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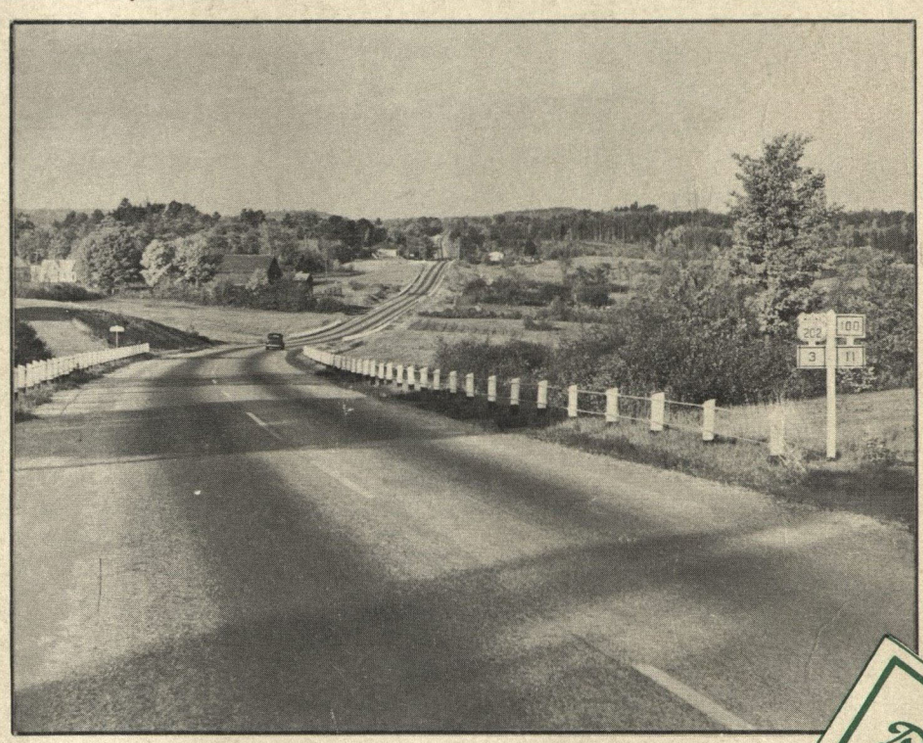
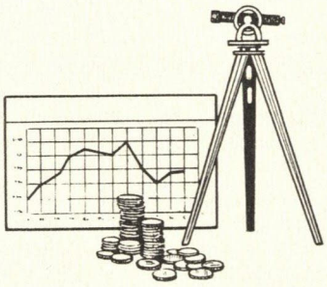
Maine HIGHWAY NEEDS



Report to the 94th. Legislature

Maine
HIGHWAY NEEDS

An engineering and economic study prepared for the 94th Legislature



by the
MAINE STATE HIGHWAY COMMISSION

in co-operation with the
UNITED STATES PUBLIC ROADS ADMINISTRATION

MAR 23 1949

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COMMISSIONERS
LLOYD B. MORTON
CHAIRMAN
CORNELIUS J. RUSSELL
HARLEY D. WELCH

LUCIUS D. BARROWS
CHIEF ENGINEER
TELEPHONE NO. 1200

State Highway Commission

State of Maine

Augusta

March 1, 1949

To the Senate and House of Representatives:

We have the honor to present an engineering and economic report entitled "Maine Highway Needs".

This report sets forth the results of an engineering study and suggests means of financing a long-range program of highway and bridge improvements in accordance with Chapter 151 of the Resolves of 1947.

Respectfully,

Lloyd B. Morton

C. J. Russell

Harley D. Welch

State Highway Commission

Foreword

The 93rd Legislature, cognizant of the importance of highways in promoting the growth of the State and also aware of the necessity of protecting the State's investment in highways and of eliminating the deterioration which began in depression and war years, ordered the State Highway Commission to place before the 94th Legislature an integrated highway program.

In accordance with the terms of this order, there has been prepared an appraisal of highway needs, both present and future. Anticipated highway income over a period of years, has been forecast and a series of programs, varying from six to 20 years, has been set forth to determine the costs of bringing the highways to present day standards.

Appreciation is extended to the United States Public Roads Administration for its co-operation and to other agencies and individuals for their advice and counsel.

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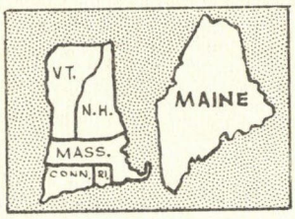
CHAPTER 1

Maine *and its* Present Highways

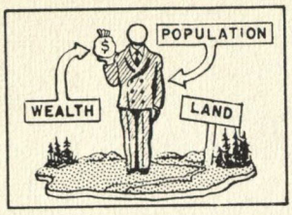


Introduction

Transportation systems have played an important part in the development and history of Maine. While modes of travel have changed through the years, the basic purposes are unaltered, for the economic life of the people depends upon the movement of commodities.

Maine's position as the northeasternmost state in the country places it in a somewhat isolated location. Although the largest of the New England states, Maine, with a land area of 30,444 miles, ranks 38th in the country in size.

Today we are living in an era when the motor vehicle performs a transportation service which affects the daily life of nearly every person. The problem of providing adequate highways is more, therefore, than a matter of proper construction. The distribution of population; the production of crops and goods; climate, topography, geography, and geology of the State; all are elements which have a direct bearing on the past development and future requirements of a highway system. The discussion of Maine and its highways in this chapter will be divided, therefore, into two general sections. One will deal with non-highway elements, and the other will be concerned directly with highways and the use made of them.

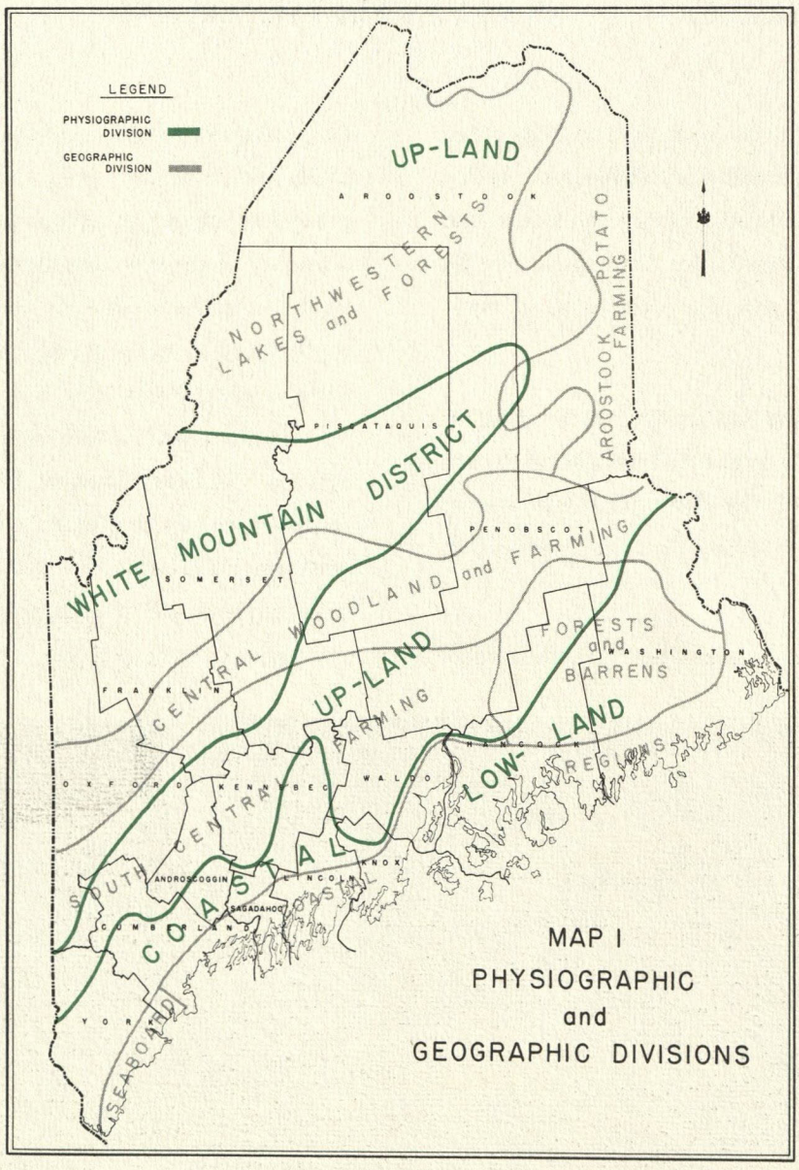


Non-Highway Elements

Physiography and Geography

Geologic upheavals and glacial influence were two factors in molding the physical development of the State. The prehistoric behavior of the earth's crust produced the slates, granites, and limestones which comprise the principal mineral wealth of the State. The retreat of the glacier, which covered Maine during the ice age, left masses of fertile silt and sand and gravel and also created numerous water power sites.

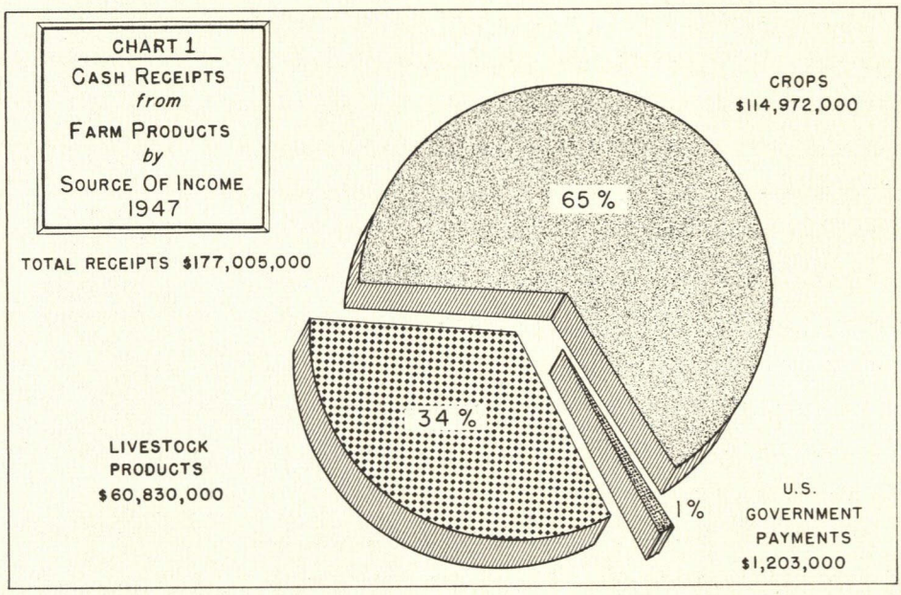
Maine is a plateau-like upland gradually increasing in altitude away from the coast. The Appalachian Mountain system, which breaks the level topography in western central Maine, terminates at Mt. Katahdin, second highest mountain in New England. Frost-free days range from 164 days on the coast to 111 days in the northern areas, and rainfall averages 40.5 inches annually. Map 1 indicates the physiographic and geographic sub-divisions in Maine.



Economic Activities

Agriculture — Agriculture relies upon highways, and since Maine is largely rural in area, highways must be planned with proper consideration of the needs of the farmer. In 1939, 18.5 per cent of all motor vehicles in the State were owned by farm residents. The trend is continuing upward. Over 21 per cent of all motor vehicles were owned by farm residents during 1945, the latest year for which data are available.

The crop culture of the State may be divided generally into potatoes, factory crops, apples, and market garden products. Major livestock interests are cattle and poultry. The Maine Department of Agriculture sets total payments to farmers in 1947 at 177 million dollars, and chart 1 shows the source of income for farmers in detail.

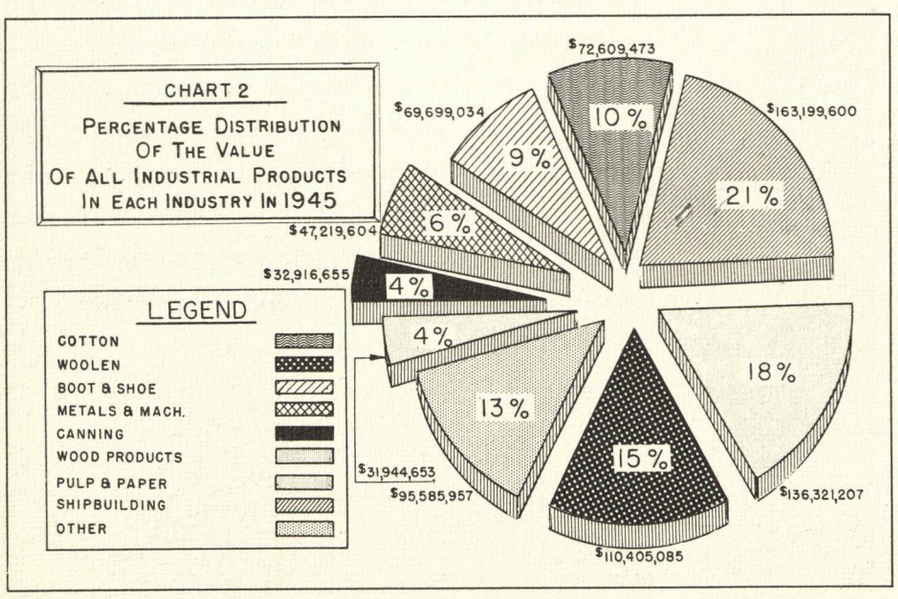


Potato growing is largely confined to northern Penobscot and Aroostook Counties. Factory crops, primarily corn, peas, and beans, are concentrated in the south central farming area, a 30–50 mile belt extending from the New Hampshire line to the Penobscot valley, although a considerable acreage of peas has been planted in the past few years in Aroostook County. Blueberries, for the most part, are grown on the Washington and Hancock County "barrens," but some of the other coastal counties between the Penobscot and Kennebec Rivers are finding blueberry culture a lucrative activity. Apples are a main crop in several scattered sections of the south central farming belt. Market gardening is generally located on the outskirts of the larger centers of population.

Fewer than ten communities in the State have more than 1,000 cattle, but smaller herds are scattered over wide areas throughout the State. Poultry raising ranks second to cattle and dairying.

Industry — When highways are planned, consideration must be given to the movement of raw materials and of finished products to and from industrial centers and to the transportation of workers to and from their jobs.

The Maine Department of Labor and Industry in 1945 reported the value of the products of all industries in the State as almost 760 million dollars. The value of various industrial products is shown in chart 2; however, if current information were available, the per cent assignable to shipbuilding would probably be reduced somewhat.



Industrial plants are concentrated in a relatively few communities; probably not over 50 of the municipalities in Maine can be classified as primarily industrial.

Fishing — Fishing is an important economic activity in Maine. Rapid transportation is, of course, vital to this industry. Commercial fish landings in 1945 amounted to 14 million dollars, and 70,000 persons in Maine are directly or indirectly dependent upon this industry for a livelihood. The State, ranking second only to California in production of canned seafood products, provides the United States with 95 per cent of its domestic herring sardine, 90 per cent of its domestic lobster, and 75 per cent of its domestic soft shell clam production.

Retail Trade — Retail trade plays an important part in the planning of highways, since the economic well-being of the individual and the community depends upon providing a meeting of distributor and consumer. The 1939 Census of Business placed Maine's retail sales at 281 million dollars.

Wholesale Sales — Wholesale sales in Maine for the year 1939 amounted to 166 million dollars, with 42 per cent of the total in Cumberland County. Other counties where the percentage of wholesale sales exceeds the percentage of population are Penobscot, Aroostook, and Androscoggin. Wholesale sales by counties and percentages of sales and population are shown in table 1.

TABLE 1

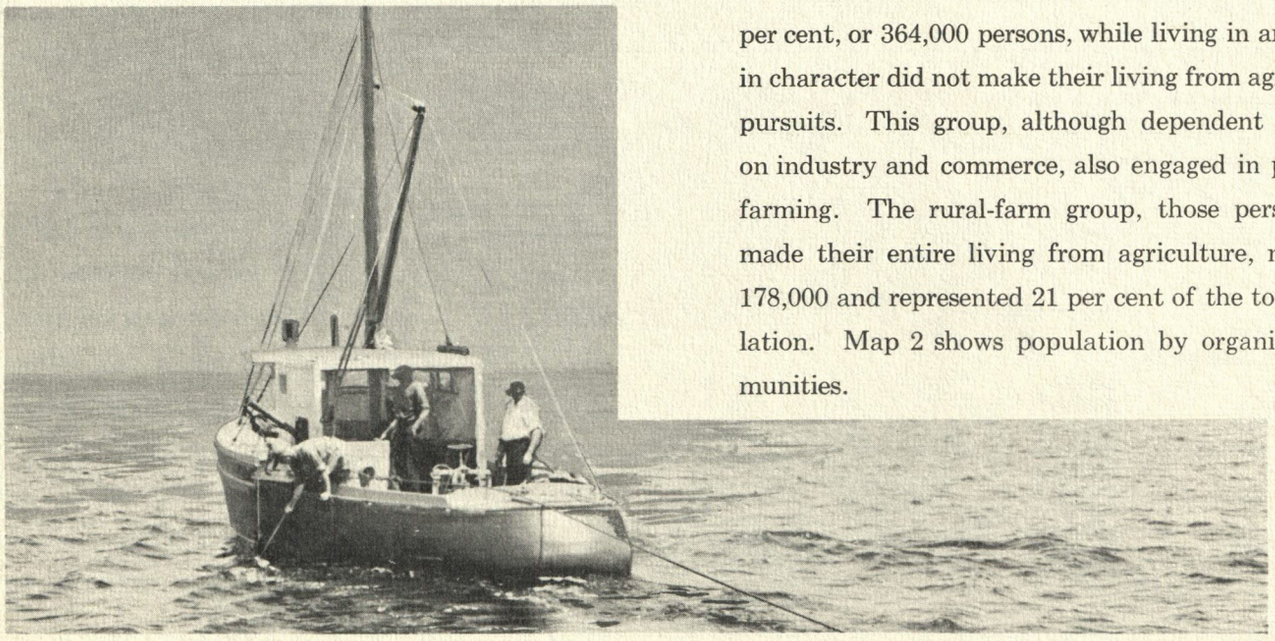
WHOLESALE SALES AND PERCENTAGES OF SALES AND POPULATION BY COUNTIES[1]

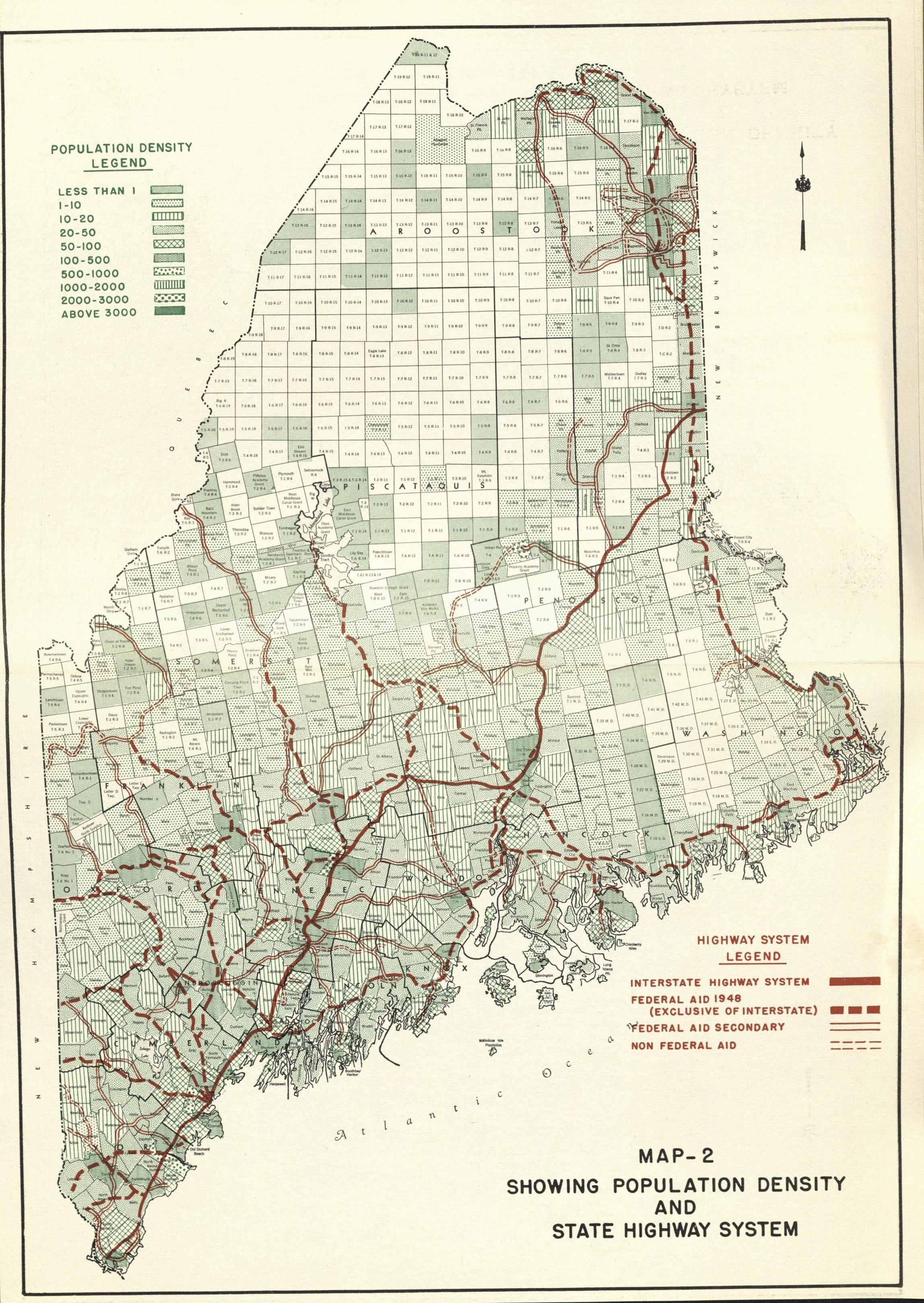
Counties	Wholesale Sales		Per cent of population[2]
	Thousands	Per cent	
Androscoggin	$ 13,080	7.9	7.9
Aroostook	21,568	13.0	9.7
Cumberland	69,482	41.9	17.5
Franklin	659	0.4	2.4
Hancock	1,820	1.0	4.0
Kennebec	10,374	6.3	9.4
Knox	4,774	2.9	3.4
Lincoln	1,075	0.7	2.0
Oxford	2,227	1.3	5.2
Penobscot	23,510	14.2	11.8
Piscataquis	1,193	0.7	2.4
Sagadahoc	2,228	1.3	2.5
Somerset	2,067	1.3	4.6
Waldo	1,646	1.0	2.7
Washington	5,029	3.0	4.6
York	5,116	3.1	9.9
Total	$165,848	100.0	100.0

[1] Source — 1939 Census of Business
[2] Source — 1940 Census of Population

Population

The distribution of population within the State is an important factor in determining a highway program. Population naturally follows industrial, commercial, or agricultural opportunities. Maine's population, in 1940, was 847,000. Thirty-six per cent, or 305,000, resided within urban areas of 5,000 or more inhabitants. This population was dependent largely on industrial or commercial activities. Forty-three per cent, or 364,000 persons, while living in areas rural in character did not make their living from agricultural pursuits. This group, although dependent generally on industry and commerce, also engaged in part time farming. The rural-farm group, those persons who made their entire living from agriculture, numbered 178,000 and represented 21 per cent of the total population. Map 2 shows population by organized communities.





MAP-2
SHOWING POPULATION DENSITY AND STATE HIGHWAY SYSTEM

Wealth and Income

Maine's assessed valuation of 718 million dollars in 1946 was unevenly distributed throughout the 16 counties, with 21 per cent accounted for in Cumberland County. Savings bank deposits in 1946 totaled 215 million dollars.

Total income payments to individuals in Maine for 1947 were 998 million dollars, or $1,128 per capita, as compared with $1,444 per capita for New England and $1,323 per capita for the United States as a whole.

TABLE 2

INCOME PAYMENTS, ASSESSED VALUATION, AND BANK DEPOSITS, BY YEARS

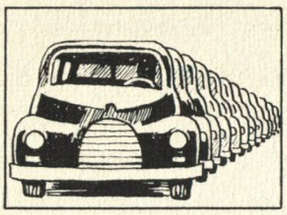
Years	Income payments (In millions)	Assessed valuation (In millions)	Bank deposits (In millions)
1929	$449		
1930	432	$757	$113
1931	381		
1932	298	696	
1933	297		
1934	323	664	
1935	353		121
1936	398	661	
1937	408		
1938	377	672	
1939	400		
1940	431	685	129
1941	505		
1942	673	704	
1943	857		
1944	864	707	
1945	847		190
1946	916	718	
1947	998		
1948			233

Maine ranks fourth among New England states in income payments per capita and has shown a greater ability to maintain its income position in relation to the other 47 states than all other New England states with the exception of Connecticut. In general, Maine possesses only moderate wealth, but its limited fiscal capacity is partially compensated for by the greater stability of its economy. Table 2 shows assessed valuation, savings bank deposits, and income payments to individuals; table 3, valuation by counties in 1946 and percentages of persons within counties filing income tax returns in 1943.

TABLE 3

ASSESSED VALUATION BY COUNTIES (1943)
PER CENT OF VALUATION AND PER CENT OF NUMBER OF INDIVIDUALS FILING INCOME TAX RETURNS (1943)

Counties	Assessed valuation — 1943 Total (In thousands)	Per cent	Individual income tax return percentages — 1943
Androscoggin	$ 68,200	9.7	22.3
Aroostook	59,500	8.5	7.8
Cumberland	148,400	21.1	23.8
Franklin	17,100	2.4	13.2
Hancock	33,600	4.8	11.2
Kennebec	55,800	7.9	18.1
Knox	21,400	3.0	13.9
Lincoln	14,300	2.0	15.7
Oxford	30,800	4.4	14.3
Penobscot	76,800	10.9	15.3
Piscataquis	22,400	3.2	13.7
Sagadahoc	14,700	2.1	27.2
Somerset	40,100	5.7	13.9
Waldo	12,200	1.7	8.7
Washington	19,300	2.7	8.7
York	69,400	9.9	22.2
Total	$704,000	100.0	16.9



Highway Elements

Motor vehicle registrations

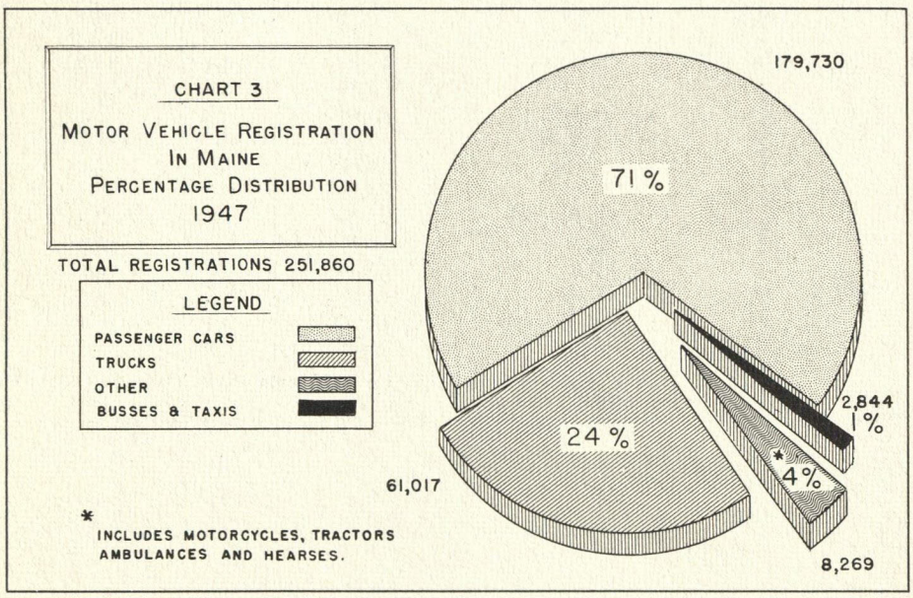
In 1947, 240,720 motor vehicles, an all time high for the State and a six and one-half per cent increase over the previous year's figures, were registered. Of the total, 173,318 (72 per cent) were passenger cars; 57,773 (24 per cent) were motor trucks; and 2,407 (one per cent) were motor busses and "for hire" vehicles such as taxis, private busses, etc. A miscellaneous group, including ambulances, hearses, tractors, and motorcycles, accounted for the remaining three per cent. (See chart 3.) Table 4 indicates registrations and percentages by counties.

TABLE 4

MOTOR VEHICLE REGISTRATIONS — AND PERCENTAGES OF TOTAL FOR EACH COUNTY IN 1947

Counties	Registrations	Per Cent
Androscoggin	19,980	8.3
Aroostook	23,591	9.8
Cumberland	47,421	19.7
Franklin	5,537	2.3
Hancock	8,907	3.7
Kennebec	22,146	9.2
Knox	7,944	3.3
Lincoln	6,018	2.5
Oxford	12,277	5.1
Penobscot	25,997	10.8
Piscataquis	4,814	2.0
Sagadahoc	6,018	2.5
Somerset	10,592	4.4
Waldo	6,259	2.6
Washington	8,425	3.5
York	24,794	10.3
Total	240,720	100.0

In 1947, there were an estimated 3.68 persons to each motor vehicle in Maine as compared with 4.07 for the United States as a whole.

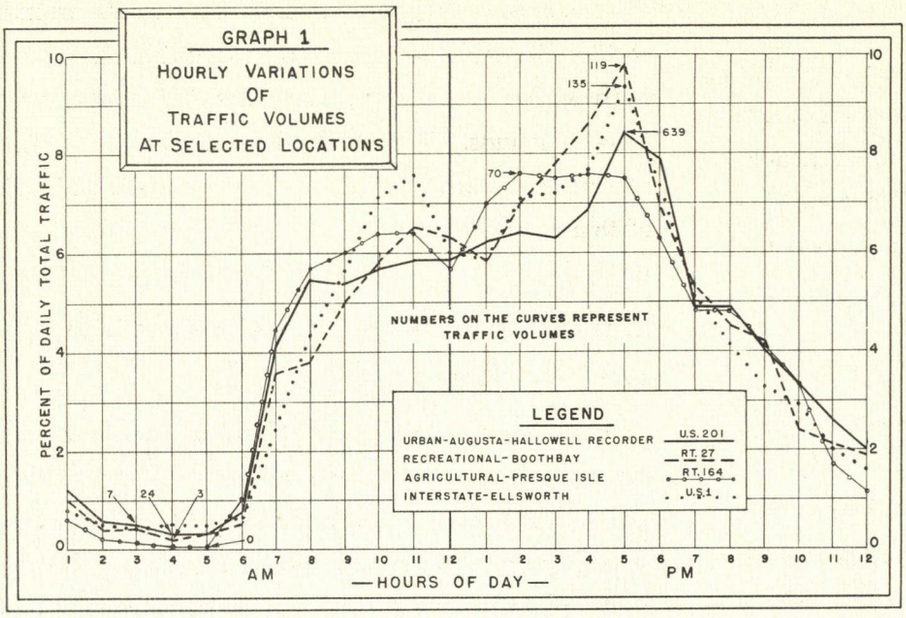


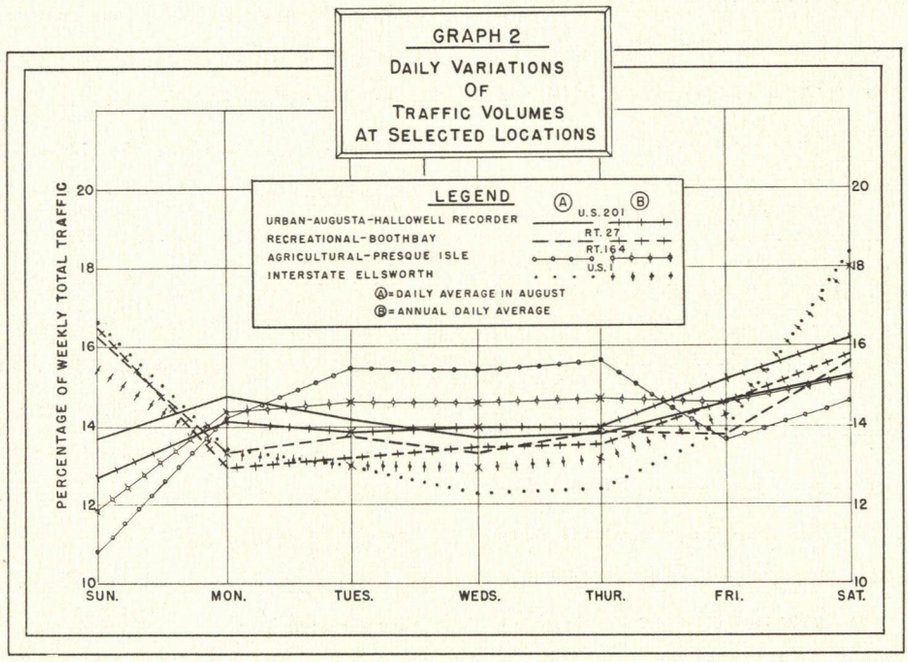
Travel and traffic patterns

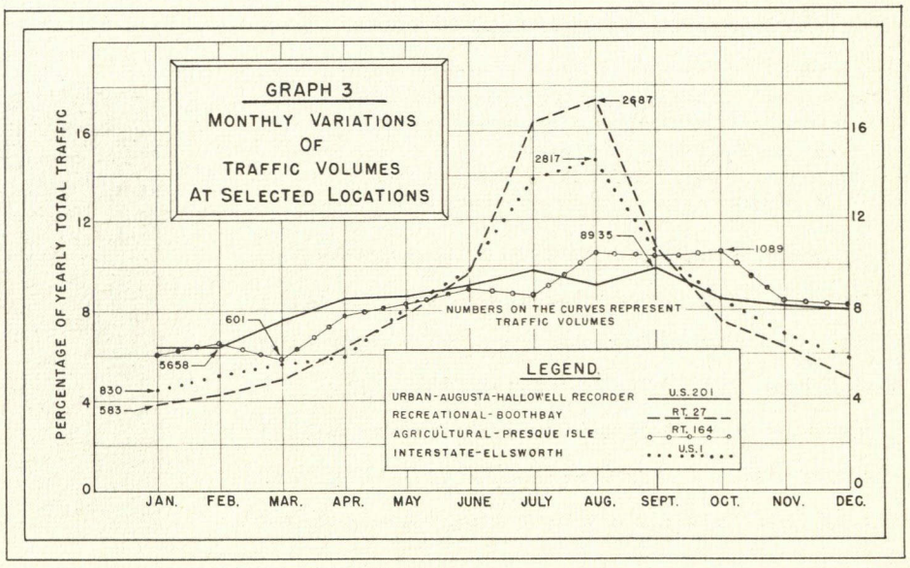
Highway usage is increasing year after year. More vehicles and more miles traveled by each vehicle have been the trends throughout highway history. Miles traveled on Maine highways have increased from an estimated 731 million in 1925 to an approximate 2.5 billion in 1947.

Traffic patterns may be defined as the daily, monthly, seasonal, and yearly fluctuations of the number and type of vehicles passing a given point.

A comparison of rural traffic patterns shows that a similarity exists in all areas with the exception of the Aroostook County farming area. Urban traffic patterns differ to some extent from rural patterns. There are presented a series of graphs indicating the variation in hourly volumes, daily volumes, and monthly volumes at four locations. One location is at Presque Isle in the farming area, two locations are in rural areas elsewhere in the State and the remaining location, an urban one, is between Augusta and Hallowell.


GRAPH 1
HOURLY VARIATIONS
OF
TRAFFIC VOLUMES
AT SELECTED LOCATIONS
PERCENT OF DAILY TOTAL TRAFFIC
NUMBERS ON THE CURVES REPRESENT
TRAFFIC VOLUMES
LEGEND
URBAN-AUGUSTA-HALLOWELL RECORDER U.S. 201
RECREATIONAL-BOOTHBAY RT. 27
AGRICULTURAL-PRESQUE ISLE RT. 164
INTERSTATE-ELLSWORTH U.S. 1
AM
—HOURS OF DAY—
PM


GRAPH 2
DAILY VARIATIONS
OF
TRAFFIC VOLUMES
AT SELECTED LOCATIONS
PERCENTAGE OF WEEKLY TOTAL TRAFFIC
LEGEND
URBAN-AUGUSTA-HALLOWELL RECORDER U.S. 201
RECREATIONAL-BOOTHBAY RT. 27
AGRICULTURAL-PRESQUE ISLE RT. 164
INTERSTATE ELLSWORTH U.S. 1
Ⓐ=DAILY AVERAGE IN AUGUST
Ⓑ=ANNUAL DAILY AVERAGE
SUN.
MON.
TUES.
WEDS.
THUR.
FRI.
SAT.


GRAPH 3
MONTHLY VARIATIONS
OF
TRAFFIC VOLUMES
AT SELECTED LOCATIONS
PERCENTAGE OF YEARLY TOTAL TRAFFIC
NUMBERS ON THE CURVES REPRESENT
TRAFFIC VOLUMES
LEGEND
URBAN-AUGUSTA-HALLOWELL RECORDER U.S. 201
RECREATIONAL-BOOTHBAY RT. 27
AGRICULTURAL-PRESQUE ISLE RT. 164
INTERSTATE-ELLSWORTH U.S. 1
JAN.
FEB.
MAR.
APR.
MAY
JUNE
JULY
AUG.
SEPT.
OCT.
NOV.
DEC.

Highway service

The primary value of a highway is based upon its usability every day of the year. Improved summer and winter maintenance have made an increased proportion of the highway system in Maine available under all weather conditions. While rural areas are sometimes isolated during the mud season, increased travel during the winter months indicates that highways are increasingly a year round service.

In the second place, the highway system to be satisfactory must be designed to meet the traffic demands upon it. The total number of vehicles using the highways has increased rapidly year by year, with the number of trucks increasing to a greater degree than pleasure vehicles. These increases are illustrated by comparing information obtained at four selected locations in 1938 with similar information obtained in 1948 at identical locations.

Location of traffic counters	Average 24 hour day		Number of trucks per 100 vehicles	
	1938	1948	1938	1948
Presque Isle	595	897	23	36
Ellsworth	1,289	1,600	17	25
Boothbay	1,188	1,337	19	34
Readfield	395	538	24	31

Highways must not only carry more vehicles but they must be so constructed that heavier loads may move at higher speeds. Studies have been made twice annually since 1942 in order to obtain speed of vehicles at certain selected locations in rural areas. The results of these observations are indicated below.

Year	1942	1943	1944	1945	1946	1947	1948
Average speed of all vehicles	36.1	35.2	36.2	39.6	44.2	43.0	47.2

Evidence obtained at weighing stations shows that sixteen out of each hundred trucks in 1948 were heavy single unit trucks and tractor trucks with semitrailers as compared with six per hundred in 1938.

The average weight of all empty trucks weighed increased from 6,300 pounds in 1938 to 7,700 pounds in 1948. The average weight of loaded trucks during the same span of years increased from 11,100 pounds to 14,200 pounds, and the average weight of all trucks, both loaded and empty, rose from 9,900 pounds to 11,600 pounds. The average maximum axle load of trucks weighed in 1938 was 6,800 pounds, while in 1948 it was 8,200 pounds.

Motor vehicle accidents in Maine during 1947

Motor vehicle accidents in Maine and in the nation at large are a cause of grave concern. The fatalities, the temporary and permanent injury to persons and property, and the economic loss are appalling. During 1947 the nation's toll in motor vehicle accidents was 32,300 dead and 1,150,000 injured, at an estimated loss of two and six-tenths billion dollars. Maine's contribution to these depressing totals was 3,741 accidents reported to State authorities, with 160 killed, 1,861 injured, and an estimated loss of nearly five million dollars. Unfortunately, the only reliable statistics on accidents in Maine are those on fatalities; consequently this discussion will be confined to fatal accidents. Chart 4 compares fatalities in Maine in 1941 and 1947. The age of the driver, the use of alcohol, reckless and unsafe driving, pedestrians, and unfavorable road conditions are important contributing factors to highway accidents.

The age of the driver is a consideration in any analysis of accidents. In Maine, 28 per cent of the fatal accidents in 1947 involved drivers under 24 years of

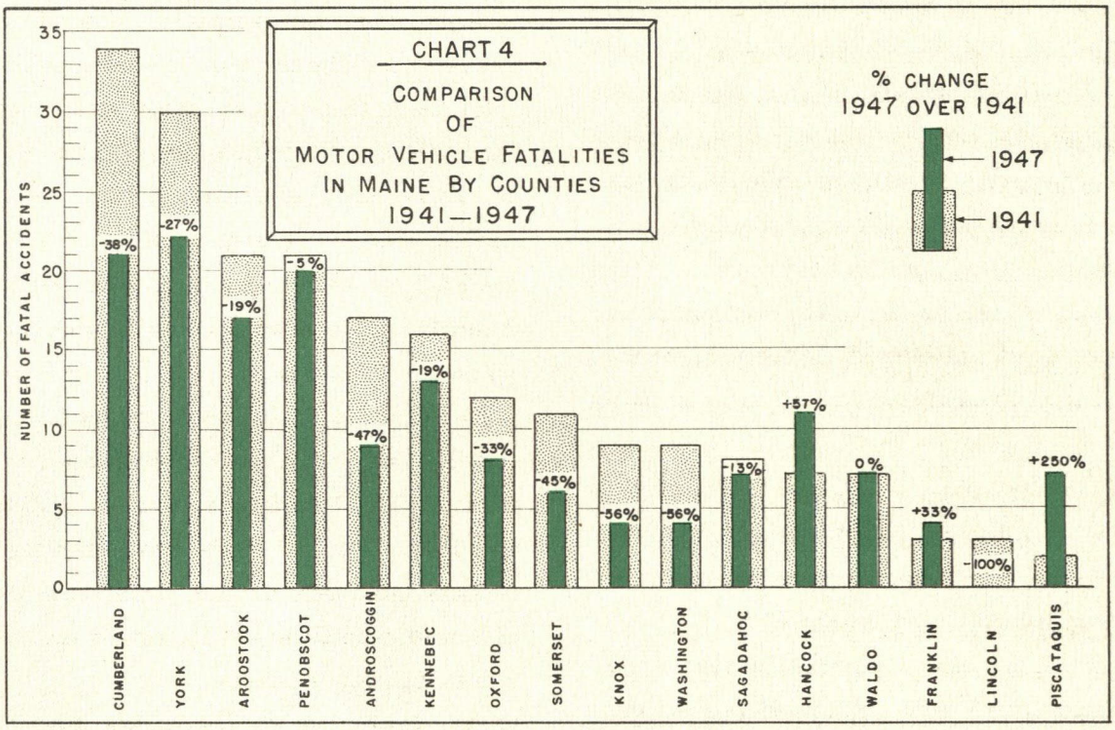
age; 35 per cent, those 25–44; 15 per cent, those 45–64; 4 per cent, those 65 or over; and 18 per cent, drivers of undetermined age.

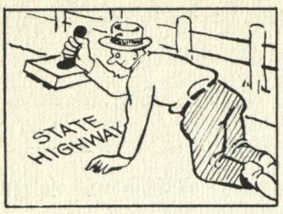
More than 13 per cent of the drivers and 12 per cent of all adult pedestrians involved in fatal mishaps in this State in 1947 had been drinking to some extent. These percentages are compared to 18 and 24 per cent, shown in an accident study made in the same year for the nation as a whole.

Driving at unsafe speeds; although not necessarily in excess of the legal limits, accounted for 21 per cent of the fatal accidents in Maine. Reckless driving was responsible for 19 per cent of the fatalities.

Unfavorable road conditions — rain, mud, snow, or ice — contributed to 31 fatal accidents in Maine in 1947, or 20 per cent of the total. Only one fatal accident was ascribed to obscured vision.

Pedestrian deaths constituted 36 per cent of the motor vehicle fatalities in Maine in 1947, as well as nationally, and in three out of four cases the pedestrian was at fault.





Highway Systems

General

The State Highway Commission has classified highways, for administrative purposes, into four general categories. The state highways are an integrated system of main through routes. State aid highways are also designated by the Commission but are not included in the state highway system. These state aid highways are usually thoroughfares between principal settlements or between communities and their markets or shipping points, and insofar as practicable are feeders to the state highway system. Third class highways are those designated by the Commission and constructed with state funds but not included in the state or state aid systems. They comprise but a small part of all mileage and since they are being transferred to the state aid system as rapidly as possible, this classification will eventually disappear. Fourth class highways include all other roads and streets subject to public maintenance.

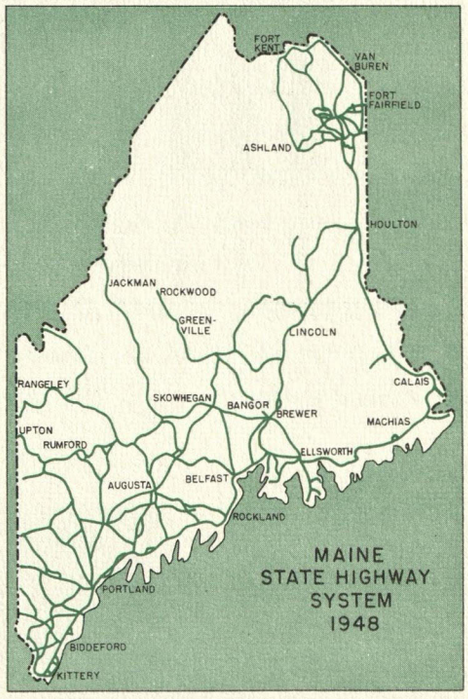
In 1913, when the various classes of highways were first designated, there were only three classes, state highways, state aid highways, and third class highways. The latter category involved all highways not included in the first two classes. This classification remained until 1944, but at every session since 1919 the Legislature had designated certain state funds to be used to construct third class highways. In 1944, the highways which had not been designated for construction with these state funds were classified as fourth class.

State highway mileages

The state highway system consists of 3,049 miles. There has been little change in it since 1942 when there was 2,988 miles, but between 1933 and 1942 there was an increase of approximately 38 per cent from 2,164 to 2,988 miles. Transfer of mileage from the state aid to the state highway system rather than designation of new mileage has caused most of the increase.

STATE HIGHWAY SYSTEM

Year	Miles	Year	Miles
1933	2,164	1941	2,985
1934	2,209	1942	2,988
1935	2,510	1943	2,988
1936	2,585	1944	2,988
1937	2,711	1945	2,988
1938	2,835	1946	3,016
1939	2,876	1947	3,044
1940	2,876	1948	3,049



Mileage of state aid system

During the period from 1933 to 1947 the improved state aid highway mileage slowly increased as new roads were constructed and as third class highways were transferred to the state aid system.

Three distinct periods in the history of state aid construction are evident; the first, from 1933 to 1941, marked by construction of new roads and an increasing amount of reconstruction of old roads; the second, the war period from 1942 to 1945, with no significant road construction; and the third, 1945 to 1947, with renewed construction and reconstruction and transfers of third class mileage to the state aid system. As can be seen from graph 4, the reconstruction of old highways was becoming increasingly important in the pre-war period, while the construction of new ones was declining. The same trend is apparent in the post-war period.

The mileage of state aid highways has grown since 1936. Significant increases in the last three years have resulted from the transfer under the provisions of Chapter 136 of the Private and Special Laws of 1945 of improved third class highways to the state aid system. In 1945, 281 miles of roads were transferred while three miles were reconstructed or constructed. In 1946, 109 miles were transferred, and 32 were built or rebuilt. In 1947, 391 miles were transferred, and 100 were improved.

STATE AID SYSTEM

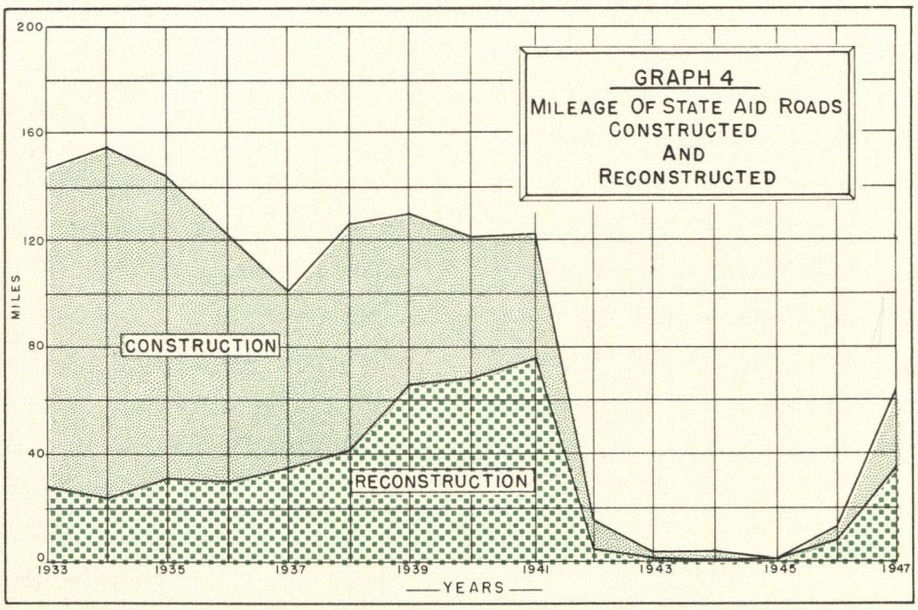
Year	Miles	Year	Miles
1933	5,382	1941	6,266
1934	5,502	1942	6,274
1935	5,693	1943	6,301
1936	5,752	1944	6,305
1937	5,821	1945	6,337
1938	5,884	1946	6,627
1939	5,935	1947	6,855
1940	6,098	1948	7,301

Federal aid highway systems

Federal aid for highway construction was authorized by an Act of Congress in 1916. This Act provided that federal funds could be expended on seven per cent of the rural road mileage in the State; however, the original Act has been modified and extended from time to time. At present the Federal Aid Act of 1944 provides funds for the improvement of highways classified as:

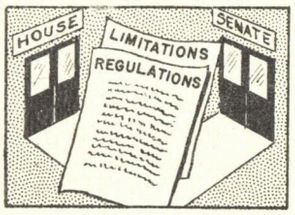
1. Interstate highway system
2. Federal aid system (rural and urban)
3. Federal aid secondary system
4. Federal forest road system

There is considerable overlapping between the federal and the state and state aid systems; 86 per cent of the state highway and 16 per cent of the state aid mileage are on some classification of the federal system.



CHAPTER 2

Legislative and Financial History



Statutory Limitations and Regulations—State

It is the proper responsibility of the Legislature, representing the people of Maine, to lay down the general outlines of a highway policy for the State. Since 1905 when legislation regulating the use of highways was first enacted, successive sessions of the Legislature have gradually developed the body of laws which now governs the construction and maintenance of the highway system. This section will be concerned with a brief recital of the high points of the evolution of legislative regulations and limitations relating to highways.

Early history

The first law calling for the registration of all motor vehicles and the licensing of operators was passed in 1905, but registration fees were not at first set aside specifically for highway purposes. In 1907, when the need for additional funds for state aid was felt, a tax of one-third of a mill on all property was added to provide funds for road improvement. The one-third mill tax was found insufficient in 1909, and it was then increased to three-fourths of a mill.

In 1911, two changes occurred: First, the three-fourths mill tax was stricken out, and the law changed so that the sum of $250,000 was appropriated annually. These funds were for state aid for highway improvement. Second, the registration and license fees were put on an annual basis, and the revenue was used for the repair, maintenance, and construction of state highways. The Legislature was by now well into two sources of revenue, registration and license fees, and the property tax and other legislative appropriations. In order to provide funds for the construction of state highways the Legislature first authorized the sale of bonds in 1912.

Two changes in highway legislation occurred in 1913. Registration and license fees were to be utilized first for interest payments and bond retirements, and second for administrative costs and for maintenance of state and state aid highways. With minor changes the disposition of these fees remained the same until 1931 when they became a part of the income of the General Highway Fund. The second change which occurred in 1913 was an increase in the appropriation for state aid construction from $250,000 to $300,000.

The beginning of federal aid—1917

More funds were found necessary in 1917, since the state and state aid programs continued to grow and,

in addition, the Federal Act of 1916 provided funds for highway improvement which could be secured only when matched by a state contribution. The Legislature accepted federal funds in 1917, and it became necessary to find a source of income not only to match them but also to provide for additional needs resulting from an expansion in the highway programs of the State, counties, cities, and towns.

The creation of the Mill Tax Highway Fund

The Mill Tax Highway Fund was the result of this pressure for more funds. The sum of $200,000 of the receipts from this tax of one mill on the valuation of the State was added to the $300,000 appropriated for state aid construction and the two sums combined were called the State Aid Highway Fund. The balance of receipts was called the State Highway Fund and was to be used exclusively for construction of state highways. In fact, the State Highway Fund was to be used, first to match federal aid funds, and then the combined state and federal funds were to be apportioned equitably among the several counties, with the provision that the funds were not to be expended on business streets.

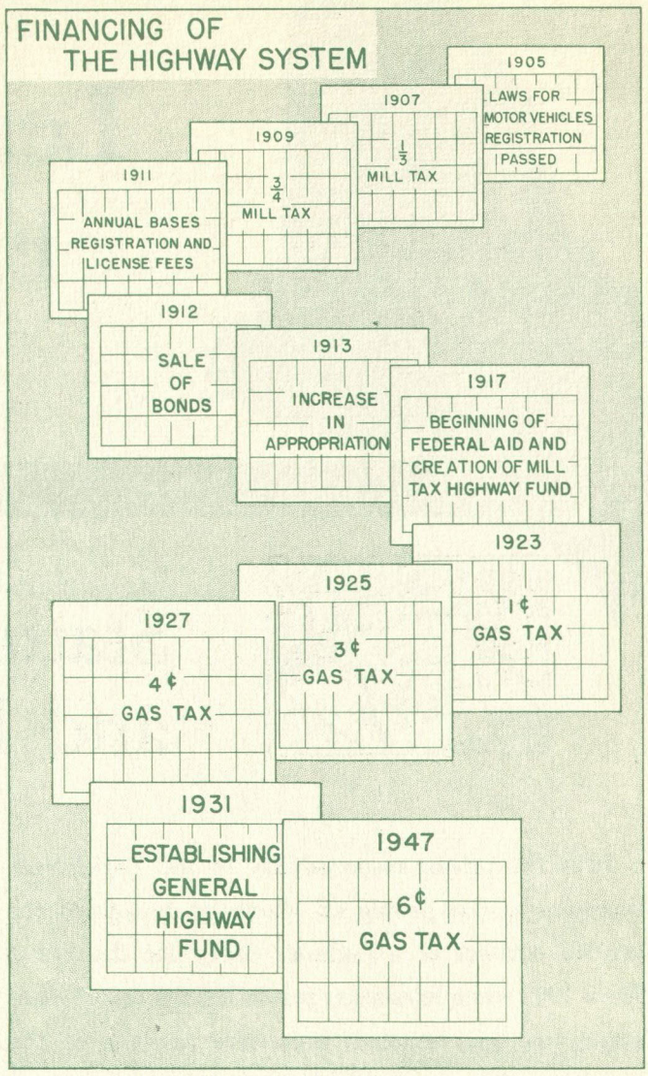


TABLE 5

ALLOCATION OF INCOME 1917

Sources of income	Bond interest and retirement	State highway construction	State highway maintenance	State aid construction	State aid maintenance	Commission administration
Registration and license fees	1st		2nd		2nd	2nd
$300,000 appropriation				All		
Mill tax		Balance match federal funds and used here		1st $200,000		
Bonds		In part	In part*			
Federal aid		All including bridges				

*Prohibited by constitutional amendment in 1919.

Highway debt policy—1919-35

By a constitutional amendment which became effective September 24, 1919, the limit on bonds which could be issued was raised to 10 million dollars. At the same time it was stipulated that proceeds of the bonds could be spent "for purposes of building state highways, intrastate, interstate, and international bridges ". The ceiling on highway bonds was raised to 31 million dollars in 1929 and again to 36 million dollars in 1935. The income was to be utilized to construct and reconstruct state highways and bridges.

The gas tax—1923-27

When additional sums were needed in 1923, a one cent gasoline tax was added. Since the gas tax proved such a fruitful source of funds it was increased in 1925 to three cents and in 1927 to four cents.

Sources of highway income—1929

By 1929 six sources of income were employed, often with rather complicated formulas governing the distribution of their proceeds. The following table shows the sources and distributions of receipts just prior to the formation of the General Highway Fund.

TABLE 6

ALLOCATION OF INCOME 1929

Sources of income	Bond interest and retirement	State aid construction	State aid maintenance	State highway and bridge construction	State highway maintenance	3rd class construction	Commission administration	Bridge maintenance
Registration and license fees	1st		2nd		2nd		2nd	
$300,000 appopriation		All						
Mill Tax Fund		$200,000		$150,000 for special resolve construction		Balance		
Gasoline tax		37½%	From 1st 50%		From 1st 50%	12½%		From 1st 50%
Bonds		In part for bridge construction only		In part		In part for bridge construction only		
Federal aid				All				

The creation of the General Highway Fund

The public laws of 1931 established a General Highway Fund to clear up the welter of confusion and to make the use of highway revenue more efficient. The Act provided "funds for the construction of state aid and third class highways, for the maintenance of state and state aid highways and interstate, intrastate, and international bridges, and for other items of expenditure . . . This fund shall include all fees received from the registration of motor vehicles and licensing of operators, the receipts from the . . . Mill Tax Highway Fund, the receipts from the tax on gasoline, . . . The appropriation of three hundred thousand dollars . . . , all fines, forfeitures, and costs accruing to the State, and all sums received . . . for permits to open highways or from other sources the disposition of which is not otherwise designated by law ".

The General Highway Fund was to be utilized first to meet bond interest and retirement charges and then for various specific purposes. Apportionments for administration and for construction were specified, and the remainder of the fund was to be used for maintenance as the State Highway Commission should direct.

Highway financing during the depression

In 1933, as the State felt the full effect of the depression, the sources of highway income were decreased radically by suspension of the mill tax and the $300,000 appropriation. The practical effect of this step was that only revenue coming from highway users was available for the construction and maintenance of state highways and bridges. Property owners, who benefited from state highways, did not contribute directly toward their construction and maintenance. Highway expenditures were, of course, cut along with receipts.

The law of 1935 again suspended the mill tax and the $300,000 appropriation, this time until July 1, 1937. In addition, it provided that the General Highway Fund could be used to finance the construction of state highways, a provision not included in the 1931 law. The only significant increase in highway appropriations was $700,000 to match federal aid funds.

By action of the Legislature in 1933 the sources of state highway revenues were limited to taxes on high-

way users. In 1936, to ensure that these revenues were used solely for highway purposes, the people of the State by referendum vote adopted a directly-initiated bill which provided that "neither the General Highway Fund, nor any fund derived from direct taxation imposed for highway construction, bridge construction, or the improvement and maintenance thereof, shall be diverted or expended, either temporarily or permanently, for any other purpose than set forth in this act".

Highway legislation, 1937-47

The law of 1931 was repealed in 1937, and a new law enacted. The mill tax and the $300,000 appropriation, which had been suspended in 1933, were finally repealed. Some of the minor appropriations were increased slightly. The law of 1937 further authorized the State Highway Commission to accept federal funds for the improvement of secondary or feeder roads. In 1944, a Constitutional Amendment became effective which prohibited the diversion of any highway funds. From 1937 until 1947 these were the only significant changes in legislation.

An increase in the gas tax—1947

To meet an emergency in which current sources of income did not provide sufficient revenue for the necessary maintenance of highways and to match available federal funds for construction, the Legislature voted in 1947 to increase the gasoline tax to six cents a gallon.

Legislation relating to winter maintenance

The responsibilities of the towns and the State for snow removal have been changed several times since the Legislature first authorized state participation. In 1927, the State Highway Commission was empowered, upon petition by the towns, to designate "accepted ways" on state and state aid highways. The State reimbursed the towns for 50 per cent of the cost of snow removal on these accepted ways up to a maximum of $25 per mile, and paid out a total of $30,819, in 1927. With the towns' contribution added, a total of $69,639 was spent in the first winter. In 1931 the law was changed so that town ways, as well as state and state aid highways, could be designated as "accepted ways", and the State's contribution was increased to $50 per mile.

In 1935 the law was changed to its present form. On state highways, municipalities contribute $40 per mile per year toward the costs of snow removal, and the State pays the remainder, which amounted to $411 per mile for the winter of 1947-48. On state aid roads and town ways, which have been designated as "accepted ways" by the State Highway Commission, the State pays half the cost of snow removal up to $50 per mile and the town pays the rest. Towns with less than $200,000 valuation pay 50 per cent of the cost up to $35 per mile, and the State pays the remainder. On state aid highways and town ways not "accepted" the towns are responsible for the entire cost. Responsibility for performing the work rests with the State for state highways and with the towns for all other roads.

Statutory provisions for summer maintenance

The Legislature in 1914 provided maintenance funds from the proceeds of registration and license fees and the sale of bonds, but the utilization of bonds to finance maintenance ceased in 1919. The Legislature in 1923 allocated one-half the gas tax increase for that year to maintenance to meet the demand for additional funds. Changes in the percentage of the gas tax used for this purpose were made by the legislative sessions in 1925, 1927, and 1929. When the General Highway Fund was set up in 1931, provision was made for annual appropriations for maintenance, and no change in the financing of maintenance has occurred since then.

By statute, legal responsibility for maintenance on the state and improved state aid highways rests with the State, while the maintenance of town ways and unimproved state aid roads is carried out and paid

for exclusively by the towns. Towns and cities also share financially in the maintenance of state highways and improved state aid roads. Until 1945 the charges per mile against the towns for summer maintenance were $60 for improved state highways and $30 for improved state aid highways. In 1945 the charges were changed to $70 and $40 respectively in order to pay for the work of cutting bushes, a former responsibility of the towns assumed by the State. The State does not, however, participate in the cost of maintenance of state highways in compact sections of towns having a population of over 5,000.

Bush removal

Until 1945 the work of cutting and removing all trees, shrubs, bushes, and weeds growing between the road limit and the shoulder part of the state and state aid highways was by law the responsibility of the towns. In that year the law was amended so that all such work became the responsibility of the State Highway Commission. At the same time the charges against the towns for maintenance of state and state aid highways were increased $10 per mile per year, presumably to recompense the State, at least in part, for the additional burden assumed by it.

Legislation governing bridge construction and maintenance

The "General Bridge Act", passed by the Legislature in 1915 and approved by referendum vote in 1916, marked the beginning of state and county aid to towns in the construction of bridges. Aid was not restricted as to highway system, nor was there any size limitation. The State assumed 20 per cent of the cost, the county 30 per cent, and the town 50 per cent. In 1929, the Bridge Act was amended to provide that a bridge must be 10 feet or more in length before the State would share the costs; the amendment also removed the provision for state participation in the construction costs of bridges built on town roads. Further amendments governing the town's share have been made, until, at present, the town pays from 45 to 10 per cent. There is a maximum limit in that the local payment may not exceed one per cent of the town's valuation.

The construction of bridges on the state highway system has been the responsibility of the State since 1931. The towns were relieved of payments in 1929, and since 1931 the counties have not contributed toward construction of bridges on this class of highway.

Methods of financing the State's share of bridge construction have varied. For the first three years in which work was done under the Bridge Act of 1915, an annual appropriation of $100,000 was provided. In 1919, because of increased demand, income from bond issues was apportioned for this work, and this method of financing continued until 1937. Since that date, funds have been allotted from the General Highway Fund.

Prior to 1931 the responsibility for bridge maintenance, with a few exceptions, rested with the town. In that year, the law was changed so that maintenance of bridges on the state highway system, excepting those within the compact section of any city or town of over 10,000 population, became the responsibility of the State. This exception was removed in 1933; all bridges on the state highway system are now maintained by the State. The law was again amended in 1947, when the responsibility of maintaining all bridges built under the General Bridge Act was transferred to the State. The allocation of funds for bridge maintenance also has been from the General Highway Fund.

Statutory limitations and regulations—bonded debt

Bonds issued to obtain funds for highway and bridge construction constitute the major share of the State's funded debt, but by December 31, 1947, Highway and Highway and Bridge Loan Bonds had declined to $10,180,500, approximately 83 per cent of the State's bonded indebtedness.

In 1945, the Legislature finally adopted the policy, which had been in the making for eleven years, of not creating new highway indebtedness in excess of that retired during the biennium. But in 1945, to provide funds to match federal aid for construction,

the Legislature authorized the reissue over the biennium ending June 30, 1947 of $3,453,000 of bonds which had matured and been retired. It was not possible or feasible to use funds on such a scale for highway building in the immediate post-war period; therefore it was proposed that the time limit be extended to June, 1949. While the extension was being considered, the justices of the State Supreme Court gave an advisory opinion which, in effect, prohibited the reissuance of bonds which had been retired. The justices found that the Legislature had authority to reissue highway bonds up to a limit of 2 million dollars, from 1912 to 1919. It had authority to reissue highway bonds up to a limit of 10 million dollars from 1919 to 1925. From 1925 to 1929 its authority to reissue highway bonds was somewhat limited. It has had no authority to reissue highway bonds since 1929, but the Legislature has undoubted authority to issue any authorized bonds which have never been sold. Since all authorized bonds have been issued, a constitutional amendment will be required before any more highway borrowing is possible.

Conclusions

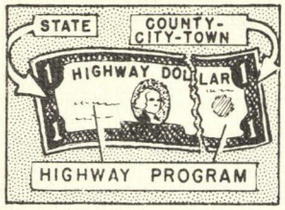
There have been at least three major trends in the evolution of a legislative policy for highways. First, the Legislature has seen fit to impose an increased proportion of highway costs directly on the user, so that today the state and state aid systems are largely financed from this source. Second, the Legislature in recent years appears to have reversed its earlier attitude that borrowing was a feasible and equitable method of financing construction; it now endorses a pay-as-you-go policy. Third, the Legislature has gradually increased the proportion of highway costs borne by the State directly and has decreased the financial responsibility of local government in this field. In general, it may also be observed that the financing of highways, both in terms of receipts and expenditures, has become increasingly complex as one session after another has legislated on various aspects of the total program.

Highway Finance

General

Highway financing is an important part of the story of the state highway system. The adequacy of our roads depends directly upon the ability and the willingness of the people of the State to pay for them; and the equity with which highway costs are distributed is determined by the supporting tax system. This chapter is concerned, therefore, with the expenditures for state and local highways and with the sources from which these funds are drawn.

Throughout this report all transfers of funds are excluded; thus all receipts and all expenditures are net amounts. For example, state financial assistance to municipalities and local payments to the State are not regarded as expenditures of both the state and local government but of the unit of government legally responsible for the service. Repayments for both long and short term loans are also not classified as expenditures, since they were shown as such in the year in which the money was spent. The utilization of net rather than gross expenditures makes it possible to show the real dollar costs to the tax payer of our highway system.



Expenditures

(By the State, Counties, Cities, and Towns)

Highway expenditures in general

Total state and local expenditures on all highways and streets of the State in 1947 were $23,391,553, the highest in the history of the State. The major portion of this sum was utilized for construction and maintenance. In fact, 93 per cent, or $21,804,751, went directly into work on the roads themselves. Fifty-eight per cent of total expenditures, $13,550,086, was spent for maintenance, while 35 per cent, $8,254,665, went for construction. Of the remaining $1,586,802, the sum of $494, 802 was spent for administration, $507,999 for interest payments on bonds, and $584,001 for other purposes, of which $504,894 was used to defray 90 per cent of the expenses of the State Police.

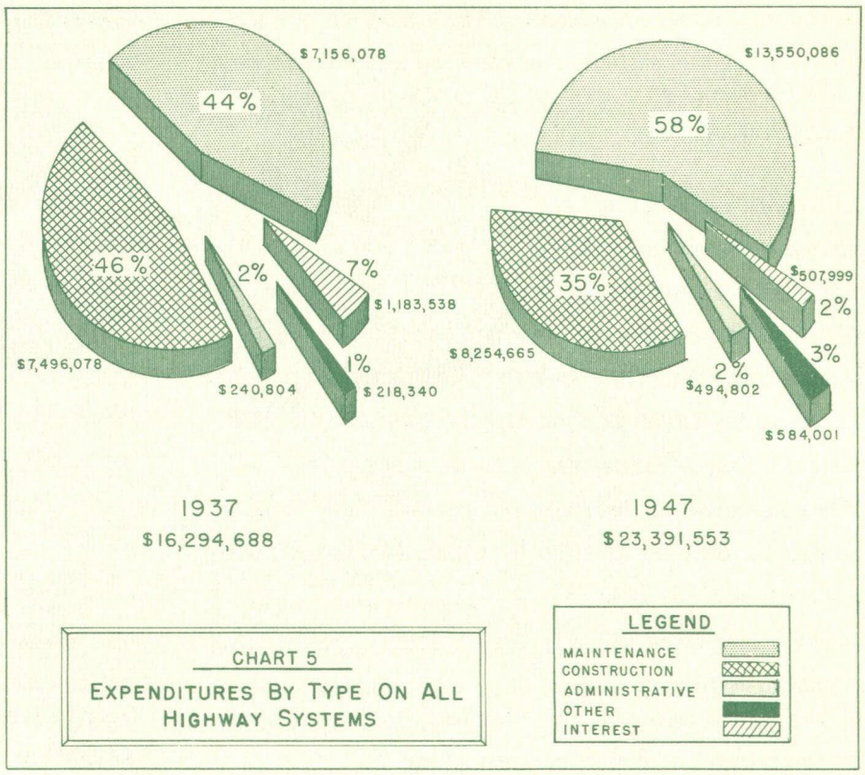


CHART 5
EXPENDITURES BY TYPE ON ALL HIGHWAY SYSTEMS

Highway expenditures— a ten year contrast

Chart 5 compares the total highway expenditures in 1947 with those in 1937. In 1937, only $16,294,038 was spent on the roads of the State, but, in contrast to 1947, more money was expended for construction than for maintenance. Forty-six per cent of the total, $7,496,-078 was devoted to road-building, while $7,156,078, forty-four per cent of the total, went for up-keep. Slightly over seven per cent of all expenditures, or $1,183,538, was paid as interest on bonds and loans.

A comparison of highway expenditures by systems for 1937 and 1947 is shown in chart 6. The increased

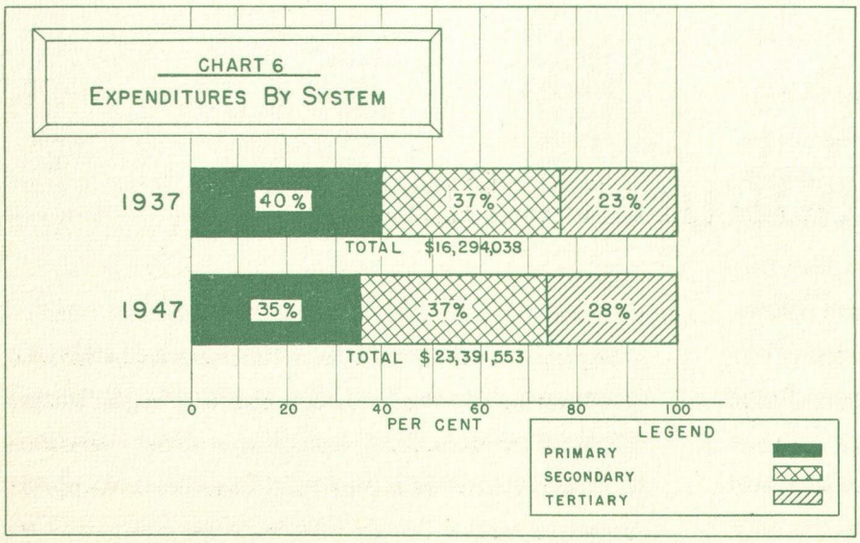


CHART 6
EXPENDITURES BY SYSTEM

emphasis on improvements to the tertiary system, which is made up of local roads and streets, is readily apparent. While expenditures on the primary system in 1937 amounted to 40 per cent of total highway costs, they had dropped to 35 per cent by 1947. In the same period expenditures on the tertiary system increased from 23 to 28 per cent, and those on the secondary system remained fairly constant.

Construction expenditures

Construction expenditures on primary highways were slightly less in 1947 than in 1937, $3,055,580 and $3,188,948 respectively. Since 160 dollars were required in 1947 to do the work of 100 dollars in 1937,[1] the actual construction accomplished in the latter year was far less than is indicated by comparison of dollar amounts alone.

A decrease in emphasis on construction is also noticeable on the secondary system. In 1937, 65 per cent of the money expended on these roads went for construction and 32 per cent was for maintenance, the percentages in 1947 were 49 and 48 per cent respectively.

In the light of this decreased emphasis on construction, it is interesting to note the experience on the tertiary system. The relative amounts spent for construction increased from 11 per cent of total expenditures in 1937 to 14 per cent in 1947. While the outlay for construction is still a small part of total disbursements, it is, nevertheless, significant that in 1947 more progress was made in the construction of local roads and streets than of the primary or secondary highways.

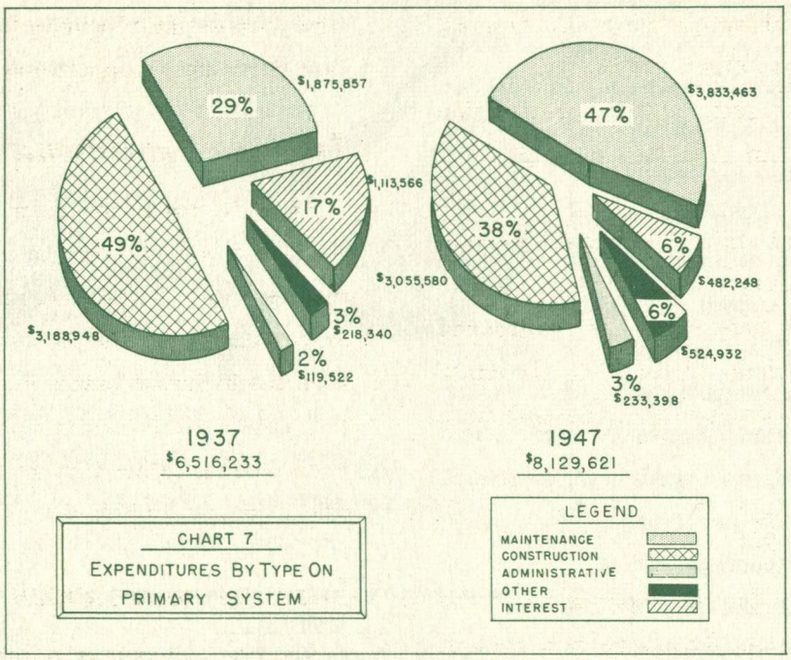
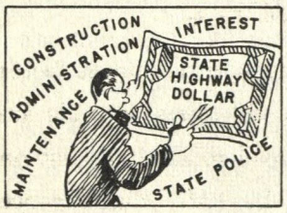


CHART 7
EXPENDITURES BY TYPE ON PRIMARY SYSTEM

"Special resolve" construction expenditures authorized by the Legislatures have been relatively small; they have varied in the past from $42,660 to $291,654.

Expenditures by cities and towns for construction are also small compared to those for maintenance. Complete data have been obtained for the years 1937 and 1947 only. In these years municipalities spent $461,263 and $609,922 respectively for construction.



Expenditures—State

Highway construction

Expenditures by the State for highway construction increased fairly steadily from 1913 until 1930, when $9,581,567 was spent. This sum has not been equalled since.

Approximately 9 million dollars was spent in 1930, 1931, and 1932, the years in which the largest volume of road construction was programmed. In 1933, total expenditures for construction declined to approximately 5 million dollars and remained well below the

[1] *The federal-aid primary price index, exclusive of bridge costs, stood at 179 in 1947 and 112 in 1937.*

1930–32 level throughout the depression period. In 1937, for example, about 6 million dollars was spent.

From 1937 to 1941 expenditures for all highway construction decreased steadily from about 6 million dollars to 4 million dollars. The reduction came entirely in expenditures on the primary roads, since state expenditures on secondary highways remained approximately the same at $2,750,000. Construction expenditures on state highways, however, dropped from $3,451,327 in 1937 to $1,496,921 in 1941.

During the war years, 1942 to 1945, construction activities decreased. and in 1945 they reached a low of $626,694.

In the post-war period state construction is again at a high level, since it has been necessary to undertake many projects on which action had been postponed because of wartime restrictions. In 1947, the State spent $6,183,378 for construction on state and state aid highways.

Bridge construction

Expenditures made, under the supervision of the State Highway Commission, for bridge construction for the period, 1917 to 1947 inclusive are shown below.

Year	Expenditures	Year	Expenditures
1918	$ 121,648	1933	$ 620,548
1919	340,886	1934	904,991
1920	592,783	1935	917,356
1921	538,520	1936	1,675,821
1922	575,841	1937	2,874,894
1923	600,360	1938	1,376,641
1924	721,727	1939	1,600,668
1925	608,146	1940	757,153
1926	887,226	1941	1,025,557
1927	841,511	1942	801,122
1928	1,187,189	1943	219,852
1929	1,513,340	1944	180,206
1930	1,415,586	1945	241,683
1931	2,068,882	1946	490,171
1932	1,582,514	1947	1,025,930

From the foregoing it can be seen that bridge construction increased fairly steadily from 1917 to 1932. During the depression, like all highway activities, it was at a low ebb. Following the flood of 1936, bridge construction reached a peak in 1937, when nearly 3 million dollars was expended.

Federal aid for the construction of bridges on the federal aid systems, has been substantial and in increasing amounts. Outright grants for grade crossing elimination, bridge construction, and flood relief amounted to $3,809,138 during the years 1935–1938 inclusive. Federal aid grade crossing elimination funds averaged approximately $200,000 a year for the period 1938–1943. Regular federal aid for highway purposes also includes funds for bridge construction which are not apportioned separately.

Highway maintenance costs

Expenditures to maintain the highway system are divided into two categories, summer and winter maintenance. The former may be regarded primarily as protection of the investment. Expenditures to keep the highways usable under winter conditions, on the other hand, cannot properly be classified as maintenance; rather they represent an effort to make this investment usable throughout the year.

Summer maintenance—highway

Summer maintenance is intended to retain the highway in as near its original condition as possible. It represents a long list of activities ranging from surface treatment, to improving drainage, to painting guard posts. Legal responsibility for summer maintenance on state and state aid highways rests with the State, although municipalities contribute financially.

Highway maintenance costs vary greatly—as to surface type

The type of surface is naturally a significant factor in maintenance costs. In general, costs per mile are highest on surface treated gravel roads and least on bituminous concrete roads. In 1947, maintenance cost per mile on state highways amounted to $870 for surface treated gravel roads, $690 for Portland cement concrete roads, $530 for plain gravel roads, $479 for bituminous macadam roads, and $383 for bituminous concrete roads. Cost figures such as these are not strictly comparable since the volume of traffic is also a factor that must be considered as well as surface type.

Multiple lane highways also mean higher costs, but since the total mileage of such highways is insignificant, the increased costs arising from multiple lanes are not an important factor in total maintenance expenditures.

Bush removal

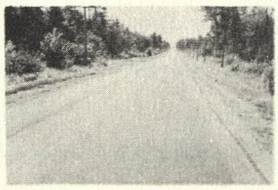
From 1936 to 1941 cutting grass from the shoulders of state and state aid highways cost the State approximately $2 per mile per year. From 1942 on, the costs to the State increased rapidly until they averaged about $9 per mile in 1944.

In 1945, the first year in which all bushes and grass within the road limits of state highways were removed by the State, the expenditure per mile was $38.58. Costs increased again in 1946 to $45.86 and remained the same in 1947.

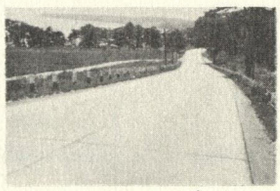
Results were similar on state aid highways. Costs per mile from 1944 to 1947 were as follows: 1944 — $6.78, 1945 — $26.19, 1946 — $38.45, 1947 — $38.66. These changes increased state expenditures for this type of maintenance by 385 per cent in three years, from $74,696 in 1944 to $362,337 in 1947.

Bituminous Concrete $383 Per Mile

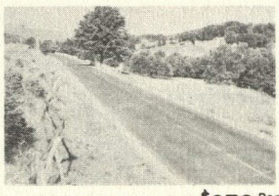
Bituminous Macadam $479 Per Mile



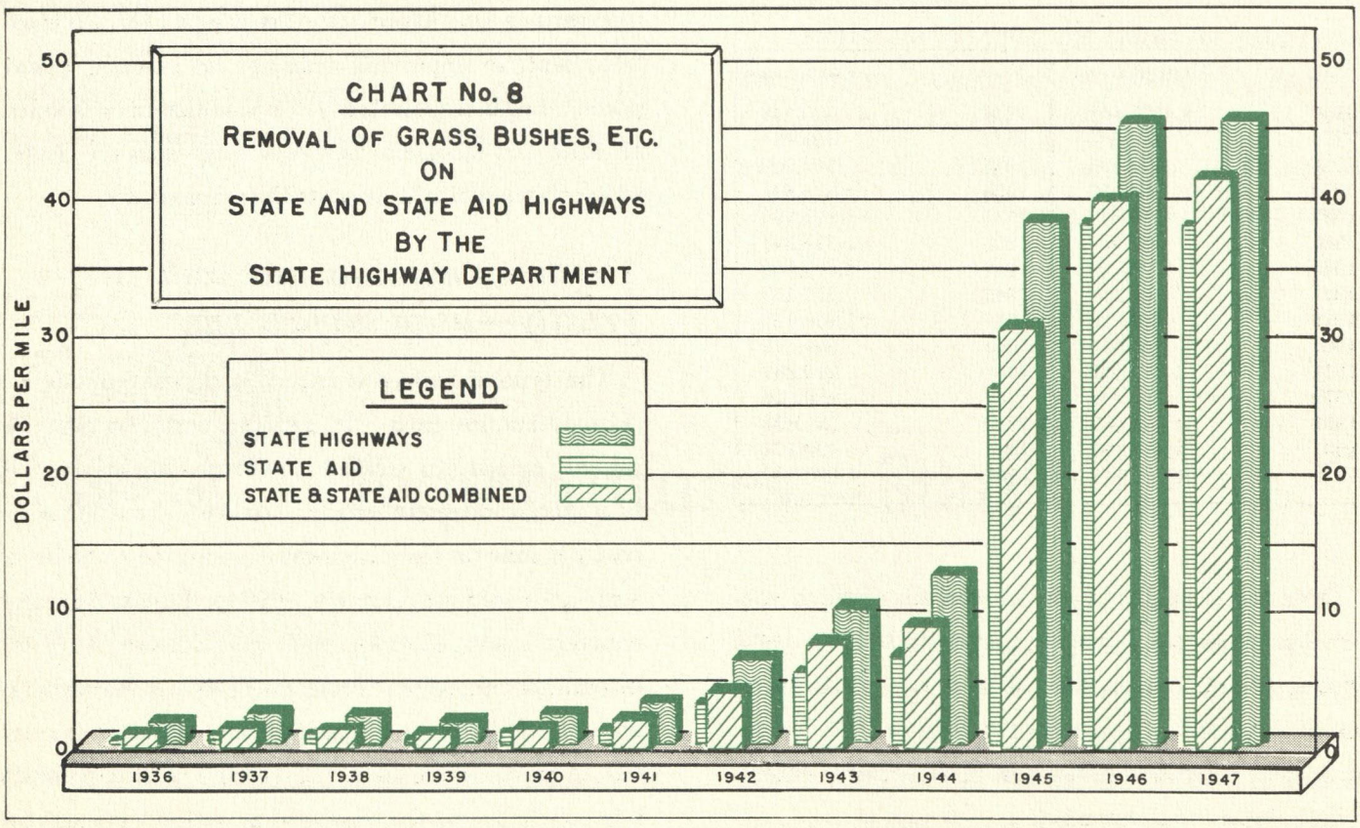
Gravel Road $530 Per Mile



Cement Concrete $690 Per Mile



Service Treated Gravel $870 Per Mile



The trend in highway maintenance expenditures

The growth of total expenditures by the State for summer maintenance since 1914 is shown in table 7. The sums spent increased rapidly, along with the mileages of roads maintained, until 1930 and then remained relatively constant until 1942. Since 1942 expenditures have more than doubled in six years. This last increase can be attributed in part to general price changes which have made labor and material costs higher and in part to increased responsibilities assumed by the State.

TABLE 7

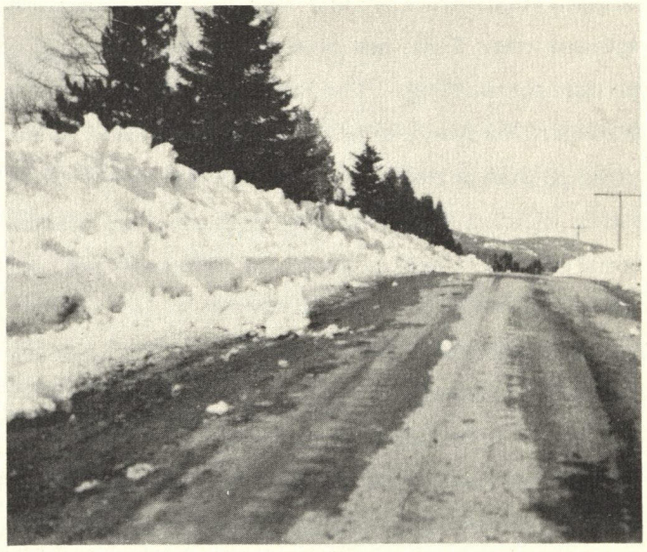
MAINTENANCE OF IMPROVED STATE AND STATE AID HIGHWAYS

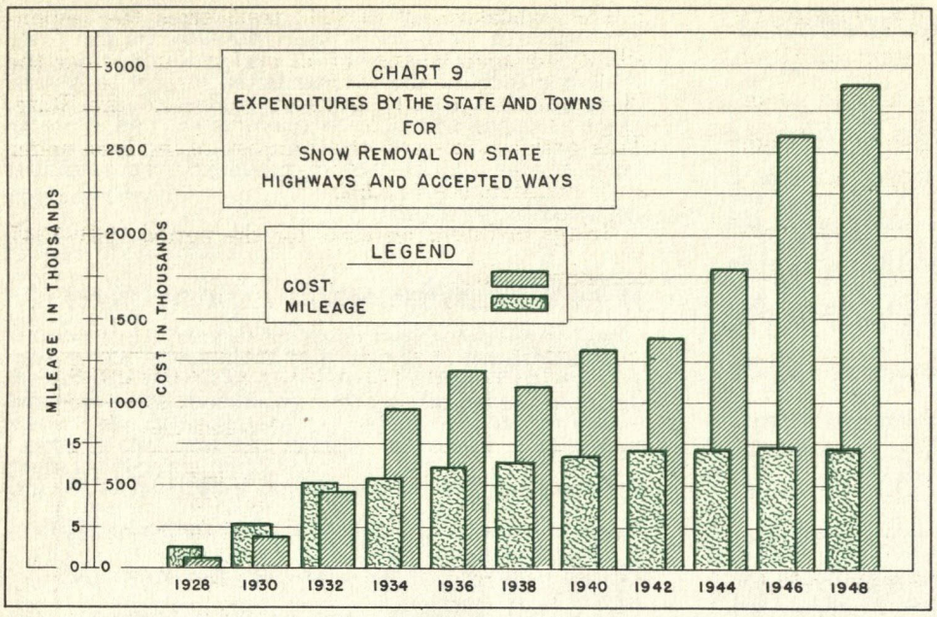
Calendar year	Miles	Expenditures
1914	659	$ 86,524
1915	972	165,430
1916	3,467	286,400
1917	3,705	442,717
1918	4,235	589,892
1919	4,285	678,609
1920	4,241	799,721
1921	4,306	865,622
1922	4,418	1,029,112
1923	4,426	1,118,367
1924	4,482	1,493,596
1925	4,582	1,684,954
1926	4,611	1,759,819
1927	4,692	1,763,819
1928	4,635	1,830,458
1929	4,674	2,359,348
1930	4,954	2,962,852
1931	5,234	2,566,138
1932	5,698	2,776,519
1933	6,089	1,915,863
1934	6,264	2,726,119
1935	6,580	2,085,997
1936	6,577	2,287,628
1937	6,827	2,689,599
1938	7,016	2,543,570
1939	7,303	2,212,802
1940	7,702	2,362,905
1941	7,924	2,604,983
1942	8,058	2,467,932
1943	8,088	2,882,838
1944	8,091	3,530,195
1945	8,091	4,307,956
1946	8,379	4,801,851
1947	8,452	5,343,383

Winter maintenance expenditures

Expenditures to insure that traffic may move over the road under all weather conditions have become increasingly important during the last two decades. For example, the sum spent on state highways and accepted ways for the winter of 1947–1948 was $2,910,-055, an increase of over 4,000 per cent over 1927–28.

The rise in expenditures on state highways and accepted ways over the years is illustrated in chart 9. The increase since 1942 has been particularly rapid, with the cost to the taxpayers more than doubling since then. It has not been accompanied by any great expansion in mileage, as was the case with increases in expenditures up to 1942, but has been the result of increased costs and services.





Distribution of snow removal costs

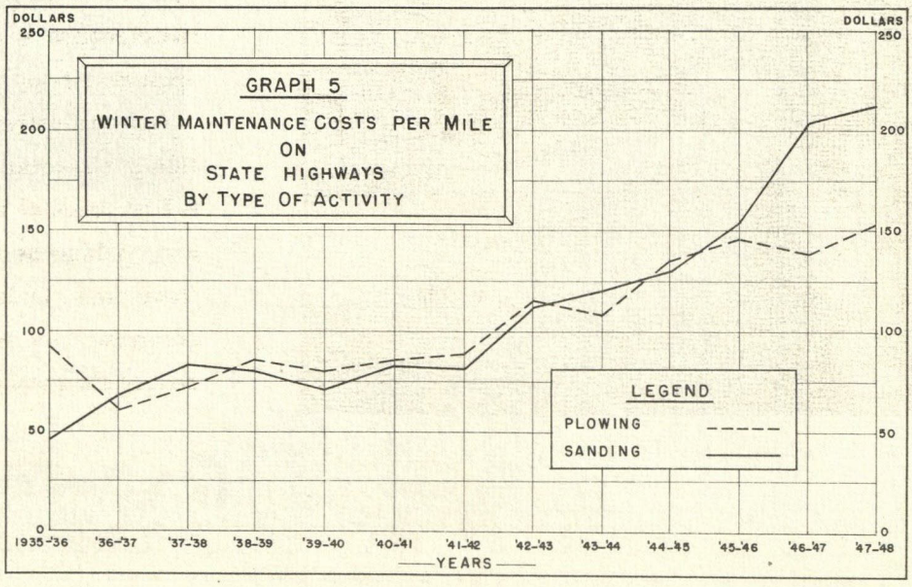
The major share of these increased expenditures is borne by the State. In the winter of 1927–28 the State paid 44 per cent of the total cost of snow removal on state highways and accepted ways while the towns paid 56 per cent. These percentages have slowly changed until the winter of 1947–48 when the State paid 65 and the towns 35 per cent of the total. Increased costs plus better service explain this change in the relative share paid by the State.

Prices have gone up about 72 per cent in these years. The balance of the increase can be attributed to expansion in service rendered. Particular emphasis has been placed on improving sanding and ice control. As can be seen from graph 5, in the winter of 1941–42, $89 was spent per mile for plowing and $81 for sanding on state highways. By the winter of 1947–48 these expenses were $152 per mile for plowing and $213 per mile for sanding. The large increase in costs for sanding is the result of better service provided to the public in the control of icy and slippery roads. Now it is a common practice that highways are plowed during storms as well as after, and that sand, salt, and calcium chloride are spread before the ice starts rather than after hazardous conditions have developed.

Although information on expenditures by towns for snow removal on town ways is available for the years 1937 and 1947 only, the same increase is apparent. For the fiscal year prior to June 30, 1937 total expenditures on secondary and tertiary roads amounted to $1,256,354. For the fiscal year prior to June 30, 1947 expenditures on these systems totaled $2,697,655, a 115 per cent increase.

For the year 1947–48, snow removal expenditures per mile on state highways were 153 per cent higher than the average of 1937–40. In the same year expenditures per mile on accepted state aid roads and town ways were 113 per cent higher than the 1937–40 average. It is evident that the state highways are coming in for more emphasis than the accepted ways.

An increase in winter maintenance expenditures by towns on both state aid roads and city streets is apparent from an examination of the information available for the years 1937 and 1947. Some of this increase can be attributed to the greater mileage

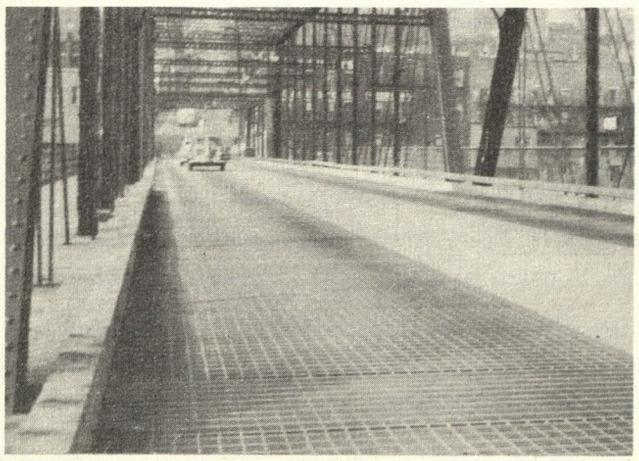


from which snow is cleared, since the mileage of "accepted" state aid roads went up from 4,141 in 1937 to 5,704 in 1947, a 38 per cent expansion. Over the same period the dollars expended rose from $440,706 to $717,956, a 63 per cent increase. Additional expenditures, other than those resulting from more miles of road, are caused by price changes, which necessitate greater expenditures in order to maintain the same amount of service, and by better service, such as more sanding and plowing.

The same general comments may be made with regard to the city and town ways, although information is incomplete. From 1937–1947 the total sum expended by towns rose 143 per cent, from $815,648 to $1,979,699. Additional miles of streets cleared, price advances and better services account for this increase.

Bridge maintenance

In 1931, when the State took over their maintenance there were 550 bridges on the state highway system. This number was gradually augmented, as more mileage was added to the system, until 1947, when there were 742 bridges under state maintenance. From 1931 through 1945, the cost of this type of maintenance has averaged approximately $172,000 per year. Because of the backlog of work resulting from war restrictions and because of increased costs, these charges increased to $277,000 in 1946 and to $380,000 in 1947.



The legislative act of 1947 transferred the responsibility for maintenance of all bridges built under the "General Bridge Act" from the towns to the State. This action increased the number of bridges under state maintenance to 1,550.

Bridge maintenance costs for the period 1931–1947 are shown below.

BRIDGE MAINTENANCE EXPENDITURES

Year	Expenditures
1931	$ 67,057
1932	141,550
1933	139,636
1934	169,740
1935	175,075
1936	210,472
1937	235,328
1938	161,691
1939	168,618
1940	251,053
1941	151,311
1942	170,641
1943	191,554
1944	192,454
1945	161,127
1946	277,118
1947	379,829

Administration

Expenditures for administration include salaries and expenses of members of the State Highway Commission and of the engineering and clerical staff where salaries and expenses are not charged directly to projects. They also include payments for office supplies and furniture, telephone and telegraph, printing, maintenance and upkeep of laboratories, and for engineering supplies and equipment.

Administrative costs have never been a large proportion of the total expenditures and have been as low as 0.7 per cent of total state expenditures for highways and as high as two per cent during the years when there was little construction activity. Currently, administrative expenses are running about one per cent of the total of state expenditures for highways.

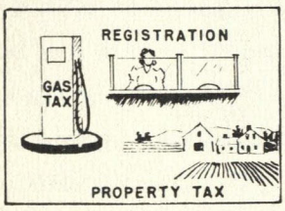
Other expenses—State Police

In 1937, $206,206 of state highway funds were spent for State Police services while in 1947 the amount had changed to $504,894, an increase of 145 per cent. This increase is far greater than the 25 per cent for all expenditures on state highways over the same period.

Conclusions

Maintenance expenditures have grown because of the assumption by the State of additional responsibilities. For example, transfers of mileage from third class highways to the state aid system and from the state aid to the state highway system have made the State responsible for more summer and winter maintenance. Still other examples might be cited. The trend, wherein the State takes on additional responsibility for the highways while the towns relinquish responsibility, is continuing, and while it will increase the problems of state financing, it may result in better service to highway users.

Especially significant are the great increases in snow removal expenditures, in the miles of road from which snow is cleared, and in the service rendered to the public. The period from 1927 to 1942 saw rapid increases in both mileage and expenditures. The mileage on which snow was removed by the State rose from 2,950 to 14,453. Recent increases in expenditures have been caused by rising costs and better service, since the State removed snow from only 14,764 miles in 1947–48.



Receipts

(By the State, Counties, Cities, and Towns)

Receipts in general

Citizens must pay for increased services, highway as well as others, and it is no accident that revenue dedicated to highway use has been increased along with expenditures. It is also interesting to note that highway receipts have not only grown in the aggregate, but that the sources from which they are drawn have changed in relative importance. As the highway program has developed, it has been either a matter of necessity or policy to shift the relative proportion of the total costs borne by various types of taxpayers.

Total receipts, between 1937 and 1947, rose from $16,294,038 to $23,391,553, an increase of 44 per cent for the decade. However according to the federal aid construction price index, the increase in receipts has not been as great as that in prices.[1]

Total revenue for highways is not only greater, but there have been significant changes in the sources from which new funds have been drawn. It is obvious that the highway user is paying a greater part of the highway bill. In 1947, the motor fuel tax, largely, it is true, because of the increase in the rate that year, became the most important source of highway receipts. Revenue was $8,894,269, or 38 per cent of all income used for expenditures as compared with $3,785,556, or 23 per cent in 1937. Property taxes, on the other hand, are now in second place in importance as a source of income. In the last decade, they have increased slightly, from 30.7 to 31.5, as a percentage of total revenue. Fees received from licenses and registrations, like funds received from the fuel tax, have increased as a per cent of the total from 16 to 20 per cent. Loans have dropped from 9.8 to 1.4 per cent of total income.

Federal aid funds allocated for 1947 were approximately 4 million dollars. However, a total of 6.6

[1] NOTE ON PRICE INDEX — *The index mentioned is the federal aid primary price index for highway expenditures. This index was compiled for costs of state highway construction in the State of Maine using the period 1937–1940 as a base.*

million dollars was available for matching. In addition nearly 7 million dollars was either programmed or set aside for projects under construction. Actual federal aid expenditures, however, decreased between 1937 and 1947 from 17.5 to 8.4 per cent of expenditures. This decline is largely attributable to unstable conditions which made it impossible for the State to use in 1947 all available federal aid funds.

1937, while in 1947 it brought in but 19 per cent. During the same period, income from motor fuel taxes increased from 32 to 47 per cent of the total revenues allocated to the secondary system, and use of revenue from licenses increased from 22 to 25 per cent.

The same trend is true of the tertiary system, although property taxes still supply the greatest part of this income. Motor fuel taxes accounted for only

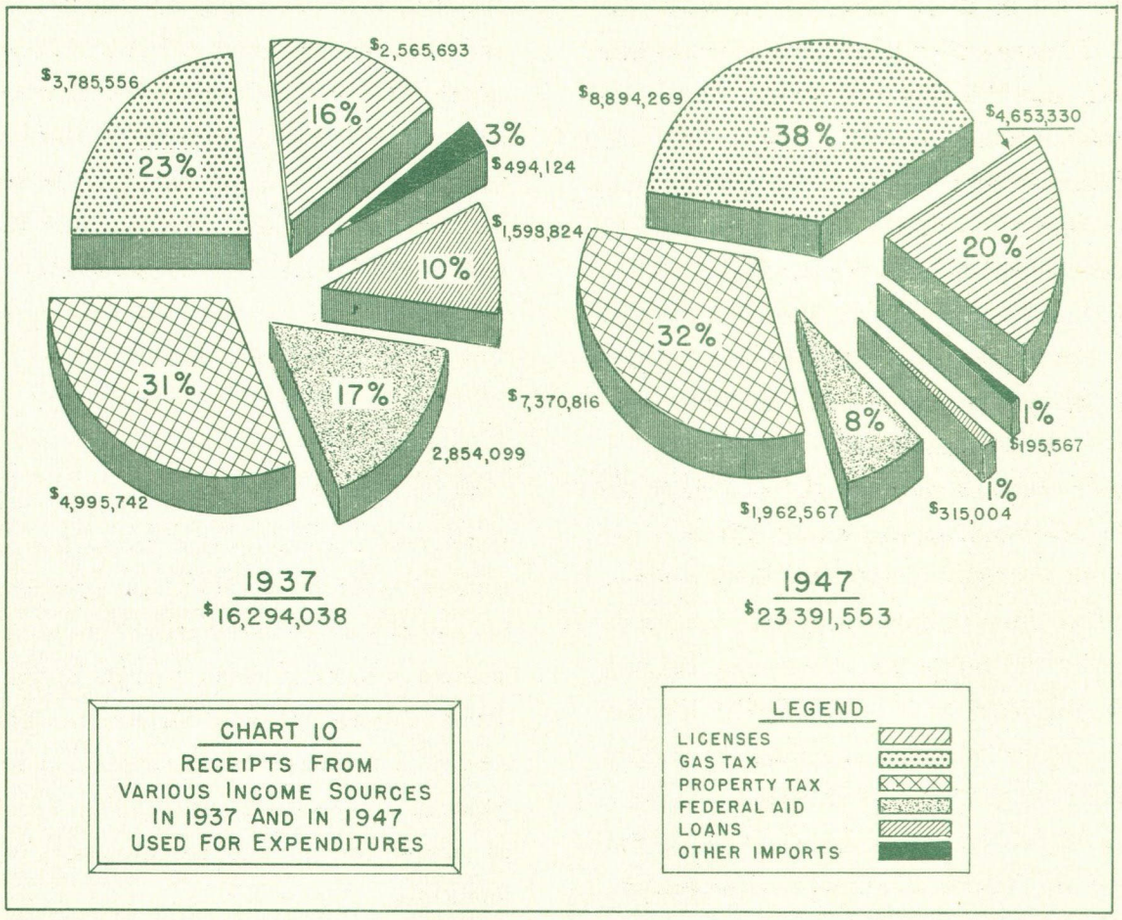


CHART 10
RECEIPTS FROM VARIOUS INCOME SOURCES IN 1937 AND IN 1947 USED FOR EXPENDITURES

Importance of highway revenues—to system

The greater importance of the fuel and license taxes in total receipts is matched by their increased importance to the various highway systems. The fuel tax supplied 52 per cent of the funds used for expenditures on the primary system in 1947, as contrasted to 27 per cent in 1937. The license tax supplied 27 per cent of the funds in 1947, and 18 per cent in 1937.

The trend toward increased reliance on these taxes is also evident on the secondary system. For example, the property tax brought in 25 per cent of the revenue used for expenditures on the secondary system in

nine per cent of total funds used for expenditures in 1947, and three per cent in 1937. In these same years receipts from license taxes were five per cent and two per cent, respectively, and income from property taxes was 82 per cent and 85 per cent.

Income for construction

The greatest part of the funds expended on primary highway construction, apart from federal aid, has come from the sale of bonds. Highway and bridge bonds, first issued in 1913, reached a peak in 1933, when the total long term indebtedness of the State (exclusive of minor civil divisions) was $25,583,500. It is interesting to note that the issue of 1933 could

be utilized only to match federal aid. In 1935 the debt limit of the State for highway purposes was raised to 36 million dollars with the provision that bonds amounting to 5 million dollars could be used only for state highway construction at the rate of 1 million dollars a year, and that they could not be reissued once retired. The bonds for highway construction were all issued over the next six years; the last issue was for $500,000 in 1941. However, in each year the amount of bonds retired exceeded the total of new bonds issued, and the debt was slowly reduced to approximately 10 million dollars in 1947. The final issuance of any bond by the State for highway purposes was a reissue amounting to $700,000 in 1942. However, an attempt by the Legislature in 1947 to authorize the reissuance of about three and one-half millions in bonds failed when the Maine Supreme Court, in an advisory opinion, found that the Legislature had no power to reissue bonds.

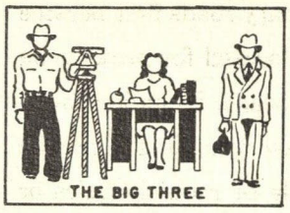
Federal aid, another important source of funds for construction, averaged approximately $700,000 per year from 1919 to 1930. In 1933, the State received $3,369,917 from federal grants which did not need to be matched by the State, and these non-matching grants were continued in 1934 and 1935. Regular federal aid, resumed in 1936, amounted to slightly over 1 million dollars in 1937. Federal aid allocations in 1947 were $3,913,324. Of this amount $1,948,844 was allocated for federal aid primary construction, $1,043,942 for federal aid secondary construction, and $560,538 for federal aid urban construction.

In 1938, federal aid for secondary roads first became available. These funds were allocated for projects on principal secondary and feeder roads, including farm-to-market roads, rural free delivery mail, and public school bus routes, either outside of municipalities or inside of municipalities of less than 5,000 population. Expenditures were to be made on a system of roads selected by the State Highway Commission in co-operation with the county or other local road officials and the Commissioner of Public Roads. Approximately $225,000 was allocated in that year, but the amounts became smaller until 1943 when $151,613 was made available. No secondary funds were allocated for 1944 and 1945, but the amounts in 1946 and 1947 were $1,404,017 and $1,403,942 respectively.

Urban federal aid first became available in 1946. The allocation for 1947 was $560,538.

Conclusions

The increased use on all systems, including the tertiary, of the gas tax and license fees as sources of highway funds and the shift from a policy of borrowing to pay-as-you-go for construction were the major changes in highway revenue policy in the last decade. These changes become significant when they are related to the needs, both current and future, of the highway systems, to the availability of various sources of funds, and to the requirements for additional financing.



Comparison with Other Governmental Activities

(State, Counties, Cities, and Towns)

Highway, welfare, and education are the most expensive activities carried on by state and local governments. In this section a comparison is made of the proportion of total expenditures allocated to each of these three activities in 1937 and 1947. The picture, while not conclusive, indicates an interesting trend.

Expenditures by all governmental units for highway, education, and welfare purposes were $45,556,616 in 1937 and $71,164,873 in 1947.[1] This represents a 56.2 per cent overall increase in dollars spent. In 1947, a sum of $23,391,553, or 32.9 per cent, was spent for highways; $20,670,931, or 29.0 per cent, for education; and $27,102,389, or 38.1 per cent, for welfare. These dollar amounts are naturally substantially above those for 1937. Highway expenditures are up 43.6 per cent; education expenditures, 73.1 per cent; welfare expenditures 56.5 per cent.

When price changes in recent years are considered[2], the situation is altered somewhat. Thus, although more dollars were spent, total highway accomplishments were 10 per cent less in 1947 than in 1937. Education expenditures, in terms of real dollars, represent an increase of only 11 per cent. Welfare expenditures, after adjustments for price changes, are less than one per cent greater.

[1] *See note A following on the choice of years for comparison.*

[2] *See note B following for method of adjusting for price changes.*

These statistics indicate that, in spite of the large increase in dollars spent for all purposes, expenditures, in terms of real purchasing power, have decreased for highways, while they have increased slightly for education and remained about constant for welfare.

The contrast is even sharper when state expenditures alone are considered. State expenditures for highways have decreased 14 per cent since 1937, if adjustments are made for price change; for education they have increased 40.8 per cent and for welfare 26 per cent. It is evident that highways are responsible for a smaller proportion of the state tax dollar today than in 1937.

A — Note on the choice of years for comparison.

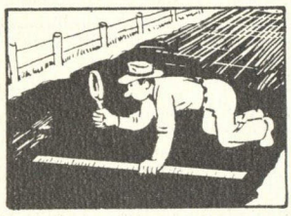
The comparison of highway department activities with the activities of the education and welfare departments has been made for the years 1937 and 1947. The detailed information necessary for making the comparison is available for these years only. However, since 1937 represents a normal pre-war year, it may be chosen as representative of that period.

B — Note on the method of adjustment for price changes.

Two indexes were used to correct for price changes. The first, a federal aid primary price index for highway expenditures, was compiled for costs of highway construction in the State of Maine using the period 1937–1940 as a base. It is, therefore, reliable for use as an index of highway expenditures. The second, the Bureau of Labor Statistics cost of living index,was chosen as an index for educational and welfare expenditures through lack of any better index. Its application is, therefore, not perfect. The federal aid primary price index shows a greater change from 1937 to 1947 (112 to 179) than does the cost of living index (102 to 159). This is in accord with the relatively greater increase in construction costs than in costs as a whole.

CHAPTER 3

The Adequacy *of the* Existing Highway System

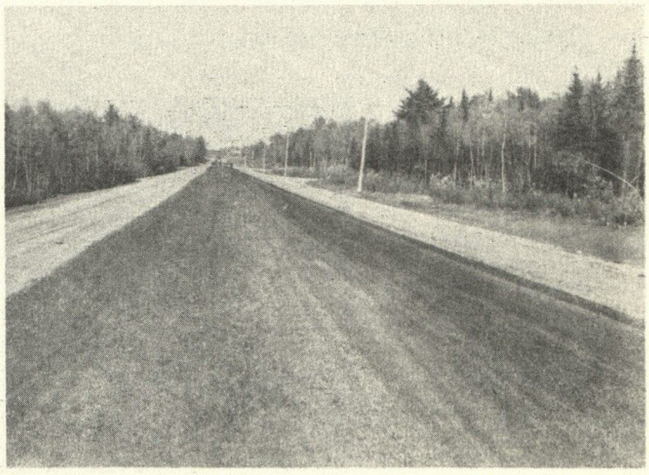


Introduction

Highways must be planned, designed, and constructed so that they are capable of meeting present and expected traffic conditions at a minimum cost. Standards are important, therefore, from both the physical and the financial viewpoint. Those which are too high or too low encourage extravagance or waste of public funds. In the first case, money is expended on unnecessary services; in the latter case the highways furnished are inadequate and, therefore, costly.

The standards utilized to determine the desirable condition of highways in Maine are based on the experience not only of the State but also of national authorities. National standards have been evolved on the basis both of experience and of research. The latter is centered in the Highway Research Board of the National Academy of Sciences. Important contributions to the formulation of nationally recognized highway standards also have been made by the United States Public Roads Administration and the American Association of State Highway Officials.

Tolerable standards, as used in this report, are based, therefore, on a considerable amount of data accumulated by national organizations interested in highways



and on information reported by various state highway studies. It has been necessary, of course, to modify these standards, especially in the case of the state and state aid systems, in accordance with the peculiar conditions existing in Maine. These modifications were agreed upon by the heads of the various Divisions of the State Highway Commission.

A yardstick, "Tolerable Standards", was applied to the physical condition of the complete highway network as it existed on June 30, 1948. These standards were based on factors measuring highway adequacy, such as pavement type and width, number of lanes, and surface condition, and they were applied to every mile of highway maintained by the State or local civil subdivisions. The actual appraisal was made by engineers of the State Highway Commission — in all cases, those who were most familiar with that part of the mileage which they were requested to evaluate. From this comprehensive examination of highway conditions, a complete inventory of the deficiency was determined.

Table 9 indicates in detail the various standards employed in establishing the number of miles of deficient rural highways.

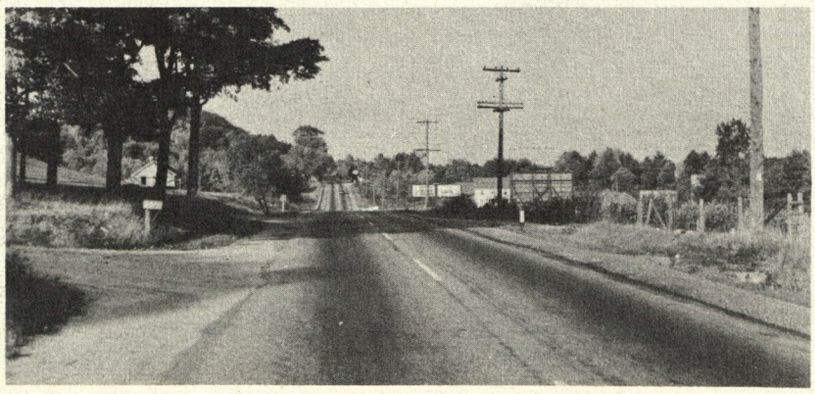
These standards represent the minimum existing conditions which are considered acceptable, but they are not desirable standards of design for the construction of new highway facilities. Consequently, design standards for future construction are more stringent and result in safer and more convenient highways, highways with a practical traffic capacity up to 50 per cent greater than most of the roads rated as acceptable under the lower standards stated in table 9.

Once the deficiencies on existing mileage were determined, another yardstick, one based upon minimum standards of design for future construction was applied. The costs of bringing up all deficient highways to these future standards were determined. The anticipated cost for the whole road network is presented in this chapter with a breakdown of costs by systems. A more detailed analysis of these costs is included in Chapter V.

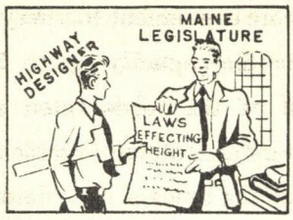
TABLE 9
TOLERABLE STANDARDS
Rural Highways (Irrespective of System)

Design and condition elements	Average 24 hour traffic flow capacity range							
	Above 6000	4000–5999	1200–3999	800–1199	400–799	100–399	26–99	Less than 26
	HIGHWAYS							
Number of lanes	4	3	2	2	2	2	2	2
Pavement type	High	High	Inter-mediate	Inter-mediate	Low	Low	Low	Low
Surface condition	Good							
Lane width (ft.)	10	10	10	9	9	9	8	7
Shoulder width (ft.)	3	3	3	3	2	1½	1	—
Maintenance	Not excessive to maintain in good condition							
	STRUCTURES							
Load capacity	Not less than legal limits							
Height over pavement (ft.)	14.0							
Clear width—curb to curb (ft.)	42	32	24	22	22	20	14	14

NEW CONSTRUCTION — BUILT TO TOLERABLE STANDARDS



LEWISTON ROUTE U. S. 202



Vehicle Standards

General

It is essential that the designer have specific knowledge as to the weight, size, and speed of the vehicles that will utilize the highway which he is designing. Furthermore, he should be able to assume that these factors will not change radically during the expected life of the project. This assumption is especially important with respect to bridges and grade separation structures, as their useful life usually exceeds that of the roads leading to and from them. If the maximum size and weight of vehicles, especially those of a commercial type, were not standardized by law, an economical design for any type of highway or structure would be practically impossible.

The legal limitations as to weight, length, width, and height of motor vehicles, as established by the Maine Legislature, conform closely to those recommended by the American Association of State Highway Officials. They are summarized in table 10.

TABLE 10

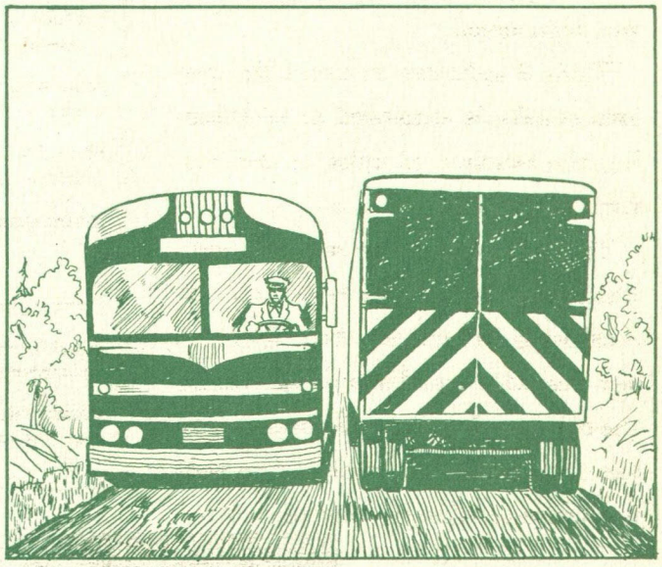
VEHICLE LIMITATIONS IN MAINE AS COMPARED WITH THOSE RECOMMENDED BY THE A.A.S.H.O.

	Maine Law	A.A.S.H.O.
Width	8′	8′
Height	12.5′	12.5′
Length		
Any vehicle and/or combination of vehicle	45′	60′
Trailer	26′	—
Gross weight		
Single axle	22,000 lbs.	18,000 lbs.
Tandem axle less than 10′ apart	16,000 lbs.	—
Maximum for any vehicle and load	50,000 lbs.	73,278 lbs.

Vehicle width

Since vehicles of excessive width decrease vision, require wider roads for passing and increase the possibility of collision, the width of motor vehicles must be closely regulated if traffic is to move safely. The width of any vehicle and its load is limited, therefore, by Maine law to eight feet, with the exception of vehicles and/or trailers hauling firewood, pulpwood, logs or bolts; the maximum of these vehicles cannot exceed eight and one-half feet.

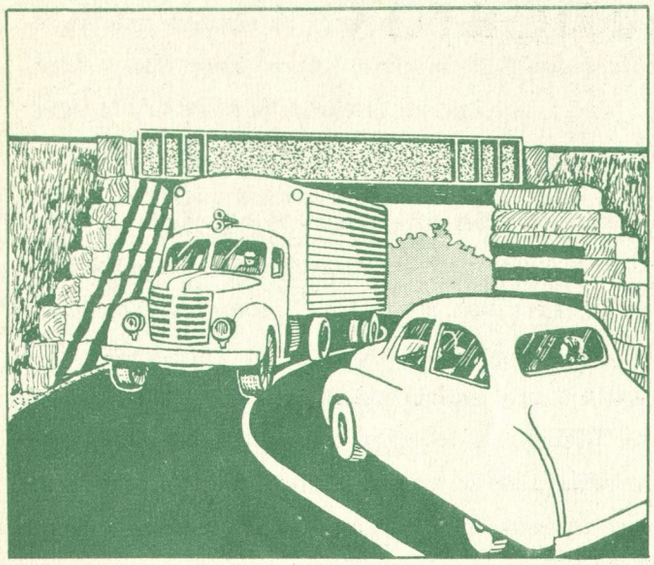
The maximum of eight feet results primarily from the widths of our present highways, the majority of which are still 20 feet or less, but it is standard in a majority of the states and is recommended by the American Association of State Highway Officials.



Height of vehicles

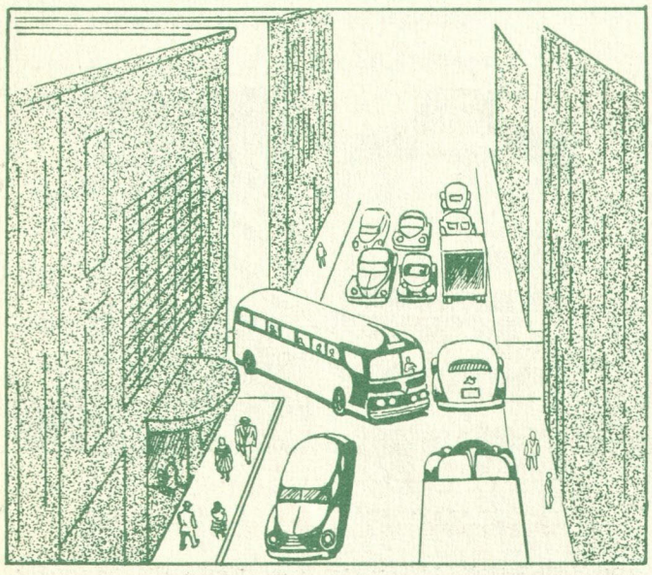
It is necessary to impose restrictions on the height of vehicles so that there may be safe clearance under grade separation and other structures. Cars and trucks in Maine are limited to 12.5 feet, but the load carried may extend one and one-half feet above the top of the vehicle.

The present state law also requires the vertical clearance of any structure to be 14 feet, but many modern structures are now being built with clearance of 14.5 feet.



Length of vehicles

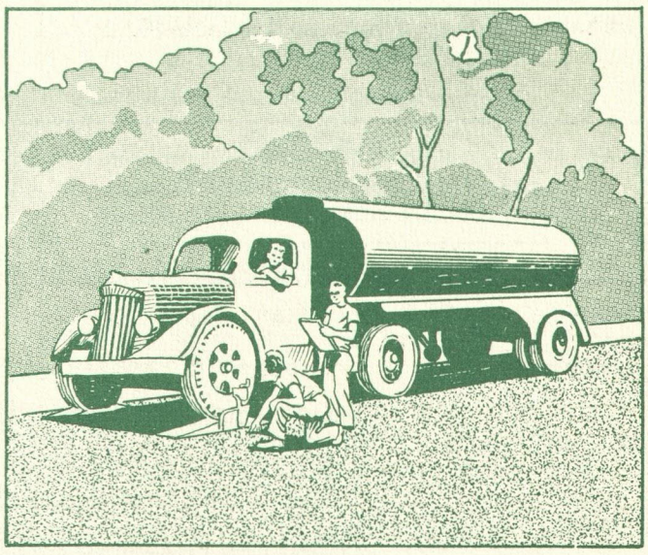
Legal limitations on the length of vehicles are established so that such vehicles will not constitute traffic hazards under certain conditions, such as heavy traffic, sharp curves, steep grades, busy intersections, or crowded city streets.

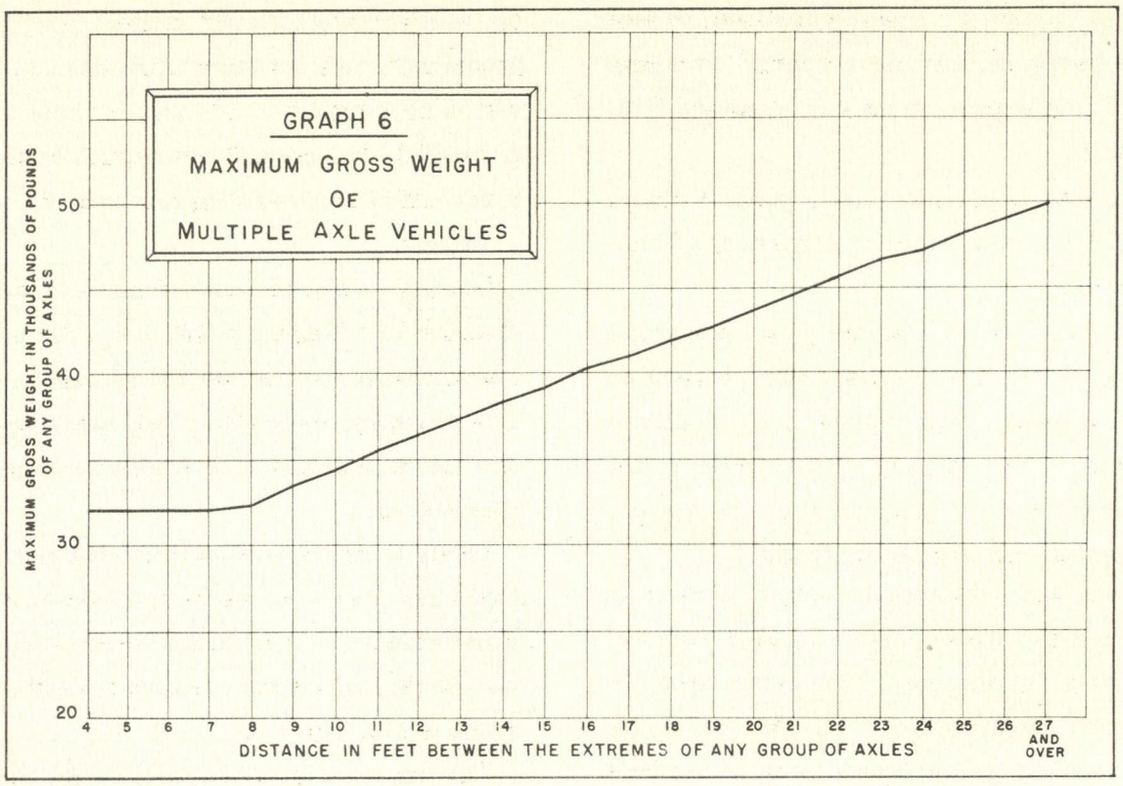


The Maine law limits the length of any motor vehicle or combination of vehicles to 45 feet, but the length of a trailer shall not exceed 26 feet. A load extension of one and one-half feet beyond the structural limits of any vehicle is permitted.

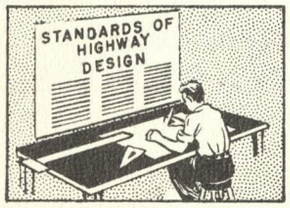
Vehicle weight

The maximum weight of motor vehicles is limited to protect the investment of the State in roads and bridges. A general limitation of 50,000 pounds is imposed for all commercial vehicles, and no vehicles with two axles may operate with a gross weight in excess of 32,000 pounds. It is also provided that not over 22,000 pounds shall be carried on any one axle, and that no vehicle with "two or more axles less than 10 feet apart shall be operated with more than 16,000 pounds imparted to the road surface from either axle ". A further limitation is stipulated in that no load shall be imparted to the road surface "which is greater than 600 pounds per inch width of tire ".





The above graph shows the maximum gross weight allowed for multiple axle vehicles for varying distances between the extremes of any group of axles.



Highway Standards

Factors in the determination of standards for highways and structures

Before standards of design for the several highway systems can be discussed, some explanation of the factors employed in the determination of these standards is necessary. In particular, it is essential to define what is meant by pavement type, sight distance, grades and curves, and design speed in relation to highways. Design load, with reference to bridges and other structures, will also be explained.

Pavement Types — Pavement types are divided into three groups, high, intermediate, and low.

High — The high type includes bituminous macadam, Portland cement concrete, and bituminous concrete. Bituminous macadam is a three inch crushed stone surface course penetrated with asphalt and placed on a gravel or crushed stone base. Portland cement concrete is a reinforced pavement usually seven inches thick at the center and nine inches at the edges. A bituminous concrete pavement consists of graded crushed gravel and/or stone and sand mixed with a bituminous material one inch or more in compacted thickness. The base may be either rigid or non-rigid.

Intermediate — This is a mixed bituminous surface course, two inches or more in compacted thickness, composed of graded gravel or crushed stone and bituminous material.

Low — Low type pavement is a gravel surfaced road, to which has been added an application of bituminous material.

Sight distance — Sight distance is an important factor in highway design and has a direct bearing on safe operating speed. Sight distance may be defined as the length of the roadway ahead visible to the driver of a vehicle at any given point on the roadway when the view is unobstructed by traffic.

In applying sight distance to design, it must be subdivided into two types — "stopping sight distance" and "passing sight distance". "Stopping sight distance" is the minimum distance to an object four inches above the roadway surface which must be available to enable the driver of the vehicle traveling at a rate not exceeding the design speed to bring his vehicle to a stop before reaching the object. "Passing sight distance" is the minimum distance that must be available to enable the driver of one vehicle to pass another vehicle safely and comfortably without interfering with the speed of an on-coming vehicle, traveling at the design speed, which has come into view after the passing maneuver is started.

Design Speed — Design speed should not be confused with operating speed. The safe operation of vehicles is dependent on the design of a highway, including a correlation of the effects of such features as curvature, super-elevation and sight distance. Design speed is the highest rate at which individual vehicles can travel with safety upon a highway when weather conditions are favorable, traffic density is low, and the design features of the highway are the governing conditions for safety.

Operating Speed — It is that over-all speed at which a driver is able to travel on a given section of roadway under prevailing conditions without exceeding the design speed.

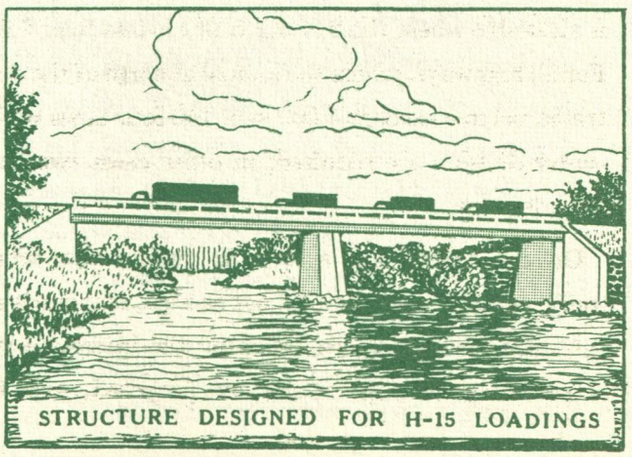
Curves — The degree of curvature on any highway is governed by the design speed. For a road with a design speed of 70 miles per hour, the maximum curve for safe operation cannot exceed four degrees and should preferably not exceed three degrees. However, with a design speed of 30 miles per hour, a 25 degree curve might be permissible but much better operating conditions will prevail if the maximum does not exceed 14 degrees.

Grades — The per cent of grade is the change in elevation in a distance of 100 feet. For example, if a road rises seven feet in 100, it is a seven per cent grade. The maximum grade allowable depends upon the system, and exception may be made where excessive costs are involved.

Design Loads — Structures are designed to carry loads and forces in addition to their own weight. These loads and forces include the live load, its impact, wind loads, and various other minor forces, such as the action of the elements.

The live load and the impact or dynamic effect of the live load, as applied to structures, are classified as H20, H15, H10, or H20–S16. An H20 loading consists of a 20 ton truck followed by or preceded by a line of indefinite length of 15 ton trucks, normally spaced, in each traffic lane. H15 and H10 loadings consist of a line of trucks in each traffic lane of three-fourths and one-half the weight respectively of those for the H20 loading. An H20–S16 loading differs from the H20 loading in that the 20 ton truck is replaced by a 20 ton tractor with a 16 ton single axle trailer.

In order to provide for infrequent heavy loads, each structure is also designed for a load in any single lane equal to twice the weight of the heaviest truck or tractor trailer in each H classification without concurrent loading of any other lane.



STRUCTURE DESIGNED FOR H-15 LOADINGS

Minimum highway standards

The minimum standards to which it is proposed to bring intolerable sections of the highway system are indicated in the following table.

Separate standards are established not only for interstate, federal aid, federal aid secondary, and non-federal aid highways in rural areas but also for different traffic volume groups on these systems. They necessarily represent a compromise between the ideal in highway design and construction and the dictates of expense. For example, although higher design speed or wider shoulders would be desirable in certain instances, the additional convenience or safety would not, under present conditions, justify the additional cost. Although they are not necessarily the ideal, highways built to these minimum standards will move anticipated traffic, both as to type and volume, at a reasonable speed. If sections of the highway system which are below the tolerable standards are improved to the recommended minimum standards, the entire system will be adequate.

Minimum standards of design for the national system of interstate highways in rural areas reflect the greater importance of this system and the higher traffic volumes that it carries. In the interests of safety and convenience, better highways must be provided. Design speed is 50 miles per hour, lane width is 12 feet, and shoulder width, with certain exceptions, is 10 feet. Grade separations are recommended only for the highest traffic range, and pavement is of high type except where the 24 hour traffic is less than 2,500 vehicles. The maximum grade is five per cent for all but the lowest traffic range. A grade of six per cent is allowable where the 24 hour traffic is less than 2,500. For all highways, where the annual average of the daily traffic volume exceeds 4,000 vehicles, four lanes with a center division are required; in other cases two lanes are adequate.

On the federal aid system in rural areas, where traffic volumes are generally not as high, standards are naturally somewhat lower than on the interstate system. No grade separations are proposed, and the number of lanes is restricted to two, except on sections where the annual average 24 hour traffic is over 4,000 vehicles. In the latter case there should be a four lane highway with center divisions. Design speed for those sections of highway in the upper traffic ranges is set at 50 miles per hour, the pavement type as high, the maximum grade at six per cent. Where the traffic volume is less than 2,500 vehicles, the design speed is 45 miles per hour, the pavement type is intermediate, and the maximum grade is seven per cent. The shoulder width for the federal aid system is eight feet, with certain exceptions, and the lane width is 12 feet except for the lowest traffic volume group for which 11 feet is the standard lane width.

Minimum standards for the rural mileage in the federal aid secondary, the state, and the state aid systems not included in the federal aid system do not vary greatly. There is no necessity for grade separations or for more than two traffic lanes. Design speed, depending on the system and the volume of traffic, varies from 35 to 45 miles per hour and lane width from eight to 11 feet. Pavement type is either intermediate or low, and the maximum grade varies from eight to 11 per cent. Shoulders are generally less than half the width considered adequate for the interstate and federal aid system.

Town ways, primarily rural roads with an average daily traffic volume of less than 50 vehicles, were evaluated according to the same standards as the state and state aid systems, with the exception of width. On town ways a low type pavement is considered adequate. There are two traffic lanes, each with a minimum width of seven feet. Shoulders are one and one-half feet or less in width.

The only design standards applied to city streets are those relating to surface width with the exception that an all weather surface is to be provided on the unsurfaced streets. Streets, which are also through ways, are to be constructed to a minimum width of 36 feet. Residential and other streets are to be 24 feet in width, and dead-end streets are to be 18 feet wide.

TABLE 11

MINIMUM STANDARDS OF DESIGN FOR FUTURE CONSTRUCTION IN RURAL AREAS

Design and condition elements	NATIONAL SYSTEM OF INTERSTATE HIGHWAYS 24 hour annual average traffic range				FEDERAL AID SYSTEM 24 hour annual average traffic range			
	Above 15,000	4,000–15,000	2,500–3,999	Under 2,500	Above 4,000	2,500–3,999	1,000–2,499	200–999
Grade separations	Yes	No	No	No	No	No	No	No
Number of lanes	4 Divided	4 Divided	2	2	4 Divided	2	2	2
Design speed (mi./hr.) (Rolling terrain)	50	50	50	50	†50	50	45	45
Pavement type	High	High	High	Inter-mediate	High	High	Inter-mediate	Inter-mediate
Lane width (ft.)	*12	12	12	12	12	12	12	11
Maximum grade (Rolling terrain)	5	5	5	6	†6	6	7	7
Shoulder width (ft.)	**10	10	10	10	8	8	8	††8
Right-of-way (ft.)	150–250	150–250	150–250	120–220	150–200	100	100	100
	STRUCTURES				STRUCTURES			
Design load	H20–S16	H20–S16	H20–S16	H20–S16	H20	H20	H20	H20
Height over pavement (ft.)	14	14	14	14	14	14	14	14
Clear width — curb to curb	Less than 80 ft. Same as pavement width plus shoulder widths.				Less than 50 ft. Same as pavement width plus shoulder widths.			
	More than 80 ft. Same as pavement width plus 4 feet.				More than 50 ft. Same as pavement width plus 4 feet.			

*Lane widths may be 11 feet where volumes are less than 1,000 per day.

**Mountainous — 4 feet.

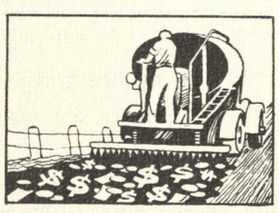
†Design speed may be lowered and per cent of grade increased in mountainous areas if found necessary.

††Shoulder width to be reduced to 4 feet when traffic volumes are less than 800 vehicles a day or in those instances where construction costs are prohibitive.

TABLE 11 (Concluded)

MINIMUM STANDARDS OF DESIGN FOR FUTURE CONSTRUCTION IN RURAL AREAS

Federal Aid Secondary System 24 hour annual average traffic range				State and State Aid Systems Not on Any Federal Aid System 24 hour annual average traffic range					Design and condition elements
Above 800	401–800	151–400	26–150	Above 800	401–800	151–400	26–150	Under 26	
No	No	No	No	No	No	No	No	No	Grade separations
2	2	2	2	2	2	2	2	2	Number of lanes
45	40	35	—	45	40	35	—	—	Design speed (mi./hr.) (Rolling terrain)
Intermediate	Intermediate	Intermediate	Low	Intermediate	Intermediate	Intermediate	Low	Low	Pavement type
11	10	9	9	11	10	9	9	8	Lane width (ft.)
8	9	10	11	8	9	10	11	—	Maximum grade (Rolling terrain)
4	3	3	3	4	3	2	1½	1	Shoulder width (ft.)
66–100	66	66	50	66–100	66	66	50	50	Right-of-way (ft.)
Structures				Structures					
H20	H20	H15	H15	H20	H20	H15	H15	H15	Design load
14	14	14	14	14	14	14	14	14	Height over pavement (ft.)
Less than 50 ft. Same as pavement width plus shoulder widths. More than 50 ft. Same as pavement width plus 4 feet.				Less than 50 ft. Same as pavement width plus shoulder widths. More than 50 ft. Same as pavement width plus 4 feet.					Clear width—curb to curb



Highway Deficiencies

General

The present highway system was evaluated as of June 30, 1948 and the total deficient mileage was calculated. It should be recognized, however, that some roads considered tolerable in 1948 shortly will become intolerable, either because of normal obsolescence or, more likely, because of increased traffic. Therefore, a highway program must include not only the construc-

tion and reconstruction of present deficient sections but also the replacement of that mileage that becomes inadequate during the life of the program.

TABLE 12

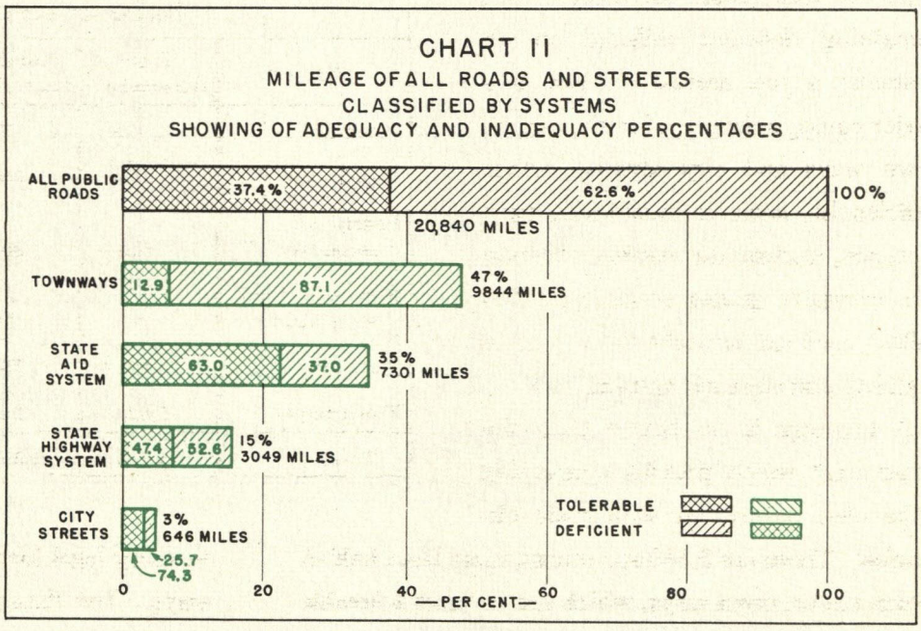
HIGHWAYS — MILES AND PER CENT TOLERABLE AND DEFICIENT, BY SYSTEM

System	Total miles	Miles tolerable	Per cent tolerable	Miles deficient	Per cent deficient
State highway	3,049	1,444	47.4	1,605	52.6
State aid	7,301	4,600	63.0	2,701	37.0
Town ways and city streets	10,490	1,745	16.6	8,745	83.4
Total	20,840	7,789	37.4	13,051	62.6

The official mileage of the State is currently reported as 21,971, but only 20,840 miles were evaluated. The lower mileage total utilized in this report can be explained by two factors. First, there has been an estimated reduction of 10 per cent in the mileage on town ways since 1938 when the last inventory was taken. This estimate of reduced local mileage is based upon an inventory of town ways in 16 selected localities. Second, all highways, such as the Maine Turnpike and private roads, not maintained by state or local funds are excluded.

Of the 20,840 miles of highway evaluated, 13,051 were found to be deficient. When one recalls the importance of highway transportation to the economy of the State of Maine, it is alarming to discover that 62.6 per cent of the total system mileage is considered to be below tolerable standards. These highway deficiencies, however, are not the result of the immediate circumstances; they represent the accumulated backlog of the depression and World War II. For almost two decades, either because of insufficient funds or because of wartime shortages, highway deficiencies have been growing, until now they have reached staggering proportions. Obviously, a system of which 63 per cent of the mileage is inadequate is failing, in a large measure, to meet the present needs of the people of Maine.

Approximately two-thirds of the mileage of public roads in the State is costing an excessive amount to maintain. In Maine, the principal causes of more-than-average maintenance expenditures are base and/or surface failures due to obsolescence induced by increased traffic and heavier loads. Another major deficiency is in highway surfaces; 2,808 miles have a surface of inadequate width, and 1,812 miles are without the proper type of surface. Sight distance and an inadequate number of traffic lanes account for the failure of 207 miles to meet tolerable standards.



The state highway and state aid systems, with a total of 10,350 miles, have 4,306 miles which are inadequate. While 42 per cent of the state system is deficient, the condition of town ways and city streets is even more deplorable. Of the 10,490 miles maintained by cities and towns, 8,745, or 83 per cent, fail to meet tolerable standards. Of the deficient town

way mileage, nearly 100 per cent is on highways with a traffic volume of less than 50 vehicles per day, and over 40 per cent has a traffic volume of less than eight vehicles per day.

These totals portray in general terms the story of the failure of both state and local highways, but the nature and scope of present deficiencies can be indicated in greater detail. In all, six types of deficiencies are observed. Failure of base and/or surface is the most common deficiency on town ways, state, and state aid highways. Inadequate surface width and type are responsible for most of the remaining deficient mileage on all systems; a too narrow surface is a major cause, however, of deficiency on town ways and city streets. Other deficiencies, such as insufficient sight distance, inadequate number of lanes, and excessive grades account for 208 miles, confined entirely to the state highway and state aid systems.

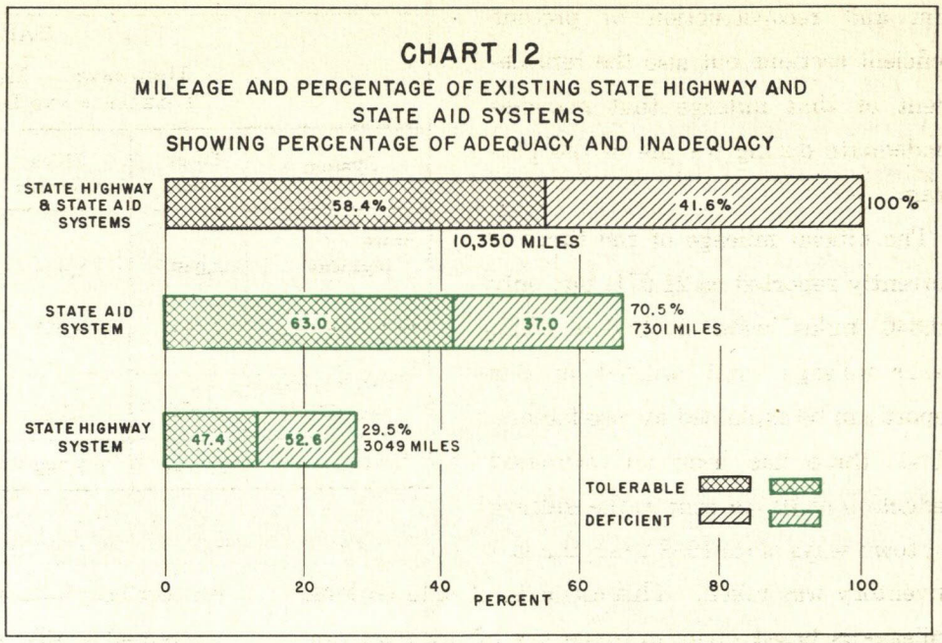


TABLE 13

STRUCTURES — NUMBER AND PER CENT TOLERABLE AND DEFICIENT, BY SYSTEM

System	Total structures	Number tolerable	Per cent tolerable	Number deficient	Per cent deficient
Interstate	89	73	82.0	16	18.0
Federal aid	360	248	68.9	112	31.1
Federal aid secondary	556	369	66.4	187	33.6
Non-federal aid state highway	91	58	63.7	33	36.3
State aid	1,425	707	49.6	718	50.4
Town ways	1,624	142	8.7	1,482	91.3
Total	4,145	1,597	38.5	2,548	61.5

A highway is no better than the structures* which provide connecting links over natural or man-made obstacles. There are 2,548 structures, more than half of which are on town ways, which fail to meet tolerable standards. The major cause of deficiency is inability to carry heavy loads; 85.2 per cent fail for this reason. However, of the 2,196 bridges of inadequate strength to carry legal loads, 1,440, or two-thirds, are on town ways. Insufficient width or underclearance explains the deficiency of the remaining structures. The above table shows the number of bridges and the number deficient by systems.

**The term structures, as employed in this report, includes railroad and highway overpasses and underpasses and bridges ten feet and over in length.*

Costs

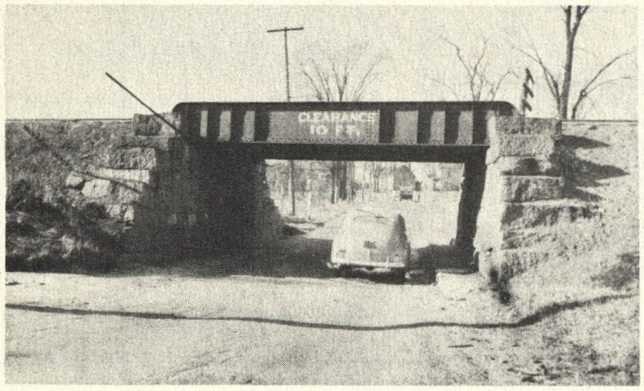
The present 62.6 per cent deficiency in the Maine highway system becomes more alarming when translated to dollars. It will cost the taxpayers $164,026,000 (June 30, 1948 prices) if the inadequate part of the highway system is brought up to minimum standards.

The following table shows the entire highway network, broken down into its component parts and the total and proportional deficient mileage by systems. It also indicates the cost of bringing intolerable sections up to minimum standards. The complete analysis of the costs is shown in Chapter V.

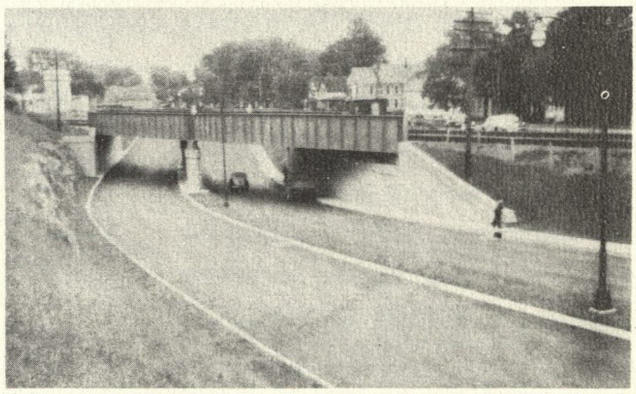
TABLE 14

HIGHWAYS, BY SYSTEMS, SHOWING TOTAL MILES, MILES DEFICIENT, PER CENT INADEQUATE, AND COSTS TO MAKE ADEQUATE

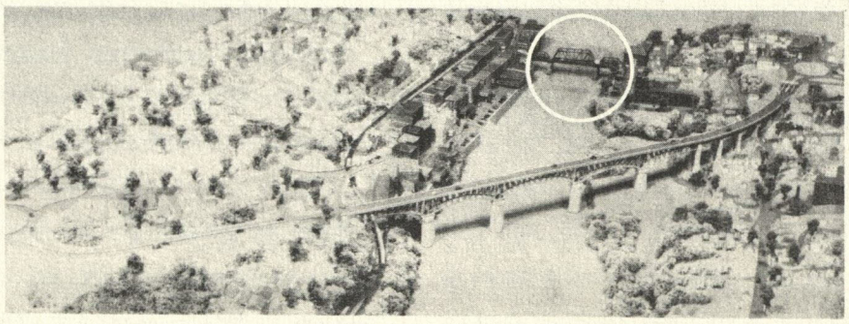
System	Total miles	Miles deficient	Per cent inadequate	Cost to make adequate
State highway	3,049	1,605	52.6	$81,670,000
State aid	7,301	2,701	37.0	52,859,000
Town ways and city streets	10,490	8,745	83.4	29,497,000
Total	20,840	13,051	62.6	$164,026,000



OLD TYPE STRUCTURE — 10 FOOT CLEARANCE



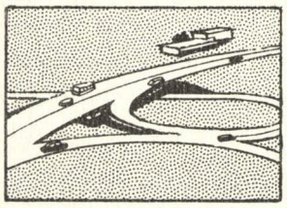
NEW STRUCTURE — 14 FOOT CLEARANCE



AUGUSTA TOLL BRIDGE — OLD BRIDGE IN CIRCLE

CHAPTER 4

Forecast Highway Income

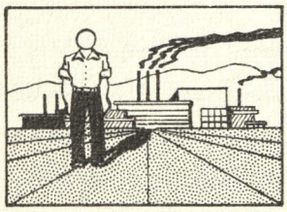


Introduction

Elements of highway planning

Highway planning and programming is based on fundamental elements — people, their activities, and geographical areas. A highway program also must be kept fluid, with an eye to future requirements as well as immediate needs. It is necessary, therefore, not only to have complete information as to the present usage of the highway system, but also to make reasonable predictions as to its utilization in the future. Otherwise, expenditures will be made for unnecessary improvements or for construction and reconstruction which will prove inadequate for future requirements.

Predictions as to future highway needs must give consideration to developments in two distinct fields. First, there are the non-highway elements, such as population, industry, natural resources, and agriculture. Second, there are the highway elements, involving motor vehicle registrations and motor fuel consumption, to mention the two most important indexes of road use.

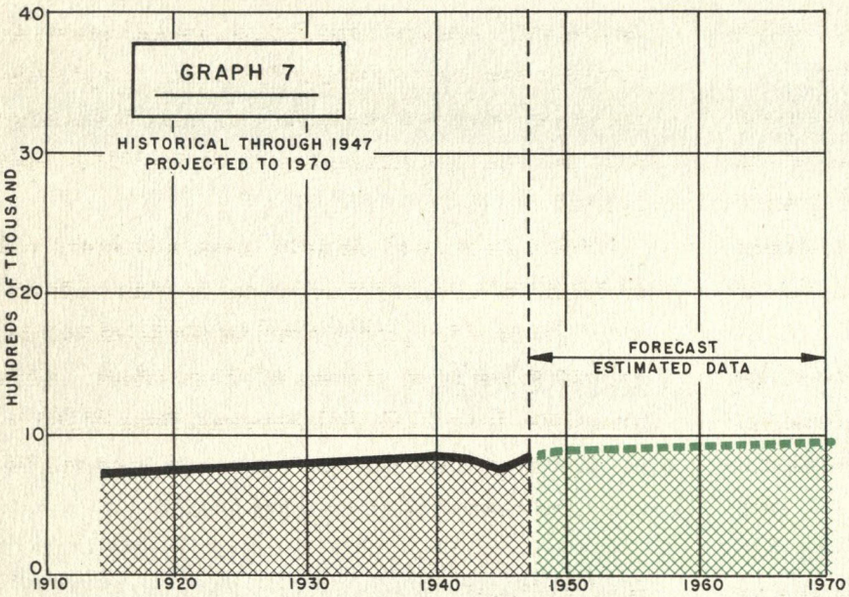


Non-Highway Elements

Population

Foremost in importance in a forecast of this nature is population, since people not only create the demand for highways but also provide the funds with which to construct and maintain them. Since 1850 Maine has not experienced the rapid increase in population typical of industrial areas but has maintained a slow rate of growth, ranging from two to eight per cent per decade. Current estimates by the United States Bureau of the

Census also reveal a normal growth of population in the State of Maine since 1940. This increase is surprising when one recalls the losses of the war years, but in-migration and a sizeable upswing in the birth rate increased the 1940 total of 847,000 to 885,000 by 1947. A forecast of 981,000 in 1970, if realized, will mean an increase of 11 per cent for the 23 year period. Of the 96,000 gain, which is predicted, 85,000 represents a natural increase, a surplus of births over deaths. The remaining 11,000 is estimated to be the balance of in-migration over out-migration. The expansion in industry, commerce, and agriculture, which occurred during and since the war, if continued, may result, however, in a somewhat more rapid increase in population. If a high level of production and national prosperity continues, the population will also increase more rapidly.



POPULATION GROWTH

There are several factors, such as industrial and agricultural activities, which affect population trends to a considerable degree, and they emphasize certain necessary qualifications inherent in any prediction of population growth.

Industry

The future of the State and its people is directly dependent upon its industrial base. If industry in Maine expands, population will increase more rapidly and people will travel more. Both trends will tend to expand highway use. It is necessary, therefore, to make some predictions as to the economic future of Maine.

Industrial growth will depend upon what the State has to offer by way of inducement to new industries and upon expansion of establishments already located here. Major considerations in industrial location and growth are specific factors, such as proximity to markets and raw materials, skilled labor, and available power.

Proximity to raw materials and markets — Maine industry, with the important exception of the processing of forest products, is under some competitive disadvantages because it is relatively distant from sources of raw materials and from the large metropolitan market areas of the eastern seaboard. However, this disadvantage is overcome to some extent by the high caliber and stability of available labor and by the almost total freedom from labor disputes. Improved means of transportation and highway facilities, which permit and encourage decentralization, also overcome, at least in part, the disadvantages of geographical isolation.

Labor supply — Labor is relatively mobile and, in the long run, will follow industrial opportunity. Although there is no substantial labor surplus in the State, there is a pool of trained and skilled labor in such fields as textiles, lumber, boots and shoes, and ship building. Additional labor could be provided by in-migra-

tion. There should be sufficient skilled labor available for any ordinary industrial expansion.

Natural resources

Maine, with over 80 per cent of its land area in timber, has a wealth in lumber and forest products exceeded by only a few states. The United States Forest Service has estimated that the growth in Maine in pole timber sizes exceeds the drain. An acceptance of the Forest Service estimate indicates that, contrary to some opinion, the basic supply of lumber is increasing.

With the coming of gas-propelled vehicles a radical change has taken place in the movement of timber and pulp wood. Trucks and tractors have opened up areas formerly inaccessible. It is estimated by the Maine Forestry Commissioner that at least 50 per cent of these products is hauled to the mills by truck.

Available power is an important, but not a determining, consideration in industrial location. Fortunately, there is sufficient water power in Maine to support a considerable expansion in industrial activity. In 1920 the development of hydro-electric power was below that of any state in New England, with the exception of Rhode Island, but in 1945 the hydro-electric capacity of Maine exceeded that of any other New England state by 30 per cent. Maine, however, has developed only 13 per cent of its hydro-electric potential, as compared with 35 per cent for other New England states. There is enough power, if developed, to support an almost unlimited increase in industrial activity.

Agriculture

Since much of Maine is still rural, agricultural activities are extremely important. Fortunately, the future of agriculture can be viewed with optimism.

The dairy industry should continue to expand. Despite a reduction in the number of cows from 144,000 in 1932 to 120,000 in 1946, the gross income from dairy products increased from $13,525,000 to $29,272,000 and the annual milk production per cow rose from 4,620 to 5,170 pounds. With an expanding population and with a greater emphasis on dairy products in our diet, the future of dairying would appear assured.

The amount of poultry raised for meat purposes, greatly expanded by wartime shortages, fluctuates considerably. Less variation occurs in egg production. Gross income from the sale of eggs has increased from $3,218,000 in 1932 to $13,806,000 in 1946. An abundance of uncontaminated range land means that the State is in a sound position for a further expansion in the field of poultry.

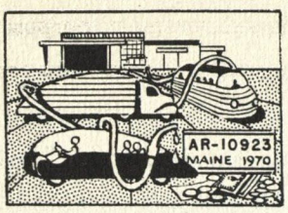
Potatoes are the most important cash crop in Maine agriculture. Acreage tends to fluctuate with prices, although government subsidies do operate as a stabilizing factor. Improved methods have raised the average yield per acre from 238 bushels in 1932 to 355 bushels in 1946.

Market crops, such as corn, peas, and beans will probably be increasingly important to Maine agriculture. Some of the products will be marketed as fresh vegetables, but many of them will be processed. Corn production from 1932–1947 increased from 29,200 to 41,300 tons, and the acreage of peas and beans in 1946 was approximately six times that of 1932.

Recreation

Americans are, at present, more recreation conscious than at any other time in history. Maine with its rock bound coast, extensive beaches, inland waters, and mountaineous areas has natural attractions of nationwide recognition. According to estimates furnished by the Maine Development Commission, one million seasonal visitors enter the State annually. Recreation is, therefore, an important part of the economy of the State. As resources, both for summer and winter re-recreational purposes, are more fully developed, recreation will continue its growth. Certainly, improved highways and modern vehicles, furnishing faster transportation with greater comfort, will make it possible for more people to come to Maine both as transient and seasonal visitors.

All these non-highway elements point to future demands for still more and better services for motor vehicles. Highway elements, more direct indexes of highway use, will be analyzed in the next section.



Highway Elements

Motor vehicle registrations

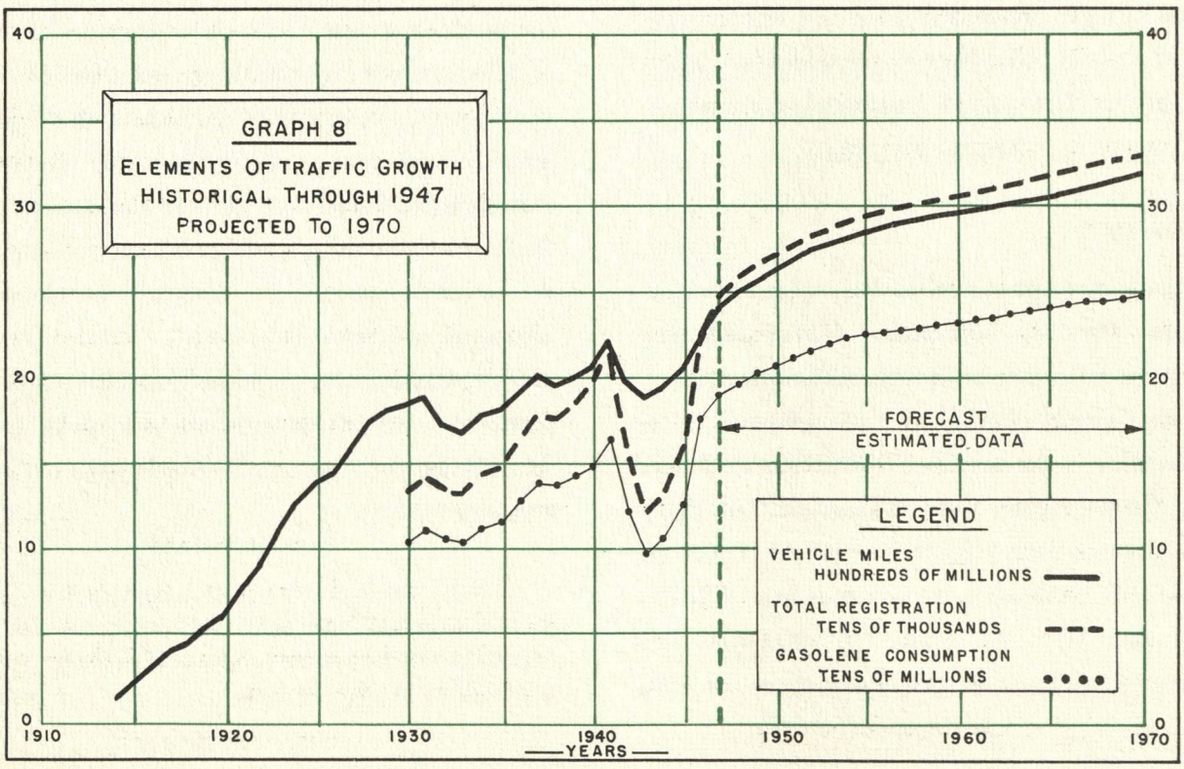
The most important factor in highway use is the number of vehicles. Vehicle ownership in any state is, of course, directly related to the population. It has been forecast that the population of Maine will show an orderly growth in the next two decades, and the number of vehicles registered will probably increase correspondingly.

The United States Public Roads Administration has forecast registrations for New England up to 1970, and it is possible to adjust these estimates so that they are applicable to Maine. The proportion of the total population owning vehicles is higher in Maine than in New England. A comparison of the ownership ratios per hundred persons from 1940 to 1970, based on this forecast, is shown on right.

YEAR	MAINE	NEW ENGLAND
1940	24.3	24.1
1945	25.7	24.0
1950	29.1	28.9
1955	30.9	29.9
1960	31.5	30.5
1965	31.9	30.9
1970	32.2	31.2

It is also estimated that total vehicle ownership from 1950–1970, by five year intervals, will be:

YEAR	REGISTRATION
1950	263,000
1955	285,000
1960	296,000
1965	305,000
1970	316,000



Highway use

Highway usage is measured by vehicle miles of travel, a product of the number of vehicles and the miles which they are driven. For example, in 1947 there were 240,720 vehicles registered in Maine, and the average mileage per vehicle was 8,594. Travel by all Maine vehicles was 2,069 million miles. Total vehicle miles, including travel by out-of-state vehicles, were 2,477 million.

The following summary shows vehicle miles, by five year intervals, from 1925 to 1945 and estimates during the period 1950 to 1970.

YEAR	VEHICLE MILES (In millions)
1925	741
1930	1,340
1935	1,494
1940	1,987
1945	1,593
1950	2,734
1955	2,964
1960	3,074
1965	3,173
1970	3,283

It is interesting to note the 81 per cent increase from 1925–1930, a period when snow removal became a part of the highway program. As expected, travel, freed of wartime restrictions, resumed its upward climb in 1947. The estimates for 1950 to 1970 are based upon conservative predictions.

Motor fuel consumption

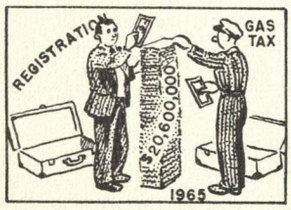
Total consumption of motor fuel, the result of travel by Maine and out-of-state vehicles, was 148 million gallons in 1940 and 189 million in 1947, an increase of 28 per cent for the period. By 1970 it is estimated that 248 million gallons will be used; of this total 207 million will be consumed by vehicles registered in Maine.

TABLE 15

MOTOR FUEL CONSUMPTION

(In millions of gallons)

Year	By Maine vehicles	By out-of-state vehicles
1940	124	24
1945	105	21
1950	173	34
1955	187	37
1960	194	38
1965	200	40
1970	207	41



Income from Highway Users

Registration and motor fuel imposts

The motor fuel tax, motor vehicle registrations, and license fees are the major sources of state highway revenue. The first, if the present rate of six cents per gallon is continued, will yield approximately 14.9 million dollars in 1970. This will be an increase of approximately three and one half million dollars, or 31 per cent, over the fiscal year of 1948, the first complete year since the adoption of the six cent rate. Receipts from registrations and licenses will be six and four-tenths million dollars by 1970. Total revenue from highway user sources, therefore, will be approximately 21.3 million dollars in 1970 as compared with 16.5 million dollars in 1948.

The following table summarizes the major elements involved in this forecast of highway developments.

TABLE 16

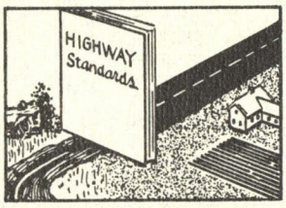
ELEMENTS OF GROWTH AND INCOME FROM HIGHWAY USERS
(*Historical and Forecast*)

Years	Population	Registrations per 100	Motor Vehicle Registrations	Motor Fuel Consumption per Vehicle	Motor Fuel Consumption: Maine Vehicles (Thousand Gallons)	Motor Fuel Consumption: Out-of-State Vehicles (Thousand Gallons)	Motor Fuel Consumption: Total (Thousand Gallons)	Average Miles per Gallon (All Vehicles)
1940	847,000	24.3	205,821	602	123,904	24,484	148,388	13.39
1941	844,000	26.3	221,972	613	136,069	26,888	162,957	13.35
1942	828,000	23.9	197,892	510	100,925	19,943	120,868	13.06
1943	802,000	23.4	187,668	431	80,885	15,983	96,868	12.58
1944	797,000	24.3	193,671	454	87,927	17,375	105,302	12.54
1945	801,000	25.7	205,857	510	104,987	20,746	125,733	12.67
1946	863,000	26.2	226,106	646	146,064	28,863	174,927	12.93
1947	885,000	27.2	240,720	656	157,912	31,204	189,116	13.10
1948	893,000	28.0	250,040	"	164,026	32,412	196,438	13.20
1949	899,000	28.6	257,114	"	168,667	33,329	201,996	13.23
1950	904,000	29.1	263,064	"	172,570	34,101	206,671	"
1951	908,000	29.6	268,768	"	176,312	34,840	211,152	"
1952	912,000	30.0	273,600	"	179,482	35,467	214,949	"
1953	916,000	30.3	277,548	"	182,071	35,978	218,049	"
1954	920,000	30.6	281,520	"	184,677	36,493	221,170	"
1955	923,000	30.9	285,207	"	187,096	36,971	224,067	"
1956	926,000	31.0	287,060	"	188,311	37,211	225,522	"
1957	929,000	31.2	289,848	"	190,140	37,573	227,713	"
1958	932,000	31.3	291,716	"	191,366	37,815	229,181	"
1959	935,000	31.4	293,590	"	192,595	38,058	230,653	"
1960	939,000	31.5	295,785	"	194,035	38,342	232,377	"
1961	942,000	31.6	297,672	"	195,273	38,587	233,860	"
1962	945,000	31.7	299,565	"	196,515	38,832	235,347	"
1963	949,000	31.8	301,782	"	197,969	39,120	237,089	"
1964	953,000	31.9	304,007	"	199,429	39,408	238,837	"
1965	957,000	31.9	305,283	"	200,266	39,574	239,840	"
1966	962,000	32.0	307,840	"	201,943	39,905	241,848	"
1967	966,000	32.1	310,086	"	203,416	40,196	243,612	"
1968	971,000	32.1	311,691	"	204,469	40,404	244,873	"
1969	976,000	32.2	314,272	"	206,162	40,739	246,901	"
1970	981,000	32.2	315,882	"	207,219	40,947	248,166	"

Years	Vehicle Miles: Maine Vehicles (Thousand Miles)	Vehicle Miles: Out-of-State Vehicles (Thousand Miles)	Vehicle Miles: Total (Thousand Miles)	Average Registration and License Fee (Maine Vehicles)	Income from Registrations and License Fees (Dollars)	Motor Fuel Tax per Gallon	Net Income From Motor Fuel Taxes (Dollars)	Total Registration and Motor Fuel Tax Income (Dollars)
1940	1,659,074	327,841	1,986,915	20.12	4,141,879	.04		
1941	1,816,522	358,954	2,175,476	19.80	4,395,965	"	6,396,183	10,792,148
1942	1,318,078	260,458	1,578,536	18.84	3,728,129	"	6,681,928	10,410,057
1943	1,017,530	201,069	1,218,599	20.94	3,929,337	"	4,593,836	8,523,173
1944	1,102,607	217,880	1,320,487	20.38	3,947,071	"	4,021,406	7,968,477
1945	1,330,186	262,851	1,593,037	20.18	4,154,455	"	4,362,396	8,516,851
1946	1,888,608	373,198	2,261,806	20.38	4,607,448	"	5,791,824	10,399,272
1947	2,068,646	408,774	2,477,420	22.24	5,353,283	.04 & .06	7,383,764	12,737,047
1948	2,165,140	427,842	2,592,982	20.36	5,090,814	.06	11,363,237	16,454,051
1949	2,231,460	440,947	2,672,407	"	5,234,841	"	12,119,760	17,354,601
1950	2,283,105	451,152	2,734,257	"	5,355,983	"	12,400,260	17,756,243
1951	2,332,607	460,934	2,793,541	"	5,472,116	"	12,669,120	18,141,236
1952	2,374,552	469,223	2,843,775	"	5,570,496	"	12,896,940	18,467,436
1953	2,408,798	475,990	2,884,788	"	5,650,877	"	13,082,940	18,733,817
1954	2,443,276	482,803	2,926,079	"	5,731,747	"	13,270,200	19,001,947
1955	2,475,279	489,127	2,964,406	"	5,806,815	"	13,444,020	19,250,835
1956	2,491,353	492,303	2,983,656	"	5,844,542	"	13,531,320	19,375,862
1957	2,515,557	497,086	3,012,643	"	5,901,305	"	13,662,780	19,564,085
1958	2,531,774	500,291	3,032,065	"	5,939,338	"	13,750,860	19,690,198
1959	2,548,035	503,504	3,051,539	"	5,977,492	"	13,839,180	19,816,672
1960	2,567,081	507,267	3,074,348	"	6,022,183	"	13,942,620	19,964,803
1961	2,583,463	510,505	3,093,968	"	6,060,602	"	14,031,600	20,092,202
1962	2,599,890	513,751	3,113,641	"	6,099,143	"	14,120,820	20,219,963
1963	2,619,134	517,553	3,136,687	"	6,144,282	"	14,225,340	20,369,622
1964	2,638,445	521,369	3,159,814	"	6,189,583	"	14,330,220	20,519,803
1965	2,649,524	523,559	3,173,083	"	6,215,562	"	14,390,400	20,605,962
1966	2,671,707	527,942	3,199,649	"	6,267,622	"	14,510,880	20,778,502
1967	2,691,194	531,793	3,222,987	"	6,313,351	"	14,616,720	20,930,071
1968	2,705,124	534,546	3,239,670	"	6,346,029	"	14,692,380	21,038,409
1969	2,727,528	538,972	3,266,500	"	6,398,578	"	14,814,060	21,212,638
1970	2,741,502	541,734	3,283,236	"	6,431,358	"	14,889,960	21,321,318

Town Way—City Street and State and State Aid Highway Programs

CHAPTER 5

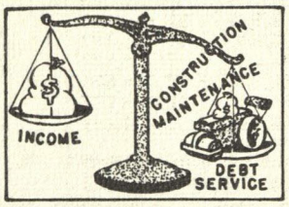


Introduction

Criteria and procedure for determining needs

As explained in Chapter III certain standards were used to evaluate the existing highway systems throughout the State. Present deficiencies were found and needs were determined primarily from these deficiencies.

The program of rehabilitation, as established in this chapter, provides for the elimination of present deficiencies and for the reconstruction of those portions of the state highway and state aid systems which will become deficient during the program periods considered. The costs of these needs, adjusted to anticipated changes in the price level, were estimated for each of the highway systems.



Present Fiscal Policy

Adequacy

The inadequacy of present highway policy is clearly reflected by the extensive mileages on various systems which fail to conform to standards of tolerability. Deficiencies, in terms of actual mileage, are more extensive on roads and streets for which towns and cities are responsible, but a heavier financial load accrues to the State, because of the higher standards required on highways under state management.

Deficiencies on town ways and city streets are primarily the result of so-called economy in town meetings. Low volume roads, never built to withstand present demands, are improved generally only when they reach the point of impassibility. Actual construction on the

local highway system except on city and town streets is almost non-existant.

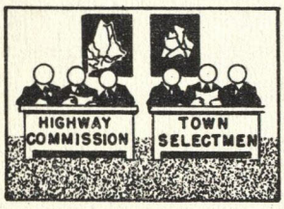
Inadequacies on the state highway systems are principally due to the failure of costly construction to keep pace with the demand created by more and heavier vehicles traveling greater distances. Additional causes for the present condition of highways under state management include: (1) curb on construction during the war period which resulted in an increase in maintenance expenditures, (2) combined pay-as-you-go policy and a bond retirement program. This fiscal policy has been doubly restrictive because of decreased war-time income and increasing post-war highway costs.

Equity

The development of the motor vehicle has had its influence on the mode of living not only in cities and towns but also in the remote sections of the State. In the latter case there has been development of rural free delivery, the transportation of school children in rural areas, and the rapid adaptation of the motor vehicle in farming, logging, and other business interests. Both urban and rural needs must be served in both summer and winter seasons. State funds have been made available for road improvement for the past 48 years and, as with any system which develops over a series of years, there are elements of inequality. It is believed that the present fiscal policy, with its inequalities, is an honest effort by all concerned to meet, as far as possible, the demands of an ever-expanding need in all sections of the State.

The allocation of state funds is determined in general by the Legislature, but expenditures in particular instances are at the discretion of the State Highway Commission.

The distribution of highway funds is inequitable when the ratio is considered between the service which various highways and highway systems render and the revenue which they contribute from traffic use. Equity is also lacking when 50 per cent of the total expenditure, state and local, is needed on the state highway system and 32 per cent on the state aid system in order to bring these systems to the required standard, while only 18 per cent is required on town ways and city streets.



Highway Mileages

Total mileage

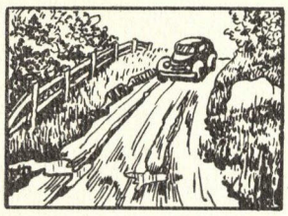
The over-all mileage, maintained by public funds, remained fairly constant during the period from 1925 to 1940.

Year	Mileage	Year	Mileage
1925	22,318	1935	22,458
1930	22,413	1940	22,497

Since 1940, however, there has been a reduction as indicated in the latest published report, that of June 30, 1948, which shows the total mileage as 21,971. The total usable mileage is now less than that shown by the report. A complete inventory of town ways and city streets in 16 communities was made in 1948, and the data secured were expanded to include all towns and cities. This survey shows that there has been a contraction of about 10 per cent in the mileage under local control. The reduction, arising largely from the failure of local units to keep sections of roads in passable condition rather than from the formal rescinding of mileage, has occurred for the most part in rural areas. In many communities the construction of new houses and the opening of new subdivisions have caused urban mileage to increase slightly.

The State Highway Commission has the authority to control the mileage on the state and state aid systems. In the past the rate of expansion of these systems has fluctuated as the personnel of the Commission varied. Under the present policy, however, there can be no marked increase in the designated mileages of the state systems. Additions can be made only when there are reductions to offset them.

Present trends indicate that state and state aid highway mileages will remain constant, and that town way mileages will continue to decrease. It should be recognized, nevertheless, that a change in policy, either by the Legislature or by the State Highway Commission, would invalidate this assumption.



Town Way and City Street Deficiencies

Analysis

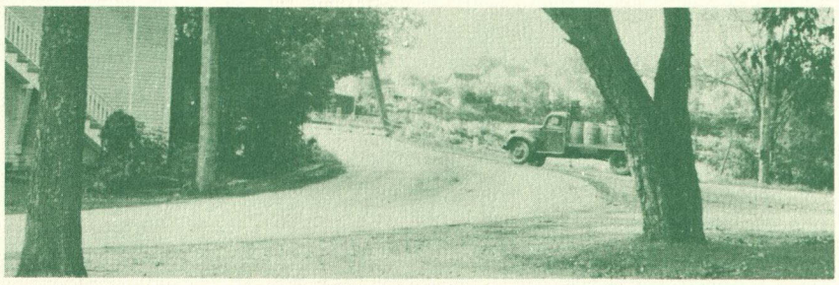
There are 10,490 miles of town ways and city streets. Here the responsibility for construction and maintenance rests with the local unit of government. Eight thousand, seven hundred and forty-five miles, approximately 83 per cent, fail to conform to tolerable standards. The correction of this deficiency will require the construction of 7,147 miles and the widening and resurfacing of 1,598 miles. In addition, there are 1,482 structures on this system, 91 per cent of the total, which are intolerable.

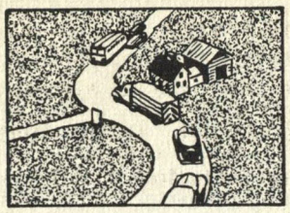
The over-all estimated cost of correcting existing deficiencies on town ways and city streets is $29,497,000.

Program

Aside from the State Highway Commission, there are nearly 500 separate units of government that have control of highways in Maine. The highways under the jurisdiction of these various governmental units have been classified as town ways and city streets in this report. No uniform procedure exists in these various units for construction and maintenance of town ways and city streets. Town way and city street mileages in the various municipalities differ, both in length and condition. Furthermore, the amount of money used for highway purposes varies according to the size of the local unit and its wealth. Since each community regulates its own expenditures, the attainment of adequate town ways and city streets is a responsibility within each municipality.

The State Highway Commission is ready and willing to furnish advice and counsel if requested by any community in developing a rehabilitation program involving needed improvements, replacements, and maintenance.





State and State Aid System Deficiencies

Analysis—state highway system

Rural mileage is 97 per cent, or 2,959 miles, of this arterial system. The remaining three per cent, or 90 miles, falls into a category defined as urban in an Act permitting the use of federal funds on non-rural construction. Under interpretation of the law, the Public Roads Administration has ruled that urban funds can be expended in the compact areas of the following places.

Auburn	Brunswick	Presque Isle
Augusta	Calais	Rockland
Bangor	Fairfield	Rumford
Brewer	Gardiner	Saco
Belfast	Lewiston	South Portland
Bath	Old Town	Waterville
Biddeford	Portland	Westbrook

Improvements made in any of these areas must be based on individual need and are subject to approval by the Public Roads Administration.

Deficiencies constitute 52.6 per cent, or 1,555 miles, of the rural part of the state highway system. A remedial program requires 1,140 miles of construction, 350 miles of resurfacing, and 65 miles of widening.

The urban part of the state highway system has 50 miles, or 55.6 per cent, that are intolerable. The correction of these deficiencies will require the reconstruction of 11 miles and in addition 39 miles need widening.

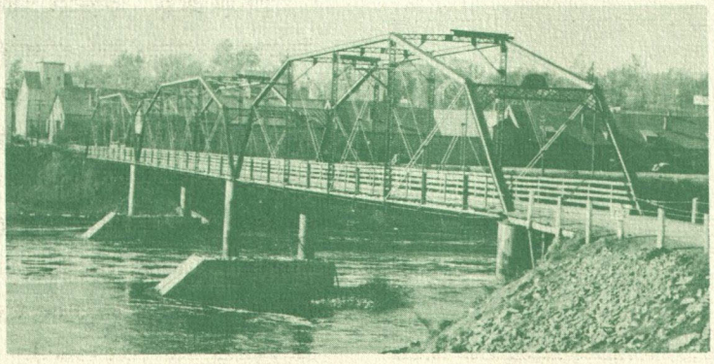
The foregoing discussion has dealt with state highway mileages, both rural and urban. No mention has been made of the deficiencies of structures, which include bridges and highway and railroad overpasses and underpasses. The deficiencies of structures cannot be shown in terms of the rural and urban classifications. There are, however, 213 structures on the state highway system that fail to meet the requirements of tolerable standards. The number inadequate and the cause of the inadequacy are listed below.

163	Insufficient width
39	" strength
11	" underclearance
213	

Analysis—state aid system

The state aid highway system, as designated, consists of 7,301 miles of secondary or feeder roads. It also is part rural and part urban. The rural section, 7,214 miles, is 99 per cent of the entire system. The one per cent that is urban consists of 87 miles. The urban mileage mentioned here is in the same group as listed in the state highway system analysis.

The rural state aid system embraces 7,214 miles, of which 2,659 miles, or 37 per cent, are intolerable. The correction of this deficient mileage requires the construction of 2,268 miles and the resurfacing of 391 miles.



On the urban part of the state aid system, 42 miles or 48 per cent, are deficient. These 42 miles are of insufficient width.

There are 1,785 structures on the entire state aid system of which 853, or 48 per cent, are intolerable. Again deficiencies cannot be segregated as to rural and urban categories. An analysis shows that 717 are of insufficient strength, that 121 lack sufficient width, and that 15 do not have sufficient underclearance.

Deficiency costs

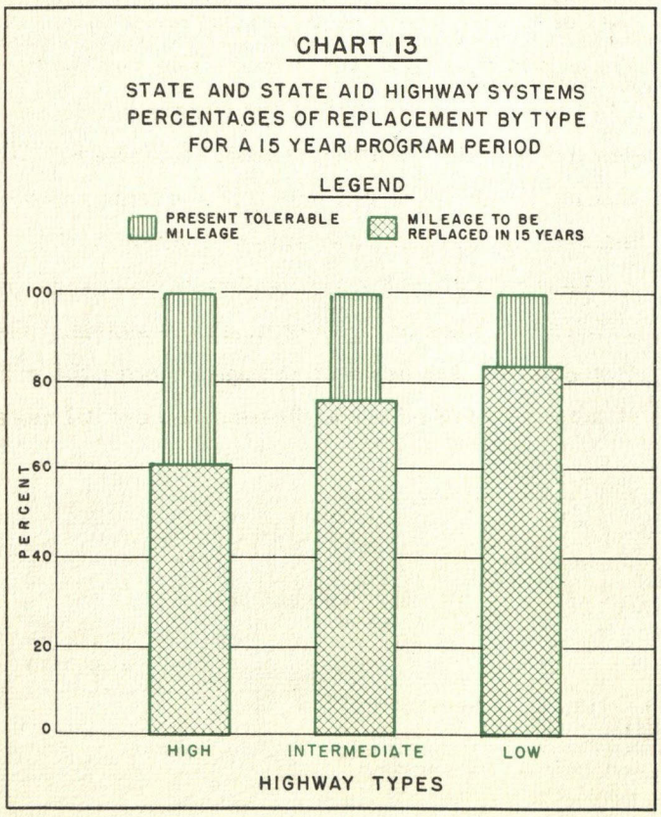
The existing deficiencies of the state and state aid systems have been analyzed. The costs of correcting the intolerable parts of these systems are as follows:

Six to twenty year program

The deficiencies of the state and state aid systems have been enumerated and evaluated. In the final program there are three additional factors that have been appraised. The costs of these are incorporated in the final program.

The first factor is replacement needs. Existing deficiencies were calculated as of June 30, 1948. Highways that are tolerable for present traffic may become intolerable during the program period, because of obsolescence or increasing demands of traffic. Therefore, a program must include not only the existing deficiencies but the annual replacement requirements for the program period. Road life data for Maine highways were analyzed and the yearly replacements required for each type of highway now considered tolerable were estimated. The results obtained for a 15 year period are shown in chart 13.

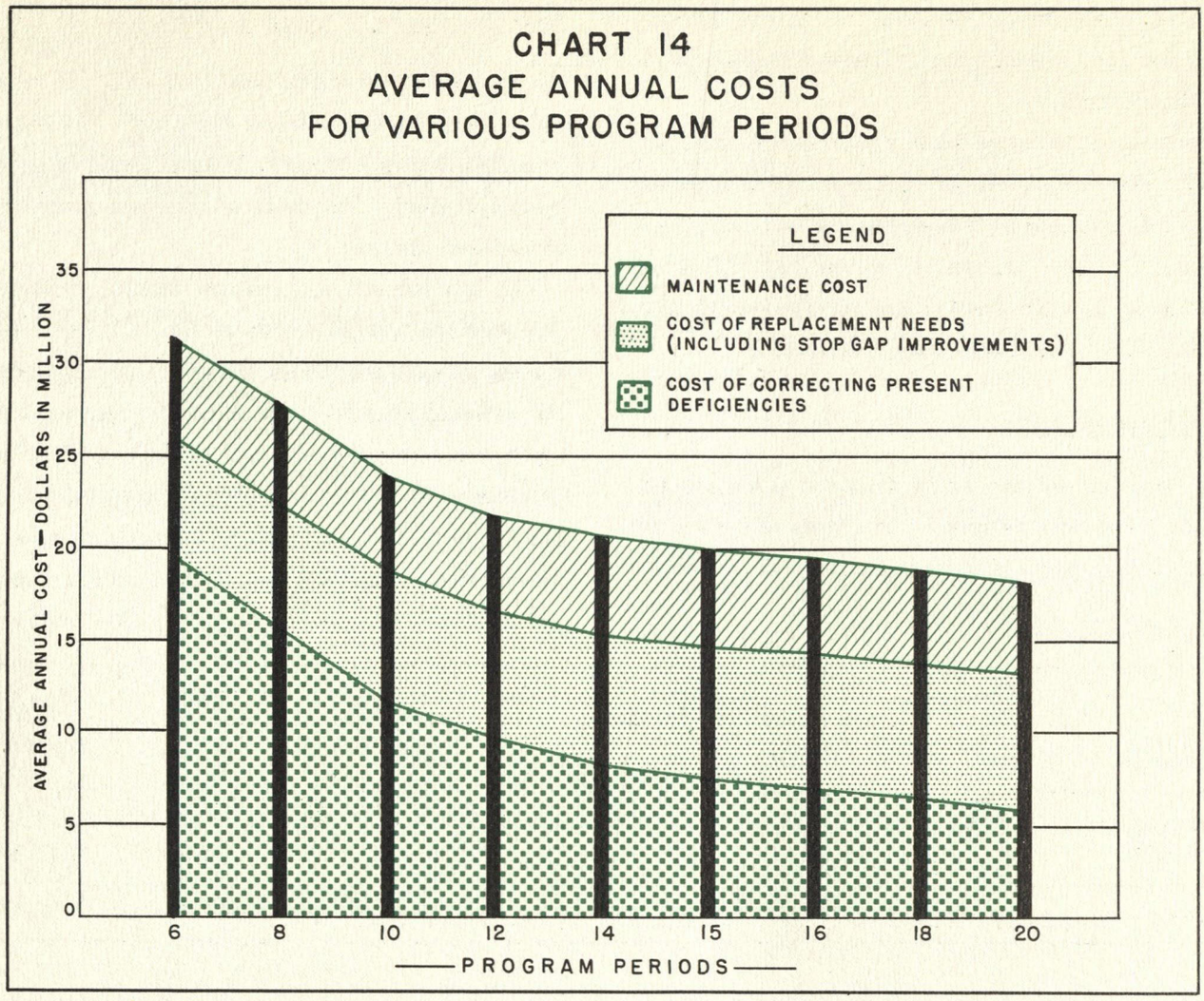
System	Construction		Widening		Resurfacing		Structures		Total Cost
	Miles	Costs	Miles	Costs	Miles	Costs	No.	Costs	
State highway	1,151	$57,752,700	104	$4,647,300	350	$8,770,000	213	$10,034,700	$81,204,700
State aid	2,268	34,938,900	42	404,100	391	2,016,000	853	15,965,300	53,324,300
Total	3,419	$92,691,600	146	$5,051,400	741	$10,786,000	1,066	$26,000,000	$134,529,000



This chart shows that, if a 15 year program is undertaken, 61 per cent of high type pavement, which at the present time is adequate, will have to be replaced. Large portions of intermediate and low type pavements, 76 and 84 per cent respectively, also will require replacement.

"Stop gap" construction is the second factor. It is resurfacing and emergency construction to keep already deficient highways usable until reconstructed.

The third factor is maintenance. The maintenance necessary and its cost are governed by the type of surface and whether a highway is adequate or inadequate. Future maintenance has been estimated to follow about the same trend as construction insofar as prices are concerned.



Highway needs during a program period represent an orderly relationship between the correction of existing deficiencies and replacements, stop-gap improvements, and maintenance.

Chart 14 portrays program periods ranging from six to 20 years and the average annual costs for each program period.

The same program periods and costs together with estimated income are shown in the table at right.

The length of program period will be determined by the people of Maine and the length of time that they are willing to wait for adequate highways. Regardless of the period chosen, the ultimate result will be the same. For example, chart 15 illustrates the existing and proposed highway surfaces for the state and state aid systems at the end of the program period irrespective of its length.

AVERAGE ANNUAL COSTS FOR VARIOUS PROGRAM PERIODS
(All amounts adjusted for price index)
FOR STATE AND STATE AID HIGHWAY SYSTEMS

Program periods (years)	Present deficiencies (average annual costs)	Replacement and stop-gap improvement requirements during program period (average annual costs)	Maintenance requirements (average annual costs)*	Total (average annual costs)	Estimated average annual income for period**
	Dollars	Dollars	Dollars	Dollars	Dollars
6	19,792,000	6,541,000	5,254,000	31,587,000	18,756,000
8	15,792,000	6,694,000	5,234,000	27,720,000	19,075,000
10	11,792,000	6,837,000	5,215,000	23,844,000	19,404,000
12	9,804,000	6,866,000	5,205,000	21,875,000	19,670,000
14	8,383,000	6,905,000	5,198,000	20,486,000	19,895,000
15	7,818,000	6,992,000	5,190,000	20,000.000	19,994,000
16	7,237,000	7,090,000	5,184,000	19,511,000	20,089,000
18	6,505,000	7,130,000	5,179,000	18,814,000	20,267,000
20	5,848,000	7,160,000	5,173,000	18,181,000	20,432,000

* Does not include maintenance in urban places of 5,000 population or over.

** Estimated income available for construction, replacement, and maintenance purposes.

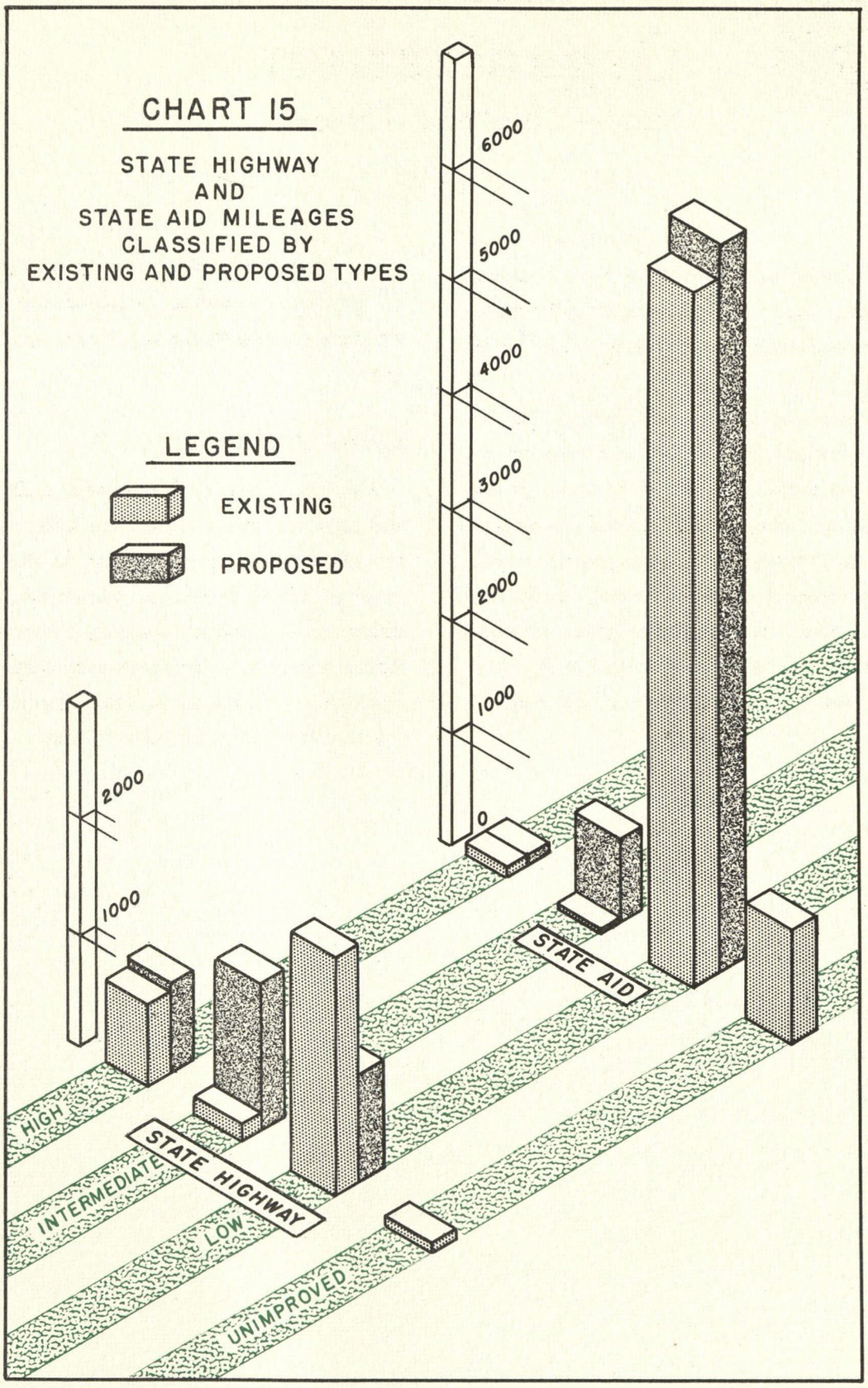


CHART 15
STATE HIGHWAY
AND
STATE AID MILEAGES
CLASSIFIED BY
EXISTING AND PROPOSED TYPES
LEGEND
EXISTING
PROPOSED
6000
5000
4000
3000
2000
1000
0
2000
1000
STATE AID
STATE HIGHWAY
HIGH
INTERMEDIATE
LOW
UNIMPROVED

Administrative Organization

State—Cities and Towns

State

The administrative structure of the State Highway Commission may require some revision if the far-reaching program suggested in this study is to be carried out most effectively.

An initial change requires the creation of at least five additional division offices. Divisional offices are not an innovation as almost all states with large areas and extensive highway mileages have adopted this method of control. One division in Maine was placed in operation at Presque Isle during 1946 with very satisfactory results. Each office will have charge of all construction and maintenance in its area, exclusive of bridge construction, subject to control from the Augusta office.

Consideration is being given to the arrangement of all activities, according to engineering functions, to facilitate the completion of a long-range highway program.

Cities and towns

The State Highway Commission realizes that qualified personnel is not always available, particularly in the smaller units of government, to effectuate a program of improvement. In recognition of this condition, the Commission is willing insofar as possible to furnish supervisory and engineering personnel to municipalities as an aid in carrying out programs of improvement on town ways and city streets.

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