U.S. Department of Transportation

Some Critical Aspects of Ferry Planning

February 1982

On the cover, cars are shown waiting to board the ferry "Walla Walla" in downtown Seattle, WA.

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Final Report—Phase II
February 1982

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EXECUTIVE SUMMARY

Introduction

Water, man's original vehicular transportation mode, has not received the focused attention of planners which has been accorded other intra-urban forms: highway, rail transit, and bus transit. In an age where construction of land-based transportation facilities in urban areas is difficult at best, and impossible at worst, it is time to re-examine the waterborne mode as a viable urban transportation option for those urban areas located on or around navigable waterways.

Ferry service plays a major role in urban transportation systems in New York, San Francisco, Seattle, Vancouver, and elsewhere. However, when planners seek to rationally investigate the waterborne option, they are met with a lack of basic information, data, and methodologies for such consideration. This, then, is the focus of the current research: to provide planners with the tools and information needed to rationally analyze the waterborne option as a viable urban transportation alternative.

Economic Analysis

In order to properly address economic issues, a comprehensive survey of ferry operators was conducted to establish a reasonable data base for cost analysis. The systems which responded were:

- Alaska Marine Highway
- British Columbia Ferry Corp.
- Cape May - Lewis Ferry
- Golden Gate Ferries
- Orient Port - New London Ferry
- Port Jefferson - Bridgeport Ferry
- Quebec Ferry Co.
- Staten Island Ferry
- Washington State Ferries

The basic data obtained is shown in Tables E1 and E2.

The analysis of costs was broken down by vessel type, and concentrated on the comparative economics of high-speed vessels vs. conventional ferry vessels.

The economic analysis of a ferry system must consider the following elements:

Capital Costs:	Vessels	- purchase and parts inventory
	Terminals	- land acquisition, harbor dredging, design, construction, parking facilities, access features, etc.
Operating Costs:	Fixed Annual Costs	- capital recovery, insurance, administration
	Variable Costs	- Vessels (crew, fuel, maint.) Terminals (support staff, utilities, maintenance)

TABLE E1
SELECTED ANNUAL OPERATIONAL CHARACTERISTICS OF EXISTING FERRY SYSTEMS

System Name	Total Operating Costs ($)	Total Vessel Miles Operated	Vessel Hours Operated	Approx. Route Length (Miles)	Number of Vessels	Number of Termi-nals	No. of pass. (in thousands (Millions)	No. of pass. - Miles
1. Alaska Marine Highway	37,983,484	570,262	38,017	Varies	9	27	294.1	85.8
2. British Columbia Ferry (2)	108,965,869	NA	NA	Varies	25	24	11,423.4	314.8
3. Cape May-Lewes Ferry	3,422,000	66,000	4,125	17	4	2	710.0	12.1
4. Golden Gate Ferries	6,190,235	85,500	3,053	13	4	3	1,117.5	14.5
5. Orient Point - New London (3)	1,811,599	81,920	10,240	16	3	2	257.1	4.1
6. Port Jefferson-Bridgeport (3)	759,735	16,672	2,084	16	1	2	112.4	1.8
7. Quebec Ferry Company (2)	13,217,605	150,000	10,000	Varies	15	11	2,401.2	9.6
8. Staten Island Ferry	22,880,320	174,920	12,500	5	5	2	18,016.0	90.1
9. Washington State Ferries	55,051,000	923,000	51,280	Varies	19 (4)	22	18,100.0	139.0
10. Jetfoil Test Service-Puget Sound	424,008	3,872	-	Varies	1	-	61,876.0	169.0

TABLE E1 (continued)

SELECTED ANNUAL OPERATIONAL CHARACTERISTICS OF EXISTING FERRY SYSTEMS (1)

	System Name	No. of Vehicles (in thousands)	No. of Vehicle - Miles (Millions)	Cost per passenger ($)	Cost per Vehicle ($)	Cost per passenger-Mile ($)	Cost per Vehicle-Mile ($)
1.	Alaska Marine Highway	72.3	22.8	129.1	525.1	0.44	1.67
2.	British Columbia Ferry (2)	4,161.3	106.7	9.54	2.62	0.35	1.02
3.	Cape May-Lewes Ferry	236.0	4.0	4.82	14.5	0.28	0.85
4.	Golden Gate Ferries	-	-	5.54	-	0.43	-
5.	Orient Point - New London (3)	103.8	1.7	7.05	17.46	0.44	1.09
6.	Port Jefferson-Bridgeport (3)	25.4	0.4	6.76	29.92	0.42	1.87
7.	Quebec Ferry Company (2)	971.0 (5)	3.6	5.50	13.61	1.37	3.67
8.	Staten Island Ferry	574.0	2.9	1.27	39.86	0.25	7.97
9.	Washington State Ferries	7,300.0	50.0	3.04	7.54	0.40	1.10
10.	Jetfoil Test Service-Puget Sound	-	-	6.85	-	0.25	-

TABLE E2
1980 OPERATING COSTS FOR SELECTED FERRY SYSTEMS

Category \ Systems	Cape May-Lewes	Golden Gate Ferries (4)	Alaska Marine Highway	Quebec Ferry Company (14)	British Columbia Ferry Corp. (14)
TOTAL EMPLOYEES	57	115	718	503	2645
• Vessel Crew	40	100	638	399	-
• Management	6	5	28	38	-
• Support	11	10	52	66	-
TOTAL OPERATING COSTS	3,422,000	6,190,235	37,983,484	13,217,605	116,805,372
• Vessel Related	2,119,000	2,583,253	34,120,184	8,410,757	109,659,530
- Fuel & Oil	752,000	1,232,649	4,601,500	1,469,783	12,103,783
- Crew Payroll	742,000	1,004,574	22,527,500	3,009,629	56,207,472
- Insurance	437,000	161,398	1,394,400	327,594	-
- Maintenance	188,000	-	5,596,784	1,587,537	7,355,505
- Depreciation	-	142,012	-	1,931,214	20,270,582
- Interest	-	-	-	85,000	879,644
- Other	-	42,620	-	-	-
• Terminal Related	738,000	1,484,546	2,356,900	3,016,785	7,582,908 (11)
- Support Payroll	500,000	693,467	-	2,928,641	-
- Rent	-	92,945	-	-	-
- Maintenance	138,000	60,630	-	88,144	-
- Utilities	88,000	81,290	-	-	-
- Other	12,000 (1)	489,825 (5)	-	-	-
		117.930 (6)	-		
• Management	199,000 (2)	895,832	1,506,400	1,415,006	3,449,166 (12)
• Marketing	49,000	-	76,000		1,996,453 (13)
• Other	-	1,029,289 (7)	-	6,950,791 (8)	-
	317,000 (3)	-	-	37,674 (9)	-

TABLE E2 (continued)
1980 OPERATING COSTS FOR SELECTED FERRY SYSTEMS

Category \ Systems	Washington State Ferries	Staten Island Ferry (15)	Bridgeport - Port Jefferson (16)	Orient Point - New London (16)
TOTAL EMPLOYEES	1250	576	NA	NA
· Vessel Cres	-	493	-	-
· Management	-	34	-	-
· Support	-	49	-	-
TOTAL OPERATING COSTS	55,051,000	26,700,000	759,735	1,811,599
· Vessel Related	44,076,200	NA	491,238	-
- Fuel & Oil	10,603,000	5,300,000	58,713	376,005
- Crew Payroll	26,403,300	17,300,000	222,103	598,677
- Insurance	512,800	-	-	-
- Maintenance	5,287,700	803,000	136,199	245,471
- Depreciation	-	-	12,584	203,015
- Interest	-	-	-	-
- Other	1,269,400	3,314,000	61,639	96,777
· Terminal Related	8,929,800	NA	96,143	56,108
- Support Payroll	6,126,700	-	-	-
- Rent	174,600	-	-	-
- Maintenance	2,063,500	-	-	-
- Utilities	-	-	-	-
- Other	565,000	-	-	-
· Management	1,773,000	NA	172,354	235,546
· Marketing	-	NA	-	-
· Other	688,500	-	-	-

For the vessel types described in Table E3, capital costs are described in Table E4. Table E5 summarized the typical hourly operating costs for these vessels, while Figure E1 shows a more relevant figure, variable operating costs per seat-mile of service delievered.

TABLE E3
IDENTIFICATION CODES FOR VESSEL TYPES
UTILIZED IN ANALYSIS

IDENTIFICATION CODE	VESSEL NAME AND TYPE(1)
A	Vancouver SEABUS - Passenger Only (Conventional)
B	CAPE MAY - LEWES FERRY M.V. New Delaware - Passenger/AUTO (Conventional)
C	Golden Gate Ferry - Passenger (Semi-Planning)
D	Staten Island Ferry, Andrew J. Barberi - Passenger Only (Conventional)
E	Washington State Superferries - Passenger/Auto (Conventional)
F	Boeing Jetfoil - Passenger Only (Hydrofoil)
G	HM.2 Mark III - Passenger Only (Surface Effect Ship)
H	Bell Halter SES - Passenger Only (Surface Effect Ship)
I	Highspeed Catamaran - Passenger Only
J	Air Cushion Vehicle Al-30 - Passenger Only

(1) Refer to Appendix V for Operating details

TABLE E4
<u>SUMMARY OF CAPITAL COSTS FOR</u>
<u>INDIVIDUAL VESSEL TYPES</u>

VESSEL TYPE	INITIAL VESSEL PRICE (VP) $	SERVICE LIFE (SLV) YEARS	ANNUAL COST (CV) OF VESSEL ($/YEAR)
A	5,700,000	25	910,860
B	11,800,000	25	1,885,640
C	10,900,000	25	1,741,820
D	17,000,000	25	2,716,600
E	17,000,000	25	2,716,600
F	14,000,000	20	2,165,800
G	1,320,000	20	204,204
H	4,870,000	20	753,389
I	3,200,000	20	495,040
J	5,780,000	20	894,166

TABLE E4
SUMMARY OF TYPICAL HOURLY
OPERATING COSTS FOR VARIOUS VESSEL TYPES
($/hour)

Vessel Type	Crew Cost (CC)	Fuel Cost (FC)(1)	Maintenance Cost (MC)	Vessel Hourly Operating Cost (VHOC)
A	59.92	75	50	187.25
B	136.17	100	45	281.17
C	143.76	642	125	910.76
D	245.22	300	69	614.22
E	170.13	250	41	461.13
F	71.37	540	219	830.37
G	35.15	35	31	101.15
H	61.11	176	75	312.11
I	79.80	540	75	694.80
J	35.15	262	50	347.15

(1) Fuel Cost based on average price of $1/gallon

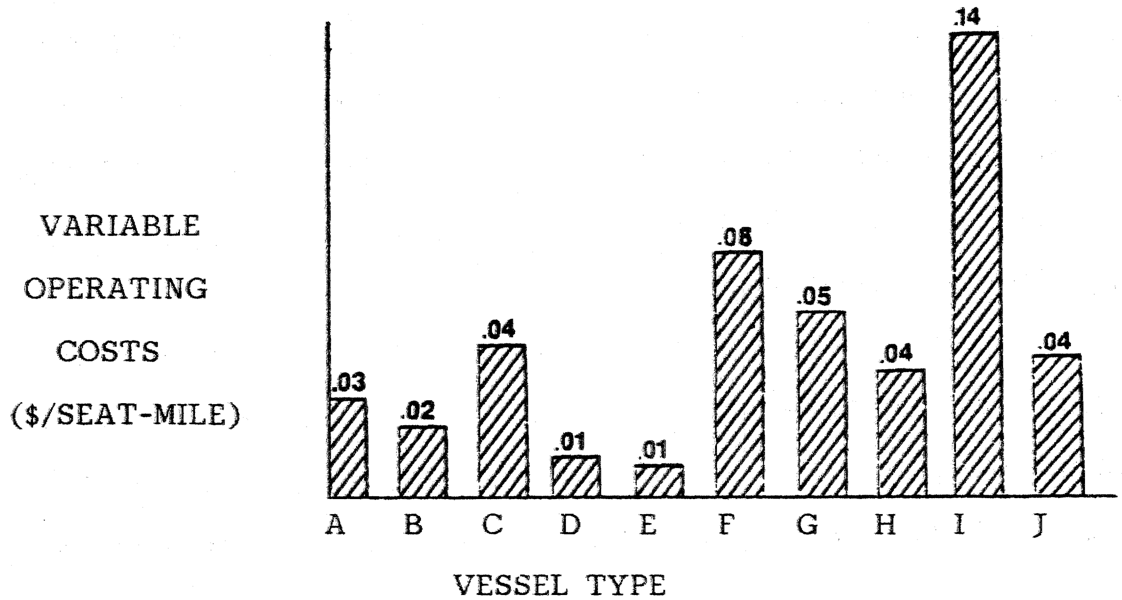

FIGURE E1

VARIABLE OPERATING COSTS PER SEAT MILE FOR VARIOUS VESSEL TYPES

A full procedure using these and other cost elements is described in the main report for analyzing ferry options. Key case comparisons are made between high-speed and conventional vessels with one critical conclusion: Although the unit costs of high-speed ferry operation, even per seat-mile of service provided, are consistently higher than those for convential ferries, the benefits of requiring fewer vessels (and, therefore, fewer crews) can outweigh this, i.e., high-speed vessels CAN be more economic in any given situation.

Ferry User Characteristics

The establishment of a comprehensive information base concerning users of ferry services serves two critical purposes:

- identifying critical user, service, and related characteristics and trends which influence ferry use
- providing a data base for calibration of ferry demand models

The second year research effort included a) an on-board survey of Staten Island Ferry riders in NYC, b) a home-based mail interview of Staten Island residents concerning their use of the ferry and alternative modes, and c) review of surveys conducted in Seattle and San Francisco concerning ferry users.

Table E5 gives basic ferry user profiles, which are reasonably similar for the three systems studied. Note that amenities on the Staten Island Ferry are not of as high quality as the other two systems, a factor which does influence these characteristics somewhat.

TABLE E5

SOME BASIC COMPARISONS AMONG FERRY RIDERS OF THREE SYSTEMS

Characteristic	Staten Island	Golden Gate	Washington State
Percent Male-Female	54 - 46	68 - 32	63 - 37
Average Age (Years)	36.8	32.8	38.5
Average Household Income ($/Yr.)	30,375	31,200	26,865
% Work Trips in Peak	96.6	100	93.0
Average Round-Trip Freq. (Trips/Week)	4.9	4.3	4.7
Principal Access Mode	Rail, Bus (63%)	Auto (53%)	Auto (86.8%)

Figures E2 and E3 illustrate the modal split impact of gender and household income on Staten Island commuters. Ferry use is strongly influenced by income, as the fare on the Staten Island Ferry is quite low (25¢ per round trip). Females more strongly choose the express bus mode which offers greater comfort and security.

Modal choice of Staten Island commuters was further examined with respect to the impact of 5 key factors:

- travel time
- travel cost
- convenience
- comfort
- special qualities of waterborne mode

Of key interest was user response to the last category. Figure E4 illustrates the relative impact of these characteristics on Staten Island commuters, and clearly shows that the "special enjoyment of a waterborne mode" was <u>NOT</u> an influenced factor. This, however, does not agree with an earlier study of the Golden Gate Ferry, which showed this factor to be quite important, as seen in Table E6.

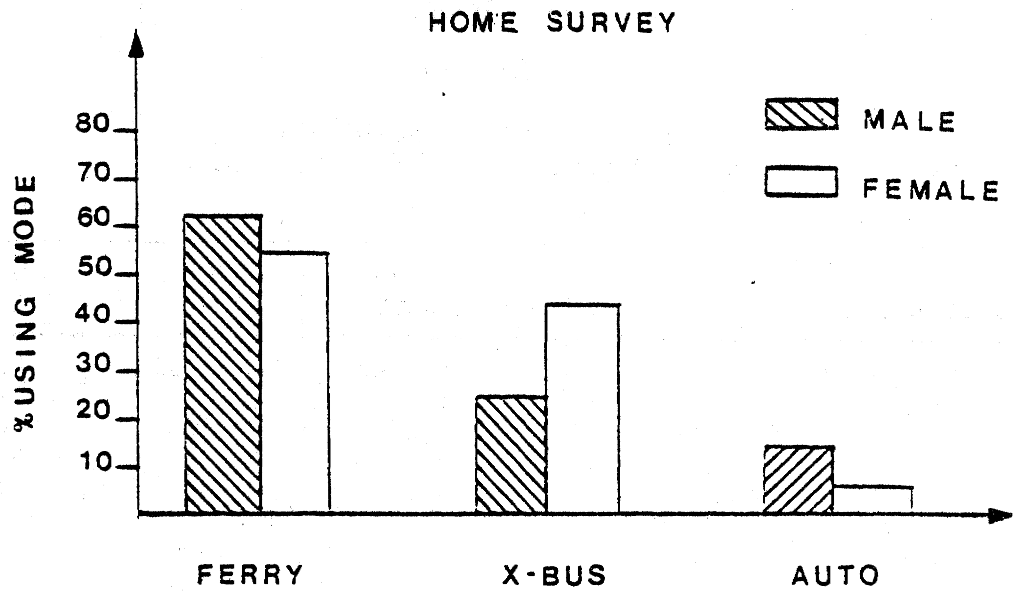

FIGURE E2

MODE USAGE BY GENDER: STATEN ISLAND

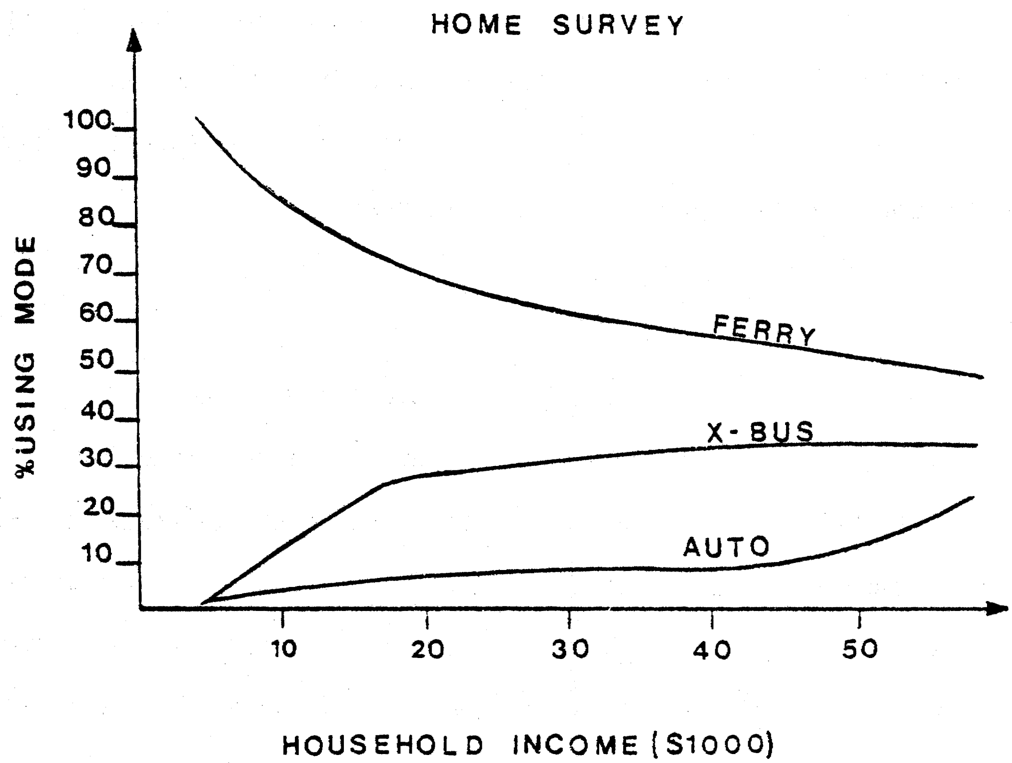

FIGURE E3

MODE USAGE BY INCOME: STATEN ISLAND

TABLE E6

RANKING OF MODE CHOICE FACTORS
FROM TWO FERRY SYSTEMS

	Staten Island Ferry	Golden Gate Ferry
Most Important Factor	Cost	Comfort
2nd Factor	Convenience	Special Enjoyment
3rd Factor	Time	Convenience
4th Factor	Comfort	Time
5th Factor	Special Enjoyment	Cost

It should be noted, however, that the Golden Gate Ferry offers a premium-type service, with modern vessels providing high-speed services and high-quality amenities (including bar) which undoubtedly influence this factor.

The critical conclusion of these surveys are that commuters react to the specific characteristics of the particular ferry service being offered, just as they do with other urban modes. There is no built-in bias either for or against the waterborne mode which would affect its viability.

Demand Forecasting

A LOGIT-type demand forecasting model was calibrated based upon the Staten Island Ferry network. The modeling approach was one of modal split forecasting, with Staten Island presenting a unique case study with three principal modal alternatives.

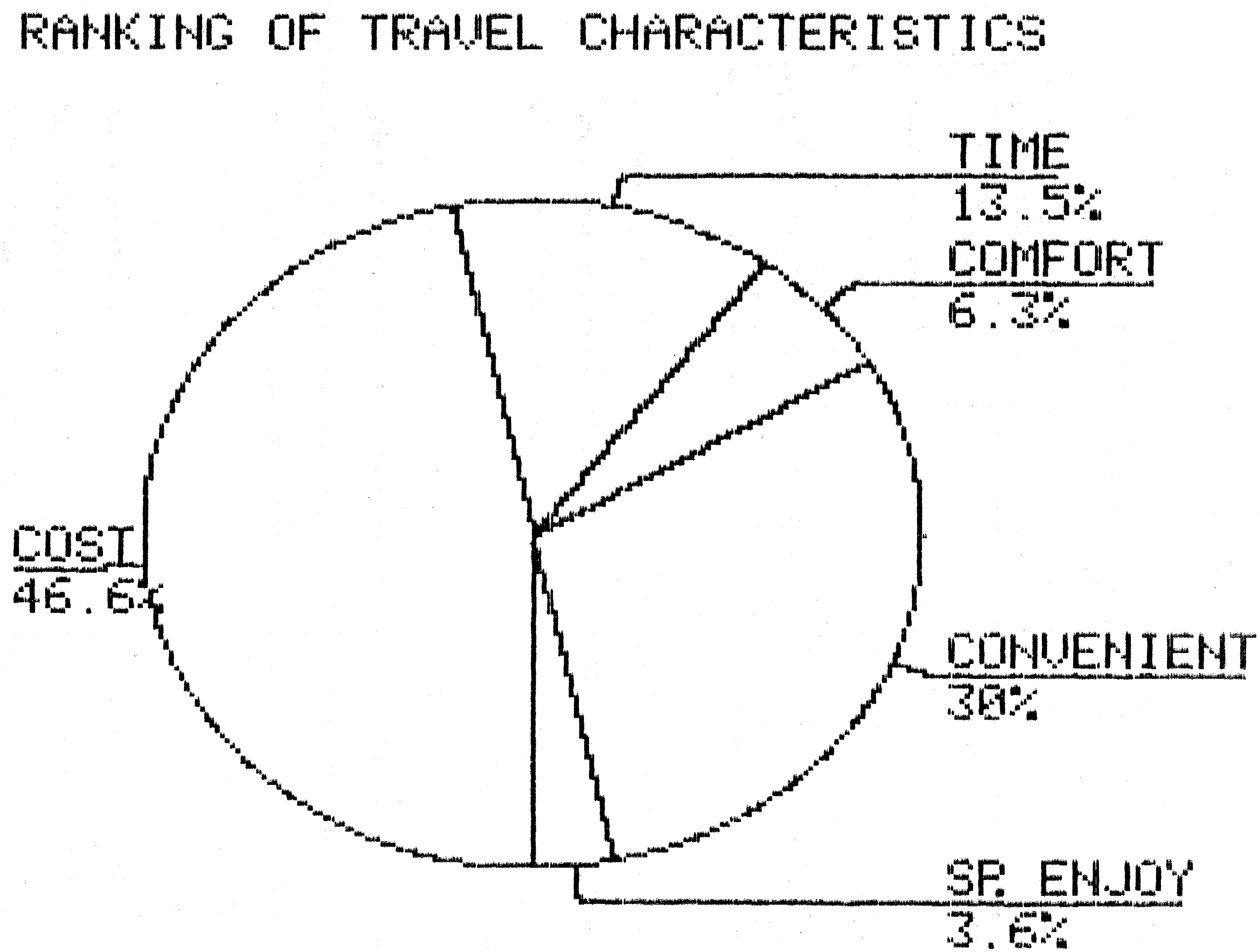

FIGURE E4
RANKING OF IMPORTANCE OF TRAVEL CHARACTERISTICS - BASED ON STATEN ISLAND FERRY RIDERSHIP SURVEY

The calibration utilized the individual trip information generated from the Staten Island home mail-back questionnaire. Two-thirds of the data was utilized for direct calibration of the model, while the remaining third was withheld for validation.

The calibrated model is of the following form:

$$p(i) = \frac{e^{-du(i)}}{\sum_{i=1}^{3} e^{-du(i)}}$$

where: mode 1 = ferry

$$du(1) = 8.3455\ COST(1) + 42.0395\ TM(1) - 0.4511\ TMREL(1)$$

mode 2 = express bus

$$du(2) = 8.3578\ COST(2) + 21.9460\ TM(2) + 8.3969$$

mode 3 = auto

$$du(3) = 8.1984\ COST(3) + 19.1350\ TM(3) + 14.0792$$

The variables utilized in the disutility expressions are defined below, together with the range of values and the average value of each found in the data base.

TABLE E7
VARIABLES USED IN CALIBRATION

VARIABLE	AVG. DATA VALUE	RANGE OF VALUES
$COST = \frac{\text{total trip cost (¢)}}{\text{household income (\$1000)}}$	8.23	0.00 - 80.00
$TM = \frac{\text{time on principal mode (min.)}}{\text{total trip time (min.)}}$	0.49	0.09 - 0.98
TMREL = user perception of schedule reliability from survey (1=poor, 5=very good)	3.13	1.00 - 5.00

The model addresses the three principal modes for commuting from Staten Island to lower Manhattan: ferry, express bus, and auto. Despite the fact that there are numerous potential access modes and routes to each of the three principal modes, trips were categorized only by the principal mode. Thus, anyone using the ferry as a basic mode was placed in the same group. The fact was ignored that autos, local buses, the Staten Island Rapid Transit, and walking are all modes used to access the ferry, although specifics of access times were not. This greatly simplified the model, avoiding the analysis of over 20 separate model combinations, and is consistent with extant usage of the model.

The model passes the first critical test of validity since it displays the following reasonable trends:

1. As trip cost increases as a proportion of income, the disutility also increases, and the probability of choosing the mode in question decreases. Thus, the more expensive the mode, the less the chance of choosing it for a particular trip will be (all other parameters remaining unchanged).

2. The time variable is interesting, as a positive calibration coefficient would be expected under certain scenarios, and negative coefficient under others. The model herein is consistent with a situation in which access times are held constant. In this case, a decrease in travel time on the principal mode will lead to a decrease in the TM variable, and the probability of selecting the mode would increase.

3. TMREL is a rating of user's perception of the time a schedule reliability of the ferry (1=poor, 5=very good). This rating was obtained from the questionnaires. The negative coefficient is reasonable: as the reliability rating increases, disutility decreases, and the probability of using the mode increases.

The validation of the model proved quite accurate, with 91.6% of individual trip records being correctly predicted.

Some Critical Aspects of Ferry Planning

PHASE II FINAL REPORT

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CHAPTER 1

INTRODUCTION AND BACKGROUND

Introduction

Water was man's first vehicular transportation mode. Historic evidence suggests that crude barge-type vessels were used to transport goods and individuals long before the invention of the wheel made over-land, vehicle-aided transportation feasible. From Ancient Egypt, for whom the Nile was a lifeline, to the 13 American Colonies, developing along the shipping ways of the Atlantic Coastline, nations have used water as a primary bloodstream, and have been shaped and molded by its influence.

In an age in which land transportation modes have become dominant for urban travel, the waterborne option has received little attention from urban and transportation planners. The 1950's and early 1960's saw the technology of vehicle's and highways advance rapidly, as well as the economic climate for vehicle ownership. With the advance of the automobile came the rapid cultivation of suburbia, and even sharper increases in auto use. During this period, engineers responded with better and more efficient highway designs, and complex control systems for urban street networks.

In the early and mid-1960's, as urban congestion became more and more unmanageable, many cities turned to rail transit systems as a solution to urban transport problems. Thus, San Francisco, Philadelphia, Atlanta, Baltimore, Los Angeles and other cities planned and/or implemented major rail transit facilities, beginning a process which still continues today in most of these cities. In New York, Boston, and Chicago, major expansions of existing systems were planned.

By the mid-1970's, the huge capital and operating costs of these systems slowed the movement to major rail facility construction, and gave way to a brief flurry of interest in "light rail" systems (trolleys) and finally to a new planning concept: Transportation Systems Management (TSM). TSM is a battery of techniques aimed at improving the efficiency with which existing facilites are used through low-capital improvements. Most focus on increasing vehicle occupancy, and car-pool, van-pool, and novel bus services have resulted. Bus lanes, express buses, and similar services have attempted to increase bus usage. Park-and-ride programs attempt to get motorists to leave their vehicles outside the city center, completing their trip on transit.

All of these phases have been greatly influenced by government policy. The highway building of the 1950's and 60's fostered by the Federal-Aid Highway Act of 1956, which authorized the Interstate System and initiated the Highway Trust Fund. The 1964 Urban Mass Transit Assistance Act and subsequent legislation spurred the development of rail and bus systems. Recent government policies have required the incorporation of TSM concepts in ongoing transportation planning efforts (required of all urban areas with a population over 50,000).

The focus of all of these policies, however, has been land-based transportation. At the same time, many of our most congested cities are located adjacent to or around navigable waterways: New York, Boston, San Francisco, Seattle, New Orleans, Balitmore, etc. National policy, however, has been slow in responding to the opportunities of waterborne transit. In San Francisco, three high-speed vessels and a new terminal facility were subsidized by UMTA in the first formal recognition of the ferry as a transit mode. Two new vessels for the Staten Island Ferry (the first placed in operation in Oct. 1981) were similarly subsidized. In both cases, however, the ferries were required to be of the passenger-only type. Vehicle-carrying ferries have, to date, been excluded from UMTA capital and operating subsidy programs. This leaves such systems as Seattle, which operate primarily vehicle-carrying ferries without access to standard transit aid programs.

Despite the lack of support, there are today over 600 ferry operators in the U.S. and Canada, ranging from small operations of 8 to 16-vehicle ferries across narrow waterways, to massive public operations, such as those in New York, Seattle, Vancouver, and others. Two hundred of these are in the United States, with 190 privately owned and operated. Twenty, including the Staten Island Ferry, however, carry almost 90% of the users of such services.

In October of 1978, these operators joined together to form the International Marine Transit Association (IMTA), and convened for their first annual meeting in Seattle. The organization has succeeded in bringing together operators, vessel manufacturers, government officials, and university researchers, to discuss their mutual problems and concerns. Subsequent meetings in Halifax (1979), and New Orleans (1980), and Copenhagen (1981) have resulted in increased attendance and interest. Planners, however, have been conspicuously absent at these meetings, as has been the serious consideration of waterborne alternatives to the solution of urban transportation problems.

This three-year effort has had one primary goal: to place the waterborne alternative visibly before transportation planners, and to provide the tools and information needed by such planners to rationally consider the waterborne alternative.

Urban ferry services are no longer a negligible part of the urban transportation scene in many cities. Over the past decade, it has become increasingly difficult to construct new land transportation facilities in urban areas. Environmental, social, and economic considerations have slowed the development of land transportation facilities to a near halt. Where urban areas are located on or near navigable waterways, the potential of waterborne services is becoming an alternative which is increasingly attractive.

Evidence of this is clear: cities like New York, San Francisco, Seattle, and Vancouver have active ferry services and are actively seeking to expand them. In New York City, the Staten Island Ferry has experienced annual increases in ridership of over 1,000,000 passengers in each of the past two years.

Furthermore, several new and/or expanded facilities are being discussed, including:

- new or increased ferry service across Long Island Sound, an alternative to building a bridge
- ferry service between Roosevelt Island and Manhattan
- "express" waterborne service in Manhattan along the East and Hudson Rivers
- ferry service to Gateway National Park
- ferry service from the New Jersey shore to Manhattan

- renewed ferry service from Brooklyn to Manhattan
- ferry service from additional locations on Staten Island to Manhattan.

Consider further that during a recent Long Island Railroad strike, several groups of Long Island businessmen banded together, hiring fishing "party boats" to take them to and from Manhattan each day.

In San Francisco, a new ferry service was initiated from Larkspur to downtown San Francisco, with 80% UMTA capital funding -- the first formal recognition by the government that ferries can and do constitute urban transit. The service was viewed as an alternative to the construction of an additional cross-bay bridge.

In Vancouver, a small but significant service was initiated -- SEABUS. This uniquely designed system combines conventional vessel and transit vehicle characteristics to form a most efficient operating system. The success of the service has pressed its capacity, and additional ridership generation -- through the construction of park 'n ride and other facilities -- has been suspended while service expansion is considered.

The British-Columbia Ferry Corporation, which operates an extensive system of routes between the Island of Vancouver and the British Columbia mainland has experienced drastic ridership increases in the past few years, and forecasts a doubling of demand by 1990. BC Ferry is now grappling with the problem of planning services for this massive increase.

In Seattle, six new ferries are being constructed for the Washington State Ferry System, while the operator copes with expanding demand and an old and insufficient fleet to service it.

As witnessed by the operators in each of these cases, service expansion is greatly retarded by the lack of planning tools for use in establishing the many parameters needed to size and cost estimate the service, or even to predict the demand that the service will generate. As waterborne services take on an increasingly important role in many urban areas, it is critical that such services be planned, designed, and operated in a coordinated fashion. Rather than an isolated facility, a ferry service must coordinate with, and enhance, the overall urban transportation system, of which it is just a single component.

Project Goals and Objectives

The primary goal of this three-year effort has been cited previously: to provide a basic planning document to assist in the planning, design, and opeartion of waterborne transportation services. Accordingly, the following specific objectives of the overall effort have been delineated.

1) to synthesize available material on the planning, functional design, and operation of waterborne transit services in a useful and cohesive informational document on the subject;

2) to develop a framework for coordinated planning of waterborne transit services in total system context;

3) to develop guidelines for the functional design of vessels, terminals, and interfaces as a coordinated system for passenger flow;

4) to develop operational guidelines and information on constraints affecting waterborne transit services; and

5) to prepare a comprehensive manual on the results of objectives 1-4 in a form useful to transportation planners and designers who may seriously consider waterborne transit alternatives in the future.

The study has, from the beginning, been organized as a three-year effort. This report details the analyses and findings of Year 2 of this research.

Background: Year 1 Results

Before presenting the detailed results of the Year 2 effort, it is useful to briefly review the results of the first year of the study, to provide a framework and context for this report.

The first year effort culminated in the submission of a Final Report to the Maritime Administration in July of 1980. The report has received much interest among planners and ferry operators, and over 40 requests for the report have been received and processed. Three papers were presented at the Transportation Research Board Annual Meeting in January of 1981, and will be published this year. Another paper was presented by special invitation to the IMTA Conference in New Orleans in October 1980.

The first year report deals with three critical issues:

- the operating and fiscal contexts in which ferry services can feasibly operate, and the character of service which they can provide.
- vessel technology: available and developing technological developments and their utility to urban ferry operations, and impact on service feasibility.
- the functional planning and design of terminal and other landside support facilities needed to make ferry services viable.

Each yielded fascinating insights into the potentials and problems facing the planner, designer, and operator who wishes to expand or initiate new ferry services. While the complete results of these analyses cannot be recounted here, some brief points might be made in an illustrative vein.

A. The Role and Context of Ferry Services in Transportation Systems

The context in which ferry services may operate is broad and varied. Services may form virtual extensions of highway systems. In such cases (BC Ferry, Washington State Ferries, others), the predominant use is by passengers bringing vehicles with them on the vessel. Such systems are usually involved in financing mechanisms which emphasize the vehicular role, through the use of road user taxes and similar measures. Services may form critical links in a transit network, such as in New York City and Vancouver (SEABUS). In these cases, predominant usage is from "walk-on" passengers, most arriving by other transit services. In Vancouver, the system is financed as an integral part of the transit system. Ferry services may be integrated into an overall system, or may be relatively isolated; in larger systems, the ferry system itself may form a regional transportation network. Longer routes may serve a vital goods movement use as well as passenger demand.

B. Vessel Technology and Capability

If the examination of the role of ferry systems yields a view of a broadly applicable and flexible mode, study of available vessel technology further strengthens this view. The development of vessels has advanced far beyond the technology generally associated with ferry services in this country. Rapid advances have been made in the areas of propulsion systems, control systems, and hull design which permit the construction of vessels for virtually any purpose imaginable, and certainly for any of the types of services which might be offered by ferry operators. Much of the "new" technologies are hardly new at all. Hydrofoils have been built and tested since the early 1960's. A small 24-seat hydrofoil was operated for two years between the World's Fair Marina of Flushing Bay and downtown Manhattan during the 1964-65 World's Fair. Though uneconomic, the demonstration was operationally successful. Hydrofoils have developed to the point where vessels carrying up to 500 passengers can be safely operated at speeds of 60 knots or more. Similarly, air cushion vehicles were safely demonstrated in the early 1960's in San Francisco, New York, and elsewhere. Today, European ACV's safely carry maximum loads of 600 passengers and 60 vehicles, again at speeds of over 60 knots. ACV's of this size have been tested at speeds of up to 85 knots successfully, although none yet operate in service at such elevated speeds. The continuing development of gas turbine engines, waterjet propulsion systems, semi- and full-planing hulls, cycloidal propellers and other developments promises to provide vessels capable of higher speeds, higher payloads, and safer, more maneuverable operation.

With so much technology available, the first-year study sought to identify reasons for its non-use in the United States. Three main issues were established:

1) Questions regarding the safety of operating high-speed vessels in congested waterways, or those in which debris is prevalent;

2) Legal restrictions to operation of passenger ferries on foreign-built hulls; and

3) High fuel consumption associated with high-speed vessel operation.

The safety issue is a complicated one, involving operating regulations and legitimate fears. It must be pointed out, however, that high-speed vessels have operated with outstanding safety records in congested waterways throughout the world. Hong Kong Harbor is a primary example in which virtually every type of ferry vessel, both high-speed and conventional, operate frequently in a harbor congested by commercial vessels, junks, and sand-pans. Radar systems have been developed to allow hydrofoils to operate safely at night, when many unlit smaller vessels litter the harbor. ACV's have been safely tested in several congested U.S. harbors (San Francisco, New York, Boston, others). Hydrofoil service to Victoria, British Columbia from Seattle, and to Toronto over the Great Lakes are operating and have operated with unblemished safety records. While speed is clearly a safety issue, there is ample evidence to suggest that safe operation of advanced vessels in congested harbors and waterways is indeed possible.

Fuel consumption is another complex issue. Most standard analyses, however, compare fuel consumption rates of high-speed and conventional vessels on a gallons per vessel-hour basis. This ignores the impact of speed, which produces more trips, and provides more passenger-miles of service in an hour. More important is the comparison of fuel consumption rates per passenger-mile, which must consider vessel capacity and the speed of operation. Such comparisons display far less difference in fuel efficiency between high-speed and conventional vessels than does a vessel-hour analysis. Chapter 2 of this report examines this issue in great detail, and illustrates techniques for addressing the issue.

Clearly, there is a great potential for more effective use of advanced vessel technology to enhance the attractiveness of U.S. ferry services and potential services.

C. Ferry Terminal Design

The third aspect of the Year 1 effort was in the area of ferry terminal design. Here again, it was found that many available design procedures and standards commonly used in developing other types of terminals, are not properly implemented in most ferry terminals. Specific procedures and guidelines were developed for ferry terminals using available techniques for pedestrian design and traffic engineering. The ferry terminal presents unique problems in ticketing, sorting and holding vehicles for multiple route and multiple destination services, overflows due to late ferries, batch discharging of vehicles and passengers, and numerous others. A conspicuous example of the proper use of traditional pedestrian and transit design principles is the SEABUS terminals in Vancouver, designed for efficient passenger flow from vessels to connecting buses. The design was carefully integrated with the design of the vessel superstructure to allow for rapid loading and unloading, and to minimize the vessel turn-around time in the dock.

CHAPTER 2

ECONOMIC CHARACTERISTICS AND ANALYSIS TECHNIQUES FOR FERRY SYSTEM OPERATIONS

The economic viability of a new ferry system, much like that of any transportation service, must be adequately assessed during the early stages of the planning process.

The purpose of this chapter is to provide the planner and/or ferry operator with a set of analysis techniques and procedures for determining the economic consequences of initiating new or expanded ferry service.

In order to develop these economic analysis techniques for application to the waterborne mode of transportation, it was necessary to collect and analyze in detail financial information on several existing ferry systems and various vessel types. Consequently, the first portion of the chapter presents a summary of the economic and operational characteristics which were compiled for each of these systems and vessels. It is believed to be necessary to present this information in detail to give the planner a better understanding of the factors which must be considered in utilizing the analysis procedures and to benefit from the experience of other operations.

Collection of Economic and Operational Data for Existing Ferry Systems and Vessels

To assist in the compilation of the economic data for the various systems, and at the same time enable direct comparisons of the collected data, it was necessary to develop a detailed questionnaire which would allow appropriate classification of all operational and cost related information.

A. Questionnaire Development

Realizing that data would be collected from a number of different systems with varying accounting and record keeping techniques, a questionnaire was developed to ensure that compatable information was collected from all systems. A copy of the questionnaire which was used to obtain the necessary data base, is contained in Appendix IV of this report.

Principal elements requested in the questionnaire are summarized below.

(1) Operating statistics

- passengers and passenger - miles traveled
- vehicles and vehicle - miles traveled
- vessel miles traveled and hours operated
- employees - vessel crew, administrative and support labor
- vessel type and number in fleet
- vessel capacities and other operational data
- number of routes & terminals
- route lengths

(2) Operating Costs

- vessel related
  - fuel and power
  - crew payroll
  - insurance
  - maintenance
  - interest and depreciation

- terminal related
  - staff payroll
  - rent
  - maintenance
  - utilities
- marketing and management

(3) Operating Revenues

- fare box - passengers & vehicles
- concessions
- government subsidies

In order to provide a comprehensive data base for use in the development of analysis techniques with universal application, it was necessary to collect data from a variety of ferry systems. Thus, the questionnaire was distributed to 20 existing systems operating in the United States and Canada.

B. Systems Responding to Questionnaire

Many of the smaller systems surveyed, were unable to supply information in enough detail to be utilized in any type of comparative analysis. However, nine operators were able to provide data in sufficient detail to allow formulation of specific relationships and use in the development of a generalized analysis procedures.

The systems for which either complete or partial data was obtained included the following:

- Alaska Marine Highway
- British Columbia Ferry Corporation
- Cape May - Lewes Ferry

· Golden Gate Ferries

· Orient Point - New London Ferry

· Port Jefferson - Bridgeport Ferry

· Quebec Ferry Company

· Staten Island Ferry

· Washington State Ferries

In order to provide a basis for comparison, as well as, an understanding of the type of operation involved, each of the above systems is briefly described below:

(1) Alaska Marine Highway - serves mainly as an extension of the highway network in connecting the various ports of Alaska with the Canadian port of Prince Ruppert and the port of Seattle, Washington. The system operates nine vessels over 22 routes and carries over 294,000 passengers and 72,000 vehicles per year..

(2) British Columbia Ferries - is also clearly an extension of the highway system. It operates 25 vessels on 16 routes which run mostly between the island of Vancouver and the British Columbia mainland. The system carries over 11 million passengers and 4 million vehicles annually.

(3) Cape May - Lewes Ferry - serves mainly as an extension of the highway network connecting southern New Jersey and Delaware. The system operates 4 vessels which carry approximately 710,000 passengers and 236,000 vehicles per year.

(4) Golden Gate Ferries - consists of two routes which connect the suburban areas of Larkspur and Sausalito with downtown San Francisco. The system operates passenger only ferries which carry in excess of 1 million passengers per year.

(5) Orient Point - New London - serves as an extension of the highway network - providing an alternative to the circuitous land route through New York City - for travel between the two ports. The system carries 257,000 passengers and 103,000 vehicles per year on 3 vessels.

(6) Port Jefferson - Bridgeport - is a relatively small seasonal operation which carries 112,000 passengers and 25,000 vehicles per year between Bridgeport, Connecticut and Port Jefferson, New York.

(7) Quebec Ferry Company - this system also serves as a continuation of the highway network in providing service for the Province of Quebec. Fifteen vessels are operated on six routes serving more than 2.4 million passengers and 970,000 vehicles per year.

(8) Staten Island Ferry - is the largest single ferry system in the United States and Canada. It operates between suburban Staten Island and the Manhattan central business district. It presently carries over 20 million passengers and 600,000 vehicles per year.

(9) Washington State Ferries - this system consists of an extensive network of passenger and vehicle ferries which service the Puget Sound Area. The system operates 19 vessels on 11 routes and carries over 18 million passengers and 7.3 million vehicle per year.

C. Summary of Questionnaire Responses

The information collected from each of these systems was summarized according to two major categories. The first category identified the major operational characteristics such as route length, number of vessels, number of annual passengers served, in addition to several other vital statistics. This information has been tabulated for each system and is shown in Table 2.1.

The second category dealt specifically with the operational costs associated with each of these systems. This information which allows a useful comparison of costs and revenues for several different size operations, is shown in Tables 2.2A and 2.2B.

In addition to the information described above, detailed operational data was compiled for each of the individual vessel types utilized by each system. Since most existing ferry operations in the U.S. and Canada operate only conventional displacement hull type vessels, it was necessary to supplement the data base with information from other sources on high speed vessels such as hovercrafts, surface effect ships and hydrofoils. This information was collected from vessel manufacturers and several european ferry operators who presently use these vessels. Table 2.3 summarizes the operational characteristics of te major types of ferry vessels, which are available for use today. A detailed description of each of these vessel types is contained in the first year study.

TABLE 2.1
SELECTED ANNUAL OPERATIONAL CHARACTERISTICS
OF EXISTING FERRY SYSTEMS (1)

System Name	Total Operating Costs ($)	Total Vessel Miles Operated	Vessel Hours Operated (6)	Approx. Route Length (Miles)	Number of Vessels	Number of Termi-nals	No. of pass. (in thousands (Millions)	No. of pass. - Miles
1. Alaska Marine Highway	37,983,484	570,262	38,017	Varies	9	27	294.1	85.8
2. British Columbia Ferry (2)	108,965,869	NA	NA	Varies	25	24	11,423.4	314.8
3. Cape May-Lewes Ferry	3,422,000	66,000	4,125	17	4	2	710.0	12.1
4. Golden Gate Ferries	6,190,235	85,500	3,053	13	4	3	1,117.5	14.5
5. Orient Point - New London (3)	1,811,599	81,920	10,240	16	3	2	257.1	4.1
6. Port Jefferson-Bridgeport (3)	759,735	16,672	2,084	16	1	2	112.4	1.8
7. Quebec Ferry Company (2)	13,217,605	150,000	10,000	Varies	15	11	2,401.2	9.6
8. Staten Island Ferry	22,880,320	174,920	12,500	5	5	2	18,016.0	90.1
9. Washington State Ferries	55,051,000	923,000	51,280	Varies	19 (4)	22	18,100.0	139.0
10. Jetfoil Test Service-Puget Sound	424,008	3,872	-	Varies	1	-	61,876.0	169.0

TABLE 2.1 (continued)

SELECTED ANNUAL OPERATIONAL CHARACTERISTICS OF EXISTING FERRY SYSTEMS (1)

System Name	No. of Vehicles (in thousands)	No. of Vehicle - Miles (Millions)	Cost per passenger ($)	Cost per Vehicle ($)	Cost per passenger-Mile ($)	Cost per Vehicle-Mile ($)
1. Alaska Marine Highway	72.3	22.8	129.1	525.1	0.44	1.67
2. British Columbia Ferry (2)	4,161.3	106.7	9.54	2.62	0.35	1.02
3. Cape May-Lewes Ferry	236.0	4.0	4.82	14.5	0.28	0.85
4. Golden Gate Ferries	-	-	5.54	-	0.43	-
5. Orient Point - New London (3)	103.8	1.7	7.05	17.46	0.44	1.09
6. Port Jefferson-Bridgeport (3)	25.4	0.4	6.76	29.92	0.42	1.87
7. Quebec Ferry Company (2)	971.0 (5)	3.6	5.50	13.61	1.37	3.67
8. Staten Island Ferry	574.0	2.9	1.27	39.86	0.25	7.97
9. Washington State Ferries	7,300.0	50.0	3.04	7.54	0.40	1.10
10. Jetfoil Test Service-Puget Sound	-	-	6.85	-	0.25	-

Notes for Table 2.1

1. The information contained in this table is based on the responses to a detailed questionnaire distributed by the Polytechnic Institute of New York to the operators of ferry systems.

2. All amounts shown for the British Columbia Ferry Corp. and Quebec Ferry Company are given in Canadian dollars.

3. For both the Orient Point-New London and Bridgeport-Port Jefferson systems, the data was extracted from table II-2 of Reference (III.1).

4. Consists of 18 passenger-auto ferries and one passenger only ferry.

5. The annual traffic now reaches about 3,200,000 passengers and 1,242,000 vechicles.

6. The number of vessel hours is estimated based on the average vessel speed and the total number of vessel-miles operated per year.

TABLE 2.2A
1980 OPERATING COSTS FOR SELECTED FERRY SYSTEMS

Systems / Category	Cape May-Lewes	Golden Gate Ferries (4)	Alaska Marine Highway	Quebec Ferry Company (14)	British Columbia Ferry Corp. (14)
TOTAL EMPLOYEES	57	115	718	503	2645
• Vessel Crew	40	100	638	399	-
• Management	6	5	28	38	-
• Support	11	10	52	66	-
TOTAL OPERATING COSTS	3,422,000	6,190,235	37,983,484	13,217,605	116,805,372
• Vessel Related	2,119,000	2,583,253	34,120,184	8,410,757	109,659,530
- Fuel & Oil	752,000	1,232,649	4,601,500	1,469,783	12,103,783
- Crew Payroll	742,000	1,004,574	22,527,500	3,009,629	56,207,472
- Insurance	437,000	161,398	1,394,400	327,594	-
- Maintenance	188,000	-	5,596,784	1,587,537	7,355,505
- Depreciation	-	142,012	-	1,931,214	20,270,582
- Interest	-	-	-	85,000	879,644
- Other	-	42,620	-	-	-
• Terminal Related	738,000	1,484,546	2,356,900	3,016,785	7,582,908 (11)
- Support Payroll	500,000	693,467	-	2,928,641	-
- Rent	-	92,945	-	-	-
- Maintenance	138,000	60,630	-	88,144	-
- Utilities	88,000	81,290	-	-	-
- Other	12,000 (1)	489,825 (5)	-	-	-
		117.930 (6)	-		
• Management	199,000 (2)	895,832	1,506,400	1,415,006	3,449,166 (12)
• Marketing	49,000	-	76,000		1,996,453 (13)
• Other	-	1,029,289 (7)	-	6,950,791 (8)	-
	317,000 (3)	-	-	37,674 (9)	-

TABLE 2.2A (continued)
1980 OPERATING COSTS FOR SELECTED FERRY SYSTEMS

Category \ Systems	Washington State Ferries	Staten Island Ferry (15)	Bridgeport - Port Jefferson (16)	Orient Point - New London (16)
TOTAL EMPLOYEES	1250	576	NA	NA
· Vessel Cres	-	493	-	-
· Management	-	34	-	-
· Support	-	49	-	-
TOTAL OPERATING COSTS	55,051,000	26,700,000	759,735	1,811,599
· Vessel Related	44,076,200	NA	491,238	-
- Fuel & Oil	10,603,000	5,300,000	58,713	376,005
- Crew Payroll	26,403,300	17,300,000	222,103	598,677
- Insurance	512,800	-	-	-
- Maintenance	5,287,700	803,000	136,199	245,471
- Depreciation	-	-	12,584	203,015
- Interest	-	-	-	-
- Other	1,269,400	3,314,000	61,639	96,777
· Terminal Related	8,929,800	NA	96,143	56,108
- Support Payroll	6,126,700	-	-	-
- Rent	174,600	-	-	-
- Maintenance	2,063,500	-	-	-
- Utilities	-	-	-	-
- Other	565,000	-	-	-
· Management	1,773,000	NA	172,354	235,546
· Marketing	-	NA	-	-
· Other	688,500	-	-	-

Notes for Table 2.2A

1. Given as "operation of terminals" cost.
2. Given as "administrative" cost.
3. Given as "employee benefits" cost.
4. System on strike from July 7 through October 21.
5. Includes insurance and depreciation costs.
6. Includes operating supplies and other miscellaneous costs.
7. Total maintenance expense.
8. Total salaries.
9. Includes restaurant and bar expenses.
10. Includes purchasing of food and supplies for concessions.
11. Includes materials, operating supplies and services expenses.
12. Includes marketing, general and administrative expenses.
13. Charter fees.
14. All amounts shown are in Canadian dollars.
15. All amounts shown for the Staten Island Ferry are rough estimates provided by the operating authority.
16. Represent 1979 Operating Costs

TABLE 2.2B
FISCAL YEAR 1980 OPERATING REVENUES FOR SELECTED FERRY SYSTEMS

Revenue Sources System	Fare Box ($) Vehicles	Fare Box ($) Passengers	Concessions ($)	Government Subsidies ($)	Other ($)
1. Cape May-Lewes	1,755,000	1,523,000	-	-	97,000
2. Golden Gate Ferries	-	1,117,508	121,736	1,611,462	8,446 (1)
3. Alaska Marine Highway	-------21,164,582-------		-	24,628,918 (2)	-
4. Quebec Ferry Company	3,142,195	1,768,942	-	7,854,241 (3)	154,949
5. British Columbia Ferry Corporation	-------60,377,636-------		17,933,492	49,447,325 (4)	4,556,252
6. Washington State Ferries	21,479,550	8,502,000	-	11,000,000 (5)	2,968,250
7. Staten Island Ferry	1,000,000	2,012,500	1,000,000	6,700,000	-

NOTES:
(1) Revenue from feeder bus service
(2) G.F. Subsidy.
(3) Government of Quebec operating subsidy.
(4) Province of British Columbia highway subsidy.
(5) Subsidy from the state motor fuel tax revenue.
(6) All amounts shown are based on rough estimates provided by operating authority.

TABLE 2.3
OPERATIONAL CHARACTERISTICS OF VARIOUS FERRY VESSELS

System Name/ Vessel Type	Route Length of Operation	Date Built	Vessel cost ($) (yr. of Complete in Millions)	Vehicles (pass. car equiv.)	Passen-gers	Required Crew Size	Type of Eng.
1. Alaska Marine Highway							
a- Matanuska	Varies	1963	21.1	120	750	54	Diesel
b-Columbia	Varies	1974	22.0	170	970	75	Diesel
2. Cape May-Lewes							
a- M.V.T. Capes	17	1974	3.9	100	802	9	Diesel
b- M.V. New Del	17	1981	10.8	100	802	9	Diesel
3. Quebec Ferry (1)							
a- Camille	Varies	1974	12.0	126	600	34	Diesel
b- Desjardins	Varies	1971	2.5	55	100	10	Diesel
4. Golden Gate Ferry Vessel	13	1978	8.0	---	750	10	Gas Turbine
5. Washington St. Superferries	Varies	1967	6.0	160	2,500	19	Diesel
6. Staten Island	5	1981	20.0	---	5,748	13	Diesel
7. Jet Foil (1)	Varies 15-85	1977	10.5	N/A	242	6	Gas Turbine
8. Air Cushion Vehicle	---	----	10.0	---	200	2	Gas Turbine
9. Surface Effect Ship	---	1978	6.0	---	240	4	Diesel

(1) Results of test service operation on Puget Sound in 1978

TABLE 2.3 (continued)
OPERATIONAL CHARACTERISTICS OF VARIOUS FERRY VESSELS

System Name/ Vessel Type	No. of Eng.	Total Horsepower	Max. Speed (Knots)	FUEL CONSUMPTION		
				At Full Speed (gas./hr)	At Full Capac. (gal./pass.-hr.)	At Full Capac. (gal./pass.-mile)
1. Alaska Marine Highway						
a. Matanuska	---	---	16-17	280	0.37	0.023
b. Columbia	---	---	19-20	800	0.82	0.043
2. Cape May-Lewes						
a. M.V.G. Capes	2	4,000	15-16	100	0.12	0.007
b. M.V. New Del	2	4,000	15-16	100	0.12	0.007
3. Quebec Ferry (1)						
a. Camille	4	9,600	15	475	0.79	0.053
b. Desjardins	2	3,240	12	135	1.35	0.113
4. Golden Gate Ferry Vessel	3	8,400	30	642	0.85	0.031
5. Washington St. Superferries	4	8,000	18	N/A	N/A	0.005
6. Staten Island	4	7,000	18	N/A	N/A	0.003
7. Jet Foil (1)	1	7,400	43	540	2.20	0.108
8. Air Cushion Vehicle	---	3,600	56	262	1.31	0.019
9. Surface Effect Ship	---	2,650	40	176	0.73	0.031

D. Summary of Vessel Types Studied

As mentioned above, Table 2.3 provides a brief summary of the major operational features of several vessel types which are in use on existing ferry systems. It was determined that to enable a complete economic analysis for any new ferry system, a more detailed data base of information on individual vessel types would be necessary.

Appendix V contains copies of summary sheets of the operating characteristics of ten different vessel types which include both high speed and slower conventional hull vessels. The vessel types included are listed in Table 2.4 with a corresponding identification code. This identification code is used for reference in all further analysis presented in this chapter.

TABLE 2.4
IDENTIFICATION CODES FOR VESSEL TYPES
UTILIZED IN ANALYSIS

IDENTIFICATION CODE	VESSEL NAME AND TYPE[1]
A	Vancouver SEABUS - Passenger Only (Conventional)
B	CAPE MAY - LEWES FERRY M.V. New Delaware - Passenger/AUTO (Conventional)
C	Golden Gate Ferry - Passenger (Semi-Planning)
D	Staten Island Ferry, Andrew J. Barberi - Passenger Only (Conventional)
E	Washington State Superferries - Passenger/Auto (Conventional)
F	Boeing Jetfoil - Passenger Only (Hydrofoil)
G	HM.2 Mark III - Passenger Only (Surface Effect Ship)
H	Bell Halter SES - Passenger Only (Surface Effect Ship)
I	Highspeed Catamaran - Passenger Only
J	Air Cushion Vehicle Al-30 - Passenger Only

(1) Refer to Appendix V for Operating details

The vital operating statistics which are provided in Appendix V for each of these vessel types include:

- Capital Cost
- Cruising Speed
- Fuel Consumption Rate
- Docking Time Required for loading/unloading
- Estimated Service Life
- Typical Maintenance Cost
- Capacity
- Required Crew Size (given by number for each individual position)
- Insurance and liability cost

Each of these items is necessary for estimating the costs associated with a particular vessel on a specific route of a system. The use of this information is described in a later section of this chapter.

Variables Utilized in Estimating a Ferry System's Costs

Several variables are identified here for use in the development of equations and analytic techniques for estimating ferry system costs. A list of these variables and associated acronyms is identified in Table 2.5 to facilitate the use of the analysis procedures described in later sections.

Costs Associated with Implementing a Ferry Service

The total costs associated with the operation of a ferry service include both direct and indirect operating costs. The direct costs are composed of fixed annual costs and variable costs, while the indirect operating costs are those incurred regardless of the number of vessel-hours operated during the year.

TABLE 2.5

LIST OF SYMBOLS USED TO

IDENTIFY FERRY SYSTEM OPERATING VARIABLES

AOC_i	=	Annual operating cost of vessel type i ($)
AT_i	=	Annual vessel trips for vessel type i
ACV_i	=	Annualized cost of vessel type i ($)
CC_i	=	Crew Cost of vessel type i ($/hr.)
$CRF_{SLV,I}$	=	Capital recovery factor for service life (SLV) and interest rate (I)
D	=	Demand per hour (passengers or autos)
FP	=	Fuel price ($/gallon)
FCR	=	Fuel consumption rate (gallons/hour)
HOC_i	=	Hourly operating Cost of Vessel type i ($)
I	=	interest rate to be utilized in estimating annual cost of vessel
L	=	length of route (miles)
MC_i	=	maintenance cost of vessel type i ($/operating hour)
n	=	number of passengers/hour/vessel
s	=	vessel cruise speed (mph)
SLV_i	=	service life of vessel i
t	=	time needed for loading/unloading vessel (hours)
T	=	trip time (hours)
NV_i	=	number of vessels of type i
VC_i	=	capacity of vessel type i
VHOC	=	vessel hourly operating cost
VP	=	Vessel Price ($)

In analyzing the economics of any system, detailed cost data must be included in each of the following categories:

(1) Capital Costs
- Vessels
  - initial investment in vessel
  - initial spare parts and equipment
- Terminals
  - land acquisition, harbour dredging
  - design and construction of terminal superstructure, parking areas and boat slips
  - access improvements

(2) Operating Costs
- Fixed Annual Costs
  - Capital recovery cost of vessels
  - insurance
  - Administrative costs
- Variable (running) Costs
  - Vessel Related
    - crew
    - fuel
    - maintenance
  - Terminal Related
    - support staff
    - utilities
    - maintenance

Before describing the actual procedures to be used for estimating each of these costs for a particular system, a brief description of what each of these categories include and some insight into how they are derived is necessary.

A. Capital Costs

In determining the capital costs associated with a new ferry system, two specific categories must be included. These categories include those capital costs associated with both the vessels and the terminals.

The capital costs associated with the terminal must be estimated on a system by system basis and must include those costs associated with land acquisition, site preparation and the design and construction of the terminal facilities. For the purpose of the procedures presented in this report, these costs are generally included for completeness of analysis but it should be noted that these costs vary widely from system to system and no site specific information has been included here.

Unlike the terminals, the capital costs associated with the vessels of a particular system can be more adequately assessed herein. In general, the capital recovery costs of the vessels are utilized in the analysis procedure, based on the expected service life of the vessel and an expected annual interest rate. Table 2.6 provides a summary of the expected capital costs expressed as an annual cost over the service life of the vessel, for each of the vessels types previously identified. This table assumes an interest rate (I) of 15% per year. The capital costs of vessels are 1981 price estimates.

TABLE 2.6

SUMMARY OF CAPITAL COSTS FOR INDIVIDUAL VESSEL TYPES

VESSEL TYPE	INITIAL VESSEL PRICE (VP) $	SERVICE LIFE (SLV) YEARS	ANNUAL COST (CV) OF VESSEL ($/YEAR)
A	5,700,000	25	910,860
B	11,800,000	25	1,885,640
C	10,900,000	25	1,741,820
D	17,000,000	25	2,716,600
E	17,000,000	25	2,716,600
F	14,000,000	20	2,165,800
G	1,320,000	20	204,204
H	4,870,000	20	753,389
I	3,200,000	20	495,040
J	5,780,000	20	894,166

These costs are expressed as annual costs and are calculated from the formula:

$$ACV = VP \times CRF_{SLV,I} \quad (2.1)$$

In determining the capital costs of vessels for an entire system, it is first necessary to estimate the number of vessels of each type that will be needed. Once this has been determined, it is just a case of multiplying the number (N) of each vessel type times the equivalent annualized cost (ACV) of that vessel.

Procedures for estimating the number of vessels needed for a particular system are developed later in the chapter and should be used in conjunction with the above information.

B. Operating Costs

As briefly mentioned above, operating costs can be classified in two sub categories, namely, those that are fixed and those that are variable.

The fixed annual costs include the capital recovery costs of the vessels (which has been detailed above), the insurance of the vessel hull and general liability insurance.

The vessel hull insurance is generally calculated as a percentage of the vessel capital cost and is usually between 2 and 3% of the vessel's initial cost. General liability insurance is also necessary for any operations and is based on a percentage of the gross revenues of a system. Typical annual insurance costs are provided in Appendix V for each of the ten vessel types.

The variable costs consist of those costs associated with the operation of the both the vessels and the terminals. Each of these categories is addressed here separately, beginning with the vessel related items.

(1) Vessel variable costs

The vessel variable costs include, crew, fuel and maintenance expenses which are all time dependent costs, and in this case are a function of the number of vessel-hours traveled.

(a) Crew costs Each vessel type has a required crew size and thus each vessel has a different crew cost associated with its operation. Table 2.7 summarizes the required crew sizes for each of the different vessel types previously identified. Crew size requirements are based upon a number of considerations, including evacuation procedures, vessel operations, number of passengers or vehicles carried, safety, and related issues.

TABLE 2.7

REQUIRED CREW SIZES FOR
VARIOUS VESSEL TYPES

VESSEL IDENTIFICATION	REQUIRED CREW SIZE
A	4
B	9
C	10
D	15
E	15
F	5
G	2
H	4
I	5
J	2

Compounding the difficulty of estimating crew costs is the fact that regulations require specific numbers of crew members in several different categories with varying pay rates. Appendix V specifies the number of crew members requied for each position for each of the vessel types studied. This information together with the hourly wage information for each position can be used to calculate the hourly crew costs.

When compiling information on crew costs for various systems, it was found that there were regional variations in the pay rates of crew members. Table 2.8 provides a comparison of the typical annual pay rates based on information obtained from different systems and from different vessel manufacturers.

TABLE 2.8

COMPARISON OF TYPICAL ANNUAL FERRY CREW PAY SCALES FOR VARIOUS SYSTEMS/VESSELS(1)

Based on Position	Cape May Lewes Ferry	Halter Marine	Hovermarine International(2)	Staten Island Ferry(2)	Pacific Northwest Region(2)
Captain/ Master	26,312	24,700	50,000	41,342	41,704
Mate	21,736	22,100	35,000	32,255	31,408
Boatswain	16,432	17,500(*)	22,000(*)	-	28,022
Able Seaman	13,738	15,600	20,000	28,869	26,998
Ordinary Seaman	13,520	15,000(*)	18,000(*)	24,175	24,523
Chief Engineer	26,104	22,100(*)	40,000	40,034	41,704
Assistant Engineer	21,736	20,000(*)	27,500(*)	-	-
Oiler	13,300(*)	14,500(*)	20,000(*)	30,110	26,998
Wiper	12,800(*)	13,800(*)	18,500(*)	30,512	24,523

(1) Source: Adapted from "Feasibility Study of a Cross-Lake Passenger Auto Air Cushion Ferry Service", August 1980
(2) Include fringe benefits and overhead
(*) Indicates figures are estimated

The figures shown in this table can be converted to hourly wages by dividing by a standard of 2080 hours/year. For both the Staten Island Ferry and for the Pacific Northwest Region this has been done with the resulting hourly rates shown in Tables 2.9A and 2.9B.

TABLE 2.9A

TYPICAL ANNUAL AND HOURLY PAY SCALES FOR THE STATEN ISLAND FERRY SYSTEM(1)

Position/ Title	Hourly w/o overhead & Fringe (2)	Annual w/o overhead & Fringe	Hourly w/ overhead & Fringe (3)	Annual w/ overhead & Fringe
1. Captain Master	12.33	25,657	19.88	41,342
2. Assistant Captain	10.91	22,702	17.59	36,581
3. Mate	9.62	20,001	15.51	32,255
4. Chief Maintenance Engineer	11.94	24,842	19.25	40,034
5. Deckhand	8.61	17,914	13.88	28,869
6. Ferry Attendant	7.21	15,000	11.62	24,175
7. Marine Engineer	11.14	23,178	17.96	37,352
8. Marine Oiler	8.98	18,672	14.48	30,110
9. Laborer	9.10	18,930	14.67	30,512

(1) Source: Staten Island Ferry Operating Statistics
(2) Hourly payrates are based on 40 hrs./wk. x 52 wks./yr. = 2080hrs./yr.
(3) Rates include a 30% Overhead and 24% Fringe Benefits

TABLE 2.9B

PACIFIC NORTHWEST REGION TYPICAL FERRY PAY SCALES(1)

Position	1977 hourly w/OH & Fringe	1981 hourly (2) w/OH & Fringe	1981 Annual(3)
1. Captain	16.29	20.05	41,704
2. Mate	12.27	15.10	31,408
3. Second Mate	11.18	13.76	28,620
4. Engineer	16.29	20.05	41,704
5. Oiler	10.55	12.98	26,998
6. Wiper	9.58	11.79	24,523
7. Able Seaman	10.55	12.98	26,998
8. Ordinary	9.58	11.79	24,523
9. Boatswain	10.95	13.47	28,022

(1) Source: "Relative Costs of Passenger Only Ferries" G.C. Nickum, E.C. Hagemann & P.A. Gow, October 1978.
(2) Adjusted to 1981 wages by wage earnings index. Includes a 30% overhead and 24% Fringe Benefit rate
(3) Assumes 2080 hours/yr.

To estimate the crew costs associated with a specific vessel type, one must determine the crew size and composition from the information contained in Table 2.7 and Appendix V and then multiply the number in each position times the hourly wage for that position. The following equation can be used to perform this computation:

Crew Cost (CC) = $Na \cdot Wa + Nb \cdot Wb + N_c \cdot Wc + Nn \cdot Wn$

where,

a,b,c,...n represent the crew member position

N is the number of crew for position a,b,c,...n, and

W is the hourly wage for the position a,b,c,n...n

(b) Fuel Costs The fuel costs of a particular vessel are a function of its fuel consumption rate and the unit price of the fuel. Table 2.10 summarizes selected operating characteristics of the major vessel types. Included in this table are the fuel consumption rates for each of the vessel types identified previously.

The unit price of fuel for these vessels was found to vary from $0.85/gallon to $1.05/gallon, depending on regional location. For the remainder of this chapter a unit fuel price of $1.00/gallon has been utilized, but may easily be adjusted for any price fluctuations.

When discussing fuel consumption rates for ferry vessels, it is interesting to compare them with the consumption rates of other transportation modes on a per passenger-mile basis. Table 2.11 makes this comparison

TABLE 2.10
SELECTED OPERATING CHARACTERISTICS
OF VARIOUS FERRY VESSEL TYPES

Vessel Type	Passenger Capacity	Service Speed		Docking Time (hrs.)	Fuel Consumption Rates	
		mph	hr/mile		gal/hr	gal./pass. mile
A	400	15.5	0.065	0.05	75	0.012
B	800	17.0	0.059	0.18	100	0.007
C	750	28.0	0.036	0.17	642	0.031
D	5,700	16.0	0.063	0.15	300	0.003
E	2,500	20.0	0.050	0.20	250	0.005
F	242	46.0	0.022	0.11	540	0.049
G	60	31.0	0.032	0.05	35	0.019
H	240	35.0	0.029	0.11	176	0.021
I	175	29.0	0.035	0.07	540	0.108
J	200	42.0	0.024	0.07	262	0.031

TABLE 2.11
FUEL CONSUMPTION RATES OF
DIFFERENT TRANSPORTATION MODES

Mode	Passenger Loading	Fuel Consumption Rate (gallons/passenger-mile)
Ferry Vessels		
A	400	0.012
B	800	0.007
C	750	0.031
D	5700	0.003
E	2500	0.005
F	242	0.049
G	60	0.019
H	240	0.021
I	175	0.108
J	200	0.031
BUS	45	0.004
AUTOMOBILE (1982 Model Year)		
Standard	1.3	0.038
Compact	1.3	0.036
Subcompact	1.3	0.025

Table 2.12 gives a similar comparison of energy consumption for various modes, however expresses it as BTU's/seat-mile.

TABLE 2.12
COMPARATIVE ENERGY CONSUMPTION OF
VARIOUS TRANSPORTATION MODES

Mode	BTUs (1000) / Seat-Mile
Bicycling	0.20
Walking	0.30
Subway	0.50
Bus (intercity)	0.90
Bus (urban)	1.20
Commuter Train	1.30
Small Automobile	5.40
Recreational Boat	6.25
Hovercraft	6.30
Large Automobile	17.00

Source: Encourage Research on Improved Water Transport Vessels - 1974 Data

(c) Maintenance Costs Vessel maintenance cost information was collected for each vessel type and has been expressed as a cost per vessel hour. While these maintenance costs may vary more significantly than either the crew or fuel costs, the information provided gives a good estimate of what maintenance costs may be, based on the number of hours a vessel is operated.

Table 2.13 summarizes the maintenance and other variable hourly operating costs for ten typical vessel types.

The information summarized in Table 2.13 when combined with the vessel capacities and service speed data from of Table 2.10 yields Figure 2.1. This figure allows a comparison of the total variable operating costs per passenger mile for each of the vessel types.

From this figure it can be seen that in general, the higher speed vessels have a considerably higher variable operating cost per seat-mile that the conventional slower speed vessels. This information must be used cautiously since capital costs of the vessels and travel

TABLE 2.13
SUMMARY OF TYPICAL HOURLY
OPERATING COSTS FOR VARIOUS VESSEL TYPES
($/hour)

Vessel Type	Crew Cost (CC)	Fuel Cost (FC)(1)	Maintenance Cost (MC)	Vessel Hourly Operating Cost (VHOC)
A	59.92	75	50	187.25
B	136.17	100	45	281.17
C	143.76	642	125	910.76
D	245.22	300	69	614.22
E	170.13	250	41	461.13
F	71.37	540	219	830.37
G	35.15	35	31	101.15
H	61.11	176	75	312.11
I	79.80	540	75	694.80
J	35.15	262	50	347.15

(1) Fuel Cost based on average price of $1/gallon

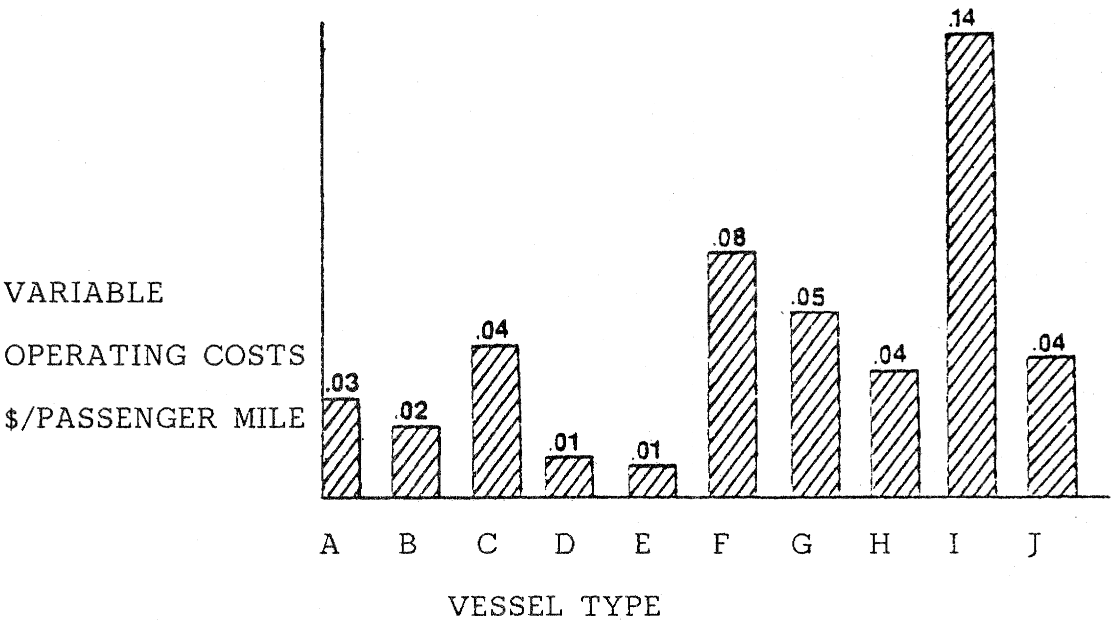


FIGURE 2.1

VARIABLE OPERATING COSTS PER SEAT

MILE FOR VARIOUS VESSEL TYPES

time savings to the passenger are not included. The latter two costs will vary from system to system and are dependent upon other variables which may be unique for a particular system or route.

(2) Terminal Variable Costs

Terminal variable costs include the terminal support staff, terminal maintenance and utilities such as lighting, heating and/or air conditioning. While specific procedures are not outlined here for determining these variable costs, they are mentioned to insure that such costs are included when determining overall system costs.

Table 2.14 provides a detailed listing of the staffing categories which are needed for a typical terminal operation. Annual pay ranges for each class of employee are also given.

TABLE 2.14
TYPICAL 1980 ANNUAL PAY SCALES FOR
SYSTEM SHORESIDE PERSONNEL

Position	Annual Salary (w/o Overhead)
Terminal	
Agents	25,000
Attendants	10,000
Ticket Seller	13,000
Maintenance	
Port Engineers	25,000
Clerks	11,000
Time Keepers	13,000
Superintendents	28,000
Store Keepers	12,000
Mechanical	
Engineers	22,000
Foreman	23,000
Mechanics	14,000
Helpers	11,000
Operators	11,000
Cleaners	10,000
Management	
General Manager	35,000
Assistant Manager	29,000
Secretary	10,000

Source: Adapted from "Feasibility Study of a Cross-Lake Passenger Auto Air Cushion Ferry Service," August 1980.

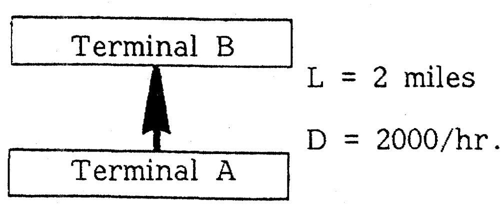
The information contained in this table, togeher with the operating cost data for terminals of existing systems, as presented previously in Table 2.2 provides the planner with a means of roughly estimating the types of costs associated with terminal operations.

Procedures for Estimating Costs Associated with Operation of a Ferry System

The first portion of this chapter has presented a summary of available information for existing ferry vessels and systems and has identified the cost variables which are to be considered in completing an economic analysis.

This section will present a description of a set of procedures which can be utilized in completing such an analysis. The procedures are presented here in the form of an illustrative example which is followed through iteratively. While the procedure describes a case consisting of one particular set of variables, it may be utilized for analyzing a route of any length, with any passenger demand, and for any combination of vessel types. Appendix VI provides a summary of outputs calculated through application of these procedures to various scenarios for each of the ten vessel types presented earlier in this chapter.

Illustrative Example



Given:
Passenger only service
Route Length (L) of 2 miles
Peak Hour Demand (D) of 2000 passengers
Annual Ridership: 1,000,000 million → 2,000,000 passenger-miles

Problem: To determine the type(s) of vessels needed to service the above demand while minimizing the total system costs.

Solution: Since the terminal and administrative costs associated with providing the service will be similar, regardless of the vessel type, identical terminal costs are used in this solution for each vessel type. It should be noted that this assumption may not hold when comparing vessel types of drastically different passenger capacities such as vessel types "D" and "G". Obviously, when this is the case, a larger number of smaller capacity vessels would be needed to service the same demand and additional slips or docking facilities may be needed to service the increased number of vessels docked at the terminal at any one time.

Step One:

To begin the analysis, the trip time (T) must be calculated for each vessel type using the equation,

$T_i = \frac{L}{S_i} + t_i$ where,

T_i = trip time in hours, for vessel type i,

L = route length in miles,

S_i = cruise speed (mph), for vessel type i

t_i = docking time (hrs.), for vessel type i

For the solution of this problem we arbitrarily chose to limit our analysis to two specific vessel types,namely, types "A" and "G". The solution is identical for analyzing several vessel types, however, involves additional calculations.

Thus, for the two vessel types being analyzed, we have:

$$T_A = \frac{L}{S_A} + t_A \qquad T_G = \frac{L}{S_G} + t_G$$

$$T_A = \frac{2}{15.5} + 0.05 \qquad T_G = \frac{2}{31} + 0.05$$

$$T_A = 0.18 \text{ hrs/trip} \qquad T_G = 0.11 \text{ hrs/trip}$$

where values of s and t are drawn from Table 2.10.

To facilitate this computation, the trip time (T) for various vessel types and varying route lengths, have been computed and are graphically displayed on Figure 2.2.

To utilize the figure, one enters the horizontal axis with a particular route length and reads the trip time on the vertical axis for each vessel type.

Step two:

Once the trip time has been determined, the number of vessel trips per hour (n_i) must be determined. This is given by the inverse of twice the one-way trip time (T) (allowing the vessel to return from terminal B to terminal A)

$$n_A = \frac{1}{2(T_A)} \qquad n_G = \frac{1}{2(T_G)}$$

$$n_A = \frac{1}{2(.18)} = 2.78 \qquad n_G = \frac{1}{2(.11)} = 4.54$$

Fractional numbers are premissible, as a vessel may make 3 trips in 2 hours, for example, for an average of 1.5 trips/hr. The results of the analysis described herein reflects the average number of passengers per hour which can be carried by any given vessel.

Step three:

We now must determine the number of passengers (P) which may be processed per hour per vessel. This relationship being given by

$$P_i = n_i \times VC_i$$

where

P_i = number of passengers per hour per vessel, for vessel type i

n_i = number of vessel trips per hour, for vessel type i, and

VC_i = capacity (passengers or autos) for vessel type i

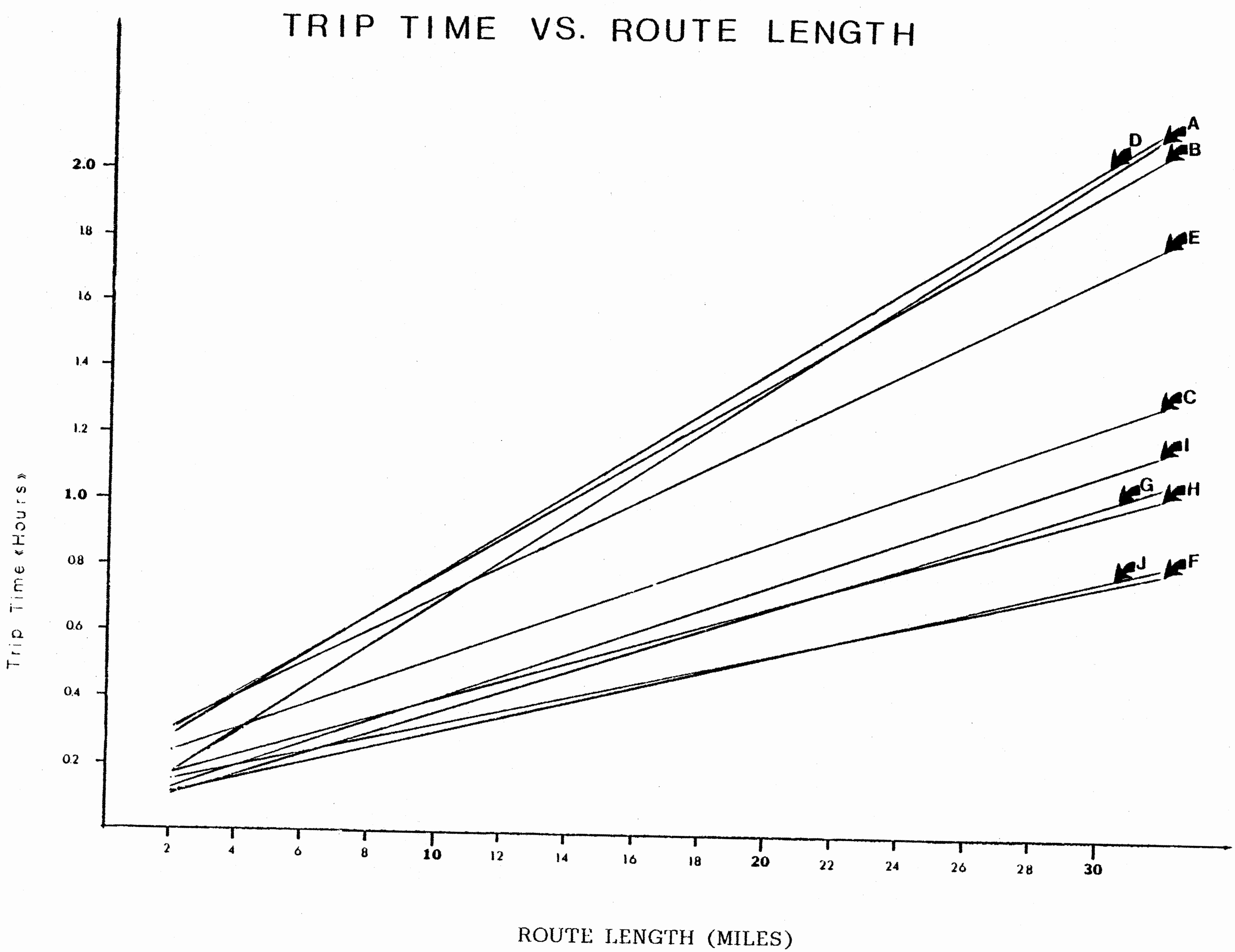


FIGURE 2.2
COMPARISON OF TRIP TIME VS. ROUTE LENGTH

Thus, for vessel type A and G,

$P_A = n_A \times VC_A$ $\quad$ $P_G = n_G \times VC_G$

$P_A = 2.78 \times 400$ $\quad$ $P_G = 4.54 \times 60$

$P_A = 1112$ passengers per hour per vessel $\quad$ $P_G = 272$ passengers per hour per vessel

Again to facilitate this calculation, Figures 2.3A, B and C have been developed for determining the values of P for various route lengths and vessel types.

Step Four

The number of vessels of type i (NV_i), needed to process the actual demand can now be calculated,

$$NV_i = \frac{D}{P_i}$$

$$NV_A = \frac{D}{P_A} \qquad NV_G = \frac{D}{P_G}$$

$$NV_A = \frac{2000}{1112} \qquad NV_G = \frac{2000}{272}$$

$$NV_A = 1.80 \Rightarrow 2 \qquad NV_G = 7.35 \Rightarrow 8$$

These values must obviously be rounded to the next highest whole number since, we are dealing with vessels. Also to allow for maintenance of a vessel at any time, and avoid disruption of service, one additional vessel should be included in the fleet.

Step Five:

Once the number of vessels (NV_i) has been determined, we can calculate the annual fixed cost of providing these vessels as given by,

$$CV = (NV_i + 1) \times V_iP \times CRF_{SLV,I}$$

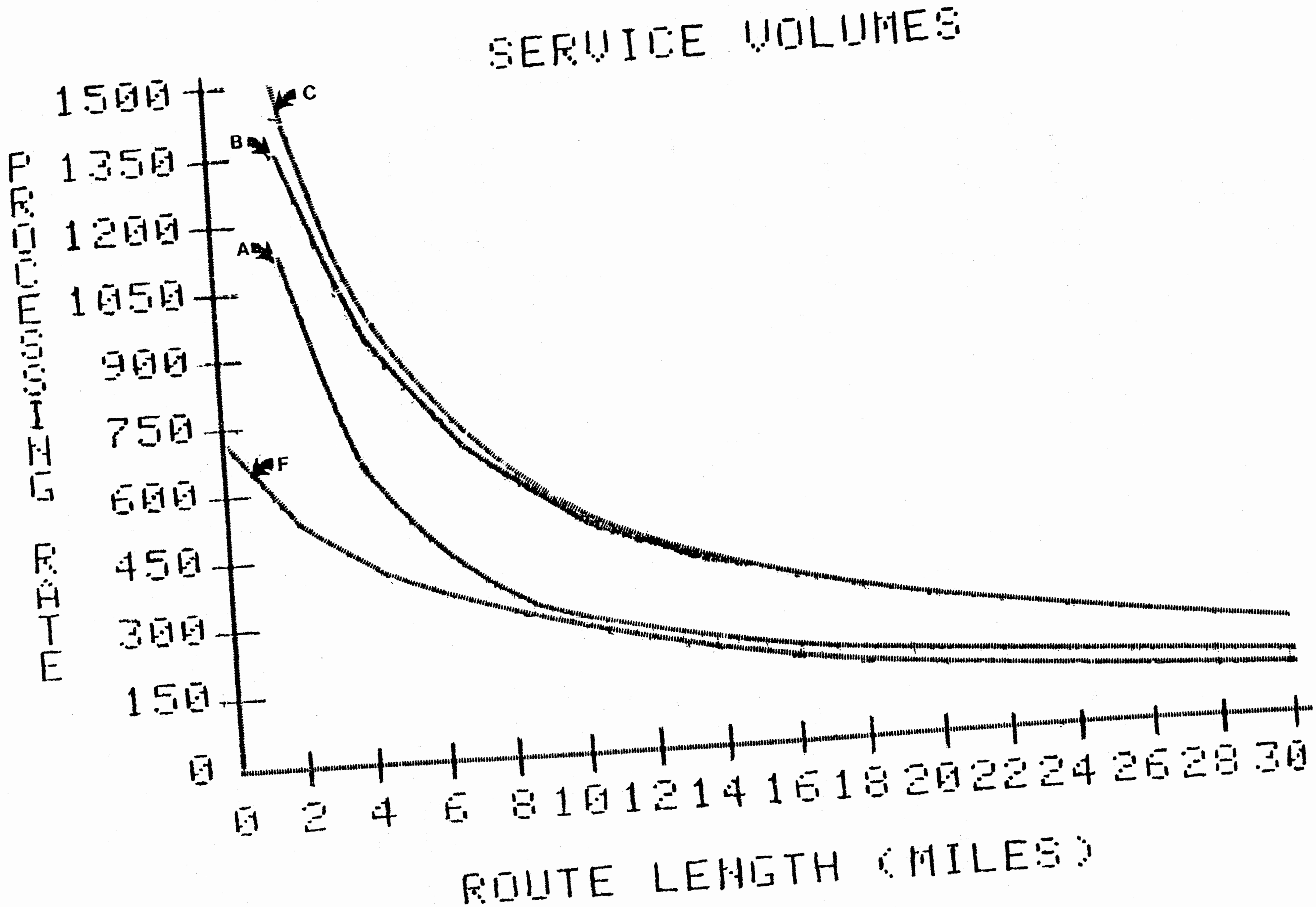


FIGURE 2.3A
NUMBER OF PASSENGERS/HR./VESSEL
FOR VESSEL TYPES A, B, C, AND F

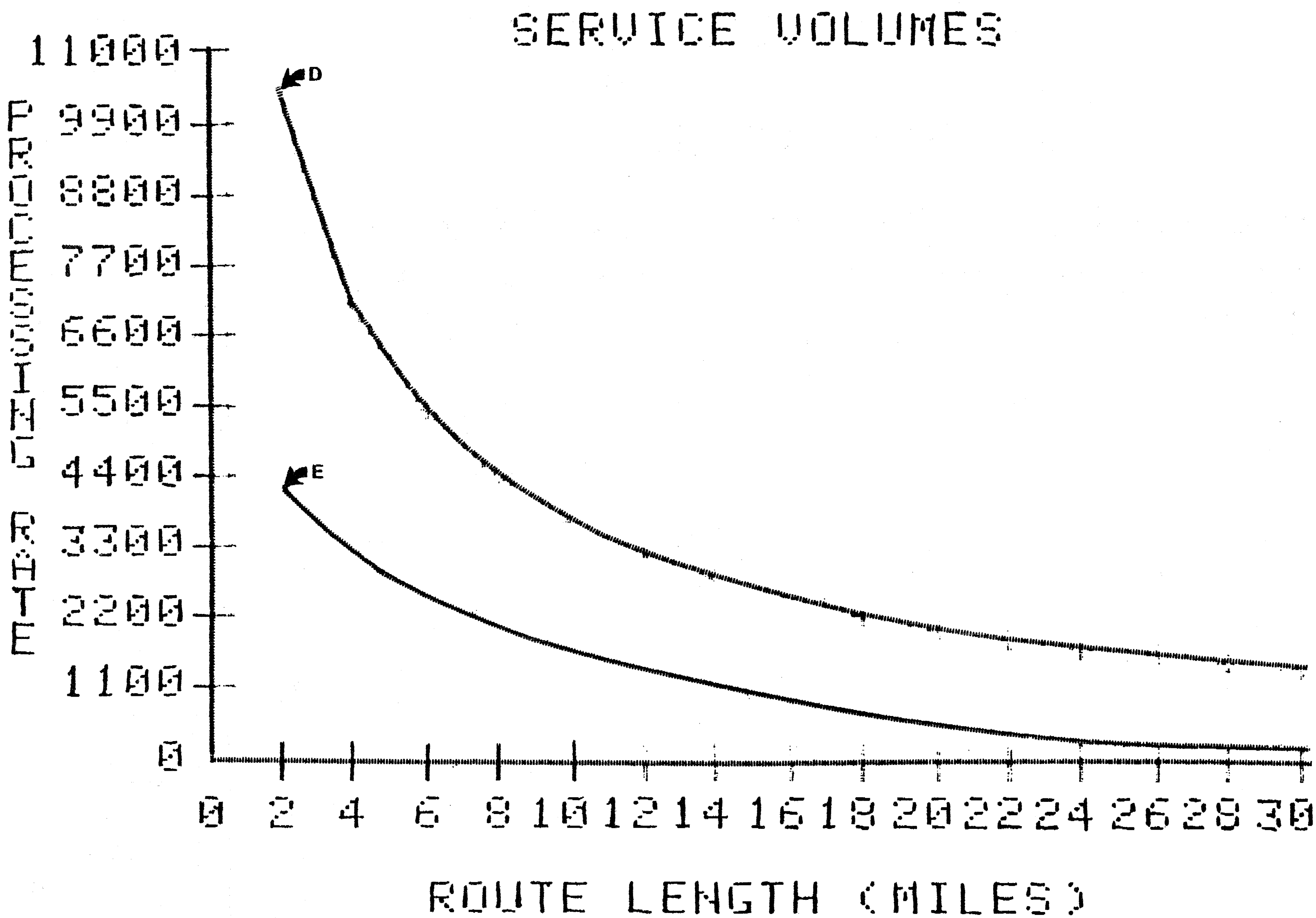


FIGURE 2.3B
NUMBER OF PASSENGERS/HR./VESSEL
FOR VESSEL TYPES D AND E

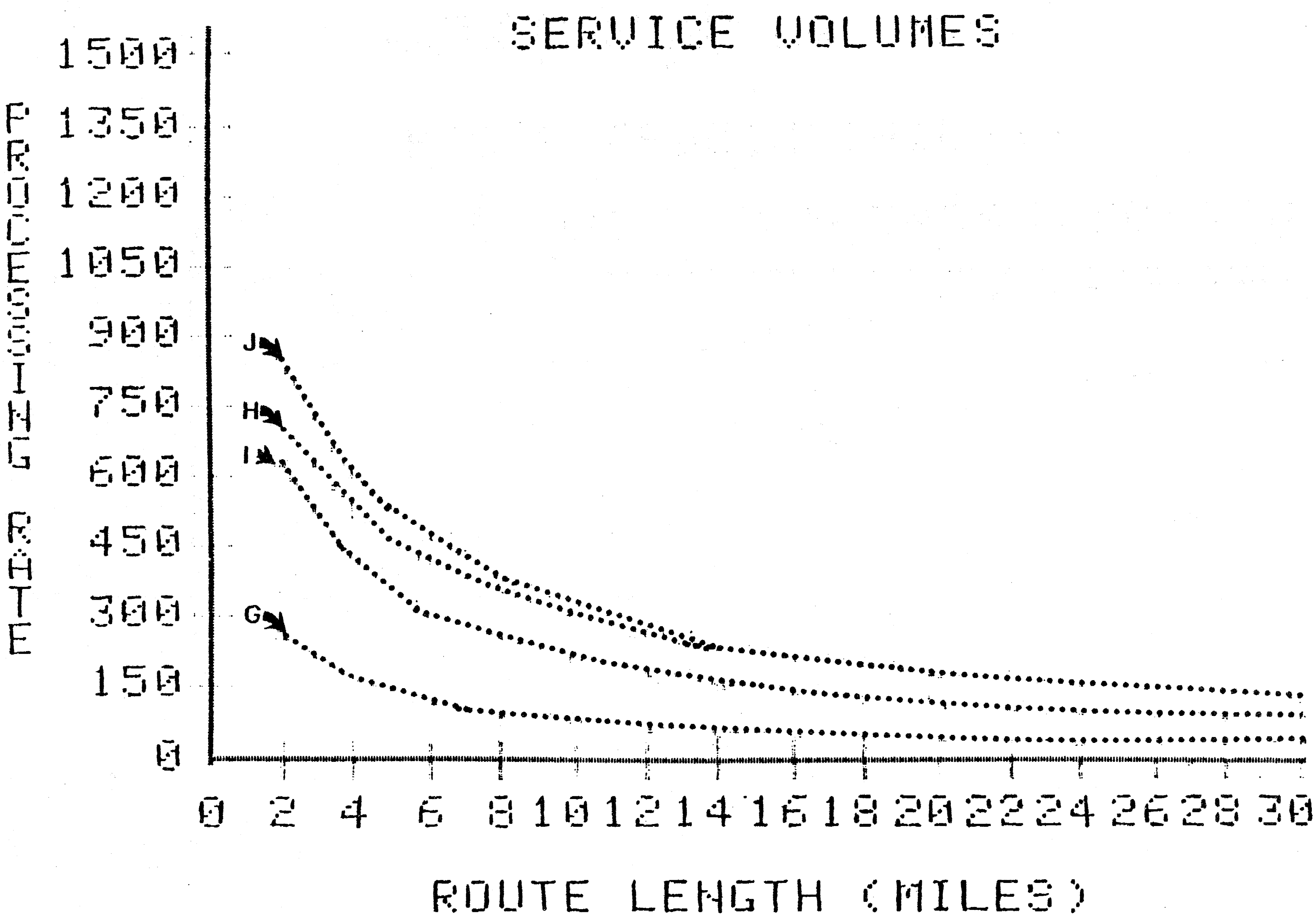


FIGURE 2.3C
NUMBER OF PASSENGERS/HR./VESSEL
FOR VESSEL TYPES G, H, I AND J

Thus,

$$CV_A = (NV_A + 1) \times V_AP \times CRF_{SLV,I}$$

$$C_{VA} = (2+1) \times (5,700,000) \times (0.1547)$$

$$CV_A = \$2,645,370/yr.$$

and

$$CV_G = (NV_G + 1) \times V_GP \times CRF_{SLV,I}$$

$$CV_G = (8+1) \times (1,320,000) \times (0.1598)$$

$$CV_G = \$1,898,424/yr.$$

where (VP) and (SLV) are drawn from Table 2.6, and (I) is assumed to be 15%. Capital Recovery Factors are available in many economic texts.

Step Six:

At this point, we have established the number of vessels needed to service the peak hour demand and the annual cost of providing these vessels. In order to provide a comparative overall system analysis for the different vessels types, we must determine the cost of operating the vessels on a common basis. Based on the information presented, thus far, we have decided to make this comparison on a per seat-mile basis.

For the case presented here the annual number of passenger-miles for this system has been estimated to be 2,000,000 passenger-miles per year. While the system actually services 2,000,000 passenger miles, the number of vessel-miles traveled is not directly proportional since each time a vessel makes a trip, it may not be completely full. To account for this occurrence, an average vessel load factor (which represents the percentage of capacity utilized), must be applied to determine the actual cost per seat-mile. A load factor of

0.6 is considered adequate for the type of service being analyzed and is used in further calculations.

Thus, the annual cost of operating the vessels on a per seat-mile basis is as follows:

$$AOC_A = (VOC_A \text{ (\$/seat-mile)} \times PM \times 0.6) + CV_A$$

$$AOC_A = (0.031 \times 2{,}000{,}000 \times 0.6) + 2{,}645{,}370$$

$$AOC_A = 37{,}200 + 2{,}645{,}370 = 2{,}682{,}570\text{/yr.}$$

$$AOC_G = VOC_G \text{ (\$/seat-mile} \times PM \times 0.6) + CV_A$$

$$AOC_G = (0.054 \times 2{,}000{,}000 \times 0.6) + 1{,}898{,}424$$

$$AOC_G = 70{,}800 + 1{,}898{,}424 = \$1{,}969{,}224\text{/yr.}$$

where VOC_i is drawn from Figure 2.1.

To these costs we must also add the costsof the terminal operations and associated administration costs. However, in the case presented here, these were assumed to be equal for the system regardless of vessel type. Thus, it happens that the system with the lowest annual cost per seat-mile also has the lowest overall annual system cost and the choice would be vessel type "G" for the service.

Note that in this case, the higher operating costs of the higher-speed vessel are outweighed by the capital costs of the slower vessel, and that the capital costs really determine the analysis results.

Summary of Economic Analysis Procedures and their Applications

The example described above provides a detailed analysis of one particular route with a choice between two particular vessel types. The procedure can be expanded to include an evaluation of several different vessel types, route lengths and varying passenger demands by simply including them in the iterative procedure.

To help facilitate these calculations, Appendix VI contains a listing of the calculated values which are needed in the analysis procedure for routes lengths of two to thirty miles, for varying hourly passenger demands for each of the vessel types described herein. This information together with the nomographs presented in previous sections should provide the transportation planner and/or ferry operator with the tools to needs to perform an economic evaluation of implementing a new or expanded ferry service.

CHAPTER 3

FERRY RIDERSHIP SURVEYS AND ANALYSIS

Ridership surveys conducted during the second year research served two primary purposes:

- identifying critical user, service, and related characteristics and trends which influence ferry use
- provide a detailed data base for calibration of a model-choice demand model for estimating ferry ridership

Two different surveys were constructed for obtaining this information, as the form and nature of the required data needed for general analyses and for model calibration differed substantially. The Staten Island Ferry was utilized as a base system for test studies due to its ready accessibility to the study team, and more importantly, because it directly competes with two other modes - express bus and auto - thus providing an excellent opportunity to observe mode choice behavior. Figure 3.1 illustrates the route of the ferry, which connects the northern tip of suburban Staten Island with lower Manhattan. Competing auto and bus services travel from Staten Island to Brooklyn over the Verrazano Bridge, then to Manhattan via one of several East River crossings. Both surveys focused on peak hour ridership, as commuter trips were to be the subject of the demand forecasting analysis. It was deemed reasonable to isolate this rider group, as their behavior is repetitive, and therefore, most amenable to prediction. Factoring can then be used to relate to other user components.

The Surveys

A. On-Board Survey

A mail-back survey questionnaire was distributed to Staten Island Ferry users during a typical weekday morning rush hour (6:30-9:00 AM) in February, 1981. During the survey period,

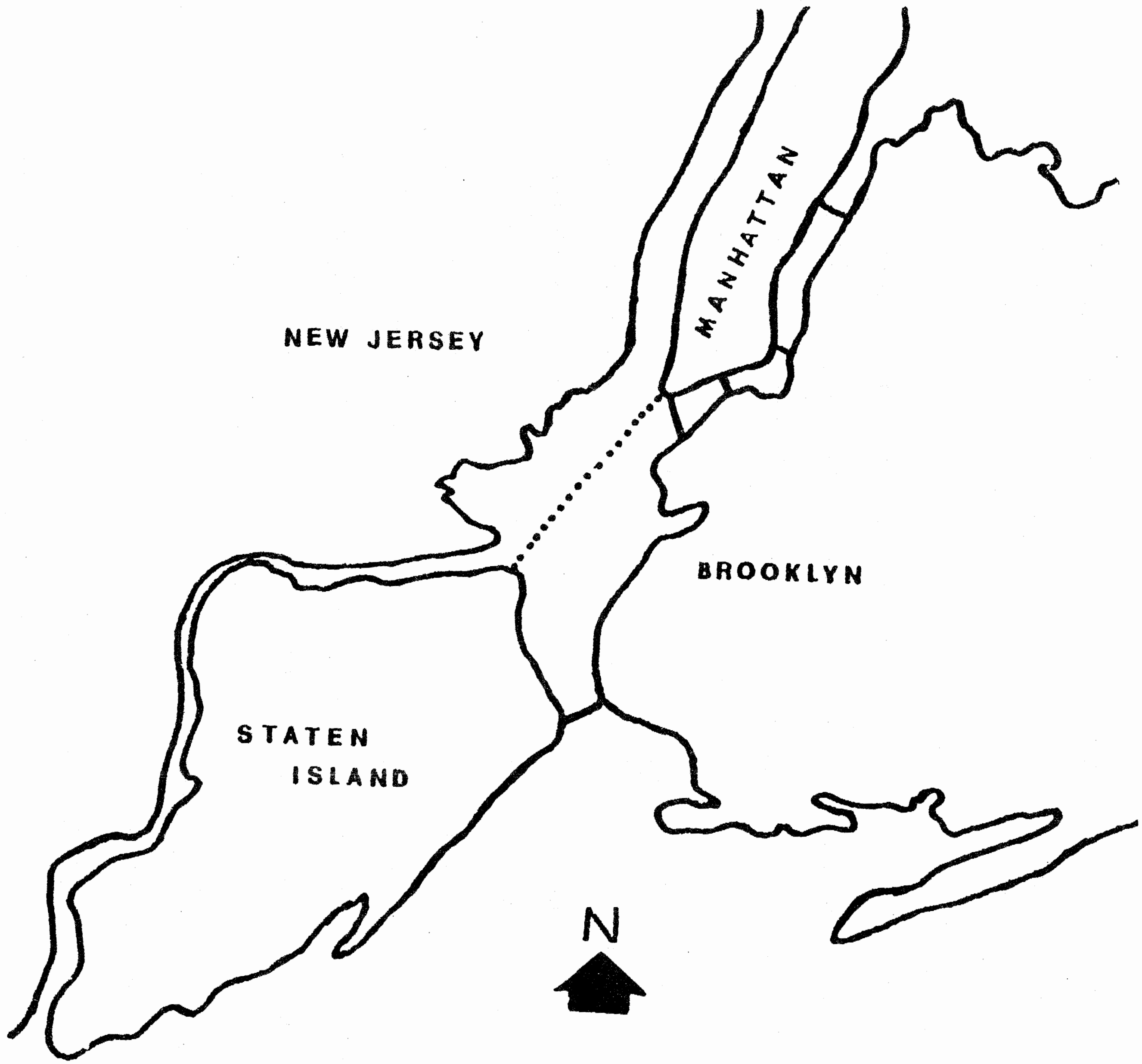


FIGURE 3.1
LOCATION MAP - STATEN ISLAND STUDY

20,000 passengers used the service, and 4,700 were given questionnaires. Of these, more than 2,300 were returned and deemed usable.

The on-board survey provided an inexpensive means of obtaining basic information on rider characteristics and their view of key service attributes. While not extremely detailed, these results were used to provide insight into rider behavior, and to assist in structuring the demand model.

B. Home Mail-Back Survey

On-board survey results were not sufficient for calibration of the demand model for a number of reasons. The model used is of the individual choice type (discussed in Chapter 4), and requires numerous detailed records concerning individual trips, not only on the subject mode, but on the competing modes as well.

Only through the use of surveys distributed to the home could users of all three modes (ferry, express bus, auto) be conveniently reached. A 100% sample of residences in 6 Staten Island census tracts was selected for this purpose. The tracts were selected to cover a wide range of socio-economic characteristics (using the 1970 census as a basis for this determination), as well as reasonable numbers of commuters using all three of the candidate modes.

A mailing list of 5,118 residences was established for the 6 census tracts. From these, 1,123 forms were returned, of which 850 worked in Manhattan, and were usable.

C. Comparisons With Other Systems

To provide for a basis of comparison with other systems, the results of two previous studies conducted on the San Fracisco and Seattle ferry systems were solicited and obtained. This allowed an evaluation of the universality of the results obtained from the two Staten Island surveys.

D. Response

The response to the two Staten Island Ferry surveys was quite good. The on-board survey produced a 49% return rate, which is unusually high for mail-back surveys. The home-based survey produced a 22% response rate, which is virtually unheard of for this type of questionnaire.

One of the reasons for the good response was the appearance of articles in the local edition of the "Daily News" and the "Staten Island Advance", a popular local newspaper, shortly before the survey which informed the public of its occurrence. The NYC Bureau of Ferries was also extremely helpful, making a number of on-board announcements on vessels and posting signs in the terminal exhorting riders to return the forms. Much of the information collected in these surveys has been passed on to the Bureau of Ferries to help them in assessing the existing service and to assist in future planning and analysis of the system.

Staten Islanders, and ferry riders in particular, have also been subjected to numerous transportation studies and surveys in recent years, primarily because of their unique situation. Staten Island is a rural/suburban community which is part of one of the densest cities in the world-New York. It is an island quite isolated from the rest of the city and is actually closer to New Jersey than to Manhattan. Manhattan is accessible only via ferry, the Verrazanno Bridge (through Brooklyn), or via several bridges through New Jersey. None of these are terribly convenient, compared to the options available to most other New Yorkers. Rather than being annoyed by many such studies, however, Staten Islanders have always been extremely cooperature in returning the requested data. Thus, the high return rates were not completely unexpected. A corollary to this is the unusually high degree of completeness and consistency with which most of the forms are filled out, again indicating the concern Staten Islanders have for their system.

Table 3.1 summarizes the basic response statistics for each of the surveys described above. Table 3.2 details the response to the home-based survey by zip code and mode used. This latter breakdown is important in analysis, as the demand model requires sufficient data from each origin zone via each mode for proper calibration.

The Survey Instruments

The on-board, mail-back questionnaire is included an Appendix I to this report. It is designed to allow an individual to complete it in no more than 5 to 10 minutes, andis therefore limited to 23 questions, some of which have several sub-parts.

Note that the questionnaire begins with a series of queries regarding the particular trip made the morning of the survey. This allows the respondent to focus on one (presumably typical) trip without trying to construct an "average" trip experience. Personal characteristic questions are asked last, as some people are loathe to answer these. If they are asked first, the rider may discard the entire form. If asked last, the rider generally just omits those to which he or she does not wish to respond.

TABLE 3.1

Summary of Recent Ferry Surveys

Survey Name	Survey Conducted By	Survey Date	Survey Type	Number of Forms Distributed	Number of Forms Returned	Response Rate
Staten Island Ferry on Board Survey	TTRC / NYC Bureau of Ferries	February 1981	On-board mail-back	4,700	2,310	49%
Staten Island Home Interview Survey	TTRC/NYC Bureau of Ferries	March 1981	Mail-back	5,118	1,123[1]	22%
Golden Gate Driver & Ferry Rider Attitudinal Survey	Golden Gate Bridge, Highway & Transp. District	April 1980	Telephone interview		500 Auto 302 Ferry	
Washington State Ferries Commuter Survey[2]	Washington State Ferries	January 1979	On-board drop-off	6,996[3]	1,491	59%

(1) Although 1123 questionnaires were returned, only 850 of these were for people who travel to the Manhattan CBD and were usable in the development of the demand model.

(2) Seattle/Winslow Route

(3) Total number of forms distributed for all routes; individual breakdown for Seattle/Winslow Route unavailable.

TABLE 3.2: SUMMARY OF RETURNED STATEN ISLAND HOME INTERVIEW QUESTIONNAIRES

Number of Usable Returns by Mode of Travel

Staten Island Zip Code Zones	Ferry	Express Bus	Auto	Percentage of Total Returns
10302	5	2	--	1.0
10304	9	2	2	2.0
10305	13	4	1	2.0
10306	95	19	6	15.5
10308	272	148	36	59.1
10310	30	--	2	4.2
10312	61	50	14	16.2
	485	225	61	100.0

Of course, critical to obtaining an adequate response on a mail-back survey is the inclusion of a postage-free return.

Appendix II contains the survey form used in the home-based, mail-back study. It is quite a bit longer than the on-board questionnaire, and is designed to be completed in about 30 minutes. It also begins with a series of questions concerning an individual work trip, but requests a far greater level of detail.

Two aspects of the latter questionnaire are worthy of mention. Asking a traveler about travel time, and obtaining actual travel times are two different things. Unless he or she is asked to time a particular trip before hand, surveys yield a response reflective of the traveler's "perceived travel time," which often over-counts waiting times, transfer times, etc., and other times perceived to be a special "nuisance." Figure 3.2 illustrates a unique form developed for

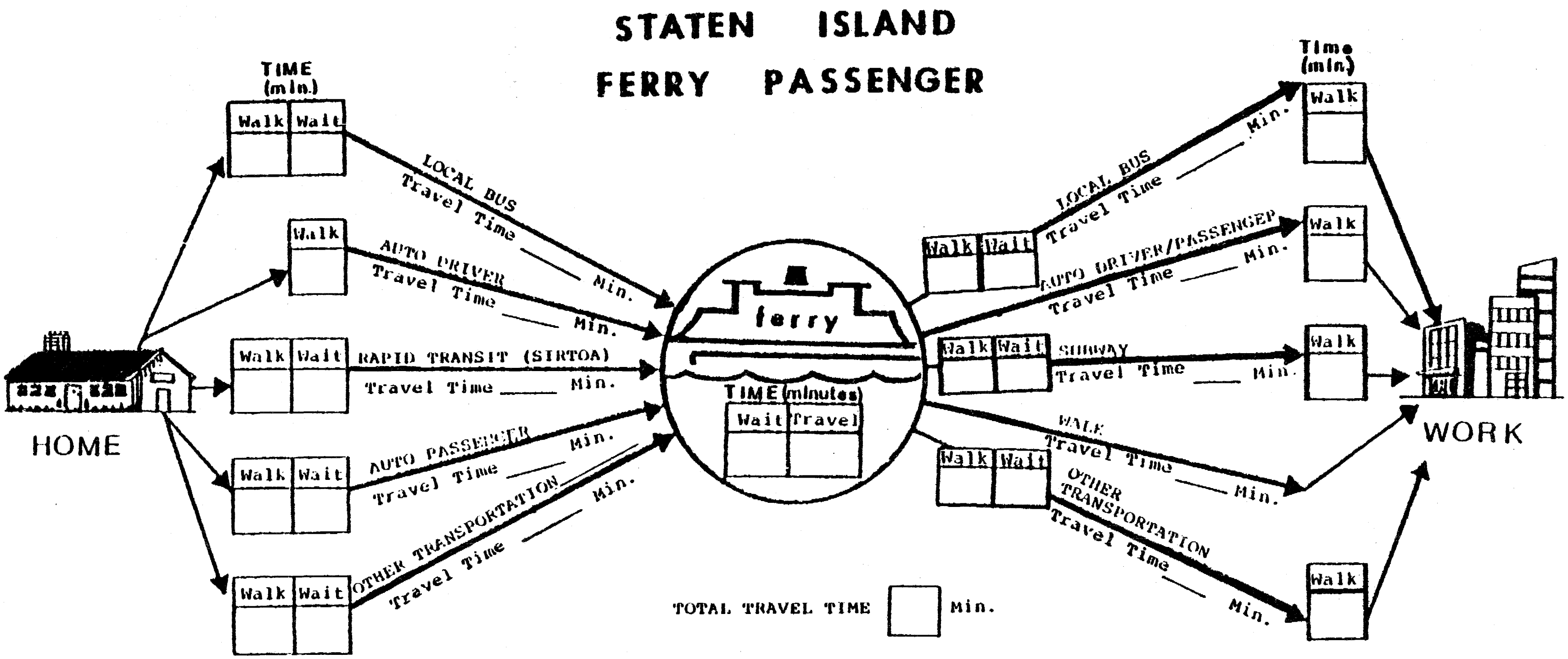


FIGURE 3.2: A SCHEMATIC FORM FOR OBTAINING DETAILED TRAVEL TIME RESPONSES

this survey to try and elicit more accurate responses. The form graphically represents the components of the home-to-work trip, and makes the rider specify various travel time components. Interestingly, the total times revealed in this question are often different from the response to a previous question which simply asks for door-to-door travel times.

Several random field checks indicate that the travel times obtained in response to this particular form are accurate to within ±10% of real total travel time, a distinct improvement over conventional means of soliciting this information.

Note that respondants to the home-based questionnaire are asked to evaluate <u>all three</u> potential modes for their Manhattan trip, even if they have never used it. In calibrating individual choice models, these evaluations are critical. The individual's choice of a particular mode is influenced by his or her perceptions of the available alternates, even if those perceptions are substantially incorrect. In understanding mode choice, it is not only necessary to know <u>why</u> a given mode was chosen, but also <u>why not</u> other modes were not chosen.

Both questionnaire are also structured to gain insight into how the general categories of "comfort" and "convenience" are viewed by users of the various modes. First, it is important to separate these two characteristics, as they are independent ideas. A very "comfortable" vessel may run on a very "inconvenient" schedule. Secondly, it is important to dissect each to find what specific attributes make up a "comfortable" or "convenient" service, and how such qualities can be quanitatively rated for a given mode. For the ferry, it is important also to identify any built in prejudices which traveler's may have either for or against the waterborne mode. Fear of the water would cause some travelrs to not use the ferry, while the special joy of viewing the Statue of Liberty on a clear day may be substantial inducement for Staten Island Ferry users. The questionnaires attempt to quantify the relative importance of these characteristics in mode choices, and what specific attributes of service affect traveler perceptions.

Comparisons and Analysis of Rider Characteristics

Survey responses were available for the Staten Island Ferry, the Golden Gate Ferry and a principal commuter route of the Washington State Ferry System. These were examined for similarities and/or differences in basic rider characteristics. Table 3.3 gives a summary comparison of key attributes, while Table 3.4 gives a more extensive comparison.

TABLE 3.3

SOME BASIC COMPARISONS AMONG FERRY RIDERS OF THREE SYSTEMS

Characteristic	Staten Island	Golden Gate	Washington State
Percent Male-Female	54 - 46	68 - 32	63 - 37
Average Age (Years)	36.8	32.8	38.5
Average Household Income ($/Yr.)	30,375	31,200	26,865
% Work Trips in Peak	96.6	100	93.0
Average Round-Trip Freq. (Trips/Week)	4.9	4.3	4.7
Principal Access Mode	Rail, Bus (63%)	Auto (53%)	Auto (86.8%)

The profiles are remarkably similar. Ridership is less male-dominant on the Staten Island Ferry, and the principal access mode is transit, reflecting the service's function as an integral part of a transit network. The Staten Island Ferry is met by both railand

TABLE 3.4: DETAILED RIDER CHARACTERISTICS ON THREE FERRY SYSTEMS

Characteristic	Ferry System: Staten Island	Golden Gate	Washington State
1) Access Mode			
a. Walk	6.9%	5.0%	9.1%
b. Bus	30.0	42.0	1.1
c. Auto Driver	16.1	53.0	86.8
d. Auto Passenger	12.0	-	-
e. Train/Subway	33.9	-	-
f. Other	1.0	-	1.9
2) Trip Purpose			
a. Work	96.6%	100.0%	93.0%
b. Shopping	0.4	-	-
c. Recreational	-	-	-
d. School	3.0	-	7.0
3) Mode Used after leaving Ferry			
a. Walk	57.1%	90.0%	54.6%
b. Bus	7.7	4.0	26.6
c. Auto Driver	3.0	-	16.0
d. Auto Passenger	0.6	-	-
e. Train/Subway	30.3	5.0	-
f. Other	1.3	-	1.1
4) Trip Frequency			
a. Once/week	0.5%	-	-
b. Twice/week	0.5	-	-
c. Three/week	1.1	17.0	-
d. Four/week	1.7	17.0	12.2
e. Five/week or more	95.5	63.0	84.7
f. Infrequently	0.8	-	3.2
5) Car Ownership			
a. one	51.4%	-	-
b. two	26.0	-	-
c. three or more	7.7	-	-
d. none	14.9	-	-
6) Gender			
a. Male	54.0%	68.0	63.0
b. Female	46.0	32.0	37.0

TABLE 3.4 (Continued)

Characteristic	Ferry System: Staten Island	Golden Gate	Washington State
7) Age Group			
a. under 25	22.1%	7.0%	10.0%
b. 25 - 34	28.8	31.0	31.0
c. 35 - 49	28.3	51.0	38.0
d. 50 - 64	19.1	10.0	18.0
e. 65 - 74	1.3	2.0	3.0
8) Income			
a.	3.8%	7.0%	7.5%
b. See Note	23.1	18.0	22.0
c. (2) below	28.0	23.0	30.9
d.	37.0	50.0	29.9
e.	8.2	-	10.0

Note:
(1) Seattle-Winslow Route
(2) Income ranges for each survey are as follows:

(a) Staten Island
a. less than $9,999 b. $10,000 to $19,999 c. $20,000 to $29,999 d. $30,000 to $49,999 e. $50,000 or more

(b) Golden Gate
a. less than 15,000 b. $15,000 to $24,000 c. $25,000 to 35,000 d. 35% or more

(c) Washington State
a. less than $10,000 b. $10,000 to $20,000 c. $20,000 to $30,000 d. $30,000 - $40,000 e. $50,000 or more

extensive bus services at either end of its run. The auto-dominance of the Washington State system reflects the fact that the majority of users bring their vehicles on the ferry. In San Francisco, free park-'n-ride facilities encourage auto access, and local buses provide access as well.

All three systems serve work trips as the strongly dominant trip purpose during peak hours, but this characteristic is similar to other modes of transport during peak periods as well.

Figures 3.3, 3.4 and 3.5 examine the rider characteristics of Staten Island Ferry riders in more detail, particularly with respect to their choice of mode.

Figure 3.3 illustrates the modal split among the three primary modes by gender. The significant characteristic displayed is that females have a much stronger preference for the express bus than do males. Previous studies of New York City express buses have shown that this is primarily a security-based characteristic--women preferring the security of a higher-price, single mode express bus trip over a ferry trip which frequently includes subway use as an access mode. Personal security is a concern which is also revealed in several other results which are discussed later.

Mode usage by income is shown in Figure 3.4, and displays some relatively interesting characteristics. Ferry use declines as income rises. More importantly, the ferry has an extremely high percentage (95-100%) of low-income riders. This is undoubtedly due to the extremely low fare on the Staten Island Ferry--25¢ per round trip--which, even when added to a 75¢ transit fare on a connecting mode, is far less expensive than the $2.50 one-way exress bus fare and the

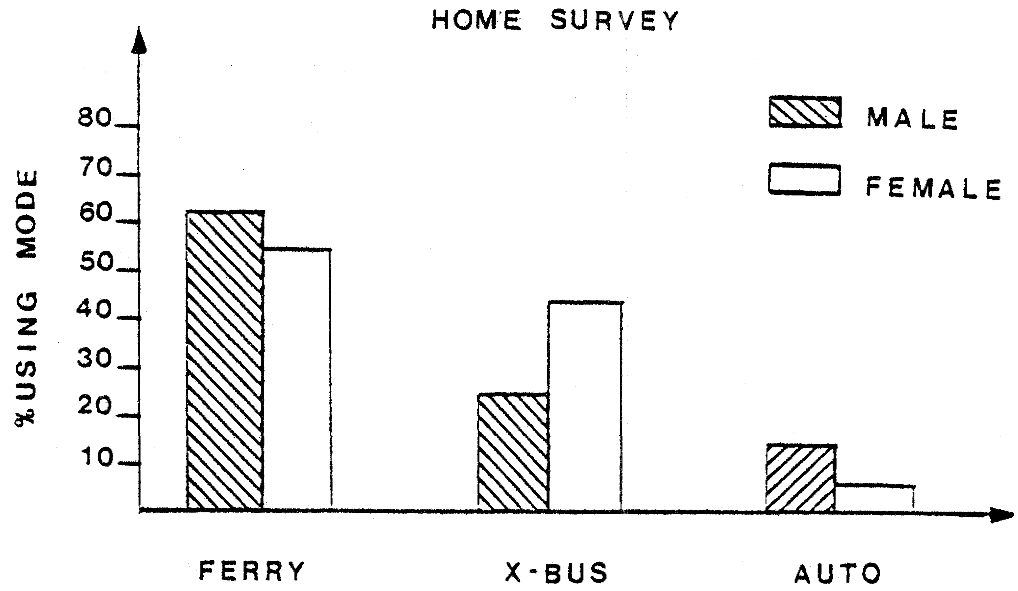


FIGURE 3.3

MODE USAGE BY GENDER: STATEN ISLAND

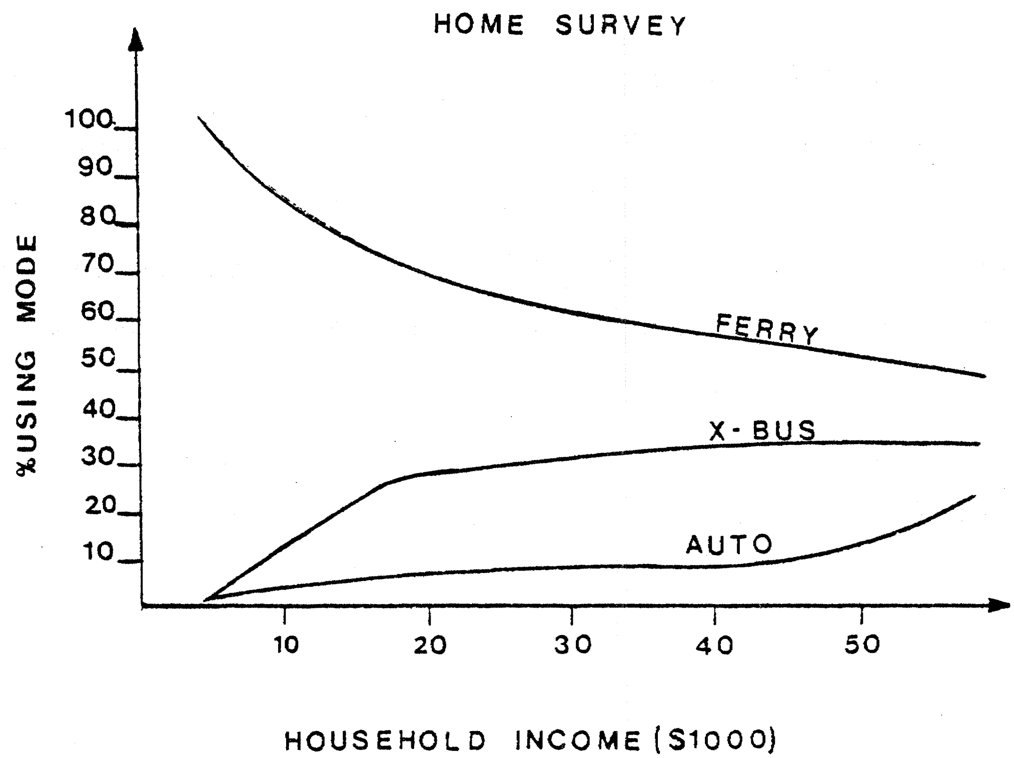


FIGURE 3.4

MODE USAGE BY INCOME: STATEN ISLAND

$8-15/day cost of tolls and parking in downtown Manhattan. The economics of the Staten Island Ferry are a strong ridership inducement. Auto use increases with increasing incme, taking a large leap at the $50,000/year level, but system capacity constraints limit auto use to downtown Manhattan substantially. The high express bus fare limits usage in low-income categories, but levels off at an income in the range of $18,000/year. This is a fairly low range in itself, emphasizing that the express bus has service features which make it extremely attractive even to workers of moderate income.

Figure 3.5 illustrates the distribution of mode usage by age group, and shows nothing of a startling nature. Preference for the ferry is strongest among younger and older groups, with presumably mid-career groups between 25 and 45 preferring other modes more strongly.

These trends are interesting, and yield some insights into how users make their modal decisions. It should be noted, however, that the dominance of the ferry among all user groups is at least partially due to the capacity constraints of the auto and express bus modes, and the unusually low ferry fare, both of which are unique to the Staten Island system.

Table 3.5 reinforces these observations, giving a detailed breakdown of user characteristics by mode used.

TABLE 3.5
SUMMARY OF USER DEMOGRAPHICS BY MODE
(BASED ON STATEN ISLAND HOME SURVEY)

Characteristic	MODE OF TRAVEL Ferry	Express Bus	Auto
1) Gender			
a. Male	72.6%	58.8%	86.9%
b. Female	27.4	41.2	13.1
2) Marital Status			
a. Married	74.7%	81.8%	93.4%
b. Single	25.3	18.2	6.6
3) Age			
a. 18 - 24	10.1%	7.7%	-
b. 25 - 34	30.0	33.5	45.9
c. 35 - 44	26.0	34.8	29.5
d. 45 - 54	20.5	15.8	14.8
e. 55 - 64	11.7	7.2	9.8
f. 65 and over	1.7	0.9	-
4) Dwelling Type			
a. single-family	67.6%	70.5%	77.0%
b. two-family	20.1	24.5	18.0
c. apartment	12.3	5.0	5.0
5) Occupation			
a. clerical	25.8%	22.5%	0.0%
b. craftsman/foreman	6.9	10.6	11.5
c. civil servent	10.7	5.0	31.1
d. sales	2.5	4.1	8.2
e. manager	21.0	27.1	21.3
f. student	2.5	0.9	0.0
g. professional	15.5	20.6	19.7
h. other	15.1	9.2	8.2
6) Drivers License			
a. Yes	89.7%	91.9%	96.7%
b. No	10.3	8.1	3.3
7) Autos in Household			
a. one	52.0%	61.3%	30.0%
b. two	34.2	28.9	53.3
c. three	5.2	5.3	10.0
d. four	5.2	2.2	6.7
e. none	3.5	2.2	-

TABLE 3.5 (Continued)

Characteristic	Ferry	Express Bus	Auto
	MODE OF TRAVEL		
8) Auto Availability			
a. always	52.2%	47.1%	83.3%
b. sometimes	22.3	23.1	11.7
c. never	25.5	29.0	3.3
9) Family Income			
a. under $10,000	3.3%	-%	-%
b. 10,000 - 14,999	6.4	4.0	1.7
c. 15,000 - 19,999	8.9	7.5	0.0
d. 20,000 - 24,999	15.1	15.0	15.5
e. 25,000 - 29,999	20.2	20.5	17.2
f. 30,000 - 39,999	26.2	29.5	31.0
g. 40,000 - 49,000	12.2	12.5	12.1
h. over $50,000	7.6	11.0	22.4

(1) Auto includes auto drivers and auto passengers

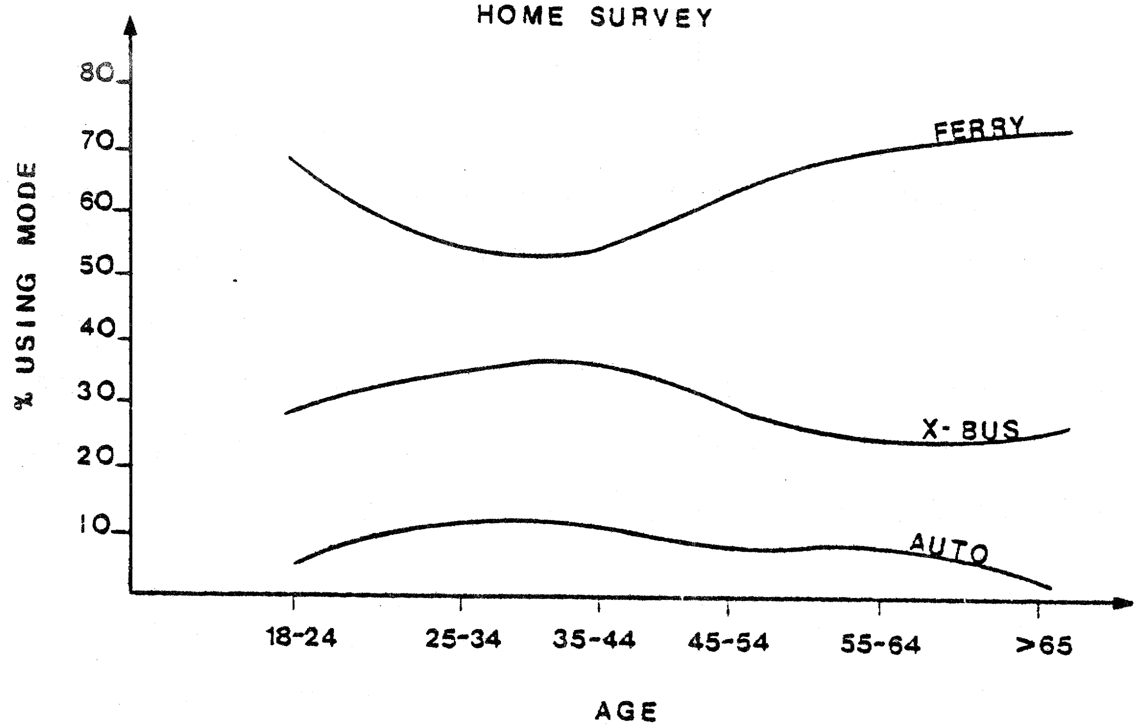


FIGURE 3.5

MODE USAGE BY AGE GROUP - STATEN ISLAND

Analyzing The Modal Choice Problem

Critical to the understanding of ferry demand forecasting is substantial insight into the process by which individual riders choose their mode of travel from among the available choices. In considering a modal choice in which the waterborne mode is one of the alternatives, reasons for selecting a particular mode were grouped into five general categories:

1. travel time
2. travel cost
3. convenience
4. comfort
5. special considerations associated with the waterborne mode.

The first four items are standard categories used in such studies. Comfort and convenience were separated (they are usually grouped together) to allow for a more detailed examination of how each of these is viewed by the user. The fifth category was added to account for any special considerations; i.e., fear of sinking, seasickness, special enjoyment of a waterborne trip, etc. These considerations may be positive or negative, but they clearly could influence mode choice, and are not included in any of the other categories.

Figure 3.6 illustrates the ranking of these five aspects of modal choice for the Staten Island Ferry. The percentages shown in the figure represent the percentage of survey respondents who chose each as the MOST IMPORTANT reason for taking the ferry.

For the Staten Island Ferry, "travel cost" is clearly the most important reason for mode choice among ferry users. This correlates extremely well to the unusually low fare on the system, which is a major inducement. "Convenience" aspects were next most important, followed by "travel time," "comfort," and "special enjoyment of a boat ride." Clearly, in the Staten Island case, the fact that the ferry is a relatively uncommon urban transport mode did not greatly influence mode choice.

More interesting, however, is that riders choosing auto or express bus modes did so for entirely different reasons. Both auto and express bus users cite "convenience" as the number one reason for choosing their mode, with "travel time" second, "comfort" third, and "travel cost" last. Table 3.6 illustrates this point.

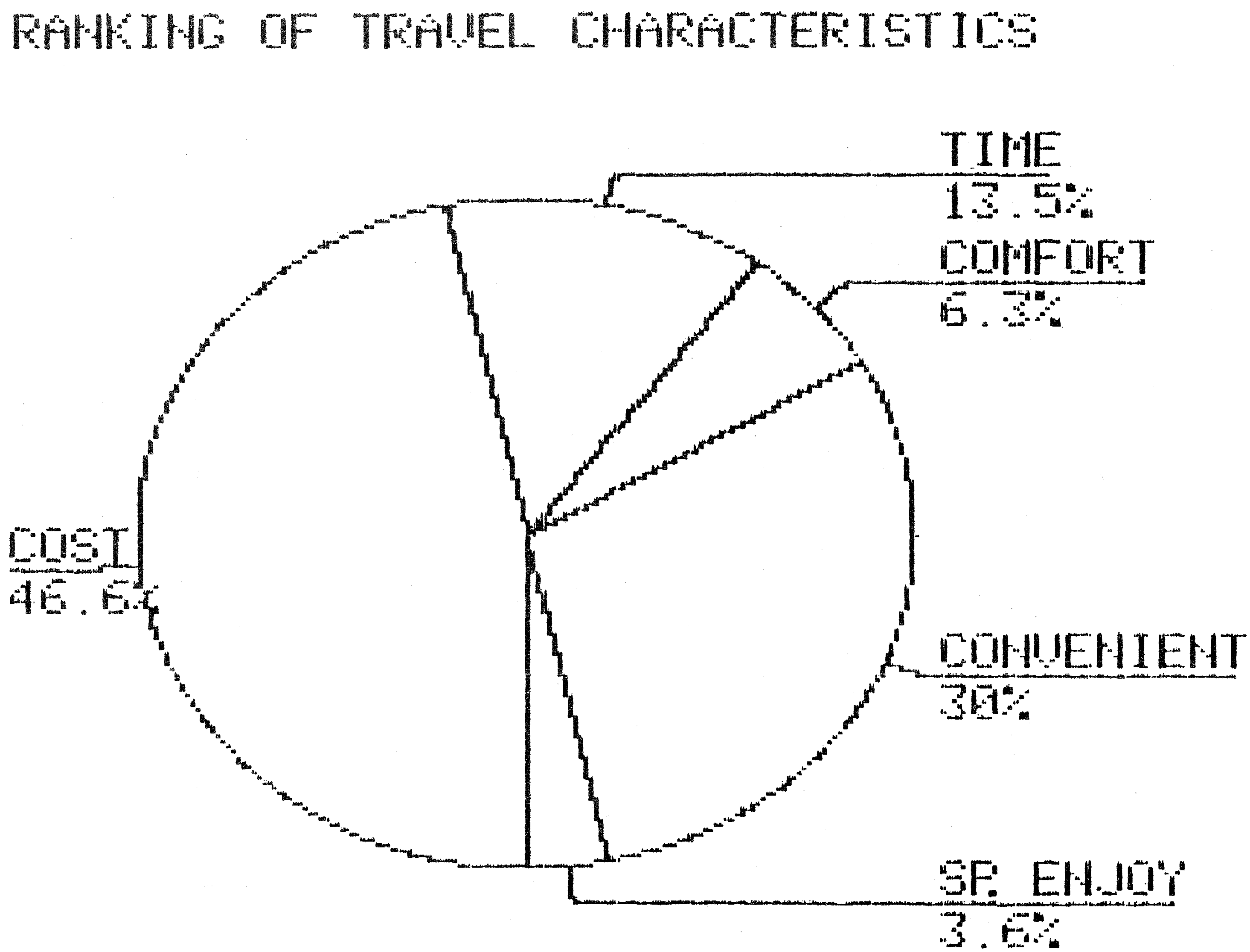


FIGURE 3.6
RANKING OF IMPORTANCE OF TRAVEL CHARACTERISTICS - BASED ON STATEN ISLAND FERRY RIDERSHIP SURVEY

TABLE 3.6

COMPARATIVE FACTORS IN MODE CHOICE AMONG
STATEN ISLAND - MANHATTAN COMMUTERS

MODE CHOICE VARIABLE	Ferry Users		X-Bus Users		Auto Users	
	Rank	Percentage	Rank	Percentage	Rank	Percentage
Travel Time	3	13.5	2	21.4	2	24.5
Travel Cost	1	46.6	4	6.8	4	4.0
Comfort	4	6.3	3	8.4	3	8.2
Convenience	2	30.0	1	63.4	1	63.3
Special Enjoyment	5	3.6	--	--	--	--

This is not totally surprising, however. One of the chief attractions of the Staten Island Ferry is its miniscule fare--obviously this shows up as the primary inducement. Cost, if anything, is a negative factor for the express bus and auto. This attraction of these modes expectedly runs more to comfort/convenience aspects. "Travel time," as the second major attraction for these modes is interesting, in that the actual travel time differentials between ferry and express bus trips for many trips are not large, and sometimes favor the ferry. Obviously, perceived travel time enters the picture here, as the waiting and transfer times associated with the typical Staten Island Ferry trip makes the trip seem longer than it actually is. In this light, "travel time" takes on almost the same meaning as "convenience," and makes the results more logical.

Figure 3.7 emphasized this point. For the four significant orgin zones, one has no express bus available, one shows bus times which are 17% less than ferry times, another bus times only 8% less than ferry times, and another bus times 5% more than ferry times. Again, the emphasis on travel time exhibited by express bus users may be influenced by other factors.

Examination of mode choice factors of Staten Island Ferry users by gender and income reveals little. There is virtually no difference in the reasons selected by male and female ferry users. Figure 3.8 illustrates the analysis of mode choice by income level and reveals two items worthy of note;

- "convenience" increases sharply as an attraction at high income levels where cost is presumably not a factor, and user looks primarily to his or her personal satisfaction with the mode;

- "travel cost" is a more important factor for middle income groups, less important at the low- and high-income portion of the scale.

The latter is particularly interesting in view of the results of Figure 3.4, in which preference for the ferry is seen to be highest among low-income groups--presumably because of the low fare.

If Staten Island Ferry users choose "travel cost" as the principal mode choice factor, due primarily to an extremely low fare level, this result cannot be expected to be duplicated in other ferry systems.

The results of the Washington State survey do not permit an analysis of this factor, but the Golden Gate survey may be manipulated to obtain similar statistics. As Table 3.7 illustrates, the results are considerably different from those obtained in the Staten Island Ferry survey.

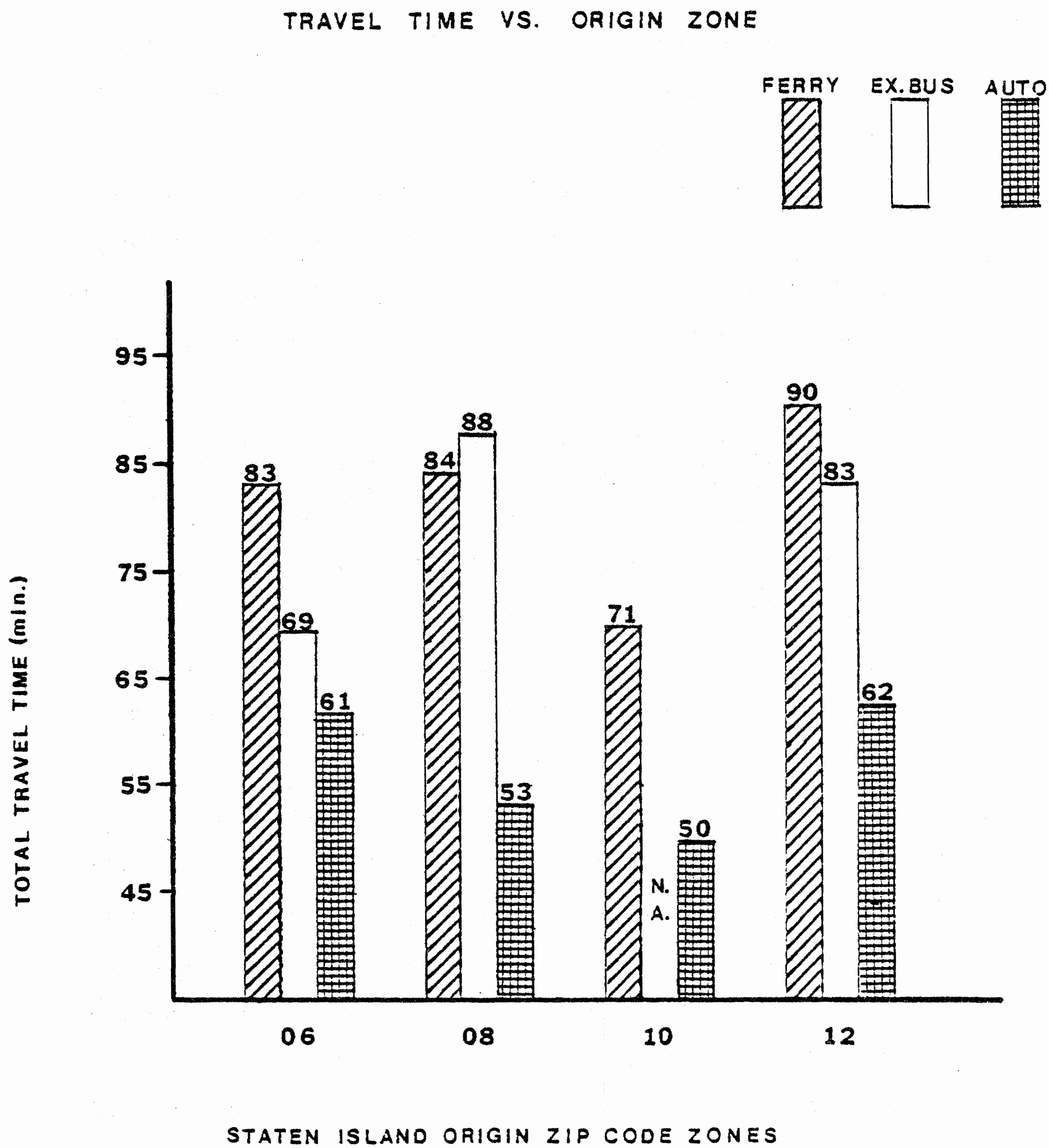


FIGURE 3.7

AVERAGE TRAVEL TIMES BY MODE TO THE MANHATTAN CBD
FROM STATEN ISLAND

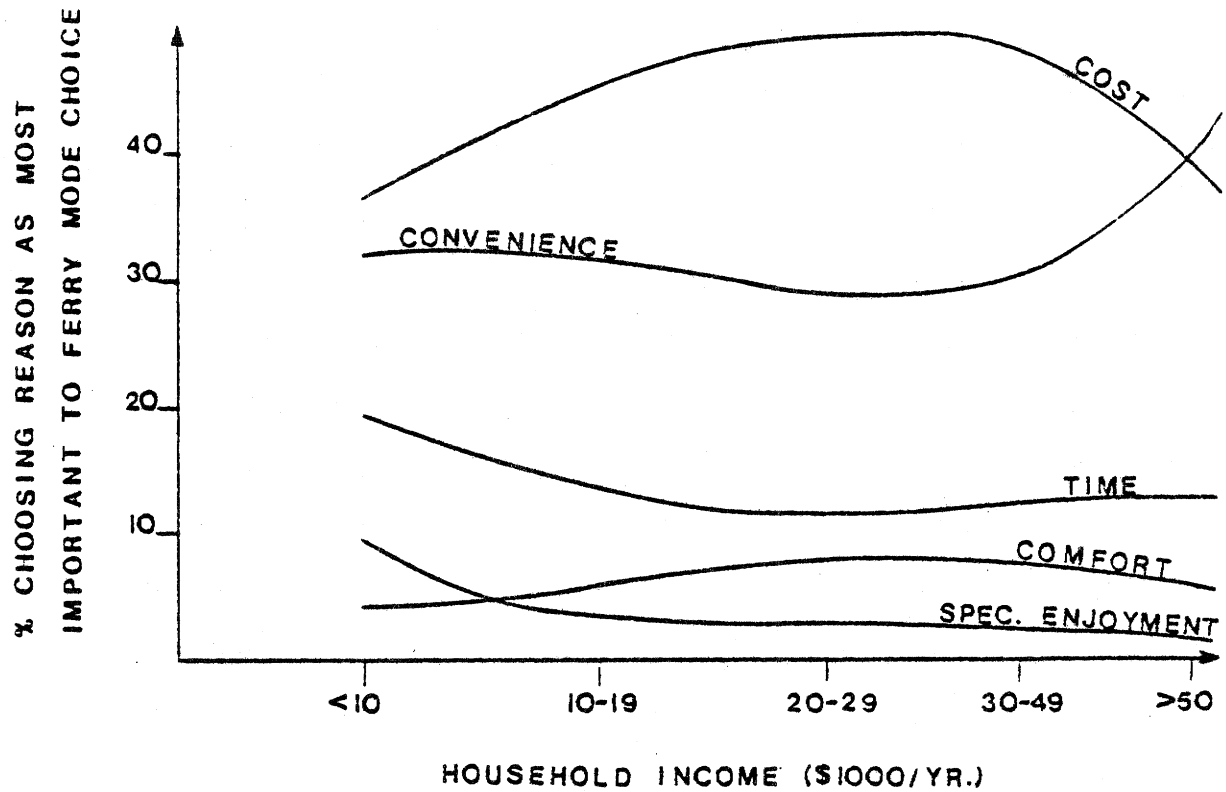


FIGURE 3.8

MODE CHOICE FACTORS BY INCOME LEVEL:
STATEN ISLAND FERRY USERS

TABLE 3.7

RANKING OF MODE CHOICE FACTORS
FROM TWO FERRY SYSTEMS

	Staten Island Ferry	Golden Gate Ferry
Most Important Factor	Cost	Comfort
2d Factor	Convenience	Special Enjoyment
3rd Factor	Time	Convenience
4th Factor	Comfort	Time
5th Factor	Special Enjoyment	Cost

Golden Gate Ferry riders place "travel cost" last among their reasons for choosing the mode. This perhaps reflects the higher cost of the system--$1.50/one-way trip--which is comparable to competing express buses, but still less than parking and toll costs for the auto mode.

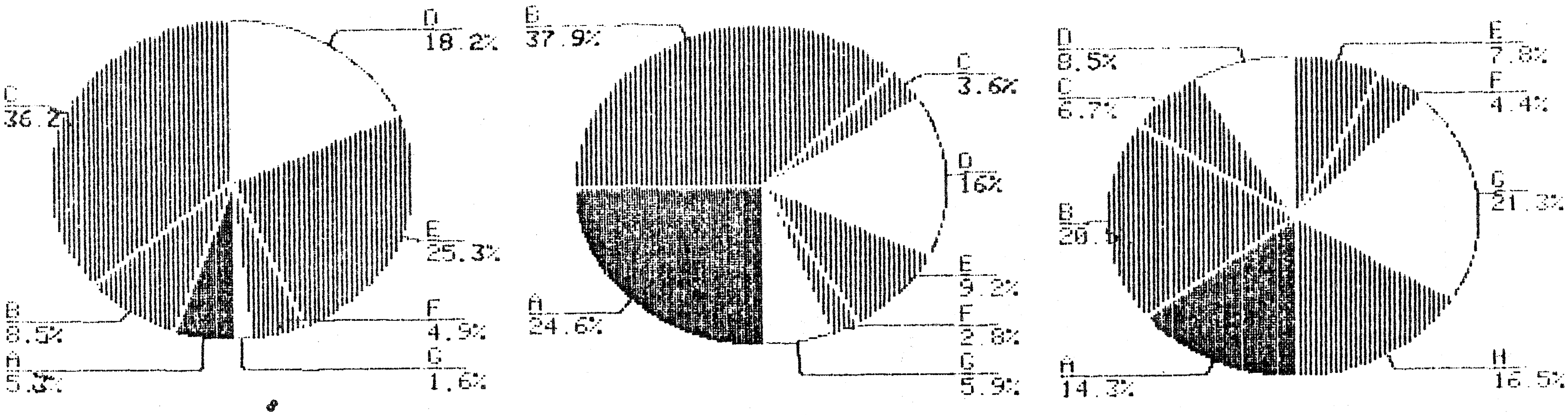
Of great interest is that the special attraction of a boat trip is the second most important factor in choosing the Golden Gate Ferry. This correlates with an earlier Staten Island Ferry study conducted in 1978 which placed this factor as the number one factor for using the ferry, but disagrees with the current survey. The 1978 study, however, included off-peak users which contained substantial numbers of tourists and sightseers. Nevertheless, the Golden Gate study points out that the mere fact of a boat trip can be a strong inducement for ferry ridership, as long as other factors are at acceptable levels.

Defining Comfort, Convenience, and Special Enjoyment of Boat Trip

"Comfort" and "convenience" are general phrases which encompass a great many characteristics. Similarly, the category of "special enjoyment..." which was used in the current work also covers a number of more specific characteristics.

Because of this, the surveys included substantial listings of specific factors associated with each overall category, and asked riders to identify and rank those characteristics of primary importance. Figure 3.9 illustrates these results.

"Comfort" was interpreted by Staten Island Ferry users to mean safety from crime, getting a seat, and safety from accidents--in that order. Other factors, such as cleanliness, heat and air conditioning,



Characteristic	% Ranking Most Important
"Comfort"	
(a) Cleanliness of Terminals	5.3
(b) Cleanliness of Vessels	8.5
(c) Personal safety from crime	36.2
(d) Personal safety from accidents	18.2
(e) Availability of a seat	25.3
(f) Heat/Air Condition	4.9
(g) Attractiveness of Ferry interior	1.6

Characteristic	% Ranking Most Important
"Convenience"	
(a) Convenience of Schedule times	24.6
(b) Reliability of Schedule	37.9
(c) Ease of ticketing procedures	3.6
(d) Proximity of ferry to origin or destination	16.0
(e) Ease of transfer to and from other	9.2
(f) Availability of route information (schedules, fares, signing, etc.)	2.8
(g) Availability of special information disruption of service or problems due to congestion.)	5.9

Characteristic	% Ranking Most Important
"Special Enjoyment of Boat Trip"	
(a) Scenic beauty of ride	14.3
(b) Smoothness of ride	20.5
(c) Availability of services (food, beverages, restrooms, etc.)	6.7
(d) Quality of services specified above	8.5
(e) Social environment	7.8
(f) Sea environment (air, other ships, etc.	4.4
(g) Relaxing quality of waterborne ride	21.3
(h) Roominess/spaciousness of vessel	16.5

FIGURE 3.9
RANKING OF "COMFORT", "CONVENIENCE" &
"SPECIAL ENJOYMENT OF A BOAT RIDE" FOR
THE STATEN ISLAND FERRY SYSTEM

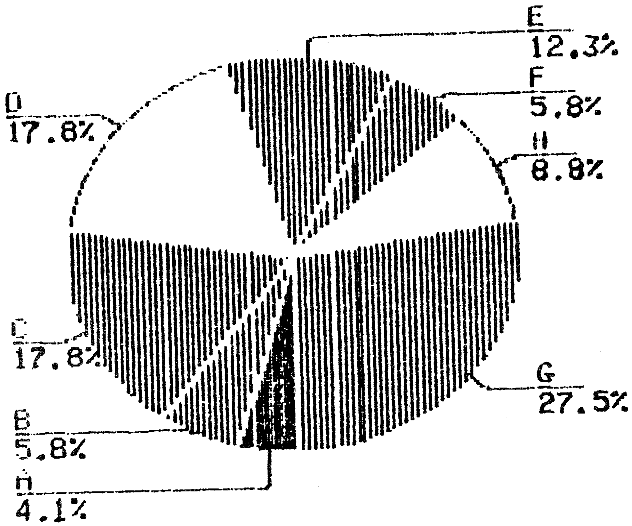
and attractiveness rank as minor issues. "Safety from crime," while not unique to New York City, would probably not rank as highly in areas where crime (both in the streets and on standard transit services) is not as highly visible. Seating availability always ranks highly in mode choice surveys, and the current study is consistent with others.

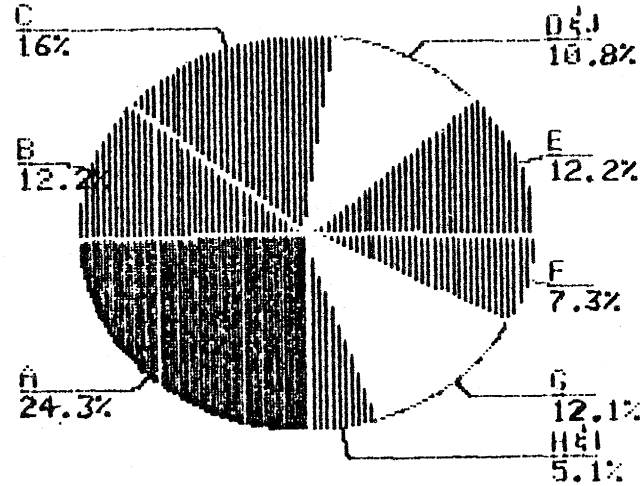
"Safety from accidents" proved unusually high as a factor in the current study. This factor is often taken for granted (particularly for public modes) and does not show up as a strong mode choice factor in many studies. In the year preceding the study, however, several rail and one ferry incident received much public attention, and may have served to heighten the awareness of this factor.

"Convenience" is generally interpreted as schedule reliability, schedule convenience to work times, proximity of ferry to trip origin/destination, and ease of transfer to other modes. These factors are reasonably consistent with the results of other studies, and are not surprising.

While "special enjoyment of the boat ride" was not a significant factor in mode choice, riders identified this factor with smoothness of ride, relaxing quality of the sea, spaciousness of the vessel, and scenic beauty--in the order given.

Figures 3.10 and 3.11 give similar rankings for express bus and auto users. Interestingly, the results are more or less consistent with the views of ferry users. Thus, while ferry users consider the major factors of cost, time, convenience, comfort, and special enjoyment quite differently from express bus and auto users, they view each individual factor in similar terms.

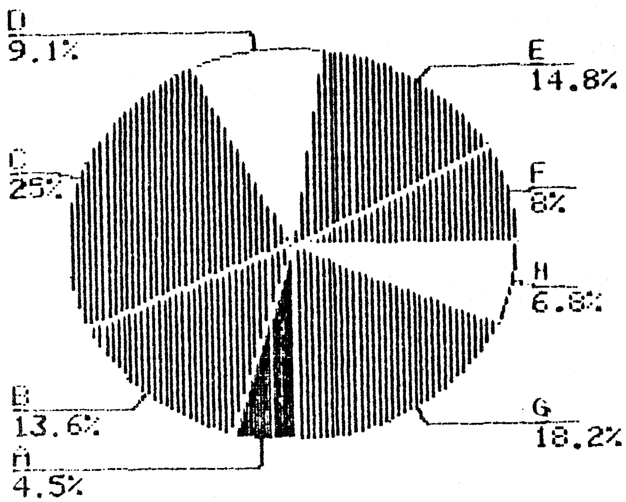


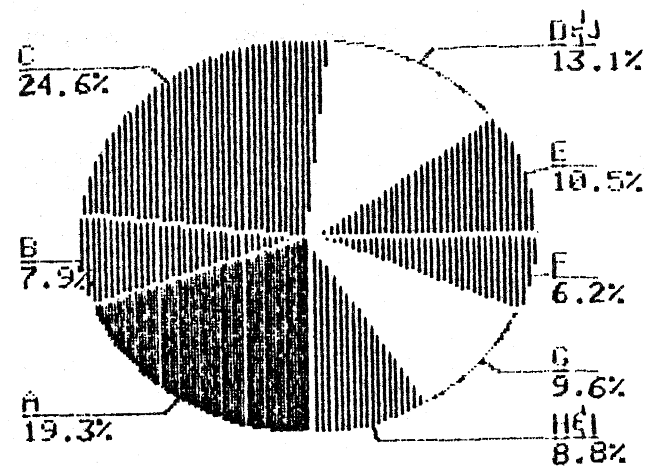


Comfort Characteristic	% Ranking Most Important
(a) Cleanliness of vehicle	4.1
(b) Freedom from annoyance	5.8
(c) Safety from crime	17.8
(d) Safety from injury	17.8
(e) Heat and Air Conditioning Comfort	12.3
(f) Weather protection	5.8
(g) Availability of seating	27,5
(h) Comfortable seating	8.8

Convenience Characteristic	% Ranking Most Important
(a) Reliability of schedule	24.3
(b) Cost of trip	12.2
(c) Travel Time	16.0
(d) Ease of transfer to other means of transportation	2.3
(e) Reliability of vehicle	12.2
(f) Waiting time	7.3
(g) Continuous ride; no transfers	12.1
(h) Availability of route information, (i.e., schedules, fares, signs, etc.)	2.3
(i) Availability of route information (i.e., disruption of service or problems due to congestion)	2.8
(j) Proximity of service to origin or destination	8.5

Figure 3.10
Ranking of "Comfort" and "Convenience" based on Home Interview Survey - Express Bus Passengers





Comfort Characteristic	% Ranking Most Important
(a) Cleanliness of vehicle	4.5
(b) Freedom from annoyance	13.6
(c) Safety from crime	25.0
(d) Safety from injury	9.1
(e) Heat and Air Conditioning Comfort	14.8
(f) Weather protection	8.0
(g) Availability of seating	18.2
(h) Comfortable seating	6.8

Convenience Characteristic	% Ranking Most Important
(a) Reliability of schedule	19.3
(b) Cost of trip	7.9
(c) Travel Time	24.6
(d) Ease of transfer to other means of transportation	5.2
(e) Reliability of vehicle	10.5
(f) Waiting time	6.2
(g) Continuous ride; no transfers	9.6
(h) Availability of route information, (i.e., schedules, fares, signs, etc.)	3.5
(i) Availability of route information (i.e., disruption of service or problems due to congestion)	5.3
(j) Proximity of service to origin or destination	7.9

Figure 3.11
Ranking of "Comfort" and "Convenience" based on Home Interview Survey - Auto Users

Some Conclusions

The results of the Staten Island Ferry surveys reveal a critical fact: Staten Island commuters consider the ferry as simply another alternative for getting to work. The fact that the ferry is a waterborne mode seems to have no impact on the mode choice. This is encouraging, as it suggests no inherent bias against the waterborne alternative. In New York City, the low cost of the ferry fare seems to be the over-riding factor in attracting ridership.

Golden Gate Ferry riders show a distinctly different pattern, and the fact of the waterborne mode appears to be a strong positive factor in developing ridership.

The reasons for Staten Island commuters choosing express bus and auto are quite different from those of Staten Island ferry users, but are in fact similar to the reasons of Golden Gate Ferry users for choosing that service. The commonality among Staten Island express bus and auto users and Gold Gate Ferry users is that all are more-or-less "premium" service with relatively high cost, whereas the Staten Island Ferry is not.

Comfort is generally interpreted to mean personal safety and availability of a seat. Convenience relates primarily to schedule and terminal location.

In Chapter 4, the calibration of a demand forecasting modal is discussed and illustrated. It will be interesting to note whether or not the modal verifies the key mode choice factors identified herein, or reveals others.

CHAPTER 4

A DEMAND FORECASTING MODEL FOR FERRY PASSENGERS

In considering demand forecasting for urban ferry services, the research focused upon the commuter for several reasons:

- commuter trips are repetitive, and therefore more amenable to prediction
- commuter trips are the most stable portion of ferry ridership, and make up the largest single segment of that ridership
- recreational and other trip purposes common to ferry use fluctuate strongly depending upon season, the economy, and other factors
- recreational trips (the second largest component of ferry ridership) have a highly complex alternative structure which includes not only other modes, but other trip locations as well.

Since commuter traffic generally represents a reasonably stable percentage of total traffic, factor analysis may be easily applied to adjust predictions of commuter traffic to total traffic.

Choosing a Model

There are a number of basic analytic forms which may be used to predict modal choice. The simplest form is regression analysis. Two more complex forms are the PROBIT or LOGIT Models, which are both "individual choice models".

In regression analysis, individual trips must be aggregated by zones for use. Thus, for all trips between zones i and j, data would include:

- the percentage of trips made by each available mode
- average travel times for trips made by each mode, often segregated into access time, in-vehicle time, waiting time, and transfer time

- average travel costs for trips made by each mode, sometimes divided into component costs
- average comfort and/or convenience indices describing each mode, based upon comprehensive user surveys.

In regression, data for all trips between zones i and j essentially provide one data point. Thus, regression models require extensive data bases for calibration. This extensive data need was well beyond the limits of project resources, and was therefore rejected for the current work.

The PROBIT and LOGIT Models are among the class of models called "disaggregate". This is because they do not require the aggregation of data on a zone-by-zone basis for use in calibration. Thus, each individual trip for which information is available becomes an independent data point. These models are therefore considerably more efficient in the use of data than are regression models.

Of these two, the LOGIT form was chosen for use for a number of practical reasons:

1. Both models are basically "share" models, predicting the percentage of total trips which utilizes each mode
2. The PROBIT form has never been used for choices among more than two modes; the current study deals with three different modes.
3. The PROBIT form involves an integral, and is mathematically difficult. This results in excessive computer time requirements for calibration and solution.
4. The LOGIT form can be used in the disaggregate mode, or at any level of aggregation desired by the user.
5. Comprehensive computer packages exist for the calibration, use, and validation of the LOGIT form.

The LOGIT Model

The LOGIT Model has the following analytic form:

$$p(i) = \frac{e^{-du(i)}}{\sum_{i=1}^{n} e^{-du(i)}}$$

where:
- $p(i)$ = probability of a given trip being made on mode i
- $du(i)$ = disutility index for mode i
- $\Sigma e^{-du(i)}$ = sum of the exponential of the disutility indicies for all modes under consideration.

A "disutility" index is a functional measure of how "bad", or "unuseful" a given mode is for a particular trip. Analytically, they are of the form:

$$du(i) = C_{i1}\, a_{i1} + C_{i2}a_{i2} + \ldots + C_{in}a_{in} + b_i$$

where
- a_{in} = variables describing or quantifying attribute 'n' for mode 'i'; attributes include various measures of cost, time, comfort, and convenience of the various modes.
- C_{in} = constants of calibration for attribute variable a_{in}
- b_i = bias coefficient for mode i

The bias coefficient allows the model to mathematically balance the impact of known attributes against those that are unknown or unquantified. It may be included or excluded in any disutility index on the discretion of the researcher.

The model output gives values for all calibration constants and bias coefficients, as well as a number of evaluative statistics. The interpretation of many of these statistics is not straightforward, and is in considerable dispute amongst those who have studied the models. There are, however, several key reports which clearly indicate the accuracy of any given calibration.

The Calibration

The calibration utilized the individual trip information generated from the home mail-back questionnaire described in Chapter 3. Two-thirds of the data was utilized for direct calibration of the model, while the remaining third was withheld for validation.

The calibrated model is of the following form:

$$p(i) = \frac{e^{-du(i)}}{\sum_{i=1}^{3} e^{-du(i)}}$$

where: mode 1 = ferry

$$du(1) = 8.3455\ COST(1) + 42.0395\ TM(1) - 0.4511\ TMREL(1)$$

mode 2 = express bus

$$du(2) = 8.3578\ COST(2) + 21.9460\ TM(2) + 8.3969$$

mode 3 = auto

$$du(3) = 8.1984\ COST(3) + 19.1350\ TM(3) + 14.0792$$

The variables utilized in the disutility expressions are defined below, together with the range of values and the average value of each found in the data base.

TABLE 4.1
VARIABLES USED IN CALIBRATION

variable	ave. data value	range of values
$COST = \frac{\text{total trip cost (¢)}}{\text{household income (\$1000)}}$	8.23	0.00 - 80.00
$TM = \frac{\text{time on principal mode (min.)}}{\text{total trip time (min.)}}$	0.49	0.09 - 0.98
TMREL = user perception of schedule reliability from survey (1=poor, 5=very good)	3.13	1.00 - 5.00

A. <u>Some Basic Characteristics of the Model</u>

The model addresses the three principal modes for commuting from Staten Island to lower Manhattan: ferry, express bus, and auto. Despite the fact that there are numerous potential access modes and routes to each of the three principal modes, trips were categorized <u>only</u> by the principal mode. Thus, anyone using the ferry as a basic mode was placed in the same group. The fact that autos, local buses, the Staten Island Rapid Transit, and walking are all modes used to access the ferry was ignored, although specifics of access time were not. This greatly simplified the model, avoiding the analysis of over 20 separate model combinations, and is consistent with extant usage of the model.

The model passes the first critical test of validity it displays reasonable trends:

1. As trip cost increases as a proportion of income, the disutility also increases, and the probability of choosing the mode in question decreases. Thus, the more expensive the mode, the less the chance of choosing it for a particular trip will be (all other parameters remaining unchanged).

2. The time variable is interesting, as a positive calibration coefficient would be expected under certain scenarios, and negative coefficient under others. The model herein is consistent with a situation in which access times are held constant. In this case, a decrease in travel time on the principal mode will lead to a decrease in the TM variable, and the probability of slecting the mode would increase.

3. TMREL is a rating of user's perception of the time a schedule reliability of the ferry (<u>1</u>=poor, <u>5</u>=very good). This rating was obtained from the questionnaires described in Chapter 3. The negative coefficient is reasonable: as the reliability rating increases, disutility decreases, and the probability of using the mode increases.

Note that bias coefficients were used on only two of the modes. When a bias coefficient is not included, the model forces the calibration to explain model choice entirely on the basis of known attribute measures. As the model focuses on ferry ridership, the research sought to quantify this mode entirely on this base, allowing the competing modes the use of a bias coefficient. Again, this procedure is relatively common in the use of the LOGIT form.

The calibration also confirms the observations of Chapter 3 that cost is the most important variable in the model choice for the Staten Island Ferry.

B. Some Statistics

The calibration data included 550 trip records. An additional 300 records were reserved for validation of the model.

Table 4.2 shows the correlation coefficients between the independent variables utilized in the model. Note that there is no strong interdependence between the variables used, a desired characteristic.

TABLE 4.2
CORRELATION COEFFICIENTS FOR INDEPENDANT VARIABLES

	TM	TMREL
COST	0.2496	-0.0501
TM	-	-0.1247

The regression coefficient for the calibration is stated as follows:

$$\text{Pseudo-}R^2 = 0.769$$

The value is not the standard square of a simple regression coefficient, but a highly complex formulation resulting in a measure with similar meaning. Psuedo-R^2 values over 0.50 are considered excellent, and the value produced by the model is truly exceptional.

A final measure of the accuracy of the calibration is found in the comparison of observed ridership and the values predicted by the model.

TABLE 4.3
OBSERVED VS. ESTIMATED MODE CHOICES FOR CALIBRATION DATA

Mode	Observed	Predicted
FERRY	303	303.4
EXPRESS BUS	197	196.6
AUTO	45	45.0

The accuracy of the model in its prediction of calibration data is virtually perfect.

C. Validation

The model was run for 300 trip records not included in the calibration data. Table 4.4 shows the aggregate results, which were also quite good - excellent for the ferry mode, which is the subject of this study.

TABLE 4.4
OBSERVED VS. ESTIMATED MODE CHOICES FOR CALIBRATION DATA

Mode	Observed	Predicted
FERRY	193	198
EXPRESS BUS	76	83
AUTO	30	18

On an individual trip basis, the model predicted 274 of the trip correctly, for an individual trip accuracy rate of 91.6%, considered excellent for this type of model.

Use of the Model

It must be noted that a LOGIT form model must be calibrated in each instance in which it is used. There is no overriding reason to expect calibration coefficients to be the same in San Francisco as they are here, as travel habits and decision-making vary from place to place. This, however, is true of any form of model split model.

The variables identified here as key issues may, however, not be so unique, and clearly the survey techniques utilized to gather the appropriate data may be adopted elsewhere.

In any circumstance in which such a model is calibrated, it may then be used to anticipate future ridership patterns due to changes in source patterns on the initiation of new services. While calibrated as a disaggregate model, however, its use in prediction will require some level of aggregation based upon zonal definitions, which may be often based upon census tracts, zip codes, or transportation study zones. In such a case, attributes would be described for the average trip between zones i and j, and the model would predict the proportion of total trips between them being made on various modes.

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Appendix I

ON-BOARD, MAIL-BACK QUESTIONNAIRE FOR THE STATEN ISLAND STUDY

TTRC

FERRY RIDERSHIP SURVEY

No Postage
Necessary
If Mailed
In The
United States

BUSINESS REPLY MAIL
FIRST CLASS PERMIT NO. 6617 BROOKLYN, N.Y.

POSTAGE WILL BE PAID BY

Polytechnic

Polytechnic Institute of New York
Att: Mr. Philip Grealy - Box #188
333 Jay Street
Brooklyn, NY 11201

SYSTEM CODE

○○○

FORM NUMBER

○○○○

Make no marks above this line

FERRY RIDERSHIP SURVEY QUESTIONNAIRE

This survey is being conducted by the Polytechnic Institute of New York under the sponsorship of the U.S. Maritime Administration and with the cooperation of the operating authority of this facility.

The survey is designed to collect information relative to the operating characteristics of this system which will in turn be utilized in the planning and design of similar facilities throughout the United States. Please assist us by answering the questions below:

After completing this questionnaire, please fold and staple or tape closed with address and pre-paid postage stamp visible and drop in the mail.

(1) What is the approximate distance from your trip origin (i.e., home) to the Ferry Terminal? (estimate to the nearest half mile) _________ ○○○

(2) How did you get to the Ferry this morning?

1.____Walk 2.____Bus 3.____Auto (Driver) 4.____Auto (passenger)

5.____Train 6.____Taxi 7.____Other (Please specify)__________ ○

(3) Approximately how long does it take you to get from your origin to the Ferry? ____minutes. ○○○

(4) Are you taking a car on the Ferry with you? 1.____Yes 2.____No. ○

(5) If you arrived at the Ferry in a car, were there other passengers with you? 1.____Yes 2.____No. If yes, how many? ____ ○ ○

(6) Was a car available to you as either a driver or as a passenger for making this trip? (Disregard any cost barriers)

1.____Yes 2.____No. ○

(7) Are other modes of transportation available to you for making this trip? (Check as many as apply)

1.____Bus 2.____Car 3.____Train 4.____Other__________ ○ ○ ○

(specify)

(8) What is the purpose of your trip?

1.____Commuting for work 2.____Shopping 3.____Recreational 4.____School 5.____Visiting

6.____Medical 7.____Other __________(please specify) ○

(9) How often do you make this trip by Ferry? (Include only one direction of travel; the return trip is handled in a separate question.)

1.____Once per week 2.____Twice per week 3.____Three times per week 4.____Four times per week

5.____Five or more times per week 6.____Several times per month 7.____Infrequently ○

(10) What is the approximate distance from the Ferry to your final destination? (estimate to the nearest half mile) ____ ○○○

(11) After getting off the Ferry, how will you get to your final destination this morning?

1.____Walk 2.____Bus 3.____Auto (Driver) 4.____Auto (Passenger) 5.____Taxi

6.____Other (please specify)__________ ○

(12) Approximately how long does it take to get to your final destination after you leave the Ferry? ___minutes ○○○

(13) Approximately what is the total travel time from your trip origin to final destination? ____minutes. ○○○

Make no marks in these circles

Breakdown of Total Travel Time of This Trip
(Include time spent waiting or transferring)

1. Origin to Ferry .... ____ minutes

2. On Ferry .... ____ minutes

3. Ferry to Final Destination .... ____ minutes

(14) What is the principal means of transportation you will use for your return trip?

1.____Ferry 2.____Car 3.____Bus 4.____Train 5.____________________Other (please specify)

(15) Are you a seated or a standing passenger?

1.____Seated 2.____Standing

(16) How many cars do you own? (Indicate total number owned by members of your household) ____

(17) Sex (check one): 1.____Male 2.____Female

(18) Age Group (check one): 1.____Under 25 2.____25-34 3.____35-44 4.____45-54 5.____55-64

6.____65-74 7.____over 75.

(19) Is your use of the Ferry system affected by weather conditions? 1.____Yes 2.____No

(20) Which of these general income groups best describes your combined family income before taxes?

1. ____Less than $ 9,999   4. ____$30,000 to $49,999

2. ____$10,000 to $19,999   5. ____$50,000 or more

3. ____$20,000 to $29,999

(21) Rank in order of importance how the following items affected your choice of using the ferry:
(Use 1 indicating the most important, 2 the next most important, and 5 the least important)

	RANKING
1. Savings in Travel time	________
2. Savings in Travel cost	________
3. Comfort	________
4. Convenience	________
5. Special enjoyment of boat trip	________

(22) Of the five (5) items rated above, the "comfort," "convenience," and "special enjoyment of a boat trip" classifications consist of numerous individual items, please rate them by checking the appropriate box which you feel represents the quality of the service to you personally.

Then in the last column provided please rank in order of importance (for each grouping) the three most important factors influencing your decision to use the ferry (with 1 indicating the most important, 2 the second most important and 3 the third most important).

Factor	Very Poor	Poor	Fair	Good	Very Good	Rank in order of importance
"Comfort"						
(a) Cleanliness of Terminals	☐	☐	☐	☐	☐	________
(b) Cleanliness of Vessels	☐	☐	☐	☐	☐	________
(c) Personal safety from crime	☐	☐	☐	☐	☐	________
(d) Personal safety from accidents	☐	☐	☐	☐	☐	________
(e) Availability of a seat	☐	☐	☐	☐	☐	________
(f) Heat/Air Condition	☐	☐	☐	☐	☐	________
(g) Attractiveness of Ferry interior	☐	☐	☐	☐	☐	________

Make no marks in these circles

Factor	Very Poor	Poor	Fair	Good	Very Good	Rank in order of importance
"Convenience"						
(a) Convenience of Schedule times	☐	☐	☐	☐	☐	______
(b) Reliability of Schedule	☐	☐	☐	☐	☐	______
(c) Ease of ticketing procedures	☐	☐	☐	☐	☐	______
(d) Proximity of ferry to orgin or destination	☐	☐	☐	☐	☐	______
(e) Ease of transfer to and from other access modes	☐	☐	☐	☐	☐	______
(f) Availability of route information (schedules, fares, signing, etc.)	☐	☐	☐	☐	☐	______
(g) Availability of special information (disruption of service or problems due to congestion)	☐	☐	☐	☐	☐	______
"Special Enjoyment of Boat Trip"						
(a) Scenic beauty of ride	☐	☐	☐	☐	☐	______
(b) Smoothness of ride	☐	☐	☐	☐	☐	______
(c) Availability of services (food, beverages, restrooms, etc.)	☐	☐	☐	☐	☐	______
(d) Quality of services specified above	☐	☐	☐	☐	☐	______
(e) Social environment	☐	☐	☐	☐	☐	______
(f) Sea environment (air, other ships, etc.	☐	☐	☐	☐	☐	______
(g) Relaxing quality of water borne ride	☐	☐	☐	☐	☐	______
(h) Roominess/spaciousness of vessel	☐	☐	☐	☐	☐	______

ADDITIONAL REMARKS OR COMMENTS

____

____

____

____

After completing this questionnaire, please fold and staple or tape closed with address and pre-paid postage stamp visible and drop in the mail.

THANK YOU FOR YOUR COOPERATION!

Appendix II

HOME-BASED, MAIL-BACK QUESTIONNAIRE FOR THE STATEN ISLAND STUDY

S T A T E N   I S L A N D   T R A N S P O R T A T I O N   S T U D Y

Dear Staten Islander:

You have been selected to be part of a detailed study of Staten Island's transportation system. This study is part of a total program to analyze and improve Staten Island transportation service. Your answers are needed for the success of this effort. Please allow a few minutes of your time to complete this questionnaire; and return it in the enclosed postage paid envelope.

All answers will be kept confidential and will be grouped with the responses of other Staten Island residents for final presentation.

To help analyze the questionnaires please check the appropriate box, that represents your principal place of work:

- ▢ Staten Island
- ▢ New Jersey
- ▢ Brooklyn
- ▢ Manhattan
- ▢ Other ______________

Thank you for your cooperation!

Please NOTE: If more than one member of your household works in Manhattan, we would appreciate if one person would complete this questionnaire for the family.

STUDY SPONSORED BY: UNITED STATES MARITIME ADMINISTRATION
IN COOPERATION WITH: POLYTECHNIC INSTITUTE OF NEW YORK
TRANSPORTATION TRAINING AND RESEARCH CENTER
NEW YORK CITY BUREAU OF
FERRIES AND GENERAL AVIATION

Transportation Training and Research Center

Polytechnic Institute of New York

A. GENERAL INFORMATION

The questions below relate to your use of transportation services for your trip to work.

1. Please write in the spaces provided the zip code of your residence and the names of the nearest streets to your home.

   Zip Code ☐☐☐☐☐

   ______________________ & ______________________
   (Street Location)

2. Please write in the spaces provided the zip code of your place of work and the names of the nearest streets to this location.

   Zip Code ☐☐☐☐☐

   ______________________ & ______________________
   (Street Location)

3. Listed below are the various kinds of transportation used by Staten Islanders to commute to work. Please check the box next to the one you use most often. Please note the classifications.

   (a) ☐ Auto Driver
   (b) ☐ Auto Passenger
   (c) ☐ Rapid Transit (SIRTOA)
   (d) ☐ Local Bus
   (e) ☐ Staten Island Ferry
   (f) ☐ Express Bus
   (g) ☐ Other ____________

4. Please write in the space provided the usual time it takes you (door to door) to go from your home to your place of work. _____ minutes

5. FOR STATEN ISLAND FERRY PASSENGERS ONLY. OTHERS GO TO QUESTION NO. 6.

   How do you get to the Ferry? Please check various kinds of transportation used. (Check as many as apply)

   (a) ☐ Local Bus
   (b) ☐ Auto Driver
   (c) ☐ Auto Passenger
   (d) ☐ Taxi/Car Service
   (e) ☐ Rapid Transit (SIRTOA)
   (f) ☐ Walk
   (g) ☐ Bicycle/motorcycle
   (h) ☐ other __________

6. Several diagrams are shown below which indicate various methods of transportation used for your traveling from home to work. Complete the appropriate diagram(s) that apply to you. Please read carefully and follow the sample. (Give all times in minutes).

(Continue on back of page)

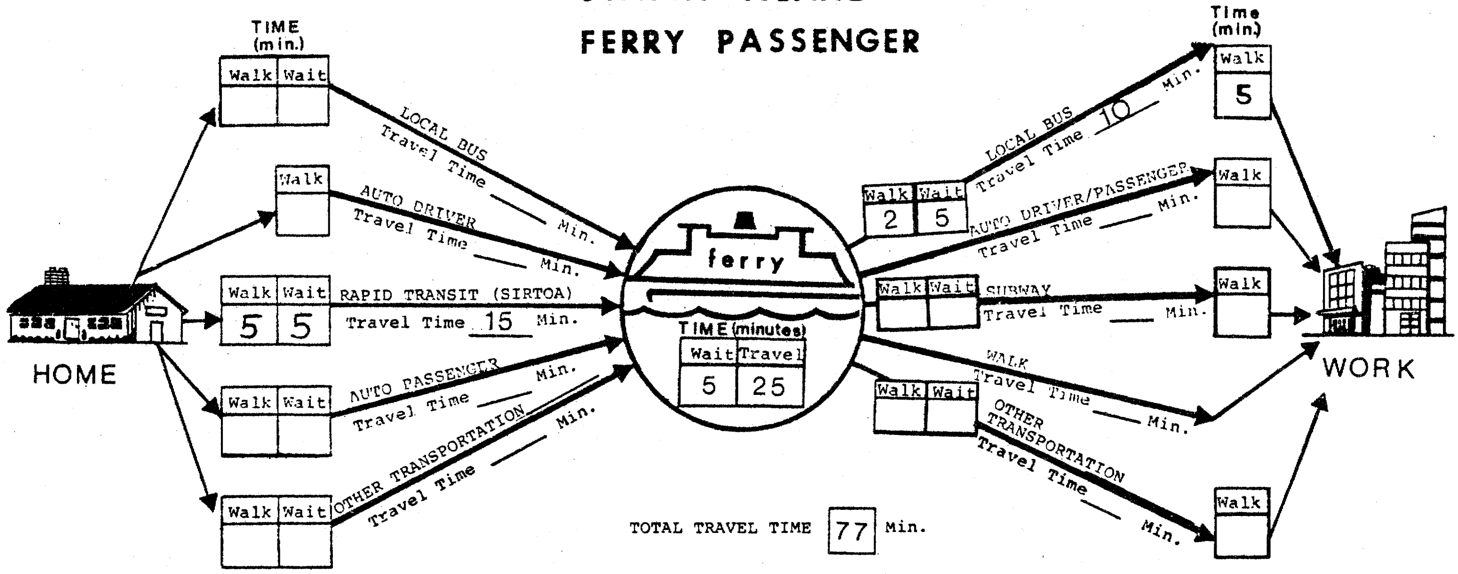
The sample shown below is for a Staten Island commuter who leaves home, walks 5 minutes to the SIRTOA station, waits 5 minutes for a train to arrive and then travels 15 minutes on the train to reach the ferry terminal. After waiting 5 minutes for the next ferry, boards and travels 25 minutes to Manhattan. In Manhattan, walks 2 minutes to a local bus stop and waits 5 minutes for the next bus to arrive. Once on the bus, travels 10 minutes then walks 5 minutes to work.

Please review each of the following four diagrams and be sure to complete the one that applies to you.

NOTE: Please enter in the space provided the usual time it takes to: walk, wait and travel to work in minutes.

SAMPLE

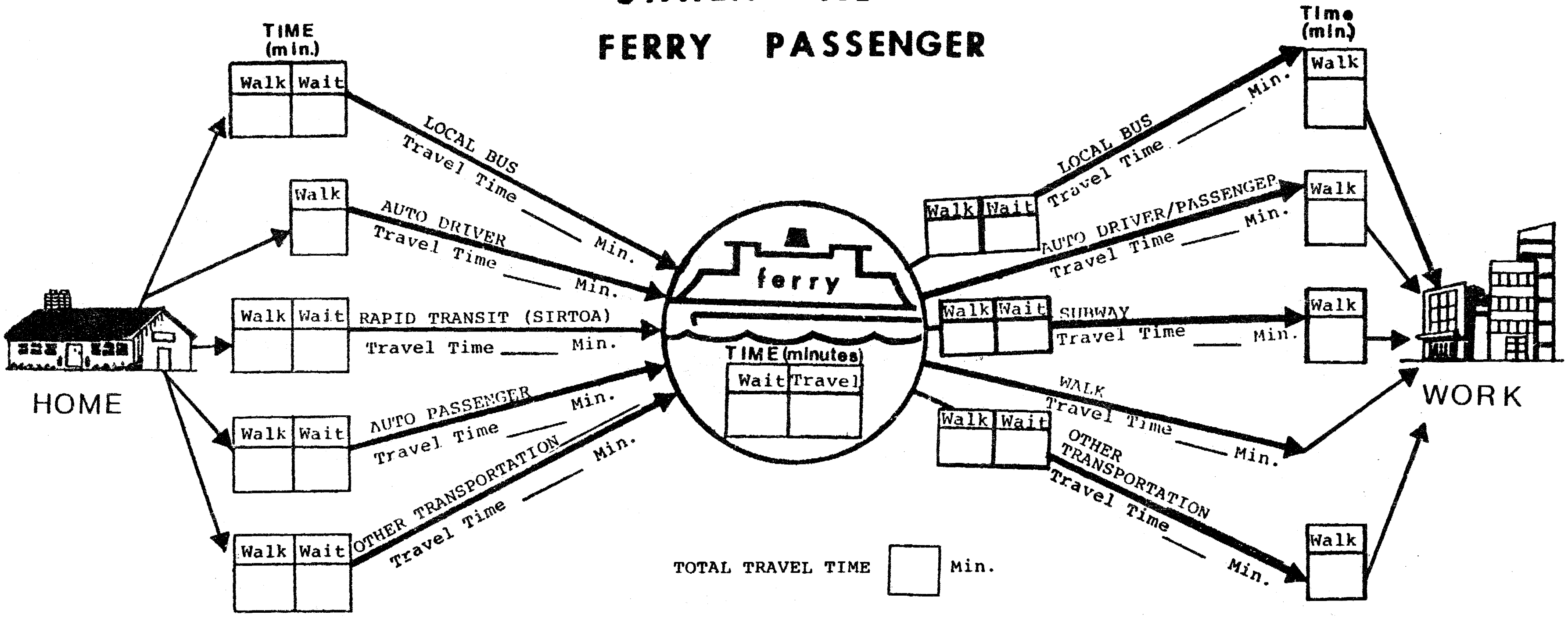
STATEN ISLAND FERRY PASSENGER



(Continue on next page)

110

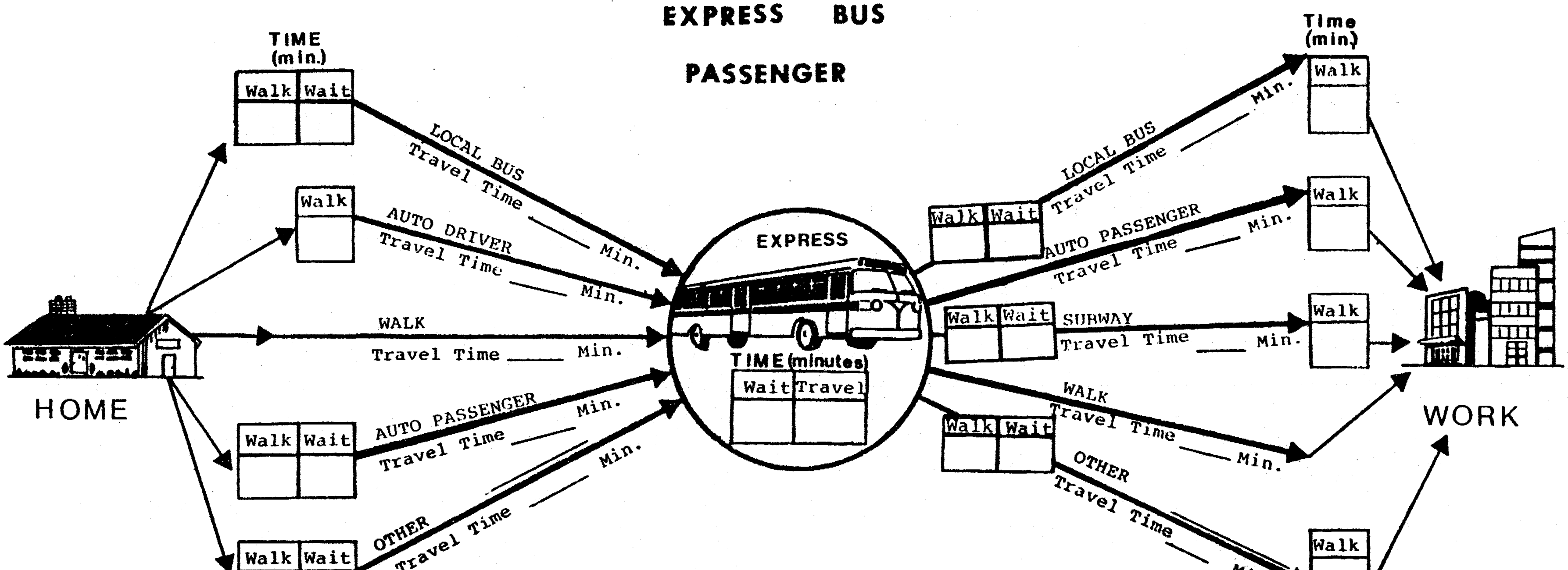
STATEN ISLAND FERRY PASSENGER



(CONTINUE ON BACK OF PAGE)

CHECK ONE: PRIVATE SERVICE ☐
CITY SERVICE ☐

EXPRESS BUS PASSENGER

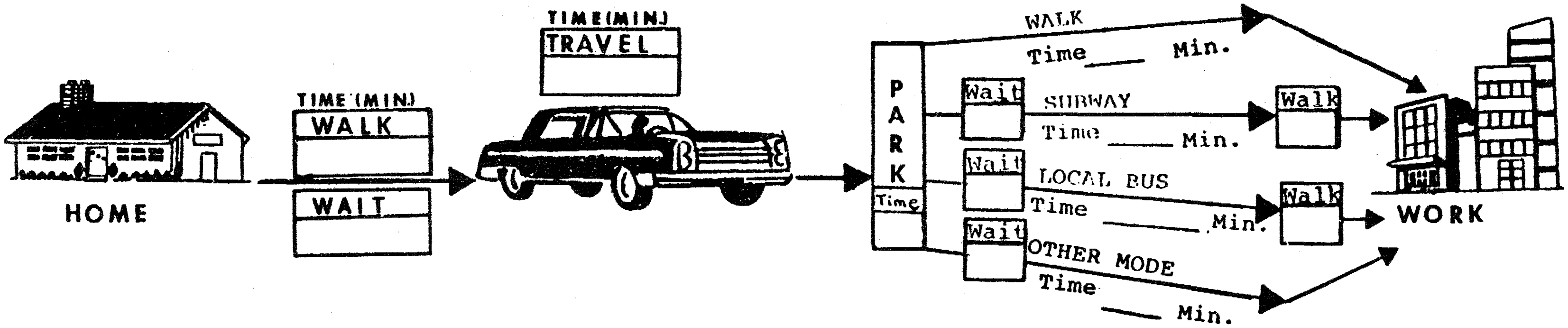


TOTAL TRAVEL TIME ☐ Min.

(CONTINUE WITH NEXT PAGE)

CHECK ONE: **AUTO DRIVER** ☐

AUTO PASSENGER ☐



TOTAL TRAVEL TIME ☐ Min.

(CONTINUE WITH NEXT PAGE)

7. Why do you travel to work the way you do? (Write in answers).

____

____

____

8. What is your approximate daily, out-of-pocket cost to travel to work? Indicate cost to you for one direction of travel only.

   a. Tolls $________ (one way)
   b. Fares $________ (one way)
   c. Parking $________ (one way)
   d. Car Pool (your share) $________ (one way)
   e. If driving, what is your trip length in miles _____ (one way)

9. Do you ever use other means of travel to work? □ Yes, □ No. If yes, please indicate the number of times a week you do so. (check all appropriate answers).

Transportation Type	Number of times (in days per week)				
	Less than 1	1	2	3	4 or more
a. Express Bus	□	□	□	□	□
b. Auto Driver	□	□	□	□	□
c. Auto Passenger	□	□	□	□	□
d. Ferry	□	□	□	□	□
e. Local Bus	□	□	□	□	□
f. Rapid Transit (SIRTOA)	□	□	□	□	□
g. Subway	□	□	□	□	□
h. Other __________	□	□	□	□	□

10. COMMUTERS WHO DO NOT USE THE FERRY!

I do not use the Staten Island Ferry to commute to work because:

a. □ inconvenient/inaccessible
b. □ slower travel time
c. □ too expensive
d. □ don't like boats
e. □ schedule
f. □ seat not available
g. □ other __________

(Continue on next page)

B. TRAVEL INFORMATION

We are interested in determining which of the following travel characteristics are most important to your getting to work. Even though you may feel that all are important, we are only interested in the four items that are most important to you in each group.

- Which four of the following travel items in groups 1, 2, and 3, would you consider most important to your travel needs. Circle the letter of the four characteristics and check the appropriate box (1-4) indicating their order of importance.

GROUP NO. 1	Most Important 1	2	3	Least Important 4
a. Cleanliness of vehicle	☐	☐	☐	☐
b. Freedom from annoyance	☐	☐	☐	☐
c. Safety from crime	☐	☐	☐	☐
d. Safety from injury	☐	☐	☐	☐
e. Heat and Air conditioning comfort	☐	☐	☐	☐
f. Weather protection	☐	☐	☐	☐
g. Availability of seating	☐	☐	☐	☐
h. Comfortable seating	☐	☐	☐	☐

GROUP NO. 2	1	2	3	4
a. Reliability of schedule	☐	☐	☐	☐
b. Cost of trip	☐	☐	☐	☐
c. Travel time	☐	☐	☐	☐
d. Ease of transfer to other means of transportation	☐	☐	☐	☐
e. Reliability of vehicle	☐	☐	☐	☐
f. Waiting time	☐	☐	☐	☐
g. Continuous ride; no transfers necessary	☐	☐	☐	☐
h. Availability of route information (i.e., schedules, fares, signs, etc.)	☐	☐	☐	☐
i. Availability of special information (i.e. disruption of service or problems due to congestion)	☐	☐	☐	☐
j. Proximity of service to origin or destination	☐	☐	☐	☐

(Continue on back of page)

GROUP NO. 3

		Most Important 1	2	3	Least Important 4
a.	Enjoyment of Ride	□	□	□	□
b.	Attractiveness of vehicle	□	□	□	□
c.	Quality of Ride	□	□	□	□
d.	Scenic ride	□	□	□	□
e.	Nostalgia	□	□	□	□
f.	Relaxing qualities	□	□	□	□
g.	Freedom of Movement	□	□	□	□
h.	Opportunity to buy coffee, food, beverages	□	□	□	□
i.	Social environment	□	□	□	□
j.	Other ____________	□	□	□	□

C. GENERAL INFORMATION

We would like to ask a few short questions about yourself. Please answer all questions.

1. What is your sex?

   a. □ Male b. □ Female

2. What is your marital status?

   a. □ Married b. □ Single

3. What is your age group?

   a. □ 18-24 c. □ 35-44 e. □ 55-64
   b. □ 25-34 d. □ 45-54 f. □ 65 and over

4. What type of housing do you live in?

   a. □ single family c. □ three family
   b. □ two family d. □ apartment house

5. What is your current occupation?

   a. □ clerical e. □ manager
   b. □ craftsman or foreman f. □ student
   c. □ civil servant g. □ professional
   d. □ sales person h. □ other ____________

6. Do you have a drivers license?

   a. □ Yes b. □ No

(Continue on next page)

7. How many autos (include cars and vans) are owned by members of your household?

a.	□ One	c.	□ Three
b.	□ Two	d.	□ Other ___________

8. How many licensed drivers are in your household?

a.	□ One	b.	□ Three	c.	□ More ___________
d.	□ Two	e.	□ Four		

9. How often is an automobile available for the trip to work

a. □ Always b. □ Sometimes c. □ Never

10. Please check the range of your total family income (include income for entire family residing at this address).

a.	□ under $10,000	e.	□ $25,000 - $29,999
b.	□ $10,000 - $14,999	f.	□ $30,000 - $40,000
c.	□ $15,000 - $19,999	g.	□ $40,000 - $50,000
d.	□ $20,000 - $24,999	h.	□ over $50,000

D. COMPARISON OF TRANSPORTATION SYSTEMS

Listed below are a number of statements about the various kinds of transportation systems on Staten Island. We would like your opinion on how satisfied or dissatisfied you are with each.

First read each statement then check the box in the right hand column which represents how satisfied or dissatisfied you are with each form of transportation.

If you have not used a particular form of transportation, check the column which represents how satisfied or dissatisfied you think you might be if you used that form of transportation.

CHARACTERISTIC	Transportation System	Very dissatisfied	Somewhat dissatisfied	Neither satisfied or dissatisfied	Somewhat satisfied	Very satisfied
a. Travel time during rush hours	Auto	□	□	□	□	□
	Express Bus	□	□	□	□	□
	Ferry Boat	□	□	□	□	□

(Continue on back of page)

CHARACTERISTIC		Very dis-satisfied	Some-what dis-satisfied	Neither satisfied or dis-satisfied	Some-what satisfied	Very satisfied
b. Waiting time during rush hours	Auto	☐	☐	☐	☐	☐
	Express Bus	☐	☐	☐	☐	☐
	Ferry Boat	☐	☐	☐	☐	☐
c. Availability of seating	Auto	☐	☐	☐	☐	☐
	Express Bus	☐	☐	☐	☐	☐
	Ferry Boat	☐	☐	☐	☐	☐
d. Comfort with respect to ride quality (smooth ride)	Auto	☐	☐	☐	☐	☐
	Express Bus	☐	☐	☐	☐	☐
	Ferry Boat	☐	☐	☐	☐	☐
e. Cost of Trip	Auto	☐	☐	☐	☐	☐
	Express Bus	☐	☐	☐	☐	☐
	Ferry Boat	☐	☐	☐	☐	☐
f. Freedom from annoyance by other passengers	Auto	☐	☐	☐	☐	☐
	Express Bus	☐	☐	☐	☐	☐
	Ferry Boat	☐	☐	☐	☐	☐
g. Cleanliness	Auto	☐	☐	☐	☐	☐
	Express Bus	☐	☐	☐	☐	☐
	Ferry Boat	☐	☐	☐	☐	☐
h. Vehicle amenities (lighting, comfortable seating, etc.)	Auto	☐	☐	☐	☐	☐
	Express Bus	☐	☐	☐	☐	☐
	Ferry Boat	☐	☐	☐	☐	☐
i. Safe from crime	Auto	☐	☐	☐	☐	☐
	Express Bus	☐	☐	☐	☐	☐
	Ferry Boat	☐	☐	☐	☐	☐
k. Safe from accidents	Auto	☐	☐	☐	☐	☐
	Express Bus	☐	☐	☐	☐	☐
	Ferry Boat	☐	☐	☐	☐	☐
l. Ease of transfer to or from other transportation systems	Auto	☐	☐	☐	☐	☐
	Express Bus	☐	☐	☐	☐	☐
	Ferry Boat	☐	☐	☐	☐	☐

PLEASE FOLD AND PLACE IN PREPAID ENVELOPE AND MAIL TODAY!

Appendix III

ADDITIONAL WATERBORNE TRANSPORTATION REFERENCES OF INTEREST

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Appendix IV

QUESTIONNAIRE USED TO COLLECT FERRY SYSTEMS FINANCIAL AND OPERATING STATISTICS

FERRY SYSTEM FINANCIAL AND OPERATING STATISTICS QUESTIONNAIRE

Please fill in the missing information in as much detail as possible and verify the statistics already shown. Where information cannot be subdivided into the specific items shown, please indicate the general classification where these items are included. At the end of the form please list any comments or note any items of special importance.

1. Name of System ______________________________

2. Year of Operation			
3. Total Number of Passengers carried			
4. Total Number of Vehicles carried			
5. Total Number of Vessel Miles Traveled (operated)			
6. Total Number of Employees			
(a) Vessel Crew employees			
(b) Management Staff employees			
(e) Support staff employees			
7. Total Operating Costs			
8. Breakdown of Costs			
(a) Vessel Related			
(1) Fuel & Oil			
(2) Crew Payroll			
(3) Marine Insurance			
(4) Maintenance			
(5) Depreciation			
(6) Interest			
(7) Other			
(b) Terminal Related			
(1) Support Payroll			
(2) Rent			
(3) Maintenance			
(4) Utilities			
(5) Dredging			
(6) Other			

(c) Management			
(d) Marketing			
(e) Other			
(1)			
(2)			
(3)			
9. Total Operating Revenues Sources			
(a) Fare Box			
(1) passengers			
(2) vehicles			
(b) Concessions			
(c) Federal Aid			
(1) source__________			
(2) source__________			
(d) State Aid			
(1) source__________			
(2) source __________			
(e) Other			

10. Please provide any detailed cost data available related to the construction of terminals, including buildings and or access improvements. 1.____________enclosed 2.__________ not available.

11. Please provide a copy of any financial budget projections for your system: 1.__________ enclosed 2.__________not available

12. Please provide copies of your latest fare structures and any support data used in establishing them. 1.________enclosed 2.________not available

13. How many terminals do you operate?____________________

14. How many routes do you operate and what is the approximate length of each route?

Route Name	Length	Crossing Time

15. Vessel characteristics (fill in attached table)

16. Please provide any accident data (include information on accident type, vessel damage, property damage or personal injury statistics).

17. Comments and additional information.

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____

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____

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THANK YOU FOR YOUR ASSISTANCE!

15. VESSEL CHARACTERISTICS

					Vessel Capacities				Engine and Related Data						
						Passengers									
Vessel Class	Number in Fleet	Vessel Name	Date Built	Vessel Cost (yr. of) completion)	Vehicles (pass.car equiv.)	Seat Capacity	Standing Capacity	Required Crew Size	Type Of Eng.	Number of Eng.	Total Horse-power	Max. Speed	Fuel Type Used	Fuel Consump. Full Speed (ga./hr)	Latest Fuel Cost ($/gal)

Notes or Comments: ______________________________

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Appendix V

VESSEL OPERATING CHARACTERISTICS SUMMARY SHEETS

Vessel Operating Characteristic Summary Sheet

1. Vessel Name and Identification Code - (A) Seabus
2. Location of Present Operation - Vancouver, B.C. Canada
3. Number of Vessels in Fleet - 2
4. Route Length (D) - 1.75n miles; 2.0 statute miles
5. Vessel Cruise Speed (S) - 15.5 mph or 13.5 Knots
6. Vessel Cost (C) - Yr. of Completion $4 Million (1977) estimated 1981 cost $5.7 Million
7. Total Loading/unloading time (t) 3 min. or 0.05 hrs.

   Note: this time is for one terminal stop and must be doubled in computations to include origin and destination of vessel
8. Fuel Consumption Rate (FR) - 75 gal/hr.(1)
9. Maintenance Cost (MC) - $50/operating hour
10. Estimated Service Life - 25 yrs.
11. Crew Size - 4

Master/Captain	1	Ordinary Seaman	___
Assistant Captain	___	Oiler	___
Mate	1	Wiper	___
Second Mate	___	Able Seaman	1
Chief Main. Engineer	___	Boatswain	___
Deckhand	1	Laborer	___
		Marine Engineer	___
		Ferry Attendant	___

12. Fuel Price (FP) NA $/gallon
13. Vessel Capacity (VC) - 400 passengers
14. Insurance & Liability - $456,750/yr.
15. Crew Costs ($/hr) - (including fringe benefits and overhead) $59.92

Notes: (1) Fuel Consumption value is estimated

Vessel Operating Characteristic Summary Sheet

1. Vessel Name and Identification Code - (B) Conventional M.V. New Delaware
2. Location of Present Operation - Cape May-Lewes Ferry, NJ to Delaware
3. Number of Vessels in Fleet - 3 (As of 6/81)
4. Route Length (D) - 17 miles
5. Vessel Cruise Speed (S) - 17 mph or 15 Knots
6. Vessel Cost (C) - Yr. of Completion $10.8 Million (1980) estimated 1981 cost $11.8 Million
7. Total Loading/unloading time (t) 11 min. or 0.18 hrs.

   Note: this time is for one terminal stop and must be doubled in computations to include origin and destination of vessel
8. Fuel Consumption Rate (FR) - 100 gal/hr.
9. Maintenance Cost (MC) - $45/operating hour
10. Estimated Service Life - 25 yrs.
11. Crew Size - 9

Master/Captain	1	Ordinary Seaman	1
Assistant Captain		Oiler	1
Mate	1	Wiper	1
Second Mate		Able Seaman	1
Chief Main. Engineer	1	Boatswain	1
Deckhand		Laborer	
		Marine Engineer	1
		Ferry Attendant	

12. Fuel Price (FP) 0.85 $/gallon
13. Vessel Capacity (VC) - 800 passengers
    100 autos
14. Insurance & Liability - $624,500/yr.
15. Crew Costs ($/hr) - (including fringe benefits and overhead) - $136.17

Notes:

Vessel Operating Characteristic Summary Sheet

1. Vessel Name and Identification Code - (C) Golden Gate Vessel - Conventional Semi-Planning
2. Location of Present Operation - Golden Gate Ferries, San Francisco, CA
3. Number of Vessels in Fleet - 3
4. Route Length (D) - 13 miles
5. Vessel Cruise Speed (S) - 28 mph or 25 Knots
6. Vessel Cost (C) - Yr. of Completion $8 Million (1978) estimated 1981 cost $10.9 Million
7. Total Loading/unloading time (t) 10 min. or 0.17 hrs.

   Note: this time is for one terminal stop and must be doubled in-computations to include origin and destination of vessel
8. Fuel Consumption Rate (FR) - 642 gal/hr.
9. Maintenance Cost (MC) - $125[1]/operating hour
10. Estimated Service Life - 25 yrs.
11. Crew Size - 10

Master/Captain	1	Ordinary Seaman	2
Assistant Captain		Oiler	1
Mate	1	Wiper	1
Second Mate	1	Able Seaman	1
Chief Main. Engineer	1	Boatswain	1
Deckhand		Laborer	
		Marine Engineer	
		Ferry Attendant	

12. Fuel Price (FP) NA $/gallon
13. Vessel Capacity (VC) - 750 passengers
14. Insurance & Liability - $599,750
15. Crew Costs ($/hr) - $143.76/hr.

Notes: (1) Estimated

Vessel Operating Characteristic Summary Sheet

1. Vessel Name and Identification Code - (D) Conventional Passenger Vessel - A. Barberi Class
2. Location of Present Operation - Staten Island, N.Y.
3. Number of Vessels in Fleet - 1
4. Route Length (D) - 5 miles
5. Vessel Cruise Speed (S) - 16 mph or 14 Knots
6. Vessel Cost (C) - Yr. of Completion $17 Million estimated 1981 cost $17 Million
7. Total Loading/unloading time (t) 9 min. or 0.15 hrs.

   Note: this time is for one terminal stop and must be doubled in computations to include origin and destination of vessel
8. Fuel Consumption Rate (FR) - 300 gal/hr.
9. Maintenance Cost (MC) - $69/operating hour
10. Estimated Service Life - 25 yrs.
11. Crew Size - 15

Master/Captain	1	Ordinary Seaman	
Assistant Captain	1	Oiler	2
Mate	2	Wiper	
Second Mate	1	Able Seaman	
Chief Main. Engineer	1	Boatswain	
Deckhand	7	Laborer	
		Marine Engineer	1
		Ferry Attendant	

12. Fuel Price (FP) 1.05 $/gallon
13. Vessel Capacity (VC) - 5700 passengers
14. Insurance & Liability - $767,500/yr.
15. Crew Costs ($/hr) - $245.22

Notes: Crew Costs based on 16 man crew

Vessel Operating Characteristic Summary Sheet

1. Vessel Name and Identification Code - (E) SUPERFERRY CONVENTIONAL HULL
2. Location of Present Operation - Washington State Ferries
3. Number of Vessels in Fleet - 4
4. Route Length (D) - Varies
5. Vessel Cruise Speed (S) - 23 mph or 18 Knots
6. Vessel Cost (C) - Yr. of Completion $6 Million 1967 estimated 1981 cost $17 Million
7. Total Loading/unloading time (t) 12 min. or 0.2 hrs.

   Note: this time is for one terminal stop and must be doubled in-computations to include origin and destination of vessel
8. Fuel Consumption Rate (FR) - 250 gal/hr.
9. Maintenance Cost (MC) - $41/operating hour
10. Estimated Service Life - 25 yrs.
11. Crew Size - 15

Master/Captain	1	Ordinary Seaman	1
Assistant Captain		Oiler	2
Mate	1	Wiper	1
Second Mate		Able Seaman	4
Chief Main. Engineer	1	Boatswain	1
Deckhand		Laborer	
		Marine Engineer	
		Ferry Attendants	3

12. Fuel Price (FP) 0.86 $/gallon
13. Vessel Capacity (VC) - 2500 passengers
160 autos
14. Insurance & Liability - NA
15. Crew Costs ($/hr) - $170.13/hr.

Notes: Variable operating Costs - $477/hr.

Vessel Operating Characteristic Summary Sheet

1. Vessel Name and Identification Code - (F) Boeing Jetfoil
2. Location of Present Operation - Test Service Puget Sound 1978
3. Number of Vessels in Fleet - NA
4. Route Length (D) - Varies
5. Vessel Cruise Speed (S) - 46 mph or 40 Knots
6. Vessel Cost (C) - Yr. of Completion $10.5 Million (1977) estimated 1981 cost $14 Million
7. Total Loading/unloading time (t) 7 min. or 0.11 hrs.

   Note: this time is for one terminal stop and must be doubled in computations to include origin and destination of vessel
8. Fuel Consumption Rate (FR) - 540 gal/hr.
9. Maintenance Cost (MC) - $219/operating hour
10. Estimated Service Life - 20 yrs.
11. Crew Size - 5 (4 min; 6 max)

Master/Captain	1	Ordinary Seaman	
Assistant Captain		Oiler	
Mate	1	Wiper	
Second Mate		Able Seaman	1
Chief Main. Engineer		Boatswain	
Deckhand		Laborer	
		Marine Engineer	
		Ferry Attendant	2

12. Fuel Price (FP) NA $/gallon
13. Vessel Capacity (VC) - 242 passengers
14. Insurance & Liability - $685,000/yr.
15. Crew Costs ($/hr) - $71.37/hr.

Notes: Operating Costs for 1978 Test Service Crew/Maintenance - 27%; Fuel - 28% Terminals/overhead - 15%; Depreciation/insurance - 30%

Vessel Operating Characteristic Summary Sheet

1. Vessel Name and Identification Code - (G) Surface Effect Ship - HM2 Mark III
2. Location of Present Operation - Test Service Boston Harbor 1978
3. Number of Vessels in Fleet - NA
4. Route Length (D) - NA
5. Vessel Cruise Speed (S) - 31 mph or 27 Knots
6. Vessel Cost (C) - Yr. of Completion (1974) $400,000 estimated 1981 cost $1.32 Million
7. Total Loading/unloading time (t) 3 min. or 0.05 hrs.

   Note: this time is for one terminal stop and must be doubled in computations to include origin and destination of vessel
8. Fuel Consumption Rate (FR) - 35 gal/hr.
9. Maintenance Cost (MC) - $31/operating hour
   - $1/mi yr.
10. Estimated Service Life - 20 yrs.
11. Crew Size - 2

Master/Captain	1	Ordinary Seaman	
Assistant Captain		Oiler	
Mate	1	Wiper	
Second Mate		Able Seaman	
Chief Main. Engineer		Boatswain	
Deckhand		Laborer	
		Marine Engineer	
		Ferry Attendant	

12. Fuel Price (FP) 0.80 $/gallon
13. Vessel Capacity (VC) - 60 passengers
14. Insurance & Liability - $336,300/yr.
15. Crew Costs ($/hr) - $35.15/hr.

Notes:

Vessel Operating Characteristic Summary Sheet

1. Vessel Name and Identification Code - (H) SES - Bell Hatter
2. Location of Present Operation - NA
3. Number of Vessels in Fleet - NA
4. Route Length (D) - NA
5. Vessel Cruise Speed (S) - 35 mph or 30 Knots
6. Vessel Cost (C) - Yr. of Completion (1979) $4.1 Million estimated 1981 cost 4.87 Million
7. Total Loading/unloading time (t) 7 min. or .11 hrs.

   Note: this time is for one terminal stop and must be doubled in-computations to include origin and destination of vessel
8. Fuel Consumption Rate (FR) - 176 gal/hr.
9. Maintenance Cost (MC) - $75/operating hour
10. Estimated Service Life - 20 yrs.
11. Crew Size - 4

Master/Captain	1	Ordinary Seaman	
Assistant Captain		Oiler	
Mate	1	Wiper	
Second Mate		Able Seaman	2
Chief Main. Engineer		Boatswain	
Deckhand		Laborer	
		Marine Engineer	
		Ferry Attendant	

12. Fuel Price (FP) NA $/gallon
13. Vessel Capacity (VC) - 240 passengers
14. Insurance & Liability - 2 3/4% of Hull - $433,925/yr.
15. Crew Costs ($/hr) - $61.11/hr.

Notes:

Vessel Operating Characteristic Summary Sheet

1. Vessel Name and Identification Code - (I) Highspeed Catamaran
2. Location of Present Operation - Copenhagen, Denmark to Malmo, Sweden
3. Number of Vessels in Fleet - 3
4. Route Length (D) - 17.5 miles
5. Vessel Cruise Speed (S) - 28.8 mph or 25 Knots
6. Vessel Cost (C) - Yr. of Completion (1975) $2.1 Million estimated 1981 cost $3.2 Million
7. Total Loading/unloading time (t) 4 min. or 0.067 hrs.

   Note: this time is for one terminal stop and must be doubled in- computations to include origin and destination of vessel
8. Fuel Consumption Rate (FR) - 540 gal/hr.
9. Maintenance Cost (MC) - $50/operating hour
10. Estimated Service Life - 20 yrs.
11. Crew Size - 5

Master/Captain	1	Ordinary Seaman	___
Assistant Captain	___	Oiler	___
Mate	1	Wiper	___
Second Mate	___	Able Seaman	1
Chief Main. Engineer	1	Boatswain	___
Deckhand	___	Laborer	___
		Marine Engineer	___
		Ferry Attendant	1

12. Fuel Price (FP) NA $/gallon
13. Vessel Capacity (VC) - 175 passengers
14. Insurance & Liability - $388,000/yr.
15. Crew Costs ($/hr) - $79.80/hr.

Notes:

Vessel Operating Characteristic Summary Sheet

1. Vessel Name and Identification Code - (J) Air Cushion Vehicle A1-30
2. Location of Present Operation - NA
3. Number of Vessels in Fleet - NA
4. Route Length (D) - NA
5. Vessel Cruise Speed (S) - 42 mph or 36.5 Knots
6. Vessel Cost (C) - Yr. of Completion (1980) $5.2 Million estimated 1981 cost $5.78 Million
7. Total Loading/unloading time (t) 5 min. or 0.083 hrs.

   Note: this time is for one terminal stop and must be doubled in computations to include origin and destination of vessel
8. Fuel Consumption Rate (FR) - 262 gal/hr.
9. Maintenance Cost (MC) - $75 /operating hour
   - $303,450/vessel/yr.
10. Estimated Service Life - 20 yrs.
11. Crew Size - 2

Master/Captain	1	Ordinary Seaman	
Assistant Captain		Oiler	
Mate	1	Wiper	
Second Mate		Able Seaman	
Chief Main. Engineer		Boatswain	
Deckhand		Laborer	
		Marine Engineer	
		Ferry Attendant	

12. Fuel Price (FP) NA $/gallon
13. Vessel Capacity (VC) - 200 passengers
14. Insurance & Liability - $458,950/yr.
15. Crew Costs ($/hr) - $35.15

Notes:

Appendix VI

SUMMARY OF DATA FOR USE IN ECONOMIC ANALYSIS PROCEDURES

TYPE	CAP	SPEED	DOCK	DEMAND	DIST	TRIP TIME	NV	TRIPS/HR/VES.	SV
A	400	15.5	.05	1000	2	.179032258	1	2.79279279	1117
A	400	15.5	.05	2000	2	.179032258	1	2.79279279	1117
A	400	15.5	.05	3000	2	.179032258	2	2.79279279	1117
A	400	15.5	.05	4000	2	.179032258	3	2.79279279	1117
A	400	15.5	.05	5000	2	.179032258	4	2.79279279	1117
A	400	15.5	.05	6000	2	.179032258	5	2.79279279	1117
A	400	15.5	.05	7000	2	.179032258	6	2.79279279	1117
A	400	15.5	.05	8000	2	.179032258	7	2.79279279	1117
A	400	15.5	.05	9000	2	.179032258	8	2.79279279	1117
A	400	15.5	.05	10000	2	.179032258	8	2.79279279	1117
A	400	15.5	.05	1000	4	.308064516	1	1.62303665	649
A	400	15.5	.05	2000	4	.308064516	3	1.62303665	649
A	400	15.5	.05	3000	4	.308064516	4	1.62303665	649
A	400	15.5	.05	4000	4	.308064516	6	1.62303665	649
A	400	15.5	.05	5000	4	.308064516	7	1.62303665	649
A	400	15.5	.05	6000	4	.308064516	9	1.62303665	649
A	400	15.5	.05	7000	4	.308064516	10	1.62303665	649
A	400	15.5	.05	8000	4	.308064516	12	1.62303665	649
A	400	15.5	.05	9000	4	.308064516	13	1.62303665	649
A	400	15.5	.05	10000	4	.308064516	15	1.62303665	649
A	400	15.5	.05	1000	6	.437096774	2	1.14391144	457
A	400	15.5	.05	2000	6	.437096774	4	1.14391144	457
A	400	15.5	.05	3000	6	.437096774	6	1.14391144	457
A	400	15.5	.05	4000	6	.437096774	8	1.14391144	457
A	400	15.5	.05	5000	6	.437096774	10	1.14391144	457
A	400	15.5	.05	6000	6	.437096774	13	1.14391144	457
A	400	15.5	.05	7000	6	.437096774	15	1.14391144	457
A	400	15.5	.05	8000	6	.437096774	17	1.14391144	457
A	400	15.5	.05	9000	6	.437096774	19	1.14391144	457
A	400	15.5	.05	10000	6	.437096774	21	1.14391144	457
A	400	15.5	.05	1000	8	.566129032	2	1	353
A	400	15.5	.05	2000	8	.566129032	5	1	353
A	400	15.5	.05	3000	8	.566129032	8	1	353
A	400	15.5	.05	4000	8	.566129032	11	1	353
A	400	15.5	.05	5000	8	.566129032	14	1	353
A	400	15.5	.05	6000	8	.566129032	16	1	353
A	400	15.5	.05	7000	8	.566129032	19	1	353
A	400	15.5	.05	8000	8	.566129032	22	1	353
A	400	15.5	.05	9000	8	.566129032	25	1	353
A	400	15.5	.05	10000	8	.566129032	28	1	353
A	400	15.5	.05	1000	10	.69516129	3	1	287
A	400	15.5	.05	2000	10	.69516129	6	1	287
A	400	15.5	.05	3000	10	.69516129	10	1	287
A	400	15.5	.05	4000	10	.69516129	13	1	287
A	400	15.5	.05	5000	10	.69516129	17	1	287
A	400	15.5	.05	6000	10	.69516129	20	1	287
A	400	15.5	.05	7000	10	.69516129	24	1	287
A	400	15.5	.05	8000	10	.69516129	27	1	287
A	400	15.5	.05	9000	10	.69516129	31	1	287
A	400	15.5	.05	10000	10	.69516129	34	1	287
A	400	15.5	.05	1000	12	.824193548	4	1	242
A	400	15.5	.05	2000	12	.824193548	8	1	242
A	400	15.5	.05	3000	12	.824193548	12	1	242
A	400	15.5	.05	4000	12	.824193548	16	1	242
A	400	15.5	.05	5000	12	.824193548	20	1	242
A	400	15.5	.05	6000	12	.824193548	24	1	242
A	400	15.5	.05	7000	12	.824193548	28	1	242
A	400	15.5	.05	8000	12	.824193548	33	1	242
A	400	15.5	.05	9000	12	.824193548	37	1	242
A	400	15.5	.05	10000	12	.824193548	41	1	242

A	400	15.5	.05	3000	14	.953225807	14	1	209
A	400	15.5	.05	4000	14	.953225807	19	1	209
A	400	15.5	.05	5000	14	.953225807	23	1	209
A	400	15.5	.05	6000	14	.953225807	28	1	209
A	400	15.5	.05	7000	14	.953225807	33	1	209
A	400	15.5	.05	8000	14	.953225807	38	1	209
A	400	15.5	.05	9000	14	.953225807	43	1	209
A	400	15.5	.05	10000	14	.953225807	47	1	209
A	400	15.5	.05	1000	16	1.08225806	5	1	184
A	400	15.5	.05	2000	16	1.08225806	10	1	184
A	400	15.5	.05	3000	16	1.08225806	16	1	184
A	400	15.5	.05	4000	16	1.08225806	21	1	184
A	400	15.5	.05	5000	16	1.08225806	27	1	184
A	400	15.5	.05	6000	16	1.08225806	32	1	184
A	400	15.5	.05	7000	16	1.08225806	38	1	184
A	400	15.5	.05	8000	16	1.08225806	43	1	184
A	400	15.5	.05	9000	16	1.08225806	48	1	184
A	400	15.5	.05	10000	16	1.08225806	54	1	184
A	400	15.5	.05	1000	18	1.21129032	6	1	165
A	400	15.5	.05	2000	18	1.21129032	12	1	165
A	400	15.5	.05	3000	18	1.21129032	18	1	165
A	400	15.5	.05	4000	18	1.21129032	24	1	165
A	400	15.5	.05	5000	18	1.21129032	30	1	165
A	400	15.5	.05	6000	18	1.21129032	36	1	165
A	400	15.5	.05	7000	18	1.21129032	42	1	165
A	400	15.5	.05	8000	18	1.21129032	48	1	165
A	400	15.5	.05	9000	18	1.21129032	54	1	165
A	400	15.5	.05	10000	18	1.21129032	60	1	165
A	400	15.5	.05	1000	20	1.34032258	6	1	149
A	400	15.5	.05	2000	20	1.34032258	13	1	149
A	400	15.5	.05	3000	20	1.34032258	20	1	149
A	400	15.5	.05	4000	20	1.34032258	26	1	149
A	400	15.5	.05	5000	20	1.34032258	33	1	149
A	400	15.5	.05	6000	20	1.34032258	40	1	149
A	400	15.5	.05	7000	20	1.34032258	46	1	149
A	400	15.5	.05	8000	20	1.34032258	53	1	149
A	400	15.5	.05	9000	20	1.34032258	60	1	149
A	400	15.5	.05	10000	20	1.34032258	67	1	149
A	400	15.5	.05	1000	22	1.46935484	7	1	136
A	400	15.5	.05	2000	22	1.46935484	14	1	136
A	400	15.5	.05	3000	22	1.46935484	22	1	136
A	400	15.5	.05	4000	22	1.46935484	29	1	136
A	400	15.5	.05	5000	22	1.46935484	36	1	136
A	400	15.5	.05	6000	22	1.46935484	44	1	136
A	400	15.5	.05	7000	22	1.46935484	51	1	136
A	400	15.5	.05	8000	22	1.46935484	58	1	136
A	400	15.5	.05	9000	22	1.46935484	66	1	136
A	400	15.5	.05	10000	22	1.46935484	73	1	136
A	400	15.5	.05	1000	24	1.5983871	8	1	125
A	400	15.5	.05	2000	24	1.5983871	16	1	125
A	400	15.5	.05	3000	24	1.5983871	24	1	125
A	400	15.5	.05	4000	24	1.5983871	32	1	125
A	400	15.5	.05	5000	24	1.5983871	40	1	125
A	400	15.5	.05	6000	24	1.5983871	48	1	125
A	400	15.5	.05	7000	24	1.5983871	56	1	125
A	400	15.5	.05	8000	24	1.5983871	64	1	125
A	400	15.5	.05	9000	24	1.5983871	72	1	125
A	400	15.5	.05	10000	24	1.5983871	80	1	125
A	400	15.5	.05	1000	26	1.72741935	8	1	115
A	400	15.5	.05	2000	26	1.72741935	17	1	115
A	400	15.5	.05	3000	26	1.72741935	26	1	115
A	400	15.5	.05	4000	26	1.72741935	34	1	115
A	400	15.5	.05	5000	26	1.72741935	43	1	115
A	400	15.5	.05	6000	26	1.72741935	52	1	115

A	400	15.5	.05	9000	26	1.72741935	78	1	115
A	400	15.5	.05	10000	26	1.72741935	86	1	115
A	400	15.5	.05	1000	28	1.85645161	9	1	107
A	400	15.5	.05	2000	28	1.85645161	18	1	107
A	400	15.5	.05	3000	28	1.85645161	28	1	107
A	400	15.5	.05	4000	28	1.85645161	37	1	107
A	400	15.5	.05	5000	28	1.85645161	46	1	107
A	400	15.5	.05	6000	28	1.85645161	56	1	107
A	400	15.5	.05	7000	28	1.85645161	65	1	107
A	400	15.5	.05	8000	28	1.85645161	74	1	107
A	400	15.5	.05	9000	28	1.85645161	84	1	107
A	400	15.5	.05	10000	28	1.85645161	93	1	107
A	400	15.5	.05	1000	30	1.98548387	10	1	100
A	400	15.5	.05	2000	30	1.98548387	20	1	100
A	400	15.5	.05	3000	30	1.98548387	30	1	100
A	400	15.5	.05	4000	30	1.98548387	40	1	100
A	400	15.5	.05	5000	30	1.98548387	50	1	100
A	400	15.5	.05	6000	30	1.98548387	60	1	100
A	400	15.5	.05	7000	30	1.98548387	70	1	100
A	400	15.5	.05	8000	30	1.98548387	80	1	100
A	400	15.5	.05	9000	30	1.98548387	90	1	100
A	400	15.5	.05	10000	30	1.98548387	100	1	100

]

TYPE	CAP	SPEED	DOCK	DEMAND	DIST	TRIP TIME	NV	TRIPS/HR/VES.	SV
B	800	17	.18	1000	2	.297647059	1	1.6798419	1343
B	800	17	.18	2000	2	.297647059	1	1.6798419	1343
B	800	17	.18	3000	2	.297647059	2	1.6798419	1343
B	800	17	.18	4000	2	.297647059	2	1.6798419	1343
B	800	17	.18	5000	2	.297647059	3	1.6798419	1343
B	800	17	.18	6000	2	.297647059	4	1.6798419	1343
B	800	17	.18	7000	2	.297647059	5	1.6798419	1343
B	800	17	.18	8000	2	.297647059	5	1.6798419	1343
B	800	17	.18	9000	2	.297647059	6	1.6798419	1343
B	800	17	.18	10000	2	.297647059	7	1.6798419	1343
B	800	17	.18	1000	4	.415294118	1	1.20396601	963
B	800	17	.18	2000	4	.415294118	2	1.20396601	963
B	800	17	.18	3000	4	.415294118	3	1.20396601	963
B	800	17	.18	4000	4	.415294118	4	1.20396601	963
B	800	17	.18	5000	4	.415294118	5	1.20396601	963
B	800	17	.18	6000	4	.415294118	6	1.20396601	963
B	800	17	.18	7000	4	.415294118	7	1.20396601	963
B	800	17	.18	8000	4	.415294118	8	1.20396601	963
B	800	17	.18	9000	4	.415294118	9	1.20396601	963
B	800	17	.18	10000	4	.415294118	10	1.20396601	963
B	800	17	.18	1000	6	.532941176	1	1	750
B	800	17	.18	2000	6	.532941176	2	1	750
B	800	17	.18	3000	6	.532941176	4	1	750
B	800	17	.18	4000	6	.532941176	5	1	750
B	800	17	.18	5000	6	.532941176	6	1	750
B	800	17	.18	6000	6	.532941176	8	1	750
B	800	17	.18	7000	6	.532941176	9	1	750
B	800	17	.18	8000	6	.532941176	10	1	750
B	800	17	.18	9000	6	.532941176	12	1	750
B	800	17	.18	10000	6	.532941176	13	1	750
B	800	17	.18	1000	8	.650588235	1	1	614
B	800	17	.18	2000	8	.650588235	3	1	614
B	800	17	.18	3000	8	.650588235	4	1	614
B	800	17	.18	4000	8	.650588235	6	1	614
B	800	17	.18	5000	8	.650588235	8	1	614
B	800	17	.18	6000	8	.650588235	9	1	614
B	800	17	.18	7000	8	.650588235	11	1	614
B	800	17	.18	8000	8	.650588235	13	1	614
B	800	17	.18	9000	8	.650588235	14	1	614
B	800	17	.18	10000	8	.650588235	16	1	614
B	800	17	.18	1000	10	.768235294	1	1	520
B	800	17	.18	2000	10	.768235294	3	1	520
B	800	17	.18	3000	10	.768235294	5	1	520
B	800	17	.18	4000	10	.768235294	7	1	520
B	800	17	.18	5000	10	.768235294	9	1	520
B	800	17	.18	6000	10	.768235294	11	1	520
B	800	17	.18	7000	10	.768235294	13	1	520
B	800	17	.18	8000	10	.768235294	15	1	520
B	800	17	.18	9000	10	.768235294	17	1	520
B	800	17	.18	10000	10	.768235294	19	1	520
B	800	17	.18	1000	12	.885882353	2	1	451
B	800	17	.18	2000	12	.885882353	4	1	451
B	800	17	.18	3000	12	.885882353	6	1	451
B	800	17	.18	4000	12	.885882353	8	1	451
B	800	17	.18	5000	12	.885882353	11	1	451
B	800	17	.18	6000	12	.885882353	13	1	451
B	800	17	.18	7000	12	.885882353	15	1	451
B	800	17	.18	8000	12	.885882353	17	1	451
B	800	17	.18	9000	12	.885882353	19	1	451
B	800	17	.18	10000	12	.885882353	22	1	451
B	800	17	.18	1000	14	1.00352941	2	1	398

B	800	17	.18	3000	14	1.00352941	7	1	398
B	800	17	.18	4000	14	1.00352941	10	1	398
B	800	17	.18	5000	14	1.00352941	12	1	398
B	800	17	.18	6000	14	1.00352941	15	1	398
B	800	17	.18	7000	14	1.00352941	17	1	398
B	800	17	.18	8000	14	1.00352941	20	1	398
B	800	17	.18	9000	14	1.00352941	22	1	398
B	800	17	.18	10000	14	1.00352941	25	1	398
B	800	17	.18	1000	16	1.12117647	2	1	356
B	800	17	.18	2000	16	1.12117647	5	1	356
B	800	17	.18	3000	16	1.12117647	8	1	356
B	800	17	.18	4000	16	1.12117647	11	1	356
B	800	17	.18	5000	16	1.12117647	14	1	356
B	800	17	.18	6000	16	1.12117647	16	1	356
B	800	17	.18	7000	16	1.12117647	19	1	356
B	800	17	.18	8000	16	1.12117647	22	1	356
B	800	17	.18	9000	16	1.12117647	25	1	356
B	800	17	.18	10000	16	1.12117647	28	1	356
B	800	17	.18	1000	18	1.23882353	3	1	322
B	800	17	.18	2000	18	1.23882353	6	1	322
B	800	17	.18	3000	18	1.23882353	9	1	322
B	800	17	.18	4000	18	1.23882353	12	1	322
B	800	17	.18	5000	18	1.23882353	15	1	322
B	800	17	.18	6000	18	1.23882353	18	1	322
B	800	17	.18	7000	18	1.23882353	21	1	322
B	800	17	.18	8000	18	1.23882353	24	1	322
B	800	17	.18	9000	18	1.23882353	27	1	322
B	800	17	.18	10000	18	1.23882353	31	1	322
B	800	17	.18	1000	20	1.35647059	3	1	294
B	800	17	.18	2000	20	1.35647059	6	1	294
B	800	17	.18	3000	20	1.35647059	10	1	294
B	800	17	.18	4000	20	1.35647059	13	1	294
B	800	17	.18	5000	20	1.35647059	17	1	294
B	800	17	.18	6000	20	1.35647059	20	1	294
B	800	17	.18	7000	20	1.35647059	23	1	294
B	800	17	.18	8000	20	1.35647059	27	1	294
B	800	17	.18	9000	20	1.35647059	30	1	294
B	800	17	.18	10000	20	1.35647059	34	1	294
B	800	17	.18	1000	22	1.47411765	3	1	271
B	800	17	.18	2000	22	1.47411765	7	1	271
B	800	17	.18	3000	22	1.47411765	11	1	271
B	800	17	.18	4000	22	1.47411765	14	1	271
B	800	17	.18	5000	22	1.47411765	18	1	271
B	800	17	.18	6000	22	1.47411765	22	1	271
B	800	17	.18	7000	22	1.47411765	25	1	271
B	800	17	.18	8000	22	1.47411765	29	1	271
B	800	17	.18	9000	22	1.47411765	33	1	271
B	800	17	.18	10000	22	1.47411765	36	1	271
B	800	17	.18	1000	24	1.59176471	3	1	251
B	800	17	.18	2000	24	1.59176471	7	1	251
B	800	17	.18	3000	24	1.59176471	11	1	251
B	800	17	.18	4000	24	1.59176471	15	1	251
B	800	17	.18	5000	24	1.59176471	19	1	251
B	800	17	.18	6000	24	1.59176471	23	1	251
B	800	17	.18	7000	24	1.59176471	27	1	251
B	800	17	.18	8000	24	1.59176471	31	1	251
B	800	17	.18	9000	24	1.59176471	35	1	251
B	800	17	.18	10000	24	1.59176471	39	1	251
B	800	17	.18	1000	25	1.70941176	4	1	233
B	800	17	.18	2000	26	1.70941176	8	1	233
B	800	17	.18	3000	26	1.70941176	12	1	233
B	800	17	.18	4000	26	1.70941176	17	1	233
B	800	17	.18	5000	26	1.70941176	21	1	233
B	800	17	.18	6000	26	1.70941176	25	1	233
B	800	17	.18	7000	26	1.70941176	30	1	233

B	800	17	.18	9000	26	1.70941176	38	1	233
B	800	17	.18	10000	26	1.70941176	42	1	233
B	800	17	.18	1200	28	1.82705882	4	1	218
B	800	17	.18	2000	28	1.82705882	9	1	218
B	800	17	.18	3000	28	1.82705882	13	1	218
B	800	17	.18	4000	28	1.82705882	18	1	218
B	800	17	.18	5000	28	1.82705882	22	1	218
B	800	17	.18	6000	28	1.82705882	27	1	218
B	800	17	.18	7000	28	1.82705882	32	1	218
B	800	17	.18	8000	28	1.82705882	36	1	218
B	800	17	.18	9000	28	1.82705882	41	1	218
B	800	17	.18	10000	28	1.82705882	45	1	218
B	800	17	.18	1000	30	1.94470588	4	1	205
B	800	17	.18	2000	30	1.94470588	9	1	205
B	800	17	.18	3000	30	1.94470588	14	1	205
B	800	17	.18	4000	30	1.94470588	19	1	205
B	800	17	.18	5000	30	1.94470588	24	1	205
B	800	17	.18	6000	30	1.94470588	29	1	205
B	800	17	.18	7000	30	1.94470588	34	1	205
B	800	17	.18	8000	30	1.94470588	39	1	205
B	800	17	.18	9000	30	1.94470588	43	1	205
B	800	17	.18	10000	30	1.94470588	48	1	205

]

TYPE	CAP	SPEED	DOCK	DEMAND	DIST	TRIP TIME	NV	TRIPS/HR/VES.	SV
C	750	28	.17	1000	2	.241428571	1	2.07100592	1553
C	750	28	.17	2000	2	.241428571	1	2.07100592	1553
C	750	28	.17	3000	2	.241428571	1	2.07100592	1553
C	750	28	.17	4000	2	.241428571	2	2.07100592	1553
C	750	28	.17	5000	2	.241428571	3	2.07100592	1553
C	750	28	.17	6000	2	.241428571	3	2.07100592	1553
C	750	28	.17	7000	2	.241428571	4	2.07100592	1553
C	750	28	.17	8000	2	.241428571	5	2.07100592	1553
C	750	28	.17	9000	2	.241428571	5	2.07100592	1553
C	750	28	.17	10000	2	.241428571	6	2.07100592	1553
C	750	28	.17	1000	4	.312857143	1	1.59817352	1198
C	750	28	.17	2000	4	.312857143	1	1.59817352	1198
C	750	28	.17	3000	4	.312857143	2	1.59817352	1198
C	750	28	.17	4000	4	.312857143	3	1.59817352	1198
C	750	28	.17	5000	4	.312857143	4	1.59817352	1198
C	750	28	.17	6000	4	.312857143	5	1.59817352	1198
C	750	28	.17	7000	4	.312857143	5	1.59817352	1198
C	750	28	.17	8000	4	.312857143	6	1.59817352	1198
C	750	28	.17	9000	4	.312857143	7	1.59817352	1198
C	750	28	.17	10000	4	.312857143	8	1.59817352	1198
C	750	28	.17	1000	6	.384285714	1	1.30111524	975
C	750	28	.17	2000	6	.384285714	2	1.30111524	975
C	750	28	.17	3000	6	.384285714	3	1.30111524	975
C	750	28	.17	4000	6	.384285714	4	1.30111524	975
C	750	28	.17	5000	6	.384285714	5	1.30111524	975
C	750	28	.17	6000	6	.384285714	6	1.30111524	975
C	750	28	.17	7000	6	.384285714	7	1.30111524	975
C	750	28	.17	8000	6	.384285714	8	1.30111524	975
C	750	28	.17	9000	6	.384285714	9	1.30111524	975
C	750	28	.17	10000	6	.384285714	10	1.30111524	975
C	750	28	.17	1000	8	.455714286	1	1.09717868	822
C	750	28	.17	2000	8	.455714286	2	1.09717868	822
C	750	28	.17	3000	8	.455714286	3	1.09717868	822
C	750	28	.17	4000	8	.455714286	4	1.09717868	822
C	750	28	.17	5000	8	.455714286	6	1.09717868	822
C	750	28	.17	6000	8	.455714286	7	1.09717868	822
C	750	28	.17	7000	8	.455714286	8	1.09717868	822
C	750	28	.17	8000	8	.455714286	9	1.09717868	822
C	750	28	.17	9000	8	.455714286	10	1.09717868	822
C	750	28	.17	10000	8	.455714286	12	1.09717868	822
C	750	28	.17	1000	10	.527142857	1	1	711
C	750	28	.17	2000	10	.527142857	2	1	711
C	750	28	.17	3000	10	.527142857	4	1	711
C	750	28	.17	4000	10	.527142857	5	1	711
C	750	28	.17	5000	10	.527142857	7	1	711
C	750	28	.17	6000	10	.527142857	8	1	711
C	750	28	.17	7000	10	.527142857	9	1	711
C	750	28	.17	8000	10	.527142857	11	1	711
C	750	28	.17	9000	10	.527142857	12	1	711
C	750	28	.17	10000	10	.527142857	14	1	711
C	750	28	.17	1000	12	.598571429	1	1	626
C	750	28	.17	2000	12	.598571429	3	1	626
C	750	28	.17	3000	12	.598571429	4	1	626
C	750	28	.17	4000	12	.598571429	6	1	626
C	750	28	.17	5000	12	.598571429	7	1	626
C	750	28	.17	6000	12	.598571429	9	1	626
C	750	28	.17	7000	12	.598571429	11	1	626
C	750	28	.17	8000	12	.598571429	12	1	626
C	750	28	.17	9000	12	.598571429	14	1	626
C	750	28	.17	10000	12	.598571429	15	1	626
C	750	28	.17	1000	14	.67	1	1	559
C	750	28	.17	2000	14	.67	3	1	559

C	750	28	.17	4000	14	.67	7 1	559
C	750	28	.17	5000	14	.67	8 1	559
C	750	28	.17	6000	14	.67	10 1	559
C	750	28	.17	7000	14	.67	12 1	559
C	750	28	.17	8000	14	.67	14 1	559
C	750	28	.17	9000	14	.67	16 1	559
C	750	28	.17	10000	14	.67	17 1	559
C	750	28	.17	1000	16	.741428572	1 1	505
C	750	28	.17	2000	16	.741428572	3 1	505
C	750	28	.17	3000	16	.741428572	5 1	505
C	750	28	.17	4000	16	.741428572	7 1	505
C	750	28	.17	5000	16	.741428572	9 1	505
C	750	28	.17	6000	16	.741428572	11 1	505
C	750	28	.17	7000	16	.741428572	13 1	505
C	750	28	.17	8000	16	.741428572	15 1	505
C	750	28	.17	9000	16	.741428572	17 1	505
C	750	28	.17	10000	16	.741428572	19 1	505
C	750	28	.17	1000	18	.812857143	2 1	461
C	750	28	.17	2000	18	.812857143	4 1	461
C	750	28	.17	3000	18	.812857143	6 1	461
C	750	28	.17	4000	18	.812857143	8 1	461
C	750	28	.17	5000	18	.812857143	10 1	461
C	750	28	.17	6000	18	.812857143	13 1	461
C	750	28	.17	7000	18	.812857143	15 1	461
C	750	28	.17	8000	18	.812857143	17 1	461
C	750	28	.17	9000	18	.812857143	19 1	461
C	750	28	.17	10000	18	.812857143	21 1	461
C	750	28	.17	1000	20	.884285714	2 1	424
C	750	28	.17	2000	20	.884285714	4 1	424
C	750	28	.17	3000	20	.884285714	7 1	424
C	750	28	.17	4000	20	.884285714	9 1	424
C	750	28	.17	5000	20	.884285714	11 1	424
C	750	28	.17	6000	20	.884285714	14 1	424
C	750	28	.17	7000	20	.884285714	16 1	424
C	750	28	.17	8000	20	.884285714	18 1	424
C	750	28	.17	9000	20	.884285714	21 1	424
C	750	28	.17	10000	20	.884285714	23 1	424
C	750	28	.17	1000	22	.955714286	2 1	392
C	750	28	.17	2000	22	.955714286	5 1	392
C	750	28	.17	3000	22	.955714286	7 1	392
C	750	28	.17	4000	22	.955714286	10 1	392
C	750	28	.17	5000	22	.955714286	12 1	392
C	750	28	.17	6000	22	.955714286	15 1	392
C	750	28	.17	7000	22	.955714286	17 1	392
C	750	28	.17	8000	22	.955714286	20 1	392
C	750	28	.17	9000	22	.955714286	22 1	392
C	750	28	.17	10000	22	.955714286	25 1	392
C	750	28	.17	1000	24	1.02714286	2 1	365
C	750	28	.17	2000	24	1.02714286	5 1	365
C	750	28	.17	3000	24	1.02714286	8 1	365
C	750	28	.17	4000	24	1.02714286	10 1	365
C	750	28	.17	5000	24	1.02714286	13 1	365
C	750	28	.17	6000	24	1.02714286	16 1	365
C	750	28	.17	7000	24	1.02714286	19 1	365
C	750	28	.17	8000	24	1.02714286	21 1	365
C	750	28	.17	9000	24	1.02714286	24 1	365
C	750	28	.17	10000	24	1.02714286	27 1	365
C	750	28	.17	1000	26	1.09857143	2 1	341
C	750	28	.17	2000	26	1.09857143	5 1	341
C	750	28	.17	3000	26	1.09857143	8 1	341
C	750	28	.17	4000	26	1.09857143	11 1	341
C	750	28	.17	5000	26	1.09857143	14 1	341
C	750	28	.17	6000	26	1.09857143	17 1	341
C	750	28	.17	7000	26	1.09857143	20 1	341
C	750	28	.17	8000	26	1.09857143	23 1	341

C	750	28	.17	10000	26	1.09857143	29	1	341
C	750	28	.17	1000	28	1.17	3	1	320
C	750	28	.17	2000	28	1.17	6	1	320
C	750	28	.17	3000	28	1.17	9	1	320
C	750	28	.17	4000	28	1.17	12	1	320
C	750	28	.17	5000	28	1.17	15	1	320
C	750	28	.17	6000	28	1.17	18	1	320
C	750	29	.17	7000	28	1.17	21	1	320
C	750	28	.17	8000	28	1.17	25	1	320
C	750	28	.17	9000	28	1.17	28	1	320
C	750	28	.17	10000	28	1.17	31	1	320
C	750	28	.17	1000	30	1.24142857	3	1	302
C	750	28	.17	2000	30	1.24142857	6	1	302
C	750	28	.17	3000	30	1.24142857	9	1	302
C	750	28	.17	4000	30	1.24142857	13	1	302
C	750	28	.17	5000	30	1.24142857	16	1	302
C	750	28	.17	6000	30	1.24142857	19	1	302
C	750	28	.17	7000	30	1.24142857	23	1	302
C	750	28	.17	8000	30	1.24142857	26	1	302
C	750	28	.17	9000	30	1.24142857	29	1	302
C	750	28	.17	10000	30	1.24142857	33	1	302

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TYPE	CAP	SPEED	DOCK	DEMAND	DIST	TRIP TIME	NV	TRIPS/HR/VES.	SV
D	5700	16	.15	1000	2	.275	1	1.81818182	10363
D	5700	16	.15	2000	2	.275	1	1.81818182	10363
D	5700	16	.15	3000	2	.275	1	1.81818182	10363
D	5700	16	.15	4000	2	.275	1	1.81818182	10363
D	5700	16	.15	5000	2	.275	1	1.81818182	10363
D	5700	16	.15	6000	2	.275	1	1.81818182	10363
D	5700	16	.15	7000	2	.275	1	1.81818182	10363
D	5700	16	.15	8000	2	.275	1	1.81818182	10363
D	5700	16	.15	9000	2	.275	1	1.81818182	10363
D	5700	16	.15	10000	2	.275	1	1.81818182	10363
D	5700	16	.15	1000	4	.4	1	1.25	7125
D	5700	16	.15	2000	4	.4	1	1.25	7125
D	5700	16	.15	3000	4	.4	1	1.25	7125
D	5700	16	.15	4000	4	.4	1	1.25	7125
D	5700	16	.15	5000	4	.4	1	1.25	7125
D	5700	16	.15	6000	4	.4	1	1.25	7125
D	5700	16	.15	7000	4	.4	1	1.25	7125
D	5700	16	.15	8000	4	.4	1	1.25	7125
D	5700	16	.15	9000	4	.4	1	1.25	7125
D	5700	16	.15	10000	4	.4	1	1.25	7125
D	5700	16	.15	1000	6	.525	1	1	5428
D	5700	16	.15	2000	6	.525	1	1	5428
D	5700	16	.15	3000	6	.525	1	1	5428
D	5700	16	.15	4000	6	.525	1	1	5428
D	5700	16	.15	5000	6	.525	1	1	5428
D	5700	16	.15	6000	6	.525	1	1	5428
D	5700	16	.15	7000	6	.525	1	1	5428
D	5700	16	.15	8000	6	.525	1	1	5429
D	5700	16	.15	9000	6	.525	1	1	5429
D	5700	16	.15	10000	6	.525	1	1	5428
D	5700	16	.15	1000	8	.65	1	1	4384
D	5700	16	.15	2000	8	.65	1	1	4384
D	5700	16	.15	3000	8	.65	1	1	4384
D	5700	16	.15	4000	8	.65	1	1	4384
D	5700	16	.15	5000	8	.65	1	1	4384
D	5700	16	.15	6000	8	.65	1	1	4384
D	5700	16	.15	7000	8	.65	1	1	4384
D	5700	16	.15	8000	8	.65	1	1	4384
D	5700	16	.15	9000	8	.65	2	1	4384
D	5700	16	.15	10000	8	.65	2	1	4384
D	5700	16	.15	1000	10	.775	1	1	3677
D	5700	16	.15	2000	10	.775	1	1	3677
D	5700	16	.15	3000	10	.775	1	1	3677
D	5700	16	.15	4000	10	.775	1	1	3677
D	5700	16	.15	5000	10	.775	1	1	3677
D	5700	16	.15	6000	10	.775	1	1	3677
D	5700	16	.15	7000	10	.775	1	1	3677
D	5700	16	.15	8000	10	.775	2	1	3677
D	5700	16	.15	9000	10	.775	2	1	3677
D	5700	16	.15	10000	10	.775	2	1	3677
D	5700	16	.15	1000	12	.9	1	1	3166
D	5700	16	.15	2000	12	.9	1	1	3166
D	5700	16	.15	3000	12	.9	1	1	3166
D	5700	16	.15	4000	12	.9	1	1	3166
D	5700	16	.15	5000	12	.9	1	1	3166
D	5700	16	.15	6000	12	.9	1	1	3166
D	5700	16	.15	7000	12	.9	2	1	3166
D	5700	16	.15	8000	12	.9	2	1	3166
D	5700	16	.15	9000	12	.9	2	1	3166
D	5700	16	.15	10000	12	.9	3	1	3166
D	5700	16	.15	1000	14	1.025	1	1	2780

D	5700	16	.15	3000	14	1.025	1	1	2780
D	5700	16	.15	4000	14	1.025	1	1	2780
D	5700	16	.15	5000	14	1.025	1	1	2780
D	5700	16	.15	6000	14	1.025	2	1	2780
D	5700	16	.15	7000	14	1.025	2	1	2780
D	5700	16	.15	8000	14	1.025	2	1	2780
D	5700	16	.15	9000	14	1.025	3	1	2780
D	5700	16	.15	10000	14	1.025	3	1	2780
D	5700	16	.15	1000	16	1.15	1	1	2478
D	5700	16	.15	2000	16	1.15	1	1	2478
D	5700	16	.15	3000	16	1.15	1	1	2478
D	5700	16	.15	4000	16	1.15	1	1	2478
D	5700	16	.15	5000	16	1.15	2	1	2478
D	5700	16	.15	6000	16	1.15	2	1	2478
D	5700	16	.15	7000	16	1.15	2	1	2478
D	5700	16	.15	8000	16	1.15	3	1	2478
D	5700	16	.15	9000	16	1.15	3	1	2478
D	5700	16	.15	10000	16	1.15	4	1	2478
D	5700	16	.15	1000	18	1.275	1	1	2235
D	5700	16	.15	2000	18	1.275	1	1	2235
D	5700	16	.15	3000	18	1.275	1	1	2235
D	5700	16	.15	4000	18	1.275	1	1	2235
D	5700	16	.15	5000	18	1.275	2	1	2235
D	5700	16	.15	6000	18	1.275	2	1	2235
D	5700	16	.15	7000	18	1.275	3	1	2235
D	5700	16	.15	8000	18	1.275	3	1	2235
D	5700	16	.15	9000	18	1.275	4	1	2235
D	5700	16	.15	10000	18	1.275	4	1	2235
D	5700	16	.15	1000	20	1.4	1	1	2035
D	5700	16	.15	2000	20	1.4	1	1	2035
D	5700	16	.15	3000	20	1.4	1	1	2035
D	5700	16	.15	4000	20	1.4	1	1	2035
D	5700	16	.15	5000	20	1.4	2	1	2035
D	5700	16	.15	6000	20	1.4	2	1	2035
D	5700	16	.15	7000	20	1.4	3	1	2035
D	5700	16	.15	8000	20	1.4	3	1	2035
D	5700	16	.15	9000	20	1.4	4	1	2035
D	5700	16	.15	10000	20	1.4	4	1	2035
D	5700	16	.15	1000	22	1.525	1	1	1868
D	5700	16	.15	2000	22	1.525	1	1	1868
D	5700	16	.15	3000	22	1.525	1	1	1868
D	5700	16	.15	4000	22	1.525	2	1	1868
D	5700	16	.15	5000	22	1.525	2	1	1868
D	5700	16	.15	6000	22	1.525	3	1	1868
D	5700	16	.15	7000	22	1.525	3	1	1868
D	5700	16	.15	8000	22	1.525	4	1	1868
D	5700	16	.15	9000	22	1.525	4	1	1868
D	5700	16	.15	10000	22	1.525	5	1	1868
D	5700	16	.15	1000	24	1.65	1	1	1727
D	5700	16	.15	2000	24	1.65	1	1	1727
D	5700	16	.15	3000	24	1.65	1	1	1727
D	5700	16	.15	4000	24	1.65	2	1	1727
D	5700	16	.15	5000	24	1.65	2	1	1727
D	5700	16	.15	6000	24	1.65	3	1	1727
D	5700	16	.15	7000	24	1.65	4	1	1727
D	5700	16	.15	8000	24	1.65	4	1	1727
D	5700	16	.15	9000	24	1.65	5	1	1727
D	5700	16	.15	10000	24	1.65	5	1	1727
D	5700	16	.15	1000	26	1.775	1	1	1605
D	5700	16	.15	2000	26	1.775	1	1	1605
D	5700	16	.15	3000	26	1.775	1	1	1605
D	5700	16	.15	4000	26	1.775	2	1	1605
D	5700	16	.15	5000	26	1.775	3	1	1605
D	5700	16	.15	6000	26	1.775	3	1	1605
D	5700	16	.15	7000	26	1.775	4	1	1605

D	5700	16	.15	9000	26	1.775	5	1	1605
D	5700	16	.15	10000	26	1.775	6	1	1605
D	5700	16	.15	1000	28	1.9	1	1	1500
D	5700	16	.15	2000	28	1.9	1	1	1500
D	5700	16	.15	3000	28	1.9	2	1	1500
D	5700	16	.15	4000	28	1.9	2	1	1500
D	5700	16	.15	5000	28	1.9	3	1	1500
D	5700	16	.15	6000	28	1.9	4	1	1500
D	5700	16	.15	7000	28	1.9	4	1	1500
D	5700	16	.15	8000	28	1.9	5	1	1500
D	5700	16	.15	9000	28	1.9	6	1	1500
D	5700	16	.15	10000	29	1.9	6	1	1500
D	5700	16	.15	1000	30	2.025	1	1	1407
D	5700	16	.15	2000	30	2.025	1	1	1407
D	5700	16	.15	3000	30	2.025	2	1	1407
D	5700	16	.15	4000	30	2.025	2	1	1407
D	5700	16	.15	5000	30	2.025	3	1	1407
D	5700	16	.15	6000	30	2.025	4	1	1407
D	5700	16	.15	7000	30	2.025	4	1	1407
D	5700	16	.15	8000	30	2.025	5	1	1407
D	5700	16	.15	9000	30	2.025	6	1	1407
D	5700	16	.15	10000	30	2.025	7	1	1407

JTYPE CAP SPEED DOCK DEMAND DIST TRIP TIME NV TRIPS/HR/VES. SV

E	2500	20	.2	1000	2	.3	1	1.66666667	4166
E	2500	20	.2	2000	2	.3	1	1.66666667	4166
E	2500	20	.2	3000	2	.3	1	1.66666667	4166
E	2500	20	.2	4000	2	.3	1	1.66666667	4166
E	2500	20	.2	5000	2	.3	1	1.66666667	4166
E	2500	20	.2	6000	2	.3	1	1.66666667	4166
E	2500	20	.2	7000	2	.3	1	1.66666667	4166

TYPE	CAP	SPEED	DOCK	DEMAND	DIST	TRIP TIME	NV	TRIPS/HR/VES.	SV
E	2500	20	.2	1000	2	.3	1	1.66666667	4166
E	2500	20	.2	2000	2	.3	1	1.66666667	4166
E	2500	20	.2	3000	2	.3	1	1.66666667	4166
E	2500	20	.2	4000	2	.3	1	1.66666667	4166
E	2500	20	.2	5000	2	.3	1	1.66666667	4166
E	2500	20	.2	6000	2	.3	1	1.66666667	4166
E	2500	20	.2	7000	2	.3	1	1.66666667	4166
E	2500	20	.2	8000	2	.3	1	1.66666667	4166
E	2500	20	.2	9000	2	.3	2	1.66666667	4166
E	2500	20	.2	10000	2	.3	2	1.66666667	4166
E	2500	20	.2	1000	4	.4	1	1.25	3125
E	2500	20	.2	2000	4	.4	1	1.25	3125
E	2500	20	.2	3000	4	.4	1	1.25	3125
E	2500	20	.2	4000	4	.4	1	1.25	3125
E	2500	20	.2	5000	4	.4	1	1.25	3125
E	2500	20	.2	6000	4	.4	1	1.25	3125
E	2500	20	.2	7000	4	.4	2	1.25	3125
E	2500	20	.2	8000	4	.4	2	1.25	3125
E	2500	20	.2	9000	4	.4	2	1.25	3125
E	2500	20	.2	10000	4	.4	3	1.25	3125
E	2500	20	.2	1000	6	.5	1	1	2500
E	2500	20	.2	2000	6	.5	1	1	2500
E	2500	20	.2	3000	6	.5	1	1	2500
E	2500	20	.2	4000	6	.5	1	1	2500
E	2500	20	.2	5000	6	.5	2	1	2500
E	2500	20	.2	6000	6	.5	2	1	2500
E	2500	20	.2	7000	6	.5	2	1	2500
E	2500	20	.2	8000	6	.5	3	1	2500
E	2500	20	.2	9000	6	.5	3	1	2500
E	2500	20	.2	10000	6	.5	4	1	2500
E	2500	20	.2	1000	8	.6	1	1	2083
E	2500	20	.2	2000	8	.6	1	1	2083
E	2500	20	.2	3000	8	.6	1	1	2083
E	2500	20	.2	4000	8	.6	1	1	2083
E	2500	20	.2	5000	8	.6	2	1	2083
E	2500	20	.2	6000	8	.6	2	1	2083
E	2500	20	.2	7000	8	.6	3	1	2083
E	2500	20	.2	8000	8	.6	3	1	2083
E	2500	20	.2	9000	8	.6	4	1	2083
E	2500	20	.2	10000	8	.6	4	1	2083
E	2500	20	.2	1000	10	.7	1	1	1785
E	2500	20	.2	2000	10	.7	1	1	1785
E	2500	20	.2	3000	10	.7	1	1	1785
E	2500	20	.2	4000	10	.7	2	1	1785
E	2500	20	.2	5000	10	.7	2	1	1785
E	2500	20	.2	6000	10	.7	3	1	1785
E	2500	20	.2	7000	10	.7	3	1	1785
E	2500	20	.2	8000	10	.7	4	1	1785
E	2500	20	.2	9000	10	.7	5	1	1785
E	2500	20	.2	10000	10	.7	5	1	1785
E	2500	20	.2	1000	12	.8	1	1	1562
E	2500	20	.2	2000	12	.8	1	1	1562
E	2500	20	.2	3000	12	.8	1	1	1562
E	2500	20	.2	4000	12	.8	2	1	1562
E	2500	20	.2	5000	12	.8	3	1	1562
E	2500	20	.2	6000	12	.8	3	1	1562
E	2500	20	.2	7000	12	.8	4	1	1562
E	2500	20	.2	8000	12	.8	5	1	1562
E	2500	20	.2	9000	12	.8	5	1	1562
E	2500	20	.2	10000	12	.8	6	1	1562
E	2500	20	.2	1000	14	.9	1	1	1388

E	2500	20	.2	3000	14	.9	2	1	1388
E	2500	20	.2	4000	14	.9	2	1	1388
E	2500	20	.2	5000	14	.9	3	1	1388
E	2500	20	.2	6000	14	.9	4	1	1388
E	2500	20	.2	7000	14	.9	5	1	1388
E	2500	20	.2	8000	14	.9	5	1	1388
E	2500	20	.2	9000	14	.9	6	1	1388
E	2500	20	.2	10000	14	.9	7	1	1388
E	2500	20	.2	1000	16	1	1	1	1250
E	2500	20	.2	2000	16	1	1	1	1250
E	2500	20	.2	3000	16	1	2	1	1250
E	2500	20	.2	4000	16	1	3	1	1250
E	2500	20	.2	5000	16	1	4	1	1250
E	2500	20	.2	6000	16	1	4	1	1250
E	2500	20	.2	7000	16	1	5	1	1250
E	2500	20	.2	8000	16	1	6	1	1250
E	2500	20	.2	9000	16	1	7	1	1250
E	2500	20	.2	10000	16	1	8	1	1250
E	2500	20	.2	1000	18	1.1	1	1	1136
E	2500	20	.2	2000	18	1.1	1	1	1136
E	2500	20	.2	3000	18	1.1	2	1	1136
E	2500	20	.2	4000	18	1.1	3	1	1136
E	2500	20	.2	5000	18	1.1	4	1	1136
E	2500	20	.2	6000	18	1.1	5	1	1136
E	2500	20	.2	7000	18	1.1	6	1	1136
E	2500	20	.2	8000	18	1.1	7	1	1136
E	2500	20	.2	9000	18	1.1	7	1	1136
E	2500	20	.2	10000	18	1.1	8	1	1136
E	2500	20	.2	1000	20	1.2	1	1	1041
E	2500	20	.2	2000	20	1.2	1	1	1041
E	2500	20	.2	3000	20	1.2	2	1	1041
E	2500	20	.2	4000	20	1.2	3	1	1041
E	2500	20	.2	5000	20	1.2	4	1	1041
E	2500	20	.2	6000	20	1.2	5	1	1041
E	2500	20	.2	7000	20	1.2	6	1	1041
E	2500	20	.2	8000	20	1.2	7	1	1041
E	2500	20	.2	9000	20	1.2	8	1	1041
E	2500	20	.2	10000	20	1.2	9	1	1041
E	2500	20	.2	1000	22	1.3	1	1	961
E	2500	20	.2	2000	22	1.3	2	1	961
E	2500	20	.2	3000	22	1.3	3	1	961
E	2500	20	.2	4000	22	1.3	4	1	961
E	2500	20	.2	5000	22	1.3	5	1	961
E	2500	20	.2	6000	22	1.3	6	1	961
E	2500	20	.2	7000	22	1.3	7	1	961
E	2500	20	.2	8000	22	1.3	8	1	961
E	2500	20	.2	9000	22	1.3	9	1	961
E	2500	20	.2	10000	22	1.3	10	1	961
E	2500	20	.2	1000	24	1.4	1	1	892
E	2500	20	.2	2000	24	1.4	2	1	892
E	2500	20	.2	3000	24	1.4	3	1	892
E	2500	20	.2	4000	24	1.4	4	1	892
E	2500	20	.2	5000	24	1.4	5	1	892
E	2500	20	.2	6000	24	1.4	6	1	892
E	2500	20	.2	7000	24	1.4	7	1	892
E	2500	20	.2	8000	24	1.4	8	1	892
E	2500	20	.2	9000	24	1.4	10	1	892
E	2500	20	.2	10000	24	1.4	11	1	892
E	2500	20	.2	1000	26	1.5	1	1	833
E	2500	20	.2	2000	26	1.5	2	1	833
E	2500	20	.2	3000	26	1.5	3	1	833
E	2500	20	.2	4000	26	1.5	4	1	833
E	2500	20	.2	5000	26	1.5	6	1	833
E	2500	20	.2	6000	26	1.5	7	1	833
E	2500	20	.2	7000	26	1.5	8	1	833

E	2500	20	.2	9000	26	1.5	10	1	833
E	2500	20	.2	10000	26	1.5	12	1	833
E	2500	20	.2	1000	28	1.6	1	1	781
E	2500	20	.2	2000	28	1.6	2	1	781
E	2500	20	.2	3000	28	1.6	3	1	781
E	2500	20	.2	4000	28	1.6	5	1	781
E	2500	20	.2	5000	28	1.6	6	1	781
E	2500	20	.2	6000	28	1.6	7	1	781
E	2500	20	.2	7000	28	1.6	8	1	781
E	2500	20	.2	8000	28	1.6	10	1	781
E	2500	20	.2	9000	28	1.6	11	1	781
E	2500	20	.2	10000	28	1.6	12	1	781
E	2500	20	.2	1000	30	1.7	1	1	735
E	2500	20	.2	2000	30	1.7	2	1	735
E	2500	20	.2	3000	30	1.7	4	1	735
E	2500	20	.2	4000	30	1.7	5	1	735
E	2500	20	.2	5000	30	1.7	6	1	735
E	2500	20	.2	6000	30	1.7	8	1	735
E	2500	20	.2	7000	30	1.7	9	1	735
E	2500	20	.2	8000	30	1.7	10	1	735
E	2500	20	.2	9000	30	1.7	12	1	735
E	2500	20	.2	10000	30	1.7	13	1	735

]

TYPE	CAP	SPEED	DOCK	DEMAND	DIST	TRIP TIME	NV	TRIPS/HR/VES.	SV
F	242	46	.11	1000	2	.153478261	1	3.25779037	788
F	242	46	.11	2000	2	.153478261	2	3.25779037	788
F	242	46	.11	3000	2	.153478261	3	3.25779037	788
F	242	46	.11	4000	2	.153478261	5	3.25779037	788
F	242	46	.11	5000	2	.153478261	6	3.25779037	788
F	242	46	.11	6000	2	.153478261	7	3.25779037	788
F	242	46	.11	7000	2	.153478261	8	3.25779037	788
F	242	46	.11	8000	2	.153478261	10	3.25779037	788
F	242	46	.11	9000	2	.153478261	11	3.25779037	788
F	242	46	.11	10000	2	.153478261	12	3.25779037	788
F	242	46	.11	1000	4	.196956522	1	2.53863135	614
F	242	46	.11	2000	4	.196956522	3	2.53863135	614
F	242	46	.11	3000	4	.196956522	4	2.53863135	614
F	242	46	.11	4000	4	.196956522	6	2.53863135	614
F	242	46	.11	5000	4	.196956522	8	2.53863135	614
F	242	46	.11	6000	4	.196956522	9	2.53863135	614
F	242	46	.11	7000	4	.196956522	11	2.53863135	614
F	242	46	.11	8000	4	.196956522	13	2.53863135	614
F	242	46	.11	9000	4	.196956522	14	2.53863135	614
F	242	46	.11	10000	4	.196956522	16	2.53863135	614
F	242	46	.11	1000	6	.240434783	1	2.07956601	503
F	242	46	.11	2000	6	.240434783	3	2.07956601	503
F	242	46	.11	3000	6	.240434783	5	2.07956601	503
F	242	46	.11	4000	6	.240434783	7	2.07956601	503
F	242	46	.11	5000	6	.240434783	9	2.07956601	503
F	242	46	.11	6000	6	.240434783	11	2.07956601	503
F	242	46	.11	7000	6	.240434783	13	2.07956601	503
F	242	46	.11	8000	6	.240434783	15	2.07956601	503
F	242	46	.11	9000	6	.240434783	17	2.07956601	503
F	242	46	.11	10000	6	.240434783	19	2.07956601	503
F	242	46	.11	1000	8	.283913043	2	1.7611026	426
F	242	46	.11	2000	8	.283913043	4	1.7611026	426
F	242	46	.11	3000	8	.283913043	7	1.7611026	426
F	242	46	.11	4000	8	.283913043	9	1.7611026	426
F	242	46	.11	5000	8	.283913043	11	1.7611026	426
F	242	46	.11	6000	8	.283913043	14	1.7611026	426
F	242	46	.11	7000	8	.283913043	16	1.7611026	426
F	242	46	.11	8000	8	.283913043	18	1.7611026	426
F	242	46	.11	9000	8	.283913043	21	1.7611026	426
F	242	46	.11	10000	8	.283913043	23	1.7611026	426
F	242	46	.11	1000	10	.327391304	2	1.52722444	369
F	242	46	.11	2000	10	.327391304	5	1.52722444	369
F	242	46	.11	3000	10	.327391304	8	1.52722444	369
F	242	46	.11	4000	10	.327391304	10	1.52722444	369
F	242	46	.11	5000	10	.327391304	13	1.52722444	369
F	242	46	.11	6000	10	.327391304	16	1.52722444	369
F	242	46	.11	7000	10	.327391304	18	1.52722444	369
F	242	46	.11	8000	10	.327391304	21	1.52722444	369
F	242	46	.11	9000	10	.327391304	24	1.52722444	369
F	242	46	.11	10000	10	.327391304	27	1.52722444	369
F	242	46	.11	1000	12	.370869565	3	1.34818288	326
F	242	46	.11	2000	12	.370869565	6	1.34818288	326
F	242	46	.11	3000	12	.370869565	9	1.34818288	326
F	242	46	.11	4000	12	.370869565	12	1.34818288	326
F	242	46	.11	5000	12	.370869565	15	1.34818288	326
F	242	46	.11	6000	12	.370869565	18	1.34818288	326
F	242	46	.11	7000	12	.370869565	21	1.34818288	326
F	242	46	.11	8000	12	.370869565	24	1.34818288	326
F	242	46	.11	9000	12	.370869565	27	1.34818288	326
F	242	46	.11	10000	12	.370869565	30	1.34818288	326
F	242	46	.11	1000	14	.414347826	3	1.20671564	292

F	242	46	.11	3000	14	.414347826	10	1.20671564	292
F	242	46	.11	4000	14	.414347826	13	1.20671564	292
F	242	46	.11	5000	14	.414347826	17	1.20671564	292
F	242	46	.11	6000	14	.414347826	20	1.20671564	292
F	242	46	.11	7000	14	.414347826	23	1.20671564	292
F	242	46	.11	8000	14	.414347826	27	1.20671564	292
F	242	46	.11	9000	14	.414347826	30	1.20671564	292
F	242	46	.11	10000	14	.414347826	34	1.20671564	292
F	242	46	.11	1000	16	.457826087	3	1.09211776	264
F	242	46	.11	2000	16	.457826087	7	1.09211776	264
F	242	46	.11	3000	16	.457826087	11	1.09211776	264
F	242	46	.11	4000	16	.457826087	15	1.09211776	264
F	242	46	.11	5000	16	.457826087	18	1.09211776	264
F	242	46	.11	6000	16	.457826087	22	1.09211776	264
F	242	46	.11	7000	16	.457826087	26	1.09211776	264
F	242	46	.11	8000	16	.457826087	30	1.09211776	264
F	242	46	.11	9000	16	.457826087	34	1.09211776	264
F	242	46	.11	10000	16	.457826087	37	1.09211776	264
F	242	46	.11	1000	18	.501304348	4	1	241
F	242	46	.11	2000	18	.501304348	8	1	241
F	242	46	.11	3000	18	.501304348	12	1	241
F	242	46	.11	4000	18	.501304348	16	1	241
F	242	46	.11	5000	18	.501304348	20	1	241
F	242	46	.11	6000	18	.501304348	24	1	241
F	242	46	.11	7000	18	.501304348	29	1	241
F	242	46	.11	8000	18	.501304348	33	1	241
F	242	46	.11	9000	18	.501304348	37	1	241
F	242	46	.11	10000	18	.501304348	41	1	241
F	242	46	.11	1000	20	.544782609	4	1	222
F	242	46	.11	2000	20	.544782609	9	1	222
F	242	46	.11	3000	20	.544782609	13	1	222
F	242	46	.11	4000	20	.544782609	18	1	222
F	242	46	.11	5000	20	.544782609	22	1	222
F	242	46	.11	6000	20	.544782609	27	1	222
F	242	46	.11	7000	20	.544782609	31	1	222
F	242	46	.11	8000	20	.544782609	36	1	222
F	242	46	.11	9000	20	.544782609	40	1	222
F	242	46	.11	10000	20	.544782609	45	1	222
F	242	46	.11	1000	22	.588260869	4	1	205
F	242	46	.11	2000	22	.588260869	9	1	205
F	242	46	.11	3000	22	.588260869	14	1	205
F	242	46	.11	4000	22	.588260869	19	1	205
F	242	46	.11	5000	22	.588260869	24	1	205
F	242	46	.11	6000	22	.588260869	29	1	205
F	242	46	.11	7000	22	.588260869	34	1	205
F	242	46	.11	8000	22	.588260869	39	1	205
F	242	46	.11	9000	22	.588260869	43	1	205
F	242	46	.11	10000	22	.588260869	48	1	205
F	242	46	.11	1000	24	.63173913	5	1	191
F	242	46	.11	2000	24	.63173913	10	1	191
F	242	46	.11	3000	24	.63173913	15	1	191
F	242	46	.11	4000	24	.63173913	20	1	191
F	242	46	.11	5000	24	.63173913	26	1	191
F	242	46	.11	6000	24	.63173913	31	1	191
F	242	46	.11	7000	24	.63173913	36	1	191
F	242	46	.11	8000	24	.63173913	41	1	191
F	242	46	.11	9000	24	.63173913	47	1	191
F	242	46	.11	10000	24	.63173913	52	1	191
F	242	46	.11	1000	26	.675217391	5	1	179
F	242	46	.11	2000	26	.675217391	11	1	179
F	242	46	.11	3000	26	.675217391	16	1	179
F	242	46	.11	4000	26	.675217391	22	1	179
F	242	46	.11	5000	26	.675217391	27	1	179
F	242	46	.11	6000	26	.675217391	33	1	179
F	242	46	.11	7000	26	.675217391	39	1	179

F	242	46	.11	9000	26	.675217391	50	1	179
F	242	46	.11	10000	26	.675217391	55	1	179
F	242	46	.11	1000	28	.718695652	5	1	168
F	242	46	.11	2000	28	.718695652	11	1	168
F	242	46	.11	3000	28	.718695652	17	1	168
F	242	46	.11	4000	28	.718695652	23	1	168
F	242	46	.11	5000	28	.718695652	29	1	168
F	242	46	.11	6000	28	.718695652	35	1	168
F	242	46	.11	7000	28	.718695652	41	1	168
F	242	46	.11	8000	28	.718695652	47	1	168
F	242	46	.11	9000	28	.718695652	53	1	168
F	242	46	.11	10000	28	.718695652	59	1	168
F	242	46	.11	1000	30	.762173913	6	1	158
F	242	46	.11	2000	30	.762173913	12	1	158
F	242	46	.11	3000	30	.762173913	18	1	158
F	242	46	.11	4000	30	.762173913	25	1	158
F	242	46	.11	5000	30	.762173913	31	1	158
F	242	46	.11	6000	30	.762173913	37	1	158
F	242	46	.11	7000	30	.762173913	44	1	158
F	242	46	.11	8000	30	.762173913	50	1	158
F	242	46	.11	9000	30	.762173913	56	1	158
F	242	46	.11	10000	30	.762173913	63	1	158

]

TYPE	CAP	SPEED	DOCK	DEMAND	DIST	TRIP TIME	NV	TRIPS/HR/VES.	SV
G	60	31	.05	1000	2	.114516129	3	4.36619718	261
G	60	31	.05	2000	2	.114516129	7	4.36619718	261
G	60	31	.05	3000	2	.114516129	11	4.36619718	261
G	60	31	.05	4000	2	.114516129	15	4.36619718	261
G	60	31	.05	5000	2	.114516129	19	4.36619718	261
G	60	31	.05	6000	2	.114516129	22	4.36619718	261
G	60	31	.05	7000	2	.114516129	26	4.36619718	261
G	60	31	.05	8000	2	.114516129	30	4.36619718	261
G	60	31	.05	9000	2	.114516129	34	4.36619718	261
G	60	31	.05	10000	2	.114516129	38	4.36619718	261
G	60	31	.05	1000	4	.179032258	5	2.79279279	167
G	60	31	.05	2000	4	.179032258	11	2.79279279	167
G	60	31	.05	3000	4	.179032258	17	2.79279279	167
G	60	31	.05	4000	4	.179032258	23	2.79279279	167
G	60	31	.05	5000	4	.179032258	29	2.79279279	167
G	60	31	.05	6000	4	.179032258	35	2.79279279	167
G	60	31	.05	7000	4	.179032258	41	2.79279279	167
G	60	31	.05	8000	4	.179032258	47	2.79279279	167
G	60	31	.05	9000	4	.179032258	53	2.79279279	167
G	60	31	.05	10000	4	.179032258	59	2.79279279	167
G	60	31	.05	1000	6	.243548387	8	2.05298013	123
G	60	31	.05	2000	6	.243548387	16	2.05298013	123
G	60	31	.05	3000	6	.243548387	24	2.05298013	123
G	60	31	.05	4000	6	.243548387	32	2.05298013	123
G	60	31	.05	5000	6	.243548387	40	2.05298013	123
G	60	31	.05	6000	6	.243548387	48	2.05298013	123
G	60	31	.05	7000	6	.243548387	56	2.05298013	123
G	60	31	.05	8000	6	.243548387	65	2.05298013	123
G	60	31	.05	9000	6	.243548387	73	2.05298013	123
G	60	31	.05	10000	6	.243548387	81	2.05298013	123
G	60	31	.05	1000	8	.308064516	10	1.62303665	97
G	60	31	.05	2000	8	.308064516	20	1.62303665	97
G	60	31	.05	3000	8	.308064516	30	1.62303665	97
G	60	31	.05	4000	8	.308064516	41	1.62303665	97
G	60	31	.05	5000	8	.308064516	51	1.62303665	97
G	60	31	.05	6000	8	.308064516	61	1.62303665	97
G	60	31	.05	7000	8	.308064516	72	1.62303665	97
G	60	31	.05	8000	8	.308064516	82	1.62303665	97
G	60	31	.05	9000	8	.308064516	92	1.62303665	97
G	60	31	.05	10000	8	.308064516	103	1.62303665	97
G	60	31	.05	1000	10	.372580645	12	1.34199134	80
G	60	31	.05	2000	10	.372580645	25	1.34199134	80
G	60	31	.05	3000	10	.372580645	37	1.34199134	80
G	60	31	.05	4000	10	.372580645	50	1.34199134	80
G	60	31	.05	5000	10	.372580645	62	1.34199134	80
G	60	31	.05	6000	10	.372580645	75	1.34199134	80
G	60	31	.05	7000	10	.372580645	87	1.34199134	80
G	60	31	.05	8000	10	.372580645	100	1.34199134	80
G	60	31	.05	9000	10	.372580645	112	1.34199134	80
G	60	31	.05	10000	10	.372580645	125	1.34199134	80
G	60	31	.05	1000	12	.437096774	14	1.14391144	68
G	60	31	.05	2000	12	.437096774	29	1.14391144	68
G	60	31	.05	3000	12	.437096774	44	1.14391144	68
G	60	31	.05	4000	12	.437096774	58	1.14391144	68
G	60	31	.05	5000	12	.437096774	73	1.14391144	68
G	60	31	.05	6000	12	.437096774	88	1.14391144	68
G	60	31	.05	7000	12	.437096774	102	1.14391144	68
G	60	31	.05	8000	12	.437096774	117	1.14391144	68
G	60	31	.05	9000	12	.437096774	132	1.14391144	68
G	60	31	.05	10000	12	.437096774	147	1.14391144	68
G	60	31	.05	1000	14	.501612903	16	1	59
G	60	31	.05	2000	14	.501612903	33	1	59

G	60	31	.05	4000	14	.501612903	67	1	59
G	60	31	.05	5000	14	.501612903	84	1	59
G	60	31	.05	6000	14	.501612903	101	1	59
G	60	31	.05	7000	14	.501612903	118	1	59
G	60	31	.05	8000	14	.501612903	135	1	59
G	60	31	.05	9000	14	.501612903	152	1	59
G	60	31	.05	10000	14	.501612903	169	1	59
G	60	31	.05	1000	16	.566129032	19	1	52
G	60	31	.05	2000	16	.566129032	38	1	52
G	60	31	.05	3000	16	.566129032	57	1	52
G	60	31	.05	4000	16	.566129032	76	1	52
G	60	31	.05	5000	16	.566129032	96	1	52
G	60	31	.05	6000	16	.566129032	115	1	52
G	60	31	.05	7000	16	.566129032	134	1	52
G	60	31	.05	8000	16	.566129032	153	1	52
G	60	31	.05	9000	16	.566129032	173	1	52
G	60	31	.05	10000	16	.566129032	192	1	52
G	60	31	.05	1000	18	.630645161	21	1	47
G	60	31	.05	2000	18	.630645161	42	1	47
G	60	31	.05	3000	18	.630645161	63	1	47
G	60	31	.05	4000	18	.630645161	85	1	47
G	60	31	.05	5000	18	.630645161	106	1	47
G	60	31	.05	6000	18	.630645161	127	1	47
G	60	31	.05	7000	18	.630645161	148	1	47
G	60	31	.05	8000	18	.630645161	170	1	47
G	60	31	.05	9000	18	.630645161	191	1	47
G	60	31	.05	10000	18	.630645161	212	1	47
G	60	31	.05	1000	20	.69516129	23	1	43
G	60	31	.05	2000	20	.69516129	46	1	43
G	60	31	.05	3000	20	.69516129	69	1	43
G	60	31	.05	4000	20	.69516129	93	1	43
G	60	31	.05	5000	20	.69516129	116	1	43
G	60	31	.05	6000	20	.69516129	139	1	43
G	60	31	.05	7000	20	.69516129	162	1	43
G	60	31	.05	8000	20	.69516129	186	1	43
G	60	31	.05	9000	20	.69516129	209	1	43
G	60	31	.05	10000	20	.69516129	232	1	43
G	60	31	.05	1000	22	.759677419	25	1	39
G	60	31	.05	2000	22	.759677419	51	1	39
G	60	31	.05	3000	22	.759677419	76	1	39
G	60	31	.05	4000	22	.759677419	102	1	39
G	60	31	.05	5000	22	.759677419	128	1	39
G	60	31	.05	6000	22	.759677419	153	1	39
G	60	31	.05	7000	22	.759677419	179	1	39
G	60	31	.05	8000	22	.759677419	205	1	39
G	60	31	.05	9000	22	.759677419	230	1	39
G	60	31	.05	10000	22	.759677419	256	1	39
G	60	31	.05	1000	24	.824193548	27	1	36
G	60	31	.05	2000	24	.824193548	55	1	36
G	60	31	.05	3000	24	.824193548	83	1	36
G	60	31	.05	4000	24	.824193548	111	1	36
G	60	31	.05	5000	24	.824193548	138	1	36
G	60	31	.05	6000	24	.824193548	166	1	36
G	60	31	.05	7000	24	.824193548	194	1	36
G	60	31	.05	8000	24	.824193548	222	1	36
G	60	31	.05	9000	24	.824193548	250	1	36
G	60	31	.05	10000	24	.824193548	277	1	36
G	60	31	.05	1000	26	.888709677	30	1	33
G	60	31	.05	2000	26	.888709677	60	1	33
G	60	31	.05	3000	26	.888709677	90	1	33
G	60	31	.05	4000	26	.888709677	121	1	33
G	60	31	.05	5000	26	.888709677	151	1	33
G	60	31	.05	6000	26	.888709677	181	1	33
G	60	31	.05	7000	26	.888709677	212	1	33
G	60	31	.05	8000	26	.888709677	242	1	33

G	60	31	.05	10000	26	.888709677	303	1	33
G	60	31	.05	1000	28	.953225807	32	1	31
G	60	31	.05	2000	28	.953225807	64	1	31
G	60	31	.05	3000	28	.953225807	96	1	31
G	60	31	.05	4000	28	.953225807	129	1	31
G	60	31	.05	5000	28	.953225807	161	1	31
G	60	31	.05	6000	28	.953225807	193	1	31
G	60	31	.05	7000	28	.953225807	225	1	31
G	60	31	.05	8000	28	.953225807	258	1	31
G	60	31	.05	9000	28	.953225807	290	1	31
G	60	31	.05	10000	28	.953225807	322	1	31
G	60	31	.05	1000	30	1.01774194	34	1	29
G	60	31	.05	2000	30	1.01774194	68	1	29
G	60	31	.05	3000	30	1.01774194	103	1	29
G	60	31	.05	4000	30	1.01774194	137	1	29
G	60	31	.05	5000	30	1.01774194	172	1	29
G	60	31	.05	6000	30	1.01774194	206	1	29
G	60	31	.05	7000	30	1.01774194	241	1	29
G	60	31	.05	8000	30	1.01774194	275	1	29
G	60	31	.05	9000	30	1.01774194	310	1	29
G	60	31	.05	10000	30	1.01774194	344	1	29

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TYPE	CAP	SPEED	DOCK	DEMAND	DIST	TRIP TIME	HV	TRIPS/HR/VES.	SV
H	240	35	.11	1000	2	.167142857	1	2.99145299	717
H	240	35	.11	2000	2	.167142857	2	2.99145299	717
H	240	35	.11	3000	2	.167142857	4	2.99145299	717
H	240	35	.11	4000	2	.167142857	5	2.99145299	717
H	240	35	.11	5000	2	.167142857	6	2.99145299	717
H	240	35	.11	6000	2	.167142857	8	2.99145299	717
H	240	35	.11	7000	2	.167142857	9	2.99145299	717
H	240	35	.11	8000	2	.167142857	11	2.99145299	717
H	240	35	.11	9000	2	.167142857	12	2.99145299	717
H	240	35	.11	10000	2	.167142857	13	2.99145299	717
H	240	35	.11	1000	4	.224285714	1	2.22929936	535
H	240	35	.11	2000	4	.224285714	3	2.22929936	535
H	240	35	.11	3000	4	.224285714	5	2.22929936	535
H	240	35	.11	4000	4	.224285714	7	2.22929936	535
H	240	35	.11	5000	4	.224285714	9	2.22929936	535
H	240	35	.11	6000	4	.224285714	11	2.22929936	535
H	240	35	.11	7000	4	.224285714	13	2.22929936	535
H	240	35	.11	8000	4	.224285714	14	2.22929936	535
H	240	35	.11	9000	4	.224285714	16	2.22929936	535
H	240	35	.11	10000	4	.224285714	18	2.22929936	535

H	240	35	.11	2000	6	.281428571	4	1.77664975	426
H	240	35	.11	3000	6	.281428571	7	1.77664975	426
H	240	35	.11	4000	6	.281428571	9	1.77664975	426
H	240	35	.11	5000	6	.281428571	11	1.77664975	426
H	240	35	.11	6000	6	.281428571	14	1.77664975	426
H	240	35	.11	7000	6	.281428571	16	1.77664975	426
H	240	35	.11	8000	6	.281428571	18	1.77664975	426
H	240	35	.11	9000	6	.281428571	21	1.77664975	426
H	240	35	.11	10000	6	.281428571	23	1.77664975	426
H	240	35	.11	1000	8	.338571429	2	1.47679325	354
H	240	35	.11	2000	8	.338571429	5	1.47679325	354
H	240	35	.11	3000	8	.338571429	8	1.47679325	354
H	240	35	.11	4000	8	.338571429	11	1.47679325	354
H	240	35	.11	5000	8	.338571429	14	1.47679325	354
H	240	35	.11	6000	8	.338571429	16	1.47679325	354
H	240	35	.11	7000	8	.338571429	19	1.47679325	354
H	240	35	.11	8000	8	.338571429	22	1.47679325	354
H	240	35	.11	9000	8	.338571429	25	1.47679325	354
H	240	35	.11	10000	8	.338571429	28	1.47679325	354
H	240	35	.11	1000	10	.395714286	3	1.26353791	303
H	240	35	.11	2000	10	.395714286	6	1.26353791	303
H	240	35	.11	3000	10	.395714286	9	1.26353791	303
H	240	35	.11	4000	10	.395714286	13	1.26353791	303
H	240	35	.11	5000	10	.395714286	16	1.26353791	303
H	240	35	.11	6000	10	.395714286	19	1.26353791	303
H	240	35	.11	7000	10	.395714286	23	1.26353791	303
H	240	35	.11	8000	10	.395714286	26	1.26353791	303
H	240	35	.11	9000	10	.395714286	29	1.26353791	303
H	240	35	.11	10000	10	.395714286	33	1.26353791	303
H	240	35	.11	1000	12	.452857143	3	1.10410095	264
H	240	35	.11	2000	12	.452857143	7	1.10410095	264
H	240	35	.11	3000	12	.452857143	11	1.10410095	264
H	240	35	.11	4000	12	.452857143	15	1.10410095	264
H	240	35	.11	5000	12	.452857143	18	1.10410095	264
H	240	35	.11	6000	12	.452857143	22	1.10410095	264
H	240	35	.11	7000	12	.452857143	26	1.10410095	264
H	240	35	.11	8000	12	.452857143	30	1.10410095	264
H	240	35	.11	9000	12	.452857143	34	1.10410095	264
H	240	35	.11	10000	12	.452857143	37	1.10410095	264
H	240	35	.11	1000	14	.51	4	1	235
H	240	35	.11	2000	14	.51	8	1	235
H	240	35	.11	3000	14	.51	12	1	235
H	240	35	.11	4000	14	.51	17	1	235
H	240	35	.11	5000	14	.51	21	1	235
H	240	35	.11	6000	14	.51	25	1	235
H	240	35	.11	7000	14	.51	29	1	235
H	240	35	.11	8000	14	.51	34	1	235
H	240	35	.11	9000	14	.51	38	1	235
H	240	35	.11	10000	14	.51	42	1	235
H	240	35	.11	1000	16	.567142857	4	1	211
H	240	35	.11	2000	16	.567142857	9	1	211
H	240	35	.11	3000	16	.567142857	14	1	211
H	240	35	.11	4000	16	.567142857	18	1	211
H	240	35	.11	5000	16	.567142857	23	1	211
H	240	35	.11	6000	16	.567142857	28	1	211
H	240	35	.11	7000	16	.567142857	33	1	211
H	240	35	.11	8000	16	.567142857	37	1	211
H	240	35	.11	9000	16	.567142857	42	1	211
H	240	35	.11	10000	16	.567142857	47	1	211
H	240	35	.11	1000	18	.624285714	5	1	192
H	240	35	.11	2000	18	.624285714	10	1	192
H	240	35	.11	3000	18	.624285714	15	1	192
H	240	35	.11	4000	18	.624285714	20	1	192
H	240	35	.11	5000	18	.624285714	26	1	192
H	240	35	.11	6000	18	.624285714	31	1	192

H	240	35	.11	8000	18	.624285714	41	1	192
H	240	35	.11	9000	18	.624285714	46	1	192
H	240	35	.11	10000	18	.624285714	52	1	176
H	240	35	.11	1000	20	.681428571	5	1	176
H	240	35	.11	2000	20	.681428571	11	1	176
H	240	35	.11	3000	20	.681428571	17	1	176
H	240	35	.11	4000	20	.681428571	22	1	176
H	240	35	.11	5000	20	.681428571	28	1	176
H	240	35	.11	6000	20	.681428571	34	1	176
H	240	35	.11	7000	20	.681428571	39	1	176
H	240	35	.11	8000	20	.681428571	45	1	176
H	240	35	.11	9000	20	.681428571	51	1	176
H	240	35	.11	10000	20	.681428571	56	1	162
H	240	35	.11	1000	22	.738571429	6	1	162
H	240	35	.11	2000	22	.738571429	12	1	162
H	240	35	.11	3000	22	.738571429	18	1	162
H	240	35	.11	4000	22	.738571429	24	1	162
H	240	35	.11	5000	22	.738571429	30	1	162
H	240	35	.11	6000	22	.738571429	37	1	162
H	240	35	.11	7000	22	.738571429	43	1	162
H	240	35	.11	8000	22	.738571429	49	1	162
H	240	35	.11	9000	22	.738571429	55	1	162
H	240	35	.11	10000	22	.738571429	61	1	150
H	240	35	.11	1000	24	.795714286	6	1	150
H	240	35	.11	2000	24	.795714286	13	1	150
H	240	35	.11	3000	24	.795714286	20	1	150
H	240	35	.11	4000	24	.795714286	26	1	150
H	240	35	.11	5000	24	.795714286	33	1	150
H	240	35	.11	6000	24	.795714286	40	1	150
H	240	35	.11	7000	24	.795714286	46	1	150
H	240	35	.11	8000	24	.795714286	53	1	150
H	240	35	.11	9000	24	.795714286	60	1	150
H	240	35	.11	10000	24	.795714286	66	1	140
H	240	35	.11	1000	26	.852857143	7	1	140
H	240	35	.11	2000	26	.852857143	14	1	140
H	240	35	.11	3000	26	.852857143	21	1	140
H	240	35	.11	4000	26	.852857143	28	1	140
H	240	35	.11	5000	26	.852857143	35	1	140
H	240	35	.11	6000	26	.852857143	42	1	140
H	240	35	.11	7000	26	.852857143	50	1	140
H	240	35	.11	8000	26	.852857143	57	1	140
H	240	35	.11	9000	26	.852857143	64	1	140
H	240	35	.11	10000	26	.852857143	71	1	131
H	240	35	.11	1000	28	.91	7	1	131
H	240	35	.11	2000	28	.91	15	1	131
H	240	35	.11	3000	28	.91	22	1	131
H	240	35	.11	4000	28	.91	30	1	131
H	240	35	.11	5000	28	.91	38	1	131
H	240	35	.11	6000	28	.91	45	1	131
H	240	35	.11	7000	28	.91	53	1	131
H	240	35	.11	8000	28	.91	61	1	131
H	240	35	.11	9000	28	.91	68	1	131
H	240	35	.11	10000	28	.91	76	1	124
H	240	35	.11	1000	30	.967142857	8	1	124
H	240	35	.11	2000	30	.967142857	16	1	124
H	240	35	.11	3000	30	.967142857	24	1	124
H	240	35	.11	4000	30	.967142857	32	1	124
H	240	35	.11	5000	30	.967142857	40	1	124
H	240	35	.11	6000	30	.967142857	48	1	124
H	240	35	.11	7000	30	.967142857	56	1	124
H	240	35	.11	8000	30	.967142857	64	1	124
H	240	35	.11	9000	30	.967142857	72	1	124
H	240	35	.11	10000	30	.967142857	80	1	124

TYPE	CAP	SPEED	DOCK	DEMAND	DIST	TRIP TIME	NV	TRIPS/HR/VES.	SV
I	175	29	.07	1000	2	.138965517	1	3.59801489	629
I	175	29	.07	2000	2	.138965517	3	3.59801489	629
I	175	29	.07	3000	2	.138965517	4	3.59801489	629
I	175	29	.07	4000	2	.138965517	6	3.59801489	629
I	175	29	.07	5000	2	.138965517	7	3.59801489	629
I	175	29	.07	6000	2	.138965517	9	3.59801489	629
I	175	29	.07	7000	2	.138965517	11	3.59801489	629
I	175	29	.07	8000	2	.138965517	12	3.59801489	629
I	175	29	.07	9000	2	.138965517	14	3.59801489	629
I	175	29	.07	10000	2	.138965517	15	3.59801489	629
I	175	29	.07	1000	4	.207931034	2	2.40464345	420
I	175	29	.07	2000	4	.207931034	4	2.40464345	420
I	175	29	.07	3000	4	.207931034	7	2.40464345	420
I	175	29	.07	4000	4	.207931034	9	2.40464345	420
I	175	29	.07	5000	4	.207931034	11	2.40464345	420
I	175	29	.07	6000	4	.207931034	14	2.40464345	420
I	175	29	.07	7000	4	.207931034	16	2.40464345	420
I	175	29	.07	8000	4	.207931034	19	2.40464345	420
I	175	29	.07	9000	4	.207931034	21	2.40464345	420
I	175	29	.07	10000	4	.207931034	23	2.40464345	420
I	175	29	.07	1000	6	.276896552	3	1.80572852	316
I	175	29	.07	2000	6	.276896552	6	1.80572852	316
I	175	29	.07	3000	6	.276896552	9	1.80572852	316
I	175	29	.07	4000	6	.276896552	12	1.80572852	316
I	175	29	.07	5000	6	.276896552	15	1.80572852	316
I	175	29	.07	6000	6	.276896552	18	1.80572852	316
I	175	29	.07	7000	6	.276896552	22	1.80572852	316
I	175	29	.07	8000	6	.276896552	25	1.80572852	316
I	175	29	.07	9000	6	.276896552	28	1.80572852	316
I	175	29	.07	10000	6	.276896552	31	1.80572852	316
I	175	29	.07	1000	8	.345862069	3	1.44566301	252
I	175	29	.07	2000	8	.345862069	7	1.44566301	252
I	175	29	.07	3000	8	.345862069	11	1.44566301	252
I	175	29	.07	4000	8	.345862069	15	1.44566301	252
I	175	29	.07	5000	8	.345862069	19	1.44566301	252
I	175	29	.07	6000	8	.345862069	23	1.44566301	252
I	175	29	.07	7000	8	.345862069	27	1.44566301	252
I	175	29	.07	8000	8	.345862069	31	1.44566301	252
I	175	29	.07	9000	8	.345862069	35	1.44566301	252
I	175	29	.07	10000	8	.345862069	39	1.44566301	252
I	175	29	.07	1000	10	.414827586	4	1.20532003	210
I	175	29	.07	2000	10	.414827586	9	1.20532003	210
I	175	29	.07	3000	10	.414827586	14	1.20532003	210
I	175	29	.07	4000	10	.414827586	19	1.20532003	210
I	175	29	.07	5000	10	.414827586	23	1.20532003	210
I	175	29	.07	6000	10	.414827586	28	1.20532003	210
I	175	29	.07	7000	10	.414827586	33	1.20532003	210
I	175	29	.07	8000	10	.414827586	38	1.20532003	210
I	175	29	.07	9000	10	.414827586	42	1.20532003	210
I	175	29	.07	10000	10	.414827586	47	1.20532003	210
I	175	29	.07	1000	12	.483793103	5	1.03349964	180
I	175	29	.07	2000	12	.483793103	11	1.03349964	180
I	175	29	.07	3000	12	.483793103	16	1.03349964	180
I	175	29	.07	4000	12	.483793103	22	1.03349964	180
I	175	29	.07	5000	12	.483793103	27	1.03349964	180
I	175	29	.07	6000	12	.483793103	33	1.03349964	180
I	175	29	.07	7000	12	.483793103	38	1.03349964	180
I	175	29	.07	8000	12	.483793103	44	1.03349964	180
I	175	29	.07	9000	12	.483793103	50	1.03349964	180
I	175	29	.07	10000	12	.483793103	55	1.03349964	180

I	175	29	.07	2000	14	.552758621	12	1	158
I	175	29	.07	3000	14	.552758621	18	1	158
I	175	29	.07	4000	14	.552758621	25	1	158
I	175	29	.07	5000	14	.552758621	31	1	158
I	175	29	.07	6000	14	.552758621	37	1	158
I	175	29	.07	7000	14	.552758621	44	1	158
I	175	29	.07	8000	14	.552758621	50	1	158
I	175	29	.07	9000	14	.552758621	56	1	158
I	175	29	.07	10000	14	.552758621	63	1	158
I	175	29	.07	1000	16	.621724138	7	1	140
I	175	29	.07	2000	16	.621724138	14	1	140
I	175	29	.07	3000	16	.621724138	21	1	140
I	175	29	.07	4000	16	.621724138	28	1	140
I	175	29	.07	5000	16	.621724138	35	1	140
I	175	29	.07	6000	16	.621724138	42	1	140
I	175	29	.07	7000	16	.621724138	50	1	140
I	175	29	.07	8000	16	.621724138	57	1	140
I	175	29	.07	9000	16	.621724138	64	1	140
I	175	29	.07	10000	16	.621724138	71	1	140
I	175	29	.07	1000	18	.690689655	7	1	126
I	175	29	.07	2000	18	.690689655	15	1	126
I	175	29	.07	3000	18	.690689655	23	1	126
I	175	29	.07	4000	18	.690689655	31	1	126
I	175	29	.07	5000	18	.690689655	39	1	126
I	175	29	.07	6000	18	.690689655	47	1	126
I	175	29	.07	7000	18	.690689655	55	1	126
I	175	29	.07	8000	18	.690689655	63	1	126
I	175	29	.07	9000	18	.690689655	71	1	126
I	175	29	.07	10000	18	.690689655	79	1	126
I	175	29	.07	1000	20	.759655172	8	1	115
I	175	29	.07	2000	20	.759655172	17	1	115
I	175	29	.07	3000	20	.759655172	26	1	115
I	175	29	.07	4000	20	.759655172	34	1	115
I	175	29	.07	5000	20	.759655172	43	1	115
I	175	29	.07	6000	20	.759655172	52	1	115
I	175	29	.07	7000	20	.759655172	60	1	115
I	175	29	.07	8000	20	.759655172	69	1	115
I	175	29	.07	9000	20	.759655172	78	1	115
I	175	29	.07	10000	20	.759655172	86	1	115
I	175	29	.07	1000	22	.82862069	9	1	105
I	175	29	.07	2000	22	.82862069	19	1	105
I	175	29	.07	3000	22	.82862069	28	1	105
I	175	29	.07	4000	22	.82862069	38	1	105
I	175	29	.07	5000	22	.82862069	47	1	105
I	175	29	.07	6000	22	.82862069	57	1	105
I	175	29	.07	7000	22	.82862069	66	1	105
I	175	29	.07	8000	22	.82862069	76	1	105
I	175	29	.07	9000	22	.82862069	85	1	105
I	175	29	.07	10000	22	.82862069	95	1	105
I	175	29	.07	1000	24	.897586207	10	1	97
I	175	29	.07	2000	24	.897586207	20	1	97
I	175	29	.07	3000	24	.897586207	30	1	97
I	175	29	.07	4000	24	.897586207	41	1	97
I	175	29	.07	5000	24	.897586207	51	1	97
I	175	29	.07	6000	24	.897586207	61	1	97
I	175	29	.07	7000	24	.897586207	72	1	97
I	175	29	.07	8000	24	.897586207	82	1	97
I	175	29	.07	9000	24	.897586207	92	1	97
I	175	29	.07	10000	24	.897586207	103	1	97
I	175	29	.07	1000	26	.966551724	11	1	90
I	175	29	.07	2000	26	.966551724	22	1	90
I	175	29	.07	3000	26	.966551724	33	1	90
I	175	29	.07	4000	26	.966551724	44	1	90
I	175	29	.07	5000	26	.966551724	55	1	90
I	175	29	.07	6000	26	.966551724	66	1	90

I	175	29	.07	8000	26	.966551724	88	1	90
I	175	29	.07	9000	26	.966551724	100	1	90
I	175	29	.07	10000	26	.966551724	111	1	90
I	175	29	.07	1000	28	1.03551724	11	1	84
I	175	29	.07	2000	28	1.03551724	23	1	84
I	175	29	.07	3000	28	1.03551724	35	1	84
I	175	29	.07	4000	28	1.03551724	47	1	84
I	175	29	.07	5000	28	1.03551724	59	1	84
I	175	29	.07	6000	28	1.03551724	71	1	84
I	175	29	.07	7000	28	1.03551724	83	1	84
I	175	29	.07	8000	28	1.03551724	95	1	84
I	175	29	.07	9000	28	1.03551724	107	1	84
I	175	29	.07	10000	28	1.03551724	119	1	84
I	175	29	.07	1000	30	1.10448276	12	1	79
I	175	29	.07	2000	30	1.10448276	25	1	79
I	175	29	.07	3000	30	1.10448276	37	1	79
I	175	29	.07	4000	30	1.10448276	50	1	79
I	175	29	.07	5000	30	1.10448276	63	1	79
I	175	29	.07	6000	30	1.10448276	75	1	79
I	175	29	.07	7000	30	1.10448276	88	1	79
I	175	29	.07	8000	30	1.10448276	101	1	79
I	175	29	.07	9000	30	1.10448276	113	1	79
I	175	29	.07	10000	30	1.10448276	126	1	79

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TYPE	CAP	SPEED	DOCK	DEMAND	DIST	TRIP TIME	NV	TRIPS/HR/VES.	SV
J	200	42	.07	1000	2	.117619048	1	4.25101215	850
J	200	42	.07	2000	2	.117619048	2	4.25101215	850
J	200	42	.07	3000	2	.117619048	3	4.25101215	850
J	200	42	.07	4000	2	.117619048	4	4.25101215	850
J	200	42	.07	5000	2	.117619048	5	4.25101215	850
J	200	42	.07	6000	2	.117619048	7	4.25101215	850
J	200	42	.07	7000	2	.117619048	8	4.25101215	850
J	200	42	.07	8000	2	.117619048	9	4.25101215	850
J	200	42	.07	9000	2	.117619048	10	4.25101215	850
J	200	42	.07	10000	2	.117619048	11	4.25101215	850
J	200	42	.07	1000	4	.165238095	1	3.0259366	605
J	200	42	.07	2000	4	.165238095	3	3.0259366	605
J	200	42	.07	3000	4	.165238095	4	3.0259366	605
J	200	42	.07	4000	4	.165238095	6	3.0259366	605
J	200	42	.07	5000	4	.165238095	8	3.0259366	605
J	200	42	.07	6000	4	.165238095	9	3.0259366	605
J	200	42	.07	7000	4	.165238095	11	3.0259366	605
J	200	42	.07	8000	4	.165238095	13	3.0259366	605
J	200	42	.07	9000	4	.165238095	14	3.0259366	605
J	200	42	.07	10000	4	.165238095	16	3.0259366	605
J	200	42	.07	1000	6	.212857143	2	2.34899329	469
J	200	42	.07	2000	6	.212857143	4	2.34899329	469
J	200	42	.07	3000	6	.212857143	6	2.34899329	469
J	200	42	.07	4000	6	.212857143	8	2.34899329	469
J	200	42	.07	5000	6	.212857143	10	2.34899329	469
J	200	42	.07	6000	6	.212857143	12	2.34899329	469
J	200	42	.07	7000	6	.212857143	14	2.34899329	469
J	200	42	.07	8000	6	.212857143	17	2.34899329	469
J	200	42	.07	9000	6	.212857143	19	2.34899329	469
J	200	42	.07	10000	6	.212857143	21	2.34899329	469
J	200	42	.07	1000	8	.26047619	2	1.91956124	383
J	200	42	.07	2000	8	.26047619	5	1.91956124	383
J	200	42	.07	3000	8	.26047619	7	1.91956124	383
J	200	42	.07	4000	8	.26047619	10	1.91956124	383
J	200	42	.07	5000	8	.26047619	13	1.91956124	383
J	200	42	.07	6000	8	.26047619	15	1.91956124	383
J	200	42	.07	7000	8	.26047619	18	1.91956124	383
J	200	42	.07	8000	8	.26047619	20	1.91956124	383
J	200	42	.07	9000	8	.26047619	23	1.91956124	383
J	200	42	.07	10000	8	.26047619	26	1.91956124	383
J	200	42	.07	1000	10	.308095238	3	1.62287481	324
J	200	42	.07	2000	10	.308095238	6	1.62287481	324
J	200	42	.07	3000	10	.308095238	9	1.62287481	324
J	200	42	.07	4000	10	.308095238	12	1.62287481	324
J	200	42	.07	5000	10	.308095238	15	1.62287481	324
J	200	42	.07	6000	10	.308095238	18	1.62287481	324
J	200	42	.07	7000	10	.308095238	21	1.62287481	324
J	200	42	.07	8000	10	.308095238	24	1.62287481	324
J	200	42	.07	9000	10	.308095238	27	1.62287481	324
J	200	42	.07	10000	10	.308095238	30	1.62287481	324
J	200	42	.07	1000	12	.355714286	3	1.40562249	281
J	200	42	.07	2000	12	.355714286	7	1.40562249	281
J	200	42	.07	3000	12	.355714286	10	1.40562249	281
J	200	42	.07	4000	12	.355714286	14	1.40562249	281
J	200	42	.07	5000	12	.355714286	17	1.40562249	281
J	200	42	.07	6000	12	.355714286	21	1.40562249	281
J	200	42	.07	7000	12	.355714286	24	1.40562249	281
J	200	42	.07	8000	12	.355714286	28	1.40562249	281
J	200	42	.07	9000	12	.355714286	32	1.40562249	281
J	200	42	.07	10000	12	.355714286	35	1.40562249	281
J	200	42	.07	1000	14	.403333333	4	1.23966942	247
J	200	42	.07	2000	14	.403333333	8	1.23966942	247

J	200	42	.07	4000	14	.403333333	16	1.23966942	247
J	200	42	.07	5000	14	.403333333	20	1.23966942	247
J	200	42	.07	6000	14	.403333333	24	1.23966942	247
J	200	42	.07	7000	14	.403333333	28	1.23966942	247
J	200	42	.07	8000	14	.403333333	32	1.23966942	247
J	200	42	.07	9000	14	.403333333	36	1.23966942	247
J	200	42	.07	10000	14	.403333333	40	1.23966942	247
J	200	42	.07	1000	16	.450952381	4	1.10876452	221
J	200	42	.07	2000	16	.450952381	9	1.10876452	221
J	200	42	.07	3000	16	.450952381	13	1.10876452	221
J	200	42	.07	4000	16	.450952381	18	1.10876452	221
J	200	42	.07	5000	16	.450952381	22	1.10876452	221
J	200	42	.07	6000	16	.450952381	27	1.10876452	221
J	200	42	.07	7000	16	.450952381	31	1.10876452	221
J	200	42	.07	8000	16	.450952381	36	1.10876452	221
J	200	42	.07	9000	16	.450952381	40	1.10876452	221
J	200	42	.07	10000	16	.450952381	45	1.10876452	221
J	200	42	.07	1000	18	.498571429	5	1.00286533	200
J	200	42	.07	2000	18	.498571429	10	1.00286533	200
J	200	42	.07	3000	18	.498571429	15	1.00286533	200
J	200	42	.07	4000	18	.498571429	20	1.00286533	200
J	200	42	.07	5000	18	.498571429	25	1.00286533	200
J	200	42	.07	6000	18	.498571429	30	1.00286533	200
J	200	42	.07	7000	18	.498571429	35	1.00286533	200
J	200	42	.07	8000	18	.498571429	40	1.00286533	200
J	200	42	.07	9000	18	.498571429	45	1.00286533	200
J	200	42	.07	10000	18	.498571429	50	1.00286533	200
J	200	42	.07	1000	20	.546190476	5	1	183
J	200	42	.07	2000	20	.546190476	10	1	183
J	200	42	.07	3000	20	.546190476	16	1	183
J	200	42	.07	4000	20	.546190476	21	1	183
J	200	42	.07	5000	20	.546190476	27	1	183
J	200	42	.07	6000	20	.546190476	32	1	183
J	200	42	.07	7000	20	.546190476	38	1	183
J	200	42	.07	8000	20	.546190476	43	1	183
J	200	42	.07	9000	20	.546190476	49	1	183
J	200	42	.07	10000	20	.546190476	54	1	183
J	200	42	.07	1000	22	.593809524	5	1	168
J	200	42	.07	2000	22	.593809524	11	1	168
J	200	42	.07	3000	22	.593809524	17	1	168
J	200	42	.07	4000	22	.593809524	23	1	168
J	200	42	.07	5000	22	.593809524	29	1	168
J	200	42	.07	6000	22	.593809524	35	1	168
J	200	42	.07	7000	22	.593809524	41	1	168
J	200	42	.07	8000	22	.593809524	47	1	168
J	200	42	.07	9000	22	.593809524	53	1	168
J	200	42	.07	10000	22	.593809524	59	1	168
J	200	42	.07	1000	24	.641428571	6	1	155
J	200	42	.07	2000	24	.641428571	12	1	155
J	200	42	.07	3000	24	.641428571	19	1	155
J	200	42	.07	4000	24	.641428571	25	1	155
J	200	42	.07	5000	24	.641428571	32	1	155
J	200	42	.07	6000	24	.641428571	38	1	155
J	200	42	.07	7000	24	.641428571	45	1	155
J	200	42	.07	8000	24	.641428571	51	1	155
J	200	42	.07	9000	24	.641428571	58	1	155
J	200	42	.07	10000	24	.641428571	64	1	155
J	200	42	.07	1000	26	.689047619	6	1	145
J	200	42	.07	2000	26	.689047619	13	1	145
J	200	42	.07	3000	26	.689047619	20	1	145
J	200	42	.07	4000	26	.689047619	27	1	145
J	200	42	.07	5000	26	.689047619	34	1	145
J	200	42	.07	6000	26	.689047619	41	1	145
J	200	42	.07	7000	26	.689047619	48	1	145
J	200	42	.07	8000	26	.689047619	55	1	145

J	200	42	.07	10000	26	.689047619	68	1	145
J	200	42	.07	1000	29	.736666667	7	1	135
J	200	42	.07	2000	29	.736666667	14	1	135
J	200	42	.07	3000	29	.736666667	22	1	135
J	200	42	.07	4000	29	.736666667	29	1	135
J	200	42	.07	5000	29	.736666667	37	1	135
J	200	42	.07	6000	29	.736666667	44	1	135
J	200	42	.07	7000	29	.736666667	51	1	135
J	200	42	.07	8000	29	.736666667	59	1	135
J	200	42	.07	9000	29	.736666667	66	1	135
J	200	42	.07	10000	29	.736666667	74	1	135
J	200	42	.07	1000	30	.784285714	7	1	127
J	200	42	.07	2000	30	.784285714	15	1	127
J	200	42	.07	3000	30	.784285714	23	1	127
J	200	42	.07	4000	30	.784285714	31	1	127
J	200	42	.07	5000	30	.784285714	39	1	127
J	200	42	.07	6000	30	.784285714	47	1	127
J	200	42	.07	7000	30	.784285714	55	1	127
J	200	42	.07	8000	30	.784285714	62	1	127
J	200	42	.07	9000	30	.784285714	70	1	127
J	200	42	.07	10000	30	.784285714	78	1	127

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