofoils are still in experimental stages, some variations from the estimated operating cost levels could well occur.

4. Fixed Annual Costs

Each system has certain fixed annual costs associated with terminal personnel, terminal repair and maintenance, administration, office expense, insurance, dredging and miscellaneous expenses. We have used comparable fixed annual costs for each of the systems, except where clear variations are known to exist--e.g., the three Marin terminals alternative will require a larger number of terminal personnel; the AVC alternative will not require the dredging expense associated with the other systems. The cost level assumed for each of these items is spelled out in the financial analysis.

5. Capital Costs

The most significant elements of capital cost are vessels and terminals. Terminal costs for Marin are roughly estimated at $10 million. Terminal costs in San Francisco are estimated at $800,000 for the ACV and hydrofoil alternatives and at $2 million for the displacement vessel alternative. The vessel cost for the displacement hull system is estimated at $4.8 million each or $19.2 million for four vessels. The 15 hydrofoil vessels at $600,000 each generate a total investment cost of $9.6 million. The four ACVs at $6 million each generate an investment requirement of some $24 million.

We have some confidence that the estimated cost of displacement hull vessels at $4.8 million each is reasonably accurate, for similar vessels are now in service in other ferry systems. The $600,000 estimate of hydrofoil vessel cost was represented to us as appropriate by Hydrodyne Marin Corporation. Experience in other parts of the world with hydrofoil systems of comparable size indicates that the above vessel cost may be somewhat low. The ACV vessel cost of $6 million again represents a manufacturer's estimate especially made for this study. No one has yet built a 1000 passenger ACV so the investment cost estimate must contain inherent uncertainties that cannot be resolved.

The useful life before replacement of the high technology vessels is again uncertain at the present time. We have used the consistent assumption of a 30-year vessel life for each of the systems, assuming that the level of maintenance cost provided for will allow these useful lives to be realized.

6. Bond Financing Program and Financing Costs

In estimating the amount of bond financing that could be undertaken with a given operating surplus, stream of cash flow over time, certain assumptions had to be made. We have assumed that the bonds would be revenue bonds against the system and that they would require an interest rate in the market of 6½%. This interest rate reflects current financial market conditions, which of course are very tight, with historically high levels of interest required on financial instruments. We feel that a 6½% represents a conservative interest rate assumption, for financial conditions may ease during the time period before bonds would have to be issued and lower interest rates could well be achieved. We have not specified any particular term or number of years for a given bond to be outstanding, but rather have issued bonds when required and paid off bonds when the system is able to. Interest payments are calculated as paid each year.

We have also not made any assumptions as to potential federal funding of the capital cost of any of the systems, which would decrease the amount of bonding required and subsequently the amount of interest cost that would have to be paid on the financing. Nor, have we made any assumptions as to the availability of initial financing from other local government or authority sources.

The local subsidy required for each of the systems is calculated on the following basis. To the extent that yearly cash requirements can be met by operating surpluses and revenue bonds, no local tax subsidy is required. However, if operating surpluses are not sufficient to carry the capital cost of the system, including periodic replacement over time, then a constant yearly amount of local subsidy has been introduced into the financial analysis. Of course, this rate of subsidy will vary from system to system and with the assumptions made in each financial analysis.

7. Inflation

We have analyzed for each of the systems both the case where inflation is not present, and one where inflation occurs. The purpose of the noninflation case is to show in present dollar terms the financial profile of each system. In essence, the noninflation case shows what real resources are expended at the present time and the current value of those real resources that are returned over time.

The inflation analysis for each system becomes somewhat more complicated as new assumptions must be made. The following assumptions as to inflation hold for each of the systems:

- Revenues are increased by 3% a year, in addition to the 5% real growth in passengers between 1972 and 1987. Operating expenses that are labor intensive, such as crew costs, are inflated at 4% a year.

- Operating expenses that are not labor intensive, such as fuel and insurance, are inflated at 2% a year.

- Capital costs are inflated at 4% a year. Thus, when an item such as buses is periodically replaced, the financial analysis calculates the increased costs for the replacement vehicles at that future point in time.

We believe that the above assumptions are reasonable for purposes of a preliminary financial feasibility study. The assumptions have been held constant for each of the systems, so that key comparisons can be made. During the system design and development phase, it will be possible to refine the assumptions and to develop better and more reliable estimates.

D. FINANCIAL ANALYSIS OF THE ALTERNATIVE SYSTEMS

1. Financial Analysis of the Three Systems with No Inflation

a. The Displacement Hull System

Tables 38-48 show the financial analysis of the displacement hull system without inflation. Table 36 shows the projections of revenue. From the left column it may be seen that the estimated 8500 commuters a day in 1972 will generate a cash in-flow of $2.15 million a year. With 5% growth per year in income through 1987, commuter revenues will eventually increase to $4.25 million. The right hand column of Table 36 shows the total projection of revenues, which increase from about $4.6 million in 1972 to $10.2 million in 1987. No system growth in revenues is projected beyond 1987.

Expenses for the displacement hull system are shown in Table 37. The annual operating cost in the left hand column starts at $1.37 million in 1972 with four vessels and increases in steps through 1987 as new boats are placed in the system to handle passenger growth. Aside from the operating costs, on a no inflation basis the other cost elements remain constant over time. The right hand column in the second page of Table 37 gives the total projected expenses for this system.

Table 38 shows the projected capital investment program for the displacement hull system. The left hand column indicates the cash investment required in each year. It may be noted that the initial investment in 1970, 1971, and 1972 total $36 million on a cumulative basis. Assuming straight line depreciation, indicated in the second column from the right, the net accumulative investment that would show in the accounting books of the system is indicated in the column on the far right. For decision and financial analysis purpose, however, the two most relevant columns of Table 38 are on the left side. The cash investment in the system is somewhat sporadic over time as indicated in the left hand column. The $4.8 million investment, say in 1976, represents one new vessel being added to the fleet. The $1.2 million investment, perhaps in 1983, reflects a replacement of the bus fleet over a 12-year life. We can see from Table 38 that the total, cumulative investment in this system through 1985 would run to approximately $51.7 million.

Tables 39-46 show the detailed estimates by component of the capital investment placed in the system. In each case the expected use for life is indicated, as well as the investment base used for the capital investment cost estimate. For one of the projects indicated in Tables 39-46, therefore represents a subcomponent of the total system investment cost, which is displayed in Table 38 and has been previously discussed.

The total cash flow projected for the displacement hull system is shown in Table 47. Revenue, expense, and annual surplus are indicated. It may be noted that the annual surplus of the system is projected as positive at $1.8 million in the first year of operation in 1972, rising to $6 million by 1985 with the growth in passenger utilization of the system. The investment cash flow is introduced from a previous section of the analysis and a net cash flow combining both annual surplus or deficit and investment cash flow is calculated in the second column from the right. It should be noted at this point that the net cash figure shown does not include financing charges for interest cost, nor the repayment of any bonds that are placed against the system. The cumulative cash flow, in the right hand margin of Table 47, shows when the system is projected to break even and recapture its total capital investment. Note that the system can recover its complete initial investment, as well as pay for periodic replacement, by 1986, or in 15 years of operation.

Even though the system does break even by 1986, it is necessary to finance the capital costs that are expended in the first two or three years. Table 48 shows a calculation of the local subsidy requirement for the system and new bonds that could be issued against the surpluses of the system. In addition, the financial payments required for the bond program are shown, including both interest payments on annual basis and principal payments when surpluses become available to repay the bonds. The cumulative or total amount of bonds outstanding in any given year is calculated in the second column from the right and a bond cash reserve is established and shown in the right hand column of Table 48.

The significant financial conclusions that can be drawn from Table 48 are as follows. First, the displacement hull system on a no inflation basis is not expected to require local subsidy. Second, future operation surpluses are significant enough that a revenue bonding program is feasible. Looking at the "outstanding bonds," we note that by 1980 the total amount of bonds outstanding reaches a maximum of $45.8 million, declines progressively, and is completely paid off by 1995. Third, the interest payments required under the bonding program represent a significant financial cost. These interest payments run to an average of approximately $2.5 million a year for 20 years, or total approximately $50 million. The assumed interest rate is 6½%. This interest cost could be saved, if direct sources of funds could be made available to help cover the initial costs of this system.

Conclusion Under the Displacement Hull System

On a noninflation basis the displacement hull system appears to be eminently feasible from the financial point of view. While the amount of investment in the system is significant, it can be fully carried by its operating surpluses as currently projected. New revenue bonds can be placed against the system and repaid out of surpluses generated by the system itself.

b. Three Terminal Hydrofoil System

The financial analysis of the hydrofoil system is contained in Tables 49-53. The format of all the financial tables is the same as in the previous case. Table 49 shows that the hydrofoil system generates projected revenues of about $5.4 million in 1972 increasing to $12 million by 1987. Table 50 indicates that system operating costs increase with the addition of hydrofoil vessels into the system and that the total operating cost rises from about $4 million in 1972 to $6.2 million in 1986.

The capital investment required for the hydrofoil system is shown in Table 51, indicating an initial capital requirement of $26.5 million rising to $35.5 million by 1985. The total investment in this system is considerably lower than that for the displacement hull system.

The total cash flow summary for the hydrofoil system is shown in Table 52. The system generates operating surpluses of about $1.4 million in 1972 rising to $5.8 million in the mid-1980s. On a cumulative cash flow basis, shown in the right hand column, the system recaptures its initial costs within the first 15 years of operation.

Table 53 shows the financing program for the hydrofoil system. Once again we find that there is no local subsidy requirement for the system, and that new revenue bonds can be issued against future operating surpluses. The amount of bond financing required, shown in the second column from the right, reaches $31 million in 1978 and declines progressively with full payout of the bond issue by the early 1990s. Interest costs over the life of the system total about $30 million, and these funds could be saved if a source for financing initial capital costs for this system could be obtained on a noninterest basis. Less interest cost is incurred in the financing of the hydrofoil system versus the displacement hull system. Both systems, however, are projected as financially feasible and capable of recovering their capital costs, as well as sustaining their operations.

Conclusion

The hydrofoil system based on the no inflation case gives every evidence of financial feasibility.

c. Air Cushioned Vehicle System

The financial profile of the ACV system on a no inflation basis is shown in Tables 54-58. Revenues, expenses, and capital costs have been projected as in the previous cases. Turning to Table 57, we see that the system does generate annual operating surpluses that can support financing. However, the investment cash flow is relatively high in the early years, reaching $38.7 million by 1972 on a cumulative basis. A significant additional investment of $6 million is required each time a new vessel is added to the fleet. When the level of annual surplus is noted and compared with the periodic investment for these new vessels, it is not surprising that the cumulative cash flow column shows a negative position extending over all of the years covered by this analysis. This indicates that some type of local subsidy will be required for this system to become financially feasible.

Table 58 supports this analysis. While the ACV system can support some bonding, up to a maximum of $15 million in 1984, a local subsidy requirement of $1.4 million is required each year in order to financially balance the total program. That is, a constant in-flow of $1.4 million is required annually in order to pay both operating costs and meet the investment program, particularly for vessel increases, as previously indicated.

Conclusions

On the basis of preliminary analysis the ACV system is financially feasible, if local subsidy funds are available on a year-by-year basis. Table 58 indicates that the local subsidy requirement is primarily necessary to meet the annual interest payments on the bond issue. These annual interest payments run from about $2.4 million to $3.2 million, at least $1 million more than the local annual subsidy requirement. Thus, if a significant amount of nonbond financing can be arranged to carry out the initial investment program, the longer term financial position of the system is much stronger. In fact, if a significant amount of grant funds or other sources can be tapped in introducing this system, the annual operating surpluses are sufficient to carry out periodic replacements, as well as pay for the annual operating costs.

The ACV system can be made to be financially feasible, although it will require more creative work than for the other two cases. This is not to say that after the system design and development phase has been concluded, the ACV system may not prove as strong as the others. Again we would call attention to the fact that many of the cost estimates are preliminary and tentative and could well change upon more detailed and careful analysis.

2. Financial Analysis of the Three Systems Including Inflationary Factors

Tables 59-63 contain the analysis of financial feasibility under conditions of inflation for the displacement hull system. The inflation case for the hydrofoil system is shown in Tables 64-68. Financial analysis for the ACV system under conditions of inflation is shown in Tables 69-73. We shall not discuss these individual cases except for conclusions, since the structure of financial analysis has been previously laid out.

Conclusions

Under the inflation case, with revenues increasing by 3%, wage costs by 4%, and capital equipment costs by 4%, the financial feasibility of the three alternative ferry systems is fundamentally unchanged from the noninflation case. The displacement hull system and hydrofoil system continue to require no local subsidy. The ability of these two systems to support revenue bonding for initial capital investment and subsequently pay off such debt expeditiously, is in fact slightly improved over the noninflation case. This stems from the fact that a large majority of the capital investment funds must be expended in the early years at today's dollars, while the bonds can be paid off out of future dollars when revenues have risen to a higher level because of inflation.

On the other hand, the ACV system financial analysis under conditions of inflation shows some deterioration. The annual requirement for subsidy support has increased from $1.42 million without inflation to $3 million with inflation. The primary reason why this system's financial position is adversely affected by inflation is related to the high capital equipment costs for future system vessel additions. With the 4% inflation in capital equipment costs per year, these future investment expenditures become significant in size. For example, the vessel to be purchased in 1988 shows a basic cost at that time of $12 million, exactly double the current price. We would not argue that an ACV system should be excluded from consideration based upon this preliminary feasibility analysis. Rather, the potential financial feasibility that is clearly shown by the two other systems indicates that further work should be done in the design and development study stage. With a further refinement in cost analysis, and additional improvements from a technological point of view, the ACV system could well be an ultimate contender. Therefore, we suggest that if a design and development stage is pursued, the ACV system be included in the analysis along with other alternatives.

E. OVERALL CONCLUSIONS FROM THE PRELIMINARY FINANCIAL FEASIBILITY ANALYSIS

Of the three systems studied, two show considerable potential for financial feasibility on a self-sustaining basis without subsidy. The ACV system shows potential for financial feasibility, if a local subsidy in the area of $1-$3 million per year were provided, or if initial financing on other than an interest-paying debt obligation could be secured. Although realistic levels of operating cost and capital investment requirement are not precisely known, nor can they be estimated without further study, past experience has taught us that the most important variable influencing financial success lies in the area of revenue projection and demand or patronage analysis. Because of the attention which has been devoted in this study to the analysis of commuter behavior, motivation, patronage estimates, and fare structure, we feel that the financial analysis is strongly based in the most important area of revenue. If the conclusion of the above financial analysis were to be expressed in one sentence it would be this: <u>A system of waterborne transportation between Marin County and San Francisco should prove to be financially feasible, if a careful design and development program is undertaken.</u>

SAN FRANCISCO/MARIN WATER TRANSPORTATION STUDY COMMITTEE

FINANCIAL ANALYSIS, NO INFLATION — TABLE 36

DISPLACEMENT HULL SYSTEM

ESTIMATED REVENUE, ALL SOURCES

	COMMUT 8.5M/D 1972 +5%/YR	NON CM 3.5M/D 1972 +5%/YR	WK END 6.0M/D 1972 +8%/YR	PARKNG 4.0M/D 1972 +5%/YR	CONCES & OTHR REVENU +5%/YR	TOTAL
1970	0	0	0	0	0	0
1971	0	0	0	0	0	0
1972	2,150	885	672	576	300	4,583
1973	2,257	929	726	605	315	4,832
1974	2,370	976	784	635	331	5,096
1975	2,489	1,024	847	667	347	5,374
1976	2,613	1,076	914	700	365	5,668
1977	2,744	1,130	987	735	383	5,979
1978	2,881	1,186	1,066	772	402	6,307
1979	3,025	1,245	1,152	810	422	6,655
1980	3,177	1,308	1,244	851	443	7,022
1981	3,335	1,373	1,343	894	465	7,411
1982	3,502	1,442	1,451	938	489	7,821
1983	3,677	1,514	1,567	985	513	8,256
1984	3,861	1,589	1,692	1,034	539	8,716
1985	4,054	1,669	1,828	1,086	566	9,202
1986	4,257	1,752	1,974	1,140	594	9,717
1987	4,470	1,840	2,130	1,196	624	10,260
1988	4,470	1,840	2,130	1,196	624	10,260
1989	4,470	1,840	2,130	1,196	624	10,260
1990	4,470	1,840	2,130	1,196	624	10,260
1991	4,470	1,840	2,130	1,196	624	10,260
1992	4,470	1,840	2,130	1,196	624	10,260
1993	4,470	1,840	2,130	1,196	624	10,260
1994	4,470	1,840	2,130	1,196	624	10,260
1995	4,470	1,840	2,130	1,196	624	10,260

SAN FRANCISCO/MARIN WATER TRANSPORTATION STUDY COMMITTEE

FINANCIAL ANALYSIS, NO INFLATION
DISPLACEMENT HULL SYSTEM
ESTIMATED EXPENSES

TABLE 37

NO INFLATION

	ANNUAL OPERAT COST	TERMNL PERSONNEL	TERMNL REPAIR AND MAINTN	ADMIN AND MANGMT PERSNL	OFFICE EXPNSE AND ADVERT	INSURANCE
1970	0	0	0	50	10	0
1971	0	0	0	100	50	0
1972	1,370	157	200	150	130	410
1973	1,370	157	200	150	130	410
1974	1,370	157	200	150	130	410
1975	1,370	157	200	150	130	410
1976	1,541	157	200	150	130	410
1977	1,541	157	200	150	130	410
1978	1,541	157	200	150	130	410
1979	1,541	157	200	150	130	410
1980	1,712	157	200	150	130	410
1981	1,712	157	200	150	130	410
1982	1,712	157	200	150	130	410
1983	1,712	157	200	150	130	410
1984	1,883	157	200	150	130	410
1985	1,883	157	200	150	130	410
1986	1,883	157	200	150	130	410
1987	1,883	157	200	150	130	410
1988	2,054	157	200	150	130	410
1989	2,054	157	200	150	130	410
1990	2,054	157	200	150	130	410
1991	2,054	157	200	150	130	410
1992	2,054	157	200	150	130	410
1993	2,054	157	200	150	130	410
1994	2,054	157	200	150	130	410
1995	2,054	157	200	150	130	410

SAN FRANCISCO/MARIN WATER TRANSPORTATION STUDY COMMITTEE

FINANCIAL ANALYSIS, NO INFLATION

DISPLACEMENT HULL SYSTEM

ESTIMATED EXPENSES

TABLE 37 (con't)

NO INFLATION

	MACHIN MAINTN ANCE	DRY DK STORES MISCEL EXPENS	DREDG-ING	TOTAL
1970	0	0	0	60
1971	0	0	0	150
1972	195	60	100	2,772
1973	195	60	100	2,772
1974	195	60	100	2,772
1975	195	60	100	2,772
1976	195	60	100	2,943
1977	195	60	100	2,943
1978	195	60	100	2,943
1979	195	60	100	2,943
1980	195	60	100	3,114
1981	195	60	100	3,114
1982	195	60	100	3,114
1983	195	60	100	3,114
1984	195	60	100	3,285
1985	195	60	100	3,285
1986	195	60	100	3,285
1987	195	60	100	3,285
1988	195	60	100	3,456
1989	195	60	100	3,456
1990	195	60	100	3,456
1991	195	60	100	3,456
1992	195	60	100	3,456
1993	195	60	100	3,456
1994	195	60	100	3,456
1995	195	60	100	3,456

TABLE 38

T CUM INVESTMENT
17,100
33,917
34,056
32,971
31,885
30,800
34,515
33,429
32,344
31,258
34,973
33,887
32,802
32,942
36,656
35,571
34,485
33,400
36,474
34,749
33,024
31,298
29,573
27,847
27,347
25,621

SAN FRANCISCO/MARIN WATER TRANSPORTATION STUDY COMMITTEE

FINANCIAL ANALYSIS, NO INFLATION
DISPLACEMENT HULL SYSTEM

TABLE 38

CAPITAL INVESTMENT PROGRAM

SYSTEM SUMMARY

YEAR	INVEST MENT	CUMUL INVEST	DEPREC IATION	NET CUM INVESTMENT
1970	17,100	17,100	0	17,100
1971	17,800	34,900	983	33,917
1972	1,225	36,125	1,085	34,056
1973	0	36,125	1,085	32,971
1974	0	36,125	1,085	31,885
1975	0	36,125	1,085	30,800
1976	4,800	40,925	1,085	34,515
1977	0	40,925	1,085	33,429
1978	0	40,925	1,085	32,344
1979	0	40,925	1,085	31,258
1980	4,800	45,725	1,085	34,973
1981	0	45,725	1,085	33,887
1982	0	45,725	1,085	32,802
1983	1,225	46,950	1,085	32,942
1984	4,800	51,750	1,085	36,656
1985	0	51,750	1,085	35,571
1986	0	51,750	1,085	34,485
1987	0	51,750	1,085	33,400
1988	4,800	56,550	1,725	36,474
1989	0	56,550	1,725	34,749
1990	0	56,550	1,725	33,024
1991	0	56,550	1,725	31,298
1992	0	56,550	1,725	29,573
1993	0	56,550	1,725	27,847
1994	1,225	57,775	1,725	27,347
1995	0	57,775	1,725	25,621

SAN FRANCISCO/MARIN WATER TRANSPORTATION STUDY COMMITTEE

TABLE 39

FINANCIAL ANALYSIS, NO INFLATION
DISPLACEMENT HULL SYSTEM

CAPITAL INVESTMENT PROGRAM

INITIAL 4 VESSELS

LIFE 30 INVESTMENT BASE 19,200

YEAR	INVEST MENT	CUMUL INVEST	DEPREC IATION	NET CUM INVESTMENT
1970	9,600	9,600	0	9,600
1971	9,600	19,200	640	18,560
1972	0	19,200	640	17,920
1973	0	19,200	640	17,280
1974	0	19,200	640	16,640
1975	0	19,200	640	16,000
1976	0	19,200	640	15,360
1977	0	19,200	640	14,720
1978	0	19,200	640	14,080
1979	0	19,200	640	13,440
1980	0	19,200	640	12,800
1981	0	19,200	640	12,160
1982	0	19,200	640	11,520
1983	0	19,200	640	10,880
1984	0	19,200	640	10,240
1985	0	19,200	640	9,600
1986	0	19,200	640	8,960
1987	0	19,200	640	8,320
1988	0	19,200	640	7,680
1989	0	19,200	640	7,040
1990	0	19,200	640	6,400
1991	0	19,200	640	5,760
1992	0	19,200	640	5,120
1993	0	19,200	640	4,480
1994	0	19,200	640	3,840
1995	0	19,200	640	3,200

SAN FRANCISCO/MARIN WATER TRANSPORTATION STUDY COMMITTEE

TABLE 40

FINANCIAL ANALYSIS, NO INFLATION
DISPLACEMENT HULL SYSTEM

CAPITAL INVESTMENT PROGRAM

ADDITIONAL VESSELS, GROWTH

LIFE 30 INVESTMENT BASE 19,200

YEAR	INVEST MENT	CUMUL INVEST	DEPREC IATION	NET CUM INVESTMENT
1970	0	0	0	0
1971	0	0	0	0
1972	0	0	0	0
1973	0	0	0	0
1974	0	0	0	0
1975	0	0	0	0
1976	4,800	4,800	0	4,800
1977	0	4,800	0	4,800
1978	0	4,800	0	4,800
1979	0	4,800	0	4,800
1980	4,800	9,600	0	9,600
1981	0	9,600	0	9,600
1982	0	9,600	0	9,600
1983	0	9,600	0	9,600
1984	4,800	14,400	0	14,400
1985	0	14,400	0	14,400
1986	0	14,400	0	14,400
1987	0	14,400	0	14,400
1988	4,800	19,200	640	18,560
1989	0	19,200	640	17,920
1990	0	19,200	640	17,280
1991	0	19,200	640	16,640
1992	0	19,200	640	16,000
1993	0	19,200	640	15,360
1994	0	19,200	640	14,720
1995	0	19,200	640	14,080

SAN FRANCISCO/MARIN WATER TRANSPORTATION STUDY COMMITTEE

FINANCIAL ANALYSIS, NO INFLATION
DISPLACEMENT HULL SYSTEM

TABLE 41

CAPITAL INVESTMENT PROGRAM

FEEDER BUSES

LIFE 12 INVESTMENT BASE 1,225

YEAR	INVEST MENT	CUMUL INVEST	DEPREC IATION	NET CUM INVESTMENT
1970	0	0	0	0
1971	0	0	0	0
1972	1,225	1,225	102	1,123
1973	0	1,225	102	1,021
1974	0	1,225	102	919
1975	0	1,225	102	817
1976	0	1,225	102	715
1977	0	1,225	102	612
1978	0	1,225	102	510
1979	0	1,225	102	408
1980	0	1,225	102	306
1981	0	1,225	102	204
1982	0	1,225	102	102
1983	1,225	1,225	102	1,123
1984	0	1,225	102	1,021
1985	0	1,225	102	919
1986	0	1,225	102	817
1987	0	1,225	102	715
1988	0	1,225	102	612
1989	0	1,225	102	510
1990	0	1,225	102	408
1991	0	1,225	102	306
1992	0	1,225	102	204
1993	0	1,225	102	102
1994	1,225	1,225	102	1,123
1995	0	1,225	102	1,021

SAN FRANCISCO/MARIN WATER TRANSPORTATION STUDY COMMITTEE

FINANCIAL ANALYSIS, NO INFLATION — TABLE 42

DISPLACEMENT HULL SYSTEM

CAPITAL INVESTMENT PROGRAM

LAND AND ACCESS ROADS

LIFE 99 INVESTMENT BASE 2,000

YEAR	INVEST MENT	CUMUL INVEST	DEPREC IATION	NET CUM INVESTMENT
1970	1,000	1,000	0	1,000
1971	1,000	2,000	0	2,000
1972	0	2,000	0	2,000
1973	0	2,000	0	2,000
1974	0	2,000	0	2,000
1975	0	2,000	0	2,000
1976	0	2,000	0	2,000
1977	0	2,000	0	2,000
1978	0	2,000	0	2,000
1979	0	2,000	0	2,000
1980	0	2,000	0	2,000
1981	0	2,000	0	2,000
1982	0	2,000	0	2,000
1983	0	2,000	0	2,000
1984	0	2,000	0	2,000
1985	0	2,000	0	2,000
1986	0	2,000	0	2,000
1987	0	2,000	0	2,000
1988	0	2,000	0	2,000
1989	0	2,000	0	2,000
1990	0	2,000	0	2,000
1991	0	2,000	0	2,000
1992	0	2,000	0	2,000
1993	0	2,000	0	2,000
1994	0	2,000	0	2,000
1995	0	2,000	0	2,000

SAN FRANCISCO/MARIN WATER TRANSPORTATION STUDY COMMITTEE

TABLE 43

FINANCIAL ANALYSIS, NO INFLATION
DISPLACEMENT HULL SYSTEM

CAPITAL INVESTMENT PROGRAM

XX
SAN FRANCISCO TERMINAL

LIFE 40 INVESTMENT BASE 2,000

YEAR	INVEST MENT	CUMUL INVEST	DEPREC IATION	NET CUM INVESTMENT
1970	1,000	1,000	0	1,000
1971	1,000	2,000	50	1,950
1972	0	2,000	50	1,900
1973	0	2,000	50	1,850
1974	0	2,000	50	1,800
1975	0	2,000	50	1,750
1976	0	2,000	50	1,700
1977	0	2,000	50	1,650
1978	0	2,000	50	1,600
1979	0	2,000	50	1,550
1980	0	2,000	50	1,500
1981	0	2,000	50	1,450
1982	0	2,000	50	1,400
1983	0	2,000	50	1,350
1984	0	2,000	50	1,300
1985	0	2,000	50	1,250
1986	0	2,000	50	1,200
1987	0	2,000	50	1,150
1988	0	2,000	50	1,100
1989	0	2,000	50	1,050
1990	0	2,000	50	1,000
1991	0	2,000	50	950
1992	0	2,000	50	900
1993	0	2,000	50	850
1994	0	2,000	50	800
1995	0	2,000	50	750

SAN FRANCISCO/MARIN WATER TRANSPORTATION STUDY COMMITTEE

FINANCIAL ANALYSIS, NO INFLATION
DISPLACEMENT HULL SYSTEM

TABLE 44

CAPITAL INVESTMENT PROGRAM

MARIN TERMINAL

LIFE 40 INVESTMENT BASE 10,000

YEAR	INVEST MENT	CUMUL. INVEST	DEPREC IATION	NET CUM INVESTMENT
1970	5,000	5,000	0	5,000
1971	5,000	10,000	250	9,750
1972	0	10,000	250	9,500
1973	0	10,000	250	9,250
1974	0	10,000	250	9,000
1975	0	10,000	250	8,750
1976	0	10,000	250	8,500
1977	0	10,000	250	8,250
1978	0	10,000	250	8,000
1979	0	10,000	250	7,750
1980	0	10,000	250	7,500
1981	0	10,000	250	7,250
1982	0	10,000	250	7,000
1983	0	10,000	250	6,750
1984	0	10,000	250	6,500
1985	0	10,000	250	6,250
1986	0	10,000	250	6,000
1987	0	10,000	250	5,750
1988	0	10,000	250	5,500
1989	0	10,000	250	5,250
1990	0	10,000	250	5,000
1991	0	10,000	250	4,750
1992	0	10,000	250	4,500
1993	0	10,000	250	4,250
1994	0	10,000	250	4,000
1995	0	10,000	250	3,750

SAN FRANCISCO/MARIN WATER TRANSPORTATION STUDY COMMITTEE

FINANCIAL ANALYSIS, NO INFLATION

DISPLACEMENT HULL SYSTEM

TABLE 45

CAPITAL INVESTMENT PROGRAM

INITIAL MARIN DREDGING

LIFE 30 INVESTMENT BASE 700

YEAR	INVEST MENT	CUMUL INVEST	DEPREC IATION	NET CUM INVESTMENT
1970	0	0	0	0
1971	700	700	23	677
1972	0	700	23	653
1973	0	700	23	630
1974	0	700	23	607
1975	0	700	23	583
1976	0	700	23	560
1977	0	700	23	537
1978	0	700	23	513
1979	0	700	23	490
1980	0	700	23	467
1981	0	700	23	443
1982	0	700	23	420
1983	0	700	23	397
1984	0	700	23	373
1985	0	700	23	350
1986	0	700	23	327
1987	0	700	23	303
1988	0	700	23	280
1989	0	700	23	257
1990	0	700	23	233
1991	0	700	23	210
1992	0	700	23	187
1993	0	700	23	163
1994	0	700	23	140
1995	0	700	23	117

SAN FRANCISCO/MARIN WATER TRANSPORTATION STUDY COMMITTEE

FINANCIAL ANALYSIS, NO INFLATION
DISPLACEMENT HULL SYSTEM

TABLE 46

CAPITAL INVESTMENT PROGRAM

SYSTEM DESIGN AND DEVELOPMENT

LIFE 50 INVESTMENT BASE 1,000

YEAR	INVEST MENT	CUMUL INVEST	DEPREC IATION	NET CUM INVESTMENT
1970	$500	$500	0	$500
1971	500	1,000	20	980
1972	0	1,000	20	960
1973	0	1,000	20	940
1974	0	1,000	20	920
1975	0	1,000	20	900
1976	0	1,000	20	880
1977	0	1,000	20	860
1978	0	1,000	20	840
1979	0	1,000	20	820
1980	0	1,000	20	800
1981	0	1,000	20	780
1982	0	1,000	20	760
1983	0	1,000	20	740
1984	0	1,000	20	720
1985	0	1,000	20	700
1986	0	1,000	20	680
1987	0	1,000	20	660
1988	0	1,000	20	640
1989	0	1,000	20	620
1990	0	1,000	20	600
1991	0	1,000	20	580
1992	0	1,000	20	560
1993	0	1,000	20	540
1994	0	1,000	20	520
1995	0	1,000	20	500

SAN FRANCISCO/MARIN WATER TRANSPORTATION STUDY COMMITTEE

FINANCIAL ANALYSIS, NO INFLATION
DISPLACEMENT HULL SYSTEM

TABLE 47

SYSTEM CASH FLOW SUMMARY

YEAR	REVENUE CASH FLOW	EXPENSE CASH FLOW	ANNUAL SURPLUS	INVESTMENT CASH FLOW	NET CASH FLOW	CUMULATIVE CASH FLOW
1970	0	60	-60	17,100	-17,160	-17,160
1971	0	150	-150	17,800	-17,950	-35,110
1972	4,583	2,772	1,811	1,225	586	-34,524
1973	4,832	2,772	2,060	0	2,060	-32,464
1974	5,096	2,772	2,324	0	2,324	-30,140
1975	5,374	2,772	2,602	0	2,602	-27,538
1976	5,668	2,943	2,725	4,800	-2,075	-29,613
1977	5,979	2,943	3,036	0	3,036	-26,577
1978	6,307	2,943	3,364	0	3,364	-23,212
1979	6,655	2,943	3,712	0	3,712	-19,501
1980	7,022	3,114	3,908	4,800	-892	-20,392
1981	7,411	3,114	4,297	0	4,297	-16,096
1982	7,821	3,114	4,707	0	4,707	-11,388
1983	8,256	3,114	5,142	1,225	3,917	-7,471
1984	8,716	3,285	5,431	4,800	631	-6,841
1985	9,202	3,285	5,917	0	5,917	-923
1986	9,717	3,285	6,432	0	6,432	5,509
1987	10,260	3,285	6,975	0	6,975	12,484
1988	10,260	3,456	6,804	4,800	2,004	14,488
1989	10,260	3,456	6,804	0	6,804	21,292
1990	10,260	3,456	6,804	0	6,804	28,096
1991	10,260	3,456	6,804	0	6,804	34,900
1992	10,260	3,456	6,804	0	6,804	41,704
1993	10,260	3,456	6,804	0	6,804	48,508
1994	10,260	3,456	6,804	1,225	5,579	54,087
1995	10,260	3,456	6,804	0	6,804	60,891

SAN FRANCISCO/MARIN WATER TRANSPORTATION STUDY COMMITTEE

FINANCIAL ANALYSIS, NO INFLATION
DISPLACEMENT HULL SYSTEM

TABLE 48

SYSTEM FINANCIAL PROGRAM

YEAR	LOCAL SUBSIDY REQMT	NEW BONDS ISSUED	FINANCIAL PAYMENTS INTEREST	FINANCIAL PAYMENTS PRINCIPAL	OUT-STANDING BONDS	BOND RESERVE, CASH
1970	0	17,510	0	0	17,510	350
1971	0	19,456	1,138	0	36,966	739
1972	0	1,809	2,403	0	38,775	776
1973	0	422	2,520	0	39,197	784
1974	0	181	2,548	0	39,378	788
1975	0	0	2,560	92	39,286	786
1976	0	4,675	2,554	0	43,961	879
1977	0	0	2,857	236	43,725	875
1978	0	0	2,842	587	43,139	863
1979	0	0	2,804	979	42,159	843
1980	0	3,655	2,740	0	45,814	916
1981	0	0	2,978	1,402	44,412	888
1982	0	0	2,887	1,912	42,500	850
1983	0	0	2,763	1,230	41,270	825
1984	0	2,043	2,683	0	43,313	866
1985	0	0	2,815	3,218	40,095	802
1986	0	0	2,606	3,953	36,142	723
1987	0	0	2,349	4,764	31,377	628
1988	0	0	2,040	2	31,375	628
1989	0	0	2,039	4,900	26,475	529
1990	0	0	1,721	5,219	21,256	425
1991	0	0	1,382	5,559	15,697	314
1992	0	0	1,020	5,921	9,776	196
1993	0	0	635	6,306	3,469	69
1994	0	0	225	3,469	0	1,958
1995	0	0	0	0	0	8,879

SAN FRANCISCO/MARIN WATER TRANSPORTATION STUDY COMMITTEE

TABLE 49

FINANCIAL ANALYSIS, NO INFLATION
HYDROFOIL SYSTEM
ESTIMATED REVENUE, ALL SOURCES

	COMMUT 11M/DY 1972 +5%/YR	NON CM 4M/DAY 1972 +5%/YR	WK END 6.0M/D 1972 +8%/YR	PARKNG 4.6M/D 1972 +5%/YR	CONCES & OTHR REVENU +5%/YR	TOTAL
1970	0	0	0	0	0	0
1971	0	0	0	0	0	0
1972	2,783	1,012	672	672	300	5,439
1973	2,922	1,063	726	706	315	5,731
1974	3,068	1,116	784	741	331	6,039
1975	3,222	1,172	847	778	347	6,365
1976	3,383	1,230	914	817	365	6,709
1977	3,552	1,292	987	858	383	7,071
1978	3,729	1,356	1,066	901	402	7,455
1979	3,916	1,424	1,152	946	422	7,859
1980	4,112	1,495	1,244	993	443	8,287
1981	4,317	1,570	1,343	1,042	465	8,739
1982	4,533	1,648	1,451	1,095	489	9,216
1983	4,760	1,731	1,567	1,149	513	9,720
1984	4,998	1,817	1,692	1,207	539	10,253
1985	5,248	1,908	1,828	1,267	566	10,816
1986	5,510	2,004	1,974	1,331	594	11,412
1987	5,780	2,105	2,130	1,393	624	12,032
1988	5,780	2,105	2,130	1,393	624	12,032
1989	5,780	2,105	2,130	1,393	624	12,032
1990	5,780	2,105	2,130	1,393	624	12,032
1991	5,780	2,105	2,130	1,393	624	12,032
1992	5,780	2,105	2,130	1,393	624	12,032
1993	5,780	2,105	2,130	1,393	624	12,032
1994	5,780	2,105	2,130	1,393	624	12,032
1995	5,780	2,105	2,130	1,393	624	12,032

SAN FRANCISCO/MARIN WATER TRANSPORTATION STUDY COMMITTEE

FINANCIAL ANALYSIS, NO INFLATION
HYDROFOIL SYSTEM
ESTIMATED EXPENSES

TABLE 50

NO INFLATION

	ANNUAL OPERAT COST	TERMNL PERSON NEL	TERMNL REPAIR AND MAINTN	ADMIN AND MANGMT PERSNL	OFFICE EXPNSE AND ADVERT	INSUR-ANCE
1970	0	0	0	50	10	0
1971	0	0	0	100	50	0
1972	2,520	300	50	150	130	500
1973	2,676	300	50	150	130	500
1974	2,832	300	50	150	130	500
1975	2,988	300	50	150	130	500
1976	3,144	300	50	150	130	500
1977	3,300	300	50	150	130	500
1978	3,456	300	50	150	130	500
1979	3,612	300	50	150	130	500
1980	3,768	300	50	150	130	500
1981	3,924	300	50	150	130	500
1982	4,080	300	50	150	130	500
1983	4,236	300	50	150	130	500
1984	4,392	300	50	150	130	500
1985	4,548	300	50	150	130	500
1986	4,704	300	50	150	130	500
1987	4,704	300	50	150	130	500
1988	4,704	300	50	150	130	500
1989	4,704	300	50	150	130	500
1990	4,704	300	50	150	130	500
1991	4,704	300	50	150	130	500
1992	4,704	300	50	150	130	500
1993	4,704	300	50	150	130	500
1994	4,704	300	50	150	130	500
1995	4,704	300	50	150	130	500

SAN FRANCISCO/MARIN WATER TRANSPORTATION STUDY COMMITTEE

TABLE 50 (con't)

FINANCIAL ANALYSIS, NO INFLATION
HYDROFOIL SYSTEM
ESTIMATED EXPENSES

NO INFLATION

	MACHIN MAINTN ANCE	DRY DK STORES MISCEL EXPENS	DREDG-ING	TOTAL
1970	0	0	0	60
1971	0	0	0	150
1972	150	20	200	4,020
1973	150	20	200	4,176
1974	150	20	200	4,332
1975	150	20	200	4,488
1976	150	20	200	4,644
1977	150	20	200	4,800
1978	150	20	200	4,956
1979	150	20	200	5,112
1980	150	20	200	5,268
1981	150	20	200	5,424
1982	150	20	200	5,580
1983	150	20	200	5,736
1984	150	20	200	5,892
1985	150	20	200	6,048
1986	150	20	200	6,204
1987	150	20	200	6,204
1988	150	20	200	6,204
1989	150	20	200	6,204
1990	150	20	200	6,204
1991	150	20	200	6,204
1992	150	20	200	6,204
1993	150	20	200	6,204
1994	150	20	200	6,204
1995	150	20	200	6,204

SAN FRANCISCO/MARIN WATER TRANSPORTATION STUDY COMMITTEE

FINANCIAL ANALYSIS, NO INFLATION
HYDROFOIL SYSTEM

TABLE 51

CAPITAL INVESTMENT PROGRAM

SYSTEM SUMMARY

YEAR	INVEST MENT	CUMUL INVEST	DEPREC IATION	NET CUM INVESTMENT
1970	11,700	11,700	0	11,700
1971	13,100	24,800	657	24,143
1972	1,750	26,550	803	25,091
1973	0	26,550	803	24,288
1974	1,201	27,751	803	24,687
1975	0	27,751	803	23,884
1976	1,201	28,952	803	24,283
1977	0	28,952	803	23,481
1978	1,201	30,154	803	23,879
1979	0	30,154	803	23,077
1980	1,201	31,355	803	23,476
1981	0	31,355	803	22,673
1982	1,201	32,556	803	23,072
1983	1,750	34,306	803	24,019
1984	1,201	35,507	803	24,418
1985	0	35,507	803	23,615
1986	1,201	36,708	1,083	23,734
1987	0	36,708	1,083	22,651
1988	0	36,708	1,083	21,568
1989	0	36,708	1,083	20,485
1990	0	36,708	1,083	19,403
1991	0	36,708	1,083	18,320
1992	0	36,708	1,083	17,237
1993	0	36,708	1,083	16,154
1994	1,750	38,458	1,083	16,822
1995	0	38,458	1,083	15,739

SAN FRANCISCO/MARIN WATER TRANSPORTATION STUDY COMMITTEE

FINANCIAL ANALYSIS, NO INFLATION
HYDROFOIL SYSTEM

TABLE 52

SYSTEM CASH FLOW SUMMARY

YEAR	REVENUE CASH FLOW	EXPENSE CASH FLOW	ANNUAL SURPLUS	INVESTMENT CASH FLOW	NET CASH FLOW	CUMULATIVE CASH FLOW
1970	0	60	-60	11,700	-11,760	-11,760
1971	0	150	-150	13,100	-13,250	-25,010
1972	5,439	4,020	1,419	1,750	-331	-25,341
1973	5,731	4,176	1,555	0	1,555	-23,786
1974	6,039	4,332	1,707	1,201	506	-23,280
1975	6,365	4,488	1,877	0	1,877	-21,403
1976	6,709	4,644	2,065	1,201	863	-20,539
1977	7,071	4,800	2,271	0	2,271	-18,268
1978	7,455	4,956	2,499	1,201	1,297	-16,971
1979	7,859	5,112	2,747	0	2,747	-14,223
1980	8,287	5,268	3,019	1,201	1,818	-12,406
1981	8,739	5,424	3,315	0	3,315	-9,091
1982	9,216	5,580	3,636	1,201	2,435	-6,656
1983	9,720	5,736	3,984	1,750	2,234	-4,422
1984	10,253	5,892	4,361	1,201	3,160	-1,263
1985	10,816	6,048	4,768	0	4,768	3,506
1986	11,412	6,204	5,208	1,201	4,007	7,513
1987	12,032	6,204	5,828	0	5,828	13,341
1988	12,032	6,204	5,828	0	5,828	19,169
1989	12,032	6,204	5,828	0	5,828	24,997
1990	12,032	6,204	5,828	0	5,828	30,825
1991	12,032	6,204	5,828	0	5,828	36,653
1992	12,032	6,204	5,828	0	5,828	42,481
1993	12,032	6,204	5,828	0	5,828	48,309
1994	12,032	6,204	5,828	1,750	4,078	52,387
1995	12,032	6,204	5,828	0	5,828	58,215

SAN FRANCISCO/MARIN WATER TRANSPORTATION STUDY COMMITTEE

FINANCIAL ANALYSIS, NO INFLATION HYDROFOIL SYSTEM

TABLE 53

SYSTEM FINANCIAL PROGRAM

YEAR	LOCAL SUBSIDY REQMT	NEW BONDS ISSUED	FINANCIAL PAYMENTS INTEREST	FINANCIAL PAYMENTS PRINCIPAL	OUT-STANDING BONDS	BOND RESERVE, CASH
1970	0	12,000	0	0	12,000	240
1971	0	14,302	780	0	26,302	526
1972	0	2,050	1,710	0	28,352	567
1973	0	259	1,843	0	28,611	572
1974	0	1,346	1,860	0	29,957	599
1975	0	35	1,947	0	29,992	600
1976	0	1,072	1,949	0	31,063	621
1977	0	0	2,019	296	30,768	615
1978	0	679	2,000	0	31,447	629
1979	0	0	2,044	756	30,691	614
1980	0	143	1,995	0	30,834	617
1981	0	0	2,004	1,375	29,459	589
1982	0	0	1,915	566	28,893	578
1983	0	0	1,878	399	28,494	570
1984	0	0	1,852	1,369	27,125	542
1985	0	0	1,763	3,100	24,025	480
1986	0	0	1,562	2,525	21,500	430
1987	0	0	1,398	4,547	16,953	339
1988	0	0	1,102	4,843	12,110	242
1989	0	0	787	5,159	6,951	139
1990	0	0	452	5,494	1,457	29
1991	0	0	95	1,457	0	4,307
1992	0	0	0	0	0	10,394
1993	0	0	0	0	0	16,846
1994	0	0	0	0	0	21,934
1995	0	0	0	0	0	29,078

SAN FRANCISCO/MARIN WATER TRANSPORTATION STUDY COMMITTEE

FINANCIAL ANALYSIS, NO INFLATION

TABLE 54

AIR CUSHION VEHICLE SYST
ESTIMATED REVENUE, ALL SOURCES

NO INFLATION

	COMMUT 11M/DY 1972 +5%/YR	NON CM 4M/DAY 1972 +5%/YR	WK END 6.0M/D 1972 +8%/YR	PARKNG 4.6M/D 1972 +5%/YR	CONCES & OTHR REVENU +5%/YR	TOTAL
1970	0	0	0	0	0	0
1971	0	0	0	0	0	0
1972	2,783	1,012	672	672	300	5,439
1973	2,922	1,063	726	706	315	5,731
1974	3,068	1,116	784	741	331	6,039
1975	3,222	1,172	847	778	347	6,365
1976	3,383	1,230	914	817	365	6,709
1977	3,552	1,292	987	858	383	7,071
1978	3,729	1,356	1,066	901	402	7,455
1979	3,916	1,424	1,152	946	422	7,859
1980	4,112	1,495	1,244	993	443	8,287
1981	4,317	1,570	1,343	1,042	465	8,739
1982	4,533	1,648	1,451	1,095	489	9,216
1983	4,760	1,731	1,567	1,149	513	9,720
1984	4,998	1,817	1,692	1,207	539	10,253
1985	5,248	1,908	1,828	1,267	566	10,816
1986	5,510	2,004	1,974	1,331	594	11,412
1987	5,780	2,105	2,130	1,393	624	12,032
1988	5,780	2,105	2,130	1,393	624	12,032
1989	5,780	2,105	2,130	1,393	624	12,032
1990	5,780	2,105	2,130	1,393	624	12,032
1991	5,780	2,105	2,130	1,393	624	12,032
1992	5,780	2,105	2,130	1,393	624	12,032
1993	5,780	2,105	2,130	1,393	624	12,032
1994	5,780	2,105	2,130	1,393	624	12,032
1995	5,780	2,105	2,130	1,393	624	12,032

SAN FRANCISCO/MARIN WATER TRANSPORTATION STUDY COMMITTEE

FINANCIAL ANALYSIS, NO INFLATION

TABLE 55

AIR CUSHION VEHICLE SYST
ESTIMATED EXPENSES

NO INFLATION

	ANNUAL OPERAT COST	TERMNL PERSON NEL	TERMNL REPAIR AND MAINTN	ADMIN AND MANGMT PERSNL	OFFICE EXPNSE AND ADVERT	INSUR-ANCE
1970	0	0	0	50	10	0
1971	0	0	0	100	50	0
1972	2,865	300	50	150	130	500
1973	2,865	300	50	150	130	500
1974	2,865	300	50	150	130	500
1975	2,865	300	50	150	130	500
1976	3,942	300	50	150	130	500
1977	3,942	300	50	150	130	500
1978	3,942	300	50	150	130	500
1979	3,942	300	50	150	130	500
1980	5,021	300	50	150	130	500
1981	5,021	300	50	150	130	500
1982	5,021	300	50	150	130	500
1983	5,021	300	50	150	130	500
1984	6,099	300	50	150	130	500
1985	6,099	300	50	150	130	500
1986	6,099	300	50	150	130	500
1987	6,099	300	50	150	130	500
1988	7,177	300	50	150	130	500
1989	7,177	300	50	150	130	500
1990	7,177	300	50	150	130	500
1991	7,177	300	50	150	130	500
1992	7,177	300	50	150	130	500
1993	7,177	300	50	150	130	500
1994	7,177	300	50	150	130	500
1995	7,177	300	50	150	130	500

SAN FRANCISCO/MARIN WATER TRANSPORTATION STUDY COMMITTEE

FINANCIAL ANALYSIS, NO INFLATION AIR CUSHION VEHICLE SYST ESTIMATED EXPENSES

TABLE 55 (con't)

NO INFLATION

	MACHIN MAINTN ANCE	DRY DK STORES MISCEL EXPENS	MAINTN PERSON NEL	TOTAL
1970	0	0	0	60
1971	0	0	0	150
1972	150	20	300	4,465
1973	150	20	300	4,465
1974	150	20	300	4,465
1975	150	20	300	4,465
1976	150	20	300	5,542
1977	150	20	300	5,542
1978	150	20	300	5,542
1979	150	20	300	5,542
1980	150	20	300	6,621
1981	150	20	300	6,621
1982	150	20	300	6,621
1983	150	20	300	6,621
1984	150	20	300	7,699
1985	150	20	300	7,699
1986	150	20	300	7,699
1987	150	20	300	7,699
1988	150	20	300	8,777
1989	150	20	300	8,777
1990	150	20	300	8,777
1991	150	20	300	8,777
1992	150	20	300	8,777
1993	150	20	300	8,777
1994	150	20	300	8,777
1995	150	20	300	8,777

SAN FRANCISCO/MARIN WATER TRANSPORTATION STUDY COMMITTEE

FINANCIAL ANALYSIS, NO INFLATION — TABLE 56

AIR CUSHION VEHICLE SYST

CAPITAL INVESTMENT PROGRAM

SYSTEM SUMMARY

YEAR	INVEST MENT	CUMUL. INVEST	DEPREC IATION	NET CUM INVESTMENT
1970	18,900	18,900	0	18,900
1971	18,900	37,800	1,090	36,710
1972	1,750	39,550	1,236	37,224
1973	0	39,550	1,236	35,988
1974	0	39,550	1,236	34,752
1975	0	39,550	1,236	33,517
1976	6,000	45,550	1,236	38,281
1977	0	45,550	1,236	37,045
1978	0	45,550	1,236	35,809
1979	0	45,550	1,236	34,573
1980	6,000	51,550	1,236	39,337
1981	0	51,550	1,236	38,102
1982	0	51,550	1,236	36,866
1983	1,750	53,300	1,236	37,380
1984	6,000	59,300	1,236	42,144
1985	0	59,300	1,236	40,908
1986	0	59,300	1,236	39,672
1987	0	59,300	1,236	38,437
1988	6,000	65,300	2,036	42,401
1989	0	65,300	2,036	40,365
1990	0	65,300	2,036	38,329
1991	0	65,300	2,036	36,293
1992	0	65,300	2,036	34,257
1993	0	65,300	2,036	32,222
1994	1,750	67,050	2,036	31,936
1995	0	67,050	2,036	29,900

SAN FRANCISCO/MARIN WATER TRANSPORTATION STUDY COMMITTEE

FINANCIAL ANALYSIS, NO INFLATION

AIR CUSHION VEHICLE SYST

TABLE 57

SYSTEM CASH FLOW SUMMARY

YEAR	REVENUE CASH FLOW	EXPENSE CASH FLOW	ANNUAL SURPLUS	INVESTMENT CASH FLOW	NET CASH FLOW	CUMULATIVE CASH FLOW
1970	0	60	-60	18,900	-18,960	-18,960
1971	0	150	-150	18,900	-19,050	-38,010
1972	5,439	4,465	974	1,750	-776	-38,786
1973	5,731	4,465	1,266	0	1,266	-37,520
1974	6,039	4,465	1,574	0	1,574	-35,945
1975	6,365	4,465	1,900	0	1,900	-34,046
1976	6,709	5,542	1,167	6,000	-4,833	-38,879
1977	7,071	5,542	1,529	0	1,529	-37,350
1978	7,455	5,542	1,913	0	1,913	-35,437
1979	7,859	5,542	2,317	0	2,317	-33,120
1980	8,287	6,621	1,666	6,000	-4,334	-37,454
1981	8,739	6,621	2,118	0	2,118	-35,336
1982	9,216	6,621	2,595	0	2,595	-32,741
1983	9,720	6,621	3,099	1,750	1,349	-31,392
1984	10,253	7,699	2,554	6,000	-3,446	-34,838
1985	10,816	7,699	3,117	0	3,117	-31,721
1986	11,412	7,699	3,713	0	3,713	-28,008
1987	12,032	7,699	4,333	0	4,333	-23,675
1988	12,032	8,777	3,255	6,000	-2,745	-26,420
1989	12,032	8,777	3,255	0	3,255	-23,165
1990	12,032	8,777	3,255	0	3,255	-19,910
1991	12,032	8,777	3,255	0	3,255	-16,655
1992	12,032	8,777	3,255	0	3,255	-13,400
1993	12,032	8,777	3,255	0	3,255	-10,145
1994	12,032	8,777	3,255	1,750	1,505	-8,640
1995	12,032	8,777	3,255	0	3,255	-5,385

SAN FRANCISCO/MARIN WATER TRANSPORTATION STUDY COMMITTEE

FINANCIAL ANALYSIS, NO INFLATION

TABLE 58

AIR CUSHION VEHICLE SYST

SYSTEM FINANCIAL PROGRAM

YEAR	LOCAL SUBSIDY REQMT	NEW BONDS ISSUED	FINANCIAL PAYMENTS INTEREST	PRINCIPAL	OUT-STANDING BONDS	BOND RESERVE, CASH
1970	1,425	17,892	0	0	17,892	358
1971	1,425	19,149	1,163	0	37,041	741
1972	1,425	1,749	2,408	0	38,790	776
1973	1,425	0	2,521	221	38,569	771
1974	1,425	0	2,507	550	38,019	760
1975	1,425	0	2,471	918	37,100	742
1976	1,425	5,893	2,412	0	42,993	860
1977	1,425	0	2,795	216	42,777	856
1978	1,425	0	2,781	621	42,156	843
1979	1,425	0	2,740	1,075	41,081	822
1980	1,425	5,642	2,670	0	46,723	934
1981	1,425	0	3,037	574	46,150	923
1982	1,425	0	3,000	1,098	45,052	901
1983	1,425	102	2,928	0	45,154	903
1984	1,425	5,001	2,935	0	50,155	1,003
1985	1,425	0	3,260	1,371	48,784	976
1986	1,425	0	3,171	2,068	46,717	934
1987	1,425	0	3,037	2,835	43,882	878
1988	1,425	4,203	2,852	0	48,085	962
1989	1,425	0	3,126	1,646	46,440	929
1990	1,425	0	3,019	1,753	44,687	894
1991	1,425	0	2,905	1,867	42,820	856
1992	1,425	0	2,783	1,988	40,832	817
1993	1,425	0	2,654	2,118	38,714	774
1994	1,425	0	2,516	470	38,244	765
1995	1,425	0	2,486	2,286	35,958	719

SAN FRANCISCO/MARIN WATER TRANSPORTATION STUDY COMMITTEE

FINANCIAL ANALYSIS, NO INFLATION
AIR CUSHION VEHICLE SYST

TABLE 58

SYSTEM FINANCIAL PROGRAM

YEAR	LOCAL SUBSIDY REQMT	NEW BONDS ISSUED	FINANCIAL PAYMENTS INTEREST	FINANCIAL PAYMENTS PRINCIPAL	OUT-STANDING BONDS	BOND RESERVE, CASH
1970	1,425	17,892	0	0	17,892	358
1971	1,425	19,149	1,163	0	37,041	741
1972	1,425	1,749	2,408	0	38,790	776
1973	1,425	0	2,521	221	38,569	771
1974	1,425	0	2,507	550	38,019	760
1975	1,425	0	2,471	918	37,100	742
1976	1,425	5,893	2,412	0	42,993	860
1977	1,425	0	2,795	216	42,777	856
1978	1,425	0	2,781	621	42,156	843
1979	1,425	0	2,740	1,075	41,081	822
1980	1,425	5,642	2,670	0	46,723	934
1981	1,425	0	3,037	574	46,150	923
1982	1,425	0	3,000	1,098	45,052	901
1983	1,425	102	2,928	0	45,154	903
1984	1,425	5,001	2,935	0	50,155	1,003
1985	1,425	0	3,260	1,371	48,784	976
1986	1,425	0	3,171	2,068	46,717	934
1987	1,425	0	3,037	2,835	43,882	878
1988	1,425	4,203	2,852	0	48,085	962
1989	1,425	0	3,126	1,646	46,440	929
1990	1,425	0	3,019	1,753	44,687	894
1991	1,425	0	2,905	1,867	42,820	856
1992	1,425	0	2,783	1,988	40,832	817
1993	1,425	0	2,654	2,118	38,714	774
1994	1,425	0	2,516	470	38,244	765
1995	1,425	0	2,486	2,286	35,958	719

SAN FRANCISCO/MARIN WATER TRANSPORTATION STUDY COMMITTEE

TABLE 59

FINANCIAL ANALYSIS, INCLUDING INFLATION
DISPLACEMENT HULL SYSTEM
ESTIMATED REVENUE, ALL SOURCES

	COMMUT 8.5M/D 1972 +8%/YR	NON CM 3.5M/D 1972 +8%/YR	WK END 6.0M/D 1972 +11%/Y	PARKNG 4.0M/D 1972 +8%/YR	CONCES & OTHR REVENU +8%/YR	TOTAL
1970	0	0	0	0	0	0
1971	0	0	0	0	0	0
1972	2,281	939	713	611	318	4,862
1973	2,467	1,015	793	661	344	5,280
1974	2,668	1,098	882	715	372	5,735
1975	2,885	1,188	981	773	403	6,230
1976	3,120	1,284	1,092	836	435	6,768
1977	3,375	1,389	1,214	904	471	7,353
1978	3,650	1,502	1,351	978	509	7,990
1979	3,947	1,625	1,503	1,058	551	8,683
1980	4,269	1,757	1,672	1,144	596	9,437
1981	4,617	1,900	1,859	1,237	644	10,258
1982	4,993	2,055	2,068	1,338	697	11,151
1983	5,400	2,223	2,301	1,447	754	12,124
1984	5,840	2,404	2,560	1,565	815	13,183
1985	6,316	2,600	2,847	1,692	881	14,337
1986	6,831	2,812	3,167	1,830	953	15,593
1987	7,388	3,041	3,521	1,977	1,031	16,958
1988	7,610	3,132	3,626	2,036	1,062	17,467
1989	7,838	3,226	3,735	2,097	1,094	17,991
1990	8,073	3,323	3,847	2,160	1,127	18,531
1991	8,316	3,423	3,962	2,225	1,161	19,087
1992	8,565	3,526	4,081	2,292	1,196	19,659
1993	8,822	3,631	4,204	2,360	1,232	20,249
1994	9,087	3,740	4,330	2,431	1,268	20,856
1995	9,359	3,853	4,460	2,504	1,307	21,482

FINANCIAL ANALYSIS, INCLUDING INFLATION
DISPLACEMENT HULL SYSTEM
ESTIMATED EXPENSES

TABLE 60

INCLUDING INFLATION

	ANNUAL OPERAT COST	TERMNL PERSON NEL	TERMNL REPAIR AND MAINTN	ADMIN AND MANGMT PERSNL	OFFICE EXPNSE AND ADVERT	INSUR- ANCE
1970	0	0	0	50	10	0
1971	0	0	0	104	51	0
1972	1,482	170	216	162	135	427
1973	1,541	177	225	169	138	435
1974	1,603	184	234	175	141	444
1975	1,667	191	243	182	144	453
1976	1,950	199	253	190	146	462
1977	2,028	207	263	197	149	471
1978	2,109	215	274	205	152	480
1979	2,193	223	285	213	155	490
1980	2,534	232	296	222	158	500
1981	2,636	242	308	231	162	510
1982	2,741	251	320	240	165	520
1983	2,851	261	333	250	168	530
1984	3,261	272	346	260	172	541
1985	3,391	283	360	270	175	552
1986	3,527	294	375	281	178	563
1987	3,668	306	390	292	182	574
1988	4,161	318	405	304	186	586
1989	4,327	331	421	316	189	597
1990	4,501	344	438	329	193	609
1991	4,681	358	456	342	197	621
1992	4,868	372	474	355	201	634
1993	5,063	387	493	370	205	647
1994	5,265	402	513	384	209	659
1995	5,476	419	533	400	213	673

SAN FRANCISCO/MARIN WATER TRANSPORTATION STUDY COMMITTEE

FINANCIAL ANALYSIS, INCLUDING INFLATION
DISPLACEMENT HULL SYSTEM
ESTIMATED EXPENSES

TABLE 60 (con't)

	MACHIN MAINTN ANCE	DRY DK STORES MISCEL EXPENS	DREDG-ING	TOTAL
1970	0	0	0	60
1971	0	0	0	155
1972	211	62	108	2,973
1973	219	64	112	3,080
1974	228	65	117	3,190
1975	237	66	122	3,305
1976	247	68	127	3,640
1977	257	69	132	3,772
1978	267	70	137	3,910
1979	278	72	142	4,052
1980	289	73	148	4,453
1981	300	75	154	4,616
1982	312	76	160	4,786
1983	325	78	167	4,962
1984	338	79	173	5,441
1985	351	81	180	5,643
1986	365	82	187	5,853
1987	380	84	195	6,070
1988	395	86	203	6,643
1989	411	87	211	6,891
1990	427	89	219	7,149
1991	444	91	228	7,418
1992	462	93	237	7,696
1993	481	95	246	7,985
1994	500	97	256	8,286
1995	520	98	267	8,598

SAN FRANCISCO/MARIN WATER TRANSPORTATION STUDY COMMITTEE

FINANCIAL ANALYSIS, INCLUDING INFLATION
DISPLACEMENT HULL SYSTEM

TABLE 61

CAPITAL INVESTMENT PROGRAM

SYSTEM SUMMARY

YEAR	INVEST MENT	CUMUL INVEST	DEPREC IATION	NET CUM INVESTMENT
1970	17,100	17,100	0	17,100
1971	18,512	35,612	1,003	34,609
1972	1,325	36,937	1,114	34,820
1973	0	36,937	1,114	33,706
1974	0	36,937	1,114	32,592
1975	0	36,937	1,114	31,478
1976	6,074	43,010	1,114	36,438
1977	0	43,010	1,114	35,324
1978	0	43,010	1,114	34,210
1979	0	43,010	1,114	33,096
1980	7,105	50,116	1,114	39,087
1981	0	50,116	1,114	37,973
1982	0	50,116	1,114	36,859
1983	2,121	52,237	1,180	37,800
1984	8,312	60,549	1,180	44,932
1985	0	60,549	1,180	43,752
1986	0	60,549	1,180	42,572
1987	0	60,549	1,180	41,392
1988	9,724	70,273	2,221	48,895
1989	0	70,273	2,221	46,674
1990	0	70,273	2,221	44,453
1991	0	70,273	2,221	42,233
1992	0	70,273	2,221	40,012
1993	0	70,273	2,221	37,791
1994	3,396	73,669	2,327	38,860
1995	0	73,669	2,327	36,533

SAN FRANCISCO/MARIN WATER TRANSPORTATION STUDY COMMITTEE

FINANCIAL ANALYSIS, INCLUDING INFLATION
DISPLACEMENT HULL SYSTEM

TABLE 62

SYSTEM CASH FLOW SUMMARY

YEAR	REVENUE CASH FLOW	EXPENSE CASH FLOW	ANNUAL SURPLUS	INVESTMENT CASH FLOW	NET CASH FLOW	CUMULATIVE CASH FLOW
1970	0	60	-60	17,100	-17,160	-17,160
1971	0	155	-155	18,512	-18,667	-35,827
1972	4,862	2,973	1,889	1,325	564	-35,263
1973	5,280	3,080	2,200	0	2,200	-33,063
1974	5,735	3,190	2,545	0	2,545	-30,518
1975	6,230	3,305	2,925	0	2,925	-27,593
1976	6,768	3,640	3,128	6,074	-2,946	-30,539
1977	7,353	3,772	3,581	0	3,581	-26,958
1978	7,990	3,910	4,081	0	4,081	-22,877
1979	8,683	4,052	4,631	0	4,631	-18,246
1980	9,437	4,453	4,984	7,105	-2,121	-20,367
1981	10,258	4,616	5,642	0	5,642	-14,725
1982	11,151	4,786	6,366	0	6,366	-8,360
1983	12,124	4,962	7,162	2,121	5,041	-3,319
1984	13,183	5,441	7,742	8,312	-570	-3,889
1985	14,337	5,643	8,694	0	8,694	4,805
1986	15,593	5,853	9,741	0	9,741	14,546
1987	16,958	6,070	10,888	0	10,888	25,434
1988	17,467	6,643	10,824	9,724	1,100	26,534
1989	17,991	6,891	11,100	0	11,100	37,634
1990	18,531	7,149	11,381	0	11,381	49,015
1991	19,087	7,418	11,669	0	11,669	60,684
1992	19,659	7,696	11,963	0	11,963	72,647
1993	20,249	7,985	12,264	0	12,264	84,911
1994	20,856	8,286	12,571	3,396	9,174	94,085
1995	21,482	8,598	12,884	0	12,884	106,970

SAN FRANCISCO/MARIN WATER TRANSPORTATION STUDY COMMITTEE

FINANCIAL ANALYSIS, INCLUDING INFLATION
DISPLACEMENT HULL SYSTEM

TABLE 63

SYSTEM FINANCIAL PROGRAM

YEAR	LOCAL SUBSIDY REQMT	NEW BONDS ISSUED	FINANCIAL PAYMENTS INTEREST	PRINCIPAL	OUT-STANDING BONDS	BOND RESERVE, CASH
1970	0	17,510	0	0	17,510	350
1971	0	20,188	1,138	0	37,698	754
1972	0	1,879	2,450	0	39,577	792
1973	0	331	2,573	0	39,908	798
1974	0	1	2,594	0	39,910	798
1975	0	0	2,594	386	39,523	790
1976	0	5,579	2,569	0	45,102	902
1977	0	0	2,932	718	44,385	888
1978	0	0	2,885	1,274	43,110	862
1979	0	0	2,802	1,919	41,191	824
1980	0	4,846	2,677	0	46,037	921
1981	0	0	2,992	2,760	43,277	866
1982	0	0	2,813	3,678	39,599	792
1983	0	0	2,574	2,566	37,033	741
1984	0	2,992	2,407	0	40,026	801
1985	0	0	2,602	6,266	33,760	675
1986	0	0	2,194	7,742	26,018	520
1987	0	0	1,691	9,416	16,602	332
1988	0	0	1,079	42	16,560	331
1989	0	0	1,076	10,248	6,312	126
1990	0	0	410	6,312	0	4,793
1991	0	0	0	0	0	16,750
1992	0	0	0	0	0	29,718
1993	0	0	0	0	0	43,764
1994	0	0	0	0	0	55,565
1995	0	0	0	0	0	71,783

SAN FRANCISCO/MARIN WATER TRANSPORTATION STUDY COMMITTEE

TABLE 64

FINANCIAL ANALYSIS, INCLUDING INFLATION
HYDROFOIL SYSTEM
ESTIMATED REVENUE, ALL SOURCES

	COMMUT 11M/DY 1972 +8%/YR	NON CM 4M/DAY 1972 +8%/YR	WK END 6.0M/D 1972 +11%/Y	PARKNG 4.6M/D 1972 +8%/YR	CONCES & OTHR REVENU +8%/YR	TOTAL
1970	0	0	0	0	0	0
1971	0	0	0	0	0	0
1972	2,952	1,074	713	713	318	5,770
1973	3,193	1,161	793	771	344	6,263
1974	3,453	1,256	882	834	372	6,797
1975	3,735	1,358	981	902	403	7,379
1976	4,039	1,469	1,092	975	435	8,010
1977	4,368	1,589	1,214	1,055	471	8,697
1978	4,724	1,718	1,351	1,141	509	9,443
1979	5,109	1,858	1,503	1,234	551	10,255
1980	5,526	2,009	1,672	1,334	596	11,137
1981	5,976	2,173	1,859	1,443	644	12,096
1982	6,463	2,350	2,068	1,561	697	13,139
1983	6,990	2,542	2,301	1,688	754	14,274
1984	7,560	2,749	2,560	1,825	815	15,509
1985	8,176	2,973	2,847	1,974	881	16,852
1986	8,842	3,215	3,167	2,135	953	18,313
1987	9,553	3,479	3,521	2,302	1,031	19,887
1988	9,840	3,584	3,626	2,371	1,062	20,484
1989	10,135	3,691	3,735	2,443	1,094	21,098
1990	10,439	3,802	3,847	2,516	1,127	21,731
1991	10,753	3,916	3,962	2,591	1,161	22,383
1992	11,075	4,033	4,081	2,669	1,196	23,055
1993	11,407	4,154	4,204	2,749	1,232	23,746
1994	11,750	4,279	4,330	2,832	1,268	24,459
1995	12,102	4,407	4,460	2,917	1,307	25,192

SAN FRANCISCO/MARIN WATER TRANSPORTATION STUDY COMMITTEE

FINANCIAL ANALYSIS, INCLUDING INFLATION — TABLE 65
HYDROFOIL SYSTEM
ESTIMATED EXPENSES

[illegible] INFLATION

	ANNUAL OPERAT COST	TERMNL PERSON NEL	TERMNL REPAIR AND MAINTN	ADMIN AND MANGMT PERSNL	OFFICE EXPNSE AND ADVERT	INSUR-ANCE
1970	0	0	0	50	10	0
1971	0	0	0	104	51	0
1972	2,726	324	54	162	135	520
1973	3,010	337	56	169	138	531
1974	3,313	351	58	175	141	541
1975	3,635	365	61	182	144	552
1976	3,978	380	63	190	146	563
1977	4,343	395	66	197	149	574
1978	4,730	411	68	205	152	586
1979	5,141	427	71	213	155	598
1980	5,578	444	74	222	158	609
1981	6,041	462	77	231	162	622
1982	6,532	480	80	240	165	634
1983	7,053	500	83	250	168	647
1984	7,606	520	87	260	172	660
1985	8,191	540	90	270	175	673
1986	8,811	562	94	281	178	686
1987	9,163	584	97	292	182	700
1988	9,529	608	101	304	186	714
1989	9,911	632	105	316	189	728
1990	10,307	657	110	329	193	743
1991	10,719	684	114	342	197	758
1992	11,148	711	118	355	201	773
1993	11,594	739	123	370	205	788
1994	12,058	769	128	384	209	804
1995	12,540	800	133	400	213	820

SAN FRANCISCO/MARIN WATER TRANSPORTATION STUDY COMMITTEE

TABLE 65 (con't)

FINANCIAL ANALYSIS, INCLUDING INFLATION
HYDROFOIL SYSTEM
ESTIMATED EXPENSES

INCLUDING INFLATION

	MACHIN MAINTN ANCE	DRY DK STORES MISCEL EXPENS	DREDG-ING	TOTAL
1970	0	0	0	60
1971	0	0	0	155
1972	162	21	216	4,321
1973	169	21	225	4,656
1974	175	22	234	5,011
1975	182	22	243	5,387
1976	190	23	253	5,786
1977	197	23	263	6,208
1978	205	23	274	6,655
1979	213	24	285	7,128
1980	222	24	296	7,628
1981	231	25	308	8,158
1982	240	25	320	8,717
1983	250	26	333	9,309
1984	260	26	346	9,935
1985	270	27	360	10,596
1986	281	27	375	11,295
1987	292	28	390	11,729
1988	304	29	405	12,180
1989	316	29	421	12,648
1990	329	30	438	13,135
1991	342	30	456	13,641
1992	355	31	474	14,167
1993	370	32	493	14,714
1994	384	32	513	15,282
1995	400	33	533	15,872

SAN FRANCISCO/MARIN WATER TRANSPORTATION STUDY COMMITTEE

FINANCIAL ANALYSIS, INCLUDING INFLATION HYDROFOIL SYSTEM

TABLE 66

CAPITAL INVESTMENT PROGRAM

SYSTEM SUMMARY

YEAR	INVESTMENT	CUMUL INVEST	DEPRECIATION	NET CUM INVESTMENT
1970	11,700	11,700	0	11,700
1971	13,624	25,324	671	24,653
1972	1,893	27,217	828	25,718
1973	0	27,217	828	24,889
1974	1,405	28,622	828	25,466
1975	0	28,622	828	24,637
1976	1,520	30,142	828	25,329
1977	0	30,142	828	24,500
1978	1,644	31,786	828	25,316
1979	0	31,786	828	24,487
1980	1,778	33,564	828	25,437
1981	0	33,564	828	24,608
1982	1,923	35,487	828	25,703
1983	3,030	38,518	923	27,810
1984	2,080	40,598	923	28,967
1985	0	40,598	923	28,044
1986	2,250	42,847	1,343	28,950
1987	0	42,847	1,343	27,607
1988	0	42,847	1,343	26,264
1989	0	42,847	1,343	24,921
1990	0	42,847	1,343	23,577
1991	0	42,847	1,343	22,234
1992	0	42,847	1,343	20,891
1993	0	42,847	1,343	19,547
1994	4,852	47,699	1,495	22,904
1995	0	47,699	1,495	21,409

SAN FRANCISCO/MARIN WATER TRANSPORTATION STUDY COMMITTEE

FINANCIAL ANALYSIS, INCLUDING INFLATION
HYDROFOIL SYSTEM

TABLE 67

SYSTEM CASH FLOW SUMMARY

YEAR	REVENUE CASH FLOW	EXPENSE CASH FLOW	ANNUAL SURPLUS	INVESTMENT CASH FLOW	NET CASH FLOW	CUMULATIVE CASH FLOW
1970	0	60	-60	11,700	-11,760	-11,760
1971	0	155	-155	13,624	-13,779	-25,539
1972	5,770	4,321	1,449	1,893	-444	-25,983
1973	6,263	4,656	1,606	0	1,606	-24,376
1974	6,797	5,011	1,786	1,405	381	-23,995
1975	7,379	5,387	1,992	0	1,992	-22,004
1976	8,010	5,786	2,225	1,520	705	-21,299
1977	8,697	6,208	2,489	0	2,489	-18,810
1978	9,443	6,655	2,789	1,644	1,145	-17,665
1979	10,255	7,128	3,127	0	3,127	-14,538
1980	11,137	7,628	3,509	1,778	1,731	-12,807
1981	12,096	8,158	3,939	0	3,939	-8,869
1982	13,139	8,717	4,422	1,923	2,499	-6,370
1983	14,274	9,309	4,965	3,030	1,934	-4,435
1984	15,509	9,935	5,574	2,080	3,493	-942
1985	16,852	10,596	6,255	0	6,255	5,313
1986	18,313	11,295	7,018	2,250	4,768	10,082
1987	19,887	11,729	8,158	0	8,158	18,240
1988	20,484	12,180	8,304	0	8,304	26,544
1989	21,098	12,648	8,450	0	8,450	34,994
1990	21,731	13,135	8,596	0	8,596	43,590
1991	22,383	13,641	8,742	0	8,742	52,331
1992	23,055	14,167	8,887	0	8,887	61,218
1993	23,746	14,714	9,032	0	9,032	70,251
1994	24,459	15,282	9,177	4,852	4,325	74,575
1995	25,192	15,872	9,320	0	9,320	83,895

SAN FRANCISCO/MARIN WATER TRANSPORTATION STUDY COMMITTEE

FINANCIAL ANALYSIS, INCLUDING INFLATION — TABLE 68
HYDROFOIL SYSTEM

SYSTEM FINANCIAL PROGRAM

YEAR	LOCAL SUBSIDY REQMT	NEW BONDS ISSUED	FINANCIAL PAYMENTS INTEREST	FINANCIAL PAYMENTS PRINCIPAL	OUT-STANDING BONDS	BOND RESERVE, CASH
1970	0	12,000	0	0	12,000	240
1971	0	14,841	780	0	26,841	537
1972	0	2,200	1,745	0	29,042	581
1973	0	251	1,888	0	29,293	586
1974	0	1,518	1,904	0	30,811	616
1975	0	0	2,003	26	30,785	616
1976	0	1,285	2,001	0	32,070	641
1977	0	0	2,085	452	31,618	632
1978	0	890	2,055	0	32,508	650
1979	0	0	2,113	1,075	31,433	629
1980	0	280	2,043	0	31,714	634
1981	0	0	2,061	1,954	29,760	595
1982	0	0	1,934	612	29,147	583
1983	0	0	1,895	76	29,071	581
1984	0	0	1,890	1,672	27,399	548
1985	0	0	1,781	4,599	22,799	456
1986	0	0	1,482	3,381	19,418	388
1987	0	0	1,262	7,061	12,357	247
1988	0	0	803	7,669	4,688	94
1989	0	0	305	4,688	0	3,556
1990	0	0	0	0	0	12,365
1991	0	0	0	0	0	21,849
1992	0	0	0	0	0	32,047
1993	0	0	0	0	0	43,002
1994	0	0	0	0	0	49,907
1995	0	0	0	0	0	62,221

SAN FRANCISCO/MARIN WATER TRANSPORTATION STUDY COMMITTEE

FINANCIAL ANALYSIS, INCLUDING INFLATION

AIR CUSHION VEHICLE SYST

ESTIMATED REVENUE, ALL SOURCES

TABLE 69

INCLUDING INFLATION

	COMMUT 11M/DY 1972 +8%/YR	NON CM 4M/DAY 1972 +8%/YR	WK END 6.0M/D 1972 +11%/Y	PARKNG 4.6M/D 1972 +8%/YR	CONCES & OTHR REVENU +8%/YR	TOTAL
1970	0	0	0	0	0	0
1971	0	0	0	0	0	0
1972	2,952	1,074	713	713	318	5,770
1973	3,193	1,161	793	771	344	6,263
1974	3,453	1,256	882	834	372	6,797
1975	3,735	1,358	981	902	403	7,379
1976	4,039	1,469	1,092	975	435	8,010
1977	4,368	1,589	1,214	1,055	471	8,697
1978	4,724	1,718	1,351	1,141	509	9,443
1979	5,109	1,858	1,503	1,234	551	10,255
1980	5,526	2,009	1,672	1,334	596	11,137
1981	5,976	2,173	1,859	1,443	644	12,096
1982	6,463	2,350	2,068	1,561	697	13,139
1983	6,990	2,542	2,301	1,688	754	14,274
1984	7,560	2,749	2,560	1,825	815	15,509
1985	8,176	2,973	2,847	1,974	881	16,852
1986	8,842	3,215	3,167	2,135	953	18,313
1987	9,553	3,479	3,521	2,302	1,031	19,887
1988	9,840	3,584	3,626	2,371	1,062	20,484
1989	10,135	3,691	3,735	2,443	1,094	21,098
1990	10,439	3,802	3,847	2,516	1,127	21,731
1991	10,753	3,916	3,962	2,591	1,161	22,383
1992	11,075	4,033	4,081	2,669	1,196	23,055
1993	11,407	4,154	4,204	2,749	1,232	23,746
1994	11,750	4,279	4,330	2,832	1,268	24,459
1995	12,102	4,407	4,460	2,917	1,307	25,192

SAN FRANCISCO/MARIN WATER TRANSPORTATION STUDY COMMITTEE

FINANCIAL ANALYSIS, INCLUDING INFLATION

TABLE 70

AIR CUSHION VEHICLE SYST
ESTIMATED EXPENSES

INCLUDING INFLATION

	ANNUAL OPERAT COST	TERMNL PERSON NEL	TERMNL REPAIR AND MAINTN	ADMIN AND MANGMT PERSNL	OFFICE EXPNSE AND ADVERT	INSUR-ANCE
1970	0	0	0	50	10	0
1971	0	0	0	104	51	0
1972	3,099	324	54	162	135	520
1973	3,223	337	56	169	138	531
1974	3,352	351	58	175	141	541
1975	3,486	365	61	182	144	552
1976	4,988	380	63	190	146	563
1977	5,187	395	66	197	149	574
1978	5,395	411	68	205	152	586
1979	5,611	427	71	213	155	598
1980	7,432	444	74	222	158	609
1981	7,730	462	77	231	162	622
1982	8,039	480	80	240	165	634
1983	8,360	500	83	250	168	647
19X4	10,561	520	87	260	172	660
1985	10,984	540	90	270	175	673
1986	11,423	562	94	281	178	686
1987	11,880	584	97	292	182	700
1988	14,539	608	101	304	186	714
1989	15,121	632	105	316	189	728
1990	15,726	657	110	329	193	743
1991	16,355	684	114	342	197	758
1992	17,009	711	118	355	201	773
1993	17,689	739	123	370	205	788
1994	18,397	769	128	384	209	804
1995	19,133	800	133	400	213	820

SAN FRANCISCO/MARIN WATER TRANSPORTATION STUDY COMMITTEE

FINANCIAL ANALYSIS, INCLUDING INFLATION
AIR CUSHION VEHICLE SYST
ESTIMATED EXPENSES

TABLE 70 (con't)

INCLUDING INFLATION

	MACHIN MAINTN ANCE	DRY DK STORES MISCEL EXPENS	MAINTN PERSON NEL	TOTAL
1970	0	0	0	60
1971	0	0	0	155
1972	162	21	324	4,803
1973	169	21	337	4,981
1974	175	22	351	5,167
1975	182	22	365	5,359
1976	190	23	380	6,922
1977	197	23	395	7,184
1978	205	23	411	7,457
1979	213	24	427	7,740
1980	222	24	444	9,631
1981	231	25	462	10,000
1982	240	25	480	10,384
1983	250	26	500	10,783
1984	260	26	520	13,064
1985	270	27	540	13,570
1986	281	27	562	14,095
1987	292	28	584	14,641
1988	304	29	608	17,392
1989	316	29	632	18,069
1990	329	30	657	18,773
1991	342	30	684	19,505
1992	355	31	711	20,265
1993	370	32	739	21,056
1994	384	32	769	21,877
1995	400	33	800	22,732

SAN FRANCISCO/MARIN WATER TRANSPORTATION STUDY COMMITTEE

FINANCIAL ANALYSIS, INCLUDING INFLATION
AIR CUSHION VEHICLE SYST

TABLE 71

CAPITAL INVESTMENT PROGRAM

SYSTEM SUMMARY

YEAR	INVEST MENT	CUMUL INVEST	DEPREC IATION	NET CUM INVESTMENT
1970	18,900	18,900	0	18,900
1971	19,656	38,556	1,112	37,444
1972	1,893	40,449	1,270	38,067
1973	0	40,449	1,270	36,798
1974	0	40,449	1,270	35,528
1975	0	40,449	1,270	34,259
1976	7,592	48,041	1,270	40,581
1977	0	48,041	1,270	39,312
1978	0	48,041	1,270	38,042
1979	0	48,041	1,270	36,773
1980	8,881	56,922	1,270	44,385
1981	0	56,922	1,270	43,115
1982	0	56,922	1,270	41,845
1983	3,030	59,953	1,364	43,512
1984	10,390	70,343	1,364	52,537
1985	0	70,343	1,364	51,173
1986	0	70,343	1,364	49,809
1987	0	70,343	1,364	48,444
1988	12,155	82,498	2,665	57,934
1989	0	82,498	2,665	55,269
1990	0	82,498	2,665	52,604
1991	0	82,498	2,665	49,939
1992	0	82,498	2,665	47,274
1993	0	82,498	2,665	44,609
1994	4,852	87,349	2,817	46,644
1995	0	87,349	2,817	43,828

SAN FRANCISCO/MARIN WATER TRANSPORTATION STUDY COMMITTEE

FINANCIAL ANALYSIS, INCLUDING INFLATION
AIR CUSHION VEHICLE SYST

TABLE 72

SYSTEM CASH FLOW SUMMARY

YEAR	REVENUE CASH FLOW	EXPENSE CASH FLOW	ANNUAL SURPLUS	INVESTMENT CASH FLOW	NET CASH FLOW	CUMULATIVE CASH FLOW
1970	0	60	-60	18,900	-18,960	-18,960
1971	0	155	-155	19,656	-19,811	-38,771
1972	5,770	4,803	968	1,893	-925	-39,696
1973	6,263	4,981	1,281	0	1,281	-38,415
1974	6,797	5,167	1,631	0	1,631	-36,784
1975	7,379	5,359	2,020	0	2,020	-34,764
1976	8,010	6,922	1,088	7,592	-6,503	-41,268
1977	8,697	7,184	1,513	0	1,513	-39,755
1978	9,443	7,457	1,987	0	1,987	-37,768
1979	10,255	7,740	2,515	0	2,515	-35,253
1980	11,137	9,631	1,506	8,881	-7,376	-42,629
1981	12,096	10,000	2,096	0	2,096	-40,533
1982	13,139	10,384	2,755	0	2,755	-37,778
1983	14,274	10,783	3,491	3,030	461	-37,317
1984	15,509	13,064	2,444	10,390	-7,946	-45,263
1985	16,852	13,570	3,282	0	3,282	-41,981
1986	18,313	14,095	4,218	0	4,218	-37,762
1987	19,887	14,641	5,246	0	5,246	-32,516
1988	20,484	17,392	3,092	12,155	-9,063	-41,580
1989	21,098	18,069	3,029	0	3,029	-38,551
1990	21,731	18,773	2,958	0	2,958	-35,593
1991	22,383	19,505	2,878	0	2,878	-32,714
1992	23,055	20,265	2,789	0	2,789	-29,925
1993	23,746	21,056	2,690	0	2,690	-27,235
1994	24,459	21,877	2,581	4,852	-2,271	-29,505
1995	25,192	22,732	2,461	0	2,461	-27,045

SAN FRANCISCO/MARIN WATER TRANSPORTATION STUDY COMMITTEE

FINANCIAL ANALYSIS, INCLUDING INFLATION
AIR CUSHION VEHICLE SYST

TABLE 73

SYSTEM FINANCIAL PROGRAM

YEAR	LOCAL SUBSIDY REQMT	NEW BONDS ISSUED	FINANCIAL PAYMENTS INTEREST	PRINCIPAL	OUT-STANDING BONDS	BOND RESERVE, CASH
1970	3,008	16,278	0	0	16,278	326
1971	3,008	18,206	1,058	0	34,483	690
1972	3,008	120	2,241	0	34,603	692
1973	3,008	0	2,249	2,124	32,479	650
1974	3,008	0	2,111	2,619	29,860	597
1975	3,008	0	1,941	3,186	26,674	533
1976	3,008	5,303	1,734	0	31,977	640
1977	3,008	0	2,079	2,531	29,446	589
1978	3,008	0	1,914	3,180	26,266	525
1979	3,008	0	1,707	3,926	22,341	447
1980	3,008	5,911	1,452	0	28,252	565
1981	3,008	0	1,836	3,369	24,883	498
1982	3,008	0	1,617	4,261	20,622	412
1983	3,008	0	1,340	2,197	18,425	369
1984	3,008	6,238	1,198	0	24,663	493
1985	3,008	0	1,603	4,813	19,850	397
1986	3,008	0	1,290	6,081	13,769	275
1987	3,008	0	895	7,526	6,243	125
1988	3,008	6,585	406	0	12,829	257
1989	3,008	0	834	5,325	7,504	150
1990	3,008	0	488	5,599	1,904	38
1991	3,008	0	124	1,904	0	3,898
1992	3,008	0	0	0	0	9,930
1993	3,008	0	0	0	0	16,2[illegible]4
1994	3,008	0	0	0	0	17,934
1995	3,008	0	0	0	0	24,479

VII. COSTS, BENEFITS AND RECOMMENDATIONS

A. DOLLAR BENEFITS AND COSTS

The previous chapter presented financial evaluation of three conceptualized systems. No attempt was made to design an optimum system but these evaluations strongly suggest that the investment required to establish a high quality ferry service to serve the Golden Gate corridor could be recovered before the system is replaced with a new high-speed fixed rail or other form of rapid transit system some 15 or 20 years hence. If the system were not replaced, but gradually reduced as vessels wear out, there might even be a residual profit.

While both the hypothesized one terminal displacement vessel system and the three <u>initial</u> terminal advanced technology systems appear financially feasible, we strongly suggest that the more advanced vessels be tested first, before any displacement vessels are ordered. First, market demand factors point irrefutably to the desirability of offering a faster service with more terminals than can be coupled with exclusive reliance on displacement hull craft. Second, technological advances could well result in a future increase in the financial advantages offered by hydrofoil or ACV craft. This possibility would be greatly enhanced if the Federal Government were to support a research effort using the San Francisco Marin ferry service as a pilot project. Finally, the more advanced vessels offer greater potential for flexibility and incremental expansion.

The relatively easy expandability of a ferry system utilizing at least some advanced design vessels works to reduce the financial risks inherent in providing such a system. The initial investment in any system should be enough to provide a "critical mass" of service features including good access to the terminals, convenient parking, efficient feeder service on both sides, and fast dependable boat service. To do otherwise would preclude the applicability of the forecasts of use made in this report.

However, the inclusion of at least some advanced technology vessels which carry relatively small numbers of passengers would permit the system to expand with demand or be inaugurated even before it reached the capacity required to serve the initial round-trip load of 11,000 commuters which we have forecast for a three terminal system utilizing vessels with speeds in excess of 35 mph.

Somewhat smaller <u>initial</u> use may result anyway from the feedback effect that will result from the success of the ferry system. Our forecasting model is based on a condition that existed in early 1969. We have developed and used what economists refer to as a "ceteris paribus" forecast. While the level of road congestion will climb beyond the 1969 level before the ferry system is placed into operation, the switch of 11,000 commuters from cars and line-haul buses to ferries would temporarily reduce highway, bridge, and street congestion below 1969 levels. For example, if the ferry service is inaugurated in 1971, while traffic continues to grow at the presently indicated rate, the congestion problem will have increased by the addition of more than 4000 commuters to the daily traffic load. However, if 11,000 commuters switch to the ferry service the total reduction in traffic over the bridge will reduce congestion below the 1969 level. This reduction in road congestion may temporarily induce some ferry users to return to their cars and line-haul buses.

The financial danger of their feedback effect can of course be reduced if the system itself is exceptionally well designed, convenient and well advertised. It can also be reduced by initiating the system at slightly less than the capacity requirements we have forecast, and expanding it as the population of Marin County grows.

Such incremental development of the system, preceded by a program of system design that includes a vessel-testing phase, will greatly limit the financial risks associated with the implementation of a ferry service. Nevertheless, as indicated in the previous chapter, a successful ferry system will require a public investment of between $27 million and $40 million as the system is built and additional investment of more than $20 million to replace vessels and expand it in the future. The ferry service will not be cost-free to the community because the public treasury has a limited amount of money to invest, even on financially feasible projects. Of course the fact that the investment is likely to pay its own way makes it more desirable than those public investments which require money out of the general taxpayer's pocket instead of having users pay for it over time. The public cannot avoid this cost by turning the investment requirement over to private capital sources. To do so would encourage the development of a system that would provide maximum profit instead of mixing the desire for profitability with the need to provide comprehensive service to the community. Furthermore, a privately financed ferry service would probably find it difficult to integrate the bridge, ferry, and bus systems so as to most efficiently utilize the advantages of each mode. The need for such integration is both obvious and critical.

Thus, the public must bear the investment costs of their system even though all or most of them will eventually be recovered.

We turn now to a consideration of the benefits to be gained from accepting these investment costs instead of allocating public funds or credit to an alternative use.

B. DIVERSION OF COMMUTER TRAFFIC FROM GOLDEN GATE BRIDGE

If the one Marin terminal displacement vessel system were put into operation by 1971, an average of approximately 8500 commuters per day would utilize the ferry each weekday; approximately 1105 of these would otherwise ride the bus, while about 7395 would otherwise drive their cars.

If we assume 1.5 passengers per car and 40 passengers per bus load, then 4920 fewer cars and 28 fewer buses would make round-trip crossings of the bridge each day. If a three terminal fast ferry service were utilized approximately 6380 fewer car round trips and 36 fewer bus round trips would use the bridge each week day.

As the community population expands the proportion of those who switch to ferry use would also increase. As indicated above, the 1971 ferryboat switchers would find that they have caused a decrease in the time it takes their friends who do not join them on the ferry, to drive to work. Initially the feedback effect of the ferry rider on the improved road condition may cause some of them to revert back to the use of their autos. This would, of course, be particularly so if the ferry service were not of very high quality. However, as the population of Marin and Sonoma Counties builds up some commuters would use both the roads and the ferries. The roads will become increasingly congested. This would cause the percentage of commuters who use the ferry to increase over time.

Thus the benefits to the public include the maintenance of bridge traffic at acceptable congestion levels. The ferries would not end bridge use or even all congestion. But they would help to take traffic off the bridge when its potential congestion level became unacceptable to a significant proportion of commuters. In effect, the new investment in a ferry system including feeder buses, would maintain the efficiency of the public's existing investment in the Golden Gate Bridge.

C. CONFORMITY WITH SAN FRANCISCO COMMUNITY GOALS

In September 1967 the Marin County Planning Department stated the following in its comments on a San Francisco-Marin crossing:

> "A truly balanced transportation system must not only balance the automobile with public transportation, but must also balance the transportation system with land use and community goals..."

Allan Jacobs, the chief of San Francisco's Planning Department, quoted the preceding statement in a report he wrote in that same month. Mr. Jacobs' report then went on to state San Francisco's goals as he saw them:

> "Basically what San Francisco wants, in relation to any new crossings to Marin County, is this: (1) We want to bring in the most people in the fewest vehicles. Like New York City, we have a high-density central business district where too many automobiles can become inefficient and a liability. Thus,

we are and should be encouraging more transit -- rapid and surface, suburban and local -- to form the backbone of our transportation system serving the central business district; (2) we also want a crossing facility which does not ruin our vistas of San Francisco Bay, which does not spoil Angel Island and which does not require massive freeway approach facilities which could ruin our Northern Waterfront area, and Marin County areas such as the Sausalito hills and the Tiburon Peninsula."

The provision of a ferry service would accomplish the goals so well stated by Mr. Jacobs. The benefits to San Francisco would include an increased ability to determine its own land use pattern and not have its development imposed by a transportation system.

D. INTEGRATION WITH THE SAN FRANCISCO MUNICIPAL RAILROAD

As has been discussed in Chapter V the San Francisco Municipal Railway would pick up economically beneficial "back hauls" if a ferry service were inaugurated. This benefit would aid them in providing better feeder systems for all commuters, and aid their establishment of an improved service to intra CBD travelers.

E. TIME TO DEVELOP NEW RAPID TRANSIT SYSTEMS

The greatest single benefit of a ferry system would be that it would buy time. The traffic problems to the Golden Gate are intense. We predict they will accelerate enormously. The need for more transportation service will grow as the northern counties develop. But long-run solutions including such possibilities as a tube under the Bay, a tie in with BARTD, and perhaps the development of a more technologically advanced fixed raid rapid transit system into the northern counties should not be ignored or precluded by decisions made currently.

Ferry service could provide the feeder transportation service while the parameters for a long-range solution are being set, just as this report sets the parameters in the development of a ferry system. The ferry system can be designed to maximize the opportunities for a later tie-in with a rail system or other rapid transit system that would replace the ferry system. For example, terminals could be designed so that they could later be expanded for use with another system. Use of ferries as an intermediate solution to the commute problems would permit the rational development of a long-run solution and not encourage any large intermediate expenditure on the scale represented by such alternatives as a second bridge deck, or the immediate construction of a tube under the Bay.

F. RECOMMENDATIONS

A ferry system appears feasible and capable of diverting significant numbers of commuters from the bridge and highway system. This statement answers the questions posed by the Marin-San Francisco Water Transportation Study Committee which paid for the preliminary feasibility study.

The significant benefits summarized above could be qualified and compared to the potential subsidy that may be required to initiate and operate a high-quality ferry service. We have resisted the temptation to make such quantitative judgments. In the final analysis they would merely reflect our value judgment concerning the worth of relieving congestion on the bridge, encouraging the further development of Marin County, partially freeing San Francisco from dominance by the automobile, encouraging improvements in local intra-county bus service, and buying the time needed to rationally develop a technologically advanced rapid transit system. We could place a price tag on any one of these benefits that would exceed the total potential cost of establishing a ferry service, but to do so would be an exercise in mathematical sophistry. We urge that the following steps be taken immediately:

1. One authority should be assigned the responsibility of providing an integrated Bridge-Ferry Bus System serving the Golden Gate Corridor as soon as possible while it begins to plan for the provision of a rapid transit system to meet long-range needs. The Golden Gate Bridge and Highway District seems the logical candidate for this job.

2. A system design and development effort should start immediately in a program aimed at creating a ferry service. The first task of their effort should include vessel testing and the design of an optimum integrated Ferry Bus System. After this task is completed contracts should be let and the system developed. The parameters of a long-range solution should begin to be established as the elements of the Ferry Bus System are being developed.

APPENDIX A

SURVEY RESEARCH METHODOLOGY UTILIZED TO COLLECT CROSS-SECTIONAL DATA FOR DETERMINING DEMAND

A. THE FERRYBOAT PILOT STUDY

ADL undertook a pilot study to test the ferryboat commuter survey methodology and questionnaire format. We interviewed 147 persons: 83 on the Tiburon ferry, 35 at Bechtel Corporation, and 29 at Bank of America. The Tiburon ferry sample was included to obtain a demographic picture of the type of person or group who currently rides the ferry to work. The two firms were chosen on the basis of their respective San Francisco locations. Because Bechtel's Beale St. building is much closer to the Ferry Building terminus than the Bank of America Montgomery/California Sts. location, it was hypothesized that employees at Bechtel would be more likely to ride the ferry than the more distant Bank of America employees. The results of our pilot study verified this hypothesis. The two firms provided us with a sample which included a wide range of salaried employees. Although the pilot questionnaire was structured, the experienced interviewers were instructed to deviate from it in order to pursue all topics associated with ferryboat use in which the respondent revealed an interest or knowledge. Therefore, the pilot study questionnaire was both a structured and depth interview process. Based on the pilot study experiences, changes were made in the questionnaire format. Copies of the pilot study and final commuter questionnaires are attached.

B. SAMPLING METHODOLOGY FOR FINAL FERRYBOAT COMMUTER SURVEY

1. Determination of Sample Size

Utilizing the 1968 MCTD origin and destination survey data, San Francisco was partitioned into 16 destination zones. Each zone and its boundaries are delineated on Figure A-1. The percent of Marin County commuters traveling to each San Francisco zone was computed. the ADL commuter sample apportioned the interviews to each zone on the basis of these destination percentages.

Figure 4* presents the 16 zonal areas, the MCTD destination percentages, the actual number of obtained interviews, and the percent distribution of obtained zones. This table gives an indication of the close alliance between the obtained percent and origin/destination percent of zonal allocations, although the financial district and Ferry Building/ Lower Market St. areas are slightly overrepresented in the sample while the primarily residential areas (e.g., Pacific Heights, San Francisco State College area, and Marina) are underrepresented.

* Chapter IV.

TABLE A-1

ZONAL DISTRIBUTION OF SAN FRANCISCO SAMPLE

San Francisco Zone		Percent to be Interviewed Based on MCTD O & D Data	Number of Obtained Interviews Per Zone	Percent of Obtained Interviews Per Zone
1	South of Market	3.1	34	3.1
2	Bay Bridge/Southern Waterfront	7.6	83	7.6
3	Financial District West Montgomery St.	38.3	239 =431	21.9 =39.5
15	Financial District East Montgomery St.		192	17.6
4	Ferry Building/Lower Market	17.5	214	19.6
5	Civic Center	11.6	129	11.8
6	North Beach area	1.2	13	1.2
7	Polk St. area	2.4	26	2.4
8	Telegraph Hill area	2.6	29	2.7
9	Medical Center	1.5	20	1.8
10	Upper Market	2.0	8	.7
11	Japanese Trade Center area	2.9	18	1.6
12	Pacific Heights	1.6	10	.9
13	Marina	.8	10	.9
14	San Francisco State College area	1.8	10	.9
16	Presidio area	4.9	55	5.0
	Total	99.8%	1,090	99.7%

The size of the sample (n), or 1090 respondents, was reached at through the prior determination of confidence coefficient and error estimates. A 95% confidence coefficient was selected. This means that we can expect the sample we selected to contain the true population proportion 95% of the time. An error estimate of $\pm$ .03% was considered to be more than adequate for the purpose of this study. The error estimate is the degree of confidence that can be ascribed to any of the survey's numerical findings. Once these two parameters have been agreed upon, one additional piece of information is needed to calculate the appropriate sample size--the approximate population from which the sample is expected to be drawn which is, in this instance, the approximate total of Marin County-San Francisco commuters. Based on the Golden Gate Bridge Authority's 1968 headcount for southbound traffic only, and depending upon the hours selected (i.e., 6-9:30 a.m. or 6-10 a.m.) there were between 30,000 and 32,000 commuters in 1968. We thus assumed that there are approximately 30,000 commuters on any average day.

Once these three coefficients were decided, we calculated the required sample size from the following formula:

$$n = \frac{N}{1 + Ne^2},$$

where n = size

N = population

e = error estimate

or

$$n = \frac{30,000}{1 + 30,000\,(.03)^2}$$

$$n = 1071.$$

Thus, in order to obtain the requisite confidence coefficient and error estimate levels, it was necessary to interview a minimum of 1071 respondent commuters. The final sample consisted of 1090 completed commuter surveys.

Knowledge concerning the confidence and error estimate levels permitted us to know with what assurance we would obtain the same responses to an identical set of questions, that is, to provide a measure of response reliability. For example, if the study results indicated that 325 respondents would ride the ferry to work five days a week provided that the total round trip cost did not exceed $1.50 per day, we could compute the probability that the same or a similar result would be derived from the identical sample or a second sample selected in the same manner.

$$P = \frac{325}{1071} = .30$$

$$.30 - .03 \qquad .30 + .03$$

$$.27 \qquad .33$$

In other words, we are confident that 95 out of 100 times between 27% and 33% of all sampled Marin County commuters will state that they are willing to ride the ferry five days a week at a fare not exceeding $1.50.

Note that we cannot say that we know that 27-33% of the Marin County commuters will, in fact, ride the ferry but only that if asked this percentage range will respond in a similar manner. Actual behavior or response validity can be inferred from the interviewer's experience. This topic will be expanded in the discussion of interviewer training processes. However, true validity can only be verified by the subsequent behavior of the commuters provided they are given the opportunity or choice situation about which they have previously been queried.

2. Sample Selection

Although Table A-1 indicates the percent of interviews to be allocated to the 16 zones, the distribution within any one zone still has to be determined. In order to achieve this, ratios of employment density or ratio of employment to total land acres in block (persons per acre) were utilized. These data were derived from the San Francisco Department of City Planning 1964 Community Renewal Program data bank (modified in 1965). Therefore, each zone was subdivided into blocks and the number of respondents to be surveyed from each block specified.

The specific respondents included in the survey were selected by one of two methods. In those blocks which were dominated by one or two large corporations, the company was contacted directly and asked to cooperate. In almost all instances we received good cooperation. These firms were then asked to provide us with a specific number of their Marin County employees. They were instructed to select a sample which was representative of a wide span of income groups and which included both male and female respondents. Frequently the companies would actually set up the interview schedules for us; otherwise, we made individual appointments with the designated persons.

In those blocks in which there was a variety of establishments, the interviewers attempted to allocate their interviews among alternate size companies. In all cases they made every attempt to select a representative sample. Thus, there was a deliberate attempt to choose different floors within any one building and differing structures within any one block which was directly proportional to the block's overall makeup. Depending upon the size of the firm, the interviewer contacted the head of the company or the director of personnel to obtain approval to interview a specified number of that firm's Marin County employees. Although there was a deliberate attempt to talk to employees at all occupational levels, there is probably a slight underrepresentation of the $25,000 and above professional/administrative executive who has a higher than average probability of being in meetings or out of town. Special efforts were made to make individual appointments or call-backs for these individuals.

C. INTERVIEWER TRAINING AND QUESTIONNAIRE FORMAT

The results obtained from any survey procedure can only be as good as the questionnaire form and the interviewer who administers it.

Six experienced interviewers, a field supervisor, and survey director took part in the field survey.

During the pretest phase and early part of the study, debriefing sessions were held to discuss the questionnaire format and survey methodology. No matter how thorough the pretest or the time taken to develop a structured questionnaire, the unique pattern of response must not be stifled but carefully considered and integrated into the survey. Thus, such problems as atypical commute patterns were analyzed and appropriate categories devised. These sessions were held on a weekly basis as the study progressed.

Each interviewer was trained to assure that the questionnaire administration was standardized. Because of the highly emotional nature of the survey topic, with most persons being favorably or unfavorably disposed to the ferryboat concept apriori, each interviewer was given special instructions to avoid getting involved in a generalized discussion of the study. She was instructed to put the respondent in touch with the project case leader if the respondent had questions concerning the nature of the study. As a point of fact, the case leader received no calls. Additionally, the interviewer attempted to ask the questions with a neutral expression. She projected a polite but noninvolved demeanor. Each questionnaire was administered on an individual basis and the respondent was interviewed in relative privacy so that his/her responses could not be overheard by others. Each interview took from 10-15 minutes.

The interviewers reported that they believed the veracity of the subjects was quite high despite the pro or con attitudes held by many of the respondents. For example, it was not infrequent to find a respondent who would make the following type of comment during the interview: "I think ferryboats should be instituted in order to solve the commute problem." However, the same respondent, when asked how frequently he or she would ride the ferry under alternate circumstances would state "few" or "no" times. Therefore, the respondents did not seem to have a problem differentiating how they felt about the subject in general from their own personal behavior. Needless to say, this is an important and necessary distinction to make in survey research.

The questionnaire design also incorporated internal consistency checks. For example, question 4 - "In general, what time do you leave your residence to go to work in the morning?" was followed by question 5 - "In general, what time do you arrive at work?" and question 12 - "In general, how long does it take you to commute from your place of residence to your place of employment?"

At the completion of the interview, the interviewer queried the respondent as to any response inconsistencies. In most cases there was a logical reason for what appeared to be an inconsistent answer. If, for example, the respondent left his house at 6 a.m. and arrived at work at 8:45 a.m. but stated that it only took one hour to commute, he may, in fact, routinely stop for breakfast before going to his job. A truism in survey research is that if all responses fit neatly into categories, there is something amiss. The real world is just too full of unique situations.

In the same manner that questions 4, 5, and 12 relate to each other, so do questions 10 and 14 which require the respondent to specify those factors which influence his selecting one transportation mode over another. Many respondents agonized over the ranking task and took great effort in analyzing their own motives. Therefore, it is our opinion that the responses to question 14 are more valid than those to question 10, although there is a high correlation between the two.

Questions 17 a, b, and c, which asked the respondent how frequently he would ride the ferry to work given a short and long time period, was purposely placed before the series of questions which dealt with the number of times the respondent would take the ferry to work under alternate price assumptions (questions 19, 20, 21, and 22). This placement was made to prevent the prior concept of a particular price from influencing the respondent's answers to the time questions. For example, if the respondent had known he would be asked how many times he would ride the ferry at $1 per day, he might, unknown to us, assume a $1 cost when responding to how many times he would ride the ferry at the two time periods. By placing the time question before the price questions, we know that if the respondent had a specific fare in mind, there would be no reason to assume that this price would be uniform for all respondents. We did recognize that the respondent might retain some time concept as he/she answered the set of questions posing alternative prices. Thus, for example, a respondent may answer the number of days he/she will take the ferry at each separate price while simultaneously thinking in terms of either the previously postulated short- or long-term estimate. To avoid the possibility of a constant bias, half the respondents were asked the shorter time estimates first, while the time sequence was reversed for the other half. Nevertheless, our use of these data did recognize that some bias may not have been eliminated when the respondent answered the series of price questions. The demand model that we derived utilized these data so as to minimize any bias. This procedure is explained in chapter IV.

The respondents showed the extent of their knowledge when answering question 18 concerning Marin County ferry terminal location preferences. The majority backed up their preferences with discussions indicating familiarity with geological, traffic, or parking advantages/disadvantages associated with alternate sites. An analysis of all the choices indicated that all but a very few were logical selections. (This does not indicate, of course, they were equally feasible.)

Questions 23 a - g posed the greatest difficulty. Many respondents were unable to separate the feeder costs from the total trip cost. The interviewer requested they attempt to look at these separately but if they could not to assume that a $2.50 round trip cost would include the feeder costs. The interviewing process indicated that the average commuter just does not separate feeder costs and that if the total cost is acceptable, he is relatively indifferent to its allocation. However, the respondent was able to clearly state his/her relative preference for the different feeder modes.

D. THE NONCOMMUTER TELEPHONE SURVEY

ADL interviewed 400 Marin County residents by telephone Monday through Friday from 9 a.m. to 5 p.m. Interviews were conducted during these hours to reach the noncommuter or, generally speaking, the housewife to ascertain her San Francisco travel patterns. (A copy of the noncommuter questionnaire is attached.)

The telephone was selected as a reliable survey media because of the high rate of telephone subscriptions associated with high-income counties. Thus, approximately 94% of all Marin County residences have their own phones. Although Novato is serviced by Western California Telephone Company while the rest of Marin County is part of Pacific Telephone jurisdiction, Novato telephone listings are included in the Pacific Telephone directory. Two telephone numbers per page were selected due to the fact there are 216 pages in the Marin County telephone book. A table of random numbers provided the means for selecting the telephone sample. A row of one-digit numbers was used to indicate which column (there are four columns to every page) to select from and two-digit columns were used to specify the appropriate telephone book row. In case the randomly selected number was a business establishment or a residence where there was a refusal to answer or no one at home, the interviewer would repeat the procedure to obtain a replacement number. We made no call-backs at residences where no one answered the telephone, but did call back when we got busy signals.

I.D. 1____

2____

3____

4____

5____

Card # 6____

INTERVIEWER'S NAME ____________________

DATE: ____________________

LOCATION OR ADDRESS: ____________________

FERRYBOAT COMMUTER QUESTIONNAIRE

Hello. My name is ____________________ and I work for Arthur D. Little, Inc., a San Francisco consulting firm. We are investigating the feasibility of establishing a ferryboat service from Marin to San Francisco. Your cooperation is very important to this project.

1. In what city do you live? Please name the two streets that intersect closest to your residence.

   Name of city: ____________________ 7-9____

   Street intersection: ____________ and ____________ 10-12____

2. What are the names of the two streets which intersect closest to your most regularly selected San Francisco destination?

   San Francisco street intersection ____________ and ____________

   Do not have regularly selected San Francisco destination ________ 13-15____

3. In general, excluding Saturday and Sunday, how many weekdays do you travel to San Francisco? 16____

   none ( )0 three ( )3

   one ( )1 four ( )4

   two ( )2 five ( )5

IF ONE OR MORE DAYS, ASK THE FOLLOWING:

4. In general, what time do you leave your residence to go to work in the morning? 17____

   before 5:45 a.m. ( )1

   5:46-6:15 a.m. ( )2

   6:16-6:45 a.m. ( )3

   6:46-7:15 a.m. ( )4

   7:16-7:45 a.m. ( )5

   7:46-8:15 a.m. ( )6

   8:16-8:45 a.m. ( )7

   8:46-9:15 a.m. ( )8

   9:16-9:45 a.m. ( )9

   after 9:46 a.m. ( )0

5. In general, what time do you arrive at work? 18 ____

before 6:15 a.m. ( )1
6:16-6:45 a.m. ( )2
6:46-7:15 a.m. ( )3
7:16-7:45 a.m. ( )4
7:46-8:15 a.m. ( )5
8:16-8:45 a.m. ( )6
8:46-9:15 a.m. ( )7
9:16-9:45 a.m. ( )8
after 9:46 a.m. ( )9

6. In general, what time do you leave your place of employment to return home in the afternoon? 19 ____

before 3:15 p.m. ( )1
3:16-3:45 p.m. ( )2
3:46-4:15 p.m. ( )3
4:16-4:45 p.m. ( )4
4:46-5:15 p.m. ( )5
5:16-5:45 p.m. ( )6
5:46-6:15 p.m. ( )7
6:16-6:45 p.m. ( )8
6:46-7:15 p.m. ( )9
after 7:16 p.m. ( )0

7. On the average, how many weekends per month do you or members of your household travel to San Francisco? 20 ____

none ( )0
one ( )1
two ( )2
three ( )3
four ( )4

8. What are the time periods you and members of your household most frequently travel to San Francisco on weekends? 21 ____

before 9:00 a.m. ( )1
9:00-12:00 a.m. ( )2
12:01-3:00 p.m. ( )3
3:01-6:00 p.m. ( )4
6:01-9:00 p.m. ( )5
9:01-12:00 p.m. ( )6
after 12:00 p.m. ( )7
varied times ( )8

9. In general, how many days per week do you take the following mode (modes) to work?

Type of Mode	None (0)	1	2	3	4	5	
			Number of Days				
Drive own car							22 ____
Ride in someone else's car							23 ____
Bus							24 ____
Ferry							25 ____
Car & bus (drive to bus stop)							26 ____
Ferry & bus (ride bus to ferry or take ferry one direction/bus the other)							27 ____
ferry & car							28 ____

10. Which of the following factors are <u>first</u>, <u>second</u>, and <u>third</u> most important to your choice of travel mode?

convenience ( )01 — 1st- 29-30 ____
time ( )02 — 2nd- 31-32 ____
safety ( )03 — 3rd- 33-34 ____
cost ( )04
comfort ( )05
privacy ( )06
dislike of alternative modes (specify)________________(07)
dependability ( ) 08
relaxing/pleasant trip ( ) 09
compatible company ( ) 10
need car for job ( ) 11
other amenities (specify) ________________(12)
other (specify)________________(13)

11. Would you say that you are presently very satisfied (1), satisfied (2), unsatisfied (3), or very unsatisfied (4) with your present mode of transportation? 35 ____

12. In general, how long does it take you to commute from your place of residence to your place of employment? 36 ____

less than 20 minutes ( )1
21-30 minutes ( )2
31-40 minutes ( )3
41-50 minutes ( )4
51-60 minutes ( )5
61-70 minutes ( )6
71-80 minutes ( )7
81-90 minutes ( )8
91 or more ( )9

13. If the travel requirements of each member were compatible, would you participate in a car pool? (Read alternatives) 37 ____

all of the time ( )4
frequently ( )3
sometimes ( )2
seldom ( )1
never ( )0

14. Please rank the following factors in order of their importance to your selection of a travel mode to and from work (Read alternatives):

Privacy (avoiding crowds--being by self)________________ 38 ____ (1-5)

Convenience (ready availability of transportation)________________ 39 ____ (1-5)

Time (total time it takes from place of residence to place of employment)________________ 40 ____ (1-5)

Comfort (comfort of conveyance as well as protection from bad weather conditions)________________ 41 ____ (1-5)

Cost (total cost of work trip including parking and bridge tolls) ________________ 42 ____ (1-5)

15. Does the nature of your business require you to drive your own car regularly? 43 ____

Yes ( )1
No ( )2

16. The features associated with two different kinds of ferryboats are listed below. Which of the two would you prefer to ride? Why?

44 ____

Type of Vessel	Time aboard in minutes assuming a Corte Madera to Ferry Bldg. Crossing	Relative reliability dependability (maintenance of time schedules)	Capacity and Amenities
Hydrofoil or Hovercraft Type Vessels 1	20 minutes	Lower rate of schedule dependability	Relatively small; insufficient to permit amenities such as restaurant/bar space, barber shop, TV room
Conventional Type Vessels 2	30-35 minutes	High rate of schedule dependability	Large enough to permit the areas for inclusion of restaurant/bar, barber-beauty shop, TV; smooth crossing

45 ____ E-speed

46 ____ E-exciting

47 ____ E-other(speci
____

48 ____ C-dependable

49 ____ C-amenities

50 ____ C-safety

51 ____ C-time unimportant

52 ____ C-other(speci
____

17. CHECK BACK TO QUESTION #1 FOR CITY OR AREA.

A. For persons living in Corte Madera south (including Mill Valley, Marin City, Tiburon, Belvedere & Sausalito)

If the total commute time from your home to the Ferry Building in San Francisco took a total of (35)(55) minutes, how many days per week would you ride the ferry to work? (INTERVIEWER: ALTERNATE THE INSERTION OF BOTH THE 35 AND 55 MINUTE TIME PERIODS. PLACE A 1 or 2 NEXT TO THE COLUMN NUMBER TO INDICATE WHICH OF THE TWO TIME PERIODS YOU ASKED FIRST.)

none = 0
one = 1
two = 2
three = 3
four = 4
five = 5
occasionally = 6
don't know = 7

53 ____ (35 minutes)

54 ____ (55 minutes)

B. For persons living north of Corte Madera and south of Ignacio (including Larkspur, Greenbrae, Ross, Kentfield, Fairfax, San Anselmo & San Rafael)

If the total commute time from your home to the Ferry Building in San Francisco took a total of (50)(70) minutes, how many days per week would you ride the ferry to work? (INTERVIEWER: ALTERNATE THE INSERTION OF BOTH THE 50 AND 70 MINUTE TIME PERIODS. PLACE A 1 OR 2 NEXT TO THE COLUMN NUMBER TO INDICATE WHICH OF THE TWO TIME PERIODS YOU ASKED FIRST.)

none = 0
one = 1
two = 2
three = 3
four = 4
five = 5
occasionally = 6
don't know = 7

55 ____ (50 minutes)

56 ____ (70 minutes)

C. For persons living in Ignacio and the northern portion of the county:

If the total commute time from your home to the Ferry Building in San Francisco took a total of (60)(80) minutes how many days per week would you ride the ferry to work? (INTERVIEWER: ALTERNATE THE INSERTION OF BOTH THE 60 AND 80 MINUTE TIME PERIODS. PLACE A 1 OR 2 NEXT TO THE COLUMN NUMBER TO INDICATE WHICH OF THE TWO TIME PERIODS YOU ASKED FIRST.)

none = 0
one = 1
two = 2
three = 3
four = 4
five = 5
occasionally = 6
don't know = 7

57 ____ (60 minutes)

58 ____ (80 minutes)

18. What are your first, second, and third choice locations for a ferry terminal?

Name of City

1st______________________________ 59-60 ____ (1st)

2nd______________________________ 61-62 ____ (2nd)

3rd______________________________ 63-64 ____ (3rd)

19. How many days per week, if any, would you take the ferry if the daily round trip fare were $2.50? 65 ____

none	( )0	
one	( )1	
two	( )2	
three	( )3	
four	( )4	
five	( )5	
other	( )6	(specify:__________________)

20. How many days per week, if any, would you take the ferry if the daily round trip fare were $2.00? 66 ____

none	( )0	
one	( )1	
two	( )2	
three	( )3	
four	( )4	
five	( )5	
other	( )6	(specify:__________________)

21. How many days per week, if any, would you take the ferry if the daily round trip fare were $1.50? 67 ____

none	( )0	
one	( )1	
two	( )2	
three	( )3	
four	( )4	
five	( )5	
other	( )6	(specify:__________________)

22. How many days per week, if any, would you take the ferry if the daily round trip fare were $1.00? 68 ____

none	( )0	
one	( )1	
two	( )2	
three	( )3	
four	( )4	
five	( )5	
other	( )6	(specify:__________________)

23. To be answered by those who state they would expect to ride the ferry at least once a week.

We are interested in knowing the frequency with which you would take the following travel mode alternatives when traveling to and from your home to the ferry terminal.

Would you (insert phrase) often 1, sometimes 2, or seldom 3:

A. Drive your car and park at the ferry terminal if parking cost $1.00 per day? 69 ____

B. Drive your car and park if parking cost $.50 per day? 70 ____

C. Drive your car if parking were free? 71 ____

D. Ride a special commuter mini-bus if round trip fare cost $.50? 72 ____

E. Ride a special commuter mini-bus if it were free? 73 ____

F. Ride the existing bus system if round trip fare cost $.50? 74 ____

G. Ride the existing bus system if it were free? 75 ____

I.D. 1 ____

2 ____

3 ____

4 ____

5 ____

Card # 6 ____

24. What amenities or features could a ferryboat offer to increase your willingness to ride the ferry? For example, restaurant/bar services, barber shop, TV room, etc.?

A. comfortable seats ( ) 7 ____

B. restaurant ( ) 8 ____

C. bar ( ) 9 ____

D. snack bar ( ) 10 ____

E. news-stand ( ) 11 ____

F. shoe-shine stand ( ) 12 ____

G. work rooms/reading rooms ( ) 13 ____

H. TV room ( ) 14 ____

I. barber shop ( ) 15 ____

J. hostesses ( ) 16 ____

K. other (specify:______________________________) 17 ____

L. other (specify:______________________________) 18 ____

25. Do you ever ride the Tiburon Ferry? Yes ( )1 No ( )2 19 ____

FOR TIBURON PASSENGERS ONLY:

A. How do you generally get to the ferry? 20 ____

walk ( )1
drive car and park ( ) 2
driven by wife or others ( )3
bus ( )4

B. Did the existence of a Tiburon Ferry service influence your move to the area? 21 ____

Yes ( )1 No ( )2

JUST A FEW SHORT QUESTIONS ABOUT YOURSELF:

26. Are you single ( )1 22 ____
married ( )2
widowed ( )3
divorced/separated ( )4

27. Do you live in an apartment ( )1, or house ( )2? 23 ____

28. How many adults 21 years of age and older currently reside in your household? 24 ____

one ( )1 two ( )2 three or more ( )3

29. How many persons age 12 through 20 currently reside in your household? 25 ____

none ( )0 three ( )3
one ( )1 four ( )4
two ( )2 five or more ( )5

30. How many children under the age of 12 years currently reside in your household? 26 ____

none ( )0 three ( )3
one ( )1 four ( )4
two ( )2 five or more ( )5

31. In what year were you born? (Do not read alternatives) 27 ____

-1950 ( )1 1949-1930 ( )2 1929-1910 ( )3 1909 ( )4

32. What was the last grade you completed in school? (Do not read alternatives) 28 ____

0-4th ( )1 Technical school ( )5
5-8th ( )2 1-3 years college( )6
1-3 yrs. high school ( )3 4 years college/grad ( )7
High school graduate ( )4 Beyond college ( )8

33. Are you the head of your household? Yes ( )1 No ( )2 29 ____

34. Occupation of head of household? (read alternatives) 30 ____

blue collar ( )1
white collar ( )2
sales ( )3
managerial/administrative ( )4
professional/technical ( )5
retired ( )6
unemployed ( )7
student ( )8

35. Please tell me the letter that corresponds to the total income, before taxes, of your family during 1968. This includes wages and salaries, business projects, net family income, pension, rent and any other income received by members of the family. 31 ____

A. $0 - 5,999 ( )1

B. $6 - 9,999 ( )2

C. $10 - 14,999 ( )3

D. $15 - 19,999 ( )4

E. $20 - 24,999 ( )5

F. $25,000 and above ( )6

( )7

36. Do you have any tendencies toward sea sickness? 32 ____

Yes ( )1

No ( )2

Don't know ( )3

THANK YOU VERY MUCH.

INTERVIEWER FILL IN:

37. Sex: male ( )1 33 ____

female ( )2

38. Race: white ( )1 34 ____

black ( )2

oriental ( )3

I.D. _____ (   )1

Name of Interviewer: ______________________________ _____ (   )2

Date: ___________________________ _____ (   )3

Telephone Number: ________________ _____ (   )4

_____ (   )5

FERRYBOAT NON-COMMUTER QUESTIONNAIRE

Hello. My name is ______________________________ and I work for Arthur D. Little, Inc., a San Francisco consulting firm. We are investigating the feasibility of establishing a ferryboat service from Marin County to San Francisco and would appreciate your answering a few questions.

Respondent's Address (INTERVIEWER FILL IN):

Street address ____________________________ (   )6-8

City _______________________________________ (   )9-10

How many weekdays (excluding Saturday and Sunday) have you traveled to San Francisco during the last 30 days?

none ( )0	five ( )5	
one ( )1	six ( )6	
two ( )2	seven ( )7	
three ( )3	eight ( )8	
four ( )4	nine or more ( )9	( )11

What time periods do you most frequently travel to San Francisco during the week?

morning (before 12:00 p.m.)	( )1	
early afternoon (12:00 p.m.- 3:00 p.m.)	( )2	
late afternoon (3:01 p.m.- 6:00 p.m.)	( )3	
evening (after 6:01 p.m.)	( )4	
varied times	( )5	( )12

How many weekends per month do you travel to San Francisco?

four ( )4		( )13
three( )3		
two ( )2		
one ( )1		
none ( )0		

If person has not traveled to San Francisco in the last 30 days at least once, turn to page 3.

What time periods do you most frequently travel to San Francisco on weekends?

morning (before 12:00 p.m.)	( )1	
early afternoon (12:01 p.m. to 3:00 p.m.)	( )2	
late afternoon (3:01 p.m. to 6:00 p.m.)	( )3	
evening (after 6:01 p.m.)	( )4	
varied times	( )5	( )14

I am going to read you a list of travel modes. Would you please tell me if you use these to go to San Francisco all of the time ( )4, most of the time ( )3, some of the time ( )2, seldom ( )1, or never ( )0?

drive your own car	( )15
ride with someone else	( )16
take a bus	( )17
ride the Tiburon Ferry	( )18
other (specify)______________________________	( )19

If there was a ferry service from Marin County to San Francisco, for which the time and cost was the same as your present mode, would you ride the ferry

all of the time	( )4	
most of the time	( )3	
some of the time	( )2	
seldom	( )1	
never	( )0	( )20

If there was a ferry service from Marin County to San Francisco, for which the total trip time was 10 minutes longer than your present mode, would you ride the ferry

all of the time	( )4	
most of the time	( )3	
some of the time	( )2	
seldom	( )1	
never	( )0	( )21

If there was a ferry service from Marin County to San Francisco, which cost $.50 more than your present mode, would you ride the ferry?

all of the time ( )4
most of the time ( )3
some of the time ( )2
seldom ( )1
never ( )0 ( )22

How many cars do you have in your household? (DO NOT READ ALTERNATIVES.)

three or more ( )3
two ( )2
one ( )1
none ( )0 ( )23

If you are married, does your husband work in San Francisco?

Yes ( )1
No ( )2
Not married ( )3
Atypical commuter pattern ( )4 ( )24

Do you have any comments you would like to make concerning the establishment of a Marin County - San Francisco ferryboat system?

no comments ( )25
pro ferryboats (romantic/nostalgic/general reasons) ( )26
pro ferryboats as answer to commuter transportation problem ( )27
pro ferryboats - good for tourism - very San Francisco ( )28
against ferryboats because commited to present mode ( )29
against ferryboats because favors another mass transit mode (i.e. bus or tube) ( )30
against ferryboats because of expense ( )31
suggestions for ferry terminal locations (specify) ______________

______________________________ ( )32

suggestions for scheduling (specify) ______________

______________________________ ( )33

suggested amenities (specify) ______________

______________________________ ( )34

THANK YOU VERY MUCH.

APPENDIX B

FORMULATION OF MATHEMATICAL MODEL
USED TO DEFINE DEMAND FUNCTIONS

W. L. Garrison gives the following criteria for a good transportation model*:

1. Forecasting models should display pertinent behavioral relations of the system under study. The model should specify the type of data that will be used, the theoretical relationships that are assumed, and the kind of forecast produced.

2. Forecasts should give accurate results and be verifiable.

3. The model should be as simple as possible.

We cannot be sure of observing Mr. Garrison's second canon since no ferryboat systems of the kind we have considered are in operation today; thus we cannot verify the model's forecasts. Since no two regions are alike, the testing of our model on advanced ferry services operating elsewhere would not be relevant. The other two canons can be followed closely. This section of the Appendix proceeds to describe the model.

We had conducted and analyzed 147 interviews with Marin commuters prior to preparing a detailed questionnaire capable of eliciting responses that suggest the reaction of Marin commuters to alternate waterborne systems. The final questionnaire was administered to 1090 Marin commuters at their place of work in San Francisco.

An analysis of these questionnaires indicates that once certain basic requirements relating to dependability and service are met, two primary factors influence the willingness of a given individual who lives in one place in Marin and works at one place in San Francisco to use the ferries. The two factors are, not surprisingly, time and cost.

This not startling conclusion concerning the significance of time and cost does not suggest that all people show the same behavioral responses to changes in the system's speed and price. Quite to the contrary--the further they live from their job, the more time they are

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* W. L. Garrison: A Prolegomenon to Forecasting Transportation Development, Northwestern University, Evanston, Ill., August 1965. Distributed by Clearinghouse for Federal, Scientific and Technical Information/U.S. Department of Commerce, National Bureau of Standards, Institute for Applied Technology.

willing to spend in getting to work. Consider the responses which indicate the percentage of commuters living in Southern Marin, Central Marin, and Northern Marin who would use a ferry five days a week if a fast ferry made the distance to and from their home to the Ferry Building equal to 35, 50, and 60 minutes, respectively, or a slower ferry made the distance equal to 55, 70, and 80 minutes, respectively:

	Shorter Time Period	Longer Time Period
Southern Marin	74%	37%
Central Marin	63%	38%
Northern Marin	77%	53%

Our analysis of the origin and destination data also suggests differences in responsiveness to alternatives in price and distance as a function of where people work in San Francisco. Thus, we needed to define a model for each appropriate zone in San Francisco so that if the coefficient of responsiveness to price and time for all groups in Marin were proportionate to their distance from terminal locations, then the summation of models defined separately for each zone in San Francisco would give us the number of round trips per week for each terminal and line haul combination system that we choose to postulate.

With these two assumptions in mind--the need for zonal breakdowns and the need to incorporate into the model responsiveness to commute time and fare structure--a conceptual model was developed that met these needs and provided a means of taking the market survey results as inputs and computing demand functions as the desired output.

A. BASIC STRUCTURE

The essential problem we were faced with in this study was how much diversion of commuter traffic would occur if a waterborne system were introduced as an alternative means of transportation. Obviously, this global problem must have some definable boundaries placed on it to allow solutions to be formulated and action taken in the "real world." A reformulation of the problem establishing a closer tolerance on the question might be, "given a set of behavioral characteristics of the commuter population and an array of alternative waterborne systems, what is the subset of these characteristics that will define the group of commuters that will switch and then proceed to quantify the amount of this modal change?" By asking this latter question we were able to formulate a "model" that hopefully answers the question. A "model" is an abstraction from reality and thus has to make assumptions and simplify. What follows is a discussion of the development of that abstraction.

We were able to make an estimate of the total commuter flow between a Marin zone and a San Francisco zone. We required a way of multiplying this interzonal flow number by some proportional factor or coefficient, the product of which is the number of ferryboat trips for that zone-to-zone flow. Thus:

(1) $F_{ij} = \alpha_{ij} C_{ij}$

Where C_{ij} = Total commuter round trips between Marin zone "i" and San Francisco zone "j".

F_{ij} = Number of commuter round trips by ferry boat between zone "i" and zone "j".

α_{ij} = A coefficient relating commuter round trips by ferry boat to total commuter round trips. It would assume values between 0 and 1.

The remainder of this section concerns itself with the problem of defining α_{ij}. For any zone-to-zone commute we previously identified two important factors that influence the ridership--commute time and round-trip fare.

(2) $\alpha_{ij} = F(T_i, P_{ij})$

Where T_i = Weighted average commuter time between Marin zone "i" and the Ferry Building.

P_{ij} = Round-trip fare between Marin zone "i" and the Ferry Building, including parking and/or feeder system in Marin.

F = The functional relationship relating ferryboat round trips to time and price. The definition of this function is explained below.

A number of functional forms could be postulated that conceivably would describe commuter behavior towards time and price changes. From our market survey we developed demand schedules for ferryboat round trips as a function of time and price (see Chapter IV). A means of generalizing this demand schedule would be to derive demand curves from these schedules, and using these demand curves further to define α_{ij}.

A demand curve in two dimensions is, in general, a hyperbola with the following form assuming for the moment quantity being related to price.

(3) $Q = AP^{-\varepsilon_p}$

Where Q = Quantity

P = Price

ε_p = Elasticity of quantity with respect to price

A = Coefficient

This is the defining equation for a demand curve from classical economics. Generalizing to three dimensions where quantity is a function of both price and time we have

(4) $Q = AP^{-\varepsilon_p}T^{-\varepsilon_t}$

Where T = Time

ε_t = Elasticity of quantity with respect to time.

From a functional relationship like this we can determine the quantity desired at any price and time combination. In an analogous fashion we can determine ferryboat round trips at any price and time combination.

(5) $\alpha_{ij} = AT_i^{-\varepsilon_t}P_{ij}^{-\varepsilon_p}$

Where α_{ij}, T_i, P_{ij}, ε_t, ε_p are as before.

A = A proportional coefficient determined from the fitting of the demand curve so that α_{ij} assumes values between 0 and 1.

The elasticities, ε_t and ε_p, measure the responsiveness of the number of round trips that a commuter is willing to take on the ferry system to changes in the time or fare, respectively, required for them to make the commute.

The elasticities are defined as follows:

(6) $$\varepsilon_t = \frac{\frac{\Delta F_{ij}}{F_{ij}}}{\frac{\Delta T_{ij}}{T_i}}, \quad \varepsilon_p = \frac{\frac{\Delta F_{ij}}{F_{ij}}}{\frac{\Delta P_{ij}}{P_{ij}}}$$

To normalize the equation so that α_{ij} will in fact take on values between 0 and 1, A becomes the reciprocal of the maximum number of round trips in the sample between any two zones:

$$(7) \qquad A = \frac{1}{TR_{ij}}$$

Where TR_{ij} = Minimum number of round trips possible between zone "i" and zone "j".

Thus the complete equation specifying the relationship between total commuters and that portion diverted to the ferry system is:

$$(8) \qquad F_{ij} = \alpha_{ij} C_{ij}$$

$$F_{ij} = C_{ij} \frac{T_i^{-\varepsilon t} P_{ij}^{-\varepsilon p}}{TR_{ij}}$$

In addition to breaking down Marin County and San Francisco into zones and establishing equations for all zone-to-zone combinations, it was necessary to define different α_{ij}'s for the behavior of the commuters depending on their current mode of transportation--automobile or bus. Thus the more complete equation is

$$(9) \qquad F_{ij} = {}^{m_1}C_{ij} \frac{T_i^{{}^{m_1}-\varepsilon t} P_{ij}^{{}^{m_1}-\varepsilon p}}{{}^{m_1}TR_{ij}} + \frac{{}^{m_2}C_{ij} T_i^{{}^{m_2}-\varepsilon t} P_{ij}^{{}^{m_2}-\varepsilon p}}{{}^{m_2}TR_{ij}}$$

Where F_{ij}, T_i, and P_{ij} are as before and the superscripts m_1 and m_2 stand for variables applicable to current Mode 1 (automobile) and current Mode 2 (bus), respectively.

B. STATISTICAL FITTING OF DEMAND FUNCTION

Having developed the conceptual model in Section A above, we used the cross-sectional market survey data, i.e., the demand schedule, to "fit" the demand curve. The demand curve thus developed serves as the α_{ij} in the previous equations. Recalling that:

$$(10) \quad {}^{m_1}\alpha_{ij} = \frac{B_1 T_i^{-{}^{m_1}\varepsilon_t} P_{ij}^{-{}^{m_1}\varepsilon_p}}{{}^{m_1}TR_{ij}} > {}^{m_2}\alpha_{ij} = \frac{B_2 T_i^{-{}^{m_2}\varepsilon_t} P_{ij}^{-{}^{m_2}\varepsilon_p}}{{}^{m_2}TR_{ij}}$$

Using a double logarithmic transformation we have:

$$(11) \quad \log_e {}^{m_1}\alpha_{ij} = \log_e B_1 - \log_e {}^{m_1}TR_{ij} - {}^{m_1}\varepsilon_t \log_e T_i - {}^{m_1}\varepsilon_p \log_e P_{ij}$$

similarly for ${}^{m_2}\alpha_{ij}$

simplifying and letting

$$
\begin{aligned}
{}^{m_1}Y &= \log_e {}^{m_1}\alpha_{ij} \\
x_2 &= \log_e P_{ij} \\
x_3 &= \log_e T_i \\
\beta &= \log_e B_1
\end{aligned}
$$

and ignoring for a moment the constant value "$\log_e {}^{m_1}TR_{ij}$" we have:

$$(12) \quad {}^{m_1}Y = \beta - {}^{m_1}\varepsilon_p x_2 - {}^{m_1}\varepsilon_t x_3$$

In this form we have the equation of a plane in terms of the logarithms of the variables. A means of solving equation (12) is through least squares estimates for x_2 and x_3. The coefficients of x_2 and x_3 are of course the elasticities ε_p and ε_t, respectively, the parameters needed to define the demand curves.

The basis for the double logarithmic fitting of demand curves is well established in economic literature. The most recent article that utilizes this formulation appeared in the May 1969 issue of The Review of Economics and Statistics entitled "Income and Price Elasticities in World Trade" by H. W. Houthakker and S. P. Magee; the double logarithmic formulation was used to relate imports and exports to income and price variables with the respective income and price elasticities computed directly as the regression coefficients. A clear advance of the present study over many studies in recent years that sought to determine demand elasticities was the development of cross-sectional data from the field survey. In most cases--and the recent article referred to is no exception--the researchers have had to rely on time series data; they had to spend the bulk of their time testing for autocorrelation, changing underlying assumptions, watching out for multi-collinearity and adjusting the data series for these statistical problems. By having cross-sectional information, the data usually assumed in textbook discussions, we were able to arrive at more meaningful curves.

To provide an example of how these curves were "fit," the α_{ij} between Central Marin (zone 2) and CBD (zone A) will be computed:

$$auto_{\alpha_{2a}} = auto_B \frac{T_2^{-\varepsilon_t^{auto}} \; P_{2a}^{-\varepsilon_p^{auto}}}{auto_{TR_{2a}}}$$

$$bus_{\alpha_{2a}} = bus_B \frac{T_2^{-\varepsilon_t^{bus}} \; P_{2a}^{-\varepsilon_p^{bus}}}{bus_{TR_{2a}}}$$

Based on the market survey, the following demand curve was developed:

Current Automobile Riders			Current Bus Riders		
Weekly Round Trips	Price	Time (minutes)	Weekly Round Trips	Price	Time (minutes)
474	$1.00	50	452	$1.00	50
409	$1.50	50	388	$1.50	50
270	$2.00	50	157	$2.00	50
175	$2.50	50	84	$2.50	50
214	$1.00	70	284	$1.00	70
206	$1.50	70	247	$1.50	70
144	$2.00	70	94	$2.00	70
99	$2.50	70	46	$2.50	70

Since the sample size for trips between Central Marin and CBD was $N_{auto} = 186$ and $N_{bus} = 116$, the maximum number of round trips these people could have taken on the ferry system was:

$$^{auto}TR_{2a} = 186 \text{ X } 5 = 930$$

$$^{bus}TR_{2a} = 116 \text{ X } 5 = 580$$

So, for example, at \$1 fare and 50-minute trip from Central Marin to the Ferry Building by automobile rider, 474 weekly round trips were diverted to the ferry system, or 51% of the total possible.

The next step was to take the demand schedule--transform the variables into logarithmic form and use a least squares regression calculation to obtain demand curves. As a further refinement, instead of computing one demand curve from the \$1 fare to the \$2.50 fare, it was noted that the slope and hence the elasticity changed drastically at \$1.50 indicating a "kink" in the demand curve and requiring a separate curve for the demand schedule below \$1.50 and one for the demand schedule above \$1.50.

Automobile:

$$\text{loge } ^{auto}\alpha_{2a} = 15.804 - \text{loge } 930 - 0.23 \text{ loge } P_{2a} - 2.20 \text{ loge } T_2$$
$$\text{where } 50 \leq T_2 \leq 70, \$1.00 \leq P_{2a} \leq \$1.50$$

$$\text{loge } ^{auto}\alpha_{2a} = 21.038 - \text{loge } 930 - 1.54 \text{ loge } P_{2a} - 1.87 \text{ loge } T_2$$
$$50 \leq T_2 \leq 70, \$1.50 \leq P_{2a} \leq \$2.50$$

Similar results were obtained for bus riders. By supplying appropriate values of T_2 and P_{2a} for these equations, the percent diversion (α_{2a}) could be obtained. For example, at Paradise Drive we estimated that $T_2 = 48$ minutes for one ferry service alternative and assumed a fare of \$1.50. Placing these values in the appropriate equations we have:

$$^{auto}\alpha_{2a} = 0.47$$

$$^{bus}\alpha_{2a} = 0.73$$

Applying these α_{2a}'s to the total commuter flow by mode

$^{auto}F_{2a}$ = 2,360 round trips per day.

$^{bus}F_{2a}$ = 1,020 round trips per day.

Total = 3,380

This states that of the possible 6430 trips per day between Central Marin and CBD, we estimate that 3380 will switch to the ferry system at a fare of $1.50 and 48-minute commute.

APPENDIX C

The following letters were received in response to questions by Arthur D. Little, Inc., concerning the ability of hydrofoil vessels and air cushioned vehicles to meet the basic ferry service requirements spelled out in this report. They are included here for the committee's information.

ARTHUR D. LITTLE, INC., HAS NOT MADE ANY INDEPENDENT ENGINEERING EVALUATION OF THE CLAIMS CONTAINED WITHIN THESE LETTERS.

HYDRODYNE MARINE CORPORATION
235 MONTGOMERY STREET
SAN FRANCISCO, CALIFORNIA 94104
415 362-2586

June 20, 1969

Arthur D. Little, Inc.
500 Sansome Street
San Francisco, California 94111

Att: Dr. Claude Gruen

Dear Dr. Gruen:

Our company for the past three years has been involved in research and development of large scale commercial production and operations of hydrofoil in the United States. We have engaged the assistance of Rados Western Corporation, located in San Pedro, who are a well known and recognized marine architectural design and engineering firm, employing 85 naval architects, marine engineers and design technicians relating to the ship building and operations industry. Rados Western Corporation's architects and engineers have been closely associated to the design and operational characteristics of commercial hydrofoil. They have been involved in the mult-million dollar research and development programs conducted by "Boeing" and "Lockheed" for the United States Military, and were instrumental in the initial and original design and construction of the Supramar type hydrofoils which are todays largest and most successful hydrofoil operations throughout the free world.

Upon the receipt of your letter dated June 4, 1969, requesting information pertaining to the credibility and operational characteristics of our commuter hydrofoil model HM 80 CT, we submit the following information in answer to the ten questions you have asked.

1) Q: Can hydrofoils operate dependably in the fog and sea conditions that occur in San Francisco Bay?

A: Yes. The summer fog is typically characterized by a long tongue coming through the Gate over Alcatraz and sometimes extending as far as Berkeley. From Angel Island northward the route would seldom be effected by fog. The fog is also usually above the sea level, which would permit normal operations to continue beneath the fog layer most of the time.

When a dense layer of fog at sea level does occur, proper navigation is insured by radar, depth sounder and compass. Speed would be reduced to a level considered safe by the captain, just as a cautious bus driver or automobile driver slows down in the fog. The nautical rules of the road dictate that the captain should proceed at a speed which will allow his vessel to stop in 1/2 the range of his visibility and that he should sound his horn at regular intervals. Our commuter hydrofoil model HM 80 CT can travel considerably faster than a conventional ferry in foggy conditions because of its tremendous short distance stopping capabilities. Fog would slow the hydrofoil operation at times, but probably not much more than highway traffic. The probability of hydrofoil accidents caused by fog would be much lower than highway accidents because of the use of radar and the lack of dense traffic.

For further safety in poor visibility it would also be feasible to place a string of electronic sensors on the bottom of the Bay along the hydrofoil routes, which the vessel would automatically home-in on and away from, just as aircraft have been doing for years.

Seas up to five feet would be handled by the proposed hydrofoil without reducing speed. In waves five feet and over, which are rare in San Francisco Bay, except in the proximity of the Golden Gate Bridge, the hydrofoil would reduce speed. The vessel could proceed in a conventional displacement manner if necessary.

Many hydrofoils of the size proposed here operate successfully in the open ocean. Weather conditions encountered in San Francisco Bay should be no problem.

The following is an example of hydrofoils operating in other parts of the world. This list is by no means complete.

Hong Kong:	Hong Kong Harbor and Hong Kong to Macao	5 PT 50's 6 PT 20's
Sidney, Australia:	Sidney Harbor	2 PT 20's 1 PT 50
New Zealand:	Auckland	1 PT 20
Japan:	Throughout Japan's inland waterways and seaports	8 PT 20's 3 PT 50's
Venezuela:	Lake Maracaibo	8 PT 20's

Italy:	
Norway:	
Sweden:	
England:	Number of craft not known due to expansion this year.
France:	
Switzerland:	
Brazil:	
Uruguay:	
Egypt:	

Russia: More hydrofoil than all other countries combined, ranging from 66 passenger - 45 mph craft to 300 passenger - 70 mph craft.

2) Q: Can hydrofoils operate dependably during evening hours?

A: Yes. Powerful headlights can be used on hydrofoils and would be employed at night to show up objects in the water.

3) Q: Can hydrofoils operate dependably through flotsam and logs?

A: Hydrofoils are operating successfully in dozens of ports all over the world. Many, if not most, are dirtier than San Francisco.

Flotsam floats on the surface and the propeller, which would be the most vulnerable to contact, passes beneath the flotsam. The foil members which may strike the flotsam usually deflect or splinter it, but on occasion can become fouled and lose lift. This condition is corrected simply by stopping, backing and then going ahead again.

Hydrofoil operations should not be recommended in an area where there is an active logging industry using the waterways, such as Puget Sound, unless an adequate electronic underwater detection device is developed. A sufficiently large log may bend or shear off a foil. On the other hand, such a log may put a hole in the hull of a conventional craft. The foils on the proposed hydrofoil are designed to shear off without damage to the hull in the event of collision with an object of sufficient mass. If one foil should be so lost, the opposite foil is simultaneously dropped by explosive bolts so that the vessel "lands" evenly on the water. The foils are attached to floats that enable them to be retrieved for further use. In the event of such a collision, the passengers would experience a deceleration, which would not be much different from a normal "landing" caused by a sudden power loss.

Fortunately, San Francisco Bay is not used by the logging industry for transportation of log rafts and is probably a cleaner harbor than most in which hydrofoils are operating today.

The electronics industry has indicated that sophisticated electronic detection systems can soon be made available for use on hydrofoil that will enable the operator to detect debris in the water far enough in advance to enable the hydrofoil operator to literally run blind if necessary.

4) Q: Can hydrofoils turn or otherwise avoid small boats?

A: Yes. A hydrofoil has been operated in San Francisco Bay on "opening day" of the sailing season. Although the Bay was literally filled with boats, the hydrofoil could steer through them as though they were relatively standing still. A sharp, banked turn can be made with the use of the roll control in conjunction with the rudder. The captain can always stop if necessary. The hydrofoil does not "glide". As soon as power is reduced, the vessel settles into the water and is stopped smoothly and swiftly by the cushion and mass of the water.

5) Q: Can hydrofoils operate economically on such a relatively short run?

A: The economics of a short run are demonstrated in the projections.

6) Q: Would the operation of a large fleet of hydrofoils present navigation hazards on the Bay?

A: There is a lot more space on the water than on the highways. Fourteen or more hydrofoils on fixed routes on the Bay would not present a problem. A look at the 11 hydrofoils in the crowded Hong Kong Harbor would indicate that San Francisco Bay has a long way to go before her waterways become hazardous due to congestion - or are even properly utilized.

7) Q: Would maintenance-induced down time be excessive?

A: No. Foil cleaning, if necessary, and all engine maintenance including changing engines would be performed at night with no effect on schedule. A complete inventory of spare parts would be maintained at all times as well as a stand-by vessel. Both are included in the projections. A proper preventive maintenance program should keep breakdowns at a level at least commensurate with other modes of transportation.

8) Q: Would hydrofoils produce noise pollution problems for the residents who live near the terminals?

A: No. The proposed model HM 80 CT will be powered by turbine engines exhausted through a specially designed silencing system, which will eliminate offensive noise.

9) Q: Would noise bother the passengers and make the trip uncomfortable?

A: No. The passenger compartment of the craft can be insulated in such a manner that noise levels will not be uncomfortable.

10) Q: Would the ride be smooth?

A: Yes. The hydrofoil Model HM 80 CT will operate smoothly in wave heights up to about five feet. The ride would be comparable to a bus traveling on a freeway. In wave heights from about five to seven feet, the passengers would experience a ride similar to an airliner in minor turbulence. Waves over seven feet may force the vessel to reduce speed and proceed in a conventional displacement manner with the foils providing extra stability.

Most hydrofoils used commercially in the free world today are of the PT-50 or PT-20 type. They have wide V-type surface-piercing foils fore and aft. The result is considerable roll and heave. No electronic stabilizing system is used. Most critics of the hydrofoil ride have had their experience with these vessels.

A 48-passenger hydrofoil vessel similar in foil configuration to the proposed HM 80 CT has been operated on San Francisco Bay with pleasing results. The rear foils, being fully submerged, are little effected by fluctuating wave heights. The forward surface-piercing foils are separated and placed on either side of the vessel with flaps, which are electronically activated to smooth out the waves. Stability is thereby greatly enhanced, as is safety. If a forward foil should ever be sheared off, it would not damage the hull because it is beside the hull, rather than beneath it.

SUMMARY: A fleet of 14 250-passenger hydrofoils should provide an effective, popular answer to the commute problem between Marin County and San Francisco. As demand increases, more hydrofoil vessels may be added and larger, passenger capacity craft can be utilized on the most popular routes.

The inherent advantages of the hydrofoil system as proposed here are:

1) Using the waterways which are free to carry some of the traffic that increasingly congests the expensive highways.

2) Accomplishing this with speeds that are equal or superior to autos and buses, but with a trip time that is considerably faster.

3) Providing a schedule with departures every few minutes during the peak demand times.

4) Rapid turn-around times, resulting in high equipment utilization.

5) Versatility provided by many craft using different terminals located as closely as possible to commuter population centers, rather than one or two large terminals which have to be reached by everyone.

6) No wake to damage shorelines, yacht harbors or inconvenience to other boats.

7) A system which will lure people from their cars because the ride is quicker, cheaper, more comfortable and highly convenient.

8) A system which can be utilized during off commute hours to assist in general Bay Area transportation problems, such as San Francisco International Airport to the downtown area. The hydrofoil fleet could also be used for tourist bay tours and will constitute a further Bay Area tourist attraction.

9) A system which can be fully operational by November, 1970, providing an order is placed no later than December, 1969.

If such a system is rejected in favor of conventional displacement ferries, someone will undoubtedly put hydrofoils on the Bay anyway. Hydrodyne Marine already has one order for a vessel for San Francisco Bay. If people are given the choice, which system would they ride? As more hydrofoils are added, what will become of the conventional ferries?

Hydrodyne Marine Corporation would welcome the opportunity to make available our naval architects and design engineers to answer any questions which may arise pertaining to the aforementioned answers.

Yours truly,

Richard Stach
President

RS:kh

BELL AEROSYSTEMS - A textron COMPANY

BUFFALO, NEW YORK 14240 AREA CODE 716-297-1000

June 20, 1969

Dr. Claude Gruen
Arthur D. Little, Inc.
500 Sansome Street
San Francisco, California 94111

Dear Dr. Gruen:

Thank you for your letter dated June 10, 1969. We would be happy to advise you regarding the application of our air cushion vehicles (ACV's) to the proposed ferry system between Marin and San Francisco Counties.

May I first deal with the questions raised in Pages 2 and 3 of your letter in the same order as given:

1. Due to their better maneuverability and quick-stop capabilities, ACV's are able to operate safely in fog at speeds well above those acceptable for normal ship ferries.

2. Military operations with Bell SK-5 craft are regularly carried out at night on a routine basis. Scheduled passenger carriers using SR.N6 craft in England maintain their schedules at night as part of their normal service. The large car ferry SR.N4 craft have been cleared for night operations on cross-Channel (England/France) routes.

3. Bell amphibious ACV's have zero-draft and operate with their flexible skirts above or just in contact with the water surface. Their hull structures proper are 4 feet or more above the surface over which they are travelling. Logs and flotsom therefore represent absolutely no problem to their safe operation.

4. British ACV services in the Solent area and cross-Channel have routes which cut across heavily-used shipping lanes and their terminals are located in prime small pleasure boat locations. The ACV's maneuverability effectively permits operation in these heavy traffic areas. For example, a large craft such as the 180 ton SR.N4 can be easily stopped from cruise speed (60 knots) in about 7 craft lengths.

Dr. Claude Gruen June 20, 1969

5. The Bell Draft Report enclosure with this letter elaborates on the ACV's economic viability. It may be seen that operating costs are similar to those of the proposed ship ferries, while capital investment in terminals and access roads is less.

6. Due to their ability to easily avoid other traffic, a fleet of ACV's should not present any navigation hazards on the Bay. Note that we are tentatively proposing a fleet of 3 craft for the operation you have in mind.

7. The craft should be easily capable of attaining acceptable regularity on the proposed service. It is of interest to note the following reliability figures currently being achieved in British ACV operations:

   a. SR.N6 "Hovertravel" and "Seaspeed" Solent operations: (4 craft, 1 1/2 million passengers to date)

      Reliability greater than 98%.

   b. SR.N4 "Hoverlloyd" and "Seaspeed" cross-Channel operations: (3 craft, first season of scheduled services)

      Reliability 95%
      (4% cancellations due to weather with waves over 8-10 ft.)

8. The smaller current ACV's (Bell SK-5, BHC SR.N6) are relatively noisy, although some scheduled operations still have terminals close to built-up areas. The larger SR.N4 incorporates slower turning propellers emitting lower frequency and more acceptable noise levels. Comments to date on SR.N4 have been favorable in this regard.

   Any ACV Fast Ferry developed by Bell would incorporate the learning from SR.N4 experience combined with Bell's own considerable experience in this field. Note that an earlier Bell craft, the SKMR-1, was fitted with ducted propellers.

9. Considerable reductions in SR.N4 internal noise level have already been achieved since the first craft of this type was launched in 1968. These developments are continuing.

Dr. Claude Gruen

June 20, 1969

This data is available to Bell and we are confident that acceptable internal noise levels can be achieved in large ferry vehicles.

10. Any Bell large ACV ferry would incorporate a skirt system designed and developed from experience with our own military/research vehicles and from the SR.N4. The ride in Bay area conditions should be comfortable.

    Note that both the Bell military and B.H.C. SR.N4 skirt systems are developed for much more severe sea conditions than occur on the Bay.

I am enclosing a copy of a draft report which we have produced on the application of a Large ACV Fast Ferry to the San Francisco/Marin County system. We believe that our findings are most encouraging.

I would add that there appears to be a number of other potential routes in the United States for a craft in this size category.

I trust that the above notes plus the enclosure will be of interest and assistance to you. Thank you for giving us this opportunity of contributing to the study effort.

Sincerely,

Colin Faulkner
Assistant Product Manager (ACV's)

CF/sn

Enc.: Bell Report "San Francisco-Marin County Air Cushion Vehicle Fast Ferry System"