DOVER-SOMERSWORTH TRANSPORTATION STUDY

Memorandum No. 1 September 28, 1965

FROM: Tippetts-Abbett-McCarthy-Stratton

TO: New Hampshire Department of Public Works and Highways

SUBJECT: Home Interview Survey Sample Selection

1. Electric Utility Accounts

Selection of the majority of the home interview sample addresses was by means of electric utility accounts, records of which were furnished by the Public Service Company of New Hampshire in the form of printouts of meter service locations prepared in conjunction with the regular monthly billing cycle. These printouts include the following information for each account:

- city or town (Dover, Somersworth, or Rollinsford)
- customer's name
- location address of meter
- mailing address of customer
- rate code (see below)
- class code (0, 1, 2, 3, indicating the rate at which customers are charged for electric service, which in turn depends on the quantity of power they customarily use)
- meter reader route number
- account number

The printouts are listed in the order in which accounts are read every month.

The rate codes shown on the printouts have the following meaning:

10 normal domestic account
11 domestic account with space heating
12 seasonal domestic account
*13-15, 17-19 separate home water heater
40 general service (non-domestic) account
45 general service account with space heating
42 seasonal general service account
*43-44, 47-48 separate non-home water heater
*80 area light

Accounts with rate codes marked with an asterisk (*) cannot conceivably correspond to dwelling units and hence were eliminated from the listing (sample universe) prior to sample selection. Accounts in the 40-series generally involve commercial enterprises which do not house any dwelling units. For example most downtown stores,

service stations, offices, etc. have a 40-rate code. However, occasionally a 40-rate code is used for a structure devoted primarily to business or other non-residential use, but which also includes living quarters, such as a room in a warehouse where a watchman lives or a barber's quarters in back of his shop. Thus all accounts listed with rate codes in the 40-series had to be scrutinized to determine if there was a possibility that anyone might live at the meter location. The meter readers most familiar with the areas in question assisted in determining whether or not living quarters were indeed involved, and therefore whether or not the listed account should remain in the sample universe.

Since hotels, motels, institutions, government housing projects, and rooming houses were sampled separately, the accounts listed in the electric meter printouts for such places were eliminated prior to sample selection. To the maximum practicable extent, accounts for places outside the cordon line but in Dover or Somersworth were also eliminated from the sample universe.

After making the adjustments described above, 1818 samples were selected from the electric meter printouts on a 1-in-5 basis.

2. Field Sample Selection

Since the meter listings described above included places in Dover and Somersworth only, the dwelling places in the corner of Rollinsford, that is included within the study area, were sampled directly in the field. Thirty-four samples were selected in this way.

The following government housing projects in the Dover-Somersworth area do not have individual electric meters for each dwelling unit and therefore had to be field samples also:

Place	No. of Dwelling Units	No. of Samples
High Rise Building, Henry Law Ave., Dover	70	14
Wedgewood Mineral Park, Whittier St., Dover	184	36
Niles Park, Court St., Dover	40	8
Union Court, Court St., Dover	30	6
Total	324	64

A comprehensive list of rooming houses, hotels, motels, and institutions was prepared with the help of the local Chamber of Commerce and using the City Directory and similar references (see Appendix). An interviewer was sent to each of these places to determine the number of dwelling units occupied or intended for occupancy by persons or groups of persons for periods of a week or more. Such dwelling units formed a supplemental universe from which samples were field-selected on a 1-in-5 basis.

3. Summary

A total of 1,993 home interview samples were selected, as follows:

Type	Sample Numbers	No. of Samples
Rollinsford Field Selected Samples	1-34	34
Electric Utility Accounts	35-1852	1818
Government Housing Projects	1853-1916	64
Institutions, Motels, Hotels and Rooming Houses	1917-1993	77
Total		1993

The distribution of interview results from these samples is shown below:

Disp. Code	Description	Rollinsford Field Selected Samples	Electric Utility Account Samples	Government Housing Project Samples	Institutions, Motels, Hotels, etc	Totals
0	Trip Data Obtained	29	1,450	59	77	1,615
1	Refusal	1	49	-	-	50
2	No One Home	1	96	2	-	99
3	Other Incomplete Interview	-	5	-	-	5
4	Vacant	3	91	3	-	97
5	Residents Out-of-Area	-	87	-	-	87
6	Other Complete Interview	-	-	-	-	-
7	Commercial	-	3	-	-	3
8	Other Excluded Sample	-	7	-	-	7
9	Non-Interview	-	30	-	-	30
Totals		34	1,818	64	77	1,993

APPENDIX

Institutions, Motels, Hotels, and Rooming Houses

Type of Place	Address	No. of Dwelling Units	No. of Samples
Nursing & Convalescent Home			
Green Pastures, Inc.	Stark Avenue, Dover	42	8
Hurd Rest Homes	188 Locust Street, Dover	10	2
O'Hearn's Nursing Home	92 Locust Street, Dover	16	3
Wentworth Home for Aged	795 Central Avenue, Dover	30	6
Hurd Home	728 Central Avenue, Dover	20	4
St. Ann's Home	195 Dover Pt. Road, Dover	51	10
Motels-Hotels			
Hotel Kimball	48 Third Street, Dover	11	2
Janetos Evangelos	89 Main Street, Dover	13	2
Orpheum Hotel	124 Washington St., Dover	8	2
Sherwood Motor Hotel	Silver Street, Dover	3	1
Imperial 400 Motel	479 Central Avenue, Dover	3	0
Somersworth Hotel	67 Elm Street, Somersworth	8	2
Schools & Rectories			
St. Georges Rec.	66 Portland Avenue, Dover	1	0
Dover Children Home	20 Locust Street, Dover	23	4
St. Mary's Rec.	25 Third Street, Dover	3	1
St. Mary's Convent	154 Central Avenue, Dover	16	3
St. Joseph Rec.	150 Central Avenue, Dover	3	1
Rooming Houses			
Emma McCone	82 Broadway Street, Dover	3	0
Mrs. Rose LaSalle	184 Washington St., Dover	1	0
Harold Paul	42 Mt. Vernon Street, Dover	3	1
Mrs. Geo. Labrie	29 Mt. Vernon Street, Dover	6	1
Mrs. King	200 Washington St., Dover	1	0
Mrs. Kidney	41 Fourth Street, Dover	0	0
The Roberts House	226 Dover Pt. Road, Dover	3	1
Maurice Pollard	26 Walnut Street, Dover	3	1
Gibson Rooms	27 Walnut Street, Dover	3	0
Dionne (Strafford Inn)	21 Broadway Street, Dover	13	3
	2 Fifth Street, Dover	18	3
Welch	4 Fifth Street, Dover	13	3
	6 Fifth Street, Dover		
Welch	8 Fifth Street, Dover	11	2
Bridges (Elms)	10 Fifth Street, Dover	10	2
Nadeau	9 Fifth Street, Dover	8	2
Marion Cross	557 Central Avenue, Dover	4	1
W. Noel (Noel's Inn)	Rte. 16A, Somersworth	15	3
Kavanaugh	1 Beacon, Somersworth	4	0
John's Rooms	189 Main Street, Somersworth	5	1
Francoeur	19 High Street, Somersworth	6	2
Total		391	77

DOVER-SOMERSWORTH TRANSPORTATION STUDY

Memorandum No. 2

September 30, 1965

FROM: Tippetts-Abbett-McCarthy-Stratton

TO: New Hampshire Department of Public Works and Highways

SUBJECT: Internal Survey Interviews

1. Survey Period and Personnel

Interviewing was started on July 22 and completed on August 25, 1965. A total of 19 persons were employed as interviewers or office checkers during this period. Each received approximately 6 hours of training.

2. Internal Survey Administration

Home interview samples were selected as described in Memorandum No. 1. The 34 Rollinsford samples were pre-selected in the field. Other field-selected samples were interviewed in conjunction with field determination of the sample universe and selection of samples.

Samples selected from electric utility records were identified and numbered in the meter account listing. A tabulation was then prepared in two copies showing sample number, sample address, and addresses of preceding and following dwelling units in the sample universe. Pages from one of the copies of this tabulation were issued to the interviewers and formed their work assignments. The other copy was retained in the office and used to record the following information:

- date issued to interviewer
- interviewer's name
- date each interview was turned in to the office in a satisfactory and complete form
- dates of follow-up telephone calls from the office

Interviewers were required to turn in completed work daily; new work assignments were made as required. Interviews were reviewed for completeness and reasonableness immediately after they were turned in to the office. Where there were questions, interviews were re-issued, generally to the original interviewer on the next day.

Follow-up telephone calls were then made for 10 percent of the interviews, selected at random. In these calls respondents were reminded of the interview recently conducted with them and asked questions to ascertain the completeness and accuracy with which trips had been reported. Records of follow-up telephone calls were kept as described above and on the interview forms (back of Form 1).

After follow-up telephone calls were completed, interviews were counted and reported trips were added to provide information for weekly progress reports. Then forms were sent to the coding crew and processed for subsequent keypunching and verifying.

3. Disposition of Interviews

Each home interview sample was coded as to its disposition, as follows:

Code	Disposition
0	Completed interview, trip data obtained.
	Incomplete interview, trips possible but no data obtained because of:
1	Refusal
2	No one home after repeated call-backs
3	Other reason
	Completed interview, no trips possible because of:
4	Vacancy
5	Residents out of area
6	Other reason
	Completed interview, excluded sample:
7	Converted to commercial purposes
8	Other reason
9	Non-interviews (in sample by mistake, address outside internal survey area, etc.)

The distribution of samples according to disposition is as follows (see Memorandum No. 1 for detailed breakdown):

Disposition	Per Cent
0	81.0
1	2.5
2	5.0
3	0.3
4	4.9
5	4.4
6	-
7	0.1
8	0.3
9	1.5
Total	100.0

The unusually high rate of refusals (2.5%) was a surprise. Interview forms for refused interviews were kept separate until the end of the field survey period. Interviewers were required to explain (back of Form 1) the circumstances surrounding any such situation. The Internal Survey Supervisor personally followed up each refusal by talking with the interviewers concerned and, for about 20 refused interviews, by attempting a new interview. In every case such attemps were fruitless; there is no reason to believe that interviewers were undiplomatic or insufficiently persistent within the bounds of courtesy and reason. Almost all interviewers experienced one or more refusals and no single interviewer was responsible for an unreasonably large number. The reasons behind the refusals are difficult to determine, but probably include the following:

- opposition by some to the local expenditures of the cities of Dover and Somersworth for the Study
- adverse publicity given to the Study on several occasions by the local radio station's "open-mike" program, in which people call in to complain, quite often without any basis for their complaints and always without any informed rebuttal

The number of interviews that could not be completed because of failure to find anyone at home after repeated attempts (5.0%) was also surprisingly large and must be attributed to the fact that people spend more time out-of-doors and away from home during the summer season. The Internal Survey Manual requires that three or more call-backs must be made at different times of day during two successive work-days following the day the first contact was attempted before the interview can be accepted as an "incomplete interview". Usually interviewers tried eight or more times before giving up. Of course, it is possible that household members at some of these sample addresses were out of the area on vacation. An attempt was always made to ascertain whether such could be the case by asking neighbors or by observation, but Disposition Code 5 was only used when the interviewer was sure that the residents were away on the travel date and could not have made any trips in the area.

Interval and meter checks were made by the interviewers in accordance with instructions outlined in the Internal Survey Manual. Although several additional dwelling units in the interval or using the same meter as the sample address were reported to the office by interviewers, all were found to be accounted for elsewhere in the universe listing of electric meter accounts. With regard to interval checks this was not unexpected because of the fact that the listing from which samples were selected was prepared less than a month before interviews were conducted and therefore included all recent construction. The reason for finding no additional dwelling units as a result of the meter check is that all rooming houses were identified and deleted from the meter listing in advance of sample selection.

4. Distribution of Interviews

Because of the short time duration of the interview survey, the fact that it did

not extend into two seasons, and the limited geographic extent of the Study Area, no attempt was made to control the distribution of interviews by pre-assigning interview dates according to location. Because interviewers worked more-or-less regular hours Tuesday through Saturday, the distribution of completed interviews in which trip data were obtained (Disposition 0) by day of the week varied somewhat, as shown below:

Travel Day	No. of Interviews	Per Cent
Monday	320	19.8
Tuesday	365	22.6
Wednesday	375	23.2
Thursday	279	17.3
Friday	276	17.1
Total	1,615	100.0

5. Expansion of Home Interviews

The formula for computation of dwelling unit expansion factor is as follows:

$$\text{Dwelling Unit Factor} = F = \frac{A - C\ \frac{(A)}{(B)}}{B - C - D}$$

$$= \frac{A}{B}\ \frac{(B - C)}{(B - C - D)}$$

A = Total Number in Universe used in Sample Selection
B = Total Number of Samples Selected
= Number of Selected Samples with Dispositions 0,1,2,3,4,5,6,7,8 or 9
A/B = Sampling Rate
C = Number of Samples Selected for which no trips were possible within the Study Area or which are excluded from both the sample and the universe
= Number of Selected Samples with Dispositions 4,5,6,7,8 or 9
D = Number of Samples Selected for which trips within the Study Area were possible but for which no trip data were obtainable
= Number of Selected Samples with Dispositions 1, 2, or 3

Four separate expansion factors have been computed covering each of the groups from which samples were selected, as shown below:

Group	A/B	B	C	D	F
Rollinsford - Field Selected	5	34	3	2	5.35
Electric Utility Records	5	1,818	218	150	5.52
Gov't. Housing Projects	5	64	3	2	5.17
Institutions, etc.	5.08	77	0	0	5.08

The factor F will be punched into all No. 1 cards having disposition 0. To permit determination of the number of dwelling units and population, the factor A/B will be punched into No. 1 cards having dispositions 4, 5, or 6. Dwelling units and population will be obtained from cards having dispositions 0, 4, 5 or 6.

6. Expansion of Internal Trip Reports

The formula of computation of the internal trip expansion factor is as follows:

$$\text{Trip Factor} = F \frac{(G)}{(G - H)}$$

F = Dwelling Unit Factor
G = Total number of persons 5 years of age or over residing at dwelling units for which trip data were obtained
H = Number of persons 5 years of age or over with trips unknown residing at dwelling units for which trip data were obtained

The trip expansion factors are shown below:

Group	G	H	F	Trip Factor
Rollinsford - Field Selected	89	0	5.35	5.4
Electric Utility Records	4,224	27	5.52	5.6
Gov't. Housing Projects	138	0	5.17	5.2
Institutions, etc.	94	0	5.08	5.1

These factors will be punched into all No. 2 cards.

DOVER-SOMERSWORTH TRANSPORTATION STUDY

Memorandum No. 3 September 28, 1965

FROM: Tippetts-Abbett-McCarthy-Stratton

TO: New Hampshire Department of Public Works and Highways

SUBJECT: Traffic Zoning

1. Cordon Line

A cordon line was established in the Dover-Somersworth area to enclose areas of major existing development and areas in which the greatest growth is expected to occur in the next twenty years. In establishing the cordon line, careful attention was given to points of crossing of major roads as to their suitability for operating roadside interview stations safely and effectively. The 14 roadside interview stations that were operated delineate a large portion of the cordon line around the area. Elsewhere the cordon line was drawn in such a way as to follow city boundaries and areas zoned for uses other than agricultural, as applicable.

The cordon line, by definition, serves as the boundary between the internal and the external areas.

2. Internal Area

The internal area was sub-divided into 50 traffic zones for purposes of data collection, analysis and forecasting: 35 zones in Dover, 13 in Somersworth, and 2 in Rollinsford.

To make it possible to take maximum advantage of available sources of statistical data, the traffic zoning system recognized enumeration distinct boundaries as used in the 1960 U.S. Census wherever feasible. There were 13 enumeration districts in Dover and 6 in Somersworth. Further sub-division was accomplished by drawing traffic zone boundaries along major arterial highways or by following physical barriers such as rivers, railroads, or the Spaulding Turnpike. Aside from these considerations the area, shape, population, land use, trip generation and attraction potential, and practical considerations of trip data coding governed the manner in which the internal area was sub-divided into traffic zones.

3. External Areas

The portions of Dover, Somersworth and Rollinsford outside the cordon line were sub-divided into eight external zones by following enumeration district boundaries.

Elsewhere in New Hampshire and in Vermont, Massachusetts, Connecticut and Rhode Island, trips were coded to town. In the remainder of the United States, except for York County, Maine, trips were coded to county and state. York County, due to the fact that it adjoins the Study Area, was sub-divided into six external zones. Trips to and from Canada were coded to province.

DOVER-SOMERSWORTH TRANSPORTATION STUDY

Memorandum No. 4 September 28, 1965

FROM: Tippetts-Abbett-McCarthy-Stratton

TO: New Hampshire Department of Public Works and Highways

SUBJECT: Taxi Survey

1. Taxi Samples

Interviews were conducted with drivers or dispatchers of 13 of the 20 taxis based in Dover and Somersworth. The remaining cabs are not operated during the summer months.

Taxi samples were as follows:

Sample No.	Name and Address	No. of Taxis Operated During Summer Months	No. of Taxis Operated During Remaining Months
3001-3003	City Taxi Co., Inc. 390 Central Avenue Dover	3	6
3004-3007	White Top Cab Co. 7 Dover Street Dover	4	5
3008-3009	Town Taxi Co. 17 Third Street Dover	2	4
3010-3011	Yellow Cab Co. 1 Main Street Somersworth	2	3
3012-3013	Dover Taxi Co. 59 Grove Street Dover	2	2
Total		13	20

2. Trip Reporting

A total of 909 trips were reported, equivalent to 70 trips per taxi per average weekday.

DOVER-SOMERSWORTH TRANSPORTATION STUDY

Memorandum No. 5

October 13, 1965

FROM: Tippetts-Abbett-McCarthy-Stratton

TO: : New Hampshire Department of Public Works and Highways

SUBJECT: Inventory of Current Land Use

1. Land Use Classifications

In inventorying and analyzing current land use in the portions of Dover, Somersworth and Rollinsford within the Study Area, the following five land use classifications were used:

Residential
Commercial
Industrial
Public and Semi-public (including parks and cemeteries)
Vacant and Other

2. Data Collection

A land use map for the City of Dover was prepared by the Dover Planning Board in June 1965. This map was reviewed in the field, with particular emphasis on the central business district, and corrections were made where necessary. Land use data for Somersworth and Rollinsford were not available and a field inventory was made.

The inventory was based on gross areas. Streets, parking areas, loading zones and the like were included with the contiguous land use. In the case of isolated, single family dwellings located at outlying areas, a lot size of one acre was assumed. Where more than one land use occupied a site, the first floor use was recorded.

3. Summary of Current Land Use

Land use areas within the Study Area are summarized below:

Study Area Land Use - 1965
(acres)

City	Residential	Commercial	Industrial	Public & Semi-Pub.	Vacant & Other	Totals
Dover	1,689	192	134	259	6,966	9,240
Somersworth	581	80	58	195	4,402	5,316
Rollinsford	73	4	2	0	1,380	1,459
Totals	2,343	276	194	454	12,748	16,015

Downtown Dover contains a mixture of commercial, industrial, residential and public uses. Retail stores extend along Central Avenue in the form of a strip development with the heaviest concentration on the west side of Central between Washington Street and Third Street. Retail uses also extend westward a short distance from Central Avenue on Washington Street and Third Street. Many of the commercial structures in Dover require substantial remodeling to meet modern retail needs.

Several large industrial plants in Dover border on, or are located close to the Cocheco River and the railroad in central Dover. An industrial district is under development south of the Spaulding Turnpike in the area between Littleworth Road and the Boston and Maine Railroad.

Residential uses are scattered throughout central Dover. Many residential buildings near commercial and industrial structures are substandard. The most common dwelling type is the two-family structure. Multi-family dwelling units for the elderly have recently been constructed at the east side of Central Avenue south of William's Street.

Public uses in Dover are scattered throughout the central area with the City Hall located at Saint Thomas Street and Central Avenue.

Somersworth does not have a well-defined central business district. Business uses are scattered along Main, Green and High Streets and are separated by residential and other uses. There is a concentration of old mill buildings in the area east of Main Street, which borders on the Salmon Falls River and is served by the Boston and Maine Railroad. Residential uses occupy most of the developed land area. Approximately half are detached, single family residences and the remainder are multi-family and two-family units. As in Dover, many of the dwelling units bordering the business and industrial areas are in poor condition. Multi-family dwelling units designed for the elderly are being constructed along Washington Street, east of High Street.

Most of the outlying portions of both cities are devoted to agricultural uses or are vacant.

A tabulation of current land use by traffic zone is given in Appendix A.

APPENDIX A

STUDY AREA LAND USE - 1965

Zone	Total Area	Residential	Commercial	Industrial	Public and Semi-Public	Vacant
1	827	125	2	0	19	679
2	1,425	47	8	0	0	1,370
3	404	77	14	0	33	280
4	349	51	7	0	28	263
5	396	131	0	0	4	261
6	58	5	4	8	0	41
7	720	109	3	0	0	608
8	621	103	2	0	22	494
9	128	42	14	0	0	72
10	197	77	1	18	16	85
11	44	30	8	2	4	0
12	243	55	2	0	43	143
13	211	34	4	0	33	140
14	288	61	5	15	6	201
15	36	23	3	1	0	9
16	6	0	0	4	0	2
17	11	0	3	4	3	1
18	31	6	7	13	1	4
19	9	3	4	2	1	0
20	39	32	3	0	2	2
21	26	11	6	0	9	0
22	264	77	1	0	0	186
23	86	21	1	0	0	64
24	180	42	7	7	3	121
25	283	131	2	4	10	136
26	50	38	4	4	3	1
27	34	3	5	26	0	0
28	121	60	5	1	2	53
29	143	64	1	0	10	68
30	244	28	51	0	2	163
31	240	9	0	24	0	207
32	509	35	0	0	0	474
33	373	29	0	1	0	343
34	285	90	9	0	5	181
35	350	40	6	0	0	304
36	511	37	1	1	0	472
37	948	37	3	1	0	907
38	480	52	4	12	0	412
39	360	36	2	0	0	322
40	985	94	4	1	92	794
41	931	69	39	11	0	812
42	937	18	9	0	51	859

Zone	Total Area	Residential	Commercial	Industrial	Public and Semi-Public	Vacant
43	781	83	2	0	2	649
44	211	29	4	2	5	171
45	33	1	2	27	0	3
46	89	70	5	2	4	8
47	95	36	1	0	0	58
48	270	22	1	2	16	229
49	106	40	4	0	23	39
50	39	31	3	1	2	2

DOVER-SOMERSWORTH TRANSPORTATION STUDY

Memorandum No. 6 September 28, 1965

FROM: Tippetts-Abbett-McCarthy-Stratton

TO: New Hampshire Department of Public Works and Highways

SUBJECT: Accident Location Study

1. Accident Reports to State as a Possible Data Source

The New Hampshire Department of Motor Vehicles requires that an accident report be filed with them within 48 hours of the occurrence of any motor vehicle accident involving personal injury or property damage in excess of $50.00. Accident reports are filed by the Department alphabetically according to the names of those involved in the accident; thus there are often two or more reports in the file for a single accident. Accidents are numbered serially without regard to location in the State and an index is kept to facilitate cross-reference to the alphabetical file.

Extracting accident data for the cities of Dover and Somersworth from these files would obviously be extremely difficult. Therefore local sources of accident data were investigated.

2. Somersworth

The city of Somersworth requires that any accident reported to the State be reported to the Somersworth Police Department as well. Accident report forms are filed in the Police Station by month. Each report form corresponds to a single accident and includes a detailed description of where it occurred. Accident location information was extracted from these files for the two-year period between August 1, 1963 and August 1, 1965, and posted directly on a city map. An accident spot map was then prepared. Accidents occurring between intersections were collectively plotted at a single mid-block location.

3. Dover

Unfortunately accident data were not as readily obtainable from records kept in the Dover Police Department. Some accidents are reported on forms similar to those used in Somersworth and a similar file is maintained, but there is no requirement that reports be made to the Police Department. According to the Dover Police Chief perhaps 25 percent or more of the motor vehicle accidents occurring in Dover are not so reported and there is no reason to believe that these unreported accidents are any less severe than those that are reported. This data source was therefore felt to be unsatisfactory.

It was learned, however, that all motor vehicle accidents of any consequence are reported to the Police Station by investigating officers and recorded by the desk sergeant in the running log of day and night reports. Although these day and night reports contain a great deal of extraneous material, they were used to obtain accident location information for the two-year period between August 1, 1963 and August 1, 1965. An accident spot map was prepared using a similar procedure to that employed in Somersworth.

DOVER-SOMERSWORTH TRANSPORTATION STUDY

Memorandum No. 7

October 19, 1965

FROM: Tippetts-Abbett-McCarthy-Stratton

TO: New Hampshire Department of Public Works and Highways

SUBJECT: Roadside Interview Stations

1. Station Locations

Tentative roadside interview stations were established in April 1965 at points where the proposed cordon line intersected the major routes entering and leaving the Dover-Somersworth area. Based upon limited traffic count data, the average daily traffic to be expected at each of the 22 potential stations was estimated and the 17 locations accommodating 95% of the total were tentatively selected as roadside interview stations. Subsequently the New Hampshire Department of Public Works and Highways made machine counts of traffic passing all 22 possible station locations and on this basis a new determination was made of the stations to be operated so that the routes selected would, in the aggregate, account for 95% of the total daily traffic entering and leaving the area.

The following table lists the stations that were operated and indicates the traffic volumes that were estimated and those that were actually experienced.

Station No.	Location	Total Daily Traffic Volume: Original Estimate as per Work Program	Revised Estimate Based on Short-period Machine Count	Manual Count on Day of Interviews
1	Spaulding Turnpike, Dover Point	7,000	5,000	6,174
2	Rt. 16 (Dover Point Road), Dover Point	12,000	7,200	5,666
3	Rt. 4 (Portland Ave.), Rollinsford-Dover Line	2,000	3,500	4,130
4	RR Overpass, Rollinsford	1,000	1,700	2,107
5	Rt. 9 Berwick-Somersworth Bridge	7,000	9,300	8,088
6	Rt. 16 (Rochester Road) to Rochester	3,000	3,200	6,565
8	Rt. 16B (Old Rochester Road) to Rochester	3,000	1,000	1,853
10	Spaulding Turnpike, Rochester	5,000	3,600	4,177

Station No.	Location	Total Daily Traffic Volume: Original Estimate as per Work Program	Revised Estimate Based on Short-period Machine Count	Manual Count on Day of Interviews
12 19	Sixth Street, Dover, West of Turnpike	1,000	900	1,138
14 13a14	Rt. 4/9 (Littleworth Road), Dover	3,000	2,700	2,860
15 11	Rt. 155 (Knox Marsh Road), Dover	3,000	2,800	3,004
16 9	Rt. 108 (Durham Road), Dover	5,000	4,400	4,963
17 4	Back River Road, Dover	1,000	1,100	1,075
19 D	Gulf Road (to Eliot), Dover	500	2,800	2,321
	Sub-total	53,500	49,200	54,121
	Other Possible Stations	5,100	2,600	
	Total	58,600	51,800	

2. Hours of Operation

Interviews were conducted for 8, 16 or 24-hour periods, depending upon the anticipated daily volume of traffic as follows:

Daily Traffic Volume	Hours of Operation	No. of Hours
Less than 2,000	11 A.M. - 7 P.M.	8
2,000 to 3,000	6 A.M. - 10 P.M.	16
More than 3,000	6 A.M. - 6 A.M.	24

In determining hours of operation at each station the daily traffic volume according to the State's short period machine count was used. One exception was Station 3 which was run for 16 hours rather than 24, even though the anticipated volume exceeded 3,000. This was allowed because past records indicated that the proportion of the daily traffic passing the station between 10 P.M. and 6 A.M. would be likely to be very low. This was indeed proved to be the case, since 91% of the traffic passing on the day of station operation occurred during the 16-hour operating period.

3. Interviews Conducted

Interviews were conducted with drivers passing in both directions. With few exceptions, interviews were obtained for a minimum of 25% of the vehicles passing in each direction in each hourly period. During the entire periods of operation at the various stations, the percents interviewed were considerably higher, as shown below:

Station No.	No. of Hours in Operation	Traffic Passing During Hours Of Operation	Interviews Obtained	Percent Interviewed
1	24	6,174	2,825	46
2	24	5,666	2,999	53
3	16	3,774	1,964	52
4	8	1,030	580	56
5	24	8,088	3,932	49
6	24	6,565	2,372	36
8	8	889	482	61
10	24	4,177	2,644	63
12	8	581	416	72
14	16	2,632	1,261	48
15	16	2,810	1,362	49
16	24	4,963	2,956	60
17	8	532	382	72
19	16	2,125	1,004	47
Total		50,006	25,179	50

DOVER-SOMERSWORTH TRANSPORTATION STUDY

Memorandum No. 8

October 25, 1965

FROM: Tippetts-Abbett-McCarthy-Stratton

TO: New Hampshire Department of Public Works and Highways

SUBJECT: Current Employment

Current employment for the Dover-Somersworth Study Area by traffic zone was obtained for the four following categories:

(a) Manufacturing and non-manufacturing industry, including transportation, utilities and construction
(b) Retail trade
(c) Other commercial activities, including wholesale trade, storage, personal services and business and professional services.
(d) Public and quasi-public activities

The basic source of information for employment data in categories (a), (b) and (c) was the New Hampshire Department of Employment Security (DES), which also furnished data on employment covered by social security. Public and quasi-public employment was obtained by Tippetts-Abbett-McCarthy-Stratton from interviews with City, County, State and Federal Agencies in the Study Area.

The DES data covers all employees who worked for more than 20 weeks in establishments with more than four employees. Information published by the DES is available only for job centers, which, in the Dover-Somersworth Area, includes a total of eight cities and towns. For the Dover-Somersworth Transportation Study, however, the DES furnished employment data for the first three categories listed above by traffic zone, using the following procedure:

1. A list of all covered establishments in the Dover-Somersworth Area was furnished to Tippetts-Abbett-McCarthy-Stratton by the DES.

2. Each establishment in the listing was coded by type and traffic zone by Tippetts-Abbett-McCarthy-Stratton and the listing returned to the DES.

3. Employment by type in each traffic zone was furnished to Tippetts-Abbett-McCarthy-Stratton by DES based on the coded listing.

Where two or fewer establishments were included within an employment category for a single traffic zone, an approximate employment figure was used to avoid possible disclosure of confidential information.

To account for employees not covered by the DES, the Department made estimates for employment covered under social security which is not covered by DES. Further adjustments were made to account for employment not covered by either the DES or social security. Adjusted employment was checked by using the 1964 Manning's Directory for Dover-Somersworth to identify all establishments with non-covered employment, by traffic zone, and applying an average number of employees considered to be representative of non-covered establishments in each category.

Tabulated below are the number of employees within the Study Area covered by the DES and under social security and other data, by type of employment:

Industrial Employment		
Number of establishments	-	63
Employees covered by DES	-	8,462
Employees covered by social security	-	8,924
Estimated employees not covered by social security	-	0
Estimated total employees	-	8,924
Retail Trade Employment		
Number of establishments	-	220
Employees covered by DES	-	1,248
Employees covered by social secutiry	-	1,850
Estimated employees not covered by social security	-	54
Estimated total employees	-	1,904
Other Commercial Employment		
Number of establishments	-	265
Employees covered by DES	-	1,093
Employees covered by social security	-	1,400
Estimated employees not covered by social security	-	242
Estimated total employees	-	1,642
Public and Quasi-Public Employment		
Estimated total employees	-	660

Employment in July-August 1965 for each category is summarized below for the portions of Dover, Somersworth and Rollinsford within the Study Area and is tabulated by traffic zone in Appendix A.

Employment by Town (portions within Study Area)

	Industrial Employment	Retail Trade Employment	Other Commercial Employment	Public & Semi-Public Employment
Dover	5,733	1,493	1,292	560
Somersworth	3,161	405	326	100
Rollinsford	30	6	24	-
Totals	8,924	1,904	1,642	660

APPENDIX A

EMPLOYMENT - 1965

Zone Employment	Industrial Employment	Retail Trade Employment	Other Commercial Employment	Public & Semi-Public Employment
001	21	6	4	10
002	0	0	6	0
003	0	59	28	17
004	7	10	10	0
005	12	0	6	0
006	127	121	80	0
007	17	8	4	0
008	14	6	8	7
009	35	12	76	0
010	26	3	7	16
011	12	28	38	19
012	38	18	8	0
013	0	98	32	82
014	51	80	52	26
015	7	41	2	0
016	970	5	0	0
017	1,201	62	66	0
018	55	151	240	16
019	192	143	82	2
020	14	8	10	52
021	12	78	260	98
022	7	0	2	16
023	0	3	0	0
024	366	85	58	4
025	131	26	36	16
026	359	65	17	2
027	721	56	8	0
028	12	47	39	0
029	0	9	10	162
030	66	243	64	15
031	1,221	0	0	0
032	0	0	0	0
033	14	3	6	0
034	25	9	33	0
035	0	10	0	0
Subtotal: Dover	5,733	1,493	1,292	560

Zone Employment	Industrial Employment	Retail Trade Employment	Other Commercial Employment	Public & Semi-Public Employment
036	15	0	2	0
037	15	6	22	0
Subtotal: Rollinsford	30	6	44	0
038	485	46	14	0
039	14	0	4	0
040	0	2	11	0
041	77	20	35	0
042	7	45	8	9
043	0	3	2	2
044	85	66	103	41
045	2,322	47	60	0
046	44	89	20	2
047	30	33	6	0
048	38	12	15	9
049	39	33	32	21
050	20	9	16	16
Subtotal: Somersworth	3,161	405	326	100
GRAND TOTAL	8,924	1,904	1,642	660

DOVER-SOMERSWORTH TRANSPORTATION STUDY

Memorandum No. 22 June 16, 1966

FROM: Tippetts-Abbett-McCarthy-Stratton

TO: New Hampshire Department of Public Works and Highways

SUBJECT: Forecast of Passenger Vehicle Ownership

In 1965 a total of 9,529 passenger vehicles were owned by the 29,147 residents of the Study Area (reference Memorandum No. 9), for an average ownership ratio of 0.327 automobiles per person. This is about 15 percent below the New Hampshire average.

An analysis was made to determine the relationship between automobile ownership and family income in the Dover-Somersworth Area. In this analysis, the range between the highest and the lowest current zonal average family income was divided into five equal parts, thereby forming five income groupings. Automobile ownership ratios computed for these income groupings are as follows:

Income Grouping (a)	Automobiles Per Person	Ratio to Average (b)
1	0.261	0.80
2	0.312	0.96
3	0.341	1.04
4	0.345	1.05
5	0.347	1.06
Average	0.327	1.00

(a) In fifths of the full range between minimum and maximum current zonal average income (Grouping 1 = lowest 20 percent of range).

(b) Ratio of Automobiles Per Person for the Income Grouping to the Average (0.327).

In forecasting 1985 passenger vehicle ownership in the Study Area, comparisons were made of national, State, and local trends. The number of automobiles per person in the United States as a whole is currently about 0.385 and is expected to reach 0.405 by 1985. Historically, the ownership ratio in New Hampshire has been less than the national average and, as noted above, in the Dover-Somersworth Area the current ownership level appears to be even lower. Trends show that the automobile ownership ratio in the State has been increasing faster than the national average and this trend is expected to continue. Similarly, it is anticipated that the

Study Area will tend to catch up with the State. It is estimated that by 1985 there will be an average of 0.40 automobiles per person in the Study Area, for a total of 15,690 automobiles.

Anticipated future (1985) automobile ownership ratios were computed for each of five income groupings by multiplying the forecasted average ratio (0.40) by the "Ratio to Average" tabulated above. Forecasted 1985 automobile ownership within each zone was then obtained by multiplying the forecasted zonal population (from Memorandum No. 10) by the appropriate ownership ratio. Zones were regrouped for this purpose into five groupings according to forecasted average family income (see Memorandum No. 19) in a manner similar to that described above for current income levels.

Resulting passenger vehicle ownership forecasts by traffic zone are tabulated in Attachment A along with current data repeated from Memorandum No. 9.

ATTACHMENT A

DOVER-SOMERSWORTH TRANSPORTATION STUDY

PASSENGER VEHICLE OWNERSHIP - 1965 AND 1985

Traffic Zone	Passenger Vehicle Ownership 1965	1985
1	214	415
2	61	482
3	231	257
4	325	456
5	395	668
6	55	94
7	220	560
8	204	249
9	241	465
10	319	445
11	173	190
12	329	1,013
13	120	235
14	329	546
15	105	154
16	-	-
17	-	-
18	17	-
19	44	36
20	187	382
21	38	26
22	203	274
23	167	277
24	223	338
25	575	803
26	286	487
27	28	32
28	390	408
29	270	316
30	88	100
31	22	25
32	60	96
33	104	270
34	308	533
35	138	209
36	65	132
37	97	160
38	193	269

Traffic Zone	Passenger Vehicle Ownership 1965	1985
39	122	230
40	390	805
41	299	344
42	72	53
43	215	436
44	322	333
45	-	4
46	522	805
47	132	276
48	176	468
49	231	302
50	224	232
	9,529	15,690

DOVER-SOMERSWORTH TRANSPORTATION STUDY

Memorandum No. 9 November 4,1965

FROM: Tippetts-Abbett-McCarthy-Stratton

TO: New Hampshire Department of Public Works and Highways

SUBJECT: Current Population

Current (1965) population in the Dover-Somersworth Study Area was based on the 1960 Census of Population made by the Bureau of the Census, U.S. Department of Commerce. These data were updated using a 1965 school census conducted in Dover; 1965 population for Somersworth was estimated using recent growth rates. The total population for Dover and Somersworth as obtained from the Census for 1960 and estimated as described above for 1965 is as follows:

1960 and 1965 Population

	Population		Increase	
	1960	1965	Population	Percent
Dover	19,131	21,221	2,090	11%
Somersworth	8,529	9,300	771	9%
Totals	27,660	30,521	2,861	10%

For the Dover-Somersworth Transportation Study, expanded home interview survey data is used to provide information on current population by traffic zone. A tabulation of expanded survey data relating to dwelling units and population is summarized below and is given by zone in Appendix A.

Summary of Home Interview Data

	No. of Dwelling Units		No. of	No. of	No. of Total Person
	Family	Institution	Residents	Passengers	Trips
Dover	6,416	360	20,042	6,469	54,977
Rollinsford	125	-	465	162	1,540
Somersworth	2,786	66	8,640	2,898	24,766
Totals	9,327	426	29,147	9,529	81,383

To provide an independent check on the accuracy of the home interview survey, population obtained from the expanded survey data has been compared with independent estimates of population. This comparison can be made for 11 areas where groupings of enumeration districts (established by the U. S. Bureau of the Census) coincide or nearly coincide with groupings of traffic zones. The independent population estimates for these groupings were obtained from the 1960 Census; the total estimated population increase for Dover and Somersworth was distributed among enumeration districts using 1960 and current information on the number of dwelling units in each district. Current dwelling unit counts were obtained from Manning's Directory and by checks in the field.

Where boundaries of enumeration district groupings do not coincide exactly with traffic zone grouping boundaries, adjustments were made by counting dwelling units in the area where the boundaries differed. These dwelling units were converted to population by using household sizes of 3.34 persons for Dover and 3.39 for Somersworth, with a household size of 1.5 persons being used for housing for the elderly in both cities.

The comparison of population for the 11 groups of traffic zones is listed below:

Comparison of Population

Enumeration Districts	Zones	Population: Independent Estimates	Population: Expanded Survey Data	Comparison Ratios
34P, 35	8, 10, 11	1,968	1,912	0.97
34N	12	1,272	1,104	0.87
31, 33	13,15,17 19,20,21	1,983	1,860	0.94
25	14, 27	1,170	1,324	1.13
30	18, 24	1,023	892	0.87
29	25, 33	1,790	1,923	1.07
27	26	1,161	1,270	1.09
26	28	1,012	993	0.98
22P, 23	38,39,46	3,011	2,815	0.93
21, 22N	40,41,45, 47,50	2,956	2,899	0.98
19	44	1,185	1,063	0.90
Totals		18,531	18,055	0.97

The overall comparison ratio of 0.97 indicates satisfactory accuracy in sample selection and interviewing. Comparison ratios for individual enumeration districts or groups of districts range from 0.87 to 1.13; these ratios refer to enumeration districts which have populations in the order of 1,100 persons. The standards established by the U.S. Bureau of Public Roads for population accuracy checks require that expanded survey population for a census tract (which usually has a population in the order of

4,000 persons) be within 15% of population for the tract as obtained from independent sources. Using this criterion, the difference between expanded survey data and population obtained from independent sources would normally be expected to be greater than 15% for areas smaller than a census tract. For the Dover-Somersworth Study, however, the requirement of not more than 15% variation has been met for groupings of enumeration districts which are considerably smaller than a census tract.

APPENDIX A

EXPANDED HOME INTERVIEW DATA

Zone	No. of Dwelling Units: Family	No. of Dwelling Units: Institution	No. of Residents	Avg. Fam. Income	No. of Pass. Vehicles	Total Pers. Trips
001	170	56	634	$ 6,314	214	1,309
002	55	-	171	6,250	61	517
003	197	41	745	4,827	231	1,925
004	263	-	796	7,028	325	1,909
005	322	-	1,291	8,282	395	3,724
006	56	-	226	7,250	55	781
007	150	-	545	7,852	220	1,936
008	165	-	462	7,447	204	1,744
009	189	5	694	9,480	241	2,050
010	322	20	922	7,968	319	3,030
011	307	51	528	$ 4,931	173	994
012	364	-	1,104	6,460	329	3,722
013	214	-	509	3,657	120	744
014	378	15	1,247	5,885	329	3,245
015	148	5	412	5,352	105	786
018	55	15	93	3,740	17	215
019	88	-	193	3,900	44	451
020	231	-	578	6,357	187	1,392
021	50	20	168	$ 5,287	38	304
022	170	-	418	7,152	203	1,810
023	204	-	730	3,969	167	1,348
024	262	66	799	4,380	223	2,033
025	545	10	1,595	5,985	575	5,117
026	394	5	1,270	5,162	286	2,338
027	23	-	77	7,250	28	138
028	355	-	993	5,760	390	2,514
029	241	51	717	6,152	270	1,698
030	82	-	225	7,250	88	710
031	28	-	61	$ 6,000	22	259
032	44	-	192	6,250	60	528
033	71	-	328	7,700	104	1,232
034	252	-	851	7,251	308	3,251
035	121	-	469	7,500	138	1,223
036	60	-	151	6,500	65	459
037	65	-	314	6,608	97	1,081
038	220	-	655	6,351	193	1,986

Zone	No. of Dwelling Units: Family	No. of Dwelling Units: Institution	No. of Residents	Avg. Fam. Income	No. of Pass. Vehicles	Total Pers. Trips
039	121	-	496	$ 6,900	122	1,326
040	314	-	1,171	7,244	390	3,579
041	254	15	773	$ 6,677	299	2,268
042	62	-	138	4,800	72	281
043	171	-	608	7,538	215	1,915
044	354	25	1,063	5,477	322	2,816
045	16	5	11	5,500	-	22
046	583	5	1,664	5,348	522	4,512
047	126	-	380	5,928	132	842
048	149	-	567	6,796	176	1,804
049	202	-	550	6,850	231	1,667
050	214	16	564	5,543	224	1,848
	9,327	426	29,147		9,529	81,383

DOVER-SOMERSWORTH TRANSPORTATION STUDY

Memorandum No. 10

December 27, 1965

FROM: Tippetts-Abbett-McCarthy-Stratton

TO: New Hampshire Department of Public Works and Highways

SUBJECT: Forecasts of Population and Residential Land Use

1. Current Study Area Population

The Dover-Somersworth Transportation Study Area includes 95% of the 1965 population of Dover, 93% of the population of Somersworth and 21% of the population of Rollinsford. The total Study Area population in 1965 was 29,147, of which 20,043 persons or 68.8% of the total resided in Dover, 8,639 persons or 29.6% resided in Somersworth and 465 persons or 1.6% resided in Rollinsford.

2. Forecast of 1985 Study Area Population

Since almost all of the population of Dover and Somersworth is included in the Study Area, forecasts of future populations of each traffic zone were based on projections of the total population of these cities to 1985. Using this total growth as a basis, the added population was distributed among traffic zones by estimating the new residential construction appropriate for each zone, as well as areas suitable for redevelopment, and applying appropriate densities for redevelopment. This procedure is described in detail in Paragraph 3 of this Memorandum.

From 1950 to 1960, the population of Strafford County increased by 16.0% as compared to a state-wide increase of 13.8% and a national increase of 18.5%. During the same period, the population of Dover and Somersworth increased by 20.5% and 23.1% respectively, which follows the national trend of greater population increases in urban centers. As a result, whereas Dover and Somersworth in 1950 contained 31% and 13% respectively of the population of Strafford County, these proportions increased to 32% and 14% by 1960. Forecasts of 1970 population growth in Strafford County and the City of Dover made by the New Hampshire State Planning Project and the Dover Planning Board indicate that the 1950-1960 trend is expected to continue.

Based on historical trends and on the 1970 forecast made by the State Planning Project, it is estimated that the County population will be 87,000 persons by 1985. Dover is expected to account for an increasing share of the County population, and by 1985 should contain 35% of the total. Somersworth should retain its 14% share of the County population. By 1985, therefore, the population of the City of Dover is expected to reach 29,000, while the City of Somersworth should achieve a population of 12,000. The 1985 population of the portion of Rollinsford within the Study Area is estimated at 700. These forecasts are summarized below:

FORECAST OF 1985 POPULATION

	1965	1985	Increase
City of Dover (entire)	21,220	29,000	7,780
City of Somersworth (entire)	9,300	12,000	2,700
Portion of Rollinsford in Study Area	465	700	235
Total	30,985	41,700	10,715

These forecasts for Dover and Somersworth include areas outside the Study Area as well as the portion of the cities within the cordon line.

3. Residential Land Use and Population by Traffic Zone - 1985

To accommodate the expected population increases described in Paragraph 2, a total of 3,200 new dwelling units would be required, of which 2,330 would be in Dover, 800 in Somersworth, and 70 in Rollinsford, based upon an average family size in these communities of 3.34, 3.39 and 3.35 persons respectively. In addition, an estimated 316 dwelling units in Dover and 300 dwelling units in Somersworth are expected to be displaced by construction and require replacement.

Present residential development in the Dover-Somersworth area consists of multi-family dwellings, two-family dwellings, single family developments in built-up areas and single-family developments in rural areas. It is expected that the most intensive future residential development in the Dover-Somersworth area will be in the form of garden apartments, similar to the housing currently under construction in the Washington Street and Bartlett Avenue projects in Somersworth, or town houses, rather than high-rise apartments. Density of this type of housing is in the order of 16 dwelling units per acre. In areas where two-family dwellings prevail, the density averages 8 dwelling units per acre. Single-family dwellings in built-up areas yield an average density of 4 dwelling units per acre, while single-family dwellings in rural areas usually have a density of one dwelling unit per acre.

In the United States, the proportion of various dwelling types in cities with populations of less than 50,000 is generally as follows: multi-family, 5%; two-family, 9%; and single family, 86%. In Dover-Somersworth, single-family development is expected to be divided between rural areas (15%) and built-up areas (71%). The forecasted population growth would be distributed throughout the Study Area in approximately these proportions. Displaced residents currently reside either in, or close to, the core areas and, as a result, are expected to be accommodated in about equal proportions in either multi-family developments or two-family dwellings.

New dwelling units were distributed among traffic zones using the proportions discussed above. In assigning areas for development or redevelopment, consideration was given to existing land uses, desirable mixtures of land uses and other environmental

factors, physical condition of existing buildings, topography (with particular attention to steep grades and drainage conditions), accessability, and availability of utilities. Selections were based on field inspections, review of maps and other physical data, study of previous planning reports prepared for the area and discussions with the City engineers, planning officials, and other public officials of the communities within the Study Area.

In existing built-up areas, additional development is expected to take place through the utilization of vacant parcels and through redevelopment of sub-standard areas to a higher density. In selecting redevelopment areas, considerable reliance was placed on the recommendations in the Community Renewal Plan prepared by the Dover Planning Board and on the proposals of the Triangle Urban Renewal Project in Somersworth.

In Dover, about 14 acres of vacant land bounded by Hanson and Niles Streets in Traffic Zone 012 are considered suitable for multi-family development. In the same traffic zone, about 7 acres of land between Hanson and Union Streets could be cleared of existing sub-standard structures and redeveloped for multi-family housing. Similar treatment would be appropriate on about 7 acres of land in Traffic Zone 013, 4 acres in Zone 015 and 8 acres in Zone 020, for a total in Dover of 37 acres or 592 new dwelling units of multi-family housing by 1985.

In Somersworth, multi-family housing is currently under construction on Bartlett Avenue and Washington Street in Traffic Zones 048 and 049, respectively, on sites of 4 acres each. An additional 12 acres of land in Traffic Zone 046, between Main and Green Streets where many existing structures are sub-standard, could be redeveloped for multi-family use. By 1985, therefore, a total of 312 new multi-family dwelling units are expected to be developed in Somersworth.

Most two-family development is expected to take place on numerous small parcels close to the core areas where existing development consists of sub-standard, single-family housing. The largest such developments are expected in Traffic Zone 025 in Dover and 048 in Somersworth. The only new two-family developments on existing vacant land are expected in Traffic Zones 09, 014 and 015 in Dover.

Most single-family urban development is expected to be in the form of extensions to existing development in areas already served by utilities or where extension of utility mains could be accomplished economically. A large part of the future single-family rural development is expected to take place beyond the limits of the Study Area.

A tabulation showing changes in population, dwelling units and residential land area in the Study Area from 1965 to 1985 by traffic zone, appears in Appendix A and is summarized below.

STUDY AREA RESIDENTIAL LAND USE AND POPULATION - 1985

	1965			Change 1965 - 1985			1985		
	Area (Acres)	No. of Dwelling Units	No. of Residents	Area (Acres)	No. of Dwelling Units	No. of Residents	Area (Acres)	No. of Dwelling Units	No. of Residents
Dover(1)	1,689	6,876	20,043	415	2,215	7,372	2,104	9,091	27,415
Somersworth(1)	581	2,852	8,640	168	787	2,668	749	3,639	11,308
Rollinsford	74	125	465	27	70	235	101	195	700
Sub-Total: Study Area	2,344	9,853	29,148	610	3,072	10,275	2,954	12,925	39,423
Outside Study Area(2)				70	128	430			
Total				680	3,200	10,705			

(1) Portion within Study Area
(2) Includes the portions of the Cities of Dover and Somersworth outside of the Study Area.

RESIDENTIAL LAND USE AND POPULATION - 1985

Traffic Zone	1965 Area (Acres)	1965 No. of Dwelling Units	1965 No. of Residents	Change 1965 - 1985 Area (Acres)	Change 1965 - 1985 No. of Dwelling Units	Change 1965 - 1985 No. of Residents	1985 Area (Acres)	1985 No. of Dwelling Units	1985 No. of Residents
001	125	226	634	30	108	362	155	334	996
002	47	55	171	79	295	986	126	350	1,157
003	77	238	745	5	17	58	82	255	803
004	51	263	796	23	89	298	74	352	1,094
005	131	322	1,291	23	89	298	154	411	1,589
006	5	56	226	0	0	0	5	56	226
007	109	150	545	61	235	785	170	385	1,330
008	103	165	462	12	39	130	115	204	592
009	42	194	694	15	120	400	57	314	1,094
010	77	342	922	4	40	135	81	382	1,057
011	30	358	528	-2	19	64	28	377	592
012	55	364	1,104	50	409	1,326	105	773	2,430
013	34	214	509	-1	67	224	33	281	733
014	61	393	1,247	10	52	174	71	445	1,421
015	23	153	412	-12	-4	-12	11	149	400
016	0	0	0	0	0	0	0	0	0
017	0	0	0	0	0	0	0	0	0
018	6	70	93	-7	-41	-136	-1	29	-43
019	3	88	193	-3	-25	-83	0	63	110
020	32	231	578	0	102	340	32	333	918
021	11	70	168	-12	-30	-100	-1	40	68
022	77	170	418	18	72	240	95	242	658
023	21	204	730	5	40	135	26	244	865
024	42	328	799	19	76	255	61	404	1,054
025	131	555	1,595	24	148	495	155	703	2,090
026	38	399	1,270	-4	-1	-3	34	398	1,267
027	3	23	77	0	0	0	3	23	77
028	60	355	993	3	20	68	63	375	1,061
029	64	292	717	8	32	105	72	324	822
030	28	82	225	1	4	14	29	86	239
031	9	28	61	1	1	3	10	29	64
032	35	44	192	5	11	38	40	55	230
033	29	71	328	25	94	315	54	165	643
034	90	252	851	32	128	428	122	380	1,279
035	40	121	469	3	9	30	43	130	499
036	37	60	151	18	50	165	55	110	316
037	37	65	314	9	20	70	46	85	384
038	52	220	655	2	-3	-10	54	217	645
039	36	121	496	5	17	57	41	138	553
040	94	314	1,171	59	224	760	153	538	1,931

Traffic Zone	1965 Area (Acres)	1965 No. of Dwelling Units	1965 No. of Residents	Change 1965 - 1985 Area (Acres)	Change 1965 - 1985 No. of Dwelling Units	Change 1965 - 1985 No. of Residents	1985 Area (Acres)	1985 No. of Dwelling Units	1985 No. of Residents
041	69	269	773	7	16	54	76	285	827
042	18	62	138	5	8	27	23	70	165
043	83	171	608	34	127	430	117	298	1,038
044	29	379	1,063	-5	-58	-196	24	321	867
045	1	21	11	0	0	0	1	21	11
046	70	588	1,664	2	128	434	72	716	2,098
047	36	126	380	25	100	339	61	226	719
048	22	149	567	18	164	556	40	313	1,123
049	40	202	550	16	52	176	56	254	726
050	31	230	564	0	12	41	31	242	605
060				6	6	20			
061				8	8	27			
062				3	3	10			
063				12	12	41			
064				36	94	315			
067				5	5	17			

DOVER-SOMERSWORTH TRANSPORTATION STUDY

Memorandum No. 11

December 30, 1965

FROM: Tippetts-Abbett-McCarthy-Stratton

TO: New Hampshire Department of Public Works and Highways

SUBJECT: Cordon Line Comparisons

The cordon line surrounding the Dover-Somersworth Study Area is crossed by 22 highway routes; interviews were conducted on 14 of these routes to obtain data on the origins and destinations of travel to, from and through the Study Area. The 22 routes carried a combined total of 57,600 vehicles on an average weekday during the summer of 1965. The routes on which interviews were conducted had a 1965 average weekday summer volume totaling 55,500 vehicles, about 96% of the total volume crossing the cordon line. Daily traffic volume during the summer of 1965 at the interview locations are shown in Table A-1.

Tables A-2, A-3 and A-4 present hourly comparisons between expanded internal trip data and expanded external trip data for travel which was made by residents of the Study Area and which crossed the Study Area cordon line. The cordon line comparisons shown in these tables are summarized below:

Cordon Line Crossings:

Expanded Internal Survey Data as a Percent of External Survey Data

	Autos	Trucks	Total
Average summer weekday	101	77	99
16 hours; 6 AM - 10 PM	94	70	92
AM peak period: 7 AM - 9 AM	139	67	128
PM peak period: 4 PM - 7 PM	79	55	77

For average daily traffic and for the 16-hour period usually used as a basis for comparison, the expanded internal survey data for automobile travel are in close agreement with expanded external survey data. For these same periods, truck travel obtained in the internal survey appears to be somewhat low. Automobile travel obtained in the internal survey is high in the AM peak period, but all other peak period movements are somewhat low.

For automobile travel, the good agreement between internal and external data on a daily basis indicates that trips were properly recorded, while the poor agreement found in peak periods indicates that the time of travel was poorly reported. The under-reporting of truck travel shown by these comparisons has been found in other surveys, and probably results from the desire of truck drivers to report fewer trips than actually made to reduce the length of the interview.

TABLE A-1

Total Vehicle Volumes Crossing Cordon Line

Station No.	Location	Average Summer Weekday Traffic Volumes
1	Spaulding Turnpike, Dover Point	6,600
2	Rt. 16 (Dover Point Road), Dover Point	5,610
3	Rt. 4 (Portland Ave.), Rollinsford-Dover Line	3,660
4	RR Overpass, Rollinsford	1,850
5	Rt. 9 Berwick-Somersworth Bridge	9,200
6	Rt. 16 (Rochester Road) to Rochester	6,240
8	Rt. 16B (Old Rochester Road) to Rochester	1,930
10	Spaulding Turnpike, Rochester	4,880
12	Sixth Street, Dover, West of Turnpike	1,150
14	Rt. 4/9 (Littleworth Road), Dover	2,920
15	Rt. 155 (Knox Marsh Road), Dover	3,120
16	Rt. 108 (Durham Road), Dover	4,810
17	Back River Road, Dover	1,090
19	Gulf Road (to Eliot), Dover	2,440
Sub-total		55,500
Other routes crossing cordon line		2,100
Total		57,600

TABLE A-2

Passenger Vehicle Trips Crossing Cordon Line
(Made by Residents of the Study Area)

Hour Beginning At	Expanded Internal Survey Data			Expanded External Survey Data			Percent (Internal/ External)
	Home-Based Work Trips	Other Trips	Total	Home-Based Work Trips	Other Trips	Total	
06	526	284	810	426	152	578	140
07	563	514	1,077	528	180	708	152
08	196	337	533	178	239	417	128
09	62	364	426	93	239	332	129
10	78	531	609	44	416	460	132
11	34	398	432	117	558	675	64
12	95	557	652	182	550	732	89
13	56	436	492	87	556	643	77
14	118	456	574	150	502	652	88
15	168	510	678	321	547	868	78
16	447	659	1,106	734	655	1,389	80
17	324	552	876	446	676	1,122	78
18	117	732	849	174	839	1,013	84
19	34	732	766	71	798	869	88
20	39	632	671	64	595	659	102
21	34	381	415	66	437	503	83
Sub-total 16 hrs, 6AM-10PM	2,890	8,074	10,964	3,683	7,940	11,623	94
22	78	313	391	56	267	323	
23	95	236	331	58	132	190	
00	28	91	119	35	91	126	
01	56	151	207	27	44	71	
02	22	44	66	4	27	31	
03	39	50	89	12	10	22	
04	84	151	235	19	13	32	
05	146	73	219	38	14	52	
Total: 24 hours	3,438	9,183	12,621	3,932	8,538	12,470	101

Note: Totals obtained from unrounded data

TABLE A-3

Truck Trips Crossing Cordon Line
(Made by Residents of Study Area)

Hour Beginning At	Expanded Internal Survey Data			Expanded External Survey Data			Percent (Internal/ External)
	Home-Based Work Trips	Other Trips	Total	Home-Based Work Trips	Other Trips	Total	
06	62	22	84	33	23	56	150
07	17	39	56	91	61	152	37
08	11	116	127	29	94	123	103
09	22	62	84	16	95	111	76
10	11	95	106	6	56	62	171
11	6	67	73	6	94	100	73
12	-	84	84	19	66	85	99
13	-	33	33	9	82	91	36
14	11	50	61	23	71	94	65
15	11	78	89	19	87	106	84
16	39	39	78	60	89	149	52
17	34	33	67	46	71	117	57
18	6	22	28	28	32	60	47
19	6	-	6	10	31	41	15
20	-	11	11	16	31	47	23
21	-	6	6	5	20	25	24
Sub-total	234	757	991	417	1,003	1,420	70
22	6	6	12	5	4	9	
23	-	6	6	2	2	4	
00	6	5	11	3	2	5	
01	-	17	17	-	-	-	
02	-	22	22	-	3	3	
03	6	11	17	2	1	3	
04	11	6	17	5	1	6	
05	11	28	39	6	10	16	
Total	274	858	1,132	440	1,026	1,466	77

Note: Totals obtained from unrounded data

TABLE A-4

Total Vehicle Trips Crossing Cordon Line
(Made by Residents of Study Area)

Hour Beginning At	Expanded Internal Survey Data			Expanded External Survey Data			Percent (Internal/ External)
	Home-Based Work Trips	Other Trips	Total	Home-Based Work Trips	Other Trips	Total	
06	588	306	894	459	175	634	141
07	580	553	1,133	619	241	860	132
08	207	453	660	207	333	540	122
09	84	426	510	109	334	443	115
10	89	626	715	50	472	522	137
11	40	465	505	123	652	775	65
12	95	641	736	201	616	817	90
13	56	469	525	96	638	734	72
14	129	506	635	173	573	746	85
15	179	588	767	340	634	974	79
16	486	698	1,184	794	744	1,538	77
17	358	585	943	492	747	1,239	76
18	123	754	877	202	871	1,073	82
19	40	732	772	81	829	910	85
20	39	643	682	80	626	706	96
21	34	387	421	71	457	528	80
Sub-total	3,124	8,831	11,955	4,100	8,943	13,043	92
22	84	319	403	61	271	332	
23	95	242	337	60	134	194	
00	34	96	130	38	93	131	
01	56	168	224	27	44	71	
02	22	66	88	4	30	34	
03	45	61	106	14	11	25	
04	95	157	252	24	14	38	
05	157	101	258	44	24	68	
Total: 24 hours	3,712	10,041	13,753	4,372	9,564	13,936	99

Note: Totals obtained from unrounded data

DOVER-SOMERSWORTH TRANSPORTATION STUDY

Memorandum No. 12

December 30, 1965

FROM: Tippetts-Abbett-McCarthy-Stratton

TO: New Hampshire Department of Public Works and Highways

SUBJECT: Forecasts of Industrial and Commercial Employment and Land Use

1. Forecast of Total Employment

From 1955 to 1964, the Department of Employment Security covered employment in the Dover Job Center increased from 9,213 to 10,666 for a gain of 1,453 or 15.8%. Although industry remains the dominant employer in the Center, this category actually experienced the smallest percentage gain at 8.9% while commercial employment (other than retail) experienced the largest at 70.6% (Table 1). This trend is typical of maturing urban areas which place increasing reliance on commercial services of all types and less on manufacturing.

Table 1

Covered Employment 1955-1964

Dover Job Center

Employment Category	Number of Employees 1955	1964	Total Increase	% Increase	Average Annual Increase in No. of Employees
Industrial	7,463	8,128	665	8.9	74
Retail	1,177	1,560	383	32.5	42
Other Commercial	573	978	405	70.6	45
Total	9,213	10,666	1,453	15.8	161

Source: New Hampshire Department of Employment Security

It is expected that employment in the Dover-Somersworth area will continue to grow in the future at about the same rate as during the past 10 years. Such a rate of growth is consistent with the expected population increase in the area (Memorandum No. 10).

The expected employment growth for the Dover Job Center employment was converted to annual increases for each of the cities within the Study Area and adjusted for non-covered employment as shown in Table 2.

Total employment in the Study Area is expected to increase from 12,470 in 1965 to 16,550 in 1985 for an increase of 4,080 or 33%. The expected rate of increase for each employment category varies from an average annual rate of 0.8% for industrial employment to 3.8% for commercial employment other than retail. Retail employment is expected to gain at an average annual rate of 3.4%. Dover would continue to accommodate the largest share of new employment.

Table 2

Study Area Employment - 1985

	Covered Employment as Percent of Total Employment	Percent of Total Job Center Employment In Study Area	Average Annual Increase in No. of Covered Employees for Dover Job Center	Average Annual Change in Total Employment No. of Employees	Employment 1965	Total Change 1965-1985	Employment 1985
Industrial							
Dover	94%	63%		50	5,733	1,000	6,733
Somersworth	96%	35%	74	27	3,161	540	3,701
Rollinsford	100%	0.4%		1	30	20	50
Retail Trade							
Dover	72%	83%		48	1,493	960	2,453
Somersworth	43%	15%	42	15	405	300	705
Rollinsford	0%	0.4%		0.5	6	10	16
Other Commercial							
Dover	70%	83%		51	1,292	1,020	2,312
Somersworth	56%	15%	43	11	326	220	546
Rollinsford	42%	0.4%		0.5	24	10	34
Sub Totals							
Industrials				78	8,924	1,560	10,484
Retail Trade				63.5	1,904	1,270	3,174
Other Commercial				62.5	1,642	1,250	2,892
Total				204	12,470	4,080	16,550

2. Forecast of Industrial Land Use and Employment

Industry is the largest employer in the Dover-Somersworth area. Many existing industries, which include manufacture of leather goods, rubber products and electrical machinery and printing, developed shortly after the turn of the century, and located close to the rivers in order to satisfy their needs for power and disposal of wastes. The surrounding areas were subsequently densely built-up, and the industrial facilities were left without adequate room for expansion and modernization. Industries in the area are now operating in obsolete, multi-story buildings with inadequate off-street parking and loading facilities. Adequate land must be provided to accommodate the future industrial growth in the area and to satisfy the needs of existing industries seeking to modernize and expand.

With the advent of low-cost electrical power and efficient waste disposal systems, industries are no longer dependent upon river side locations. However, there is now considerably greater flexibility in selecting appropriate sites for industrial development and communities throughout the country and finding that the most efficient way to provide these sites is through the development of industrial parks. Modern plants are generally constructed on one level and provide ample space for parking, loading, landscaping and future expansion. These can best be provided through unified developments outside of built-up areas where it becomes practicable to provide the necessary highway and rail facilities and utility services. It is also possible to arrange and shield facilities so as to minimize objectionable effects upon surrounding land uses.

The amount of land needed to satisfy industrial growth is estimated by applying an appropriate density for development to the expected employment growth. Although employee density in existing industrial areas averages 46 workers per acre; it is estimated that an employment density of 25 workers per acre for future growth would be appropriate. The amount of land needed by industries seeking to expand and modernize is based on the estimate that an average of 2% of the existing industrial areas will be renewed annually. On this basis 40% of existing industrial land will require replacement by 1985. It is estimated that this land will also be developed at an average density of 25 workers per acre (Table 3).

As indicated in Table 3, 77 acres of new industrial land is estimated to be needed in Dover by 1985. Of this amount, 10 acres would be distributed in relatively small parcels at various locations beyond the boundary of the urbanized portions of the city where they would be used by small industries, including contractors. Fifty-three acres of new industrial land would be developed by expanding the existing Dover Industrial Park, in traffic zones 8 and 31. Fourteen acres of new industrial land would be developed in traffic zones 15 and 17 in the downtown area to provide the necessary parking area and other expanded facilities for industries now located there.

In Somersworth, 48 acres of new industrial land would be required. Here also, 5 acres would be distributed in the outskirts of the built-up area in small parcels where they will be used by small industries. The proposed Triangle Area Urban Renewal Project would be developed directly across the street from existing industrial plants which are badly in need of parking space and it is assumed that two acres of the Triangle Project

would be devoted to parking for these industries. The remaining 41 acres of new industrial land would be developed in areas zoned and otherwise suitable for industrial development in the wester portion of the loop formed by the Indigo Hill Road and Main Street (14 acres), in the area between Routes 16 and 16B south of Gonic Road (22 acres), and in the area bounded by Depot Street, Indigo Hill Road and the railroad (4 acres) These areas are located in traffic zones 38 and 42.

A breakdown by traffic zone of future industrial employment and land use appears in Appendix A.

Table 3

Additional Industrial Land Required - 1985

	Dover	Somersworth	Rollinsford
Industrial Employment - 1965	5,733	3,161	30
Industrial Area - 1965 (acres)	139	59	2
% of Existing Industries to be Redeveloped	40	40	40
Employees to be Displaced	2,290	1,260	12
Industrial Land to be Cleared (acres)	57	24	1
Estimated Increase in Industrial Employment 1965 - 1985	1,000	540	20
Total Employees on New or Re-developed Industrial Land	3,290	1,800	32
Density of Workers / Acres	25	25	25
New or Redeveloped Industrial Land Required - 1985 (acres)	132	72	1
Existing Industrial Land to be Converted to Other Uses (acres)	2	0	0
Additional Industrial Land Required - 1985 (acres)	77	48	0

Additional Industrial Land Required = (New or Redeveloped Industrial Land Required) + (Existing Industrial Land to be Converted to Other Uses) - (Industrial Land to be Cleared)

3. Forecast of Commercial Land Use and Employment

Additional land would be required for commercial uses by 1985 to accommodate expected economic growth and to meet the need to modernize existing facilities which, in many cases, are now housed in structurally unsatisfactory or functionally obsolescent buildings. The largest portion of new land would be required in the Central Business Districts of Dover and Somersworth which form the core of the region's commercial activity, but other new land, largely for convenience retail and service commercial uses, would be needed in outlying areas as well.

As shown in Paragraph 1, the increase in retail trade employment by 1985 is estimated at 1,270 workers of whom 960 would be in Dover, 300 in Somersworth and 10 in Rollinsford. Employment in other commercial activities is estimated to increase by 1,250 workers by 1985, of whom 1,020 would be in Dover, 220 in Somersworth and 10 in Rollinsford. Based upon an economic life of 40 years for commercial buildings, it is estimated that 50% of existing commercial land would undergo major renovation or replacement over the next 20 years.

There is a marked difference between existing employment densities of commercial areas in the Central Business Districts and outlying areas. The existing average density for all commercial activities in both Central Business Districts is 45 employees per acre. Density of non-retail commercial activities, about 50 employees per acre, is somewhat higher than retail activities which is in the order of 40 employees per acre. In rural areas, commercial employment densities are in the order of 10 employees per acre or less.

Although it is expected that there would be increased multi-story construction in the Central Business Districts in the future, a net decrease in commercial densities should result due to the amount of land which would be allocated for off-street parking facilities. At Dover it is expected that the density of non-retail commercial functions in 1985 would continue to be somewhat higher than retail densities, estimated at 40 and 35 employees per net acre, respectively. In Somersworth, on the other hand, where construction of high-rise buildings is unlikely, the estimated density for all commercial employment is 35 workers per acre. At outlying areas in both communities the density of all commercial activities is estimated to remain at 10 workers per acre.

Based upon these average densities, it is estimated that 27 acres of new commercial land would be required in the Dover Central Business District by 1985. Much of this land would be developed in the areas identified as Study Area 1 and 36 (traffic zones 14, 15, 18 and 19) in the "Community Renewal Program Report" prepared by the Dover Planning Board which currently are occupied by old and deteriorated residential structures. The new development would build upon and strengthen the existing commercial area which has developed linearly along Central Avenue.

An additional 92 acres of new commercial land would be required in areas outside the Dover Central Business District. Fifty acres of this total would be located principally at the intersection of major roads, or extensions to existing commercial developments. The remaining 42 acres would be neighborhood establishments and would be distributed among the traffic zones in proportion to the expected population increases.

In Somersworth the proposed Triangle Urban Renewal Project provides for a major commercial redevelopment of the area bordered by High, Pleasant and Main Streets. Almost all of this area, which is 9 acres in size, is currently in residential use. It is assumed that 7 acres of the redevelopment project would be devoted to commercial uses and would thereby satisfy the need for downtown commercial land to 1985. The remaining 2 acres would be used for parking by industries east of Main Street. The distribution of the 16 acres of new commercial land required in the portions of Somersworth outside the

Central Business District by 1985 would be similar to the distribution in outlying portions of Dover. Seven acres would be at strategic highway locations or adjacent to existing commercial areas while the remaining nine acres would serve neighborhood functions and would be distributed among traffic zones in accordance with population increases.

The land areas in each traffic zone expected to be devoted to commercial use by 1985 are listed in Appendix B.

Applying appropriate employment densities to the proposed new and redeveloped commercial areas, retail trade and other commercial employment expected by 1985 in each traffic zone is obtained. These are listed in Appendix C.

APPENDIX A

INDUSTRIAL LAND USE AND EMPLOYMENT - 1985

Traffic Zone	1965 No. of Employees	1965 Area (Acres)	Change 1965 - 1985 Number of Employees Due to Modernization	Change 1965 - 1985 Number of Employees New Employment	Change 1965 - 1985 Number of Employees Total Change	Change 1965 - 1985 Area (Acres)	1985 No. of Employees	1985 Area (Acres)
001	21	1	3	25	28	1	49	2
002	0	0	0	25	25	1	25	1
003	0	0	0	25	25	1	25	1
004	7	0	2	0	2	0	9	0
005	12	0	1	25	26	1	38	1
006	127	8	24	0	24	0	151	8
007	17	0	-1	25	24	1	41	1.5
008	14	0	0	685	685	29	699	28
009	35	1	-2	0	-2	0	33	1
010	26	18	165	0	165	0	191	18
011	12	2	20	0	20	0	32	2
012	38	1	-5	0	-5	0	33	1
013	0	0	0	0	0	0	0	0
014	51	15	130	0	130	0	181	15
015	7	1	8	275	283	11	290	12
016	970	4	-362	0	-362	0	608	4
017	1,201	4	-455	75	-380	3	821	7
018	55	13	103	0	103	0	158	13
019	192	2	-192	0	-192	-2	0	0
020	14	0	0	0	0	0	14	0
021	12	0	1	0	1	0	13	0
022	7	0	3	25	28	1	35	1
023	0	0	0	0	0	0	0	0
024	366	7	-71	0	-71	0	295	7
025	131	4	-12	0	-12	0	119	4
026	359	4	-104	0	-104	0	255	4
027	721	26	-39	0	-39	0	682	26
028	12	1	6	0	6	0	18	1
029	0	0	0	0	0	0	0	0
030	66	2	-1	0	-1	0	65	2
031	1,221	24	-124	635	511	27	1,732	50
032	0	0	0	25	25	1	25	1
033	14	0	5	25	30	1	44	2
034	25	1	2	0	2	0	27	1
035	0	0	0	25	25	1	25	1
036	15	1	10	0	10	0	25	1
037	15	1	10	0	10	0	25	1
038	485	12	-69	475	406	19	891	31
039	14	0	0	25	25	1	39	1

Traffic Zone	1965 No. of Employees	1965 Area (Acres)	Change 1965 - 1985 Number of Employees Due to Modernization	Change 1965 - 1985 Number of Employees New Employment	Change 1965 - 1985 Number of Employees Total Change	Change 1965 - 1985 Area (Acres)	1985 No. of Employees	1985 Area (Acres)
040	0	0	0	25	25	1	25	1
041	77	11	69	0	69	0	146	11
042	7	0	3	595	598	24	605	24
043	0	0	0	0	0	0	0	0
044	85	2	-9	25	16	3	101	5
045	2,322	27	-662	50	-612	0	1,710	27
046	44	2	7	0	7	0	51	2
047	30	1	0	0	0	0	30	1
048	38	2	6	0	6	0	44	2
049	39	1	-3	0	-3	0	36	1
050	20	1	3	0	3	0	23	1
Dover	5,733	139			1,000	77	6,733	215.5
Somersworth	3,161	59			540	48	3,701	107.0
Rollinsford	30	2			20	0	50	0.0
Total	8,924	200			1,560	125	10,484	322.5

APPENDIX B

COMMERCIAL LAND USE - 1985
(Acres)

Traffic Zone	1965	Change 1965 - 1985	1985
001	2	2	4
002	8	7	15
003	14	5	19
004	7	2	9
005	0	2	2
006	4	0	4
007	3	8	11
008	2	1	3
009	14	10	24
010	1	1	2
011	8	2	10
012	2	8	10
013	4	2	6
014	5	12	17
015	3	3	6
016	0	0	0
017	3	0	3
018	7	6	13
019	4	4	8
020	3	9	12
021	6	4	10
022	1	1	2
023	1	1	2
024	7	1	8
025	2	3	5
026	4	4	8
027	5	0	5
028	5	0	5
029	1	1	2
030	51	7	58
031	0	3	3
032	0	0	0
033	0	2	2
034	9	2	11
035	6	6	12
Sub Total Dover	192	119	311
036	1	1	2
037	3	1	4
Sub Total Rollinsford	4	2	6

Traffic Zone	1965	Change 1965 - 1985	1985
038	4	0	4
039	2	0	2
040	4	3	7
041	39	3	42
042	9	4	13
043	2	2	4
044	4	4	8
045	2	0	2
046	5	2	7
047	1	1	2
048	1	2	3
049	4	1	5
050	3	2	5
Sub Total Somersworth	80	24	104
Total	276	145	421

APPENDIX C

RETAIL TRADE AND OTHER COMMERCIAL EMPLOYMENT - 1985

Traffic Zone	Number of Employees in Retail Trade					No. of Employees in Other Commercial Activities				
		Change 1965 - 1985					Change 1965 - 1985			
	1965	[1] Due to Modernization	[2] New Employment	Total Change	1985	1965	[1] Due to Modernization	[2] New Employment	Total Change	1985
001	6	3	11	14	20	4	2	9	11	15
002	0	0	39	39	39	6	37	32	69	75
003	59	17	27	44	103	28	9	23	32	60
004	10	10	11	21	31	10	10	9	19	29
005	0	0	11	11	11	6	-3	9	6	12
006	121	-48	0	-48	73	80	-32	0	-32	48
007	8	9	44	53	61	4	5	36	41	45
008	6	1	6	7	13	8	2	4	6	14
009	12	4	55	59	71	76	22	46	68	144
010	3	1	6	7	10	7	3	4	7	14
011	28	10	21	31	59	38	11	86	97	135
012	18	-2	44	42	60	8	-1	35	34	42
013	98	0	0	0	98	32	-1	33	32	64
014	80	-9	163	154	234	52	-11	104	93	145
[illegible]	41	-5	57	52	93	2	0	63	63	65
[illegible]	5	-3	0	-3	2	0	0	0	0	0
017	62	0	-3	-3	59	66	0	-5	-5	61
018	151	0	125	125	276	240	0	51	51	291
019	143	0	24	24	167	82	0	122	122	204
020	8	5	50	55	63	10	6	41	47	57
021	78	0	10	10	88	260	0	51	51	311
022	0	0	5	5	5	2	-1	5	4	6
023	3	8	5	13	16	0	0	5	5	5
024	85	-24	5	-19	66	58	-17	5	-12	46
025	26	-9	17	8	34	36	-12	13	1	37
026	65	0	45	45	110	17	0	102	102	119
027	56	-1	0	-1	55	8	-1	0	-1	7
028	47	-13	0	-13	34	39	-10	0	-10	29
029	9	-5	6	1	10	10	-5	4	-1	9
030	243	89	38	127	370	64	19	31	50	114
031	0	0	16	16	16	0	0	14	14	14
032	0	0	0	0	0	0	0	0	0	0
033	3	-1	11	10	13	6	-3	9	6	12
034	9	5	11	16	25	33	14	9	23	56

1. Employment change due to modernization of existing facilities
2. Employment change due to construction of new facilities

Traffic Zone	Number of Employees in Retail Trade					No. of Employees in Other Commercial Activities				
		Change 1965-1985					Change 1965-1985			
	1965	[1] Due to Modernization	[2] New Employment	Total Change	1985	1965	[1] Due to Modernization	[2] New Employment	Total Change	1985
035	10	25	33	58	68	0	0	27	27	27
036	0	0	5	5	5	2	0	4	4	6
037	6	1	4	5	11	22	4	2	6	28
038	46	-9	0	-9	37	14	-1	0	-1	13
039	0	0	0	0	0	4	8	0	8	12
040	2	3	20	23	25	11	11	10	21	32
041	20	102	20	122	142	35	67	10	77	112
042	45	11	26	37	82	8	3	14	17	25
043	3	5	13	18	21	2	2	7	9	11
044	66	0	75	75	141	103	0	79	79	182
045	47	0	-6	-6	41	60	0	-11	-11	49
046	89	-21	13	-8	81	20	-4	7	3	23
047	33	-15	6	-9	24	6	-2	4	2	8
048	12	-4	13	9	21	15	-2	7	5	20
049	33	-12	7	-5	28	32	-6	3	-3	29
050	9	3	50	53	62	16	4	10	14	30
Sub Totals:										
over	1,493	67	893	960	2,453	1,292	43	977	1,020	2,312
olds-	6	1	9	10	16	24	4	6	10	34
ford										
omers-	405	63	237	300	705	326	80	140	220	546
worth										
Total	1,904	131	1,132	1,270	3,174	1,642	127	1,123	1,250	2,892

1. Employment change due to modernization of existing facilities
2. Employment change due to construction of new facilities

DOVER-SOMERSWORTH TRANSPORTATION STUDY

Memorandum No. 13 February 9, 1966

FROM: Tippetts-Abbett-McCarthy-Stratton

TO: New Hampshire Department of Public Works and Highways

SUBJECT: Public and Semi-Public Land Use and Employment 1965 and 1985

The expected population increase between 1965 and 1985 (see Memorandum No 10) will generate a need for additional public and semi-public facilities of all types, including schools, churches, offices of public agencies, hospitals, parks and the like.

Schools

Both Dover and Somersworth operate on a 6-3-3 school system (elementary school, grades 1-6; junior high school, grades 7-9; and high school, grades 10-12). It is estimated that 12% of the population will be in the elementary school age group, 6% in the junior high school age group and 6% in the high school age group. By 1985, therefore, there would be an estimated additional 1,020 elementary school students, 510 junior high school students and 510 high school students in Dover and 350 elementary school students, 175 junior high school students and 175 high school students in Somersworth. To accommodate the expected increased enrollment, three additional elementary schools and one additional junior high school will be required in Dover. In view of the current crowded conditions in the existing high school in Dover, a new high school is indicated, despite the fact that the expected enrollment increase would not by itself justify an additional school. In Somersworth, one new elementary school will be required. It is expected that the increased enrollment in the junior high and high school will be accommodated by additions to the existing buildings. Each new elementary school is estimated to require about 8 acres of land while the new junior high school in Dover is expected to require 15 acres and the high school, 25 acres.

In Dover, approximately 120 additional employees, including teachers and administrative personnel, would be required by 1985, while Somersworth would require approximately 35 additional employees in its school system.

Hospitals

The Wentworth-Douglas Hospital in Dover serves the entire study area. This hospital is expected to increase its capacity from 96 beds to 200 beds, requiring an additional six acres of land and an increase of 160 in its staff.

Churches

There is approximately one church for every 2,000 persons in the Dover-

Somersworth area. Assuming that this proportion remains unchanged, there would be a need for an additional four new churches in Dover and one new church in Somersworth by 1985. Each new church is estimated to occupy two acres of land and to employ three persons.

Parks

Because of the large amounts of open space in the Dover-Somersworth area and the major recreation facilities available at the seashore and mountain areas nearby, it is believed that a standard of two acres of park land per 1,000 population would be appropriate for the study area. On this basis, 16 additional acres of park land would be required in Dover and five acres in Somersworth by 1985. An estimated total of five employees would be required to service and care for the additional park land.

Other

Other public and semi-public employees, including policemen, firemen, postal clerks, and municipal, state and federal agency staffs would be required in proportion to population increases in the Dover-Somersworth area. It is estimated that a total of 115 such personnel would be required in Dover and 22 in Somersworth. Approximately four acres of land would be required for these activities in Dover and two acres in Somersworth.

* * * * * * * * *

In summary, an estimated total of 407 public and semi-public additional employees would be required in Dover by 1985, occupied in activities that would occupy 75 acres of land. In Somersworth, an estimated 60 additional public and semi-public employees would be required by 1985. The land requirements for these activities are estimated at 21 acres. A breakdown of the distribution of the additional land and employment appears in Appendix A.

Appendix B presents an overall summary of expected 1985 land uses in the study area.

APPENDIX A

PUBLIC AND SEMI-PUBLIC LAND USE AND EMPLOYMENT 1965 AND 1985

Traffic Zone	1965		Change 1965 - 1985		1985	
	Area	Employment	Area	Employment	Area	Employment
001	19	10	0	0	19	10
002	0	0	22	29	22	29
003	33	17	0	0	33	17
004	28	0	0	0	28	0
005	4	0	0	0	4	0
006	0	0	0	0	0	0
007	0	0	17	33	17	33
008	22	7	29	45	51	52
009	0	0	0	0	0	0
010	16	16	1	20	17	36
011	4	19	0	0	4	19
012	43	0	10	10	53	10
013	33	82	2	60	35	142
014	6	26	0	0	6	26
015	0	0	0	0	0	0
016	0	0	0	0	0	0
017	3	0	-2	0	1	0
018	1	16	2	0	3	16
019	1	2	0	0	1	2
020	2	52	0	0	2	52
021	9	98	1	35	10	133
022	0	16	0	0	0	16
023	0	0	0	0	0	0
024	3	4	0	0	3	4
025	10	16	2	3	12	19
026	3	2	0	0	3	2
027	0	0	0	0	0	0
028	2	0	0	0	2	0
029	10	162	6	160	16	322
030	2	15	0	0	2	15
031	0	0	0	0	0	0
032	0	0	0	0	0	0
033	0	0	0	0	0	0
034	5	0	8	15	13	15
035	0	0	0	0	0	0
Sub-Total Dover	259	560	98	410	357	970

Traffic Zone	1965 Area	1965 Employment	Change 1965 - 1985 Area	Change 1965 - 1985 Employment	1985 Area	1985 Employment
036	0	0	0	0	0	0
037	0	0	0	0	0	0
Sub-Total Rollinsford	0	0	0	0	0	0
038	0	0	0	0	0	0
039	0	0	0	0	0	0
040	92	0	10	18	102	18
041	0	0	5	2	5	2
042	51	9	0	0	51	9
043	2	2	0	0	2	2
044	5	41	0	0	5	41
045	0	0	0	0	0	0
046	4	2	0	0	4	2
047	0	0	0	0	0	0
048	16	9	3	18	19	27
049	23	21	2	10	25	31
050	2	16	1	14	3	30
Sub-Total Somersworth	195	100	21	62	216	162
TOTAL	454	660	119	472	573	1,132

APPENDIX B

SUMMARY OF STUDY AREA LAND USE - 1985

Traffic Zone	Total Area	Residential	Commercial	Industrial	Public & Semi-Public	Vacant
001	826	155	4	2	19	646
002	1,425	126	15	1	22	1,261
003	404	82	19	1	33	269
004	349	74	9	0	28	238
005	396	154	2	1	4	235
006	58	5	4	8	0	41
007	720	170	11	1	17	521
008	621	115	3	29	51	423
009	128	57	24	1	0	46
010	197	81	2	18	17	79
011	44	28	10	2	4	0
012	243	103	10	1	53	76
013	211	33	6	0	35	137
014	288	71	17	15	6	179
015	36	11	6	12	0	7
016	6	0	0	4	0	2
017	11	0	3	7	1	0
018	31	0	13	13	3	2
019	9	0	8	0	1	0
020	39	30	7	0	2	0
021	26	1	15	0	10	0
022	264	95	2	1	0	166
023	86	26	2	0	0	58
024	180	61	8	7	3	101
025	283	155	5	4	12	107
026	50	34	8	4	3	1
027	34	3	5	26	0	0
028	121	63	5	1	2	50
029	143	72	2	0	16	53
030	244	29	58	2	2	153
031	240	10	3	51	0	176
032	509	40	0	1	0	468
033	373	54	2	2	0	315
034	285	122	11	1	13	138
035	350	43	12	1	0	294
Sub-Total Dover	9,230	2,103	311	217	357	6,242

Traffic Zone	Total Area	Residential	Commercial	Industrial	Public & Semi-Public	Vacant
036	511	55	2	1	0	453
037	948	46	4	1	0	897
Sub-Total Rollinsford	1,459	101	6	2	0	1,350
038	480	54	4	31	0	391
039	360	41	2	1	0	316
040	985	153	7	1	102	722
041	931	76	42	11	5	797
042	937	23	13	24	51	826
043	736	117	4	0	2	613
044	211	24	8	5	5	169
045	33	1	2	27	0	3
046	89	72	7	2	4	4
047	95	61	2	1	0	31
048	270	41	3	2	19	205
049	106	56	5	1	25	19
050	39	30	5	1	3	0
Sub-Total Somersworth	5,272	749	104	107	216	4,096
TOTAL	15,961	2,953	421	326	573	11,688

DOVER-SOMERSWORTH TRANSPORTATION STUDY

Memorandum No. 14

June 3, 1966

FROM: Tippetts-Abbett-McCarthy-Stratton

TO: New Hampshire Department of Public Works and Highways

SUBJECT: Existing Arterial System

The existing arterial system in the Dover-Somersworth area has adequate capacity and does not require major improvements such as pavement widening and construction of new facilities to accommodate current traffic. However, at certain locations, particularly in business and commercial districts, the number of reported accidents appears to be excessive in comparison with traffic volumes. At most of these locations, pedestrian and vehicular safety could be improved immediately by the application of relatively low cost measures including channelizing islands, pavement markings, stop and yield signs, turning movement regulations, curbside parking controls, and modernization of obsolete traffic signal installations.

Analyses of existing conditions and preliminary recommendations for immediate low cost improvements for nine key locations in the City of Dover and five key locations in the City of Somersworth are presented in this memorandum. The estimated construction cost of these improvements is $183,200 of which $160,600 is assigned to Dover and $22,600 is assigned to Somersworth. These costs are compared in Tables 1 and 2 with the estimated costs to the public of 244 accidents reported at these fourteen locations in the one year period 1964-1965. For the nine locations in Dover, the costs of the recommended improvements, taken together, would amount to 83.0 percent of the annual accident costs, for the five Somersworth locations, the costs of the improvements would be equal to only 26 percent of the accident costs. The recommended improvements, if implemented, would not eliminate all accidents; nevertheless, a 50 percent reduction in the accident rate at those locations would result in an annual savings of $122,000; by contrast, the estimated total cost of the fourteen improvement plans is $183,200.

Summary of Estimated Costs for Improvements

Estimated construction costs for the recommended improvements are itemized in Tables 3 and 4.

Estimated quantities and costs for all pavement markings are based on 4-inch wide thermoplastic material.

The costs for signal installations and improvements does not reflect possible salvage value of existing equipment.

Costs listed under other work, except as noted, would include minor street repaving, adjustments to catch-basins and manholes, relocation of utility poles and installation of regulatory, guide and warning signs.

TABLE 1

COMPARISON OF COSTS OF IMPROVEMENTS
AND COSTS OF ACCIDENTS IN 1964-1965

CITY OF DOVER

Location	Reported Accidents 1964-1965 Number	Percent of City Total	Estimated Annual Costs to Public	Estimated Costs of Recommended Improvements
1 - Central Avenue - Spaulding Turnpike Interchange No. 4 - Mill Road - Durham Road - Back River Road	14	2.3	$ 16,800	$ 16,600
2 - Central Avenue - Stark Avenue	11	1.8	13,200	21,600
3 - Silver Street - Central Avenue	16	2.7	19,200	13,200
4 - Lower Square	23	3.8	27,600	10,300
5 - Washington Street - Main Street	11	1.8	13,200	2,200
- Upper Square	46	7.7	55,000	22,000
7 - Portland Avenue - Portland Street	N.A.	—	—	2,300
8 - Broadway Street - St. John Street	N.A.	—	—	4,400
9 - Central Avenue - Glenwood Avenue to Dover-Somersworth Traffic Circle	40	6.7	48,000	78,000
Totals	161	26.8	$193,000	$160,600

Notes: Unit accident cost of $1,200 is based on data presented in Traffic Engineering Handbook, Third Edition, 1965 - Institute of Traffic Engineers.

City-wide accident total - 600

TABLE 2

COMPARISON OF COSTS OF IMPROVEMENTS
AND COSTS OF ACCIDENTS IN 1964-1965

CITY OF SOMERSWORTH

Location	Reported Accidents 1964-1965 Number	Percent of City Total	Estimated Annual Costs to Public	Estimated Costs of Recommended Improvements
10 - Market Street: Main and High Streets to Berwick Bridge	30	10.4	$ 36,000	$ 7,500
11 - High Street - Orange Street - Highland Street	16	5.5	19,200	1,400
12 - High Street - West High Street- Washington Street - Hamilton Street	10	3.5	12,000	8,700
13 - High Street - Franklin Street	7	2.4	8,400	3,100
14 - Main Street - Franklin Street Main Street - Washington Street	10	3.5	12,000	1,900
Totals	73	25.0	$ 87,600	$ 22,600

Notes: Unit accident cost of $1,200 is based on data presented in Traffic Engineering Handbook, Third Edition, 1965 - Institute of Traffic Engineers.

City-wide accident total - 290

TABLE 3

ESTIMATED COST OF IMPROVEMENTS

CITY OF DOVER

Location	Pavement Markings	Curbs	Island Paving	Signals	Other Work	Engineering and Contingencies	Total
1 - Central Avenue-Durham Road - Back River Road	(1,650LF) $ 410	(855LF) $ 3,600	(2,770SF) $ 1,100	—	$ 890	$ 600	$ 6,60
2 - Central Avenue-Stark Avenue	(2,515LF) $ 630	(3,070LF) $13,000	(9,470SF) $ 3,800	—	2,200	1,970	21,60
3 - Central Avenue-Silver Street	(2,295LF) $ 575	(950LF) $ 4,050	(2,925SF) $ 1,170	$4,960	1,245	1,200	13,20
4 - Lower Square	(1,200LF) $ 300	(1,090LF) $ 4,650	(8,025SF) $ 3,200	—	1,210	940	10,30
5 - Washington Street - Main St.	(490LF) $ 125	(220LF) $ 935	(1,300SF) $ 520	—	420	200	2,20
6 - Upper Square	(1,965LF) $ 490	(1,400LF) $ 6,000	(9,505SF) $ 3,800	6,880	2,750	2,080	22,00
7 - Portland Street-Portland Avenue	(495LF) $ 125	(270LF) $ 1,150	(820SF) $ 330	—	485	210	2,30
8 - Broadway Street-St.John Street	(535LF) $ 135	(400LF) $ 1,700	(3,200SF) $ 1,280	—	885	400	4,40
9 - Central Avenue - Glenwood Avenue to Dover-Somersworth Circle	(10,205LF) $2,550	(6,380LF) $27,000	(6,160SF) $ 2,450	4,900	34,000*	7,100	78,00
Totals	(21,350LF) $5,340	(14,635LF) $62,085	(44,175SF) $17,650	$16,740	$44,085	$14,700	$ 160,60

Unit Costs - Pavement Markings - $0.25 per LF
Curbs - $4.25 per LF
Island Paving - $0.40 per SF

* Includes 5500 SY of major paving at $5.00 per SY ($27,500)

TABLE 4

ESTIMATED COST OF IMPROVEMENTS

CITY OF SOMERSWORTH

Location	Pavement Markings	Curbs	Island Paving	Signals	Other Work	Engineering of Contingencies	Total
10-Market Street: Main Street to Berwick Bridge	(1,795LF) $ 450	(800LF) $3,400	(4,450SF) $1,780	—	$1,190	$ 680	$ 7,500
11-High Street - Highland Street- Orange Street	(590LF) $ 145	(75LF) $ 320	—	—	805	130	1,400
12-High Street-West High Street - Washington Street- Hamilton Street	(650LF $ 160	(210LF) $ 900	(700SF) $ 280	$5,600	970	790	8,700
13-High Street - Franklin Street	(425LF) $ 105	(330LF) $1,400	(1,175SF) $ 470	—	845	280	3,100
14-Main Street - Franklin Street & Main Street - Washington Street	(645LF) $ 160	(65LF) $ 275	—	—	1,295	170	1,900
Totals	(4,105LF) $1,020	(1,480LF) $6,295	(6,325SF) $2,530	$5,600	$5,105	$ 2,050	$ 22,600

Unit Costs - Pavement Markings - $0.25 per LF
Curbs - $4.25 per LF
Island Paving - $0.40 per SF

1 - CENTRAL AVENUE - SPAULDING TURNPIKE INTERCHANGE NO. 4 - DURHAM ROAD BACK RIVER ROAD

This location encompasses three separate, but interrelated intersections: (1) Durham Road (Route 108) and Back River Road; (2) Spaulding Turnpike ramps, Central Avenue (Route 108) and Mill Street; (3) Central Avenue and Charles Street.

Central Avenue (Route 108) is Dover's major north-south through arterial street. The Spaulding Turnpike extends northward from an intersection with the New Hampshire and Maine Turnpikes (Interstate 95) at Portsmouth to a terminus at Rochester. Durham Road (Route 108) connects Dover with the City of Durham. Back River Road is an important street serving the developing residential communities along the west bank of the Bellamy River. Mill Street and Charles Street are local thoroughfares, which serve a major retail outlet and several factories.

Existing Conditions

Existing pavement widths, channelizing island, traffic controls, 1965 peak hour traffic volumes, and the locations and number of reported accidents in 1964-1965 are shown in Figure 1-A.

Central Avenue varies in width from 30 feet at the Bellamy River crossing to 45 feet opposite Charles Street. Durham Road is 30 feet wide and Back River Road is 20 feet wide, and neither is curbed. Mill Street generally is 20 feet wide and widens to 110 feet at Central Avenue. Charles Street is 20 feet wide. The two Spaulding Turnpike ramps are each 16 feet wide.

Regulatory traffic control devices consist of a stop sign and flashing red beacon on the Turnpike exit ramp at Central Avenue and a stop sign on Back River Road at Durham Road. Warning devices include flashing amber caution beacons on Central Avenue at the Turnpike ramps and on Durham Road at Back River Road. There are no other existing traffic controls on parking regulations and all turning movements are permitted.

During peak hours, Central Avenue between Charles Street and Mill Street, carries a two-way total of 920 vehicles; Back River Road carries 310 vehicles, Durham Road carries 490 vehicles; Mill Street carries 250 vehicles and Charles Street carries 200 vehicles. Turning movement volumes are relatively heavy at the intersection of Mill Street and Central Avenue; this is probably due to the presence of a major retail outlet on Mill Street at Charles Road.

In the one-year period 1964-1965, nine accidents occurred at the intersection of Mill Street, Central Avenue and Spaulding Turnpike; two at the junction of Back River Road and Durham Road; and three on Central Avenue, east of Charles Street.

Recommended Improvements - Figure 1-B

It is recommended that the intersection of Durham Road and Back River Road be channelized with curbed islands designed to favor the heavier movements; the minor

movement - Back River Road to Durham Road (20 vehicles during peak hours) would be eliminated.

It is recommended that Mill Street be made one-way southbound and the wide expanse of pavement on Mill Street at Central Avenue narrowed with curbing and a channelizing island.

It is recommended that dividing islands be marked on Central Avenue and separate left turn holding lanes designated on Central Avenue at Mill Street and Charles Street.

Stop signs are recommended for controlling Durham Road traffic at the Durham Road - Back River intersection; Charles Street traffic at Central Avenue; and traffic on the Spaulding Turnpike exist ramp. The existing caution lights would be relocated elsewhere in the City.

These measures, taken together, would enable the heavy left turning movements on Central Avenue to operate safely without interferring with through movements; and the proposed channelizing islands and dividers would provide well defined travel paths on Central Avenue from Back River Road and Durham Road to east of Charles Street.

The total cost of the recommended improvements is estimated at $6,600; an itemized listing is given in Table 3.

2 - CENTRAL AVENUE - STARK AVENUE

Central Avenue is Dover's primary north-south arterial street; it runs from the Spaulding Turnpike at the Bellamy River, through the central business district, and connects with Rochester Road and High Street at the Dover-Somersworth boundary.

Stark Avenue (Dover Point Road) is the major arterial serving the peninsula between the Bellamy and Piscataqua River.

Existing Conditions

Existing pavement widths, curbs, traffic controls, 1965 peak hour volumes, and the locations and number of accidents reported in 1964-1965 are shown in Figure 2-A.

Central Avenue, south of Stark Avenue is 36 feet wide; at Stark Avenue it widens to 80 feet; and at Trakey Street it is 40 feet wide. Stark Avenue is basically 24 feet wide and Jeness Street is 32 feet wide.

The yield sign at the intersection of Central and Stark Avenues, controlling northbound Central Avenue traffic is the only existing traffic regulation. All possible turning movements are permitted and there are no curbside parking restrictions. The centerlines on Start Avenue and Central Avenue are the only existing pavement markings.

As shown in the cross-section taken along Jeness Street, the elevation of Start Avenue is about 20 feet higher than that of Central Avenue; this topographic condition

restricts sigh distances, particularly for northbound Central Avenue traffic merging with northbound Stark Avenue traffic. Peak hour movements at the intersection of Stark and Central Avenues are about equal in magnitude and range from 250 vehicles to 310 vehicles; and the turning movements at each end of Jeness Street are about equal at 110 and 120 vehicles.

During 1964-1965 there were five accidents at the intersection of Stark and Central Avenues; three on Jeness Street; and three on Central Avenue between Watson Street and Trakey Street.

Recommended Improvements - Figure 2-B

It is recommended that curbed channelizing islands be installed at the intersection of Central Avenue - Stark Avenue - Watson Street. These islands would permit safe uninterrupted operation of southbound through movements on Central Avenue; southbound Central Avenue-Stark Avenue movements; and northbound through movements on Stark Avenue. Northbound through movements on Central Avenue would be stop sign controlled. Northbound Stark Avenue - southbound Central Avenue and northbound Centra Avenue - southbound Stark Avenue movements would be made via Jeness Street.

At Watson Avenue, only right turns to and from northbound Stark Avenue would be permitted. Traffic between Watson Avenue and southbound Stark Avenue would be routed to Watson Lane, a local street, which connects Watson Avenue and Stark Avenue.

Movements from Jeness Street to Stark Avenue and Central Avenue; from Watson Avenue to Stark Avenue; and from Trakey Street to Central Avenue, would be controlled with either stop signs or yield signs.

It is recommended that centerlines be marked on Jeness Street from Stark Avenue to Central Avenue, and for lengths of 100 feet each, on Watson Avenue and Trakey Street, and corner radii at all intersections be increased to 15 feet.

The estimated total cost of the recommended improvements is $21,600; an itemized listing is given in Table 3.

3 - SILVER STREET - CENTRAL AVENUE

Silver Street (Routes 4 and 9) connects Spaulding Turnpike Interchange No. 5 with Dover's central business district. Central Avenue (Route 16) is Dover's primary north-south arterial street.

Existing Conditions

Existing street widths, curbs, traffic controls - stop signs and signals, 1965 peak hour volumes, and the locations and number of accidents reported in 1964-1965 are shown in Figure 3-A.

Central Avenue varies in width from 50 to 55 feet; its east pavement edge is

virtually uncurbed and undefined. Silver Street is basically 38 feet wide and widens to 50 feet at Central Avenue. Church Street, Hanson Street and Court Street are local thoroughfares, ranging in width from 20 feet to 26 feet.

Movements at the intersection of Silver Street and Central Avenue are controlled with an obsolete two-phase fixed time traffic signal. Movements from Church Street and Court Street are regulated with stop signs.

There are no curbside parking restrictions, except for the no-parking zone along the west side of Central Avenue, from Silver Street to Church Street. The centerlines on Silver Street and Central Avenue are the only existing pavement markings.

During peak hours, Silver Street carries a two-way total of 590 vehicles; Central Avenue, north of Silver Street, carries a total of 1,620 vehicles; south of Silver Street, it carries 1,190 vehicles.

In 1964-1965, six accidents were reported at the intersection of Silver Street and Central Avenue; three on Central Avenue in the block from Silver Street to Church Street-Court Street-Hanson Street; and seven accidents at the intersection of Central Avenue-Church Street-Court Street-Hanson Street.

Recommended Improvements - Figure 3-B

It is recommended that a separate left turn lane be marked on Central Avenue at Silver Street; and a dividing island marked on Central Avenue from Silver Street to Church Street. These measures are designed to enable left turning vehicles to wait safely without impeding the flow of through traffic.

In order to improve control and definition of travel lanes, it is recommended that the width of Silver Street at Central Avenue be reduced to 38 feet and curbs installed on the east side of Central Avenue and on the south side of Hanson Street for a distance of 200 feet from Central Avenue.

It is recommended that the existing traffic signal at Central Avenue and Silver Street be modernized, including the installation of "Walk - Don't Walk" signals and pedestrian crosswalks.

A stop sign would be installed to control Hanson Street traffic and the existing stop signs on Church Street and Court Street would be retained.

Other improvements would include enlarged corner radii at the intersection of Church Street-Hanson Street-Court Street-Central Avenue; and stop lines and center-lines on Church Street, Hanson Street and Court Street.

The estimated cost of the recommended improvements is $13,200, of which the signal modernization would account for nearly $4,400; an itemized listing is presented in Table 3.

4 - LOWER SQUARE

Dover's City Hall, library, high school and other prominent public buildings are located in the vicinity of Lower Square. Central Avenue (Routes 4, 9 and 16), Washington Street and Henry Law Avenue intersect at Lower Square. Central Avenue and Washington Street are important arterial streets; and Henry Law Avenue is a local street serving the residential area along the south bank of the Cocheco River.

Existing Conditions

Existing street widths, channelizing islands, traffic controls, parking spaces, 1965 peak hour volumes, and the locations and number of reported accidents in 1964-1965 are shown in Figure 4-A.

All possible turning movements, except the left turn from Henry Law Avenue are permitted. The only existing traffic control devices are pedestrian crosswalk stop signs mounted on stanchions on Central Avenue, just north of Washington Street. These non-uniform signs require vehicles to stop for pedestrians.

Central Avenue, north of Washington Street, is operated one-way southbound and two-way south of Washington Street. Washington Street, from Central Avenue to Main Street is operated one-way eastbound and two-way west of Central Avenue. Henry Law Avenue is operated two-way.

Lower Square and all intersecting streets are curbed. There are two curbed channelizing islands and two narrow curbed dividers; nevertheless, vehicular travel paths are poorly defined and there are relatively large areas of uncontrolled pavement.

There are no curbside parking restrictions. Most parking spaces are metered and some are angled to the curb.

During peak hours, 1,060 vehicles use Central Avenue, north of Lower Square; south of Lower Square it carries a total two-way volume of 1,500 vehicles. Washington Street east of Central Avenue is used by 1,230 vehicles; it carries a total of 640 vehicles west of Central Avenue. Henry Law Avenue carries only 50 vehicles. Left turns on Central Avenue are relatively light.

During the one-year period 1964-1965, 23 accidents occurred in and adjacent to Lower Square; many of these accidents probably involved vehicles maneuvering in and out of the angled parking stalls on Central Avenue and Washington Street.

Recommended Improvements - Figure 4-B

It is recommended that new channelizing islands be installed, which would provide better definition of traffic lanes; eliminate unneeded pavement area; provide pedestrian safety zones; but retain all existing permissible turning movements, except the left turn from southbound Central Avenue to Henry Law Avenue.

It is recommended that stop sign control be established for eastbound Washington Street traffic; northbound Henry Law Avenue traffic; and southbound Central Avenue - eastbound Washington Avenue traffic. The existing pedestrian crosswalk stop signs would be removed.

Parking would be prohibited on all approaches and within the confines of the intersection; elsewhere, all existing parking spaces would be retained.

The estimated total cost of the recommended improvements is $10,300; an itemized listing is given in Table 3.

5 - WASHINGTON STREET AND MAIN STREET

Washington Street and Main Street form the northbound connector between Lower Square and Upper Square, and Central Avenue is the southbound connector. Washington Street, east of Main Street, is a relatively minor street.

Existing Conditions

Existing pavement widths, channelizing islands, parking spaces and parking restrictions, 1965 peak hour traffic volumes, and the location and number of reported accidents in 1964-1965 are shown in Figure 5-A.

Washington Street varies in width from 42 feet to 50 feet; Main Street varies in width from 50 to 58 feet. A curbed island, with a diameter of 7 feet is the only existing channelizing device.

There are no existing traffic controls or guide signs. Curbside parking is generally permitted, except along the west of Main Street, and on the bridge over the Cocheco River.

During peak hours, Washington Street, between Lower Square and Main Street carries 1,170 vehicles, of which 1,120 vehicles turn left onto Main Street; and Washington Street, east of Main Street carries a two-way total of only 160 vehicles.

In the one-year period 1964-1965, 11 accidents were reported at the intersection of Washington Street and Main Street. It is likely that most of these accidents were head-on collisions between eastbound and westbound Washington Street traffic.

Recommended Improvements - Figure 5-B

It is recommended that a curbed channelizing island be installed which would provide a safe transition between one-way and two-way operations on Washington Street.

Curbside parking would be prohibited on the north side of Washington Street, and on both sides of Main Street; parking would be retained along the south side of Washington Street.

The toatl cost of the recommended improvements is estimated at $2,200; an itemized listing is given in Table 3.

6 - UPPER SQUARE

Dover's principal department stores and commercial buildings are located in the Upper Square area. Six streets, including Route 9-16 and Route 4, intersect at Upper Square. Route 9-16 (Central Avenue and Main Street) is a major north-south arterial street and Route 4 (Broadway Street and Portland Avenue) connects Dover with York County, Maine. The other intersecting streets, Second Street and Third Street are local thoroughfares.

Existing Conditions

Existing street widths, channelizing islands, traffic controls-signals, stop signs and turning regulations, parking spaces and parking restrictions, 1965 peak hour traffic volumes, and the location and number of reported accidents in 1964-1965 are shown in Figure 6-A.

Upper Square, at Portland Avenue-Second Street, is 180 feet wide and narrows to a width of 85 feet at Broadway-Third Street; all intersecting streets are curbed and there are three relatively large central islands.

Movements at the intersections of Broadway Street-Central Avenue-Third Street and Main Street-Portland Avenue, are controlled with obsolete fixed time traffic signals. Stop signs control movements at Second Street and Central Avenue.

Central Avenue, south of Second Street, is operated one-way southbound. Main Street is one-way northbound and Portland Avenue is operated one-way eastbound. In general, all turns, including "U" turns, are permitted except left turns from Central Avenue to Broadway and from Third Street to Central Avenue.

Extensive curbside parking is permitted in the Square and on Central and Main Streets. Nearly all of these parking spaces are metered and most stalls are angled to the curbs.

During peak hours, 970 vehicles use Main Street; 940 vehicles use Central Avenue, south of Second Street; 570 vehicles travel northbound on Central Avenue; 450 vehicles use Broadway Street and individual turning movements range up to 300 vehicles.

In 1964-1965, 46 accidents occurred in and adjacent to Upper Square; many of these accidents probably involved vehicles maneuvering into and out of the angled parking stalls on Central Avenue.

Recommended Improvements - Figure 6-B

It is recommended that the existing channelizing islands be enlarged and additional islands installed to define vehicular and pedestrian travel ways. The proposed channelization scheme would retain all existing permissible turing movements

and would not require modifications to the existing one-way street operations.

It is recommended that the existing signal installation at Broadway Street-Central Avenue-Third Street be replaced with a modern three-phase system, which would provide a separate phase for left turning vehicles. The existing signal at Portland Street and Main Street would be replaced with a pedestrian-actuated signal. Signal heads would be mounted on overhead mast arms and pedestal-mounted "Walk - Don't Walk" signals would be installed.

It is recommended that the existing angle parking stalls on the west side of Central Avenue, from Third to Second Streets, be replaced with parallel stalls and the existing parking stalls in the center of the Square removed; all other existing parking spaces would be unaltered.

The estimated total cost of the recommended improvements is $23,000, of which the new signals would account for nearly $8,000; an itemized listing is given in Table 3.

7 - PORTLAND AVENUE - PORTLAND STREET

Portland Avenue (Route 4) connects Dover at Upper Square with York County, Maine. Portland Street runs from an intersection with Main Street and Young Street to Portland Avenue.

Existing Conditions

Existing roadway widths, curbs, channelizing islands, parking spaces and regulations, and 1965 peak hour turning movements are shown in Figure 7-A. Accident records for 1964-1965 were not available for this intersection.

Portland Avenue, west of Portland Street, is 32 feet wide; east of Portland Street it is 46 feet. Portland Street varies in width from 36 feet to 46 feet. There is an existing curbed channelizing island.

There are no existing traffic controls and all possible turning movements are permitted. Curbside parking is permitted, except along the east side of Portland Street.

During weekday peak hours, the heaviest movements are: Portland Street to Portland Avenue - 250 vehicles; Portland Avenue westbound through - 180 vehicles; Portland Avenue to Portland Street - 110 vehicles; Portland Avenue eastbound through-100 vehicles; all other movements are small.

The configuration of the intersection, coupled with the unregulated turning movements, creates safety hazards, particularly for eastbound Portland Avenue traffic and westbound Portland Avenue - Portland Street traffic.

Recommended Improvements - Figure 7-B

It is recommended that Portland Street, from Main Street to Portland Avenue be

made one-way eastbound. Traffic which currently uses Portland Street between Portland Avenue and the Lower Square area would be rerouted via Portland Avenue, St. John Street and Upper Square.

It is recommended that the centerline on Portland Avenue, between Portland Street and St. John Street, be offset by 4 feet in order to establish a 12 foot wide westbound lane and a 20 foot eastbound lane. Parking would be permitted in the eastbound lane and prohibited in the westbound lane. Parking would be allowed on Portland Street, except in and adjacent to the channelization area.

The estimated cost of the recommended improvements plan is $2,300; an itemized listing is given in Table 3.

8 - BROADWAY STREET - ST. JOHN STREET

Broadway Street connects Upper Square with the town of Rollinsford and St. John Street carries westbound State Route 4 traffic between Upper Square and Portland Avenue.

Existing Conditions

Existing pavement widths, channelizing islands, parking spaces and regulations and 1965 peak hour turning movements are shown in Figure 8-A. Accident records were not available for this intersection for 1964-1965.

Broadway Street, on either side of St. John Street is basically 33 feet wide; at St. John Street it is 110 feet wide. St. John Street is 31 feet wide and Winter Street, a minor residential street, is 15 feet wide. A curbed island is the only existing channelizing device.

The two stop signs at Broadway Street and St. John Street, which control northbound St. John Street traffic are the only existing regulatory control devices. All possible turns, including "U" turns around the channelizing island are permitted. Curbside parking is permitted, except on the east side of St. John Street and on both sides of Broadway Street opposite the City Fire Station.

The major movements during peak hours are: St. John Street to Broadway Street-eastbound (190 vehicles); Broadway Street - westbound through (180 vehicles); St. John Street to Broadway Street - westbound (110 vehicles); and Broadway Street-eastbound through (80 vehicles).

The wide expanse of uncontrolled pavement across Broadway Street, coupled with the lack of turn controls, presents safety hazards to both vehicular and pedestrian traffic.

Recommended Improvements - Figure 8-B

It is recommended that the existing channelizing island be replaced with a larger island which would more effectively control turning movements and provide a separate lane for right turns from Broadway Street to St. John Street.

It is recommended that the centerline on St. John Street be offset by 3-1/2 feet, in order to develop a 12 foot wide northbound lane and a 19 foot wide southbound lane. Parking on St. John Street would continue to be permitted only in southbound lane; parking would be prohibited in and adjacent to the channelization area - elsewhere, all existing parking regulations would be retained.

The existing stop sign at the corner of St. John Street and Winter Street would be retained and a stop sign would be installed to control right turns from Broadway Street to St. John Street. Curb radii at these corners would be increased to at least 15 feet.

The estimated cost of the recommended improvements is $4,400; an itemized listing is given in Table 3.

9 - CENTRAL AVENUE: GLENWOOD AVENUE TO DOVER-SOMERSWORTH TRAFFIC CIRCLE

This 3,000 foot long stretch of Central Avenue (Routes 9 and 16) is popularly known as Dover's "Miracle Mile". In recent years, several large retail outlets and recreational centers have been built along this heavily travelled arterial.

Existing Conditions

The existing Central Avenue roadway is comprised of an undivided 21-1/2 foot wide pavement, flanked by unimproved shoulders of an average width of 10 feet. The legal right-of-way width (building line to building line) is not definitely known; however, it is believed to be in the order of 60 feet. There are no existing access controls and the roadway is curbed only for relatively short segments. As a result, entrances and exits at most parking lots are unmarked and vehicles can enter or leave the roadway at virtually any point.

During peak hours, Central Avenue between Glenwood Avenue and the Dover-Somersworth Traffic Circle, carries a two-way volume of about 1,200 vehicles at speeds ranging from 20 to 35 miles per hour. Turning movements at parking lot entrances and exits are relatively heavy and cause undue delays and congestion, particularly for through traffic. In 1964-1965, a total of 40 accidents were reported between Glenwood Avenue and the traffic circle; it is believed that many of these accidents involved vehicles entering or exiting from parking lots.

Recommended Improvements - Figure 9

It is recommended that the Central Avenue roadway from South of Glenwood Avenue to the Dover-Somersworth Traffic Circle, be widened to a curb to curb width of 40 feet, and generally subdivided into 2-12 foot wide through lanes, separated by a 16 foot wide median. The median would be opened at parking lot entrances and exits and left turns from Central Avenue would be made from a separate lane, located within the median area. Parking lot entrances and exists would be consolidated and delineated with drop curbs.

In order to keep construction costs at a minimum, the median would be delineated with thermoplastic pavement markings and curbs would be used only at and adjacent to the auxillary left turn lanes.

Intersection of Glenwood Avenue and Central Avenue

Existing Conditions

Existing pavement widths, curbs, traffic controls, 1965 peak hour turning movements, and the number of accidents reported in 1964-1965 are shown in Figure 9-A.

The useable through pavement width on Central Avenue is 30 feet and Glenwood Avenue is basically 32 feet wide.

All possible movements and turns are permitted; stop signs control outbound movements from Glenwood Avenue. There are no posted curbside parking regulations.

During peak hours, Central Avenue west of Glenwood Avenue, carries a two-way total of 1,390 vehicles. Glenwood Avenue carries a two-way total of 280 vehicles and individual turning movements to and from Central Avenue range in volume from 20 to 100 vehicles.

In 1964-1965, 10 accidents occurred at Central Avenue and Glenwood Avenue. The probable causes of these accidents are (1) the high speed and high volumes on Central Avenue, (2) two-way operations on both branches of Glenwood Avenue, (3) inadequate sight distances for merging maneuvers from Glenwood Avenue onto Central Avenue.

Recommended Improvements - Figure 9-B

It is recommended that the 30 foot wide through pavement on Central Avenue be divided into three 10 foot wide lanes, consisting of one through lane in each direction and a separate left turn holding lane.

It is recommended that curbed channelizing islands and a partially-actuated traffic signal be installed. The channelization would provide four separate one-way roadways for turning movements. The traffic signal would have two fixed phases for Central Avenue traffic and an actuated phase for left turns from Glenwood Avenue to Central Avenue. Curbside parking would be prohibited on both sides of Central Avenue and within the four turning roadways.

Dover-Somersworth Traffic Circle

Existing Conditions

Three arterial highways - Central Avenue (Routes 9 and 16), High Street

(Route 9) and Rochester Road (Route 16) and the Spaulding Turnpike Interchange No. 6 connecting roadway meet at this location to form a traffic circle and a conventional four-leg intersection.

Existing traffic control devices consist of two stop signs and two flashing red beacons at the intersection of Rochester Road and the turnpike connector for controlling traffic crossing Rochester Road, destined for the Turnpike.

In 1964-1965, a total of 17 accidents were reported at the Dover-Somersworth Circle; 11 on the rotary and 6 at the intersection of Rochester Road and the Turnpike connector.

Recommended Improvements - Figure 9-C

It is recommended that the useable width of the Turnpike connector, on both sides of Rochester Road, be reduced by the application of pavement markings to 14 feet. This measure is designed to restrict traffic to one lane and thereby cause motorists to reduce speed and to obey the posted stop signs and flashing red beacons. It is also recommended that similar pavement restrictions be applied at other locations, particularly at island gores, in order to improve the definition of travel paths.

The total cost of the recommended improvements, including the channelization at Glenwood Avenue and the pavement markings at the Traffic Circle is estimated at $78,000. The cost of reconstructing and widening Central Avenue would account for $27,500 or 35% of the total cost; a detailed itemized summary is given in Table 5.

10 - MARKET STREET: MAIN AND HIGH STREETS TO BERWICK BRIDGE

Market Street (Route 9) is the primary thoroughfare in Somersworth's business district; it also is the major approach route to the Berwick Bridge, which connects York County, Maine, with northern Strafford County. High Street (Route 9) connects Somersworth with the City of Dover and Main Street serves the industries along the Salmon Falls River.

Existing Conditions

Existing pavement widths, curbs, parking spaces, 1965 peak hour traffic volumes, and the locations and number of reported accidents in 1964-1965 are shown in Figure 10-A.

Market Street, at Main and High Streets, is 120 feet wide; it is 50 feet wide at Prospect Street and 72 feet wide between Prospect Street and the Berwick Bridge.

There are no existing traffic controls, parking regulations or pavement markings, all possible turning movements, including "U" turns are permitted; parking is unrestricted and most spaces are angled to the curb.

During peak hours, the heaviest movements at the Berwick Bridge are the right turn from Market Street to the Bridge (480 vehicles) and the left turn from the Bridge to Market Street (280 vehicles). At Main and High Streets, the heaviest movements are Market Street to High Street and High Street to Market Street (250 vehicles each) and the through movements to and from Main Street (190 vehicles, 110 vehicles). The other possible turning movements at Main Street-High Street and at the Berwick Bridge range from only 10 to 50 vehicles.

The privately owned alley leading from Market Street connects with an industrial plant parking lot on the west bank of the power company canal; however, the measures necessary to improve the alley and canal crossing are not in the low cost category.

In the one-year period, 1964-1965, a total of 30 accidents occurred on Market Street, from Main Street - High Street to the Berwick Bridge; undoubtedly, the lack of traffic regulations and the unrestricted angle parking were major contributing factors.

Recommended Improvements - Figure 10-B

It is recommended that curbed channelizing islands be installed at the intersections of Market Street - Main Street - High Street and Market Street and the Berwick Bridge. These islands would provide well defined travel paths and also serve as pedestrian safety zones. Potential conflicting movements at these locations would be controlled with stop signs.

It is recommended that centerlines be marked on Market Street, Main Street and High Street; a centerline and lane lines marked on the Berwick Bridge; and stop lines marked in conjunction with stop signs.

It is recommended that stop signs be installed on Prospect Street and Beacon Street and corner radii at these intersections increased to 15 feet.

In general, these improvements would not require the elimination of existing curbside parking spaces, except at or immediately adjacent to the channelizing islands.

The total cost of the recommended improvements is estimated at $7,500; an itemized listing is given in Table 4.

11 - HIGH STREET - ORANGE STREET - HIGHLAND STREET

High Street (Route 9) is Somersworth's principal arterial street; Orange Street and Highland Street are local thoroughfares.

Existing Conditions

Existing pavement widths, curbs, traffic controls, parking spaces, 1965 peak hour volumes, and the locations and number of reported accidents in 1964-1965 are shown in Figure 11-A.

All possible turning movements are permitted. The stop sign regulating Highland Street traffic is the only existing traffic control device; there are no parking regulations or pavement markings.

During peak hours, High Street east of the intersection carries a two-way total of 630 vehicles; it carries 490 vehicles west of the intersection.

In the one year period 1964-1965, 19 accidents were reported at and adjacent to this intersection.

Recommended Improvements - Figure 11-B

It is recommended that centerlines be marked on all approaches and a separate left turn holding lane be designated on the east approach of High Street.

It is recommended that traffic on Highland Street and Orange Street be controlled with stop signs; stop lines would be marked in conjunction with these signs, and corner radii would be enlarged to at least 15 feet. Parking would be restricted on the intersection approaches; elsewhere, it would be permitted.

The estimated cost of the recommended improvements is $1,400; an itemized listing is given in Table 4.

12 - HIGH STREET - WEST HIGH STREET - WASHINGTON STREET - HAMILTON STREET

High Street (Routes 9 and 16A) connects downtown Somersworth and the Berwick Bridge to the City of Dover. West High Street (Route 16A) and Washington Street connect Rochester Road (Route 16) with the industrial district along Main Street. Hamilton Street is a local thoroughfare.

Existing Conditions

Existing pavement widths, traffic controls, parking spaces, 1965 peak hour turning movement volumes, and the locations and number of reported accidents in 1964-1965 are shown in Figure 12-A.

High Street is basically 32-33 feet wide; West High Street 42 feet; Washington Street 35 feet; Hamilton Street 32 feet; and all except West High Street are curbed.

All possible turning movements are permitted and there are no curbside parking restrictions. Traffic on Washington Street, West High Street and Hamilton Street is controlled by stop signs. However, sight distances are restricted by abutting buildings and the stop signs, therefore, do not effectively control movements.

During peak hours, High Street east of the intersection carries a two-way total of 470 vehicles; west of the intersection it carries 570 vehicles. Washington Street carries 350 vehicles and West High Street carries 300 vehicles. Hamilton Street is used by only 60 vehicles. Turning movement volumes range between 10 and 110 vehicles and

the heaviest turning movement is the left turn from Washington Street to High Street.

In the one-year period 1964-1965, 10 accidents were reported at this location.

Recommended Improvements - Figure 12-B

It is recommended that a traffic signal, centerlines and stop lines be installed. Washington Street, West High Street and High Street traffic would operate on fixed time phases. Hamilton Street traffic would operate on a separate actuated phase, because that street's relatively low volumes do not warrant a regular phase.

It is recommended that curbside parking on all approaches be restricted for 50 feet on either side of the intersection; elsewhere, curbside parking would be permitted.

The estimated cost of the improvements is $8,700 of which the signal would account for $5,600; an itemized listing is given in Table 4.

13 - HIGH STREET - FRANKLIN STREET

High Street (Routes 9 and 16A) is Somersworth's primary arterial street and Franklin Street connects High Street with the industrial area along Main Street.

Existing Conditions

Existing roadway widths, channelizing islands, traffic controls, parking spaces, 1965 peak hour volumes, and the locations and number of reported accidents in 1964-1965 are shown in Figure 13-A.

High Street varies in width from 29 feet to 34 feet and Franklin Street is 36 feet wide.

All possible turning movements are permitted. The stop sign on Franklin Street is the only existing traffic control device and there are no pavement markings or curbside parking restrictions.

During peak hours, Franklin Street carries a two-way total of 120 vehicles. High Street, west of the intersection, carries 720 vehicles; it carries 620 vehicles east of Franklin Street. The major turning movements are the left turn from Franklin Street to High Street, and the right turn from High Street to Franklin Street.

In 1964-1965, seven accidents were reported at this intersection.

Recommended Improvements - Figure 13-B

It is recommended that the existing channelization be replaced with the standard channelization and traffic controls for "T" intersections. Accident statistics have shown that this treatment is the safest for this type of intersection.

It is recommended that center and stop lines be marked and curbside parking restricted within the channelization area; elsewhere, parking would be permitted.

The estimated cost of the recommended improvements is $3,100; an itemized listing is given in Table 4.

14 - MAIN STREET - MARKET STREET TO INDIGO HILL ROAD

Several large industries are located on Main Street between Market Street and Indigo Hill Road. These industries, in general, do not provide employee auto parking facilities of adequate capacity; consequently, most employees park their automobiles on Main Street.

Existing Conditions

Main Street varies in width from 42 feet at Depot Street to 57 feet at Washington Street. Existing pavement widths, traffic controls, and reported accidents in 1964-1965 at two major intersecting streets, Washington Street and Franklin Street, are shown in Figure 14-A.

Movements from Washington Street and Franklin Street are stop sign controlled; there are no other existing traffic parking regulations or pavement markings. In 1964-1965, six accidents were reported at Franklin Street and Main Street and four at Washington Street and Main Street.

Recommended Improvements - Figure 14-B

It is recommended that a centerline be marked on Main Street from Market Street to Indigo Road and a separate left turn holding lane designated at the more important intersections.

It is recommended that traffic on cross streets be controlled with stop signs and corner radii at intersections increased to at least 15 feet.

The estimated total cost of the improvements recommended for the intersections of Main Street and Franklin Street and Main Street and Washington Street is $1,900; an itemized listing is given in Table 4.

DOVER-SOMERSWORTH TRANSPORTATION STUDY

Memorandum No. 15 March 18, 1966

FROM: Tippetts-Abbett-McCarthy-Stratton

TO: New Hampshire Department of Public Works and Highways

SUBJECT: Expansion of Roadside Interview Data

Data collected at each of the roadside interview stations have been expanded by hour, direction and vehicle class - that is, for passenger cars and for trucks. Expansion factors incorporate three separate factors:

(1) Expansion of the interview vehicles to represent the actual volume passing the station during each hour of the day of operation.

(2) Adjustment of the expanded hourly data at low volume stations operated for only 8 or 16 hours, to account for the actual volume passing the station during the full 24-hour period.

(3) Conversion of the expanded daily data to represent average weekday traffic during the survey period, July-August 1965.

Mathematically, R = Expansion Factor = $\frac{O}{P} \times \frac{S}{T} \times U$, where:

O = number of vehicles, by direction, of a given class (cars or trucks) passign a station during an hour (from manual classification counts).

P = number of valid interviews obtained for the same direction, vehicle class, station and hour.

S = total number of vehicles passing the station in both directions during a 24-hour period (from manual classification counts).

T = total number of vehicles passing the station in both directions during the hours of interviewing (from manual classification counts). T = S and $\frac{S}{T}$ = 1 for 24-hour stations.

U = ratio of the average two-directional weekday traffic at the station during July and August, 1965, to the total two-directional 24-hour manual count at the station.

Average weekday traffic was derived in two steps. First, the 24-hour manual count was multiplied by the ratio of the average weekday automatic traffic recorder count for several weekdays at the station, to the automatic traffic recorder count for the 24-hour period during which manual counts were made (automatic traffic recorder counts were made at each of the roadside interview stations by the New Hampshire Department of Public Works and Highways for a period of a week or so). Second, the result of the foregoing step was multiplied by a long-term factor equal to the ratio of average summer weekday traffic (1/2 x July average + 1/2 x August average) at a nearly permanent traffic recorder operated by the NHDPW&H to the average weekday traffic at the same permanent traffic recorder for the several weekdays during which automatic traffic recorder counts were obtained at the roadside interview station. Data from permanent recorders 12501 on Route 16 at Dover Point and 41501 on Route 16 in Somersworth were used for this purpose.

The factoring process described above was, by necessity, simplified somewhat at certain stations where insufficient automatic recorder count data were available. In some instances data for successive hour periods were grouped for the expansion factor computation in order to assure statistical stability.

DOVER-SOMERSWORTH TRANSPORTATION STUDY

Memorandum No. 16

March 18, 1966

FROM: Tippetts-Abbett-McCarthy-Stratton

TO: New Hampshire Department of Public Works and Highways

SUBJECT: Distribution of External Trip Ends Outside Study Area

External trip ends from data collected in roadside interviews at points on the Study Area cordon line were coded to external traffic zones as described in Paragraph 3 of Memorandum No. 3 and expanded as described in Memorandum No. 15.

Using expanded trip data, the external trip ends were aggregated by roadside interview stations using the following locations outside the Study Area:

- remainder of Dover, Somersworth and Rollinsford;
- remainder of New Hampshire;
- York County, Maine;
- remainder of Maine;
- remainder of New England; and
- remainder of United States and Canada.

Results are tabulated in Appendix A.

On an overall basis 66% of the trips crossing the cordon line originated in or were destined to points outside the cordon line in New Hampshire, 26% in Maine, 7% in Connecticut, Rhode Island, Massachusetts or Vermont, and less than 1% outside of New England. Of the external trip ends in New Hampshire, 14% were in the portions of Dover, Somersworth and Rollinsford outside the cordon line. Over 95% of the external trip ends in Maine were in York County.

APPENDIX A

DISTRIBUTION OF EXTERNAL TRIP ENDS OUTSIDE STUDY AREA

Trip End Location	External Station														
	1	2	3	4	5	6	8	10	12	14	15	16	17	19	Total
Remainder of Somersworth, Dover and Rollinsford	136	541	941	842	138	209	114	29	461	806	133	76	447	341	5,212
Remainder of New Hampshire	4,240	3,992	367	201	1,481	5,404	1,703	3,455	634	1,897	2,662	4,403	609	561	31,609
York County, Maine	405	403	2,124	765	7,557	462	65	179	41	125	160	184	10	1,552	14,030
Remainder of Maine	72	43	95	8	196	22	8	40	1	9	19	37	6	3	558
Remainder of New England	1,611	548	77	3	106	105	20	1,134	1	47	164	115	17	9	3,956
Remainder of U.S. and Canada	123	26	18	3	29	8	-	40	-	15	18	11	-	3	293
Total	6,587	5,553	3,622	1,821	9,507	6,210	1,909	4,878	1,138	2,898	3,156	4,825	1,088	2,468	55,659

Notes: (1) For locations of stations see Memorandum No. 7

(2) All entries in the table have been rounded. Therefore, actual totals of individual columns or rows may differ slightly

(3) Trip ends shown represent 24-hour travel

DOVER-SOMERSWORTH TRANSPORTATION STUDY

Memorandum No. 17

March 23, 1966

FROM: Tippetts-Abbett-McCarthy-Stratton

TO: New Hampshire Department of Public Works and Highways

SUBJECT: Card Formats

Attached to this memorandum is a card layout form showing the fields used for each of the items of data obtained in home interviews (card Nos. 1, 2 and 4), roadside interviews (card No. 3) and taxi interviews (card No. 5).

DOVER-SOMERSWORTH TRANSPORTATION STUDY

TIPPETTS-ABBETT-McCARTHY-STRATTON
ENGINEERS AND ARCHITECTS
375 PARK AVENUE, NEW YORK 22, N.Y. PLAZA 5-2000

JOB NO. 1143

DATE 2/1/65

INTERPRETER SPACING

1. HOME INTERVIEWS — D.U. CARDS

CARD NO	SAMPLE NO	RESIDENCE ZONE	TRAVEL DAY	DWEL. TYPE / NO VEHICLES	TRUCK NO 1 GARAGE ZONE	TRUCK NO 2 GARAGE ZONE	TRUCK NO 3 GARAGE ZONE	NO RES. AT DWEL. UNIT / NO. RES. 15 YR. OR OVER	NO RES. EMPLOYED / NO VIS. 6 YR. +	INCOME	TOTAL TRIPS	NO PERS. 5 YR. + MAKING TRIPS	NO PERS. 5 YR. + MADE NO TRIPS	NO. PERS. 5 YR. + WITHIN UNIT.	DISP. CODE	EXP. FACTOR
1	2 3 4 5	6 7 8	9 10 11	12 / 13	14 15 16	17 18 19	20 21 22	23 24 / 25 26	27 28 / 29	30	31 32	33 34	35 36	37 38	39	76 77 78 / 79 80

2. HOME INTERVIEWS — TRIP DATA

CARD NO	SAMPLE NO	RESIDENCE ZONE	TRAVEL DAY	PERSON NO	OCCUPATION / INDUSTRY	TRIP NO	ORIGIN	DESTINATION	MODE	MID POINT TIME	TRIP PURP. FR.	TRIP PURP. TO	DRIVER NO IN VEH	DRIVER KIND OF PARK'G	DRIVER PARK'G	COMMOD.	TRK. TRIPS LOAD	TRK. TRIPS TRK. TYPE	EXP. FACTOR
1	2 3 4 5	6 7 8	9 10 11	12 13	14 15	16 17	18 19 20 21 22 23	24 25 26 27 28 29	30	31 32 33	34	35	36	37	38	39	40	41	76 77 78 / 79 80

3. ROADSIDE INTERVIEWS

CARD NO	DIRECTION	STATION NO	TRAVEL DAY	HOUR BEGINNING	TIME MINUTES	VEH. TYPE / NO PERSONS	ORIGIN	DESTINATION	MID POINT TIME	PURP. FROM	PURP. TO	RES. IN/OUT	RT. OF ENTRY/EXIT	EXP. FACTOR
1	2	3 4	9 10 11	12 13	14 15	16 17	18 19 20 21 22 23	24 25 26 27 28 29	30 31 32 33	34	35	36	37 38	76 77 78 / 79 80

4. TRUCK DATA

Data on truck travel by residents of Study Area obtained during home interviews and shown on No. 2 cards. Travel mode (column 30) for truck trips is "3".

5. TAXI INTERVIEWS

CARD NO	SAMPLE NO	GARAGE ZONE	TRAVEL ZONE	ORIGIN	DESTINATION	MODE	MID POINT TIME	EXP. FACTOR
1	2 3 4 5	6 7 8	9 10 11	12 13 14 15	16 17 18 19 20 21 22 23	24 25 26 27 28 29	30	31 32 33	76 77 78 / 79 80

6.

DOVER-SOMERSWORTH TRANSPORTATION STUDY

Memorandum No. 18 April 26, 1966

FROM: Tippetts-Abbett-McCarthy-Stratton

TO: New Hampshire Department of Public Works and Highways

SUBJECT: External Trip End Forecasts

The general procedure for forecasting vehicular volumes crossing the Study Area cordon line will be to develop and apply compound annual traffic growth factors for each roadside interview station.

1. References

The following references were used to assemble data for the analysis of recent trends and traffic projections made by others:

A. "Automatic Traffic Recorder Reports and Miscellaneous Statistics" for 1960-1965 inclusive, NHDPW&H, Planning and Economics Division

B. "Comprehensive Transportation Plan, Portsmouth, New Hampshire", Wilbur Smith & Associates, November 1962

C. Table TF1, 1965 Estimate of Cost of Completing the Interstate System, NHDPW&H, May 1965

D. Plan sheets for NHDPW&H projects in the Dover-Somersworth Area: N.H. Projects Nos. P-3877, S-7091, P-7041

2. Recent Trends

Using data from Reference A, an analysis was made of 1959-1965 trends for July and August weekday traffic volumes on highways in and near the Dover-Somersworth Area. Average annual percent increases for each of the six locations investigated are summarized below:

Location	Average Annual Percent Increase (Average July-August Weekday Traffic) 1959-1965	1963-1965
N.H. Turnpike, total traffic	3.9	4.7
Spaulding Turnpike, Dover	7.1	2.7
Spaulding Turnpike, Rochester	3.4	0.5
General Sullivan Bridge, Newington	1.5	-1.8
N.H. 16, Dover	1.5	0.0
N.H. 16, Somersworth	2.8	3.2

It is of interest to note that the six-year trend for the period 1959-1965 has flattened out in the last two years at each of the locations except for the N.H. Turnpike and N. H. 16 in Somersworth.

3. Projections by Others

Reference B contains projections of traffic for the period 1961-1985 at each of the external stations in the Portsmouth Area. Projected average annual percent increases at certain of these external stations are as follows:

Location	Average Annual Percent Increase (Average Annual Daily Traffic)
N. H. Turnpike	4.3
N. H. 16/U.S. 4*	3.2
Woodbury Avenue*	2.5
Other	3.1
Total	3.3

*These two stations are located between Portsmouth and Dover

Data from Reference C was used to determine the anticipated average annual percent increase on various types of highways throughout the State for the period 1962-1990, using total annual vehicle-miles as a measure. These are as follows:

Type of Route*	Average Annual Percent Increase (Total Annual Vehicle-Miles)
Federal-Aid System	
Urban	3.9
Rural	2.1
State & Local System	
Urban	1.8
Rural	0.2
Subtotal	
Urban	2.6
Rural	1.8
Total	2.0

*Interstate routes not included

Reference D contains summaries of design data for three construction projects in the Dover-Somersworth area, including 1965 and 1985 ADT. Anticipated average annual percent increases in traffic at these locations are as follows:

N. H. Project Number	Location	Average Annual Percent Increase (Average Annual Daily Traffic)
P-3877	Durham, U. S. 4 Bypass	3.3
S-7091	Rochester, U.S. 202 - Turnpike Connector	3.1
P-7041	Newington-Dover, General Sullivan Bridge	3.0

4. Trip End Forecasts for the Dover-Somersworth Area

Average annual percent increases for each of the roadside interview station locations were determined on the basis of judgment, giving consideration to the types of route, the location of the station, the distribution of current external trip ends for trips passing through the station (from Memorandum No. 16), and the data summarized herein for past and projected traffic growth on similar routes. Average annual percent increases so determined, corresponding growth factors for the 20-year period 1965-1985, 1965 traffic (from Memorandum No. 16), and resulting estimates of 1985 traffic are presented below:

Station (a)	Average Annual Percent Increase	Growth Factor	Average Summer Weekday Traffic 1965	1985
1 (b)	4.0	2.19	6,587	14,430
2 (b)	3.0	1.81	5,553	10,050
3	2.5	1.64	3,622	5,940
4	2.0	1.49	1,821	2,710
5	3.5	1.99	9,507	18,920
6	3.0	1.81	6,210	11,240
8	3.0	1.81	1,909	3,460
10	3.5	1.99	4,878	9,710
12	2.5	1.64	1,138	1,870
14	3.0	1.81	2,898	5,250
15	2.5	1.64	3,156	5,180
16	3.5	1.99	4,825	9,600
17	2.0	1.49	1,088	1,620
19	2.5	1.64	2,468	4,050
Total	3.2 (c)	1.87	55,659	104,030

Notes: (a) For locations of stations see Memorandum No. 7

(b) Figures shown assume a continuation of the current toll structure on the Spaulding Turnpike at Dover. If tolls are revised or removed, it is assumed that the combined volume will be as shown but that the distribution of forecasted traffic between Stations 1 and 2 will be different

(c) Computed after adding forecasted 1985 volumes; this figure corresponds to the 3.3% anticipated 1961-1985 average annual percent increase in traffic crossing the Portsmouth cordon line according to Reference B.

DOVER-SOMERSWORTH TRANSPORTATION STUDY

Memorandum No. 18a

May 24, 1966

FROM: Tippetts-Abbett-McCarthy-Stratton

TO: New Hampshire Department of Public Works and Highways

SUBJECT: Converting Summer Weekday Traffic Volumes to Average Annual Weekday Traffic Volumes

Traffic volumes in the Dover-Somersworth area are generally higher than average in the summer months, as shown by the following tabulation of volumes recorded at permanent counters operated by the NHDPW&H during recent years:

Location	Year	Average Weekday Traffic Annual	Average Weekday Traffic Summer*	Ratio (Summer/Annual)
(1) Spaulding Turnpike, Rochester	1962	2,569	4,250	1.65
	1963	2,586	4,424	1.71
	1964	2,720	4,547	1.67
Average		2,625	4,407	1.68
(2) Spaulding Turnpike, Dover	1962	3,901	5,518	1.42
	1963	4,290	5,948	1.39
	1964	4,450	6,136	1.38
Average		4,214	5,867	1.39
(3) General Sullivan Bridge, Newington	1962	11,941	15,089	1.26
	1963	12,587	16,318	1.30
	1964	13,039	16,524	1.27
Average		12,522	15,977	1.27
(4) Route 16, Somersworth	1962	2,843	3,243	1.14
	1963	2,986	3,775	1.27
	1964	3,312	3,645	1.10
Average		3,047	3,554	1.17
(5) Route 16, Dover	1962	6,395	6,977	1.09
	1963	6,772	7,522	1.11
	1964	6,874	7,461	1.09
Average		6,680	7,320	1.10

* 1/2 July + 1/2 August

While these figures seem to indicate a wide variation in the seasonal peaking characteristics of traffic in the Dover-Somersworth area, special consideration must be given to the Spaulding Turnpike and the connecting General Sullivan Bridge, which carry heavy seasonal volumes of through vacation travel during the summer months. At locations (4) and (5) in the above tabulation, which are not located on the through route via the Turnpike, the average ratios of summer weekday traffic to average annual weekday traffic for the years 1962-1964 inclusive are 1.10 and 1.17, respectively, with a weighted average of 1.12.

Using 1.12 as a reasonable area-wide ratio between summer and average annual travel of residents in Dover and Somersworth and nearby communities, it follows that there are approximately 1,500 through trips on the Turnpike on an average summer weekday that have no counterpart during other seasons of the year. This is derived using data for location (1) as follows:

$$(1.68 - 1.12) \times 2,625 = 1,470, \text{ Say } 1,500$$

(The 1965 summer O-D survey found that there were a total of 3,812 through trips on the Turnpike on an average summer weekday; 1,500 represents 39% of this total). If these 1,500 through trips are subtracted from the average summer weekday volumes shown for locations (2) and (3), the modified ratios between average annual weekday and average summer weekday are 1.04 for location (2) and 1.15 for location (3), with a weighted average of 1.13. It therefore seems reasonable to conclude that:

- there is a general increase in traffic during summer months of about 12 percent; and
- on the Spaulding Turnpike, there are approximately 1,500 through trips during the summer months in addition to this normal 12 percent increase.

Because the origin-destination survey was made during the summer months, it is desirable to work with average summer weekday traffic to check the accuracy and completeness of survey data and to calibrate the current traffic assignment network against current counts made during the summer of 1965. Once these steps are completed, however, it is necessary that assignments be made of average annual weekday traffic (AAWT). To accomplish this, all summer O-D data will be adjusted by multiplying by a constant factor of 0.89 (1/1.12) after subtracting 1,500 trips at Stations 1 and 10. This adjustment will be made before AAWT forecasting models are developed and used to forecast 1985 traffic in the Dover-Somersworth area.

The forecasted 1985 summer trip ends at external stations presented in Memorandum No. 18 must be converted to AAWT. This is accomplished by multiplying by a constant factor of 0.89 after subtracting 3,300 trips at Stations 1 and 10 (1,500 x 2.19 = 3,300, assuming the 4% average annual percent increase shown in Memorandum No. 18 for Station 1 applies to through summer vacation travel on the Turnpike). Current and forecasted average annual weekday traffic so derived and the corresponding growth factors

and average annual percent increases for each of the roadside interview stations are given below:

Station (a)	Average Annual Percent Increase	Growth Factor	Average Annual Weekday Traffic 1965	Average Annual Weekday Traffic 1985
1 (b)	4.0	2.19	4,520	9,910
2 (b)	3.0	1.81	4,950	8,960
3	2.5	1.64	3,220	5,290
4	2.0	1.49	1,620	2,410
5	3.5	1.99	8,460	16,880
6	3.0	1.81	5,530	10,000
8	3.0	1.81	1,700	3,080
10	3.25	1.90	3,010	5,710
12	2.5	1.64	1,010	1,660
14	3.0	1.81	2,580	4,670
15	2.5	1.64	2,810	4,610
16	3.5	1.99	4,300	8,570
17	2.0	1.49	970	1,450
19	2.5	1.64	2,200	3,610
Total	3.1 (c)	1.85	46,880	86,810

Notes: (a) For locations of stations see Memorandum No. 7

(b) Figures shown assume a continuation of the current toll structure on the Spaulding Turnpike at Dover. If tolls are revised or removed, it is assumed that the combined volume will be as shown but that the distribution of forecasted traffic between Stations 1 and 2 will be different.

(c) Computed after adding forecasted 1985 volumes

DOVER-SOMERSWORTH TRANSPORTATION STUDY

Memorandum No. 19

May 9, 1966

FROM: Tippetts-Abbett-McCarthy-Stratton

TO: New Hampshire Department of Public Works and Highways

SUBJECT: Forecast of Family Income

In the period 1950-1960, median family income in the State of New Hampshire increased from $2,875 to $5,636, a gain of 96%. During the same period, median family income in the City of Dover increased 104% from $3,006 to $6,142. An analysis of changes in the Consumer Price Index and the Gross National Product Deflator in the 1950-1960 period indicates that about one-quarter of the 1950-1960 gain can be attributed to inflation, while the remaining three-quarters represented an increase in purchasing power.

In the period 1965 to 1985, it is expected that family purchasing power (or real income) in the Dover-Somersworth Study Area will increase by about 60%. A 60% increase in twenty years is equivalent to the average annual increase in real income in the 1950-1960 period. Actual family income in 1985 (in terms of 1985 dollars) would be greater than this increase in purchasing power since inflation is expected to continue; the rate of future inflation cannot be predicted since it depends on governmental policies.

In estimating family income by traffic zone for 1985, consideration was given to the average increase in income levels for the Study Area as a whole and to specific changes in residential use and occupancy within each zone, such as the redevelopment of areas which now have a high percentage of substandard dwellings. Attachment A indicates family income in 1965 and in 1985 by traffic zone. All income figures given in the Attachment are in terms of constant 1965 dollars.

ATTACHMENT A

DOVER-SOMERSWORTH TRANSPORTATION STUDY

AVERAGE FAMILY INCOME - 1965 AND 1985
(In 1965 Dollars)

Traffic Zone	Average Family Income 1965	Average Family Income 1985
001	$ 6,314	$ 10,000
002	6,250	10,000
003	4,827	7,720
004	7,028	11,240
005	8,282	13,250
006	7,250	11,600
007	7,852	12,560
008	7,447	11,920
009	9,480	15,168
010	7,968	12,750
011	4,931	7,900
012	6,460	10,660
013	3,657	6,400
014	5,885	9,420
015	5,352	9,100
018	3,740	—
019	3,900	—
020	6,357	10,500
021	5,287	8,640
022	7,152	11,440
023	3,969	6,550
024	4,380	7,230
025	5,985	9,880
026	5,162	8,260
027	7,250	11,600
028	5,760	9,220
029	6,152	9,840
030	7,250	11,600
031	6,000	9,600
032	6,250	10,000
033	7,700	12,320
034	7,251	11,600
035	7,500	12,000
036	6,500	10,400
037	6,608	10,570
038	6,351	10,160
039	6,900	11,040
040	7,244	11,590

Traffic Zone	Average Family Income 1965	Average Family Income 1985
041	$ 6,677	$ 10,680
042	4,800	7,680
043	7,538	12,060
044	5,477	8,760
045	5,500	8,800
046	5,348	9,090
047	5,928	9,480
048	6,796	11,210
049	6,850	10,960
050	5,543	8,870

DOVER-SOMERSWORTH TRANSPORTATION STUDY

Memorandum No. 20

June 10, 1966

FROM: Tippetts-Abbett-McCarthy-Stratton

TO: New Hampshire Department of Public Works and Highways

SUBJECT: Screenline Analysis

1. Screenline Location

A screenline oriented approximately northeast-southwest was established along the Boston and Maine Railroad tracks from Oak Street on the Dover-Rollinsford line at the eastern boundary of the Study Area, to a point just northeast of Central Road (N.H. 4/9) near the western boundary of the Study Area, thence parallel to and north of Central Road to the cordon line near Columbus Avenue. The screenline divides the Study Area into two sectors as follows:

Sector	Traffic Zones	Area (acres)	1965 Population
North	1-21, 31	6,309 (39%)	11,379 (39%)
South	22-30, 32-50	9,698 (61%)	17,769 (61%)

2. Screenline Stations

The screenline crosses the following six roads within the Study Area:

Station No.	Name
30	Oak Street
31	Broadway
32	Central Avenue (N.H. 9/16)
33	Chestnut Street - Third Street*
34	Washington Street
35	Spaulding Turnpike

*The railroad tracks pass diagonally through the intersection

3. Ground Counts

Manual classification counts were made at each of the six screenline stations for a total of 24 hours, and adjusted to represent average summer weekday traffic. A two-step adjustment procedure was used. First, the ratio of the average weekday automatic traffic recorder count for several weekdays at the station, to the automatic traffic recorder count for the 24-hour period during which manual counts were made,

was computed (automatic traffic recorder counts were made at screenline stations by the New Hampshire Department of Public Works and Highways for a period of a week or so). Second, the result of the foregoing step was multiplied by a long-term factor equal to the ratio of average summer weekday traffic (1/2 x July average + 1/2 x August average) at a nearby permanent traffic recorder operated by the NHDPW&H, to the average weekday traffic at the same permanent traffic recorder for the several weekdays during which automatic traffic recorder counts were obtained at the screenline station. Data from permanent recorder 41501 on Route 16 and from records kept at the Dover toll station on the Spaulding Turnpike were used for this purpose. The composite factors obtained for each station were used to adjust manual hourly counts of automobiles and trucks.

The factoring process described above was, by necessity, simplified somewhat at certain stations where insufficient automatic recorder count data were available.

A further adjustment was made to the ground count data before screenline crossing comparisons were made, in an attempt to account for double screenline crossings which are possible for certain trips in the Study Area. After an exhaustive analysis, which included study of several minimum-time-path trees built over the existing arterial network as coded for computer traffic assignment, and preparation of special tabulations of inter-zonal movements, it was concluded that double screenline crossings account for 1.3% of the ground count. Consequently, the final step in adjusting manual screenline counts was to multiply the hourly total adjusted counts for the entire screenline by 0.987.

The actual 24-hour counts at each station, the counts at each station adjusted to represent an average summer weekday, and the final adjusted 24-hour ground count for the entire screenline after correcting for double crossings, are summarized below:

Station	Manual Count	Adjusted Count
30	2,491	2,634
31	4,996	4,781
32	14,607	14,453 ←
33	3,786	3,619
34	3,946	4,404
35	12,526	10,592
Total	42,352	40,483 x 0.987 = 39,941

4. Screenline Comparisons

Tables A-1, A-2 and A-3 and Figure 1 present hourly comparisons between expanded origin-destination survey trip data and adjusted ground counts on the screenline. The screenline comparisons shown in these tables are summarized below:

Screenline Crossings

Expanded Survey Data as a Percent of Adjusted Ground Counts

	Autos	Trucks	Total
Average summer weekday	0.75	0.78	0.76
16 hours: 6 AM - 10 PM	0.76	0.77	0.76
AM peak period: 7 AM - 9 AM	0.98	0.78	0.94
PM peak period: 4 PM - 6 PM	0.80	0.79	0.80

For automobile trips in the AM peak period, the expanded survey data are in very close agreement with the ground count. For this same period, truck travel obtained in the internal and external surveys appears to be somewhat low in comparison with the ground count. In the PM peak period, both automobile and truck comparisons are somewhat low and only a few percentage points more favorable than in the 16-hour period usually used as a basis for comparison. The 16-hour comparison is very nearly equal to the comparison for the full 24 hours.

Although the immediate results of the screenline comparisons described above are disappointing, they are not out of line with results reported for other cities having populations under 50,000. A careful investigation was made to determine the reasons for this situation and to decide if O-D data should be adjusted.

5. Adequacy of Internal Survey Data

As described in Memorandum No. 9, the overall ratio of Study Area population from expanded internal survey data to that derived independently using 1960 Census information and recent growth rates in the area was 97%. This favorable comparison indicates satisfactory accuracy in sample selection and interviewing. The adequacy of internal automobile trip reporting was confirmed by the 101% overall ratio of expanded internal survey data to external survey data for residents crossing the cordon line (see Memorandum No. 11). However, the comparable ratio for trucks was not as favorable (77%).

As described in Memorandum No. 15, external survey data have been adjusted to represent an average summer weekday. To insure that internal survey data were also representative of an average summer weekday, data were compiled on the proportion of the total number of home interviews completed during each week of the survey period and the average weekday traffic at NHDPW&H permanent recorder station 12501 in Dover for each week during the survey period. A comparison of these data indicated that internal survey data are truly representative of average summer weekday travel.

A special study was also made to insure the adequacy of data collected in the home interview survey pertaining to trucks, since the usual kind of truck survey, in which truck samples are selected from lists of registered vehicles, was not conducted in the Dover-Somersworth Study Area.

During the survey period personal visits were made to all places within each of several selected zones and the number of trucks normally garaged there was ascertained. These data, compared with expanded survey data, are tabulated below:

Zone	Description	No. of Trucks Normally Garaged: Reported Total	Expanded Survey Data
6	Dover, Sawyer Mills area	1	0
16	Dover, Clarostat plant area	2	0
17	Dover, downtown Washington-Central-Main triangle	4	11
31	Dover, Industrial Park	33	22
41	Somersworth, area north of traffic circle	30	22
Total		70	55

As would be expected, the zonal figures vary widely due to the instability of the sample size in each zone. However, the totals for the five zones compare reasonably favorably (79%).

It is of interest to note the recurrence of percentages in the high seventies obtained from various accuracy checks on survey data pertaining to trucks:

- 77% of the cordon line crossings by residents were accounted for by expanded internal survey data, and
- 79% of the trucks actually found to be normally garaged in five selected zones were accounted for by expanded home interview data.

This consistency seems to point to the fact that approximately 22% of the trucks normally garaged in the Study Area are driven by external residents whose trips, except those crossing the cordon line, were not sampled. An adjustment will be made to account for these unsampled truck trips, as described in Paragraph 8.

6. Adequacy of External Survey Data

Expanded external survey data are by their very nature 100% "adequate" when it comes to accounting for total numbers of vehicles crossing the cordon line at the points where roadside interview stations were established. This is because roadside interview data were expanded to represent average summer weekday traffic at these points, as described in Memorandum No. 15.

Stations were not operated on all of the roads crossing the cordon line, however, but only on those that in the aggregate accounted for about 96% of the total (see Memoranda Nos. 7 and 11). The cordon crossing trips that are not accounted for number approximately 2,100 on an average summer weekday (the 2,600 figure shown

in Memorandum No. 7 represents unadjusted short-period counts made in June; after adjustment the total is 2,100 as shown in Memorandum No. 11). Since 34% of the expanded external cordon crossings also cross the screenline (19,055 from Table A-3 attached to this Memorandum ÷ 55,659 from Memorandum No. 16), it would be reasonable to expect that approximately 700 of the 2,100 "missed" external cordon crossings would do likewise. This would improve the overall screenline comparison by about 2%, which is not particularly significant even though it is more than would be expected in most urban areas of larger size where external trips usually account for far less than 34% of the screenline crossings (for example, 14% in Kanawha County, West Virginia, population 253,000; 17% in the Chicago area, population 5,200,000). Because of the relative insignificance of external trips crossing the cordon line at points where interview stations were not established, and in accordance with standard practice, no adjustment will be made to the O-D data to account for such "missed" information.

In the standard home-interview type origin-destination survey, trip information for internal residents is thoroughly sampled in the internal surveys, and trips made into, out of and through the internal area by external residents are sampled in the external survey. Wholly internal trips (trips with both origin and destination inside the cordon line) by external residents are not sampled. The cordon line established in most larger urban transportation studies takes in an area large enough to encompass the daily movements of persons, vehicles and goods oriented toward the hub of the area, and consequently internal travel by external residents is of minor importance. In the Dover-Somersworth area, however, such travel would be of considerably greater significance since many residents of surrounding areas outside the cordon line (Rollinsford, Berwick, Madbury, Durham, etc. as well as the fringes of Dover and Somersworth) look to Dover or Somersworth as their central city where they work, do much of their shopping, carry on their personal business, visit friends, pursue their recreational interests, and so forth. With homes outside and most of their daily activities inside the Study Area, it would not be surprising to find that external residents make a considerable number of wholly internal trips every day. How significant might this be? Internal residents make 12,125 non-home-based internal vehicle trips daily, or an average of approximately 0.6 non-home-based internal vehicle trips for every one home-based internal vehicle trip. It is reasonable to expect that residents of the surrounding area would demonstrate almost the same characteristic. Of course, some of these non-home-based trips might be made entirely outside of the Study Area but it seems reasonable to expect that, say, 75% would be made internally. We might therefore reasonably expect that external residents would make about 8,000 internal vehicle trips in the Dover-Somersworth Study Area on an average summer weekday, where 8,000 equals 0.6 x 0.75 times the number of external non-through-home-based vehicle trips made by non-residents (17,731). The expanded survey data for internal non-home-based vehicle trips by internal residents is therefore seen to account for 58% of the total number of internal non-home-based vehicle trips that might be expected by both internal and external residents $\left(\frac{12,125}{12,125+8,000} = 0.58\right)$.

An adjustment will be made to account for the unsampled vehicle trips of external residents, as described in Paragraph 8.

7. Parking Near the Screenline

Another situation which could adversely affect the screenline comparisons is related to the availability of parking spaces near the railroad tracks in Dover, particularly in the block bounded by Central Avenue, Chestnut, Third and Fourth Streets which is bisected by the railroad and otherwise is largely devoted to parking. For example, with a destination immediately north of the railroad, a driver coming from the north may choose to park south of the tracks, resulting in two crossings of the screenline which would not be accounted for in the O-D data. We do not have sufficient information to estimate the number of vehicles actually counted crossing the screenline that might be making such maneuvers or that might be cruising while searching for a parking space or for some other purpose (for example, there were a great many motorcyclists from out of the area driving around Dover during the week of July 19 when many of the screenline counts were made). Although such circumstances affect the screenline comparisons, they do not reflect any basic omission in the data collected.

8. Factoring of Origin-Destination Data

As described in the preceding paragraphs, there are two types of trips that were unsampled in the Dover-Somersworth Area. To account for such trips, internal survey trip data will be factored as follows:

(a) Internal trips by trucks garaged in the Study Area but driven by external residents:

- multiply internal truck trips by $\frac{1}{1 - 0.22} = 1.28$,

where 0.22 represents the proportion of the total number of internally garaged trucks that are driven by external residents (see Paragraph 5).

(b) Internal auto and truck trips made by external residents:

- multiply internal non-home-based vehicle trips by $\frac{1}{0.58} = 1.72$,

where 0.58 represents the ratio of the number of internal non-home-based vehicle trips by internal residents to the total number of internal non-home-based vehicle trips that might be expected by both internal and external residents (see Paragraph 6).

9. Evaluation of Factored O-D Data

Table A-4 and Figure 2 present hourly comparisons between adjusted origin-destination survey trip data and adjusted ground counts on the screenline. The

screenline comparisons shown in Table A-4 are summarized below:

Screenline Crossings

Expanded and Adjusted Survey Data as a Percent of Adjusted Ground Count

	Autos	Trucks	Total
Average summer weekday	82	92	83
16 hours: 6 AM - 10 PM	83	91	84
AM peak period: 7 AM - 9 AM	104	98	103
PM peak period: 4 PM - 6 PM	85	84	85

These comparisons are more favorable than those obtained before O-D data were adjusted to account for internal travel of external residents. In the AM peak period the agreement is very close. The overall percentage (84%) for total vehicles in the 16-hour period usually used as a basis for comparison appears to be somewhat low. There are three possible explanations for this:

- First, the fact that roadside interview stations were not operated at certain locations as described in Paragraph 6. This fact, although of minor significance to the area as a whole, has a disproportionately great influence on the screenline analysis since one of the possible stations that was omitted (Tolend Road) carries an ADT in excess of 700 and is so situated with respect to the screenline that almost all traffic entering and leaving the Study Area would cross the screenline.
- Second, the fact that the screenline was located immediately adjacent to the Dover CBD area, resulting in the probability of screenline crossings made while searching for a parking space, as described in Paragraph 7. Likewise, the fact that ground counts were influenced to some extent by other unusual factors described in Paragraph 7.
- Third, the possibility that internal trips by internal residents were under-reported.

As noted above, the first possibility would justify discounting the relatively low final screenline comparison to some extent. The second possibility also would dictate that a "good" screenline comparison should be less than 100%, but by what amount is completely indeterminate. To evaluate the third possibility, adjusted origin-destination survey trips were assigned to the existing highway network and assigned volumes throughout the network were compared with ground counts where available. The results of that comparison will be presented in a separate Memorandum, but it is indicated that no further adjustment to force the screenline comparison upwards toward 100% is warranted. Such an additional adjustment would result in over-assignments for most of the highway network.

10. Conclusions

Based on the analyses described in this Memorandum, it was concluded that O-D data should be adjusted to account for unsampled internal travel of external residents, but that otherwise trip data collected in the survey are adequate.

Table A-1

Passenger Vehicle Trips Crossing Screenline
(Unadjusted O-D Data)

Hour Beginning At	Expanded Trip Data			Adjusted Ground Count	Percent Total of Ground Count
	Internal	External	Total		
06	605	761	1,366	1,465	93
07	623	985	1,608	1,554	103
08	539	661	1,200	1,328	90
09	529	641	1,170	1,466	80
10	402	916	1,318	1,750	75
11	471	1,014	1,485	1,870	79
12	727	1,084	1,811	2,470	73
13	456	932	1,388	2,010	69
14	373	958	1,331	1,960	68
15	487	1,221	1,708	2,220	77
16	901	1,854	2,755	3,200	86
17	765	1,436	2,201	3,030	73
18	555	1,013	1,568	2,325	68
19	632	929	1,561	2,540	62
20	657	792	1,449	2,195	66
21	464	601	1,065	1,525	70
Sub-Total: 16 hours: 6AM-10PM	9,186	15,798	24,984	32,908	76
22	353	352	705	1,200	
23	124	240	364	765	
00	69	172	241	567	
01	105	110	215	273	
02	97	36	133	101	
03	110	26	136	68	
04	185	24	209	73	
05	164	73	237	210	
Total: 24 hours	10,393	16,831	27,224	36,165	76

Table A-2

Truck Trips Crossing Screenline
(Unadjusted O-D Data)

Hour Beginning At	Expanded Trip Data			Adjusted Ground Count	Percent Total of Ground Count
	Internal	External	Total		
06	50	101	151	163	93
07	118	163	281	289	97
08	50	125	175	300	58
09	39	145	184	309	60
10	34	156	190	273	70
11	39	178	217	276	79
12	62	137	199	241	83
13	28	130	158	298	53
14	45	165	210	233	90
15	67	202	269	252	96
16	17	236	253	364	70
17	44	156	200	213	94
18	17	71	88	114	77
19	11	62	73	116	63
20	17	50	67	77	87
21	6	22	28	51	55
Sub-Total: 16 hours: 6AM - 10PM	644	2,099	2,743	3,569	77
22	17	26	43	25	
23	-	10	10	31	
00	5	16	21	20	
01	6	8	14	8	
02	5	12	17	16	
03	6	8	14	32	
04	23	19	42	18	
05	17	26	43	57	
Total: 24 hours	723	2,224	2,947	3,776	78

Table A-3

Total Vehicle Trips Crossing Screenline
(Unadjusted O-D Data)

Hour Beginning At	Expanded Trip Data			Adjusted Ground Count	Percent Total of Ground Count
	Internal	External	Total		
06	655	862	1,517	1,628	93
07	741	1,148	1,889	1,843	102
08	589	786	1,375	1,628	85
09	568	786	1,354	1,775	76
10	436	1,072	1,508	2,023	74
11	510	1,192	1,702	2,146	79
12	789	1,221	2,010	2,711	74
13	484	1,062	1,546	2,308	67
14	418	1,123	1,541	2,193	70
15	554	1,423	1,977	2,472	80
16	918	2,090	3,008	3,564	84
17	809	1,592	2,401	3,243	74
18	572	1,084	1,656	2,439	68
19	643	991	1,634	2,656	62
20	674	842	1,516	2,272	67
21	470	623	1,093	1,576	69
Sub-Total: 16 hours: 6AM-10PM	9,830	17,897	27,727	36,477	76
22	370	378	748	1,225	
23	124	250	374	796	
00	74	188	262	587	
01	111	118	229	281	
02	102	48	150	117	
03	116	34	150	100	
04	208	43	251	91	
05	181	99	280	267	
Total: 24 hours	11,116	19,055	30,171	39,941	76

Table A-4

Adjusted Vehicle Trips Crossing Screenline

Hour Beginning At	Passenger Vehicles			Trucks			Total Vehicles		
	Adjusted O-D Data	Adjusted Ground Count	Percent O-D of Ground Count	Adjusted O-D Data	Adjusted Ground Count	Percent O-D of Ground Count	Adjusted O-D Data	Adjusted Ground Count	Percent O-D of Ground Count
06	1,496	1,465	102	177	163	109	1,673	1,628	103
07	1,706	1,554	110	362	289	125	2,068	1,843	112
08	1,294	1,328	98	217	300	72	1,511	1,628	93
09	1,301	1,466	89	215	309	70	1,516	1,775	85
10	1,420	1,750	81	216	273	79	1,636	2,023	81
11	1,651	1,870	88	256	276	93	1,907	2,146	89
12	2,166	2,470	88	256	241	106	2,422	2,711	89
13	1,571	2,010	78	186	298	62	1,757	2,308	76
14	1,471	1,960	75	251	233	108	1,722	2,193	79
15	1,849	2,220	83	328	252	130	2,177	2,472	88
16	2,970	3,200	93	262	364	72	3,232	3,564	91
17	2,342	3,030	77	224	213	105	2,566	3,243	79
18	1,634	2,325	70	101	114	89	1,735	2,439	71
19	1,666	2,540	66	80	116	69	1,746	2,656	66
20	1,556	2,195	71	72	77	94	1,628	2,272	72
21	1,130	1,525	74	34	51	67	1,164	1,576	74
Sub-Total: 16 hours: 6AM - 10PM	27,223	32,908	83	3,237	3,569	91	30,460	36,477	84
22	796	1,200		48	25		844	1,225	
23	377	765		10	31		387	796	
00	247	567		26	20		273	587	
01	247	273		20	8		267	281	
02	150	101		22	16		172	117	
03	164	68		16	32		180	100	
04	245	73		56	18		301	91	
05	267	210		56	57		323	267	
Total: 24 hours	29,716	36,165	82	3,491	3,776	92	33,207	39,941	83

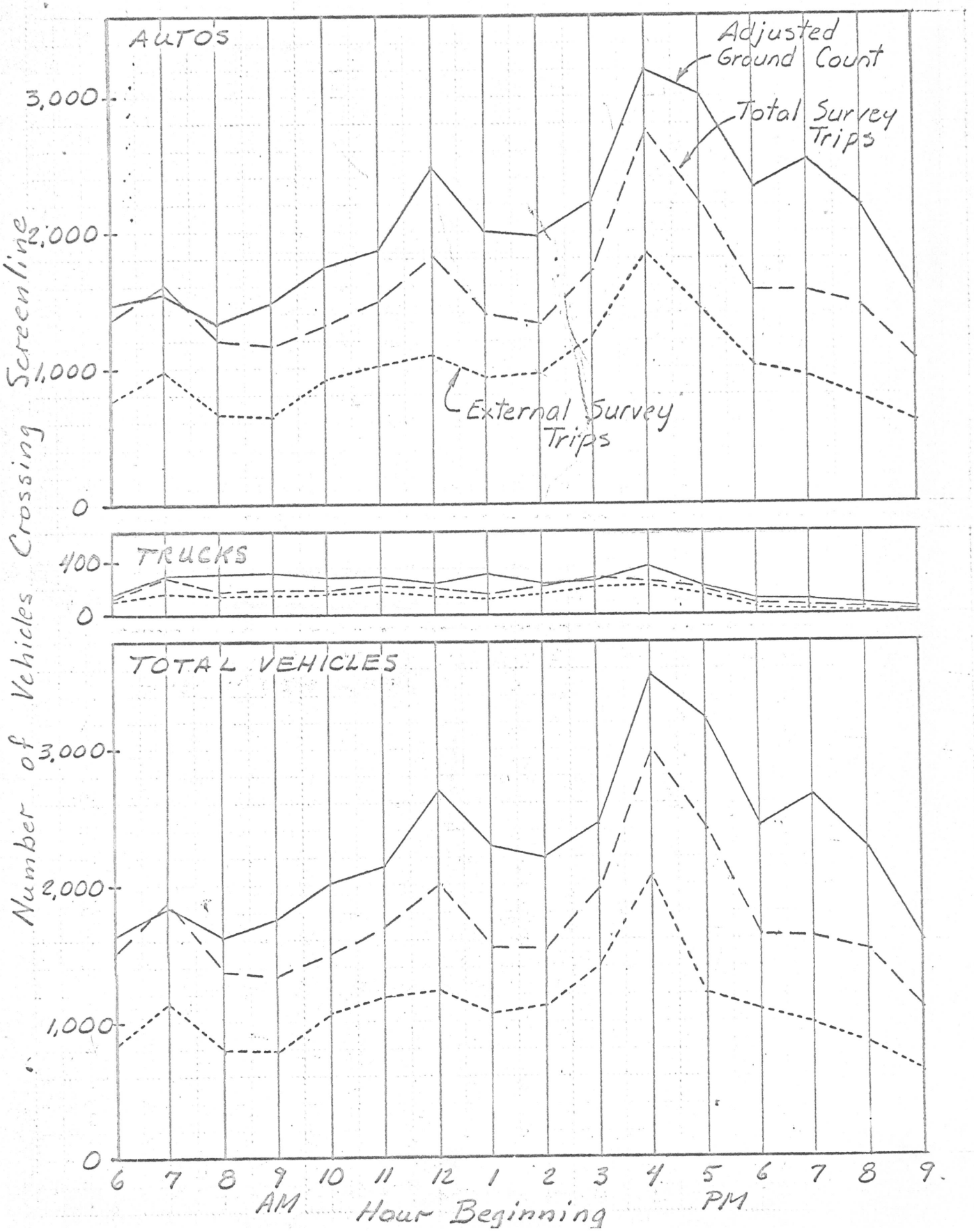
TIPPETTS-ABBETT-McCARTHY-STRATTON
ENGINEERS AND ARCHITECTS NEW YORK

Job No. 1143 Sheet 1 of 2

Project Dover-Somersworth Transportation Study Date

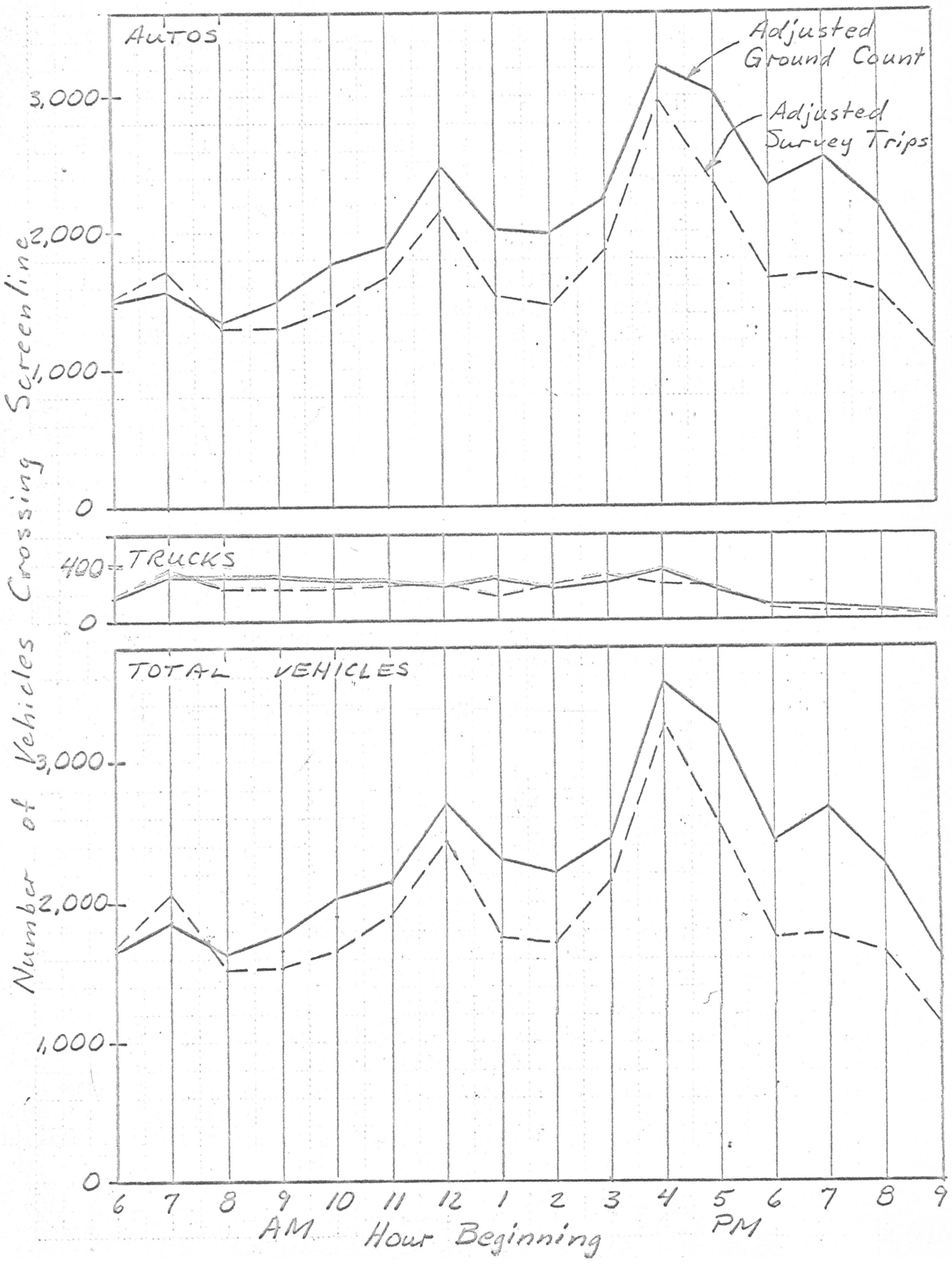
Subject Screenline Comparisons - Unadjusted O-D Data By

Figure 1 Chk. by



TIPPETTS-ABBETT-McCARTHY-STRATTON
ENGINEERS AND ARCHITECTS NEW YORK

Job No. 1143 Sheet __ of __
Project Dover - Somersworth Transportation Study Date
Subject Screenline Comparisons - Adjusted O-D Data By D
Figure 2 Chk. by



DOVER-SOMERSWORTH TRANSPORTATION STUDY

Memorandum No. 21 June 14, 1966

FROM: Tippetts-Abbett-McCarthy-Stratton

TO: New Hampshire Department of Public Works and Highways

SUBJECT: Employment Checks

The accuracy and completeness of work trip reporting in the origin-destination survey was evaluated as discussed herein. This evaluation further verifies the screen-line comparison for AM peak hours (see Memorandum No. 20) which indicated a satisfactory degree of accuracy with regard to morning peak travel when most weekday trips to work occur.

A number of factors make it impossible to achieve direct comparability between home-to-work trips and employment data:

(a) Sickness, vacations and other forms of absenteeism tend to reduce person-trips to work below the number of persons actually employed. This factor is particularly significant in the summer when 20 percent or more of the normal work force may be on vacation during any given week.

(b) In the origin-destination survey, data concerning weekend travel were not reported. Thus work trips to plants working on a six- or seven-day schedule were under-reported with respect to employment since employees on certain weekdays made no trips to work. Similarly, home-to-work travel for persons working less than five days a week would appear to be under-reported.

(c) Since the comparisons made herein were between home-to-work trip destinations and employment, it is possible that some valid travel to work was not included in the comparisons, such as when intermediate stops were made between home and work.

(d) Certain classes of workers - domestics, gardeners, etc. - probably are not completely accounted for in the employment figures presented in Memorandum No. 8.

(e) The place where a person works is not always where he is considered to be employed. For example, a concern with two offices may keep all personnel records in one office and report that as the place of employment for all workers, whether they actually work there or not. Construction

workers usually report for work on the job site, but their place of employment is considered to be the office or base of operations of the construction firm. Similarly, salesmen, repairmen, delivery-men, etc. may be employed in one area but travel to work in another area.

The first three factors noted above have the effect of reducing the overall number of average weekday home-to-work trips below the actual level of employment. Factor (d) has the opposite effect. The last factor noted above may have either effect upon a comparison of home-to-work trips with employment in any given area. The net effect is indeterminate, but it would seem reasonable to expect that a ratio of home-to-work trip destinations to employment falling somewhere within a range of 70 to 95 percent would indicate satisfactory work trip reporting. It should be recognized that such a ratio does not indicate the percent completeness of trip reporting; a ratio in the 70 to 95 percent range should be interpreted as an indication of complete trip reporting. Because of the indeterminate nature of the precise ratio that would represent a "perfect" condition, the employment check can only be taken as a general indicator of survey accuracy.

Presented below are comparisons of home-to-work trips with employment for eight portions of the Dover-Somersworth Area covering virtually all of the major employment centers, and including 87 percent of the total Study Area employment. The ratios shown for Area A are somewhat high but for all other areas, the comparisons are within the expected range. For the eight areas as a whole, the ratio is seen to be somewhere between 79 and 94 percent.

Area	Description	Zones	Home-to-Work Trip Destinations (a)	Total Employment (b)	Percent (c)
A	Sawyer Mills area	6	378	328	115
B	Dover central area, east of Central Avenue, south of railroad	13-17	2,378	2,775	86
C	Dover central area, east of Central Avenue, north of railroad	26-28	1,338	1,326	101
D	Dover central area, west of Central Avenue	18-21 24	1,760	1,926	91
E	"Miracle Mile" area	30	385	388	99
F	Dover Industrial Park	31	1,248	1,221	102
G	Somersworth industial area south of Franklin Street, east of railroad	38	555	545	102
H	Somersworth central area	44-45 49-50	2,625	2,910	90
	Total		10,667	11,419	94

Notes: (a) Computed using data from internal and external surveys. For external survey, all passengers in vehicles crossing the cordon line are considered to have same purpose and destination as driver.
(b) From Appendix A to Memorandum No. 8.
(c) Ratio of home-to-work trip destinations to total employment.

DOVER-SOMERSWORTH TRANSPORTATION STUDY

Memorandum No. 23 June 16, 1966

FROM: Tippetts-Abbett-McCarthy-Stratton

TO: New Hampshire Department of Public Works and Highways

SUBJECT: Current and Forecasted Truck Ownership

Current truck ownership by zone within the Dover-Somersworth Study Area was obtained from expanded origin-destination survey data - specifically, from 157 home interviews reporting one truck, 4 home interviews reporting two trucks, and 2 home interviews reporting three trucks. As noted in Memorandum No. 20, approximately 22 percent of the trucks normally garaged in the Study Area are driven by external residents whose trips, except those crossing the cordon line, were not sampled. Trip data were adjusted to account for such travel by multiplying internal truck trips by 1.28. Expanded truck ownership data have been adjusted likewise. Current (1965) truck ownership by zone, obtained from adjusted and expanded origin-destination survey data, is tabulated in Attachment A.

Truck registration in the United States as a percent of total vehicle registration has decreased since 1950 from about 20 percent to about 17 percent. The percentage of trucks in recent years appears to be stabilizing at a level of about 17 percent. National forecasts indicate that by 1985 one out of six vehicles in the United States will be a truck.

Total truck registration in New Hampshire as a percent of total vehicle registration has been consistently below the national average since 1950 by two to three percentage points. In 1965, close to one out of seven vehicles in the State was a truck.

Memorandum No. 9 shows 9,529 passenger vehicles in the Dover-Somersworth Study Area in 1965. The proportion of trucks to total vehicles in the Study Area in 1965 was apparently only about one in eight, but this ratio is affected by the sampling errors inherent in the numbers of passenger vehicles and trucks determined from an expanded sample.

Based on the trends and projections noted above, it is estimated that by 1985 the proportion of total vehicles represented by trucks in New Hampshire will be about 15 percent, and that the same relationship will apply in the Dover-Somersworth Area. This projection produces an anticipated 1985 Study Area total of approximately 2,770 trucks (based on the estimate of 15,690 passenger vehicle owned by residents of the Study Area in 1985 as shown in Memorandum No. 22).

Zonal forecasts of truck ownership, presented in Attachment A, were obtained by distributing the projected truck ownership for the Study Area as a whole among the fifty internal zones in proportion to current ownership.

ATTACHMENT A

DOVER-SOMERSWORTH TRANSPORTATION STUDY

TRUCK OWNERSHIP - 1965 AND 1985

Traffic Zone	Truck Ownership 1965	1985
1	36	83
2	22	51
3	8	19
4	36	83
5	22	51
6	-	-
7	36	83
8	-	-
9	-	-
10	8	19
11	14	32
12	50	116
13	56	130
14	50	116
15	14	32
16	-	-
17	14	32
18	14	32
19	-	-
20	50	116
21	8	19
22	22	51
23	-	-
24	62	144
25	42	97
26	50	116
27	35	81
28	28	65
29	14	32
30	14	32
31	28	65
32	8	19
33	14	32
34	64	148
35	36	83
36	7	16
37	27	63
38	50	116
39	-	-
40	28	65

Traffic Zone	Truck Ownership 1965	1985
41	28	65
42	8	19
43	14	32
44	28	65
45	7	16
46	50	116
47	8	19
48	36	83
49	22	51
50	28	65
	1,196	2,770

DOVER-SOMERSWORTH TRANSPORTATION STUDY

Memorandum No. 24 July 6, 1966

FROM: Tippetts-Abbett-McCarthy-Stratton

TO: New Hampshire Department of Public Works and Highways

SUBJECT: Traffic Assignment

1. General Assignment Procedure

Traffic assignment is the process by which routes used for interzonal movements are determined and volumes on various portions of the highway network are calculated. The traffic assignment process involves the schematic representation of the highway network, the determination of minimum paths through the network between all zones and external stations in the Study Area, the assignment of interzonal movements to these paths, and the accumulation of traffic volumes on the various links and turning movements at the various nodes making up the network.

The arterial network in the Dover-Somersworth Area has been coded by a standard system of link and node numbering. Major streets and highways have been included as well as additional actual and fictitious links required to provide access to and from all zones. Coded network description data include node numbers, lengths and speeds or travel times. Approximately 270 links and 200 nodes were used to describe the existing 1965 highway network in the Dover-Somersworth Area.

For any interzonal movement, there are usually a number of alternative routes, each with its own characteristics including distance, travel time or average speed, and travel costs. These are evaluated by a driver in selecting the route he will travel. For the Dover-Somersworth Study travel time will be used as the measure of travel resistance and the traffic assignment process will therefore assign trips to minimum time paths.

Other features of the assignment process to be used include:

- all-or-nothing assignment, by which process all trips are assigned to the path with the least travel resistance between origin zone and destination zone;

- desire-type assignment, meaning that explicit recognition in the computer program used is not given to the fact that travel resistance increases as volume approaches capacity (this effect is not ignored, however, since assigned volumes on links where capacity would be exceeded will be manually reassigned to parallel routes if necessary); and

- no turn penalties, meaning that time penalties are not coded into the network at the node points.

All traffic assignments will be of total 24-hour vehicle trips. The existing highway network was calibrated using current average summer weekday traffic. All assignments of future traffic will be of average annual weekday traffic.

2. Calibration Procedure

To calibrate the assignment network, total current (1965) average summer weekday traffic obtained from the origin-destination survey was assigned to the existing system and assigned volumes throughout the system were compared with actual counted volumes.

Three assignments were made as follows:

(1) Current vehicle trips from O-D data were assigned to the existing system as originally formulated and coded.

(2) Current vehicle trips from O-D data adjusted as per paragraph 8 of Memorandum No. 20 were assigned to the existing system modified as required.

(3) Same trips as in (2) were assigned to the existing system further modified.

The network coding modifications made prior to Assignments (2) and (3) included correction of minor errors in link lengths and network representation, addition of some centroid connectors, and revisions in link speeds. The objective of these modifications was to influence the following assignments so as to result in closer agreement between assigned and counted volumes.

Volumes assigned to links throughout the system were investigated for reasonableness, but particular attention was given to the comparison between assigned and counted volumes at 28 locations where counts were available. Six of these locations were on the Study Area screenline where ground counts were made and adjusted as described in Memorandum No. 20. At the other locations, counts were made by the NHDPW&H during the summer of 1965. Each of these counts was adjusted to represent average summer weekday traffic by multiplying the average of the weekday counts made at the location by the ratio of average summer weekday traffic (1/2 x July average + 1/2 x August average) at one of the State's permanent traffic recorders in the Study Area, to the average count obtained at the same permanent recorder for the same weekdays during which counts were made at the coverage count location.

3. Considerations in Evaluation of Assignment Results

Volumes determined through traffic assignment may differ from those actually counted for a number of reasons:

(a) Vehicle movements actually have their origins and destinations at residences, commercial establishments, industrial plants, and the like, which are spread geographically throughout the zones into which the Study Area has been divided; for traffic assignment, all movements into or out of a zone are considered as originating or destined at a single point located at the zone centroid. In the immediate vicinity of a zone centroid, therefore, the assigned volume may differ appreciably from counts.

(b) Vehicle movements actually use all routes within the county, but only those which are considered as arterials or which are required to connect zone centroids to the arterial system are included in the link-node system used for assignment.

(c) Intrazonal movements (those which have both their origin and destination within the same zone) are not considered in the assignment procedure, even though they use the arterial system within the Study Area.

(d) Trip data from the origin-destination survey represent average summer weekday conditions because of the way the interview surveys were conducted - over a period of several weeks, and spread as uniformly as was feasible over the five days of the week. On the other hand, most of the automatic traffic recorder counts were made only for a period of one or two days. Although they were factored to account for areawide weekly and daily variations in traffic flow, the chance exists that something unusual may have occurred in a particular area during the period of the count, making it not truly representative. Then too, the counters used may have been adjusted to too sensitive a level, thereby registering for bicycles and pedestrians.

(e) In downtown areas, drivers often have to go out of their way in search of parking spaces. This extra cruising is not accounted for in the origin-destination data.

(f) Automatic traffic recorders count axles and divide by 2 to get vehicles. Therefore cars pulling trailers and trucks with more than two axles will be over-counted. No correction factor has been applied to the counts to correct for this situation. Depending upon the number of such vehicles in the traffic stream, 5 percent or more of the "vehicles" counted could actually represent "extra" axles.

(g) Some of the counts were made at locations where a large proportion of the traffic is entering or leaving the Study Area via a highway that was not included as a roadside interview station. This portion of the traffic would therefore not be reflected in the assigned volume (see Memorandum No. 7).

4. Comparisons of Assigned Volumes with Counted Volumes

Using assigned volumes from Assignment (3) only (the final assignment of current traffic to the existing system), the comparisons between assigned and counted volumes for various sections of the Study Area are presented and discussed below.

(a) Dover - Outlying Area

Count No.	Location	Assigned Volume	Adjusted Count	Ratio Assigned/Counted
1	Route 16, Dover Point	6,048	7,520	0.80
2	Routes 4, 9, 155 west of Spaulding Turnpike	9,200	8,690	1.06
3	Spaulding Turnpike north of Silver Street Interchange	11,360	10,592	1.07
4	Route 16 north of Somersworth Traffic Circle	7,264	7,230	1.00
5	Oak Street at B&M Railroad	2,584	2,634	0.98
		36,456	36,666	1.00

Assigned volumes at these locations compare very favorably with adjusted ground counts.

(b) Dover- Intermediate Area

Count No.	Location	Assigned Volume	Adjusted Count	Ratio Assigned/Counted
6	Washington Street west of Arch Street	3,264	4,404	0.74
7	Sixth Street at Horne Street	2,728	5,500	0.50
8	Central Avenue at Ham Street	10,112	16,560	0.61
9	Broadway at Ham Street	3,800	5,860	0.65
10	Portland Avenue at Rogers Street	7,192	5,900	1.22
11	Cocheco Street west of Portland Street	1,028	1,250	0.82
12	Central Avenue south of Silver St.	11,972	14,150	0.85
		40,096	53,624	0.75

Assigned volumes in the intermediate area of Dover do not appear to compare as favorably as in the outlying area. Some of the considerations discussed in paragraph 3 are particularly pertinent to certain of these locations, however, and should be given due weight before drawing any conclusion from the above tabulation. Count Nos. 6 and 7 are affected particularly by item (g) in paragraph 3 - the fact that Tolend Road was not made a roadside interview station. Count Nos. 8 and 9 are affected considerably by item (a). Item (f) would have a greater than average effect on count Nos. 8, 9 and 12. There is some question also about the reliability of certain of the counts; i.e., the effect of item (d). Another reference was used to further evaluate this question. The recently published report entitled "Dover, N.H. - A Program of Community Renewal", prepared by the City of Dover, through its Planning Board and with the assistance of an HHFA grant, includes a traffic flow map of the central area of Dover. Volumes scaled from the map at the same locations as some of the counts tabulated above are shown, and compared with assigned volumes, below:

Count No.	Assigned Volume	Volume Scaled From CRP Report*	Assigned/Scaled*
7	2,728	2,900	0.94
8	10,112	9,000	1.12
9	3,800	2,800	1.36
10	7,192	4,700	1.53
12	11,972	8,500	1.41
	35,804	27,900	1.28

*The traffic flow map in the CRP Report is for average daily traffic; assigned volumes represent average summer weekday traffic. To achieve some degree of comparability, scaled volumes from the CRP Report have been multiplied by 1.12 (see Memorandum No. 18a)

(c) Dover - Downtown Area

Count No.	Location	Assigned Volume	Adjusted Count	Ratio Assigned/Counted
13	Broadway at Railroad	3,496	4,781	0.73
14	Central Avenue at Railroad	10,208	14,453	0.71
15	Chestnut Street at Railroad	1,672	3,619	0.46
16	Central Avenue at First Street	9,580	15,450	0.62
17	Washington Street east of Central Avenue	8,076	15,100	0.54
18	Main Street south of Portland Avenue	6,268	13,620	0.46
19	River Street north of Henry Law Avenue	1,080	880	1.23
20	Henry Law Ave. east of River St.	1,636	1,220	1.34
21	Court St. east of Central Ave.	1,856	1,850	1.00
		43,872	70,973	0.62

As expected, comparisons in the downtown area are not as favorable. Count Nos. 13, 14 and 15 were on the screenline and comparisons are affected to a significant degree by the kind of considerations discussed in items (d), (e) and (f) of paragraph 3. Comparisons at locations 16, 17 and 18 are low as should be expected, particularly in view of the extensive amount of cruising around the downtown Central-Washington-Main triangle in search of parking spaces or while waiting to pick up riders, etc. Undue weight should not be attached to these comparisons in evaluating the adequacy of assigned origin-destination survey data. At the three locations (Nos. 19, 20 and 21) to the south of the downtown area, assigned volumes compare favorably with counted volumes. Volumes scaled from the Dover CRP Report referred to under (b) above, and adjusted as described in the footnote to the table included in (b), are compared with assigned volumes at some of the same locations below:

Count No.	Assigned Volume	Volume Scaled From CRP Report*	Ratio Assigned/Scaled*
13	3,496	2,700	1.29
14	10,208	9,300	1.10
15	1,672	3,200	0.52
16	9,580	8,700	1.10
17	8,076	9,300	0.87
18	6,268	9,500	0.66
	39,300	42,700	0.92

*See footnote under (b) above

(d) Somersworth

Count No.	Location	Assigned Volume	Adjusted Count	Ratio Assigned/Counted
22	Route 16 south of West High St.	4,368	4,020	1.08
23	West High Street east of Maple Street	2,500	2,040	1.23
24	Main St. at Rollinsford Line	1,252	,520	0.82
25	Green St. south of Franklin St.	4,472	3,330	1.34
26	Route 16A south of Blackwater Road	8,612	9,420	0.91
27	Route 16A north of Blackwater Road	8,064	8,000	1.01
28	Blackwater Rd. east of Route 16	476	670	0.71
		29,744	29,000	1.02

Assigned volumes in Somersworth generally compare favorably with available counts. Count No. 25 is particularly affected by item (a) in paragraph 3, and Count No. 28 is particularly affected by item (g).

(e) Secondary Screenlines

A secondary screenline cutting across the Study Area south of downtown Dover cuts six major roads at points where ground counts were made. These six locations have been included in the tabulations presented above and are repeated below:

Count No.	Road	Assigned Volume	Adjusted Count	Ratio Assigned/Counted
5	Oak	2,584	2,634	0.98
10	Portland	7,192	5,900	1.22
11	Cocheco	1,028	1,250	0.82
20	Henry Law	1,636	1,220	1.34
21	Court	1,856	1,850	1.00
1	Route 16	6,048	7,520	0.80
		20,344	20,374	1.00

A secondary screenline cutting across Rollinsford and Somersworth cuts four major roads. Three of the four locations are included in the foregoing tabulations; at the fourth a count was taken from the Dover CRP Report. Comparisons of volumes crossing this secondary screenline are presented below.

Count No.	Road	Assigned Volume	Adjusted Count	Ratio Assigned/Counted
22	Route 16	4,368	4,020	1.08
28	Blackwater	476	670	0.71
26	Route 16A	8,612	9,420	0.91
—	Broadway*	2,448	2,800	0.87
		15,904	16,910	0.94

*At Rollinsford line (from Dover CRP Report)

The comparisons of assigned volumes with ground counts across these secondary screenlines are favorable.

5. Conclusions Regarding Network Calibration

Assigned volumes have been tabulated and compared with available ground counts for several sections of the Study Area. In Somersworth and in the outlying portion of Dover the comparisons are very favorable. In the closer-in portion of Dover the ratios of assigned to counted volumes are generally low. However, there are many possible reasons for this as discussed in preceding paragraphs, and the generally low ratios do not necessarily imply incomplete origin-destination survey

data. Screenline comparisons are much more meaningful in demonstrating survey adequacy than comparisons of assigned to counted volumes at a limited number of locations scattered throughout the area. At two secondary screenlines described under (e) in paragraph 4, the overall comparisons were excellent - 100 and 94 percent respectively. This fact, the generally good comparisons throughout the area except in and near central Dover, and the circumstances that must be considered in evaluating assignment results as described in paragraph 3 reinforce the conclusion presented in paragraph 10 of Memorandum No. 20 that trip data collected in the origin-destination survey and adjusted as described in Memorandum No. 20 are adequate to serve as the basis for travel forecasts and analyses in the Dover-Somersworth Area.

The general uniformity of comparison ratios - even where ratios were generally low, they were reasonably uniformly low - supports the conclusion that the mathematical representation of the arterial highway network for computer assignment purposes, as coded after the three traffic assignments described in paragraph 2, produces a realistic simulation of traffic flow throughout the Study Area.

In conclusion, the existing assignment network is considered to be adequately calibrated to serve its intended function in the transportation planning process.

DOVER-SOMERSWORTH TRANSPORTATION STUDY

Memorandum No. 25

July 11, 1966

FROM: Tippetts-Abbett-McCarthy-Stratton

TO: New Hampshire Department of Public Works and Highways

SUBJECT: Trip Distribution

1. General Forecasting Procedure

Trip distribution in the Dover-Somersworth Study Area will be forecasted by means of:

(a) A three-purpose gravity model for passenger vehicle travel which originated and/or terminated within the Study Area (internal-internal and internal-external trips), using the following purpose breakdown:

  (a) home based work trips
  (b) other home based trips
  (c) non-home based trips

(b) A one-purpose Fratar expansion of passenger vehicle external through travel (external-external trips)

(c) A one-purpose Fratar expansion of total truck travel (internal-internal, internal-external and external-external trips)

2. Gravity Model Theory

In the gravity model procedure, home based trips (trips having either the origin or destination at the home of the trip maker) are considered to be produced at the home end and attracted to the non-home end. Non-home based trips are considered to be produced at the origin and attracted to the destination.

The gravity model theory states that the number of trips from zone "i" to zone "j" (produced at "i" and attracted to "j") is directly proportional to the total number of trips produced at "i", directly proportional to the total number of trips attracted to "j", and inversely proportional to a function of the travel time between "i" and "j". The inverse relationship to travel time is usually expressed as a travel time factor "F" which decreases as travel time increases.

3. Travel Times

Total travel time, required for calibration of the gravity model, is composed of the origin terminal time, the interzonal or intrazonal driving time, and the destination terminal time.

Internal terminal times range from six minutes in densely built-up downtown areas to one minute in suburban or rural residential areas, and allow for parking and unparking times, walking between the parking place and the ultimate origin or destination, and other delays inherent in the use of the private automobile. Internal terminal times, determined subjectively from a knowledge of the area and the mix of activities in each of the traffic zones, are shown in Attachment A. Terminal times are also given in Attachment A for each of the external stations. These times account for the same types of delays described above, plus an estimate of the average driving time required for the external portion of internal-external passenger vehicle trips passing through the station.

Interzonal driving times are obtained from minimum time path trees prepared for use in assignment of vehicular traffic to the existing arterial highway network.

Estimated intrazonal driving times are tabulated in Attachment A. These times represent the average driving time between the zone centroids and the zone boundary on each of the highway links entering or leaving the zone, and range from one minute to four minutes.

4. Fratar Growth Factor Expansion

The Fratar Method of successive approximation is used to distribute future trip ends in each zone to all zones in accordance with a measure of the relative trip attractiveness of each zone. The future movement between two zones is considered to be a function of present attractiveness, measured by the present interzonal or intrazonal movement, modified by the zones' future growth factors. As noted in paragraph 1, the Fratar Method will be used to distribute external-external passenger vehicle trips and all truck trips.

5. External Trip Ends

Forecasts of the number of truck trip ends, and the numbers of passenger vehicle trip ends for each of the three purposes shown in paragraph 1, within each traffic zone in the Study Area will be obtained through the application of trip production and attraction equations developed to "fit" the Study Area (this will be the subject of a separate Memorandum). Forecasts of trip ends at external stations (trips crossing the cordon line) must be made in a different manner since socio-economic data relating to the external trip ends are not available to serve as the basis for deriving trip generation equations.

In Memorandum No. 18a current and forecasted average annual weekday traffic at each of the roadside interview station locations are tabulated. In this paragraph a procedure will be presented for breaking the forecasted values into purpose and vehicle-type categories corresponding to the several trip distribution groupings listed in paragraph 1.

The following is a percentage breakdown of current average summer weekday trips at each of the roadside interview stations into passenger vehicle and truck, through and non-through trips:

	Percentage Breakdown - Average Summer Weekday Traffic				
	Passenger Vehicle		Truck		
Station (a)	Through	Non-Through	Through	Non-Through	Total
1	69	22	7	2	100
2	18	71	3	8	100
3	26	61	5	8	100
4	14	75	1	10	100
5	13	74	2	11	100
6	28	61	3	8	100
8	18	73	2	7	100
10	79	13	6	2	100
12	14	73	3	10	100
14	23	60	4	13	100
15	18	69	4	9	100
16	18	69	2	11	100
17	6	84	1	9	100
19	20	72	1	7	100
Total	30	59	3	8	100

(a) For locations of stations see Memorandum No. 7

Based on the conclusions reached in Memorandum No. 18a, the distribution annual weekday traffic would be the same, except at Stations 1 and 10 on the Spaulding Turnpike. Correcting for the 1,500 "extra" through trips on the Turnpike that occur in the summer, the percentage breakdown is as follows:

	Adjusted Percentage Breakdown*-Average Annual Weekday Traffic				
	Passenger Vehicle		Truck		
Station	Through	Non-Through	Through	Non-Through	Total
1	62	29	6	3	100
10	73	19	6	2	100
Total	27	62	3	8	100

*Same as for Average Summer Weekday Traffic except for Stations 1 and 10.

In forecasting future external trip ends the assumption will be made that this percentage breakdown will remain unchanged. Thus external station growth factors for the two Fratar expansions mentioned in paragraphs 1 (b) and 1 (c) are as shown in Memorandum No. 18a. For the gravity model mentioned in paragraph 1 (a), external trip productions and attractions in each of the tree purpose groupings are required. Total forecasted passenger vehicle non-through trip ends at each of the external stations, obtained by multiplying the forecasted 1985 AAWT by the appropriate values from the Percentage Breakdown tables given above, are as follows:

Station (a)	Total 1985 AAWT (b)	Non-Through Passenger Vehicles	
		Percent	Trips
1 (c)	9,910	29	2,880
2 (c)	8,960	71	6,360
3	5,290	61	3,220
4	2,410	75	1,810
5	16,880	74	12,500
6	10,000	61	6,100
8	3,080	73	2,250
10	5,710	19	1,090
12	1,660	73	1,210
14	4,670	60	2,800
15	4,610	69	3,190
16	8,570	69	5,910
17	1,450	84	1,220
19	3,610	72	2,600
Total	86,810	62	53,140

(a) For locations of stations see Memorandum No. 7
(b) From Memorandum No. 18a
(c) Figures shown assume a continuation of the current toll structure on the Spaulding Turnpike at Dover

It will be assumed that the percentage breakdown of these forecasted trip ends into productions and attractions by purpose will be the same as the current breakdown, adjusted as required to insure that total productions and attractions are in balance for the entire Study Area.

6. Additional Documentation

Additional documentation relating to calibration of the gravity model and other aspects of trip distribution in the Study Area will be presented in addenda to this Memorandum.

ATTACHMENT A

Traffic Zone	Terminal Time (min)	Intrazonal Time (min)
1	1	2
2	1	4
3	1	1
4	1	1
5	1	2
6	2	1
7	1	3
8	1	2
9	1	1
10	1	2
11	1	1
12	1	2
13	3	1
14	1	1
15	2	1
16	5	1
17	4	1
18	3	1
19	4	1
20	2	2
21	3	1
22	1	1
23	2	1
24	2	2
25	1	2
26	1	1
27	1	1
28	1	1
29	1	2
30	3	2
31	2	2
32	1	4
33	1	1
34	1	2
35	1	1
36	1	1
37	1	3
38	2	2
39	1	2
40	1	3
41	1	3
42	1	4
43	1	2
44	3	1
45	6	1
46	2	1
47	1	1
48	1	2
49	2	1
50	2	1

External Station		
1	11	0
2	9	0
3	7	0
4	4	0
5	5	0
6	10	0
8	10	0
10	8	0
12	5	0
14	4	0
15	6	0
16	8	0
17	5	0
19	7	0

DOVER-SOMERSWORTH TRANSPORTATION STUDY

Memorandum No. 25a July 21, 1966

FROM: Tippetts-Abbett-McCarthy-Stratton

TO: New Hampshire Department of Public Works and Highways

SUBJECT: Gravity Model Calibration

The gravity model employed in the forecasting of future trip ends is calibrated and evaluated herein. Trip distribution and general forecasting theory has been presented in Memorandum No. 25.

1. Number of Trips and Average Trip Length

For each purpose category the total number of trips, the average trip length, and the total vehicle hours of travel in 1965 are as follows:

Trip Purpose	Total No. of Trips	% of Total Trips	Aver. Trip Length (min)	Total Vehicle Hours of Travel	% of Total Vehicle Hours
Home-based work auto trips	16,602	22.5	13.914	3,850	25.5
Other home-based auto trips	33,171	44.8	11.928	6,594	45.3
Non-home-based auto trips	24,196	32.7	10.173	4,102	28.2
	73,969	100.0	11.799	14,546	100.0

2. Model Calibration

In the development of gravity models for each of the trip purposes noted, the principal factors considered were:

1. The agreement between average trip length and vehicle hours of travel as determined from the gravity model with similar parameters obtained from the origin-destination survey data;
2. The shape of the trip length distribution curves obtained from the gravity model as compared to similar curves from origin-destination survey data.

The agreement between the gravity model simulation and the origin-destination data with respect to average trip length and vehicle hours of travel is presented below:

	Percent Difference in Average Trip Length: Gravity Model & Actual	Percent Difference in Vehicles Hours of Travel: Gravity Model & Actual
Home-based work auto trips	+ 0.55%	+ 0.55%
Other home-based auto trips	- 0.10%	- 0.09%
Non-home-based auto trips	- 0.52%	- 0.56%

The trip length distribution curves obtained from the origin-destination data and from the selected gravity model are shown on Figures 1 through 3 inclusive.

3. Evaluation of the Models

With respect to other home-based trips, which comprise 44.8% of the total number of internal-internal and internal-external vehicle trips and 45.3% of the total vehicle hours, there is good agreement between survey data and the gravity model for average trip lengths (-0.10%) and for total vehicle hours of travel (-0.09%). Home-based work trips and non-home-based trips, the remaining categories considered, also show good agreement between survey data and the gravity model. The percent difference in average trip length for home-based work and non-home-based trips are +0.55% and -0.52% respectively; for vehicle hours of travel, +0.55% and -0.56% respectively.

4. Trip Length Factors

Trip length factors for each of the three purpose categories are shown on Figure 4.

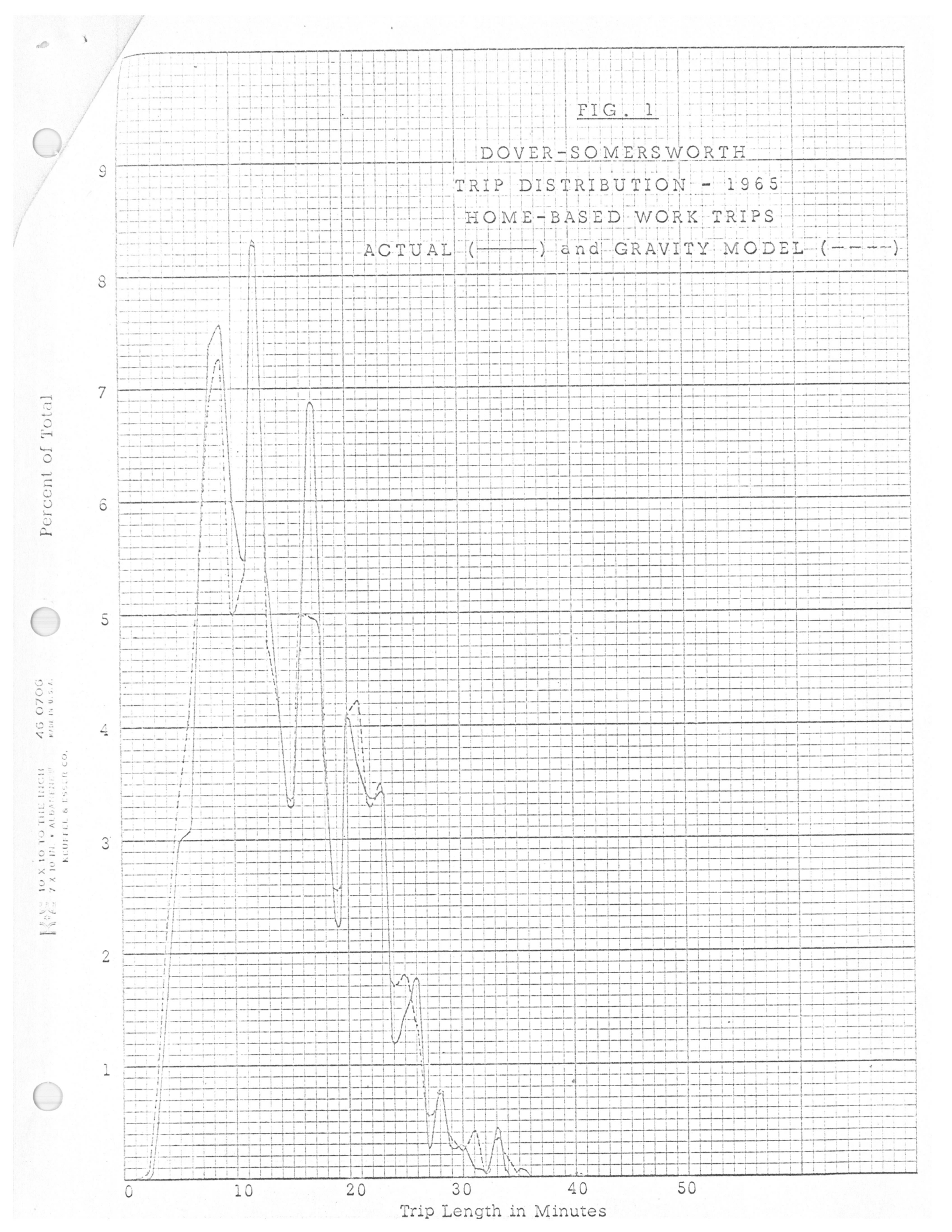


FIG. 1
DOVER-SOMERSWORTH
TRIP DISTRIBUTION - 1965
HOME-BASED WORK TRIPS
ACTUAL (———) and GRAVITY MODEL (– – – –)
Percent of Total
9
8
7
6
5
4
3
2
1
0
10
20
30
40
50
Trip Length in Minutes

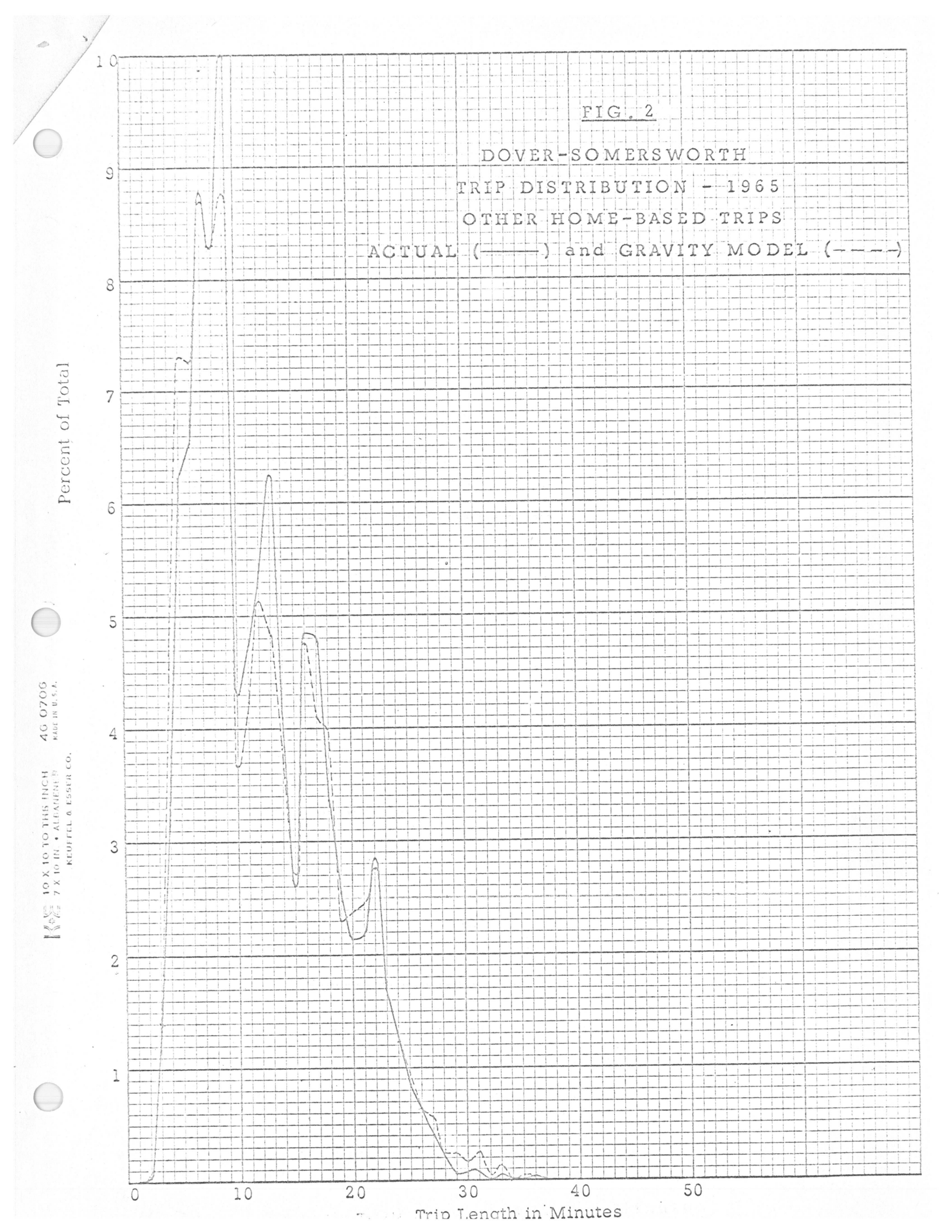


FIG. 2
DOVER-SOMERSWORTH
TRIP DISTRIBUTION - 1965
OTHER HOME-BASED TRIPS
ACTUAL (———) and GRAVITY MODEL (- - - -)
Percent of Total
10
9
8
7
6
5
4
3
2
1
0
10
20
30
40
50
Trip Length in Minutes

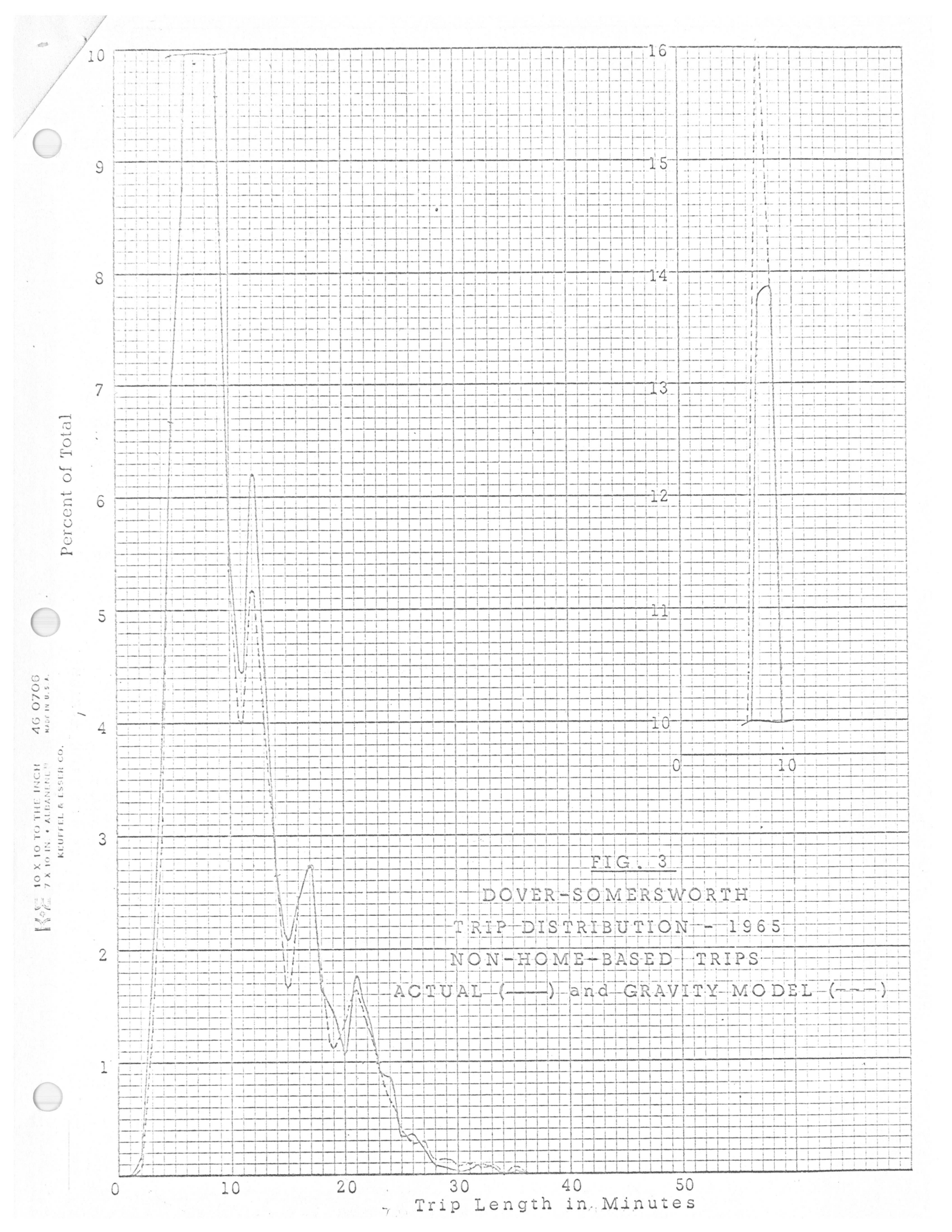


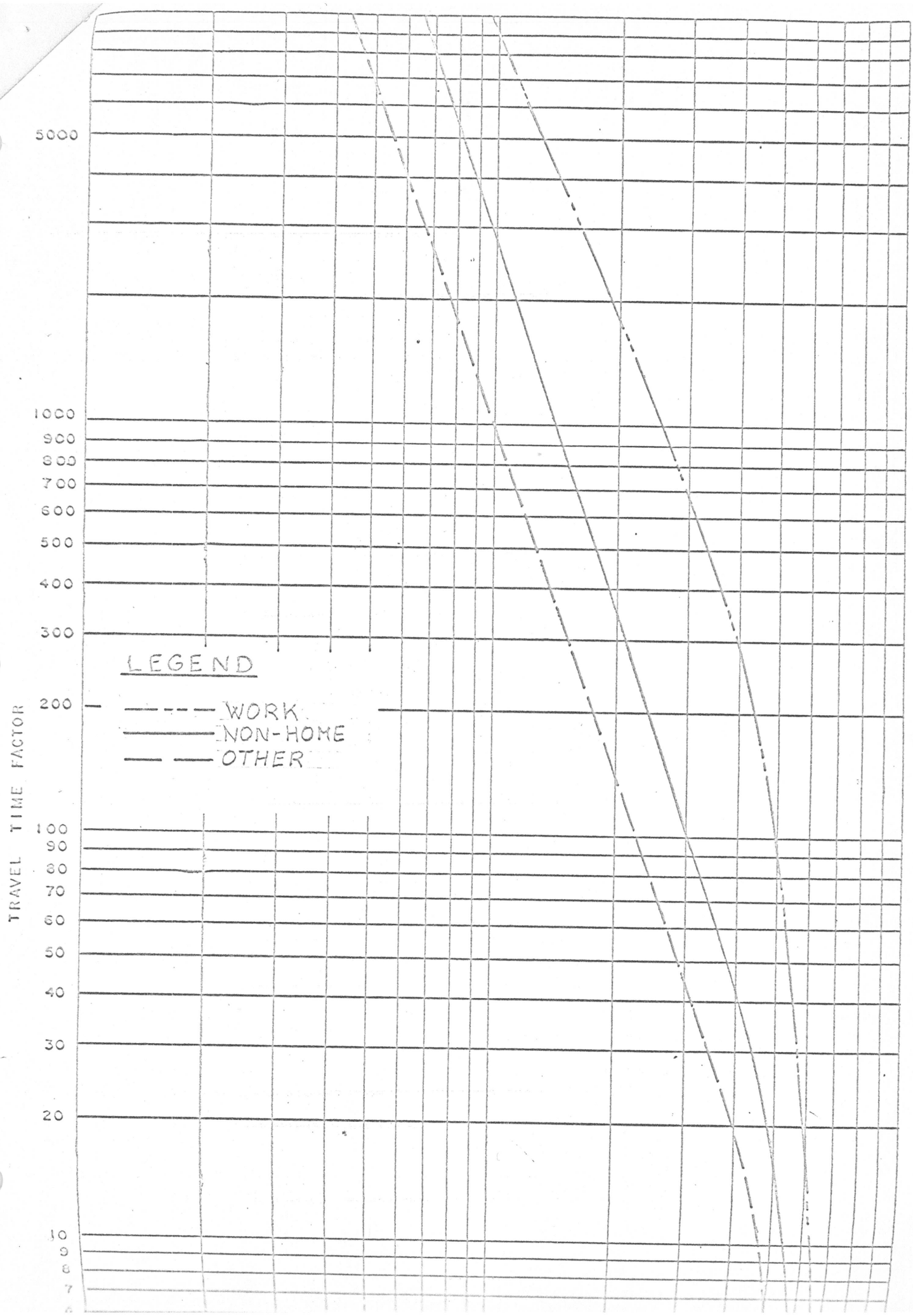
FIG. 3

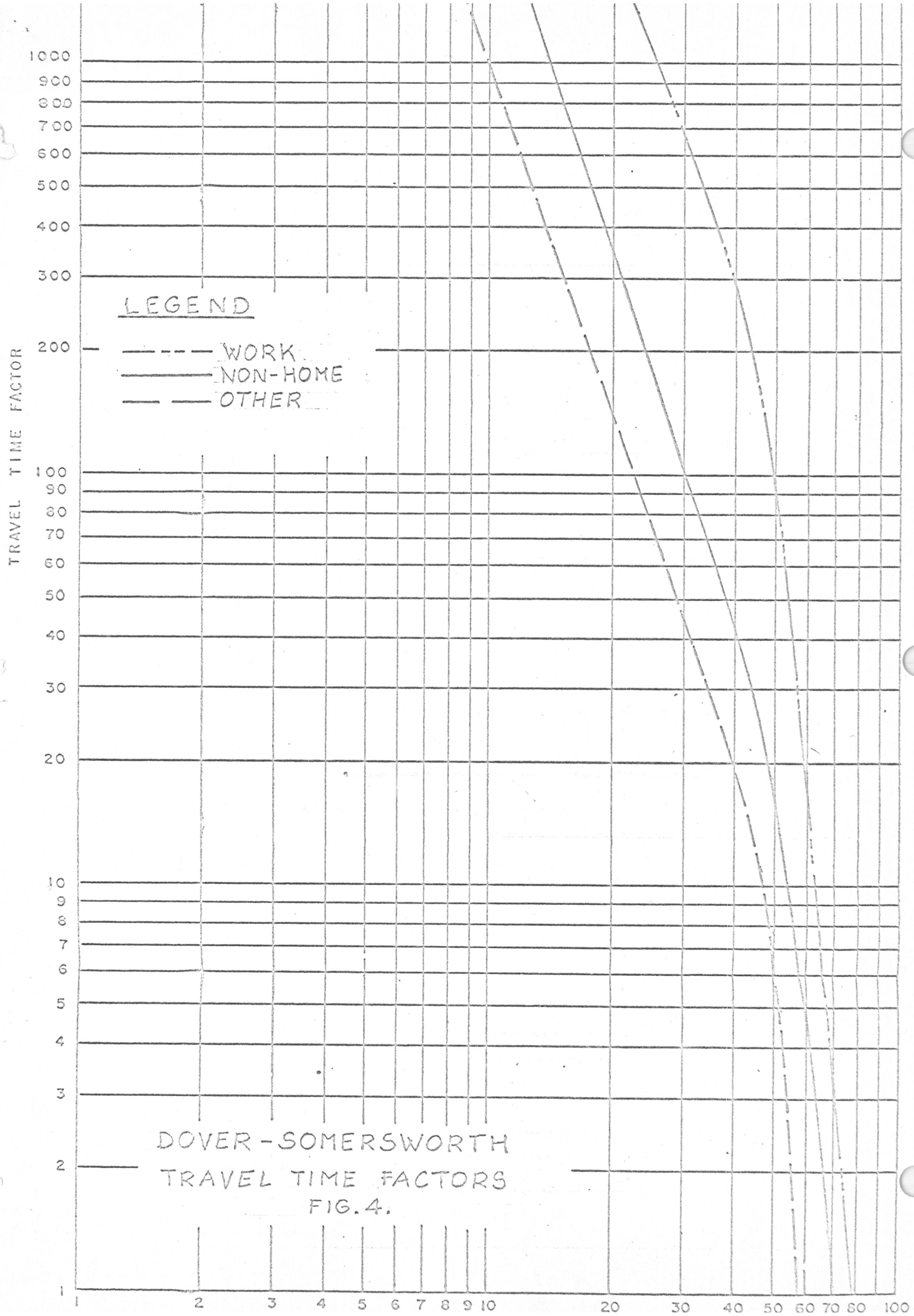
DOVER-SOMERSWORTH

TRIP DISTRIBUTION - 1965

NON-HOME-BASED TRIPS

ACTUAL (——) and GRAVITY MODEL (– – –)


5000
1000
900
800
700
600
500
400
300
200
100
90
80
70
60
50
40
30
20
10
9
8
7
TRAVEL TIME FACTOR
LEGEND
WORK
NON-HOME
OTHER



DOVER-SOMERSWORTH
TRAVEL TIME FACTORS
FIG. 4.

DOVER-SOMERSWORTH TRANSPORTATION STUDY

July 28, 1966

Memorandum No. 26

FROM: Tippetts-Abbett-McCarthy-Stratton

TO: New Hampshire Department of Public Works and Highways

SUBJECT: Tabulations of Origin-Destination Survey Data

Attached to this memorandum are the following eight tabulations prepared from origin-destination survey data:

Table No.	Title
A-1	Resident Auto Driver Trips by Destination Purpose and Type of Parking
A-2	Resident Truck Driver Trips by Destination Purpose and Type of Parking
B-1	Resident Auto Driver Trips by Origin and Destination Purpose
B-2	Resident Auto Passenger Trips by Origin and Destination Purpose
B-3	Resident Truck Driver Trips by Origin and Destination Purpose
B-4	Resident Truck Passenger Trips by Origin and Destination Purpose
C-1	Average Passenger Car Occupancy - Resident Auto Driver Trips
C-2	Average Passenger Car Occupancy - Total External Trips

All of the above tabulations except Table C-2 were prepared using original home interview survey data (No. 2 cards), including internal-external trips and before the adjustments described in Memorandum No. 20 were made. They therefore represent total resident travel. Table C-2 was prepared from No. 3 cards.

Trip purposes are identified in the attached tabulations by the following codes:

0 Home
1 Work
2 Personal Business
3 Recreation
4 School
5 Social
6 Shopping

Type of Parking is identified in the attached tabulations by the following codes:

0 Not Parked
1 Street Free
2 Street Meter
3 Lot Free
4 Lot Meter
7 Service or Repair
8 Residential Property

The home interview forms also made allowance for use of parking garages, of which there are none in the Study Area. For the very small number of No. 2 cards that indicate that parking garages were used, it was assumed that private garages were actually used and therefore such trips have been included under "Residential Property" (Code 8).

In the "A" and "B" tabulations actual column and row totals may vary somewhat from those shown due to rounding.

TABLE A-1

Resident Auto Driver Trips by

Destination Purpose and Type of Parking

Destination Purpose	Type of Parking							
	0	1	2	3	4	7	8	Total
0	134	2,303	11	763	16	6	12,738	15,970
1	950	1,734	342	5,485	162	5	626	9,303
2	3,351	2,434	743	2,242	117	178	1,810	10,875
3	223	313	56	842	123	-	162	1,719
4	28	22	5	67	39	-	-	162
5	78	1,172	73	370	11	-	1,194	2,898
6	62	889	778	2,991	50	39	95	4,904
Total	4,826	8,868	2,008	12,759	518	228	16,625	45,831

TABLE A-2

Resident Truck Drivers Trips by
Destination Purpose and Type of Parking

Destination Purpose	Type of Parking							
	0	1	2	3	4	7	8	Total
0	6	6	-	28	-	-	553	643
1	1,713	1,550	-	1,190	6	-	440	4,899
2	90	89	28	118	6	11	168	509
3	6	-	-	17	-	-	-	22
4	-	-	-	6	-	-	-	6
5	-	39	-	-	-	-	11	50
6	-	6	-	45	-	-	-	50
Total	1,814	1,741	28	1,403	11	11	1,105	6,180

TABLE B-1

Resident Auto Driver Trips by

Origin and Destination Purpose

Destination Purpose	Origin Purpose 0	1	2	3	4	5	6	Total
0	17	4,695	4,819	1,284	134	1,975	3,046	15,970
1	5,152	1,961	2,061	22	11	50	45	9,303
2	5,075	2,179	2,438	251	28	330	576	10,875
3	1,317	22	245	39	-	67	28	1,719
4	134	17	11	-	-	-	-	162
5	1,809	78	413	73	-	246	280	2,898
6	2,790	229	800	56	5	179	845	4,904
Total	16,293	9,182	10,787	1,724	178	2,847	4,820	45,831

TABLE B-2

Resident Auto Passenger Trips by

Origin and Destination Purpose

Destination Purpose	Origin Purpose							
	0	1	2	3	4	5	6	Total
0	-	2,816	2,653	2,350	56	2,064	2,497	12,436
1	3,023	420	604	11	6	22	11	4,097
2	2,779	683	934	168	11	151	453	5,180
3	2,274	17	218	123	6	72	78	2,787
4	95	6	-	-	-	-	6	106
5	1,718	56	228	128	-	206	185	2,522
6	2,348	139	509	106	-	162	653	3,916
Total	12,237	4,135	5,146	2,887	78	2,677	3,883	31,043

TABLE B-3

Resident Truck Driver Trips by

Origin and Destination Purpose

Destination Purpose	Origin Purpose							
	0	1	2	3	4	5	6	Total
0	-	408	145	17	-	28	45	643
1	392	4,233	269	-	-	-	6	4,899
2	167	263	62	6	-	11	-	509
3	22	-	-	-	-	-	-	22
4	-	6	-	-	-	-	-	6
5	22	6	-	6	-	17	-	50
6	39	11	-	-	-	-	-	50
Total	643	4,927	475	28	-	56	50	6,180

TABLE B-4

Resident Truck Passenger Trips by

Origin and Destination Purpose

Destination Purpose	Origin Purpose							
	0	1	2	3	4	5	6	Total
0	-	67	27	45	-	6	11	156
1	62	470	22	-	-	-	-	554
2	33	22	17	-	-	-	-	72
3	50	-	-	-	-	-	-	50
4	-	-	-	-	-	-	-	-
5	11	-	-	-	-	-	-	11
6	11	-	-	-	-	-	-	11
Total	167	560	67	45	-	6	11	856

TABLE C-1

Average Passenger Car Occupancy

Resident Auto Driver Trips

Destination Purpose	Origin Purpose							
	0	1	2	3	4	5	6	Total
0	-	1.6	1.6	2.8	1.4	2.0	1.8	1.8
1	1.6	1.2	1.3	1.5	1.5	1.3	1.3	1.4
2	1.5	1.3	1.4	1.7	1.4	1.5	1.8	1.5
3	2.7	1.8	1.9	4.1	-	2.1	4.0	2.6
4	1.7	1.3	1.0	-	-	-	-	1.7
5	2.0	1.7	1.6	2.8	-	1.8	1.7	1.9
6	1.1	1.6	1.6	2.9	1.0	1.9	1.8	1.8
Total	1.8	1.5	1.5	2.7	1.4	1.9	1.8	1.7

TABLE C-2

Average Passenger Car Occupancy

Total External Trips

Destination Purpose	0	1	2	3	4	5	6	Total
0	-	1.5	2.0	2.9	1.4	2.3	2.4	2.0
1	1.4	1.2	2.4	1.6	1.1	1.3	1.6	1.5
2	2.0	1.9	2.0	3.0	1.6	2.3	2.2	2.0
3	2.7	1.7	2.6	3.0	1.4	3.0	2.5	2.7
4	1.4	1.3	1.8	4.0	1.0	1.4	1.0	1.5
5	2.3	1.5	2.1	3.1	1.7	2.8	2.6	2.3
6	2.5	1.5	2.2	2.5	1.5	2.9	2.6	2.5
Total	2.0	1.5	2.1	2.0	1.4	2.4	2.4	2.0

DOVER-SOMERSWORTH TRANSPORTATION STUDY

Memorandum No. 27

July 28, 1966

FROM: Tippetts-Abbett-McCarthy-Stratton

TO: New Hampshire Department of Public Works and Highways

SUBJECT: Peak Hour Traffic Factors

Available traffic count data from the following three sources were used to analyze traffic peaking characteristics in the Dover-Somersworth Study Area:

- manual weekday counts made at roadside interview stations during the 1965 summer origin-destination survey,
- manual weekday counts made at screenline counting stations during the 1965 summer origin-destination survey, and
- data from permanent traffic recorders in the Study Area operated by the NHDPW&H for the month of July 1965 (weekdays only).

Two-directional traffic passing each of these points during the peak hour (usually 4 to 5 PM) as a per cent of total 24-hour traffic is tabulated below:

Roadside Interview Stations

Station*	Peak Hour %	Station*	Peak Hour %
1	8.7	10	7.9
2	8.9	12	11.1
3	10.4	14	9.7
4	9.8	15	11.5
5	9.9	16	8.9
6	9.3	17	7.9
8	10.7	19	12.6
		Weighted Average	9.3

* For locations of stations see Memorandum No. 7.

Screenline Stations

Station**	Peak Hours %	Stations **	Peak Hours %
30	12.0	33	10.6
31	9.4	34	11.8
32	7.5	35	10.7
		Weighted Average	8.9

** For locations of stations see Memorandum No. 20.

Permanent Recorders

Station	Location	Peak Hour %
12501	Route 16, Dover Point	8.5
41501	Route 16, Somersworth south of Route 16A	8.2

Peak hour percentages vary from a low of 7.5% at Screenline Station 32 (Central Avenue) to a high of 12.6% at Roadside Interview Station 19 (Gulf Road to Eliot, Maine), with an overall average of about 9 per cent.

These figures represent the maximum of the 24 ratios that would be obtained by dividing the traffic passing in each of the 24 hours of the day by total daily traffic. They do not represent the actual peak 60-minute period of the day, and therefore tend to understate the actual peaking of traffic in the Study Area.

Taking this into account, and in consideration of the data presented above, it is concluded that an areawide peak hour factor of 10 per cent would be appropriate to use in the Dover-Somersworth Transportation Study. This is consistent with urban areas in other parts of the country.

DOVER-SOMERSWORTH TRANSPORTATION STUDY

Memorandum No. 28

August 2, 1966

FROM: Tippetts-Abbett-McCarthy-Stratton

TO: New Hampshire Department of Public Works and Highways

SUBJECT: Recommended Generation and Attraction Equations for the Dover-Somersworth Study Area

The generation and attraction equations developed for use in forecasting 1985 internal vehicle trip ends within the Study Area are presented herein. These equations were developed by relating trip ends per zone in 1965 to current land use and economic, demographic and sociological data.

1. Trip Data and Dependent Variables

The origin-destination survey conducted in the Study Area provides comprehensive data on the total number of trips generated and attracted in each zone. In the development of equations, these trip ends were grouped by the following purposes and used as the dependent variables.

Trip Data Groupings

Purpose Grouping	Symbol	
	Generated Trip Ends	Attracted Trip Ends
Home-based work passenger vehicle trips	T (1)	T (11)
Other home-based passenger vehicle trips	T (2)	T (12)
Non-home-based passenger vehicle trips	T (3)	T (13)
Truck trips	T (4)	T (14)

2. Planning Data and Independent Variables

The data which were considered to affect trip production and attraction are:

Description	Symbol
Net residential area in acres	A
Commercial employment other than industrial or retail	C
Number of dwelling units	D
Median family income, in dollars	I
Total employment	L
Industrial employment	M
Public employment	P

Description	Symbol
Retail trade employment	R
Number of residents	S
Truck ownership (by zone of garaging)	T
Passenger vehicle ownership (by zone of residence)	V

3. Correlation Procedure

For the development of equations relating the dependent variables to the independent variables, a stepwise multiple regression computer program developed by the Esso Research and Engineering Company and modified by the School of Medicine of the University of California was used. This program performs a stepwise multiple linear regression analysis upon input data consisting of a set of observations of a number of independent variables and one dependent variable. The stepwise feature of the program permits an independent regression equation to be developed in which one variable is added at a time; the variable added is that one which yields the greatest improvement in closeness of fit.

4. Testing Procedure

In the equation development procedure all of the parameters which appeared to influence the generation and attraction of vehicle trips and truck trips were tested to determine the parameters which actually do affect the volume of travel within the Study Area. Since the dependent variable for vehicle trip ends and truck trip ends are expressed in terms of trip ends per zone, the independent variables must be modified for these analyses to insure consistency. The form of equations to be tested are listed below.

VEHICLE TRIP AND TRUCK TRIP GENERATION EQUATIONS

$$T(1) = V + D + S + DI/1000 + VD + VS + DS$$
$$T(2) = V + D + S + DI/1000 + VD + VS + DS$$
$$T(3) = V + M + R + C + P + D + S + DI/1000$$
$$T(4) = T + M + R + D + S + DI/1000 + C + P + V$$

VEHICLE TRIP AND TRUCK TRIP ATTRACTION EQUATIONS

$$T(11) = M + R + C + P + (M + R + C + P)$$
$$T(12) = R + D + S + DI/1000 + C + P + V$$
$$T(13) = V \pm M + R + C + P + D + S + DI/1000$$
$$T(14) = T + M + R + D + S + DI/1000 + C + P + V$$

5. Recommended Generation and Attraction Equations

The factors considered in the selection of generation and attraction equations from the regression analyses were (1) the rational basis for relationships between the number of trip ends and the planning data, (2) the standard errors of estimate

and correlation coefficients, (3) the stability of the equations, (4) the probable order of accuracy of forecasted values for each parameter, and (5) the agreement between actual and computed values of trip ends per zone. The recommended equations for the Dover-Somersworth Study Area are presented below.

a. Home-Based Work Passenger Vehicle Trips

On an average summer weekday in 1965, the internal zones within the Study Area generated 10,070 and attracted 12,752 home-based work passenger vehicle trips. The mean values and standard deviations about the mean per internal zone are:

	Generation	Attraction
Mean number of vehicle trip ends per zone	201.4	255.0
Standard deviation about the mean	249.2	454.9
Standard deviation as a percent of the mean	124%	178%

The generation of home-based work vehicle trips was closely related to passenger vehicle ownership (V) and the number of residents (S). The attraction of these trips was closely related to total employment in each zone (L), but public employment (P) also entered the regression equation.

The recommended equations for home-based work vehicle trips are:

		Regression Coefficient and Variable	Simple Correlation Coefficient	Regression Coef. ÷ Standard Error of Coefficient
Generation: T (1)	=	0.7799 V	0.983	4.6
		+ 0.0884 S	0.976	1.6
Attraction: T (11)	=	0.8727 L	0.980	35.4
		+ 0.9734 P	0.241	2.5

The generation equation has a multiple correlation coefficient of 0.984 and a standard error of estimate of 46.1 trip ends per zone (23% of the mean). The attraction equation has a multiple correlation coefficient of 0.982 and a standard error of estimate of 86.8 trip ends per zone (34% of the mean).

Passenger vehicle ownership was found to be closely related to number of residents (simple correlation coefficient = 0.987), but public employment is only slightly related to total employment (simple correlation coefficient = 0.179). Zero constants were used in developing these equations to prevent the generation of home-based work trips in non-residential zones and the attraction of such trips to zones without employment. To insure that the resulting equations did not result in area trip end totals which differed considerably from actual measured values, current trip ends in each zone were computed using these equations. The computed total for generated home based work trips was 0.15% less than the measured total, while the computed total for attracted trips was 5.41% less than the measured total.

b. Other Home-Based Passenger Vehicle Trips

The internal zones within the Study Area generated 23,018 and attracted 26,302 other home-based vehicle trips on an average 1965 summer weekday. These trips were for such purposes as shopping, school, recreation, religious and social activities, and medical services. Mean values and standard deviation about the mean are:

	Generation	Attraction
Mean number of vehicle trip ends per zone	460.4	526.1
Standard deviation about the mean	568.8	756.8
Standard deviation as a percent of the mean	123%	144%

The generation of other home-based vehicle trips was closely related to passenger vehicle ownership (V) and the number of residents (S). The attraction of these trips varies with retail trade employment (R), the number of dwelling units (D), and family income (I).

The recommended equations for other home-based vehicle trips are therefore:

	Regression Coefficient and Variable	Simple Correlation Coefficient	Regression Coef. ÷ Standard Error of Coefficient
Generation: T (2) =	2.1992 V	0.991	7.5
	+ 0.0720 S	0.980	0.8
Attraction T (12) =	9.9046 R	0.904	13.4
	+ 0.1171 DI/1000	0.580	3.8

The generation equation has a multiple correlation coefficient of 0.991 and a standard error of estimate of 79.2 trip ends per zone (17% of mean). The attraction equation has a multiple correlation coefficient of 0.928 and a standard error of estimate of 288.5 trip ends per zone (54.8% of mean).

As discussed above, there is a strong correlation between passenger vehicle ownership and number of residents (simple correlation coefficient = 0.987). The retail trade employment appears to be related to the total zonal income (simple correlation coefficient = 0.436), but there is no rational basis for this relationship. Zero constants were used in developing these equations to prevent the generation of other home-based trips in non-residential zones. Current generated trip ends computed using these equations were 0.33% greater than measured trip ends, and computed attracted trip ends were 2.34% less than measured trip ends.

c. Non-Home-Based Passenger Vehicle Trips

The total number of non-home-based vehicle trips originating from and destined for the internal zones of the Study Area on an average summer weekday in 1965 are 21,440 and 21,488 respectively. Mean values and standard deviation

about the mean per internal zone are:

	Origin or Destination
Mean number of vehicle trip ends per zone	429.3
Standard deviation about the mean	540.7
Standard deviation as a percent of the mean	126%

Non-home-based trips include such travel as from work to shopping, from social activities to recreational activities, and from personal business to medical services. Because of this diversity, a clear-cut relationship between the social and economic parameters and non-home-based travel is lacking.

The recommended equation for non-home-based vehicle trips below is based upon retail employment (R), number of dwelling units (D), average family income (I), and total employment (L).

		Regression Coefficient and Variable	Simple Correlation Coefficient	Regression Coef. ÷ Standard Error of Coefficient
Origin or Destination:	T (3) =	5.1859 R	0.876	13.0
	T (13) =	+ 0.1391 DI/1000	0.698	9.3
		+ 0.2628 L	0.623	5.8

The equation has a multiple correlation coefficient of 0.968 and a standard error of estimate of 140.2 trip ends per zone (33% of mean).

Simple correlation coefficient among the independent variables included in the equation above are as follows:

R vs. L	0.486
R vs. DI	0.436
DI vs. L	0.238

Computation of current trip ends using this equation yielded 1.59% more trips than where actually measured.

d. Truck Trips

For an average 1965 summer weekday 12,176 truck trips originated within the internal zones of the Study Area and 12,028 truck trips were destined for those zones. Truck travel includes trips between various industrial facilities, warehouses, wholesale and retail establishments, and residential areas throughout the Study Area. Mean values and standard deviation about the mean are as follows:

	Origin or Destination
Mean number of vehicle trip ends per zone	242.0
Standard deviation about the mean	290.4
Standard deviation as a percent of the mean	120%

The number of truck trips within the internal zones of the Study Area was related to truck ownership (T), retail trade employment (R), and the number of dwelling units (D).

The recommended equation for truck trips is:

		Regression Coefficient and Variable	Simple Correlation Coefficient	Regression Coef. ÷ Standard Error of Coefficient
Origin or Destination: T (4)	=	0.6730 D	0.873	5.1
T (14)	=	+ 1.1648 R	0.635	3.6
		+ 2.3383 T	0.824	2.2

The equation has a multiple correlation coefficient of 0.914 and a standard error of estimate of 122.2 trip ends per zone (51% of mean).

Simple correlation coefficient among the independent variables included in the equation above are as follows:

T vs. R	0.498
T vs. D	0.837
R vs. D	0.490

The high correlation coefficient between truck ownership (T) and number of dwelling units (D) indicates that many internally owned trucks are garaged at homes of residents and used at least part of the time as passenger vehicles. The number of trip ends used in computing these equations is 3.86% less than the measured number of trip ends.

6. Use of Equations

The equations presented in this memorandum were developed using data obtained from the Dover-Somersworth Transportation Study Area Origin-Destination Survey, conducted during the summer of 1965. As summer travel patterns vary appreciably from average annual figures, primarily in the area of school and vacation trips, a conversion of the summer weekday traffic volumes utilized herein to average annual weekday traffic volumes is required. This conversion is described in Memorandum No. 18a.

DOVER-SOMERSWORTH TRANSPORTATION STUDY

Memorandum No. 29 October 31, 1966

FROM: Tippetts-Abbett-McCarthy-Stratton

TO: New Hampshire Department of Public Works and Highways

SUBJECT: Peak Hour Directional Distribution Factors

Available traffic count data from the following two sources were used to analyze traffic directional distribution characteristics in the Dover-Somersworth Study Area:

- manual weekday counts made at roadside interview stations during the 1965 summer origin-destination survey, and
- manual weekday counts made at screenline counting stations during the 1965 summer origin-destination survey.

Traffic passing each of these points in the direction of predominent flow during the peak hour (usually 4 to 5 PM) as a percent of total two-directional traffic is tabulated below:

Roadside Interview Stations

Station*	Directional Distribution (%)	Station*	Directional Distribution (%)
1	52	10	52
2	66	12	66
3	66	14	65
4	56	15	57
5	63	16	64
6	75	17	60
8	68	19	74
		Weighted Average	63

*For locations of stations see Memorandum No. 7.

Screenline Stations

Station**	Directional Distribution (%)	Station**	Directional Distribution (%)
30	67	33	55
31	60	34	60
32	57	35	73
		Weighted Average	63

**For locations of stations see Memorandum No. 20.

Peak hour directional distribution percentages vary from a low of 52% at Roadside Interview Stations 1 and 10 (Spaulding Turnpike) to a high of 75% at Roadside Interview Station 6 (Route 16 to Rochester), with an overall average of 63 percent.

The uniformly low figures for the Spaulding Turnpike at Dover Point and at Rochester (52%) indicate that during the afternoon peak hour, when the two-directional hourly volume is a maximum, the directional flows are very nearly balanced. In contrast to this, a pronounced unbalance (73% in the predominant direction) occurs on the Turnpike between Somersworth and Dover (Station 35). In downtown Dover (Stations 31, 32 and 33) the weighted average peak hour directional distribution factor is 57%, whereas the comparable figure for the only station near downtown Somersworth (Station 5) is 63%. The weighted average factor for all other locations is 66%.

In view of the above, it is concluded that the following peak hour directional distribution factors would be appropriate to use for most major arterials in the Dover-Somersworth Transportation Study:

- Spaulding Turnpike
  - at Dover Point and Rochester — 52%
  - between Central Avenue Interchange and Traffic Circle — 66 to 73%
- Downtown Dover and Somersworth — 60%
- Elsewhere in Study Area — 60 to 66%