1950

A comprehensive traffic survey of Phelps County, Missouri

Clifford D. Muir

Department:

A

COMPREHENSIVE TRAFFIC SURVEY

OF

PHELPS COUNTY, MISSOURI

BY

CLIFFORD DONALD MUIR

A

THESIS

submitted to the faculty of the

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Approved by E. W. Carlton

Professor of Structural Engineering

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The author wishes to express his sincere appreciation to Professor E. W. Carlton for his valuable advice and criticisms and to the several other members of the Department of Civil Engineering, Missouri School of Mines and Metallurgy, for their encouragement and assistance.

Sincere thanks are due Mr. S. M. Rudder, Highway Planning Engineer for the Missouri State Highway Department, for suggesting the problem and cooperating wholeheartedly to make this study possible.

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INTRODUCTION

The purpose of this study is two fold. The first of these purposes is to serve as a pattern or guide for any county or township wishing to conduct a comprehensive traffic survey. The second purpose of this study is to provide traffic classification and other data on a typical county system of rural roads.

Today, many counties in the United States are faced with the problem of inadequate roads, due to the modernization of the American farm. While they realize this problem exists, many county governments have developed no organized method of studying and determining their needs.

The importance of the automobile to the farmer can easily be seen in studying the following facts.(1)

"Farmers own some 31 per cent of all the nation's motor trucks and 16 per cent of all passenger cars."

"During the past decade alone, the farmers use of motor trucks has increased almost 50 per cent."

"It is not only what the farmer sells but what the farmer buys, that is transported in these 7½ million farm vehicles over 3,000,000 miles of rural roads."

"More than 25,000 United States rural communities are entirely dependent upon highway transportation for freight and passenger service."

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(1) A publication entitled "The Farmer's Road Problem" by Russell H. MacCleeny, (National Highway Users Conference). p. VI

"Some 5,000,000 children — one out of every five school children are transported to school daily by regular school buses."

"Rural letter carriers of America travel 1,430,000 miles each day providing post office mail service to 9 million families, representing 30 million patrons or nearly one-fourth of the nation's population."

"Virtually 100 per cent of most crops make their initial off-the market movement by highway."

"Approximately 85 per cent of the fluid milk flows from the dairy farm to the consumer by truck."

"According to the U. S. Department of Agriculture, 66 per cent of all livestock received at stockyards in 1947 arrived by truck."

Although many farsighted road officials realize the need for traffic studies on rural roads, the ever present problem of finance prevents or drastically curtails the scope of these studies. Financial restrictions have forced most traffic engineers to rely on minimum number of machine counts for their data. While machine counts are in general satisfactory, machines cannot give a traffic engineer all the information, such as traffic classification, that can be obtained from a manual count. In this study, the author will recommend a solution to this problem.

When the author began preparations for this comprehensive traffic survey of Phelps County at the suggestion of the Missouri State Highway Department, there were some doubts as to the results. The reason for these doubts was slightly inadequate stationing and the relatively short time duration of the counts involved. While more complete data would be desirable, the author feels that the informa-

tion available has proven adequate for the conclusions drawn.

This study will combine information obtained by manual and machine counts, with that obtained by questionnaire and interview, into a homogeneous picture of rural traffic and road needs in Phelps County, Missouri. This picture will be used as a basis for recommending road improvements and methods for any future traffic surveys in other Missouri counties.

HISTORICAL BACKGROUND

Before discussing the technical aspects of this traffic survey, it would be beneficial to consider the history of rural roads.

Mankind has always found it practical to carve roads or trails between his points of travel. This practice doubtless had its beginning as early as the Stone Age. These roads or trails were generally built to serve one of two purposes. It is probable that the first roads or trails were for the purpose of obtaining food. As man learned to make weapons, roads were built for the purpose of warfare. An outstanding example of military roads can be found in a study of the Roman Empire. While built primarily for military purposes, these roads were also an aid to international commerce.

In the United States, road construction was primarily a local affair with exception of the National Turnpike in 1802, prior to 1891. Due to the demand for better roads than the local governments could provide, the State of New Jersey led the way with the first state aid road system in 1891.(2)

With this somewhat late beginning, state aid-road programs increased rapidly. State aid-road systems were the rule rather than the exception, when the Federal Government entered the road picture in 1916. This entrance was accomplished by passage of the Federal Aid Road Act of 1916. The Federal Road Act provided federal funds for states having an organized highway department.

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(2) "Economics of Transportation" by D. Phillip Locklin, P.H.D. (Richard D. Irwin Inc.), p. 667.

These road programs were mainly concerned with the development of inter-city routes and a few major secondary routes. This condition left farm roads still under local control. This local control led to some haphazard road building and location methods. In some sections of the county, roads had to be built and maintained by the farmers themselves.

The author can recall serving as water-boy for such a project in the early 1930's. This project, carried out in the State of Minnesota, was typical of many. In order to build a two mile stretch of county road, all the farmers in the vicinity of the road gathered on an appointed day. The equipment for this project included an elevating grader furnished by the county and the local farm implements available. Among these farm implements, one could find drags, harrows, disks, manure-spreaders, wagons, fressnos, etc. With this equipment the farmers were able to fashion a fairly decent road.

The most common method of road location was along section lines. The section line method was not the only method of road location that appeared. In one case, the State of Minnesota passed a law declaring that old Indian trails were legally open roads as long as one vehicle a year passed over them. As an example of the sometimes impractical result of such a law, the author recalls the case of one farmer who had a corn field where one such Indian trail had crossed. Even though this land was cultivated and fenced, an Indian trail had crossed it so it was therefore a legal road if one vehicle a year passed over it. The legal road statute was kept intact by a single farmer who every year on the first day of July cut the fence wires and drove his Model-

T Ford through the field for the required one vehicle trip.

The beginning of rural traffic surveys is not as recent as many people may believe. These studies can readily be traced back to the early 1920's in the United States. One such survey being made in Tennessee in 1923.(3)

It is interesting to note that these early surveys were made before the automobile become commonplace in farm communities. These early surveys were quite careful to classify traffic as to buggies (one and two horses), wagons and automobiles.

In the middle 1930's the Federal Government took an active interest in rural traffic surveys, by aiding state highway departments financially in carrying out this work. One of the reasons for this move was the almost desperate need for employment in the United States. This program of rural road study not only provided some of the needed employment, but also enabled state highway departments to obtain some valuable information. Another far more reaching effect of this program was the fact that it caused state highway departments to set up an organization for studying rural road traffic. Once organized, the various state highway departments are still continuing this work.

After reading this brief history, one can see that the problem of the farmer and his roads is a very old and important one. Not only is the problem of farm roads difficult, but so is the problem of allocating funds for the various types of roads.

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(3) A bulletin "Highway Transportation in Tennessee Counties" by N. W. Cougherty (University of Tennessee) November 1923.

SURVEY PROCEDURE

Control Stations:

Three control stations were selected and counted in connection with this traffic survey. These stations were selected and counted for the purpose of furnishing a pattern of traffic variation throughout the time covered in this traffic survey.

The control stations were selected with the aid of the Highway Planning Officials of the Missouri State Highway Department.

The first control station is located on state farm-to-market route "T", approximately one mile south of Newburg, Missouri. This station is known as station number 2406 and is part of Missouri State Highway Department's permanent traffic survey system. The chief reason for selecting this station was that a record of traffic counts over a four year period was available. A second reason for selecting this station, was the station's typical farm-to-market location.

The second station selected will be called station number one in this thesis. This station is located on a county road, approximately one-fourth mile west of State route "E". The reason for selecting this station was that it furnished a count on a highly traveled county road.

The third station selected is located approximately one-fourth mile west of State route 68. For the remainder of this thesis it will be known as station number two. The selection of this station completed the essential control requirements by furnishing a count on a low traffic volume county road.

Another control station located in the vicinity of Duke, Mis-

souri, would have been desirable, however, lack of counting equipment made the placing of such a station impossible.

The counting of these control stations was accomplished using fifteen minute traffic recording machines. These machines contained a storage battery which operated a clock mechanism. This mechanism recorded the number of vehicles crossing a hose placed perpendicularly across the road. This record was stamped on a continuous tape and indicated the number of vehicles passing a station every fifteen minutes.

The type data sheet used to tabulate information obtained by use of this machine can be seen in Figure No. 1.

WEATHER REPORT AND REMARKS _____

DAY	SUN.	MON.	TUES.	WED.	THUR.	FRI.	SAT.	TOTAL
DATE								
12 - 1 AM								
1 - 2								
2 - 3								
3 - 4								
4 - 5								
5 - 6								
6 - 7								
7 - 8								
8 - 9								
9 - 10								
10 - 11								
11 - 12								
12 - 1 PM								
1 - 2								
2 - 3								
3 - 4								
4 - 5								
5 - 6								
6 - 7								
7 - 8								
8 - 9								
9 - 10								
10 - 11								
11 - 12								
24-HOUR								
PART DAY TOTAL								
RATIO								
% AVE. DAY								

SUN.	MON.	TUES.	WED.	THUR.	FRI.	SAT.	TOTAL

STATION NO. _____ COUNTY _____ SET BY _____

LOCATION, ON ROUTE _____ SUMMARIZED BY _____

_____ AVERAGE WEEK DAY _____

_____ WEEK BEGINNING _____ SATURDAY & SUNDAY _____

RECORDER NO. _____ FINAL SUMMARY _____ SEVEN DAY AVERAGE _____

FIGURE NO. 1

Station Determination:

When the idea of a comprehensive traffic survey of Phelps County, was first conceived, it was thought that the best stationing would be to locate one station per mile of road. Although this was the most desirable stationing plan, economic practicalities forced its abandonment. If this plan had been carried out, the traffic survey in Phelps County would have included a minimum of two hundred and fifty stations. This number of stations was economically unsound for two reasons. The first of these reasons being the number of man hours required for such a count. The second of these reasons was that two hundred and fifty stations would require considerable amount of transportation expense.

The plan finally decided upon called for one hundred and eighty stations. These stations were to be mostly at intersections. This plan also called for an increased number of stations in the northeast section of the county. The reason for these extra stations was to aid in proving or disproving the practicality of reducing the number of stations to be counted. After the survey had been in progress several weeks, it was found feasible to reduce the number of stations still further to one hundred and sixty-four. This reduction of stations was made possible by reclassification of some roads as private. This plan of stationing proved rather successful as will be brought out later in this thesis.

Once the number of stations was determined, they were located by using a Phelps County map. The majority of stations were placed at road intersections in order to obtain the greatest number of in-

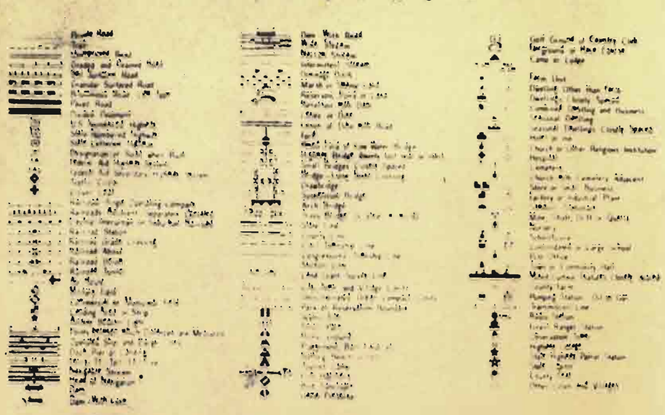
dividual road counts. Due to the limited number of stations, not all intersections could be stationed. The intersections stationed were those that, in the opinion of the author, would give the best overall picture of traffic movement throughout the entire county. The location of these stations can be seen in Plate No. I.

Manual Counts:

The method decided upon for counting the traffic at the various stations, was an eighteen-hour manual count. The count was run continuously from 6 A.M. until 12 A.M., six days a week. After studying various records of the Missouri State Highway Department, it was felt that very little if any traffic would appear on rural roads between 12 A.M. and 6 A.M. This supposition was borne out by twenty-four counts obtained at the three control stations.

It was decided to use three types of data sheets in making these counts. The first type of data sheet can be seen in Figure No. 2. This was the primary data sheet used in this traffic survey. This data sheet proved very satisfactory for low count roads. The second type of data sheet used in this survey can be seen in Figure No. 3. This data sheet was primarily a tabulator form for the information gathered at the various stations. One of these data sheets was completed for each road leading away from an intersection. While this second data sheet may seem to be duplication, its use had the beneficial effect of keeping the human traffic recorder alert. The third type of data sheet used in this survey can be seen in Figure No. 4. It is the standard intersection traffic flow data sheet. Need was found for this type of data sheet when

LEGEND



GASCONADE COUNTY

MARIES

PULASKI COUNTY

DENT COUNTY

CRAWFORD COUNTY

TEXAS COUNTY

STATION LOCATION MAP

GENERAL HIGHWAY MAP

PHELPS COUNTY

MISSOURI

PREPARED BY THE
HIGHWAY PLANNING DEPARTMENT
MISSOURI STATE HIGHWAY DEPARTMENT
IN COOPERATION WITH THE
PUBLIC ROADS ADMINISTRATION
FEDERAL WORKS AGENCY

SCALE

1949

* CONTROL COUNTS

PLATE NO. 1

DATA

TRAFFIC COUNT, PHELPS COUNTY

DATE _____ STATION _____ WEATHER _____

TYPE OF ROAD SURFACE _____ CONDITION OF ROAD SURFACE _____

OBSERVER _____ DIAGRAM OF STATION

REMARKS:

LICENSE[1]	MAKE[2]	TYPE	NO. PAS-SENGERS	LOADED-L EMPTY-E	CARGO (TYPE)	ROUTE[3]	TIME	REMARKS

1) LICENSE – LOCAL OR FOREIGN

2) MAKE – PRE-WAR OR POST-WAR

3) ROUTE THROUGH STATION (SUCH AS N-S, ETC.)

FIGURE NO. 2

TRAFFIC CLASSIFICATION SHEET

HOUR PERIOD BEGIN	PASSENGER		PAN. P. U.		SINGLE UNIT TR.			TRAC. COMB.				BUSSES			MISC.	TOTAL	NUMBER OF PASSENGER	
	LOCAL	FOR.	LOCAL	FOR.	2 AX. 1 TIRE	2 AX. DUAL	3 AX.	AXLES 3	4	5	6	C.C.	SCH.	CITY			CARS	TRUCKS
12-1AM																		
1-2																		
2-3																		
3-4																		
4-5																		
5-6																		
6-7																		
7:00-7:15																		
7:15-7:30																		
7:30-7:45																		
7:45-8:00																		
8:00-8:15																		
8:15-8:30																		
8:30-8:45																		
8:45-9:00																		
9-10																		
10-11																		
11-12PM																		
12-1																		
1-2																		
2-3																		
3-4																		
4:00-4:15																		
4:15-4:30																		
4:30-4:45																		
4:45-5:00																		
5:00-5:15																		
5:15-5:30																		
5:30-5:45																		
5:45-6:00																		
6-7																		
7-8																		
8-9																		
9-10																		
10-11																		
11-12																		
TOTAL																		

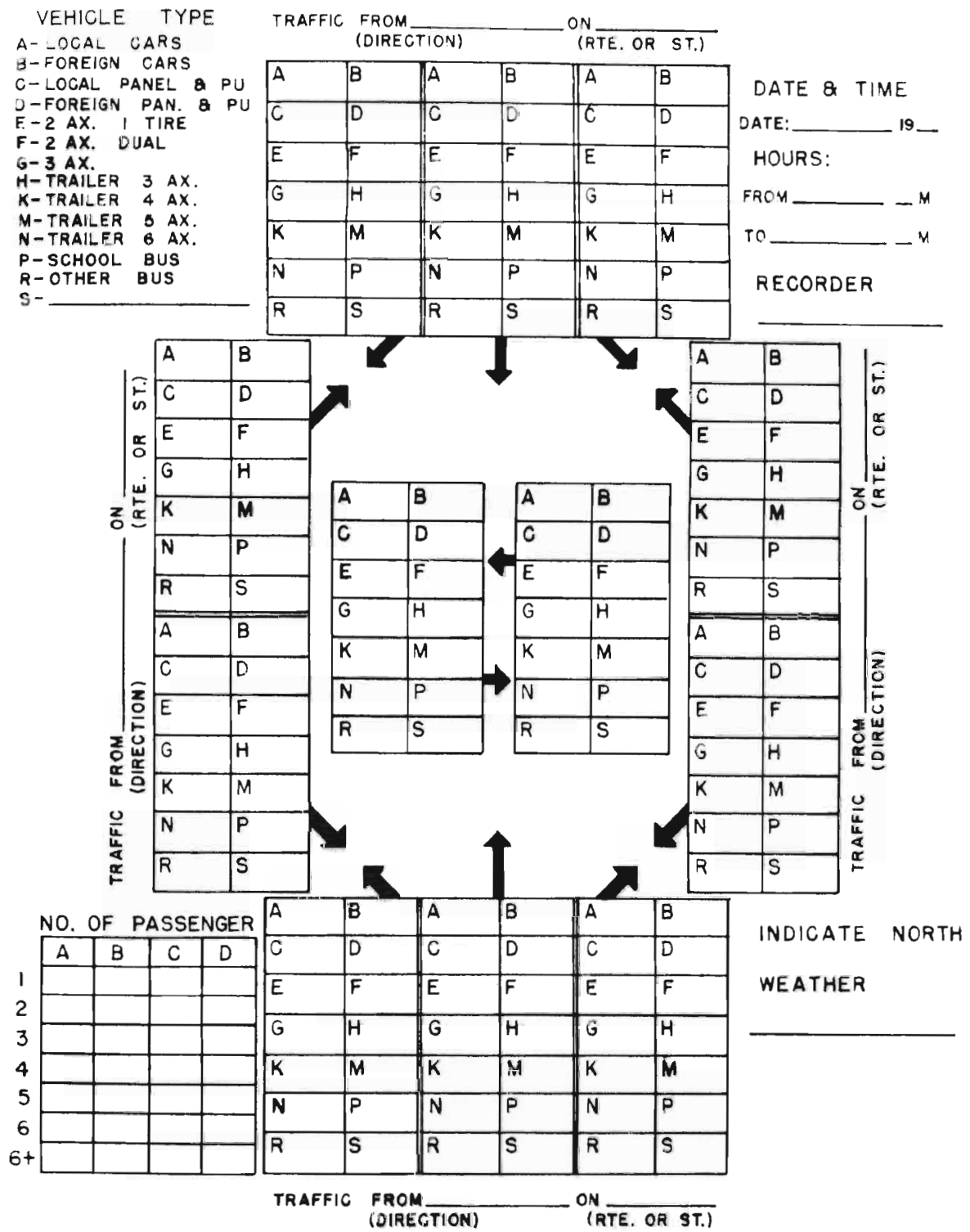
STATION NO. _____ COUNTY _____ RECORDER _____ WEATHER _____

ROAD DIRECTION RECORDED _____ DAY AND DATE _____

LOCATION _____

FIGURE NO. 3

RURAL CLASSIFICATION TALLY SHEET



STATION NO. _____ COUNTY _____ CITY _____

LOCATION _____

FIGURE NO. 4

a heavily traveled intersection was encountered.

For purposes of vehicle classification, the traffic recorders were instructed to divide vehicles into the classes as seen in the upper lefthand corner of Figure No. 4. This is the standard classification used throughout the United States.

Interviewing During Counts:

When this traffic survey was first planned, the author intended to make a series of house to house interviews. This plan was later abandoned in favor of a less formal plan. The chief reason for abandoning this plan was that, if the interviews were carried on in the immediate vicinity of the stations being counted, it was thought the traffic on the road might suddenly become abnormal. Economic circumstances prevented such a program being carried out either before or after the period of actual counting.

The plan finally adopted called for the traffic recorder carrying on an informal discussion with the many motorists who stopped to voice their opinions of rural road needs. If any of these motorists had information deemed pertinent, the author called upon them personally.

While most of the information received in this manner was not of the factual type, it helped the author greatly in understanding the importance of roads to the people of Phelps County.

Check Counts and Pickup Counts:

After the manual count had been completed, several omissions and inconsistancies were found in the data.

The omissions were caused by several county roads being built at a date later than the revision date of the maps available when this traffic survey was planned. When these omissions were discovered, steps were taken to correct them. These steps consisted of adding stations and taking machine counts at them. The machines available for these counts registered only the total number of vehicles. By using these machines, a total daily traffic count was obtained and recorded on the data sheet seen in Figure No. 5.

At several stations, conditions had been noticed which caused doubt as to the accuracy of the traffic count. One such condition was the presence of a weekly movie at a fairly isolated town. When a traffic recording machine became available, these stations were machine counted under different conditions as a check on the traffic volume recorded. The need for this move was not as urgent as expected.

Questionnaires:

In an attempt to obtain some information as to trade areas and road needs in Phelps County, a questionnaire was sent to various farm residents. A copy of this questionnaire can be seen in Figure No. 6. Included with this questionnaire, was a postage free return envelope, two copies of a Phelps County map (Plate No. 2) and a letter of explanation (Figure No. 7). Two maps were included with the questionnaire to enable the farmer to keep one as a personal copy.

The problem of distributing these questionnaires was attacked in three ways:

The first method of attack involved obtaining as many names of

ACCUMULATIVE RECORDER REPORT

FOR VEHICLE COUNT RECORDER

DATE	DAY OF WEEK	TIME	A.M.-P.M.	RECORDER READING	REMARKS	VEHICLE VOLUME		DO NOT USE THIS SPACE	
								NO. OF HOURS	AVERAGE PER HOUR
TOTALS									

STATION NO. _____ CITY OR COUNTY _____ SET BY _____

LOCATION ON ROUTE _____ SUMMARIZED BY _____

YEAR _____ RECORDER NO. _____ SHEET NO. _____ AVERAGE WEEK DAY _____

IS RECORDER NOW WORKING SATISFACTORILY ? YES ☐ NO ☐ SATURDAY & SUNDAY _____

_____ FINAL SUMMARY _____ SEVEN DAY AVERAGE _____

SIGNED

FIGURE NO. 5

1. Locate yourself on the attached map.

2. Indicate which roads you would like to see improved.

3. Where do you trade? (Town)

4. How many trips to town did you make last week?

5. What days did you go to town?

6. What farm products do you deliver to town?

7. Have poor roads prevented your children from attending school or your selling your farm products?

8. Are there any commends you care to make about the roads in your territory? Please list below.

_____

_____

_____

_____

_____

_____

_____

_____

Figure No. 6

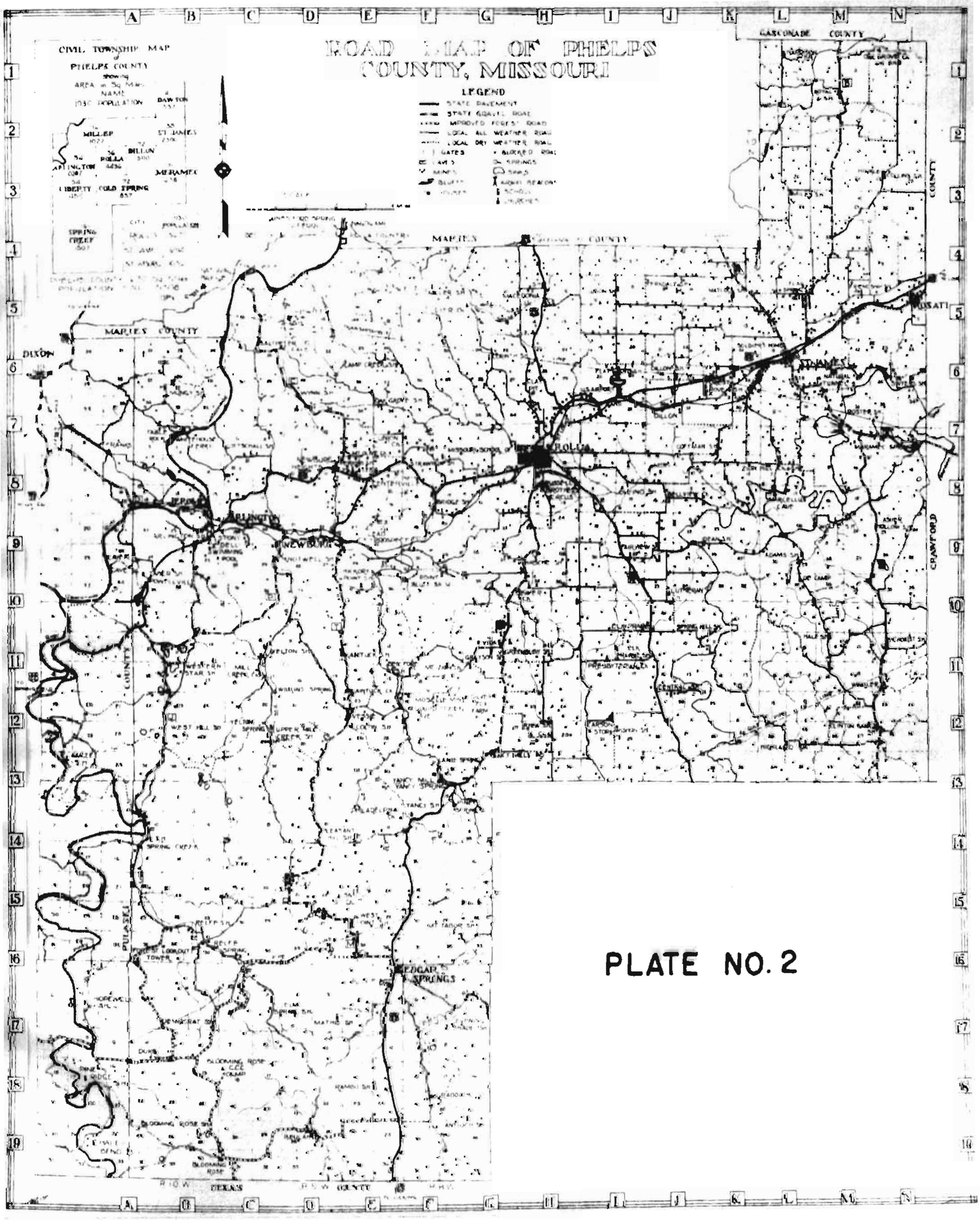

ROAD MAP OF PHELPS COUNTY, MISSOURI
LEGEND
CIVIL TOWNSHIP MAP of PHELPS COUNTY
GASCONADE COUNTY
MARIES COUNTY
CRAWFORD
PULASKI COUNTY
TEXAS COUNTY
DIXON
ROLLA
ST. JAMES
ARLINGTON
NEWBURG
EDGAR SPRINGS
DILLON

PLATE NO. 2

The University of Missouri
SCHOOL OF MINES AND METALLURGY
Rolla, Missouri

October 6, 1949

Department of Civil Engineering

Dear Sir:

At the present time we at the Missouri School of Mines are attempting to study the rural roads of Phelps County. We hope that by making the results of this study available to the State and other Highway officials, we can help you in getting better roads in Phelps County.

In order to complete this study, which many of you noticed was begun with a traffic count last August, we would appreciate your filling out the attached form and dropping it in the mail.

An extra Phelps County map is included for your personal use. A postage free return envelope has been furnished by Professor Joe B. Butler and is enclosed for your convenience.

Any information you can give us will be greatly appreciated.

Very truly yours,

/s/ Clifford Muir

Clifford Muir
Instructor in Civil Engineering

CDM:cfc

Enc. 4

Figure No. 7

Phelps County residents as possible. The majority of these names were obtained from school records, since post office records were unavailable.

The next method of attack involved publicizing these questionnaires through the medium of the press and radio (See Figure No. 8).

The third method of attack consisted of personal visits to those areas from which completed questionnaires were not arriving.

The response to these questionnaires was better than expected. Of the questionnaires mailed out, nearly twenty-five percent were completed and returned. This amounted to almost a fourteen percent sampling of rural residents.

It was also interesting to find that many people not on the original mailing list wrote requesting that they receive a questionnaire.

While this method of sampling may not be as scientifically accurate as selected interviews, the author feels it served very well in obtaining the desired results.

Rural Roads Of County Being Studied At MSM

A study of rural roads needs in Phelps County is now being made by Clifford Muir, Instructor in Civil Engineering at the School of Mines. Muir is making this study under the supervision of Professor E. W. Carlton, as part of the requirements for a Master of Science degree.

The purpose of this study is to determine the rural road needs of Phelps County and to propose a program for meeting them. With increased gas tax funds for rural road construction being a possibility in the near future, it is hoped that by making the results of this study available to the State Highway Department and any other interested persons, rural road improvement in Phelps County may be aided. This study began with a traffic count being made on all roads in Phelps County last August. At present it is being continued by a program of personal interviews and questionnaires. In order to make this study a success it is necessary that Mr. Muir obtain the opinions of as many people as possible.

The questionnaire will soon be mailed to persons in all sections of the county. Anyone interested in furnishing data concerning roads in his vicinity who does not receive a questionnaire may secure one by writing Mr. Muir at the Civil Engineering Department, School of Mines.

ROLLA DAILY NEWS

A Study Of Rural Road Needs Being Made

A study of rural road needs in Phelps County is now being made by Clifford Muir, Instructor in Civil Engineering at the Missouri School of Mines and Metallurgy. Mr. Muir is making this study under the supervision of Professor E. W. Carlton, as part of the requirements for a Master of Science degree.

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ST. JAMES JOURNAL

STUDY OF RURAL ROADS IN COUNTY BEING MADE BY MSM TEACHER

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ROLLA HERALD

FIGURE NO. 8

CORRELATION, ANALYSIS AND INTERPRETATION OF DATA

The taking of manual traffic counts made possible traffic classification at the various stations.

In this study, traffic classification was restricted to county and farm-to-market roads. The reason for this restriction being this study chiefly concerns county and directly related roads.

The first step taken in studying traffic classification was to determine the percentage of passenger cars, pickups, trucks (two axle) and miscellaneous vehicles at the various stations. These percentage values can be seen in Table No. 1.

The next step consisted of plotting the percentage of passenger cars, pickups and trucks (two axle) against the number of stations at which this percentage appeared. (Figures 9, 10, 11). In plotting these curves, it was found that by grouping the percentages, a much more satisfactory curve could be obtained. The reason for this circumstance was the limited number of stations as compared to the relatively large number of possible percentages.

The final step taken in the study of traffic classification was to show the traffic classification with regard to location on a map (Plate No. 3) and attempt to find reasons for traffic classification variation.

A complete study of the traffic classification data available indicates the following:

1. The type of traffic passing the various stations did not normally vary due to the day the count was taken.

TABLE I.

By-Station	% Loaded Trucks	By-Station	% Loaded Trucks
198	100	293	11
267	42	286	0
269	36	152	39
321	100	232	0
178	100	184	0
200	21	228	38
251	0	179	8
264	14	231	50
34	12	257	30
263	25	212	17
210	20	250	20
255	17	248	30
256	100	280	83
244	0	209	50
245	25	311	7
19	12	171	2
254	10	217	67
240	10	220	15
190	14	316	8
242	7	317	19
189	23	275	0
188	25	236	0
234	0	229	0
187	11	322	0
235	18	237	0
239	25	238	17
183	17		

TABLE I, continued

By-Station	% Loaded Trucks	By-Station	% Loaded Trucks	By-Station	% Loaded Trucks
173	33	180	67	207	23
222	25	225	61	164	0
294	40	227	27	215	30
298	35	31	50	296	18
306	50	181	0	165	17
302	17	195	67	241	14
169	17	233	75	272	23
309	36	14	13	213	0
170	38	252	16	214	0
166	36	278	17	272	23
229	0	285	8	299	17
297	100	9	0	213	0
305	17	284	0	214	0
308	50	271	5	216	0
196	50	307	31	261	50
201	44	288	14	276	0
265	30	289	31	32	0
266	0	287	21	163	6
203	0	283	39	218	0
274	50	291	50	219	0
205	28	292	0	221	25
273	75	290	17	194	18
167	10	310	50	193	15
168	21	174	0	211	100
303	25	7	23	259	50
309	100	16	100	253	25
197	100	281	67	202	0

TABLE I, continued

Station No.	% Passenger Cars	% Pick-up Trucks	% Trucks	% Miscellaneous
27	72	19	6	3
173	63	21	11	4
222	62	15	21	2
294	81	6	9	4
298	74	12	18	1
306	70	0	30	0
302	82	5	11	2
169	52	19	28	0
309	73	0	27	0
170	70	15	15	0
166	77	15	8	0
229	90	0	10	0
297	67	26	10	3
305	76	15	9	0
172	63	16	16	2
308	81	14	5	0
196	71	15	14	0
201	60	21	19	0
265	41	33	20	0
266	67	29	0	0
17	65	9	26	0
203	77	10	7	7
274	48	9	43	0
205	64	10	26	0

TABLE I, continued

Station No.	% Passenger Cars	% Pick-up Trucks	% Trucks	% Miscel-laneous
273	38	52	10	0
167	67	13	19	0
168	58	21	37	0
303	70	13	17	0
309	75	20	4	0
197	40	45	15	0
198	37	54	10	0
267	64	19	16	0
269	65	17	18	0
321	71	11	17	0
178	47	40	13	0
180	65	28	7	0
225	46	27	26	0
227	62	17	21	0
31	71	13	13	3
181	90	10	0	0
195	71	22	7	0
233	85	8	8	0
14	74	8	19	1
252	60	19	19	0
278	70	16	13	0
285	79	11	9	0
9	86	14	0	0
284	73	13	13	0

TABLE I, continued

Station No.	% Passenger Cars	% Pick-up Trucks	% Trucks	% Miscel-laneous
271	71	17	12	0
307	66	16	16	1
288	60	17	23	0
289	75	14	11	0
287	49	16	33	0
283	50	23	24	0
291	69	28	2	0
292	80	20	0	0
290	78	15	6	1
310	83	14	4	0
174	74	27	0	0
7	70	17	11	0
16	79	18	4	0
281	33	42	18	6
293	39	11	50	0
286	69	26	5	0
207	58	8	33	0
164	80	17	3	0
215	62	15	19	0
296	66	10	23	2
315	62	31	8	0
165	70	17	13	0
241	74	9	20	0
272	73	17	15	0

TABLE I, continued

Station No.	% Passenger Cars	% Pick-up Trucks	% Trucks	% Miscellaneous
299	79	0	21	0
213	78	7	9	4
214	90	8	3	0
216	93	7	0	0
261	88	6	1	0
276	100	0	0	0
32	82	12	6	0
163	68	10	22	0
218	91	8	3	0
219	82	15	3	0
221	88	7	5	0
194	69	17	13	1
20	77	20	3	0
193	62	20	19	0
211	63	25	13	0
259	76	4	19	0
253	24	20	56	0
202	93	7	0	0
200	65	7	31	0
251	42	58	0	0
264	57	21	21	0
277	53	13	30	1
34	82	2	16	0
263	90	2	9	0

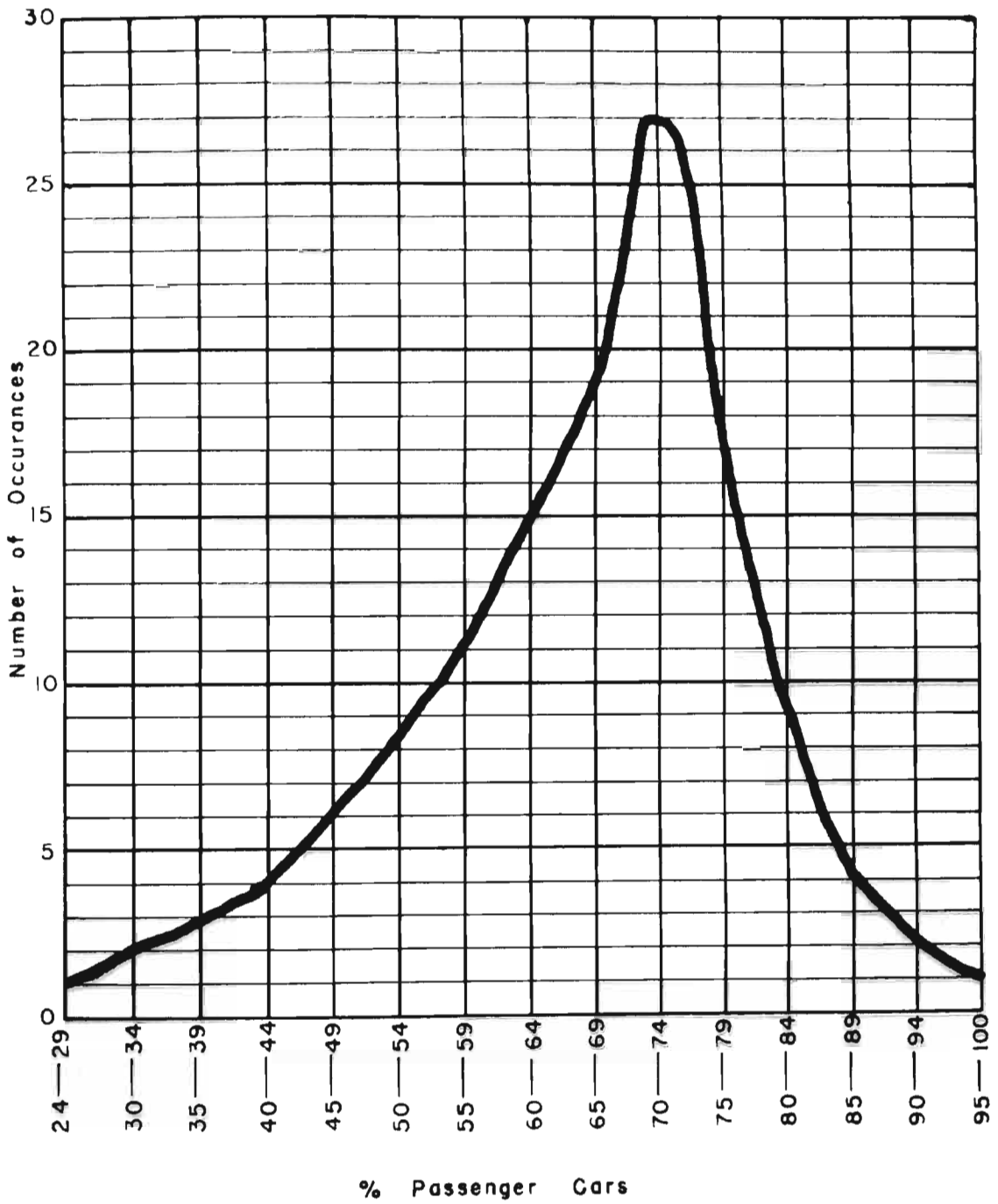
TABLE I, continued

Station No.	% Passenger Cars	% Pick-up Trucks	% Trucks	% Miscel-laneous
260	58	25	8	0
210	67	16	9	0
255	67	8	25	0
256	42	48	10	0
244	75	23	2	0
247	50	40	10	0
245	63	30	5	2
197	73	22	4	1
19	77	10	12	0
254	77	13	9	0
240	58	22	20	0
190	66	11	23	0
242	71	8	19	0
189	50	31	19	0
188	61	30	6	2
234	50	30	10	10
187	73	14	13	0
235	58	27	17	0
186	73	11	16	0
237	55	45	0	0
239	74	4	22	0
238	58	19	13	10
183	66	9	24	0
182	54	25	17	4

TABLE I, continued

Station No.	% Passenger Cars	% Pick-up Trucks	% Trucks	% Miscellaneous
232	75	25	0	0
184	49	24	26	1
185	72	14	13	1
228	48	20	32	1
179	71	20	9	0
231	33	50	17	0
23	65	18	15	1
257	52	31	17	0
212	78	6	17	0
250	59	9	31	0
248	53	16	30	0
280	58	17	25	0
209	50	41	9	0
311	51	4	45	0
171	70	6	24	0
217	90	2	6	2
220	67	17	15	7
316	51	4	45	0
317	54	18	20	3

PASSENGER CAR VARIATION

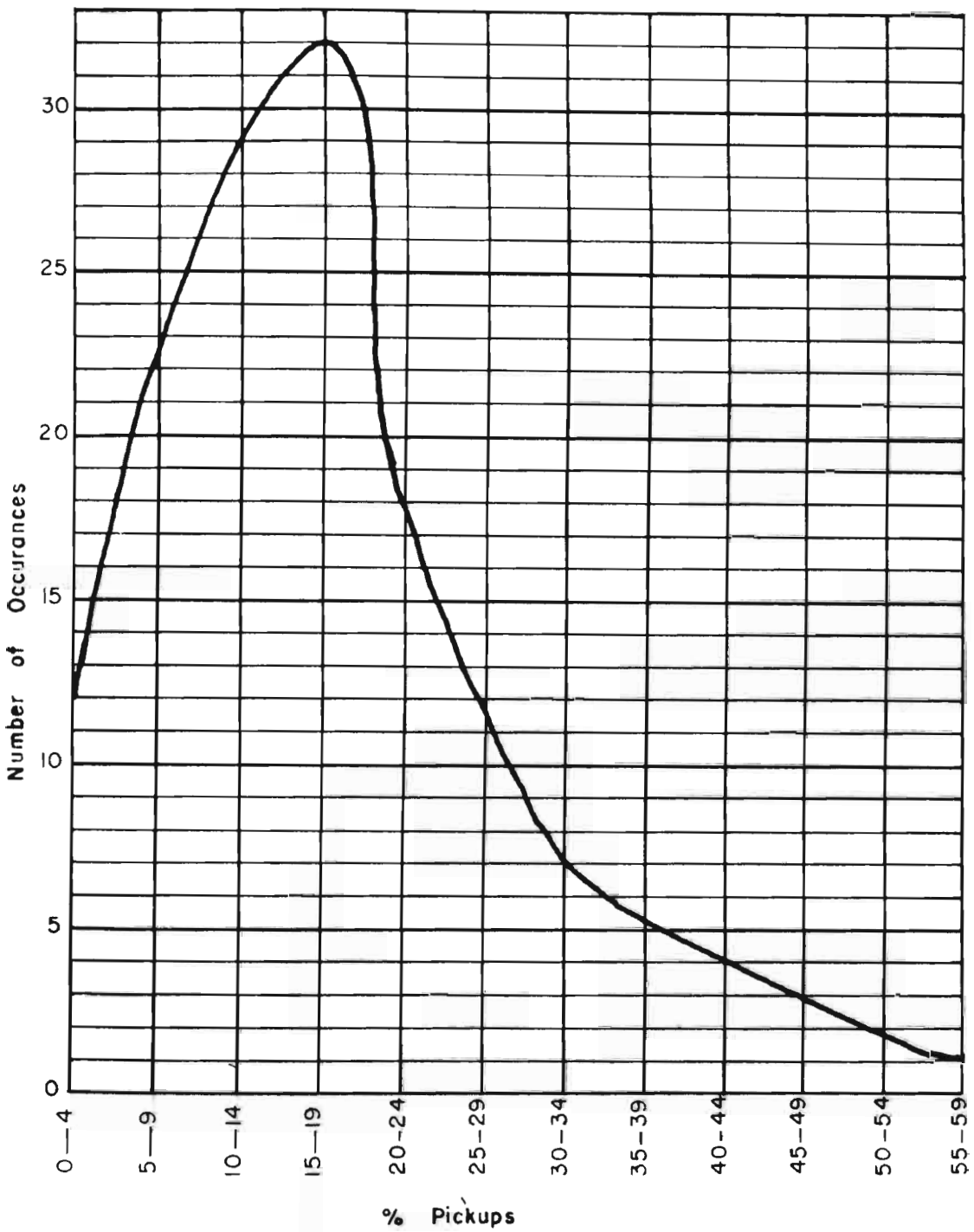


Average % = 67.3 %

R.M.S. = 14.06 %

FIGURE NO. 9

PICKUP VARIATION

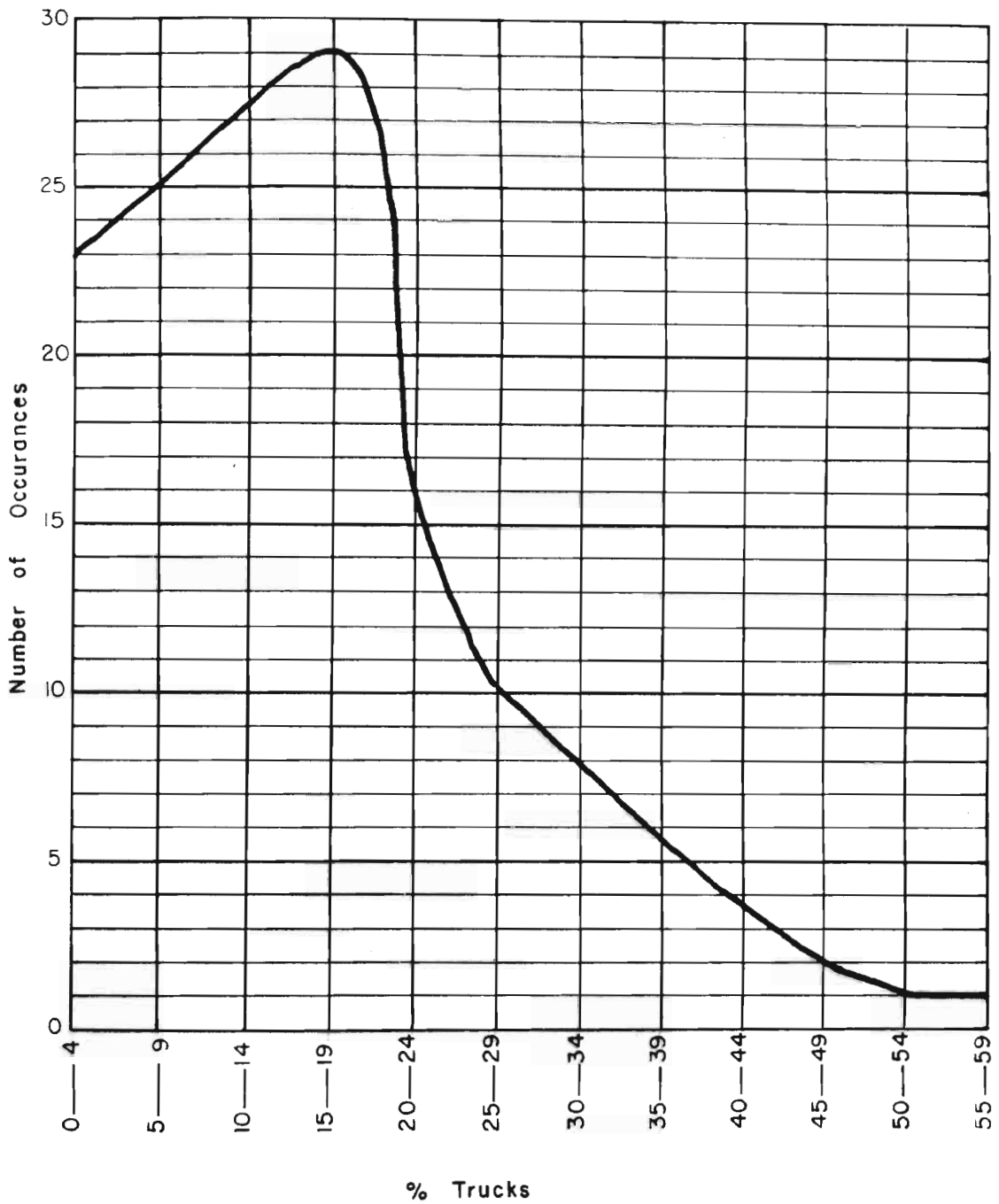


Average % = 17.7 %

R.M.S. = 11.5 %

FIGURE NO. 10

TRUCK VARIATION



Average % = 15 %

R.M.S. = 10.75 %

FIGURE NO. 11

LEGEND

KEY MAP
SHOWING LOCATION OF COUNTY

GASCONADE COUNTY

MARIES COUNTY

PULASKI COUNTY

DENT COUNTY

CRAWFORD COUNTY

TEXAS COUNTY

MARK TWAIN FOREST

TRAFFIC CLASSIFICATION MAP

GENERAL HIGHWAY MAP

PHELPS COUNTY

MISSOURI

PREPARED BY THE
HIGHWAY PLANNING DEPARTMENT
MISSOURI STATE HIGHWAY DEPARTMENT
IN COOPERATION WITH THE
PUBLIC ROADS ADMINISTRATION
FEDERAL WORKS AGENCY

SCALE

1949

FIRST NUMBER — % PASSENGER CARS
SECOND NUMBER — % PICKUPS
THIRD NUMBER — % TRUCKS

PLATE NO. 3

The only exception to this was at several stations in the northeast section counted on Labor Day. At these stations the percentage of passenger cars was abnormally high.

2. The type of traffic did not vary as to the section of the county in which the counts were taken.

3. The presence of an almost unpassable road tended to increase the percentage of pickups.

4. Although there is a great variation in the percentages of the various classifications of traffic, there is a definite tendency toward a somewhat stable traffic movement, with respect to classification, on the rural roads studied. This tendency appears to be toward a traffic movement composed of 70 percent passenger cars, 15 percent pickups and 15 percent trucks.

5. The number of miscellaneous vehicles moving on the rural roads studied is negligible.

Control Counts:

As was mentioned previously, the purpose of control counts is to establish a pattern of traffic volume fluctuation. This pattern is to be used in reducing the remainder of the station counts to a common base. This reduction was accomplished by a series of factors.

Before discussing the factors themselves, it would be advisable to consider their feasibility. Due to the limited number of control counts a statistician argues insufficient data for the conclusions.

While the desirability of more complete data is recognized, it is felt that the use of this small number of control counts can be

justified by the following observations:

1. In Figure No. 12, it can be seen that the daily fluctuation of the three control stations follow each other in trend rather closely. The main exceptions to the principle appear in the curve for Station No. 2, where the count is so small, one or two vehicles would have an exaggerated effect.

2. In Figure No. 13, it can be seen that the average variation throughout the week indicates definite trends.

3. Figure No. 14 shows that over a period of years, the counts at station 2406 have a tendency for the same weekly fluctuation.

4. When the average daily traffic for each month is plotted against time, as in Figure No. 15, a pattern of similarity in yearly traffic volume appears. With respect to this pattern, it will be observed that in the year 1948, the traffic volume appears to be high in July and low in August. This occurrence is due to the road serving as a detour during the month of July and a bridge near station 2406 being out of service for two weeks in the month of August. Also, it will be further observed that traffic is heavy for the latter part of the year 1949, due to an exceptionally mild winter.

5. When the curves shown in Figures No. 14 and 15 are adjusted for trend purposes, as in Figures 16 and 17, the pattern of traffic variation can be more readily seen. The method used for adjusting these curves to show trends is that method set forth by Mr. Ernest W. Steel in his textbook "Water Supply and Sewerage."(4) This method

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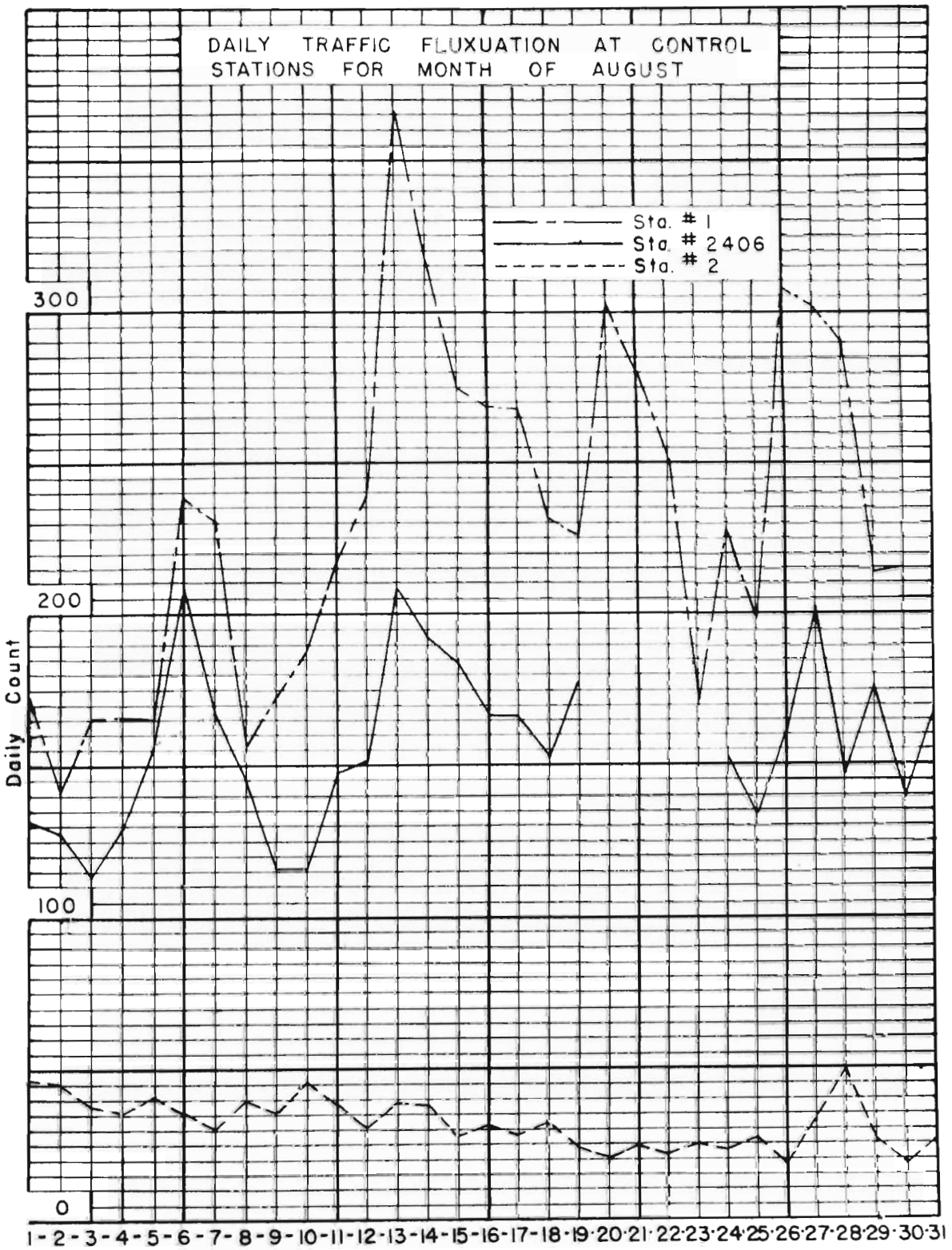
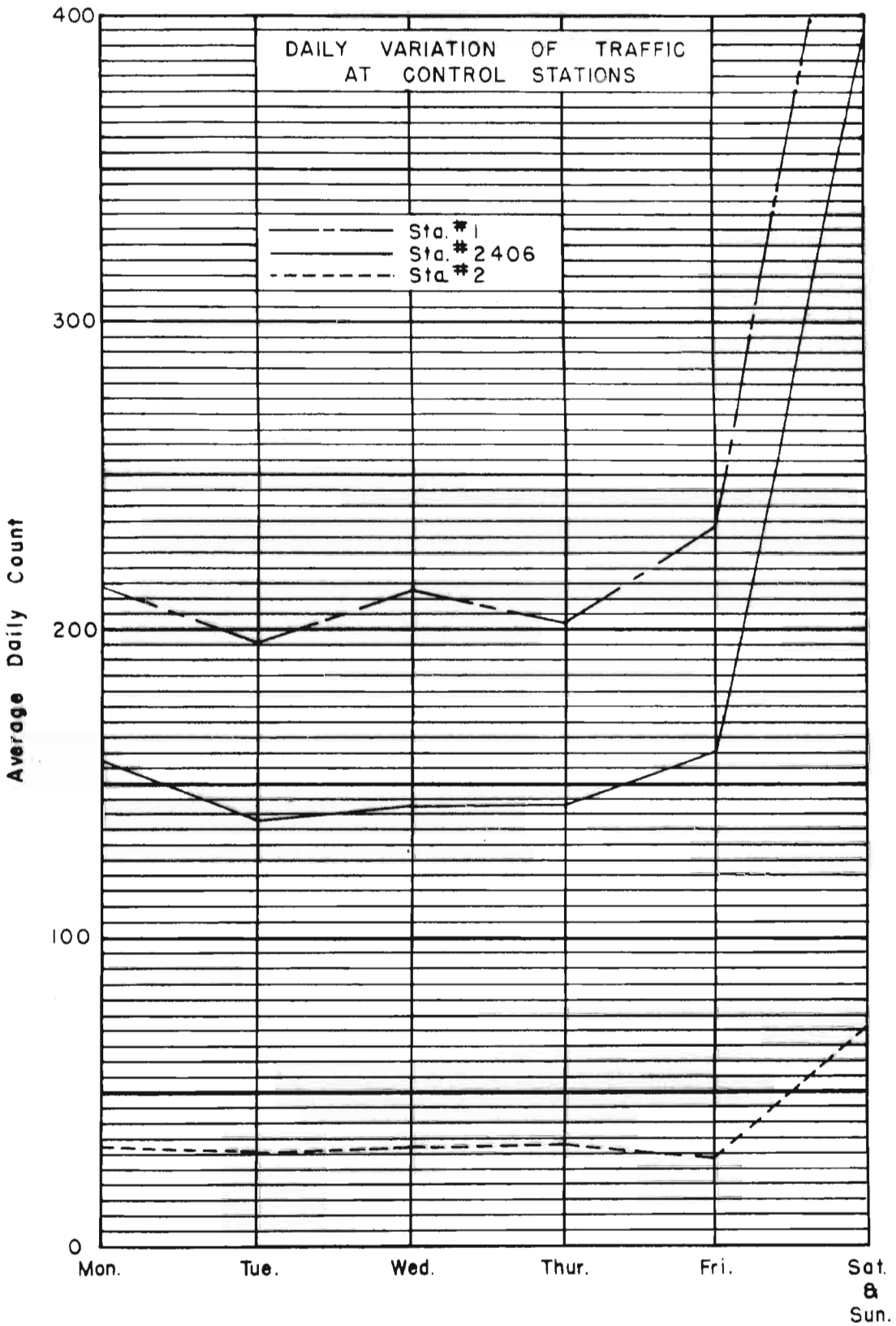
(4) Steel, Ernest W. "Water Supply and Sewerage", a textbook McGraw-Hill Book Company, 1947, p. 34.



August 1949

FIGURE NO. 12



August 1949

FIGURE NO. 13

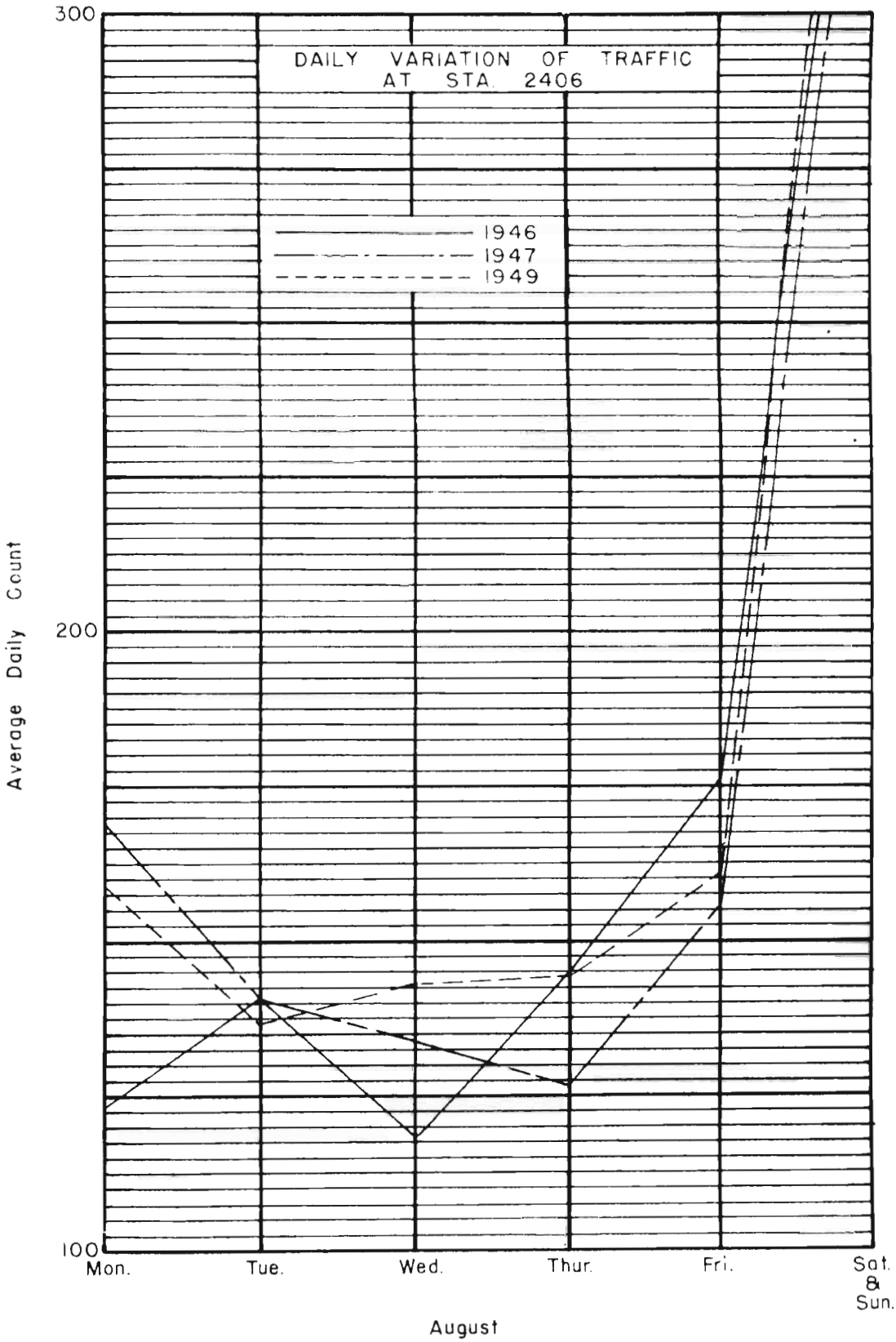
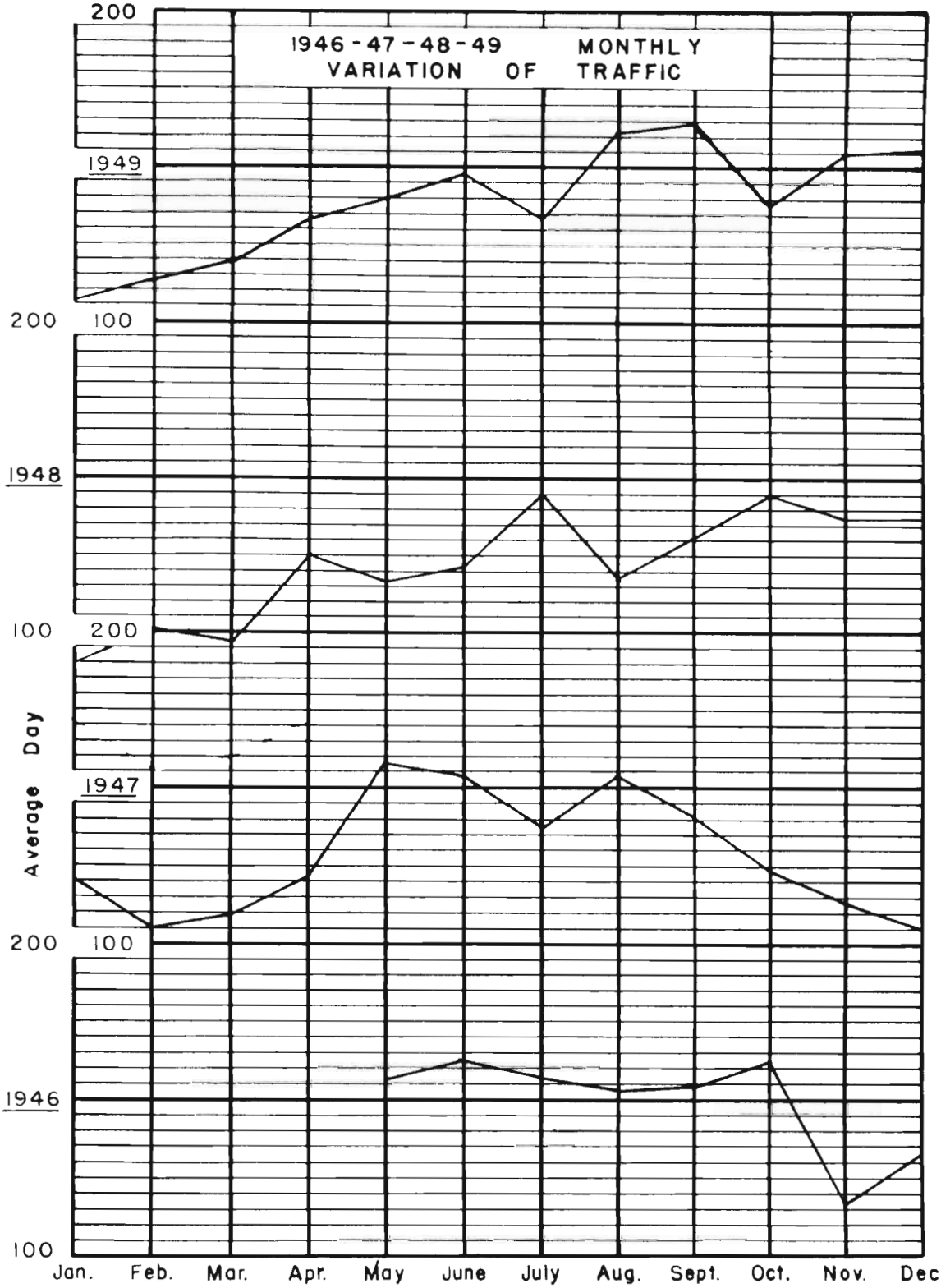

DAILY VARIATION OF TRAFFIC
AT STA. 2406
1946
1947
1949
300
200
100
Average Daily Count
Mon.
Tue.
Wed.
Thur.
Fri.
Sat. & Sun.
August

FIGURE NO. 14



COMPARISON OF TRAFFIC DURING PERIOD

1946-49 PASSING STA. NO. 2406

FIGURE NO. 15

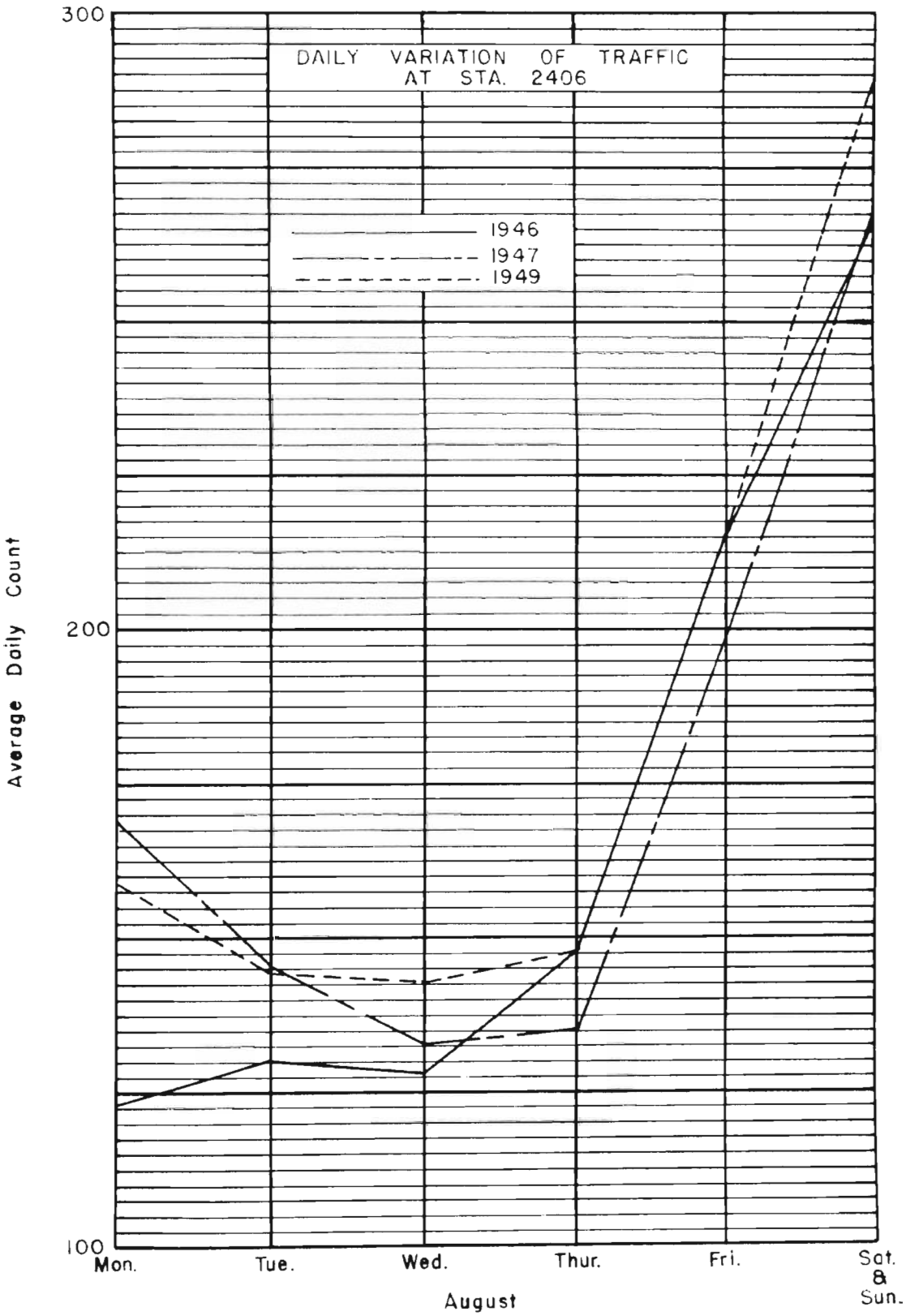
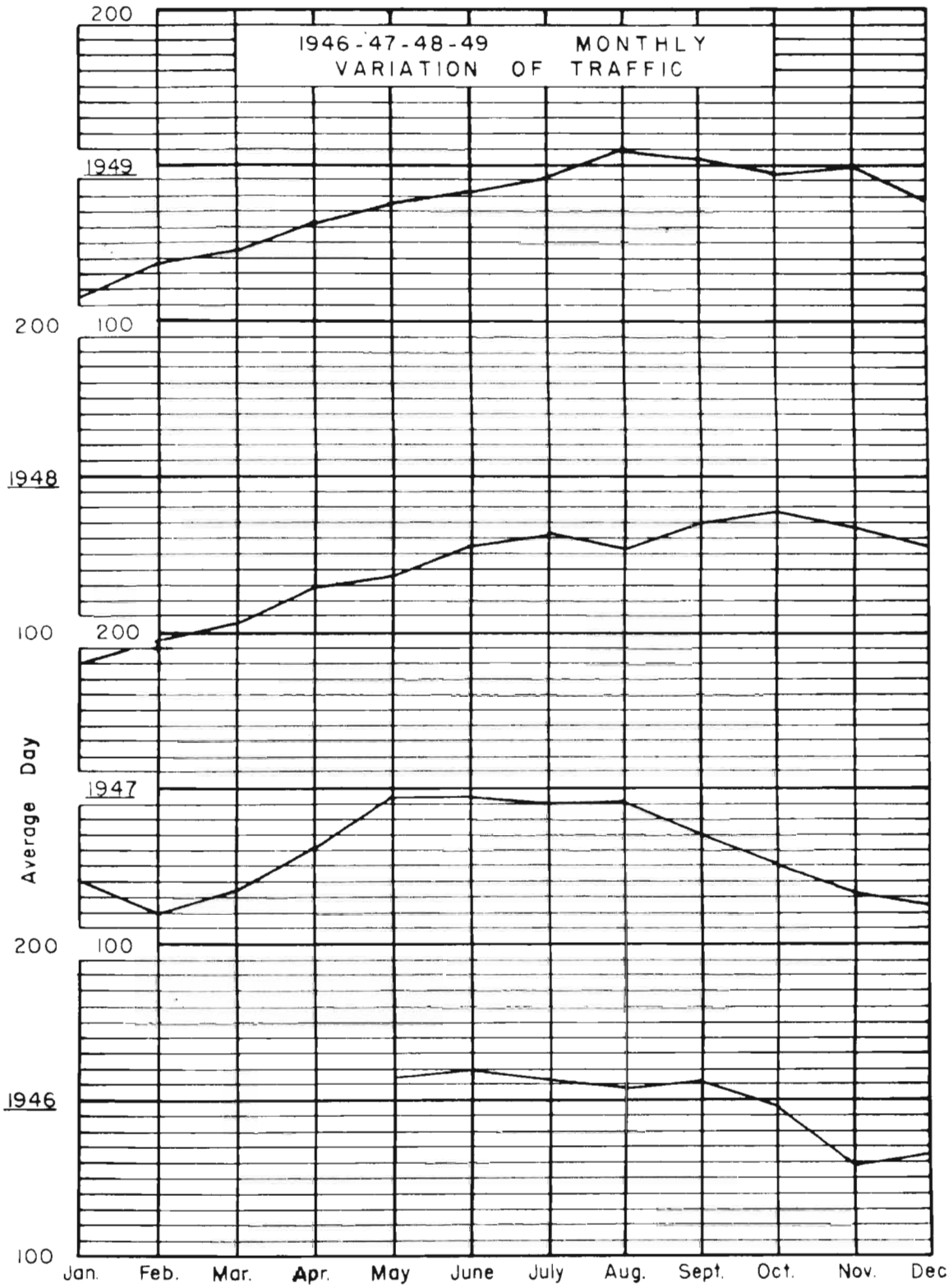

DAILY VARIATION OF TRAFFIC
AT STA. 2406
1946
1947
1949
300
200
100
Average Daily Count
Mon.
Tue.
Wed.
Thur.
Fri.
Sat.
&
Sun.
August

FIGURE NO. 16



COMPARISON OF TRAFFIC DURING PERIOD
1946-49 PASSING STA. NO. 2406

FIGURE NO. 17

consists of weighing each point on a curve according to the principle of binomial expansion for example:

$$\frac{a + 4b + 6c + 4e + d}{16} = C \text{ adjusted}$$

For the shorter curves it was decided to use the formula:

$$\frac{2 + 2b + c}{4} = b \text{ (adjusted)}$$

An example of these calculations can be seen in Figure No. 18.

After considering the aforementioned facts, the author feels justified in using the available control counts to reduce the rest of the station counts to a common base.

The method used to reduce the station counts to a common base, was to obtain factors for yearly fluctuation, daily fluctuation and the ratio of a twenty-four to an eighteen hour count. Once these factors were obtained they were applied as shown in Figure 19. In computing these factors, it was found necessary to obtain all the information as to monthly fluctuation from Station No. 2406. The reason for this necessity was that information at the other stations was available for a six weeks period only. For the daily variation factor, it was decided to use the average of the fluctuation at Stations No. 2406 and No. 1. This decision was made because of the large variation caused by one vehicle at the low count Station No. 2. For the same reason, it was necessary to obtain the eighteen to twenty-four ratio from the counts at Station No. 1, since complete data on hourly fluctuation at Station 2406 was unavailable. A complete list of the combined factors can be found in Table No. 3.

SAMPLE CALCULATIONS

Adjustments for Trend Curves

Sample No. I (Short Curve)

Point A = 123

Point B = 141

Point C = 118

$$\text{Point B Adjusted} = \frac{a + 2b + c}{4}$$

$$= \frac{123 + 282 + 118}{4}$$

$$= \frac{523}{4}$$

$$= 131$$

Sample No. 2

Point A = 121

Point B = 106

Point C = 109

Point D = 122

Point E = 159

$$\text{Point C Adjusted} = \frac{2 + 4b + 6c + 4d + e}{16}$$

$$= \frac{121 + 424 + 654 + 488 + 159}{16}$$

$$= \frac{1896}{16}$$

$$= 116$$

Figure 18

SAMPLE CALCULATIONS

Factor for the Reduction of Station

Counts to a Common Base
August 1, 1949

Station No. I: 24 hour count equals 173

12 a.m. to 6 a.m. count equals 9

Average daily count for August equals 232

Station No. 2: 24 hour count equals 131

12 a.m. to 6 a.m. count unavailable.

Average daily count for August equals 162

Average day for 1949 equals 139

Relation of eighteen hour to twenty-four count from Station No. I equals 164/173, equals 94.94 percent.

Relation of August 1, 1949 to average day in August 1949 equals; for Station I, equals 173/232, equals 74.5 percent; for Station 2406, equals 131/162, equals 81.9 percent.

Average relation of August first to the average day in August 1949 equals

$$\frac{74.5 + 81.9}{2} = 78.2 \text{ percent}$$

Relationship of August 1949, to average month in 1949, from Station 2406 equals

$$\frac{162}{139} = 1.16 \text{ percent.}$$

Combining into single factor:

$$F = \frac{1}{94.94 \times 78.2 \times 116} = 115.8 \text{ percent}$$

Count at Station equals eighteen hour count times F.

Figure No. 19

COMMON BASE FACTORS

Date		Factor
August	1	1.158
"	2	1.226
"	3	1.370
"	4	0.970
"	5	1.155
"	6	0.828
"	8	1.132
"	9	1.175
"	10	1.145
"	11	0.970
"	12	0.891
"	13	0.623
"	15	0.746
"	16	0.795
"	17	0.800
"	18	0.896
"	19	1.175
"	20	0.674
"	22	0.861
"	23	1.140
"	24	0.905
"	25	1.006
"	26	0.755
"	27	0.695
"	29	0.874
"	30	0.956
"	31	0.820
September	1	0.900
"	2	0.856
"	3	0.600
"	4	1.430
"	5	0.832

Table No. 2

Frequency of Traffic Movement:

The cost of a traffic survey is no doubt one of the chief reasons many counties have not seen fit to conduct such a survey. With this financial consideration in mind, it was decided to search for methods of reducing the cost of a comprehensive traffic survey.

One method of reducing this cost would be to reduce the number of stations that must be counted. In order to reduce the number of stations in a traffic survey, it is necessary to devise some method of estimating traffic volume at the eliminated stations. For this reason, the possibility of a relationship between the number of dwellings feeding traffic to a road and the traffic volume on that road was investigated. From the completed questionnaires returned by rural residents, it was observed that distance from town made little difference in the farmer's travel habits. (See Table No. 3). The number of trips to town by the farmer is somewhat conclusive because in most areas a few people working in town could increase the average number of trips considerably. This was due to the fact that questionnaires were completed by less than twenty percent of the rural residents. Before discussing the results of these questionnaires, it would be advisable to consider the following:

1. If a walk is taken down mainstreet of any small town on Saturday afternoon, it becomes quite apparent that the farmer population enjoys a trip to town on Saturday. This accounts for one trip to town per week.

2. A large number of farmers in Phelps County deliver milk to town. As the farmers must deliver this milk at least three times a

week, this factor accounts for two additional trips to town per week.

3. Emergencies and romance occur even in rural communities. It is therefore quite possible than an emergency or the desire to see a movie will send some member of the family to town about once a week. This factor would account for another trip to town each week.

These considerations would establish an average of four trips to town per week for each farm family. If Table No. 3 is again consulted, it will be seen that such a condition compares favorably with the results obtained from the completed questionnaires.

Along with his trips to town it is feasible to assume the average farmer makes one trip a day, traveling to his fields, visiting his neighbors, helping his neighbors with their work, or performing some necessary chore. Considering all factors it can be concluded that the average farm unit accounts for three vehicle movements per day.

In order to prove or disprove the above conclusion, it was decided to investigate the results from the actual traffic count for a relationship between the number of dwellings feeding a rural road and the increased traffic on that road. The results of this investigation which appear in Figure No. 20, substantiate the conclusion that each farm unit will account for three vehicle movements per day.

Another observation to be made from Figure No. 20, is that the agreement of these results, with the previous conclusions seems to justify the method previously explained for adjusting all counts to a common base. This justification is based on the fact that the figures used to plot Figure No. 20 were obtained by use of the adjusted counts.

TABLE No. 3

Miles From:	Average Number Trips to Town a Week
Rolla	
1	Considered part of town
2	3.5
3	4.85
4	7.66
5	5.54
6	4.06
7	5.7
8	3.63
9	4.75
10	4.5
11	4.0
12	6.5
13	3.5
14	2.62
15	4.13
16	3.00
17	3.5
18	3.83
19	4.00
20	5.33
21	5.00
22	2.00
23	2.00
24	4.20
Edgar Springs	
1	None available
2	3.25
3	3.00
4	3.00

RELATIONSHIP OF NUMBER OF DWELLINGS TO TRAFFIC VOLUME INCREASE

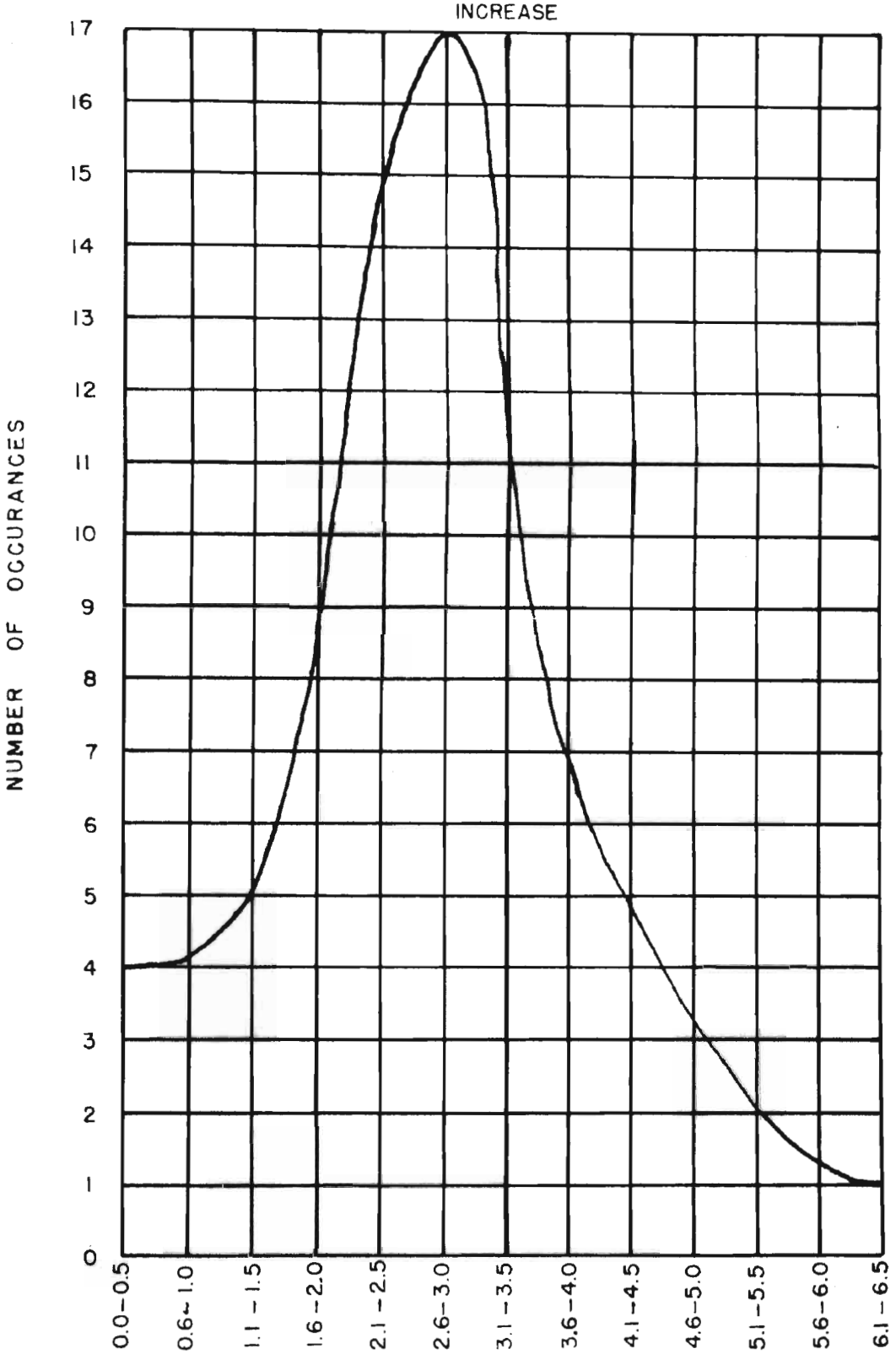


FIGURE NO. 20

Determination of Traffic Flow:

The method used in determining the traffic flow consisted of first applying the control factor to our manual counts and then placing the adjusted counts on a Phelps County map (See Plate No. 4).

It will be recalled that at the beginning of this survey it was necessary to reduce the number of stations counted. This reduction of stations resulted in the omission of several desired counts. These omissions made it necessary to predict several counts.

The method of predicting these counts was to use the principle of three vehicle counts per farm unit as previously explained and applying a movement of these vehicles as indicated by actual count of vehicle movement in the vicinity. After these counts had been predicted, they were placed on a Phelps County map, (See Plate No. 5).

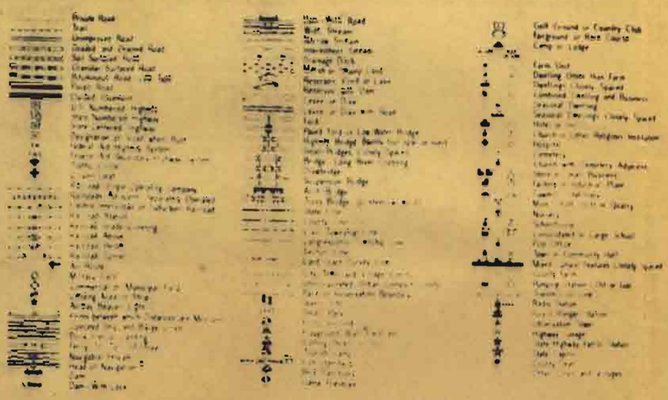
After the traffic count values were determined, it was decided to show the traffic movement graphically as seen in Plate No. 5.

A careful study and comparison of the traffic flow map (Plate No. 5) and a road map of Phelps County will indicate that although the highway system is in general handling traffic satisfactorily, two unsatisfactory conditions exist.

The first of these conditions is in some cases rural residents are willing to travel out of their way to reach a more satisfactory road.

The second of these conditions is that inadequate stream crossing often force traffic to detour against its wishes. An example of this condition can be seen in connection with the county road connecting Highways 63 and T. This road is located approximately four and one-

LEGEND



KEY MAP
SHOWING LOCATION OF COUNTY

GASCONADE COUNTY

MARIES

COUNTY

COUNTY

COUNTY

COUNTY

COUNTY

PULASKI

DENT

TEXAS COUNTY

TRAFFIC VOLUME COUNTS
GENERAL HIGHWAY MAP

PHELPS COUNTY
MISSOURI

PREPARED BY THE
HIGHWAY PLANNING DEPARTMENT
MISSOURI STATE HIGHWAY DEPARTMENT
IN COOPERATION WITH THE
PUBLIC ROADS ADMINISTRATION
FEDERAL WORKS AGENCY

SCALE

1949

LARGE FIGURES ARE ACTUAL COUNTS ——— (4)
SMALL FIGURES ARE PREDICTED COUNTS ——— (4)

PLATE NO. 4

—L E G E N D—

AVERAGE DAILY TRAFFIC

TRAFFIC VOLUME ON LOW COUNT ROADS

CENTER LINE

TRAFFIC VOLUME ON HIGH COUNT STATE HIGHWAYS

OVERLAY REPRESENTS TRAFFIC VOLUME FOR U.S. HIGHWAY 66

KEY MAP

TRAFFIC FLOW MAP

PHELPS COUNTY

MISSOURI

TRAFFIC VOLUME SCALE

5 160 320 480 640

1/64"= 5 VEHICLES

SCALE

1 0 1 2 3 4 MILES

PLATE NO. 5

half miles north of Edgar Springs.

It will also be observed upon studying the Traffic Flow Map (Plate No. 5) that there is a tendency for all traffic to move toward the three main centers of population, Rolla, Newburg, and St. James.

Trade Areas:

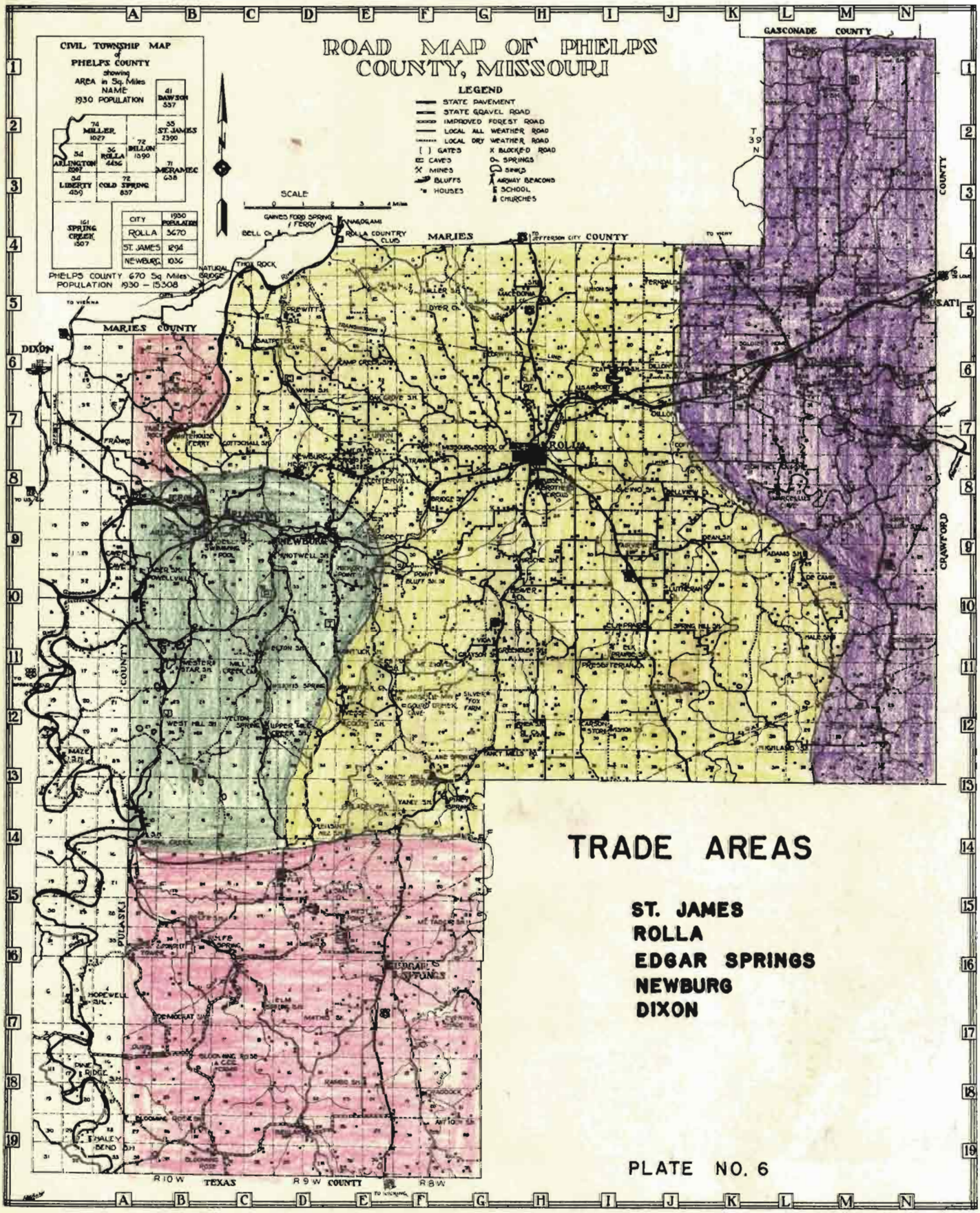
In order to obtain a better understanding of road needs in Phelps County, it was decided to determine the trade areas of the various towns in Phelps County. With the trade areas for the various towns established, it is possible to determine the following:

1. The town toward which residents of a certain district wish improved roads.

2. The effect of road conditions funneling trade toward a certain town.

3. The effect of road conditions in limiting a town's trade area.

The effect of road conditions on Phelps County trade areas can be determined by a study of the trade areas as shown in Plate No. 6. It will be observed that three definite conditions exist. The first of these conditions is that the trade area of the smaller towns is relatively limited. The second condition found to exist in a study of these trade areas is that St. James enjoys an expanded trade area, due to a systems of county roads, which tends to funnel traffic into St. James. The third condition is that, while Rolla enjoys a rather large trade area to the south, the lack of a road across the Gasconade River tends to block trade from the Northwest corner of Phelps County.


ROAD MAP OF PHELPS COUNTY, MISSOURI
CIVIL TOWNSHIP MAP of PHELPS COUNTY
showing AREA in Sq. Miles NAME 1930 POPULATION
PHELPS COUNTY 670 Sq. Miles POPULATION 1930 – 15308
CITY 1930 POPULATION
ROLLA 3670
ST. JAMES 1294
NEWBURG 1036
LEGEND
STATE PAVEMENT
STATE GRAVEL ROAD
IMPROVED FOREST ROAD
LOCAL ALL WEATHER ROAD
LOCAL DRY WEATHER ROAD
GATES
CAVES
MINES
BLUFFS
HOUSES
BLOCKED ROAD
SPRINGS
SINKS
AIRWAY BEACONS
SCHOOL
CHURCHES
SCALE
GASCONADE COUNTY
MARIES COUNTY
PULASKI COUNTY
CRAWFORD COUNTY
TEXAS COUNTY
ROLLA
NEWBURG
DIXON
MARIES
TRADE AREAS
ST. JAMES
ROLLA
EDGAR SPRINGS
NEWBURG
DIXON
PLATE NO. 6

Percent of Loaded Trucks:

An important feature in the design of any road is the amount of truck traffic. In connection with this principle, it was decided to investigate the percentage of the trucks appearing on rural roads loaded and unloaded.

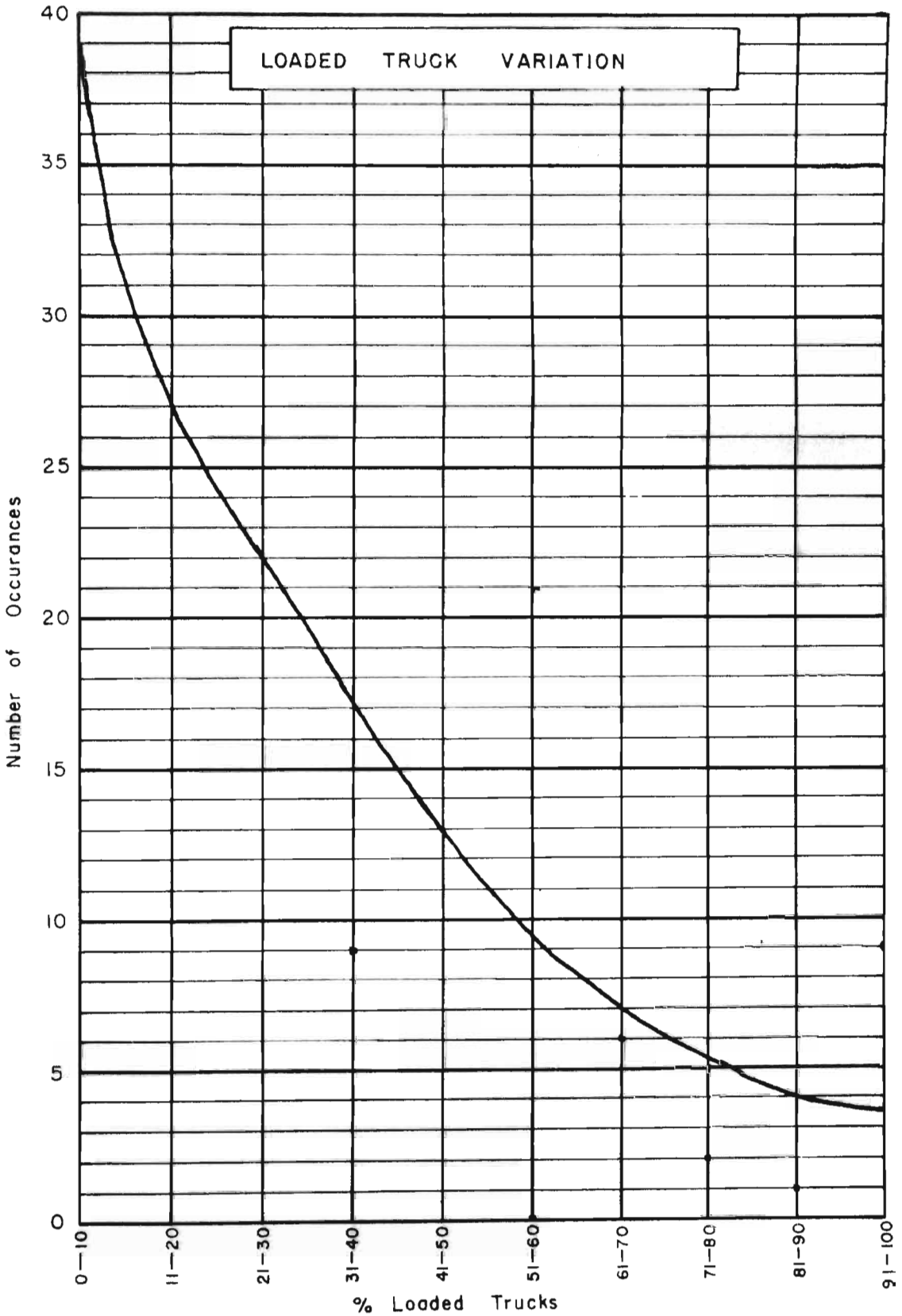
The results of this investigation can be seen in Figure No. 21 While the variation in the percentage of loaded trucks was rather wide, it is quite obvious that the percentage of loaded trucks is quite small.

Short Term Counts:

In connection with this study, the subject of short term counts (3 or 4 hours) was investigated. No notable possibilities could be found as far as this subject was concerned.

Interviews and Questionnaires:

The results of interviews made and completed questionnaires indicated that the rural resident is mainly interested in the roads directly in front of his residence. In spite of this fact, there were two items on which all farmers appeared to be in general agreement. These items were the improvement of roads leading toward Rolla and the improvement of the present stream crossings.



Average % = 27.4%

FIGURE NO. 21

R.M.S. = 24.4%

RECOMMENDATIONS FOR IMPROVING THE PHELPS COUNTY ROAD SYSTEM

As was stated previously, the county road system in Phelps County is in general adequate.

While admitting that a relatively fine system of roads now exists in Phelps County, the author feels several improvements can still be made in the Phelps County road system.

The first of these improvements is the construction or improvement of a feeder road from U. S. Highway 63 to immediate vicinity of Duke, Missouri. There are several indications of the need for such a feeder road. The first of these indications is that, although several routes from U. S. Highway 63 to Duke, Missouri now exist, they are rather indirect and somewhat treacherous to drive over. A second factor indicating the need for such a road is the fact that traffic gathers and disperses from Duke, Missouri (See Plate No. 5). The third point indicating the need for such a road is the fact that although Duke, Missouri consists of a general store, a combined church and meeting hall and three or four residences, every night the street at Duke, Missouri is crowded with people who are literally all dressed up with no place to go. It is probable that if these people had access to a road that invited travel, they would do so in search of entertainment.

The second improvement in the Phelps County road system, that the author feels justified in recommending is the extension of State Farm-to-Market rout "F" until it intersects State Highway 68. The route of this extension could either be straight east and intersecting State Highway 68 at station number two, or turn southward at sta-

tion 301 and resume its easterly direction at station 302 intersecting State Highway 68 at station 303, (See Plate No. 1). The latter of these routes would serve a larger volume traffic (See Plate No. 5) and require less improvement than the former. The chief reason such an extension of State Farm-to-Market route "F" being made is to furnish residents of the southeast portion of Phelps County a less circuitous route to Rolla, Missouri. A more direct route to Rolla, Missouri is desirable because Rolla is the county seat of Phelps County and beyond doubt an important trading center for a wide area.

The third improvement the author would like to see made in the Phelps County road system, is the establishment of a program for the construction of stream crossings throughout the county. Such a program should logically start with the construction of stream crossings at points where a county road crosses an active stream. After providing for these crossings the program should be extended to provide crossings at points where county roads are often blocked by streams, which flow intermittently. By using the traffic flow map (See Plate No. 5) as a guide this program should provide for the improvement of the most heavily traveled stream crossing first. The next step in This program would be to provide stream crossings for those roads which show a heavy traffic potential once a stream crossing is provided. The last stream crossings to be built should be those on the more lightly traveled roads.

The chief reason for recommending such a program is that the rural residents are as a whole more interested in stream crossings

than any other phase of road construction. This interest is readily understood when it is found that poor stream crossings impaired or in some cases halted rural school bus service, milk pickup service, mail service, and some rural residents attempts to reach their jobs in town.

After discussing these specific improvements in the Phelps County road system, the author would like to recommend that all expenditures for construction and maintenance be allocated only after giving due consideration to the volume of traffic on the various Phelps County roads.

CONCLUSIONS

Although the scope of this study was limited to one county, it is felt that the principles and methods set forth are readily adaptable to many localities. This statement is strengthened by the fact that Phelps County represents an area containing several different interest groups. Among these groups are the specialized grape farmers, the dairy farmers, the diversified farmers, the timber groups in the national forest, and the part-time farmers whose main income is derived from employment in one of the several towns.

The results obtained in this study have proven the practicality of reducing the number of station counts in a comprehensive traffic survey. There is, however, a minimum to which the number of station counts can be reduced. The minimum number of stations should be sufficient to assure the following:

1. At least one count for every four miles of road. This requirement is necessary because on roads which traverse four miles or more between intersections, there is a tendency for traffic to move toward both intersections.

2. At least one count on every road. This count gives an indication of which way the traffic is moving on a certain road when coupled with trip frequency calculations.

3. A count at a minimum of every other intersection. The reason for this requirement is that the accuracy of traffic prediction becomes inaccurate, when carried past more than on intersection.

These limitations were borne out when, the author made several unsuccessful attempts at long range traffic movement predictions

using the information in Plate No. 5 and Figure No. 20.

The principle of an eighteen hour count proved very successful for the purposes of this survey. This success was largely due to the fact that control station counts indicated little traffic between 12 a.m. and 6 a.m. Before this principle is used in any other locality, it would be advisable to check the amount of traffic between 12 a.m. and 6 a.m. before deciding to factor this traffic.

The method of adjusting all counts to a common base used in this study proved very successful. The soundness of the method used was proven in the results obtained in the vehicle traffic per dwelling unit studies.

The data obtained at the control stations followed a very close pattern (See Figure No. 12). This pattern leads the author to the belief that the data necessary for reducing all counts to a common base could be provided by a single control station on a well traveled road.

The results obtained by the study of rural road classifications lead to the conclusion that satisfactory information as to traffic classification could be obtained by averaging the results of as few as ten stations. This conclusion can be better understood if the rather uniform distribution of vehicle types shown in (Plate No. 3) is studied.

It is the belief of the author that a satisfactory method of predicting traffic movement for the purpose of supplementing actual data can be devised. Any method devised for traffic prediction should be regarded as strictly supplementary, due to the fact that

any method of prediction cannot account for unorthodox happenings. This is further borne out by the fact that when the method devised for predicting traffic used in this study was checked against the data shown in Plate No. 4, it was found that counts could be predicted successfully over short distances only. Attempts to predict four or five stations usually resulted in some unforeseen peculiarity of traffic movement weakening the predictions.

Early in the study of traffic movement in Phelps County, it became apparent that unless blocked by some obstacle, traffic tends to move towards the nearest population center. This can best be seen in Plate No. 5.

The trade area of a fairly large town tends under normal conditions, to curtail and overlap the trade areas of nearby smaller towns. This condition is quite logical and appeared in the results obtained by interview and questionnaire. An example of such a condition can be seen in Plate No. 6.

The questionnaire used in connection with this study was weak in one point. This weakness was the failure to ask for the total number of trips made by the family. While this weakness was overcome in this study, it would have nullified efforts to obtain a vehicle per dwelling unit ratio had this study contained fewer stations.

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VITA

Clifford Donald Muir was born May 16, 1925, near Cartwright, Manitobia, Canada, the son of Alfred W. and Stella Muir.

His early education was received in rural grade schools near Waubun, Minnesota and junior and senior high schools at Fargo, North Dakota. He entered the Agricultural and Mechanical College of Texas in February 1944 and graduated from this school in January 1947, with a B.S. degree in Civil Engineering.

After graduation, he was employed by the Texas Highway Department at Fort Stockton, Texas, as an Office Engineer. Desiring field experience, he left the Texas Highway Department and soon accepted employment with the New Mexico Highway Department at Colvis, New Mexico, as an Instrumentman.

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