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2/a INTERIM TECHNICAL REPORT

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2/ ALTERNATE RECOMMENDATIONS FOR ACCESS TO THE PROPOSED GATEWAY NATIONAL RECREATION AREA

January, 1972
Tri-State Regional Planning Commission
100 Church Street
New York, New York 10007

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These reports are considered preliminary and must be subject to review and comment before being presented to the Commission for approval, if such a course is indicated.

This report was organized and the work coordinated by Floyd Lapp, Project Manager for Gateway. Appendix A was prepared by Al Litwornia, Transportation Engineer 1 under the direction of James N. Wilson, Transportation Engineer 2 and Appendices B and C were prepared by Charles S. Henry Jr., Transportation Engineer 2 and Michael Glikin, Transportation Technican 4.

The body of the report summarizes the information in the Appendices.

ALTERNATE RECOMMENDATIONS FOR ACCESS TO THE PROPOSED GATEWAY NATIONAL RECREATION AREA

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1. BACKGROUND

The Gateway National Recreation Area as proposed by the National Park Service includes Breezy Point, Jamaica Bay, Floyd Bennett Field and Sandy Hook. The proposal includes a ferry system as indicated in Map 1.

In August, 1971 the National Park Service requested that Tri-State study the possible methods of delivering visitors to Breezy Point via land transportation. In November the analysis was broadened to include Sandy Hook.

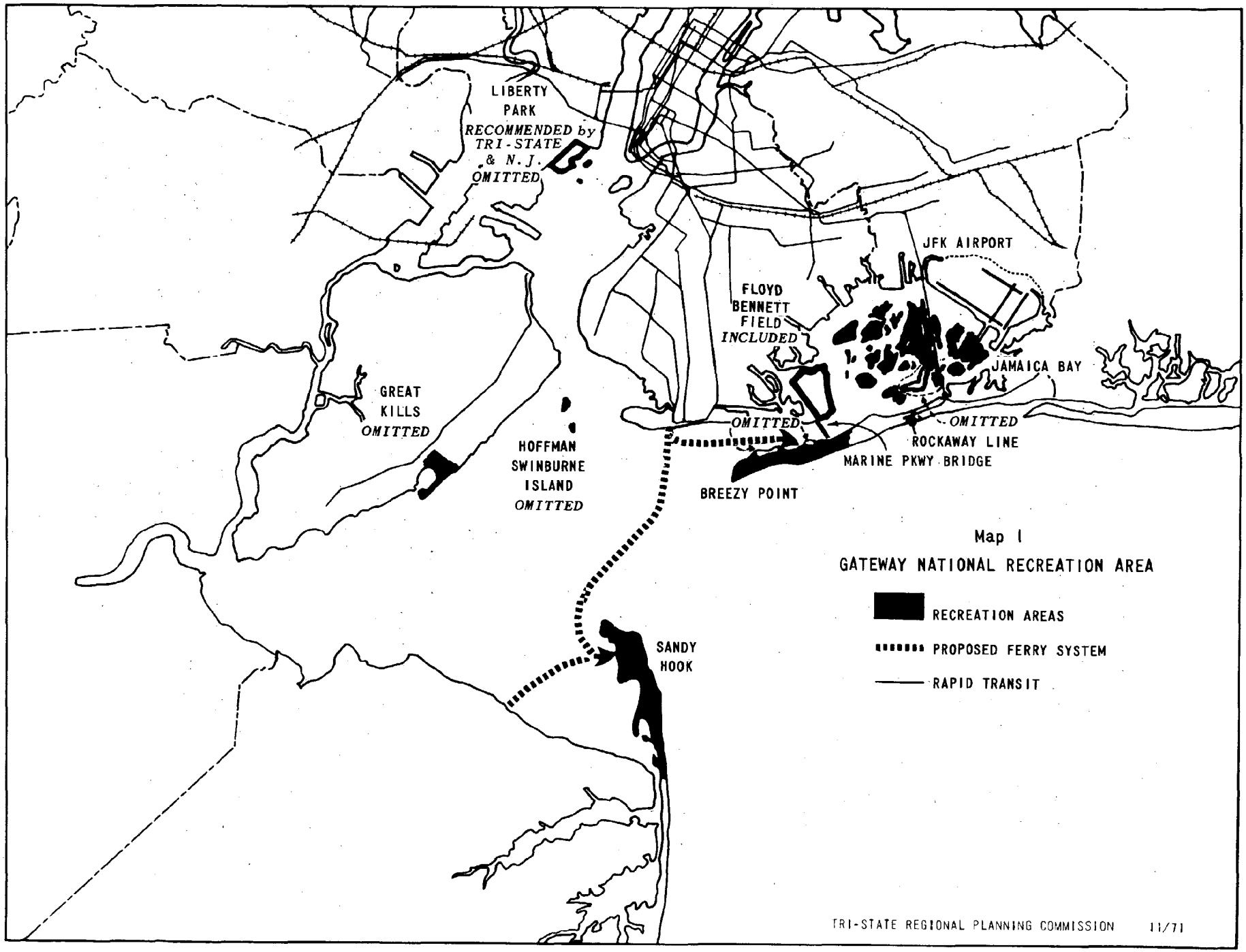
Phase I of the Gateway development is scheduled for a ten year period and emphasizes Breezy Point and Sandy Hook. Daily capacity is estimated at 180,000 persons; 130,000 for Breezy Point and 50,000 for Sandy Hook. Assuming periods for arrival and departure spread over five hours each, hourly demand at Breezy Point is estimated at 26,000 and Sandy Hook 10,000. The probable season will be approximately 13 to 14 weeks or 91 to 98 days between the Memorial and Labor Day weekends.

Seasonal use of these recreational facilities precludes any high cost, fixed capital transportation projects that would serve only recreation. Most of the proposed park locations are either on islands, hooks, or peninsulas and this limited space should discourage the introduction of the automobile to the park environment. Furthermore, 1.5 million families in the urban centers around Gateway have little or no access to automobiles.

Marine ferry operations could provide convenient site access for at least some of the users with a larger proportion to Sandy Hook. Bus service should be emphasized since it involves limited capital investment, can be initiated relatively rapidly, and lends itself to staging and seasonal use. This analysis makes a distinction between immediate or limited capital investment proposals and ultimate or long range recommendations. The limited capital investment proposals are emphasized since they are related to the ten year Phase I development.

II. BREEZY POINT

The immediate upland connections to the area are the Shore Parkway, Flatbush Avenue, Marine Parkway Bridge and Beach Channel Drive. Typical traffic activities - shopping at Kings Plaza, J.F.K. International Airport, recreational trips to Long Island, corridor traffic to the Verrazano-Narrows Bridge, intense residential and commercial development along Flatbush Avenue,


LIBERTY PARK
RECOMMENDED by TRI-STATE & N.J.
OMITTED
JFK AIRPORT
FLOYD BENNETT FIELD
INCLUDED
JAMAICA BAY
GREAT KILLS
OMITTED
HOFFMAN SWINBURNE ISLAND
OMITTED
OMITTED
OMITTED
ROCKAWAY LINE
MARINE PKWY BRIDGE
BREEZY POINT
SANDY HOOK
Map I
GATEWAY NATIONAL RECREATION AREA
RECREATION AREAS
PROPOSED FERRY SYSTEM
RAPID TRANSIT
TRI-STATE REGIONAL PLANNING COMMISSION 11/71

and recreational traffic on Beach Channel Drive - tend to produce significant summer traffic in the area. A more round-about but perhaps promising route uses Cross Bay Boulevard and Cross Bay Bridge to the Rockaway Peninsula. The Marine Parkway and Cross Bay Bridges are the only two practical routes to Breezy Point.

A. Highway Access (Detailed analysis is in Appendix A)

If the projected number of visitors are to be delivered, it will be necessary to take measures such as the following to increase passenger movements on highways leading to Breezy Point:

1. On the Marine Parkway Route

   (a) Reversible lanes and preferential signal progressions should be instituted on Flatbush Avenue.

   (b) The toll plaza on the Marine Parkway Bridge should be improved.

   (c) Buses should be given preferential treatment on the Marine Parkway Bridge. This bridge does not have the capacity for a lane reserved exclusively for buses.

2. On the Cross Bay Route

   (a) Reversible lanes and preferential signal progressions should be instituted on Beach Channel Drive and Cross Bay Boulevard to utilize the existing additional capacity on Cross Bay Bridge and thereby make maximum use of this route to the Park.

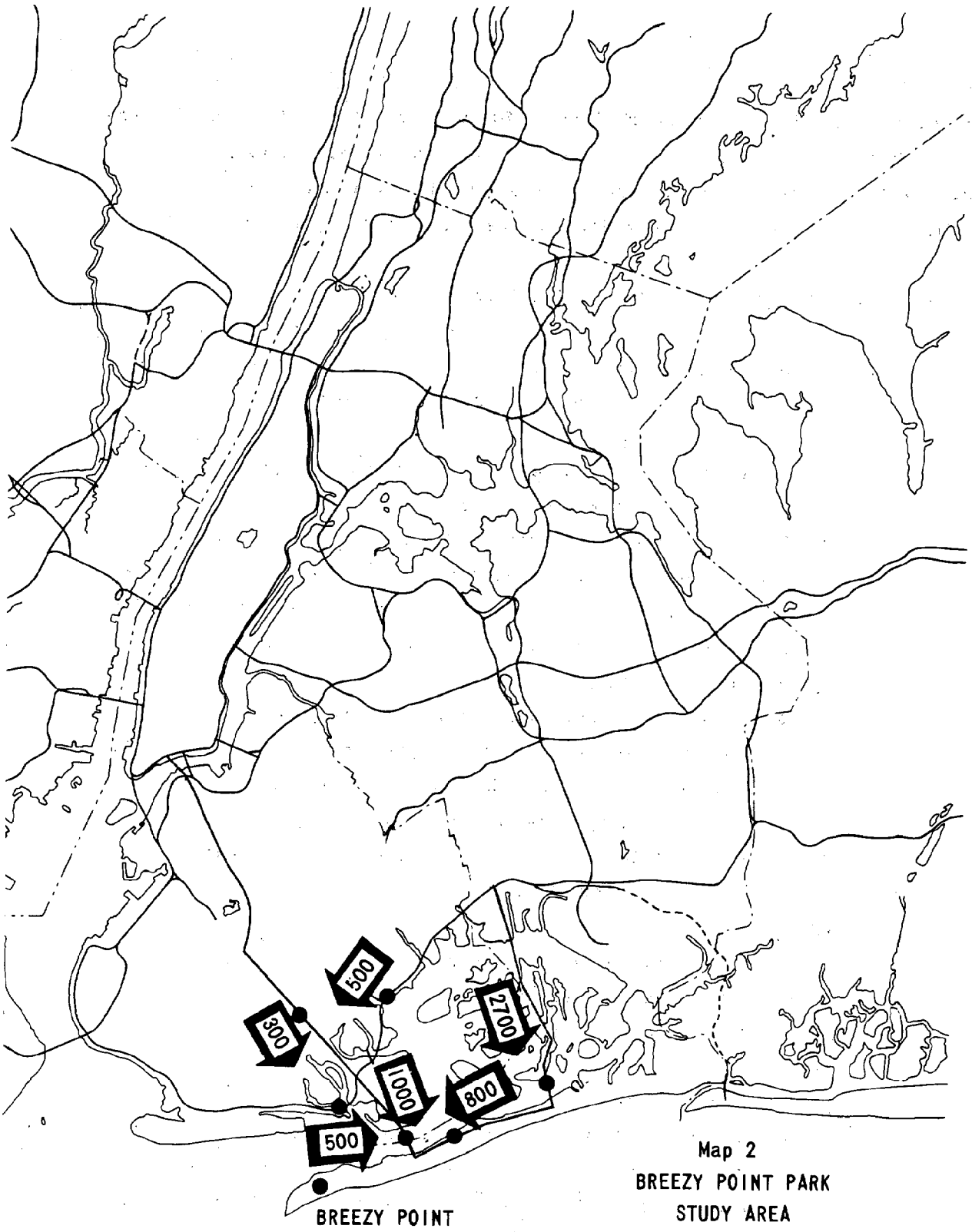
   (b) Preferential bus lanes should be instituted on Beach Channel Drive and Cross Bay Boulevard.

3. Shore Parkway

The Shore Parkway is a feeder route to the Marine Parkway and Cross Bay bridges. Ramp monitoring should be implemented for bus priority.

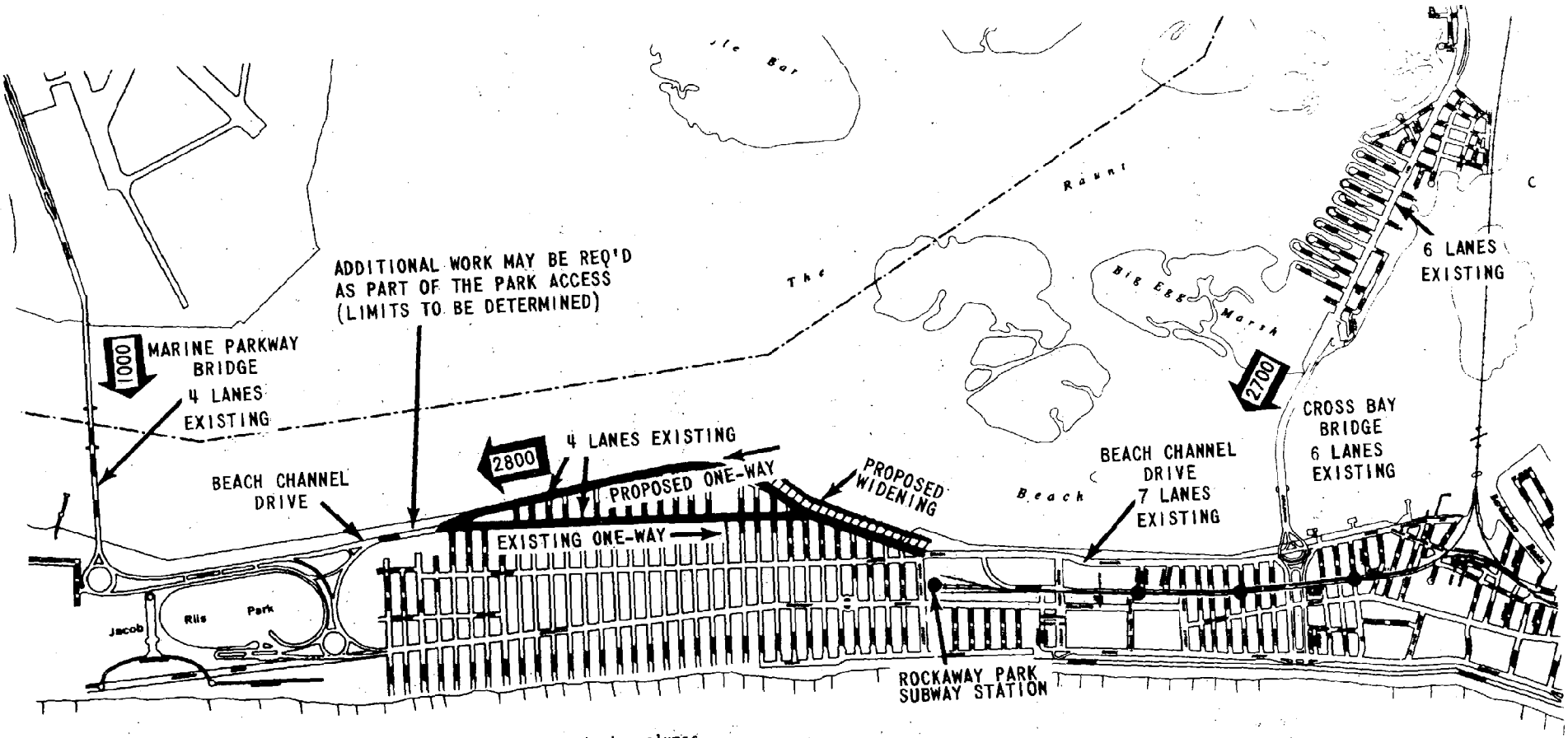
4. Beach Channel Drive

Beach Channel Drive is another connecting route between the Marine Parkway and Cross Bay routes. The route requires improvements such as the institution of signal progressions to assume smooth flowing traffic on all of the existing lanes.



Map 2
BREEZY POINT PARK
STUDY AREA

NOTE: Numbess within arrows indicate volumes in cars per hour of additional inbound capacities presently existing.



NOTE: Numbers within arrows indicate volumes in cars per hour of additional inbound capacities available after improvements are implemented.

Map 3
BREEZY POINT PARK

B. Subway Access

The delivery capacity by automobile and bus outlined above will not be enough to handle the projected number of visitors without further improvements. Additional visitors could be delivered via the subway system to a point on the Rockaway Peninsula and from there to the park by way of a new shuttle bus service. Still more visitors could be handled by picking up subway riders at the nearest station on the mainland and shuttling them by bus over the Marine Parkway Bridge to the Park.

C. Shuttle Bus Alternatives

There are two general alternatives for handling bus passengers once they reach Breezy Point; a bus terminal or buses serving as an internal distribution system (Appendix B).

A bus terminal could be located in a portion of the existing Jacob Riis Park lot. Arrivals would unload passengers and leave the bus terminal for either another trip or storage at Floyd Bennett Field.

A second alternative would be to operate an internal distribution system at Breezy Point. Stations would be placed at approximately half mile intervals and near central recreation areas. Pedestrian underpasses or overpasses would be constructed.

Our calculations indicate that these transportation services could collectively deliver the estimated daily capacity of 130,000 visitors to Breezy Point.

III. PROPOSED ACCESS TO SANDY HOOK

The existing State park at Sandy Hook now attracts 12,500 persons on a peak summer day. As part of Gateway, the daily capacity for Sandy Hook is estimated by the National Park Service at 50,000 persons. Assuming periods for arrival and departure at Sandy Hook spread over five hours each, the estimated hourly demand for the additional 37,500 persons is 7,500 persons.

Tri-State's minimum path analysis observed the following existing system:

A. Nearly all north Jersey zones north of Route 3 feed into the Port Authority bus terminal with passengers transfering to express buses to Sandy Hook.

B. Newark and Elizabeth serve as transfer points for Essex and Union Counties.

C. The PATH corridor from Exchange Place to the Penn-Central Station feeds into Newark.

D. New Brunswick and Perth Amboy zones travel to Sandy Hook via local bus.

E. If demand warrants, a local bus line could also be provided from Plainfield.

F. Hudson County zones south of Journal Square travel via Staten Island and ferry to Sandy Hook as does all of Richmond and South Brooklyn.

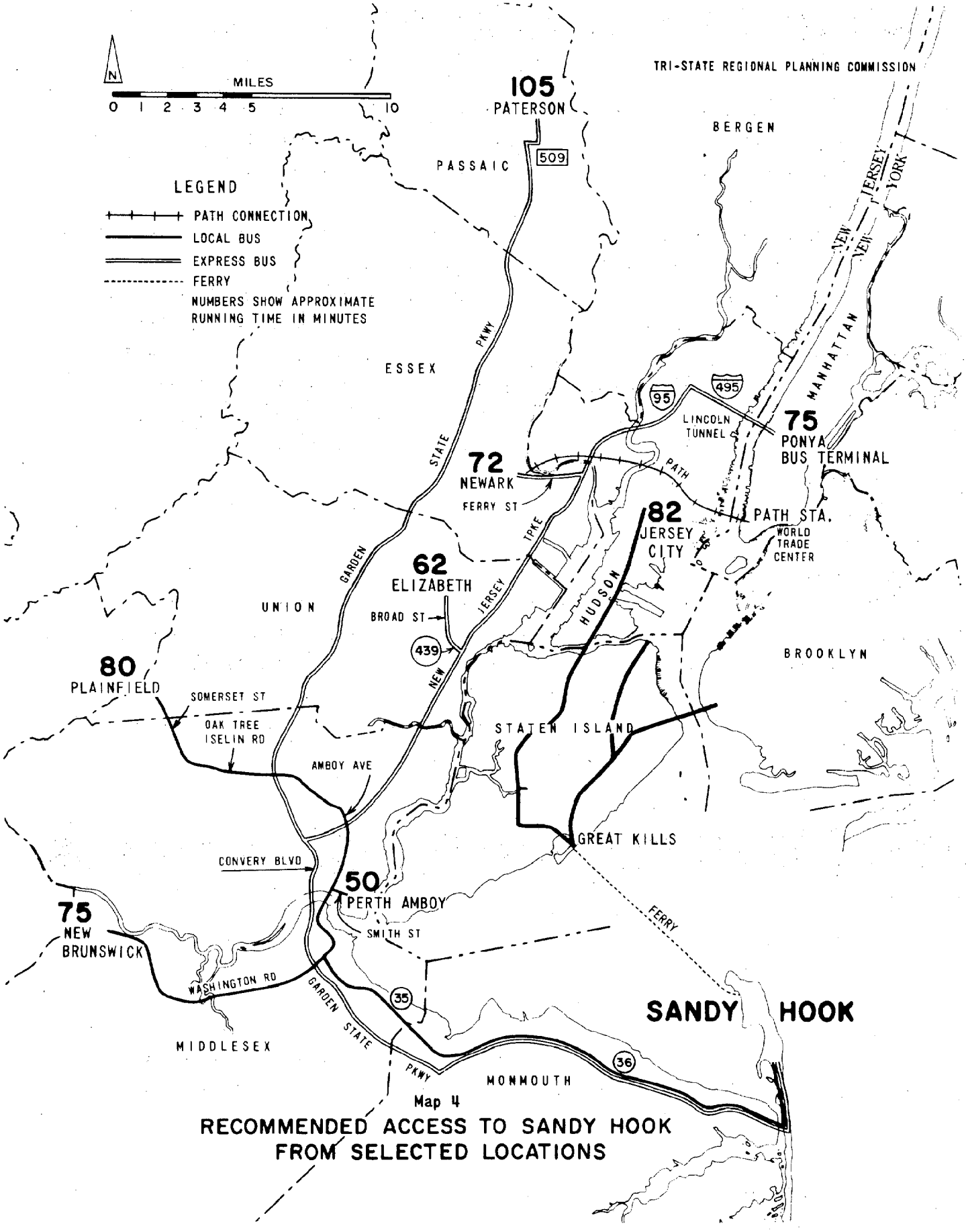
Tri-State recommends that the additional estimated hourly demand of 7,500 persons to Sandy Hook be distributed between a ferry service from Great Kills (2,000 persons per hour) and local and express bus service from selected locations (5,500 persons per hour).

Ferry from Great Kills to Sandy Hook

Our analysis indicates that ferry service from Great Kills to Sandy Hook would be attractive primarily for residents of Staten Island, southern Hudson County and Brooklyn. Thus we recommend only one ferry with a capacity of 2,000 passengers. Assuming the ferry speed at 15 miles per hour and allocating time for loading and unloading, we estimate the time for the ferry trip at 40 minutes. The cost of the ferry trip would be 65 cents.

Bus from Selected Locations

We recommend moving the remaining 5,500 persons to Sandy Hook by bus from selected locations as illustrated in Map 4. Estimated running time ranges from 50 minutes (Perth Amboy) to 105 minutes (Paterson). The round trip express bus fare is $2.30. Assuming 50 persons per bus, 550 buses would be required overall to move the 5,500 persons an hour during the peak. There is a supply of approximately 4,000 buses in New Jersey with one-third ,1,300 buses, operating on a weekend. Of the remaining 2,700 buses less than 20 percent of the available supply of buses in New Jersey (550) would be needed for service to Sandy Hook.



Map 4

RECOMMENDED ACCESS TO SANDY HOOK FROM SELECTED LOCATIONS

The approach road to Sandy Hook is Route 36, a four lane arterial. The roadway has jughandles at all traffic signals, as the 13 mile segment of roadway traverses heavily developed communities along the north shore of Monmouth County. Route 36 can accomodate an additional 110 buses an hour (equivalent to 220 automobiles) realizing that service will not be of the highest quality. The available capacity during the peak inbound (300 vehicles per hour) and outbound (400 vehicles per hour) at key locations on Route 36 will be eased with coming improvements to the Garden State Parkway. These improvements will be in three stages and completion is scheduled in advance of major additional development at Sandy Hook.

Stage 1, from the New Jersey Turnpike south over the Raritan River to the Raritan Toll Plaza, will provide ten lanes (five lanes in each direction) and is scheduled to be open by June, 1972.

Stage 2, from the Raritan Toll Plaza south to Keyport, will provide ten lanes (five in each direction). These ten lanes will consist of four interior express lanes (two in each direction) and six exterior local lanes (three in each direction). Construction is estimated for completion in June, 1974.

Stage 3, from Keyport to Asbury Park, consists of providing ten lanes as in Stage 2. Construction is estimated for completion in five years.

If the estimated daily capacity at Sandy Hook substantially exceeds 50,000 persons, additional ferries could be needed along with highway improvements.

APPENDIX A

HIGHWAY ACCESS

TRAFFIC VOLUME ANALYSIS

Breezy Point is presently served by the four-lane Marine Parkway Bridge and the four-lane Beach Channel Drive. The Marine Parkway Bridge with a width of 44 ft. can be operated with reversible lanes (3inbound and 1 outbound) and thus a peak-hour inbound capacity of 4,500 cars per hour vs. an actual 3,500 cars per hour. Bridge openings are neglegible; an average of only one bridge opening per Sunday with an average open time of 5 minutes. Traffic trend data was studied to observe the variation in volumes and verify the counts. Weekly traffic variations were plotted (Figure 1) noting the portion of the volume attributed to the Riis Parking Field. The average annual traffic (AADT) was found to be 24,665 for 1970. Monthly and daily factors were developed in reference to the AADT and are shown in Table 1. This showed July and August being the peak months with Sundays having the peak volumes. The average daily variations for July are shown in Figure 2. The high-hour southbound volume on the Marine Parkway Bridge of 3,500 cars per hour between 1:00 and 2:00 PM on a Sunday in July (Figure 3) was similar to the hourly variations at Jacob - Riis Parking Field (Figure 4), the Atlantic Beach Bridge (Figure 5), and the Cross Bay Bridge (Figure 6). The volumes were ascertained to be typical and the factors developed for the Marine Parkway Bridge were used in estimating traffic at nearby locations. Beach Channel Drive was found to have an estimated inbound volume of 1,200 vs. a capacity of 2,000 cars per hour or an available inbound capacity of 800 cars per hour.

Among the reasons why these inbound capacities on Beach Channel Drive and on the Marine Parkway Bridge are not fully utilized now are the inadequacy of the toll booths at the Marine Parkway Bridge and the high volumes on the arterials feeding the Marine Parkway Bridge. The Shore Parkway has an estimated two-way volume of 4,000 vs. a capacity of 4,500 cars per hour for each direction. Flatbush Avenue north of the Shore Parkway between Avenues "S" and "T" has an estimated inbound volume of 1100 vs. a capacity of 1400 cars per hour. Thus, the inbound capacity on the major roadways feeding the Marine Parkway Bridge as shown in Table 2, is seen to be 1300 cars per hour (Flatbush Ave., 300SB, Shore Parkway, 500NB, 500SB) which is similar to the available capacity on the Marine Parkway Bridge (1,000 cars per hour). With Beach Channel Drive's additional capacity of 800 cars per hour, the total existing inbound capacity to Breezy Point Park is seen to be 1800 cars per hour.

It should be noted that due to the stochastic nature of traffic, the capacity on the Shore Parkway and Flatbush Avenue is exceeded for short periods and practically speaking is at capacity. This is especially true during the PM peak period when the observed hourly volumes show a tendency to remain peaked near capacity for long periods of time, a characteristic of overloaded roadways (Figure 7). If volumes in excess of capacity are introduced, large traffic jams will develop, and accident rates will soar. If the recommendations for improving highway access are implemented, inbound capacities on Beach Channel Drive will be 1,800 cars per hour and 1,000 cars per hour on the Marine Parkway Bridge (Table 3).

UTILIZATION OF CAPACITY

The hourly demand at Breezy Point is 26,000 people per hour. If only buses are utilized to service this demand, and each bus carries 50 people, there would be a requirement for 520 buses per hour (26,000/50). Assuming each bus is equivalent to 2 cars, an additional inbound capacity of 1040 cars per hour would be required. The inbound capacities available for the various proposals are as follows:

Breezy Point - Additional Inbound Capacities Available (Cars/hour)

Facility	Existing Conditions	Interim Plan A	Interim Plan B
Marine Parkway Bridge	1000	1000	1000
Beach Channel Drive	800	1800	2800
Total	1800	2800	3800

Preferential bus treatment is seen to be possible under each of the above categories as all have a total additional inbound capacity greater than 1040 cars per hour. The critical aspect becomes one of providing adequate capacity on the Shore Parkway as well as providing for the automobile traffic that normal growth in the area will produce.

The additional available capacities under the recommendations provide the normal growth as well as optimizing traffic operation by producing a safer and more efficient roadway system. This includes the maximum utilization of the Cross Bay Bridge in servicing the park by assuring adequate roadway capacities of all portions of Beach Channel Drive between the Cross Bay Bridge and Breezy Point.

SUMMARY

Even though roadways in the area are presently heavily traveled, the park may be served by the planned use of buses and the proposed bus shuttle in conjunction with the discouragement of automobile traffic in the park. The critical aspect of highway access to the park is the capacity of the Shore Parkway. No park development should be undertaken unless the interim improvements, including ramp monitoring on the Shore Parkway, are implemented, otherwise the area will be congested from 10:00 AM until after midnight on the summer weekends. The park should be developed in stages and the stages opened to the public as additional roadway capacity is developed. Busses should be given preferential treatment. The possibility of scheduling busses over the Cross Bay Bridge should be investigated as the bridge has the greatest available capacity. To assure the successful implementation of the various suggested improvements, the institution of an inter-governmental task force may be necessary. The proposed task force can best handle bus scheduling, thereby assuring maximum utilization of facilities. A bus shuttle between the Rockaway Park Subway Station and Breezy Point appears possible and deserves more intensive study. Bus shuttle between Breezy Point and other subway stations may be possible and should be investigated.

TABLE A - 1

MARINE PARKWAY BRIDGE - 1970 - DAILY AND MONTHLY FACTORS

Month	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday	Monthly Factor
January	.49	.70	.65	.64	.70	.71	.69	.68
February	.70	.68	.67	.69	.74	.78	.70	.72
March	.72	.83	.78	.79	.80	.89	.90	.81
April	.83	.81	.83	.80	.84	1.00	1.21	.90
May	.87	.89	.93	.95	1.01	1.20	1.23	1.02
June	1.14	1.16	1.13	1.08	1.14	1.36	1.63	1.23
July	1.51	1.49	1.42	1.28	1.38	1.63	2.08	1.51
August	1.42	1.35	1.44	1.51	1.56	1.63	2.00	1.54
September	1.06	1.02	1.04	1.05	1.06	1.29	1.35	1.09
October	.85	.84	.84	.78	.84	.86	.96	.88
November	.78	.81	.81	.85	.84	.90	.87	.84
December	.78	.76	.78	.78	.76	.78	.78	.78

1970 AADT = 24,665

TABLE A - 2

AVAILABLE CAPACITIES FOR MAJOR ROADWAYS PROVIDING ACCESS TO THE PROPOSED BREEZY POINT PARK FOR AN AVERAGE SUNDAY IN JULY 1971 FROM 1 - 2 P.M.

Facility	Dir.	Lanes	Cap.	Vol.	v/c	Avail. Capacity
Marine Parkway Bridge	NB	1	1500	1200	.80	300
	SB	3	4500	3500	.78	1000
Shore Parkway @ Flatbush Avenue	NB	3	4500	4000*	.89	500
	SB	3	4500	4000*	.89	500
Flatbush Avenue Between Aves. "S"&"T"	NB	2	1400	1100*	.78	300
	SB	2	1400	1100*	.78	300
Beach Channel Drive @ Beach 134th St.	NB	2	2000	1200 *	.60	800
	SB	2	2000	1200 *	.60	800

Note- Asterisk denotes volume was estimated from traffic counts taken by the NYS DOT and factors developed from Marine Parkway Bridge volumes taken by T.B.T.A.

Figure A - 1
MARINE PARKWAY BRIDGE
1970 WEEKLY TRAFFIC VARIATIONS

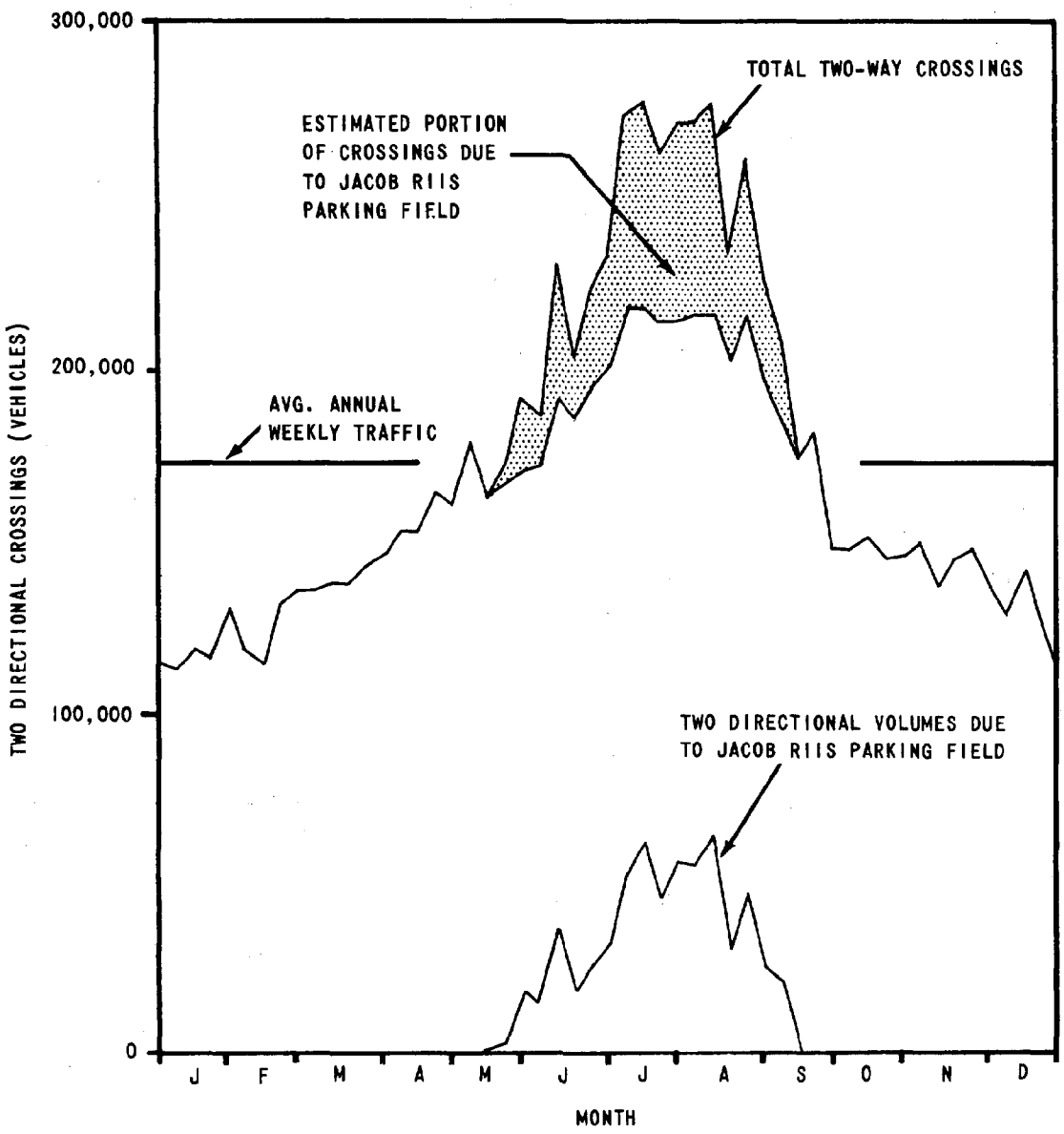


Figure A - 2
MARINE PARKWAY BRIDGE
DAILY TRAFFIC VARIATIONS
JULY 1970

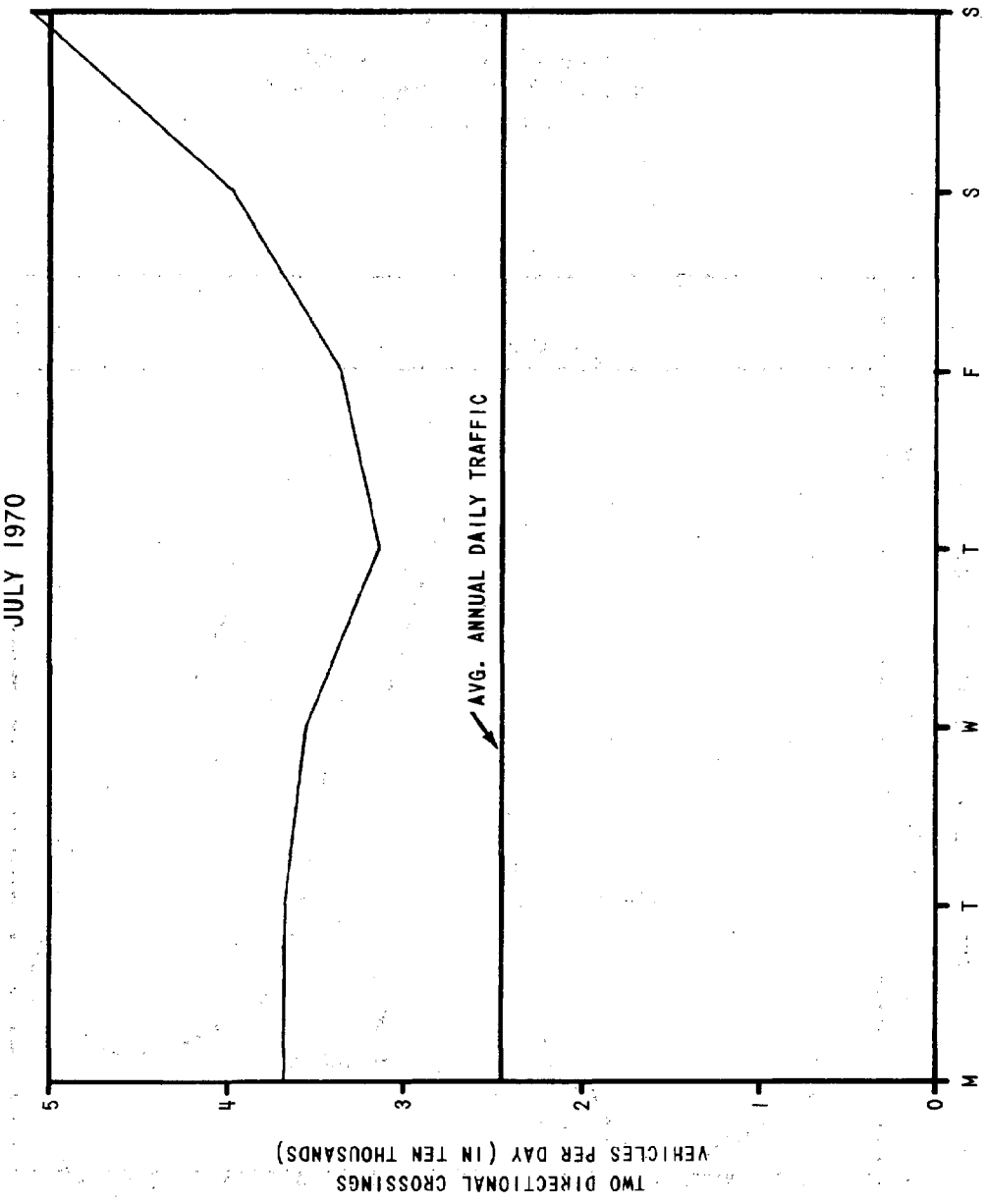


Figure A - 3

MARINE PARKWAY BRIDGE
HOURLY DIRECTIONAL TRAFFIC
SUNDAY AUG. 8, 1971

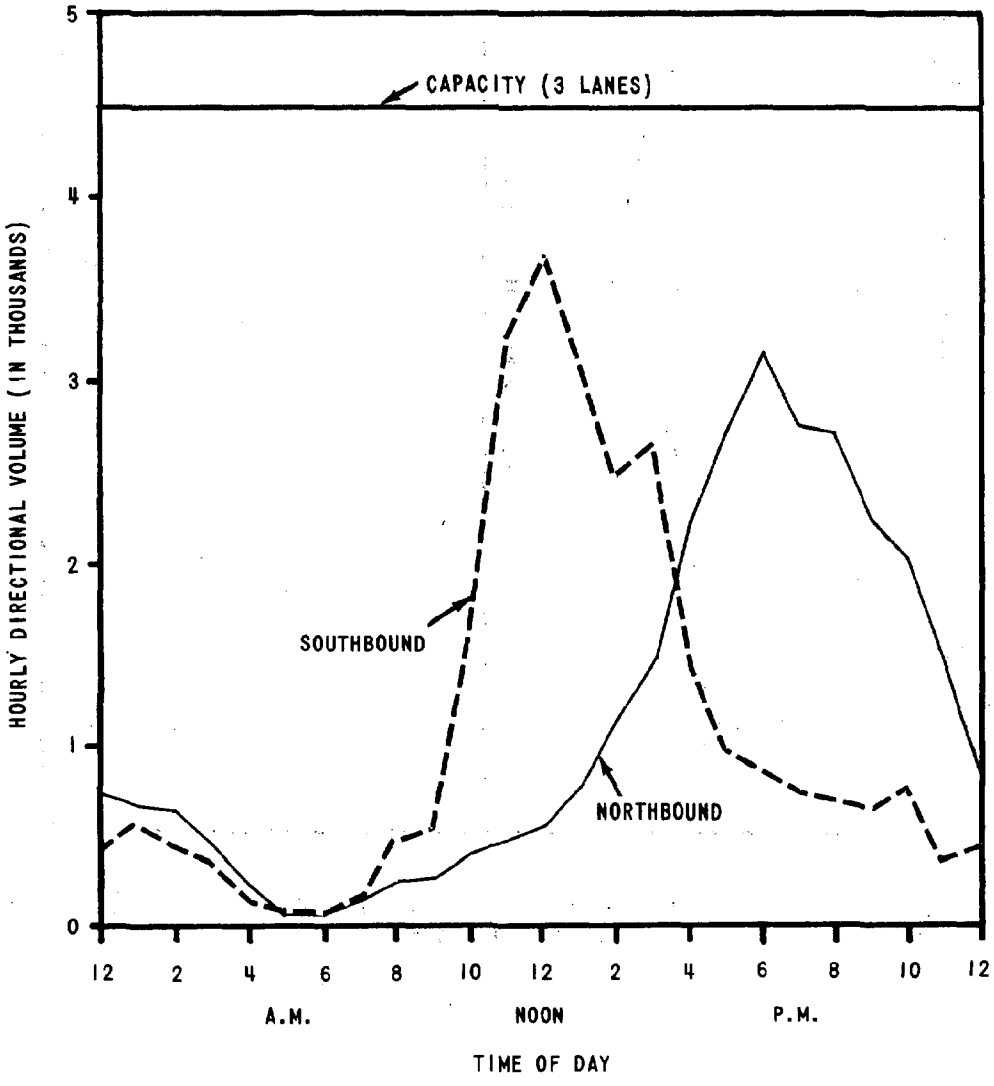


Figure A - 4
JACOB RIIS PARKING FIELD
HOURLY VARIATIONS FOR ENTERING VEHICLES
SUNDAY JULY 19, 1970

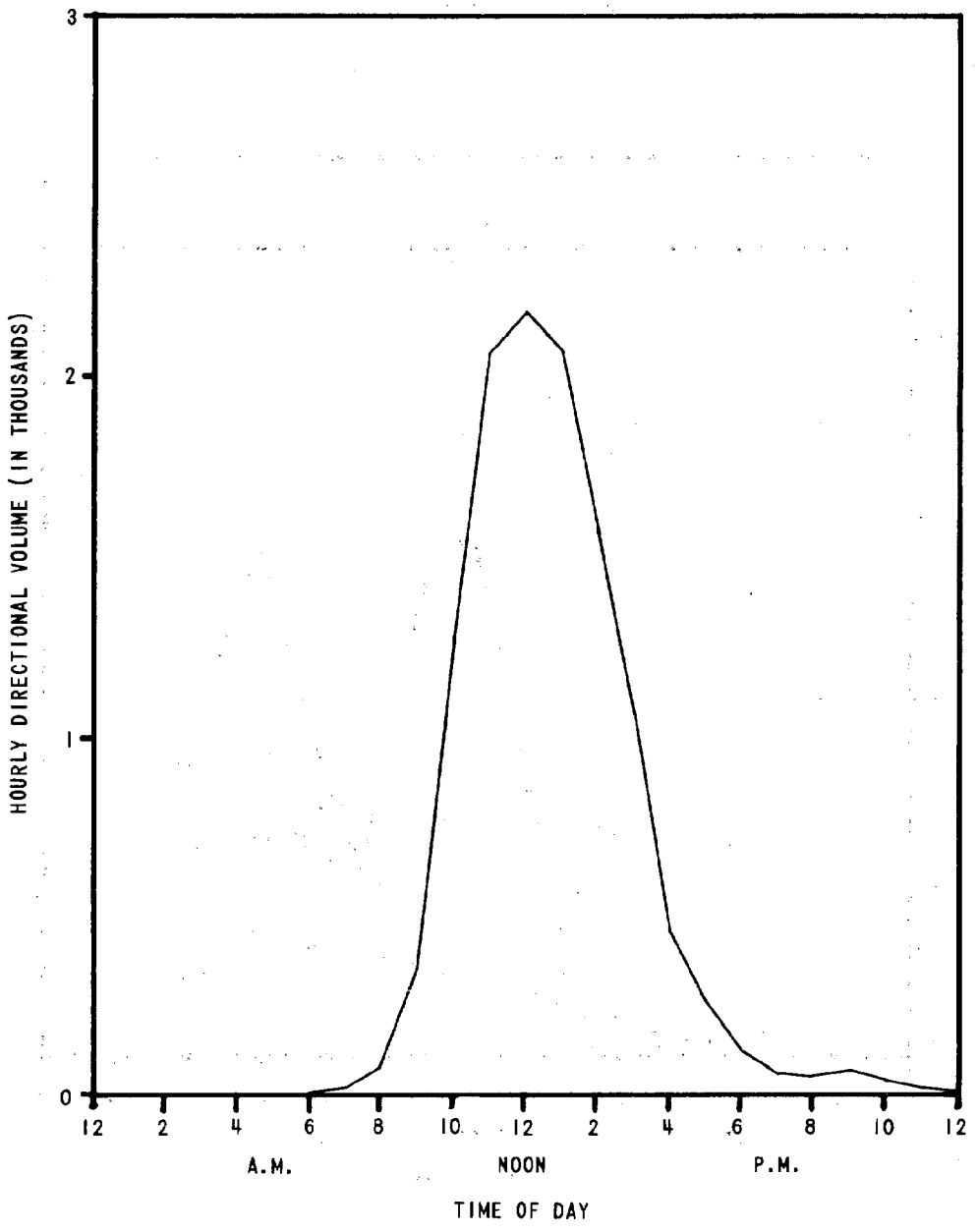


Figure A - 5
ATLANTIC BEACH BRIDGE
HOURLY DIRECTIONAL TRAFFIC
SUNDAY JUNE 27, 1971

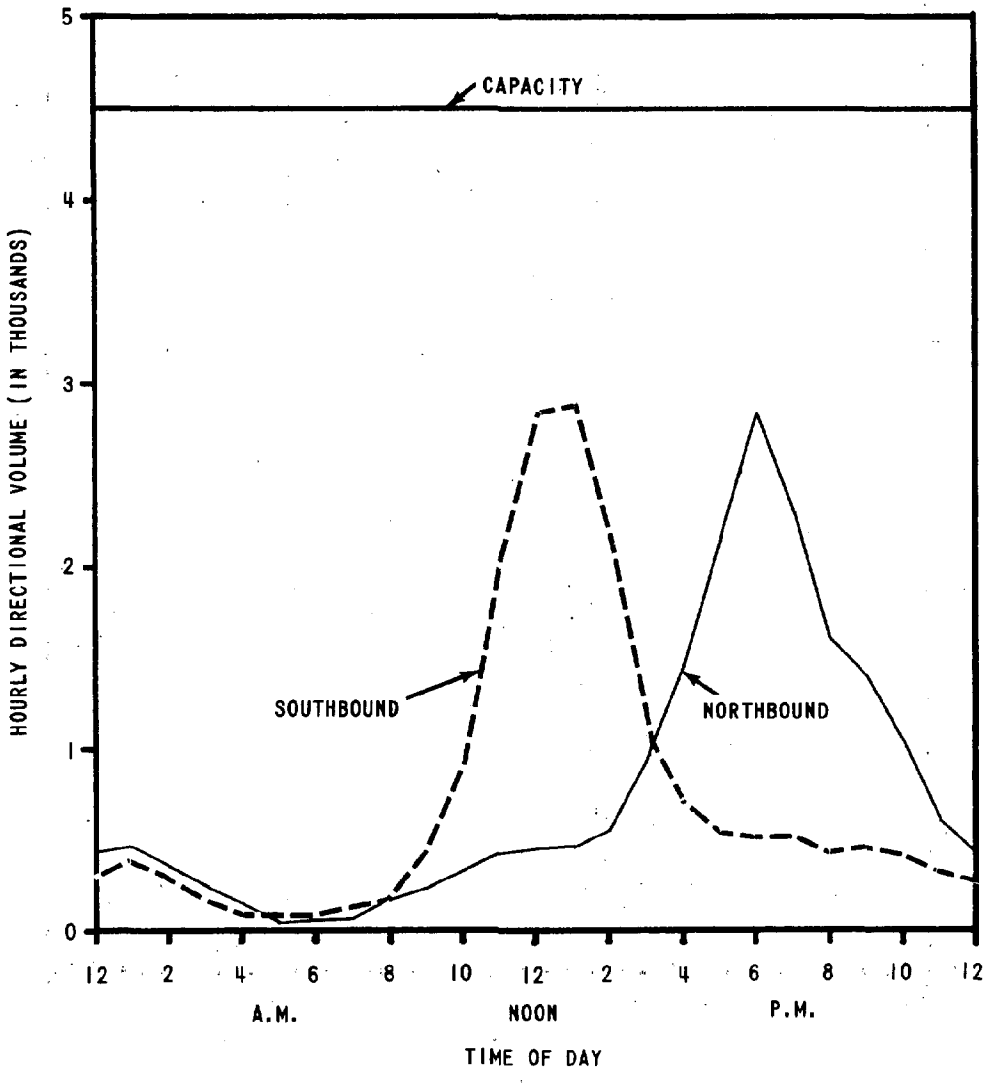


Figure A - 6
CROSS BAY BRIDGE
HOURLY DIRECTIONAL TRAFFIC
SUNDAY AUG. 8, 1971

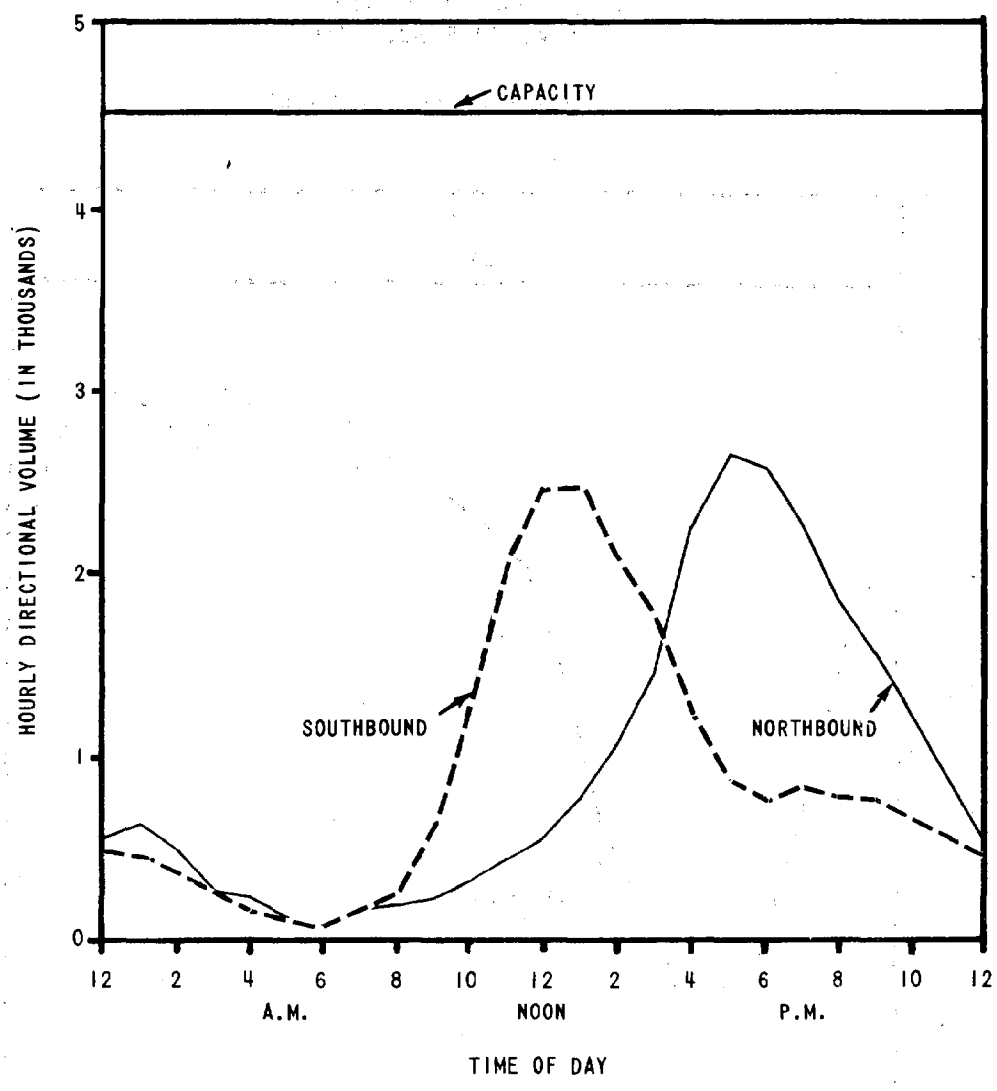
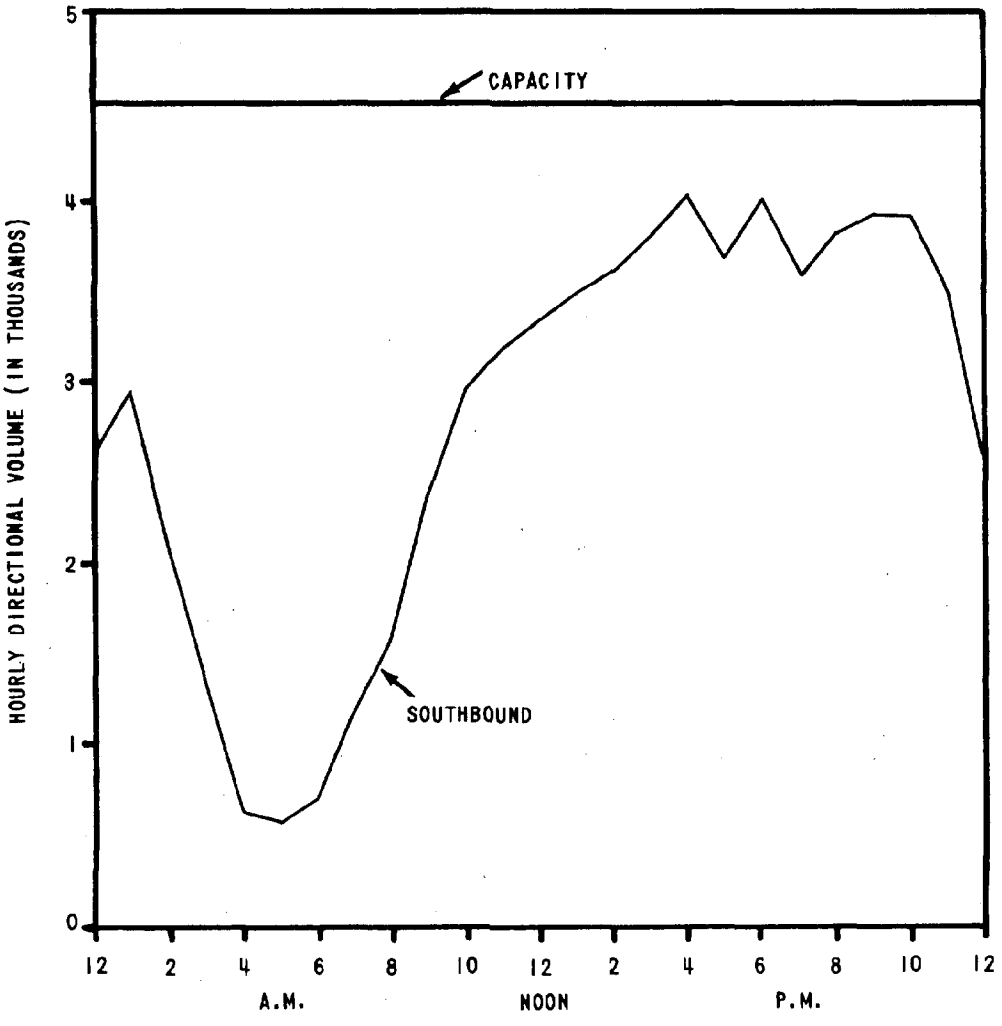


Figure A - 7
THE SHORE PARKWAY
HOURLY TRAFFIC VARIATIONS
SUNDAY JUNE 30, 1968

(BETWEEN FLATBUSH AVE. & KNAPP ST.)



APPENDIX B

SCALING THE BUS TERMINAL PROBLEM FOR BREEZY POINT TRANSIT ACCESS

SCALING THE BUS TERMINAL PROBLEM FOR BREEZY POINT TRANSIT ACCESS

There are two basic purposes for this report. They are: a) to detail a bus terminal or terminal situation capable of handling a projected daily volume of 130,000 visitors by transit at the Breezy Point recreation area, b) to detail bus utilization figures for the estimated 2600 bus vehicle trips to Breezy Point from designated city areas and subway connections.

There are two general alternatives for handling bus passengers at Breezy Point; a bus terminal, or buses serving as an internal distribution system. The first alternative, illustrated in Fig. 1, could be located in a portion of the existing Jacob Riis Park auto lot, or other suitable area. This terminal would be adjacent to a station on the internal distribution system in the Breezy Point area.

As stated before, 2600 bus trips would be necessary to transport the passenger load. Buses on routes from in-city points would enter or leave the terminal at a rate of 520 buses per hour over a 5 hour period.

Buses would leave from ten platforms at a rate of 52 buses per platform/hour.

Operating with a fare prepayment system, such as pre-platform collection, return tickets sold on inbound buses, turnstile collection or a token system, a 50 passenger bus could be loaded in a 3 minute period of time.

With five positions per lane, each of 10 platforms could theoretically dispatch 100 bus departures per hour, or 1000 buses per hour for the entire terminal. Expected hourly volumes would be 52 bus departures per lane, or 520 buses per hour through the terminal. Arrivals would unload at any available platform and leave the terminal immediately for either another trip or storage at Floyd Bennett Field.

The extra capacity of the terminal would be utilized in the event of an unexpected peak load due to rainstorms or an unusual event. Starters at each platform would notify the dispatcher at Floyd Bennett to send additional buses. Normally, 3 of the 5 positions per lane would be loading simultaneously.

Physically the terminal would consist of 10 bus lanes plus peripheral roadways. Ramp access for the adjacent internal distribution station would be provided, along with prepayment facilities. Bus lanes would be 430' long and 25' wide. Platform width would be 12'; terminal size would be 430 x 370 or 159,100 square feet. 1,290 square feet of peripheral roadway would be necessary for access to and from the exclusive bus lane.

A second alternative, as illustrated in Fig 2, would be to operate the internal distribution system at Breezy Point with the express bus system. After entering the system, buses would proceed over a 4 lane roadway with five stations, each of 10 bus capacity. A theoretical hourly capacity of 1000 buses would be possible as the system would have the same amount of loading positions as a central terminal (5 stations x 10 bus positions compared with 10 lanes x 5 bus positions). Loading time of 3 minutes would be the same as in Alternative 1. In addition, a sixth station would serve the auto parking lot, with 5 buses operating as shuttles within the system. Buses to Gateway could also be utilized for internal distribution shuttles as needed between runs, as the largest concentration of people in the recreation areas would be during the hours between arrival and departure.

Stations would be placed about 1/2 mile apart near central recreation areas. Prepayment would be in effect at all stations with turnstile payment at the parking lot station. In addition, pedestrian underpasses or overpasses would be placed 1/2 mile apart to allow access to Breezy Point open space and other areas at 1/4 mile intervals. As in Alternative 1, buses would leave the system after dropping off their last passengers and return for another trip, go into intra-park service or return to the Floyd Bennett storage area.

Figure B-1

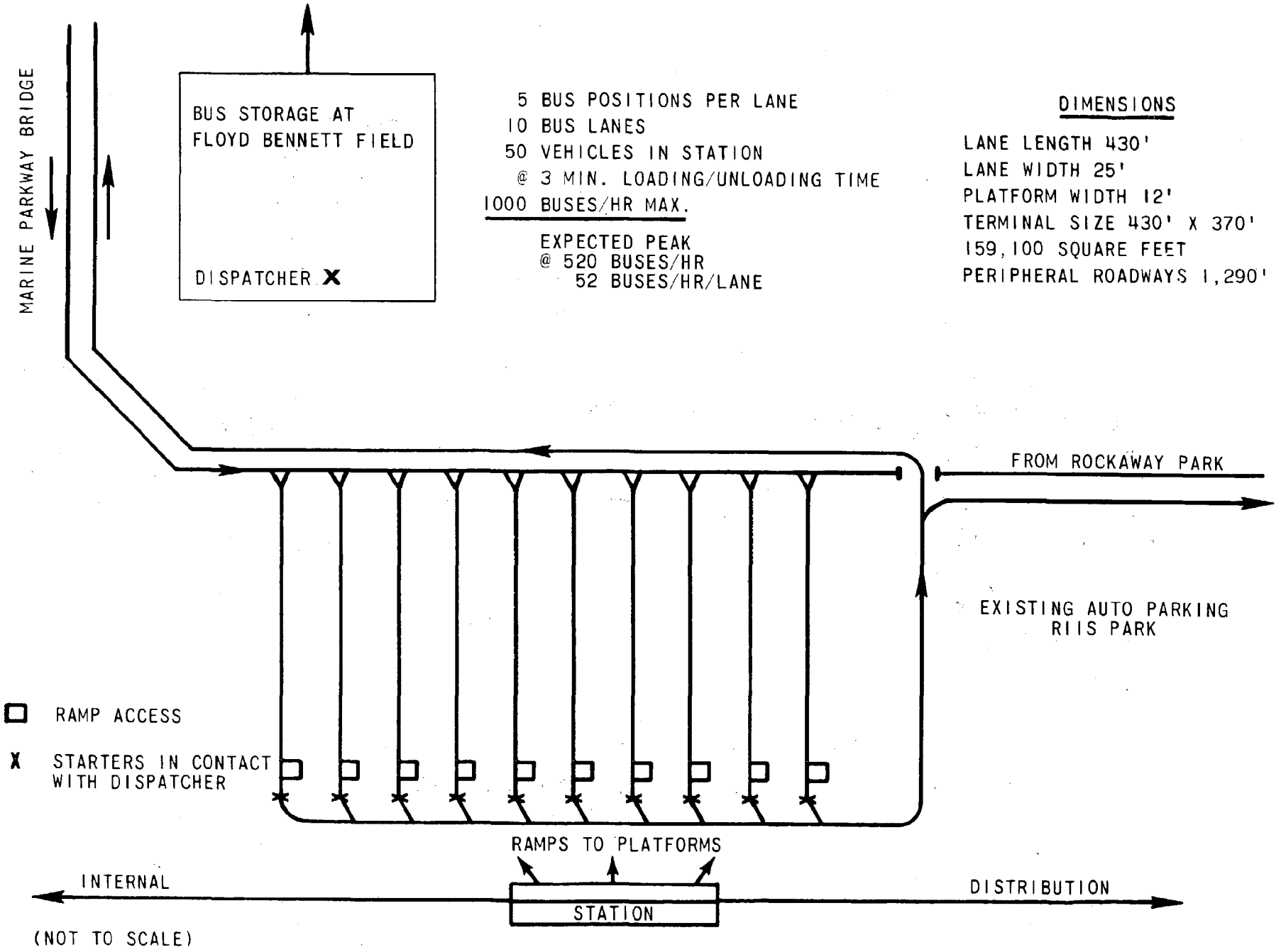
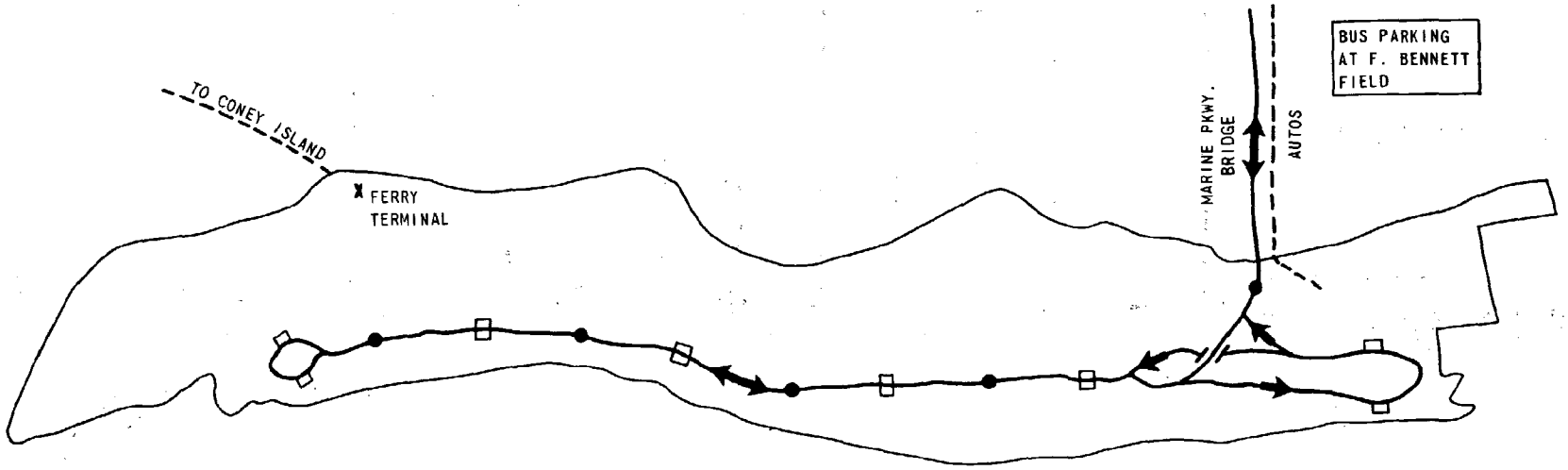
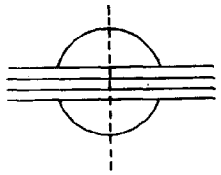

MARINE PARKWAY BRIDGE
BUS STORAGE AT
FLOYD BENNETT FIELD
DISPATCHER X
5 BUS POSITIONS PER LANE
10 BUS LANES
50 VEHICLES IN STATION
@ 3 MIN. LOADING/UNLOADING TIME
1000 BUSES/HR MAX.
EXPECTED PEAK
@ 520 BUSES/HR
52 BUSES/HR/LANE
DIMENSIONS
LANE LENGTH 430'
LANE WIDTH 25'
PLATFORM WIDTH 12'
TERMINAL SIZE 430' X 370'
159,100 SQUARE FEET
PERIPHERAL ROADWAYS 1,290'
FROM ROCKAWAY PARK
EXISTING AUTO PARKING
RIIS PARK
RAMP ACCESS
X STARTERS IN CONTACT WITH DISPATCHER
RAMPS TO PLATFORMS
INTERNAL
DISTRIBUTION
STATION
(NOT TO SCALE)

Figure B-2
BREEZY POINT BUS DISTRIBUTION SYSTEM





STATION DETAIL

STATION SPACING ± MILE
10 BUS CAPACITY
OFF 4 LANE ROAD
PEDESTRIAN UNDER/OVERPASS

ESTIMATED TRAFFIC:
520 BUSES/HR DURING PEAK PERIODS
SYSTEM CAPACITY: 1000 BUSES/HR

⊓ STATION
● PEDESTRIAN UNDER/OVERPASS
x FERRY TERMINAL

FEET
SCALE
0 _____ 2000

APPENDIX C

MINIMUM PATH ANALYSIS FOR BREEZY POINT TRANSIT ACCESS

In the course of our analysis of transportation requirements, it became necessary to test several routes for shuttle buses and a transit-ferry combination. Tri-State's 110 network of 1963 bus and subway routes in the region provided a basic framework for this analysis.

Two methods of reaching Breezy Point by transit already existed in the network, Flatbush & Nostrand-Riis Park and Rockaway-Riis Park bus routes, both of which connect with subway lines. Under Gateway, an estimated 130,000 visitors by transit daily would enter the park at Breezy Point during peak periods. In order to reflect this additional patronage, it was necessary to decrease headway on the two lines.

The first step in the network analysis was to run a minimum path "tree" from Breezy Point using the existing (110) network. Available network routes of the final approach to the Gateway area were routes Q35 Nostrand Ave. (IRT)-Riis Park and Q22 Rockaway Park (IND)-Riis Park. Results from the run indicated that a large proportion of trips to Breezy Point, without any changes to existing bus or subway routes, would be assigned to IRT subway to Flatbush and Nostrand and then shuttle bus to Breezy Point. A few closer-in zones in Brooklyn and Queens use bus transportation for their entire trip, transferring to the Q22 or Q35 for their final approach to Breezy Point.

Nearly 90% of all trips to Breezy Point chose the Flatbush IRT and Q35 bus, the other 10% being divided between Rockaway IND-Q22 and the all bus routings. Much of this disparity between the use of IRT Flatbush and IND Rockaway lines can be explained by higher friction on the Rockaway line due to longer headways and a double fare. Also calculated were minimum path values to Coney Island (Stillwell Ave. subway station), which enabled us to manually determine frictions from in-city zones to Breezy Point via ferry from Coney Island after adding a constant value to represent combined running time, access time and fare for a new ferry link. It was determined that many Staten Island zones and a number of Brooklyn zones would use bus and ferry for their trips.

As a check, the ferry link was coded into the network and a tree was run combining existing shuttle lines to Riis Park with the ferry route from Coney Island. Results of the run showed all zones from Staten Island going to Breezy Point via bus and ferry, and several zones in Brooklyn, convenient to subway routes to Coney Island, traveling via ferry, with all other city points utilizing subway and shuttle bus. Under an expanded shuttle bus system, there would be even fewer zones traveling via ferry.

A more extensive system, as shown in Fig. 1, was then coded and run on our addreviated network to determine minimum paths to Breezy Point via various routes. There were three changes to bus lines in the network, with subway headways and fares remaining constant at that time.

1. Route Q35 Flatbush and Nostrand (IRT)-Breezy Point: Headway reduced to 2', 10¢ zone fare across Marine Parkway Bridge eliminated, and access time reduced to 2' at Breezy Point end. (This also assumes a convenient terminal situation.)

2. Route Q22 Rockaway Park (IND) - Breezy Point: Headway reduced to 2', access time reduced to 2' at Breezy Point end, and new route link to represent the line as far as Rockaway Park only; Route Q22 continues up Rockaway Peninsula in the existing network.

3. Route B3-Ave. U, Brooklyn serving the three BMT and on IND subway lines that terminate in Coney Island: Headway reduced to 2' and frictionless transfer introduced between B3 and Q35 routes at Ave. U and Flatbush Ave. to stimulate through bus trip from Ave. U to Breezy Point. It has been suggested that this route use Ave. P rather than Ave. U in Brooklyn to avoid traffic congestion.

Results of this run show some relief to the Flatbush IRT-Shuttle bus routing, with about 25% of all zones or most of Southern Brooklyn, Bay Ridge, some parts of East New York and part of Flatbush, riding Coney Island oriented subway or bus lines and the Ave. U shuttle. In addition, 90% of Staten Island zones travel via R-7 bus and 4th Avenue-Sea Beach subway to connect with the Ave. U line. Travel via the Rockaway line is still low, due to continued double fares and long subway headways. The 12% of all zones traveling via this route come from the Rockaway Peninsula, part of East New York, and most of southern Queens, including the South Jamaica poverty area. See Table 1 for a detailed comparison of travel times from selected in-city zones between the existing system and the more extensive shuttle system described above.

The minimum path analysis of these three routes to Breezy Point gave us an indication of the distribution of passengers over the more extensive routes that have been proposed to handle an estimated 120,000 daily visitors to Gateway at peak periods. Subsequent ideas for testing were developed in conjunction with the New York City Transportation Administration. These included:

1. Express Bus Route-Harlem-Breezy Point
2. Limited Stop Bus - Queens Plaza-Breezy Point via Woodhaven Blvd.
3. Limited Stop Bus - Main St. Flushing-Breezy Point via Jamaica
4. Limited Stop Bus - East New York-Breezy Point
5. Extension of Brooklyn-Staten Island Route R-7 to 25th Street and Avenue U for connection with Avenue U-Breezy Point Shuttle

An assignment was run to include the above lines in our expanded shuttle system plus a Coney Island-Breezy Point Ferry. First, a minimum path analysis was run to Breezy Point (Zone 154). Then, the total population of each zone was coded into the network as destined to Breezy Point. For the purposes of this report, cumulative populations on links leading to Breezy Point will be referred to as "tributary population"; which would equal total population of each zone tributary to those links. While it is quite evident that different proportions of zone populations would travel to Breezy Point, depending on each zone's location, a much more detailed analysis would be necessary to determine these proportions. Short of this, the simplified assignment of tributary population, as illustrated in Figure 2, yields much useful information.

Following is a line-by-line analysis of the new routes coded into the network:

1. Harlem-Breezy Point Express Route: It was found that this route is not on the minimum path to Breezy Point; area residents either took the 7th Avenue IRT or other subway lines connecting with Queens IND services, transferring to the bus mode either at Flatbush Avenue (IRT) or Woodhaven and Queens Boulevards (IND).
2. Queens Plaza-Breezy Point via Woodhaven Boulevard: This line turned out to be the most important Gateway-bound service with a tributary population of 3,207,200 before joining the Jamaica-Flushing line. Most of its business was derived from subway connections at Queens and Woodhaven Boulevards with all Queens IND services. While the minimum path to Breezy Point causes a tributary population of 555,200 to

transfer to this line at the junction of Lefferts and Rockaway IND services, adjustment of fare and/or running time on the Rockaway subway line would cause passengers from the important Bedford-Stuyvesant, East New York and other central Brooklyn zones to travel as far as Rockaway Park via rapid transit before transferring to the bus mode, relieving a substantial amount of pressure on the Woodhaven Boulevard bus line. One way of equalizing fares between Rockaway line riders and all other subway riders to Gateway-bound bus routes would be to run free shuttle service from Rockaway Park to the recreation area, while retaining a double fare on the Rockaway subway line itself. All other bus lines from Breezy Point connecting with subways would still charge the standard fare, causing all dual mode users to Breezy Point to pay the same, double fare.

3. Main Street Flushing-Breezy Point via Jamaica: This route served its tributary areas as intended with the Main Street Flushing terminal drawing ridership from most of Northern Queens and a small portion of the Bronx. In the Jamaica area, the minimum path was found to be directly from Hillside Avenue to Jamaica Avenue via Sutphin Boulevard rather than via the Jamaica Center as originally coded. Transferring passengers reached the line via existing routes in the Jamaica area rather than boarding the line at its various stops in the CBD.
4. East New York-Breezy Point Shuttle: The minimum path from East New York to Breezy Point was found to be via IND subway to Woodhaven Boulevard, and then shuttle bus to the recreation area, rather than directly via this line. This route did serve a valid purpose in the Brownsville area, however, and reasons of operating convenience may justify its origin at the East New York bus garage, although its major pickup area is not at that location.
5. Utica Avenue: The existing Utica Avenue bus line was extended to Breezy Point as a by-product of coding the East New York shuttle into the network. A tributary population of 492,000 is served by this line.

6. Staten Island-Avenue U shuttle connection: Through running of the R-7 Verrazzano Bridge bus from Staten Island to 25th Avenue and Avenue U for connection with the Avenue U shuttle from Breezy Point was simulated. It was determined, however, that most of Staten Island would travel via R-7 bus and then transfer to another local bus to Brooklyn, connecting at Coney Island with a ferry route to Breezy Point. In addition, Bay Ridge and Coney Island zones with a tributary population of 396,800 would use the ferry. An all-bus routing is not the minimum path for any Staten Island zone.

Briefly, the most significant results of this analysis include: Diversion of a large quantity of traffic from the congested Flatbush Avenue-Marine Parkway Bridge corridor to the Woodhaven Boulevard-Cross Bay Bridge route, determination that Staten Island zones would utilize a Breezy Point-Coney Island Ferry route, and finding the Woodhaven Boulevard corridor as a major access route to Breezy Point with the utilization of both subway and bus connections from the Bronx, Manhattan and Queens. It might be interesting to note that should there be construction of a rail link to Kennedy Airport along the abandoned LIRR Ozone Park Branch, it would be useful to consider connecting the line with the existing Rockaway IND route for rapid transit access to Rockaway Park as an alternative to extensive bus operations along Woodhaven Boulevard.

Table 3 shows the distribution of trip time length for access to Breezy Point by a uniform one one-hundredth of the population of each zone in New York City. (The assumption of a trip generation rate of .01 would produce a daily visiting population of 78,000, as compared with the 120,000 estimate used in other analysis. This is a simplified assumption for illustrative purposes only.)

The time lengths of all trips as generated by this assumption are indicated in the first column. The second and third columns, respectively, indicated the time length distribution for the trips categorized as either "Primarily Subway" or "Primarily Bus", which is a gross description of the line-haul mode used for the trip to Breezy Point. An approximating, not a precise method was used to categorize the trips as "bus" or "subway". Generally, it is observed that the more distant zones are in the subway column, thus they have longer trip times.

Figure 3 shows that various geographical areas in New York City, classified by the principal mode are expected to be used for access to Breezy Point. Note that all of Manhattan and nearly all of the Bronx would use the subway (changing at Woodhaven Boulevard for the Limited Stop Bus, or in some cases, at Flatbush and Nostrand Avenue for the Q35). Nearly all of Staten Island would use the R7 and local bus in combination with the Coney Island to Breezy Point ferry. Heavy use of bus modes is seen in Brooklyn and especially in Queens.

Figure C-1

BREEZY POINT BUS SHUTTLE SYSTEM AS CODED

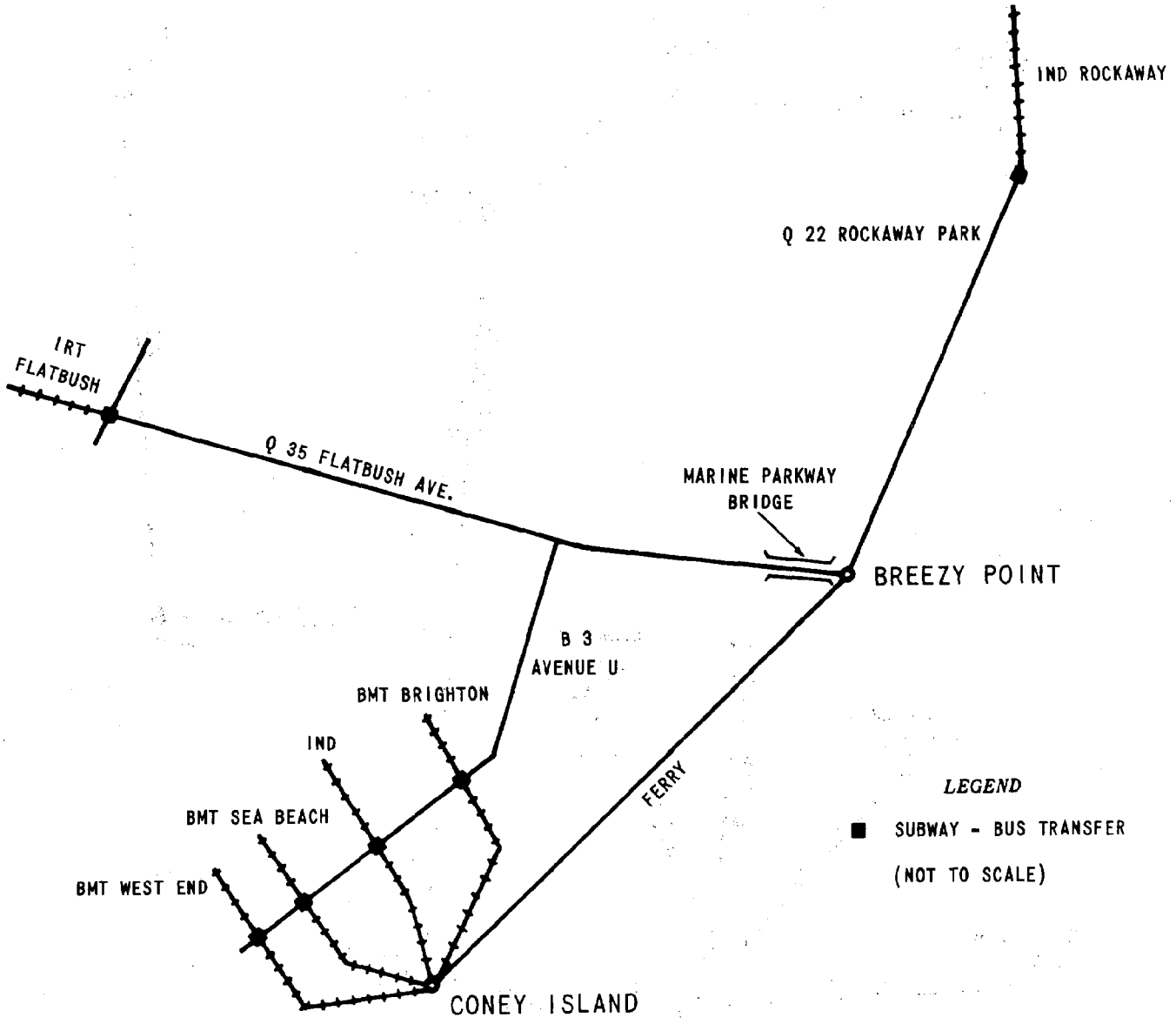


Figure C-2

TRIBUTARY POPULATIONS TO BREEZY POINT

BUS - FERRY ACCESS

(Not to Scale)

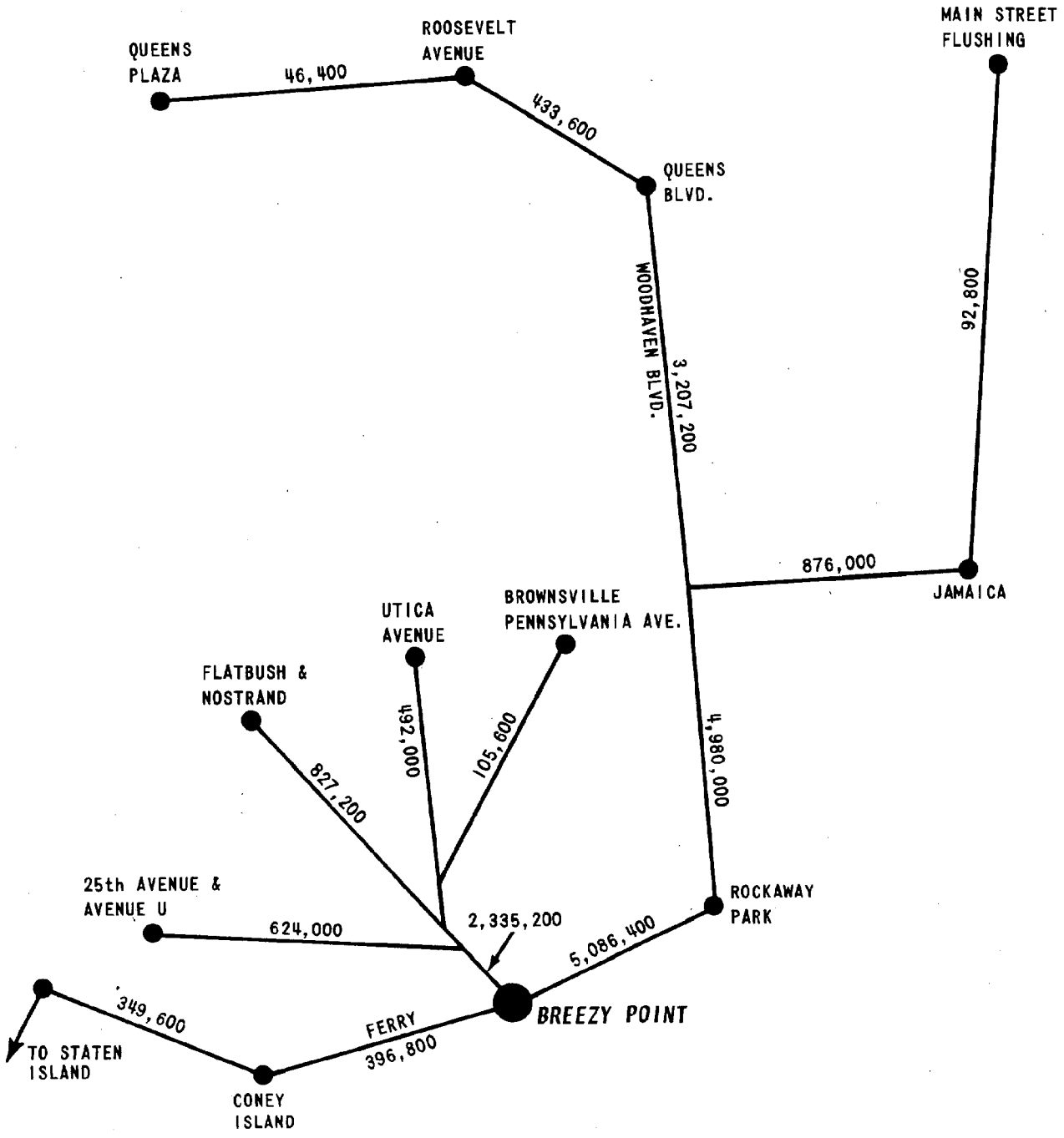


Figure C-3
MODES OF ACCESS TO BREEZY POINT
BY AREA OF NEW YORK CITY

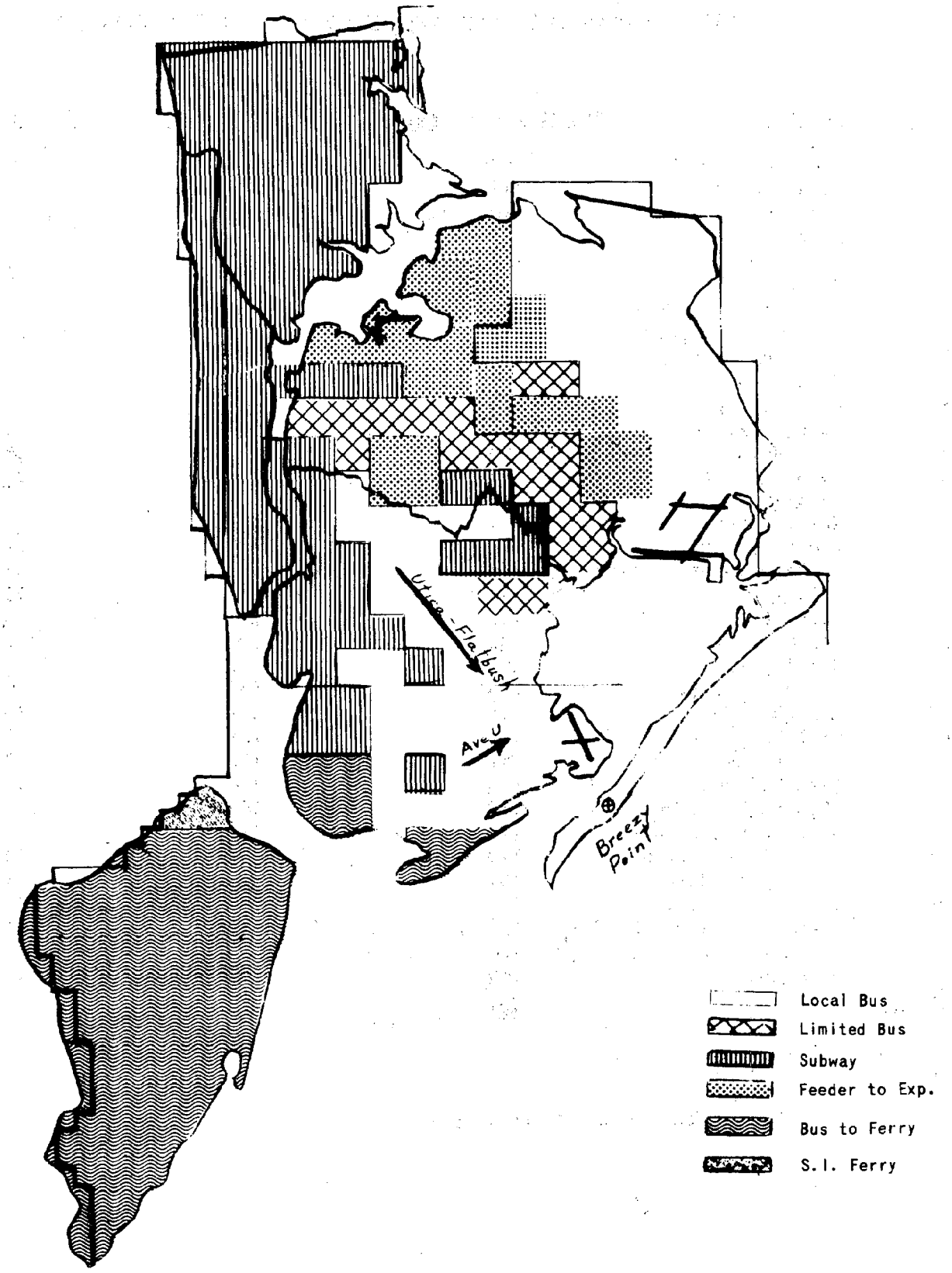


TABLE C-1

COMPARATIVE TRAVEL TIMES FROM SELECTED ORIGIN ZONES TO ZONE 154

Zone	Location	Time/Current System	Time/Expanded Shuttle System	Time Saving
103	Gravesend South	92	62	30
111	Dyker Beach Park	116	93	23
108	Bensonhurst N.	90	79	11
100	Flatlands E.	56	45	9
93	Greenwood Cemetery	104	93	11
87	Flatbush W.	78	67	11
73	East New York North	107	88	19
76	Bedford-Styvesant W.	108	95	13
77	Crown Heights	94	88	6
63	Williamsburg	129	115	14
156	Broad Channel	50	50	0
150	Jamaica-S. Laurelton	129	129	0
140	Woodhaven	98	75	23
147	Jamaica North	145	123	22
145	Hollis	165	159	6
121	Juniper Park	125	102	23
138	Fresh Meadows	159	149	10
135	Willets Point-Bayside	194	183	11
115	Hellgate	141	131	10
127	Jackson Heights E.	140	127	13
133	Flushing N.	181	170	11
56	Morrisania	144	132	12
57	Bronx River E.	146	136	10
41	Kingsbridge	152	142	10
48	Williamsbridge E.	161	151	10
15	West Village	112	102	10
7	East Village	118	108	10
28	60th-80th St. West	116	106	10
24	60th-80th St. East	123	113	10
35	120th-140th St. West	128	117	11
38	Washington Heights	141	130	11
158	Clove Lakes S.I.	176	150	26
162	Travis-Willowbrook, S.I.	214	189	25
168	New Dorp, S.I.	186	161	15
173	Huguenot, S.I.	209	184	15

Travel Time = 1/2 total friction

TABLE C-2

COMPARATIVE TRAVEL TIMES FROM SELECTED ORIGIN ZONES TO ZONE 154

Zone	Location	Time/via Ferry From Coney Island	Time/Expanded Shuttle System	Time Differential
103	Gravesend South	82	62	20
111	Dyker Beach Park	100	93	7
108	Bensonhurst N.	84	79	5
100	Flatlands E.	111	45	66
93	Greenwood Cemetary	96	93	3
87	Flatbush W.	112	67	45
73	East New York North	125	88	37
76	Bedford-Styvesant W.	119	95	24
77	Crown Heights	116	88	28
63	Williamsburg	132	115	17
156	Broad Channel	173	50	123
150	Jamaica - S. Laurelton	188	129	59
140	Woodhaven	147	75	72
147	Jamaica North	159	123	36
145	Hollis	189	159	30
121	Juniper Park	166	102	64
138	Fresh Meadows	167	149	18
135	Willets Point-Bayside	202	183	19
115	Hellgate	152	131	21
127	Jackson Heights E.	148	127	21
133	Flushing N.	188	170	18
56	Morrisania	159	132	27
57	Bronx River E.	162	136	26
41	Kingsbridge	166	142	24
48	Williamsbridge E.	180	151	29
15	West Village	119	102	17
7	East Village	119	108	11
28	60th-80th St. West	134	106	28
24	60th-80th St. East	135	113	22
35	120th-140th St. West	139	117	22
38	Washington Heights	147	130	17
158	Clove Lakes, S.I.	157	150	7
162	Travis-Willowbrook, S.I.	195	189	6
168	New Dorp, S.I.	167	161	6
173	Huguenot, S.I.	199	184	15

Travel Time = 1/2 total friction

TABLE C-3

DISTRIBUTION OF TRIP TIME LENGTH TO BREEZY POINT FROM ALL ZONES IN NEW YORK CITY

Time	New York City Total (All Transit Modes) Trips	Zones Primarily by Subway Trips	Zones Primarily by Bus Trips
Up to 3 minutes	0	0	0
6	0	0	0
10	232	0	232
15	0	0	0
20	2,904	216	2,688
30	3,984	800	3,184
40	10,536	5,344	5,192
65	24,216	11,120	13,096
90	24,344	20,592	3,752
2 hrs.	11,136	8,984	2,152
2½ hrs.	832	448	384
TOTAL	78,184	47,504	30,680

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