Multiple Screenline Study to Determine Statewide Traffic Patterns

MARK K. GREEN, Director of Traffic Analysis, Pennsylvania Department of Highways Planning Division

●FOR MANY YEARS past the Planning Division of the Pennsylvania Department of Highways has been conducting O-D studies throughout the state. The studies have varied in type and scope according to the population density of the area under study.

The extent of the studies ranged from the "Comprehensive Internal-External" type of survey used in large metropolitan areas, the "Parking-External" type of survey used for the smaller urban areas, and roadside interview surveys operated at a number of locations in rural areas of the state.

Although the surveys conducted varied in type, scope and costs, the motivation was the same—to study the highway needs of a relatively small area.

Over a period of years of analyzing the O-D information obtained both at spot locations in rural areas and that obtained from the external phase of the metropolitan area surveys throughout the state, a somewhat sketchy picture of the statewide traffic pattern was developed.

However, when it became apparent that an Interstate System of Highways was due to become something more than a mere dream, and that Congress was ready to implement a substantially increased over-all highway program, it became evident to the Planning Division of the Pennsylvania Department of Highways that the Division needed to know a lot more about its statewide traffic pattern than was known.

A comprehensive picture of the traffic pattern throughout the state would not only provide the information needed to determine the justification of proposed major highway locations but also enable the state to minimize the efforts of pressure groups proposing locations that cannot be justified by the facts.

The problem arose as to how to obtain this needed information quickly, economically, and in a form that would lend itself to rapid and easy processing.

After careful consideration of various approaches to this problem it was decided that a series of screenlines be established to obtain trip O-D information of vehicles using the highways at the four borders of the state and those using the state highway system at four locations within the state.

In addition, Pennsylvania Turnpike users would be interviewed at the west gateway, the east gateway, and at each interchange.

The primary purpose of this report is to present an outline and brief discussion of the Pennsylvania experiences in conducting and developing this multiple screenline study and to outline what has been accomplished.

Consistent to this general objective, no attempt is made to present all the detail as to the field operations or the techniques used in processing the survey information.

THE SURVEY

The field operations of the survey were conducted during the period from June 25, to September 13, 1957. Three interview crews were used throughout the survey.

Each crew consisted of an average of 11 men and a supervisor. Personnel used for the interviewing were students on summer leave from college and preparatory schools except for the crew supervisor and the portable machine man.

Each of the three crew supervisors were men with several years experience in conducting field operations for the Planning Division.

The Screenlines

Eight screenlines were established at which traffic was interviewed on all highways carrying significant traffic volumes. In general, highways carrying less than 500 vehicles per day were not interviewed. Exceptions were made in a few cases when

considerable gap in the screenline would occur by not interviewing roadways under 500 vehicles.

The eight screenlines were established as follows:

1. An east-west screenline along the northern border of the state.
2. An east-west screenline extending from the west border to the east border approximately midway between the north border and the south border.
3. A north-south screenline extending from the north border to the south border on a line approximately midway between Lancaster and Reading.
4. A north-south screenline extending from the north border to the south border approximately midway between the east border and the west border.
5. A north-south screenline extending from the north border to the south border on a line approximately midway between Greensburg and Johnstown.
6. A north-south screenline along the western border of the state.
7. An east-west screenline along the southern border of the state.
8. A north-south screenline along the eastern border of the state.

The relative location of the eight screenlines is shown in Figure 1.

Screenlines one, six, seven and eight are in effect a cordon line bounding the state, while screenlines two, three, and four and five are internal screenlines.

Also shown in Figure 1 are 22 groupings of certain stations from the eight screenlines which may be used to form a cordon line around each of eight regional areas in the state.

Pennsylvania Turnpike Traffic

Turnpike traffic was interviewed at each interchange and at both the eastern and western gateway stations. All interviewing was conducted at toll booths, thus eliminating possible hazards from stopping high-speed traffic on the main roadway of the turnpike.

Trip O-D information was obtained only from drivers leaving the turnpike. Information as to the location where the driver entered the turnpike was obtained through the cooperation of the turnpike employees who handled the toll transaction.

Thus, with both the point of entry and point of exit recorded for each turnpike trip, mainline station data was constructed to complement other screenline data available at each of the three north-south internal screenlines.

Interview Stations

Two hundred stations were scheduled for operation. Three stations were not operated on schedule as the normal traffic pattern had been considerably disrupted by construction operations at or in the vicinity of the station. However, origin-destination at these locations was taken in the summer of 1959.

Traffic was interviewed in one direction at each station location. However, on major through highways, the direction of interviewing was reversed at the several screenlines in order to check the directional consistency or balance of flow as to trips crossing more than one screenline.

In selecting the location of the interview stations, one consideration was to avoid densely populated metropolitan areas where large volumes of commuter and other local traffic would be intercepted.

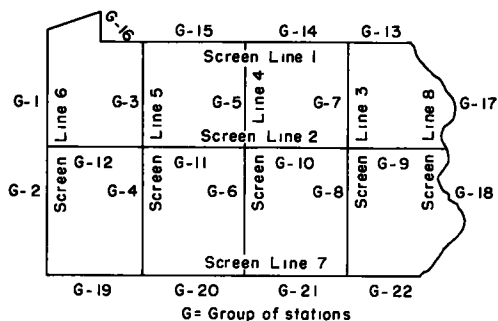Figure 1.

The Interview Form

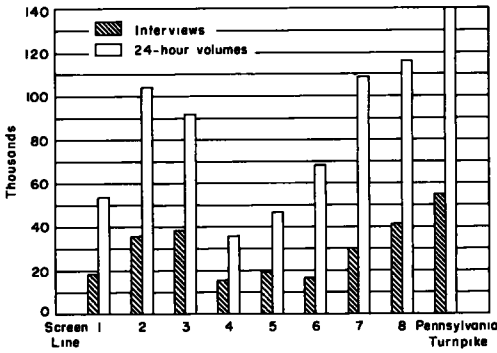The interview form adopted for use in

the field is shown in Figure 2. It will be noted that only information as to the origin and destination of his trip need be obtained from the vehicle operator. Use of the short form interview blank required minimum delay to the motorist and considerably reduced the number of field personnel required for the survey.

In view of the fact that more detailed and precise information would need be obtained to analyze specific route locations, it was decided the origin-destination information to be obtained from the vehicle operator for the purpose of the statewide survey should be that of his "over-all trip," rather than from the "point of his last stop" to that of his "next intended stop."

Figure 2. Reproduction of short form interview sheet.

A total of 279,892 usable interviews were obtained. The interviews represent a total of 764,250 vehicle trips. Figure 3 shows the number of interviews as compared to the ground count at each screenline.

Cost of Field Operations

The cost of the field operations amounted to $45,835.41.

The average cost per interview for the 279,892 interviews amounted to $0.1638.

This cost per interview considerably exceeds the average cost per external interview in metropolitan area surveys. However, a substantial portion of the cost per interview ($0.715) is represented by travel and personnel maintenance costs required due to a constantly shifting base of operations and the necessity of interviewing many routes carrying relatively small volumes of traffic.

A breakdown of the field costs is as follows:

Cost For Field Operations

Personal cars - (8 cents per mi)	$ 3,266.09
State cars & corps busses	2,486.35
Generators & trailers (for night operations)	608.00
Sub-Total	6,360.44
Expense accounts - (food & lodging)	$13,660.77
Wages - (salary & hourly)	25,814.20
Total cost for field operations	$45,835.41

Coding of Data

The basic coding of the data is on a five digit code.

Information for trip origins-destination within the United States is available at the county level.

However, for the preparation of a general report all data is reduced to an area level as follows:

Trips to or from adjacent states were assigned to areas determined by known routes of travel into or out of Pennsylvania.

Trips to or from states other than adjacent states were grouped on a regional basis.

The basic coding for areas other than Pennsylvania and adjacent states is shown at the three digit level.

Figure 3. Number of interviews obtained compared to the number of vehicles counted in each survey operation.

Tables

The tabular information was then transferred to triangulated tables which present the total (non-directional) number of trips between any two areas and the number of intra-trips within the area in which the station was operated.

The tables are arranged to present the information in three major groupings:

1. Out of state to out of state traffic.
2. "Out of State" to "Pennsylvania" traffic.
3. "Pennsylvania to Pennsylvania" traffic.

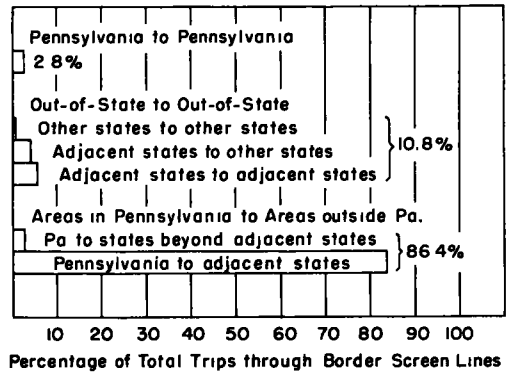Tables were prepared for each of the 198 interview stations. Composite tables were also prepared to show the origin-destination of all trips crossing each screenline.

Figures 4, 5, 6, and 7 are examples of the many possibilities for compiling significant trip data from the tables.

Figure 4.

Figure 5.

Figure 7 emphasizes the high percentage of trips crossing the border screenlines that had a Pennsylvania origin or destination in areas adjacent to the screenline which they crossed.

It will be noted that a high percentage of the "out of state" termini for trips crossing the border screenlines were in "adjacent state" areas contiguous to the Pennsylvania border.

Thus it is reasonable to assume that the characteristics of the traffic crossing border screenlines is similar to the characteristics of traffic crossing the internal screenlines.

Screenline Check of Trip Data

A screenline check was made by tabulating all cards with the trip origin-destination as a major control and the number of trips through each screenline as the intermediate control.

Screenline checks of the data on the whole were excellent where trip volumes were significant. Some examples are given in Table 1.
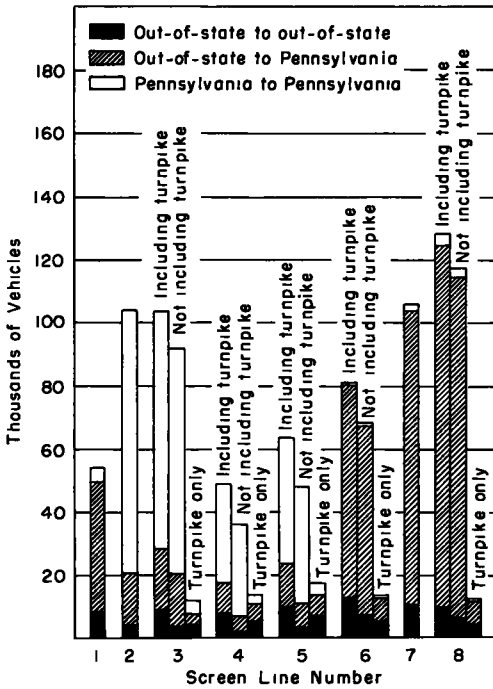
Figure 6. Showing the volume of "out of state to out of state," "out of state to Pennsylvania" and "Pennsylvania" to "Pennsylvania" traffic at each screenline.
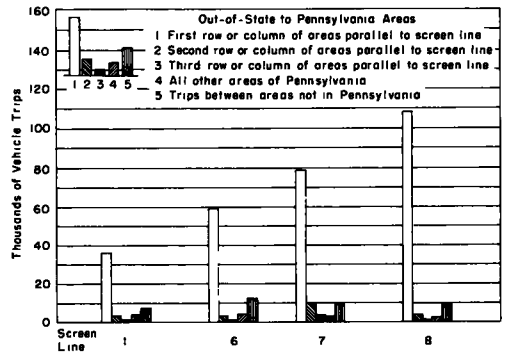

Figure 7. Number of trips through each border screenline to and from areas in Pennsylvania and between areas not in Pennsylvania.

Graphic Presentations

It was found that there are almost un-limited possibilities in preparing graphic presentations of the information, and each of these in turn could be presented for any or all of several vehicle classifications.

However, the number of graphic pre-sentations necessarily must be limited for reasons of time and cost to those which have a practical value.

A basic concept in the preparation of the desired line exhibits is to show the relationship between the trip origins and destinations to population density and the major road network.

TABLE 1

O-D Area	Trips by Screenline (no.)							
	6	5	4	3	8[1]	1	2	7
1 – 19	82	95	86	80	49	–	5	5
1 – 18	12	17	11	14	12	–	2	–
1 – 74	6	12	14	–	–	–	–	–
1 – 99	12	20	11	8	–	–	–	–
1 – 20	5	–	–	–	–	5	–	–
1 – 21	69	44	30	29	30	23	2	–
2 – 18	105	88	95	89	138	2	3	6
2 – 19	385	347	336	325	339	15	7	52
2 – 74	23	21	22	–	6	–	–	–
2 – 99	98	87	69	86	9	4	–	28
2 – 20	44	36	22	13	19	24	12	2
2 – 21	366	246	220	244	300	42	27	27
3 – 18	416	374	357	379	396	8	6	2
3 – 19	1,345	1,319	1,285	1,379	1,062	52	30	19
3 – 74	167	184	185	9	–	–	9	4
3 – 99	539	511	485	552	7	14	16	29
3 – 20	138	34	31	44	68	120	24	4
3 – 21	662	454	432	383	497	216	52	20
5 – 18	229	210	215	213	141	–	13	7
5 – 19	402	384	388	393	351	5	30	–
5 – 74	199	192	194	–	–	–	19	–
5 – 99	353	312	303	316	–	–	9	6
5 – 20	85	14	16	8	25	67	8	2
5 – 21	303	153	149	145	218	305	15	–

[1] Two key stations not available.

Turnpike Highlights

The Pennsylvania Turnpike at the western gateway was found to carry a volume of 13,960 vehicles. This volume represented approximately 17 percent of the total volume of vehicles using the highways interviewed at the western border screenline.

However, the "out of state" to "out of state" traffic using the Turnpike represented 45.4 percent of all "out of state" to "out of state" traffic found crossing the western border screenline.

The high percentage of long-haul traffic attracted to the Turnpike is readily accounted for by the extremely rugged character of the terrain in the west central section of Pennsylvania where a series of mountain ranges spread across the state in a generally southwest-northeast direction.

The Turnpike with its tunnels permits traffic to go through the mountain ranges instead of going over them and thus provides a minimum grade route with fully controlled access which affords substantial savings in both time and operation cost to users.