TABLE 3

UNIVERSITY OF MARYLAND, COLLEGE OF ENGINEERING

TRAFFIC COUNTS, BALTIMORE-WASHINGTON ROAD, JULY 4, 1927

Station	Actual number of vehicles			Average number vehicles per hour	Max and min rate per hour based on traffic for 5 mi intervals	
	3-4 P M	4-5	5-6			
B-18 near City Line—Baltimore	809	860	857	842	1284	522
P-1 Laurel	835	739	826	800	1236	504
P-2 College Park	940	769	881	863	1188	600
P-3 near D C Line	1357	1312	1502	1390	1968	912
Muirkirk		736				

TRAFFIC COUNTS AT MUIRKIRK, BALTIMORE-WASHINGTON ROAD, JULY 17, 1927

4-5 P M	Actual number of vehicles 5-6	6-7	7-8	Average number vehicles per hour	Max and min rate per hour based on traffic for 5 mi intervals	
504	673	671	595	607	924	348

TRAFFIC COUNTS AT MUIRKIRK, BALTIMORE-WASHINGTON ROAD, OCTOBER 2, 1927

1-2 P M	Actual number of vehicles 2-3	3-4	4-5	5-6	6-7	Average number vehicles per hour	Max and min rate per hour based on traffic for 5 mi intervals	
South								
222	272	322	366	505	575			
North								
315	350	383	414	335	340			
537	622	705	780	840	915	733	1284	348

NEW TRAFFIC FLOW RECORDER IN USE ON CLEVELAND TRAFFIC SURVEY

J G McKAY

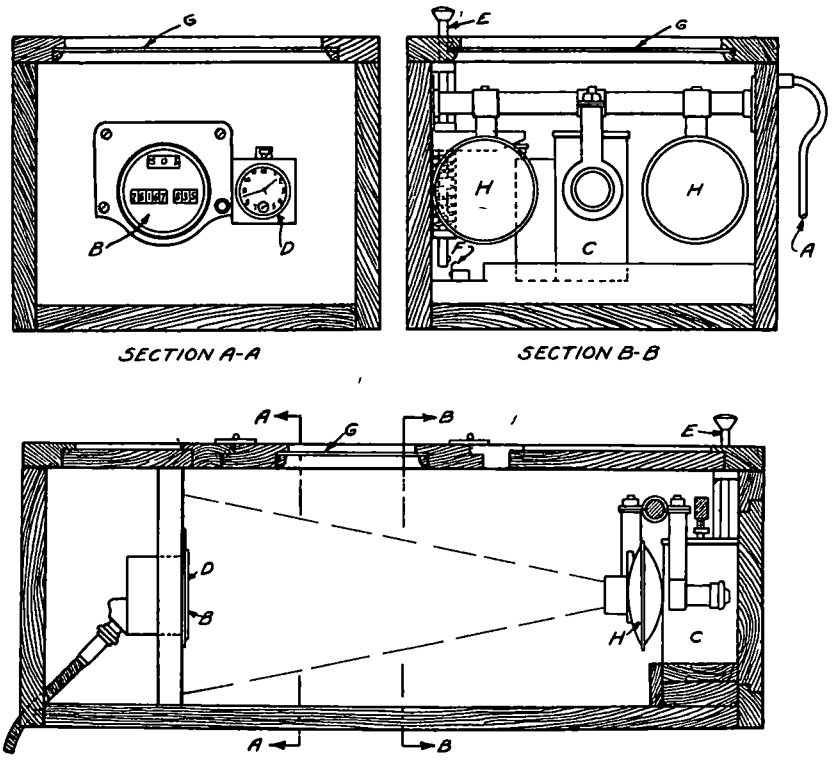
United States Bureau of Public Roads

A new device, designed to measure and record the speed of a vehicle at any instant during a run or trip and simultaneously to record the elapsed time and distance since the beginning of the run, is being used by the Bureau in connection with the highway-planning survey now in progress in cooperation with the County Commissioners of Cuyahoga County, Ohio, in the Cleveland Metropolitan Region

The device consists, essentially, of a clock, a speedometer, and an odometer, the three so mounted as to be within the field of a motion-picture camera, with which they can be photographed simultaneously

at any time when illuminated by two flashlights, which also form a part of the device The entire apparatus is enclosed in a box approximately two feet long and one foot square. A plan of the device is shown in Figure 4.

The apparatus may be installed in any car by making the necessary



A Battery Cable B-Speedometer C-Camera D-Clock
E- Operating Rod F-Lamp Switch G-Window H-Lamp

Figure 4 Sketch of the New Space-Time Recorder

connection to the speedometer, and the only other equipment required is a 6-8-volt storage battery, to provide current for the flashlights

The operation of the instrument is extremely simple A small knob on the top of the box is pressed when a record is to be made This action first turns on the flashlights, and almost immediately actuates the camera exposing the film for one-sixteenth of a second and moving it forward for the next picture The camera is loaded with 18 feet of standard motion-picture film, which provides for 250 exposures.

Installed in an automobile as above described, this device is used to measure and record the variable speed of highway traffic by so operating the test car as to "float" with the traffic. The simultaneous records of time, speed, and distance which can be made at any instant during a run or whenever the speed of the car is changed for any reason will provide the data necessary for a variety of studies of flow of traffic, the effect of traffic obstructions and congestion, the time required to travel over sections of a route, etc

The operating crew consists of three men: a driver, an instrument operator and observer, and a recorder A window in the top of the instrument box permits the operator to note the odometer figure at the instant of photographic exposure, and this figure, together with the cause of a change in movement which resulted in the picture; are given to the recorder, who notes them on the recording form An enlarged reproduction of three of the photographic records is shown in Figure 5, and a sample record form is shown in Figure 6

In making a run with traffic over test sections of highway, the initial exposure is made when the car is put in motion, and another when it attains the average speed of the traffic stream Thereafter other exposures are made when for any reason this speed is altered appreciably. In this matter a series of photographic records and correlated notes are obtained, which can be used subsequently to determine the effect upon the speed of the test car (and, consequently, of the traffic with which it is "floated"), of traffic congestion, various densities of traffic, slow vehicles, motor trucks, traffic lights, highway and street intersections, street cars, street-car loading platforms, parked vehicles, railroad crossings, narrow pavements and bridges, curves, grades, condition of the surface, rain, snow, etc

One form in which the data thus obtained may be plotted for purposes of analysis is shown in Figure 7 In this graph, speed is plotted against distance, and each up-and-down change in the direction of the graph represents a change in speed occurring at a particular distance from the starting point, with the causes of change in speed indicated at the point on the highway where the change in speed occurred, the entire graph constituting a record of the variable speed of the test car in operation over a section of highway Superimposed upon the speed record in this case, as an indication of the various combinations possible, is a record of the density of traffic on the road at the time of the run, the width of the road surface, and the roughness of the surface as determined by roughometer readings

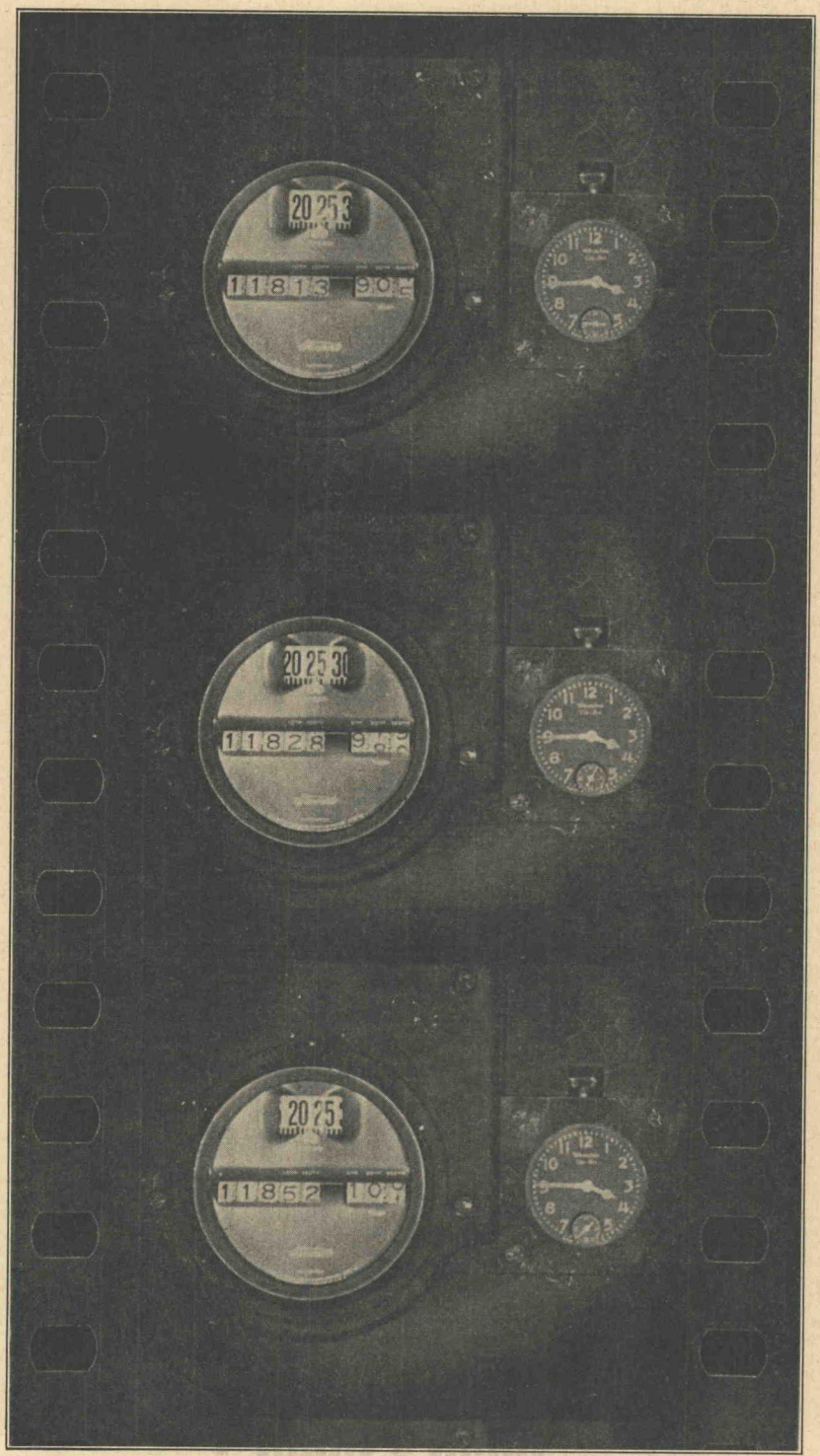


Figure 5. Photographic Record, Space-Time Recorder

Date: Oct. 27, 1927.
Route: Ridge, 73rd Lorain.

TRAFFIC CAPACITY FLOW RECORD

Sheet No. 3.
Film Roll No. 2.

Experiment No.	Odometer reading	Miles per hour	Time: Hours	Time: Minutes	Time: Seconds	Location	Movement: Start	Movement: Average	Movement: Average plus	Movement: Slow	Movement: Stop	Cause of change of movement: Right turn	Left turn	Traffic light	Officer	Trolley car	Vehicle congestion	Narrow pavement	Rough pavement	Loading platform	Pedestrian	Curve	Grade crossing	Detour	Detour	Lanes	Miscellaneous
160	117.34	30	2	42	59					√								√									
161	.40	14	3	43	10	Charles				√								√									Road construction
162	.62	26	3	43	37					√																	Intersection
163	.69	18	3	43	56	Snow Road				√																	
164	.81	24	3	44	10	Kenneth Ave				√								√									
165	.94	34	3	44	26			√																			
166	118.12	24	3	44	45	West Lake Ave				√								√									Intersection
167	.28	25	3	45	06	Wooster Pike				√																	Ditch
168	.52	23	3	45	38	Killbridge				√																	Intersection
169	.80	25	3	46	12	Brook Park				√																	
170	.95	26	3	46	28	N. Y. C. underpass				√								√									
171	119.13	33	3	46	48			√																			
172	.38	34	3	47	15			√																			
173	.47	27	3	47	29					√							√										
174	.59	35	3	47	44			√																			
175	.71	39	3	47	55			√																			

Figure 6.—Standard Form Used For Tabulating Information Obtained Simultaneously With the Record Made By the New Space-Time Recorder

One of the interesting studies in connection with the Cleveland survey for which this device is employed is that of determining the traffic capacity of pavements of various widths A number of sections

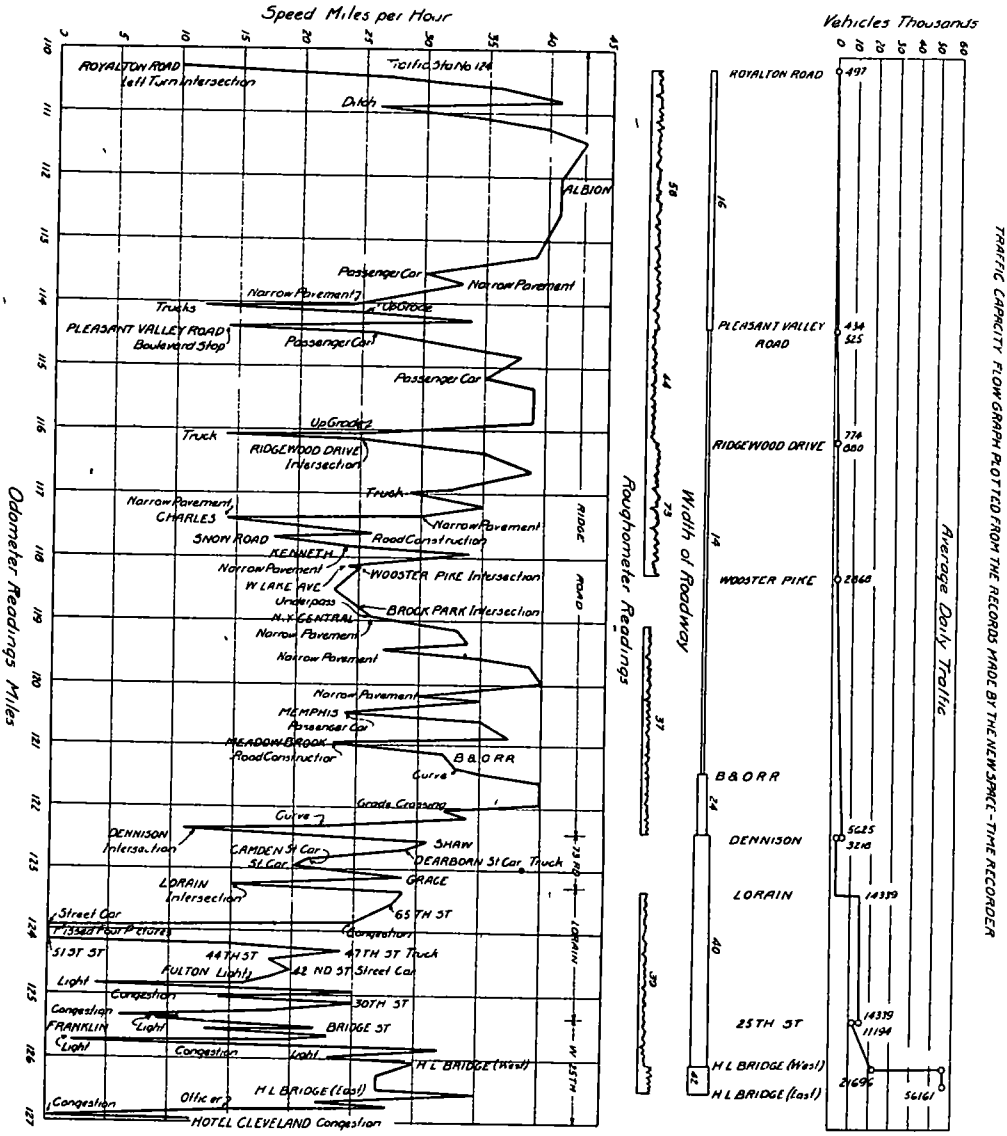


Figure 7

of highway ranging in pavement width from 18 to 50 feet and representing two-, three- and four-lane surfaces, have been selected for study Traffic on the several sections varies from 2000 to more than 30,000 vehicles per day, and in composition from an exclusively passenger-car

movement to a combined passenger-car and truck traffic, in which the trucks constitute upward of 15 per cent

It is assumed that the traffic capacity of a pavement of any particular width is that traffic volume which it will discharge without undue congestion; and it is taken for granted that congestion is invariably reflected in a retardation of the speed of vehicles Acting on these assumptions, an effort will be made to determine the traffic capacity of each of the test pavements in the following manner:

The pavement will be marked transversely at one-foot intervals, and by this means a study will be made of the lateral distribution of the traffic throughout the day, segregating in the record the observations made during every 15-minute period A traffic count, similarly subdivided, will show the variation in traffic density throughout the day, and once in each 15-minute period a run will be made with the test car equipped with the traffic flow recorder to measure time rate for various densities of traffic on the several surface widths

The analysis of the capacity of a roadway surface is influenced by the distance interval between vehicles for various rates of speed and volumes of traffic In addition to the time rate and transverse distribution studies on these sections, data will be recorded each 15-minute interval of the day, to determine the average interval of distance between vehicles for the various densities of traffic and variation in speed.

As there is invariably a wide range of traffic density during the course of a day, there will be obtained in this way data which will show, for various densities of traffic, the corresponding speed of the traffic and the distribution of the traffic transversely over the pavement, the latter serving as a measure of the degree to which the available width is utilized.

As the roads selected are those upon which there appears to be congestion at the peak hours, it will be possible, by using the traffic speed as a guide, to ascertain the density of traffic at which the congestion first makes itself felt, and the various degrees of congestion associated with greater densities, utilizing the transverse distribution data to determine whether or not the available width of pavement is fully used

DEVELOPMENT OF TRAFFIC, RATIO OF MOTOR-VEHICLE REGISTRATION TO POPULATION, PRESENT AND FUTURE

The trend of increased automobile registrations can now be platted to a curve which will furnish an indication of future expansion of registrations. The assumption is that the average mileage traveled by motor vehicles is approximately constant from year to year, and, therefore, future traffic can be estimated from the curve of future registrations Figure 8 illustrates the forecast for a state

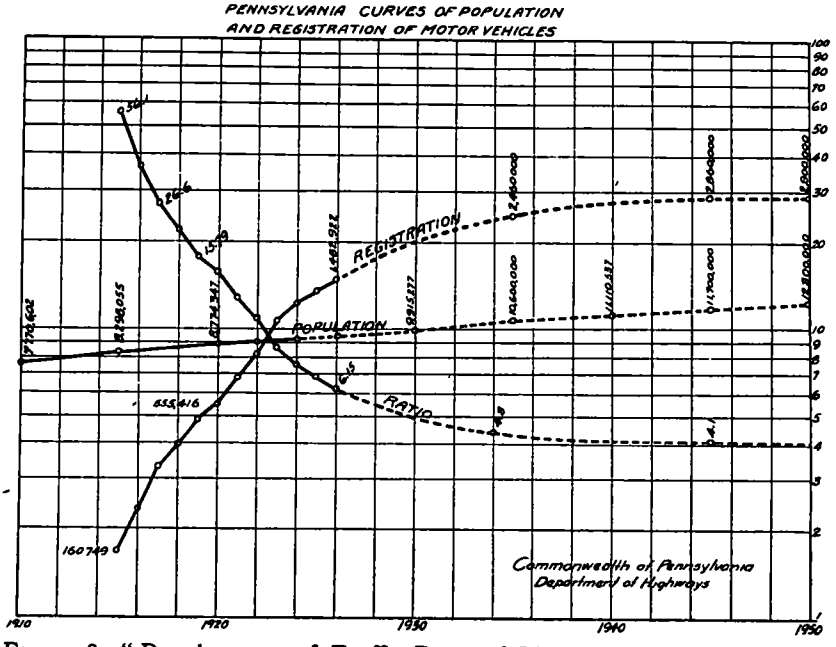


Figure 8 "Development of Traffic Ratio of Motor Vehicle Registration to Population, Present and Future"

Highway traffic is essentially local, and there are approximate determinable ratios between populations and registrations and between registrations and traffic Where basic information is available, then, whether or not the particular information as to registrations is available, traffic can be estimated

The basic assumption in estimating traffic is that a particular road under consideration carries the traffic of a particular locality According to observations in Pennsylvania, estimates are found to check against traffic counts for specimen sections of road when the outline of the area served comprises about 30 miles of the road in question.

The first step in estimating local traffic, then, is to indicate on the road map the approximate 30 miles of length, including the section in question, and terminating at either end at logical road intersections or other terminal points

Next the lateral limits of area served are delineated so as to approximately bisect distance between paralleling roads, with, occasionally, modification to allow more than half of intermediate distance to the better improved of the parelleling roads

The next step is a parallel tabulation of 1920 and 1910 census of population in the area, by city, borough and township, a derived factor of 1927 population for figuring present traffic and a derived factor of 1940 population for figuring future traffic

By extending the rate of increase shown from 1910 to 1920, using 100 per cent of population of cities, boroughs and townships, wholly included in the area, using 50, 25, 10, or other per cent of population of terminal city or borough according to the cross routes condition of the terminal, and whether it appears reasonable that the road for which traffic is being estimated gives 50, 25, 10, or other per cent road service to the terminal center, assuming that the population of townships is uniformly distributed over their areas and using the percentage of population corresponding to the percentage of the area of the township included within the delineation of the area marked out as being served by the road in question, these three steps furnish an estimate of the population at present served by the road and an estimate of the population of future service

The next step is, then, estimating the number of motor vehicles at present registered within the area, and in the future to be registered there. This estimate is accomplished by the use of the population figures and a table of county factors of present and future registrations with relation to population. Table 4

TABLE 4

COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF HIGHWAYS

1926

RELATION BETWEEN POPULATION, REGISTRATION AND TRAFFIC

County	Estimated population Dec 31, 1926	Motor vehicle registration Dec 31, 1926	Motor vehicles per (1000) persons 1926	Motor vehicles per (1000) persons 1940	Ratio of traffic to registration
Adams	34,768	7,752	223	271	895
Allegheny	1,302,017	195,602	150	188	144
Armstrong	80,707	12,971	161	265	140
Beaver	139,973	19,083	136	278	477
Bedford	38,277	7,903	206	271	414
Berks	212,504	41,193	194	333	372
Blair	142,066	21,619	152	271	359
Bradford	53,166	10,287	194	271	442
Bucks	86,270	20,276	235	333	1 189
Butler	80,129	16,250	203	271	412
Cambria	220,393	28,028	127	271	288
Cameron	6,297	745	118	265	.241
Carbon	69,447	8,050	116	265	318
Centre	44,836	8,945	200	271	690
Chester	118,804	24,898	210	333	432
Clarion	36,170	8,945	247	278	128
Clearfield	109,430	14,611	134	271	428
Clinton	34,830	5,218	150	265	519
Columbia	48,349	9,691	200	265	525
Crawford	60,667	13,120	216	271	317
Cumberland	61,214	12,971	212	271	982
Dauphin	164,447	29,370	179	333	·310
Delaware	221,548	33,396	151	188	.822
Elk	34,981	4,927	141	265	308
Erie	183,783	33,992	185	271	387
Fayette	202,024	31,904	158	271	518
Forest	7,477	1,043	139	271	
Franklin	63,832	11,779	185	271	412
Fulton	9,617	1,789	186	271	609
Greene	32,036	7,604	237	271	145
Huntingdon	40,804	7,155	175	265	817
Indiana	91,671	14,013	153	271	248
Jefferson	62,104	9,541	154	271	125
Juniata	14,464	3,131	216	271	196
Lackawanna	304,062	40,254	132	188	476
Lancaster	177,968	39,360	221	333	.273
Lawrence	96,922	17,891	185	278	445
Lebanon	65,425	20,276	310	333	322
Lehigh	170,020	26,388	155	278	380
Luzerne	423,443	53,672	127	265	193
Lycoming	84,513	16,400	194	265	490
McKean	49,570	9,689	195	271	413
Mercer	105,418	17,593	167	271	.518
Mifflin	33,923	5,963	176	265	.862

TABLE 4, Continued

County	Estimated population Dec 31, 1926	Motor vehicle registration Dec 31, 1926	Motor vehicles per (1000) persons 1926	Motor vehicles per (1000) persons 1940	Ratio of traffic to registration
Monroe	25,145	6,858	273	278	976
Montgomery	220,247	50,839	231	333	426
Montour	14,080	1,937	138	265	426
Northampton	172,080	29,222	170	278	.244
Northumberland	129,038	17,295	134	265	374
Perry	22,875	4,323	189	271	841
Philadelphia	2,017,100	241,372	120	188	201
Pike	6,818	1,789	262	278	601
Potter	21,089	3,578	170	265	.201
Schuylkill	223,851	30,712	135	265	.280
Snyder	17,317	3,578	207	271	663
Somerset	92,540	15,215	164	271	.297
Sullivan	9,520	1,639	172	265	
Susquehanna	34,763	5,665	163	271	.240
Tioga	37,118	7,008	189	278	451
Union	15,850	3,876	245	271	334
Venango	60,960	13,268	218	271	487
Warren	40,264	7,455	185	265	488
Washington	224,711	31,756	141	271	324
Wayne	27,435	5,814	212	271	.281
Westmoreland	303,387	43,832	144	271	336
Wyoming	14,101	3,876	275	271	
York	149,579	33,992	227	333	338
State total	9,500,234	1,490,117	157	272	.342

The final step is the estimating of average annual daily traffic from number of motor vehicles registered, or to be registered, and a tabulation, by county, of relation of annual average daily traffic to number of motor vehicles registered

This furnishes the estimate of local traffic

This is the estimate of general use In some cases the estimate is increased by a percentage to account for "through" or long-trip travel on trunk roads In the case of a road lying in a county where the factors are largely determined by a city, but not serving the city, it is, of course, necessary to modify the factors

There is attached a specimen estimate with check estimate showing information from the field

SPECIMEN ESTIMATE

COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF HIGHWAYS

Date March 15, 1926
From H K Craig, O R 274
To Mr W A Van Duzer

Estimate of 1940 Traffic

Application No _____, Route No O B 398, Butler ~~Boro~~ Twp, Schuylkill County

Location of road, towns connected, etc Road beginning at Frackville Borough running to Ashland Borough via Fountain Springs

Character of territory served (agricultural, mining, ~~manufacturing~~), etc

An estimate of 1920 population of the area served is 28,914 persons, as follows

County	Township or borough		Population 1920	Population 1910	Area served	Population served
Schuylkill	Ashland	B	6,666	6,855	50%	3,333
	Butler	T	3,831	3,900	50%	1,916
	Frackville	B	5,590	3,118	50%	1,559
	Mahanoy	T	5,627	6,256	10%	563
	New Castle	T	2,374	1,554	40%	950
	Blythe	T	2,513	2,405	10%	251
	Gilberton	T	4,766	5,401	40%	1,906
	St Clair	T	6,425	6,455	35%	2,273
	Pottsville	B	21,876	20,236	30%	6,523
Columbia	Centralia	B	2,336	2,429	30%	701
	Conynham	T	2,592	3,127	25%	648
Northumberland	Mt Carmel City		17,469	17,532	20%	3,494
	Mt Carmel	T	5,561	6,700	10%	556
	Shamokin		21,204	19,588	20%	4,241
			108,900	105,596		28,914

Variation, 1910-1920, 3 per cent increase, ~~decrease~~

Estimate of 1927 population of this area 29521 persons

Estimate of 1940 population of this area 30648 persons

Estimate of 1927 M V Registration 135 M V's per 1000 persons or 3985 M V's

Estimate of 1940 M V Registration 265 M V's per 1000 persons or 8122 M V's

Ratio of Traffic to registration (1927) 280 per 1000

Annual daily average traffic (1927) based on District Engineer's Report is 120 trucks, 1200 passenger cars, total 1320 M V's

Estimate of 1940 annual daily average traffic by formula

$$\frac{R(1940) \times T(1927)}{R(1927)} = T(1940)$$

	Present (1927)	Future (1940)
District Engineer's estimate	1320	2500–3000
Headquarters' dependent forecast		2690
Independent headquarters' estimate and forecast	1116	2275

NOTE—Average Daily Winter, 70 per cent, Maximum Summer 187 per cent of Annual Daily Average Traffic