U. S. DEPARTMENT OF AGRICULTURE

BUREAU OF PUBLIC ROADS

Public Roads

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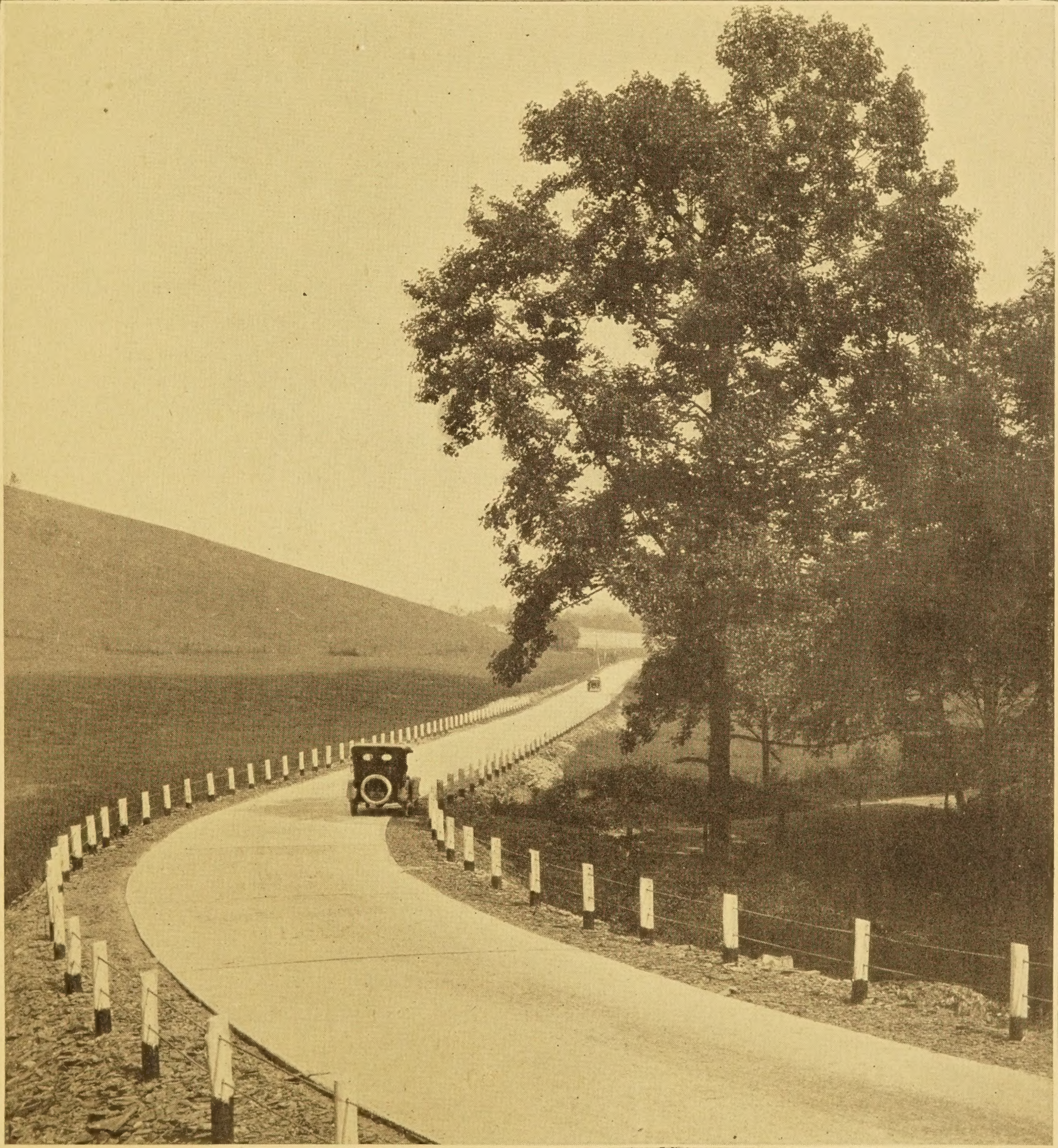

PENNSYLVANIA FEDERAL-AID PROJECT NO. 12, FROM BANGOR TOWARD EASTON

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U. S. DEPARTMENT OF AGRICULTURE

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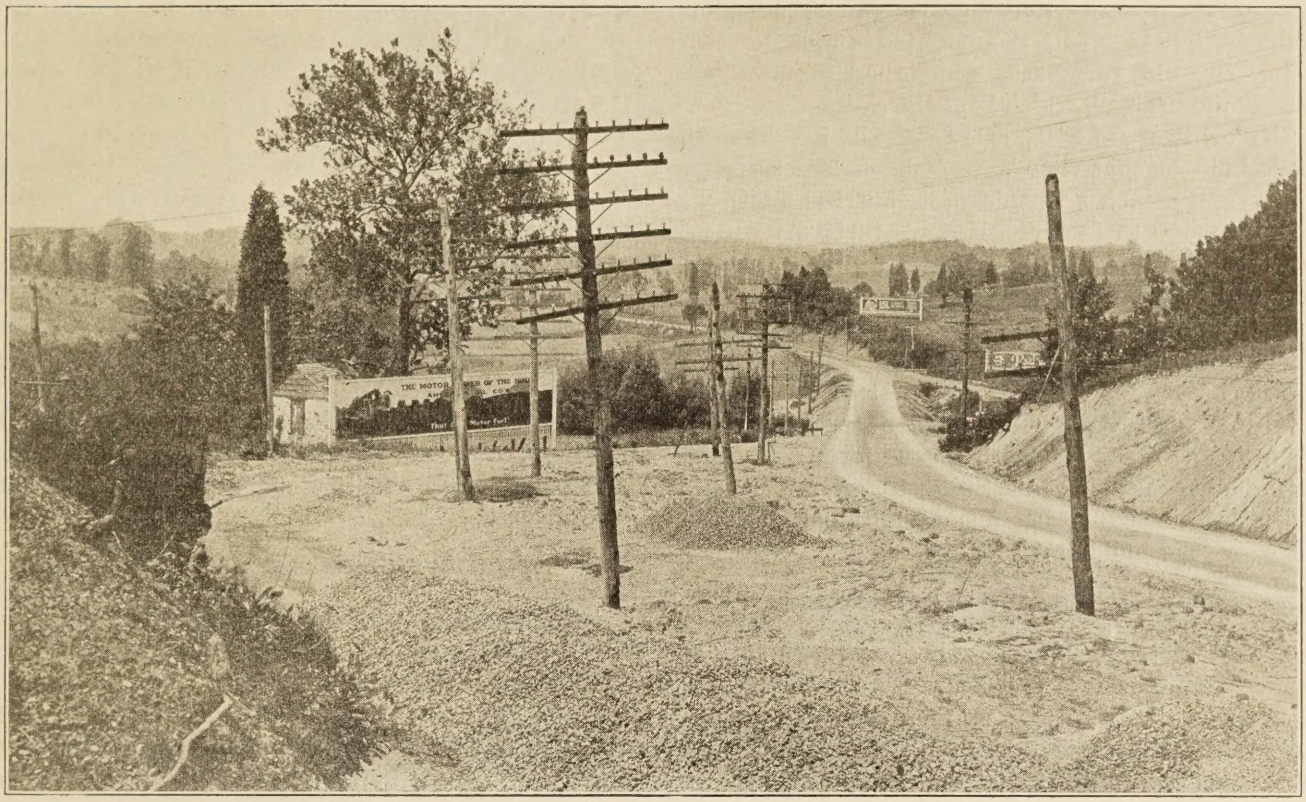
THOMAS H. MacDONALD . . . . Chief of Bureau
P. ST. J. WILSON . . . . Chief Engineer
H. S. FAIRBANK . . . . Editor

IMPROVING IMPROVED ROADS NOW THE WORD IN MARYLAND.

By J. N. MACKALL, Chairman, Maryland State Roads Commission.



FAMOUS DEADMAN'S CURVE ON THE MARYLAND ROAD BETWEEN WASHINGTON AND BALTIMORE IS NOW AS SAFE AS ANY OTHER SECTION OF THE STATE'S ROAD SYSTEM.

WHY should it be necessary to improve improved roads? Naturally, that is the first question which must arise in the mind of the reader. What policy of road construction has made it necessary to improve roads already improved? Maryland's experience in road construction provides a striking answer to these questions. It is the belief of the writer that the policy of so improving roads that later they will require further improvement is fundamentally sound and correct. Indeed, it is probably to this policy that Maryland owes her position as one of the foremost good road States of the Union.

In 1908, on the advice of the late Gov. Austin L. Crothers, Maryland embarked on a program of extensive highway improvement. Five million dollars was appropriated for the purpose, a sum which at that time appeared so large that many people throughout the State believed that the height of extravagance had been reached. The development of automobile traffic was then in its early stages. The policy of licensing the motor vehicles for road maintenance had been entered upon only a short time before, and the ideas which then prevailed as to the future development of motor traffic are well illustrated by a passage from the message of Gov. Crothers to the legislature, advocating the license fee. He recommended the creation of a motor vehicle department, the licensing of automobiles, and then added this very illuminating remark, "In time, it is probable that the revenue from this source will reach $100,000 per year". In 1920, twelve years from that time, it amounts to approximately $2,500,000. But to have embarked at that time on the construction of a system of roads designed to accommodate an automobile traffic which would yield annually in license fees the present return of $2,500,000, when the most enlightened imagination could only conceive that in time it would reach $100,000 proportions, would have entailed a burden of cost which could never have been met, because sentiment could not have been created for the financing of any such program. The commission, therefore, it seems to the writer, very wisely adopted a policy of building roads as good as the tax-payer was willing to pay for, roads which would meet reasonably well the traffic of the time and of the immediate future, leaving the unforseen future to care for itself.

LOW COST OF EARLY ROADS.

The average cost of the roads built from that first appropriation was less than $10,000 per mile. In some cases the work entailed considerable grading and drainage, but in others it amounted simply to resurfacing the old turnpikes, which had already been graded and drained, which kept the average cost down to the low figure of $10,000. Generally speaking, the roads built at that time were of macadam 12 feet in width, and 6 inches in thickness, but the width was soon increased to 14 feet. If roads 18, or even 16 feet in width, of some such material as bituminous macadam had been built at that time, it is not improbable that the public would have become alarmed at the tremendous cost, and long ago ceased to continue appropriations for road building. It is interesting to note, therefore, that the commission's policy of building low-type roads met with the uniform commendation of all the people of the State, and every successive legislature since 1908 has made additional appropriations for road building.

A COMPLETED SYSTEM FOR $30,000,000.

To date there has been spent in excess of $30,000,000 for a system of improved roads. All county seats and all towns of 1,000 people or more are connected by good roads, which enable the farmer to haul his produce to market, and the city man to send his product to the farmer. Her roads explain why Maryland has taken the lead among all the States in the development of rural motor truck express service. They have brought general prosperity to the State. Maryland people are firm in their belief that they have earned their cost, and if they require rebuilding to-day, the State is better able to rebuild them now than it would have been to have gone without them.

The point is that the perfect maintenance which all the roads of the system have received from the day they were completed, and the systematic scheme of gradual improvement which is now being worked out will enable many of the roads to give satisfactory service for years to come, and they will give that service at much less expense than the cost of roads of higher type at the present time.

IMPROVING THE ROADS.

Striking examples of the improvements which are fitting these roads to carry the increased modern traffic are to be found on the main road between Philadelphia and Washington through Baltimore. The section between Belair and Washington, a distance of more than 50 miles, has been widened from 12 and 14 feet to 20 feet, by the construction of concrete shoulders on each side of the existing macadam, and in the process of widening the crown of the road has also been made to conform to modern standards. The old roads had a crown of three-quarters inch to the foot, which made the sides so steep that the traffic was forced to cling to the center of the road, because to get on the sides meant sliding to the shoulder and gutter. All traffic, therefore, concentrated in the center, except that as the volume of traffic increased it was necessary to pass other vehicles more frequently, which meant going over to the side, and ''chewing'' off the edge of the macadam. The concrete shoulders have been so constructed as to remedy this condition as well as to widen the road.

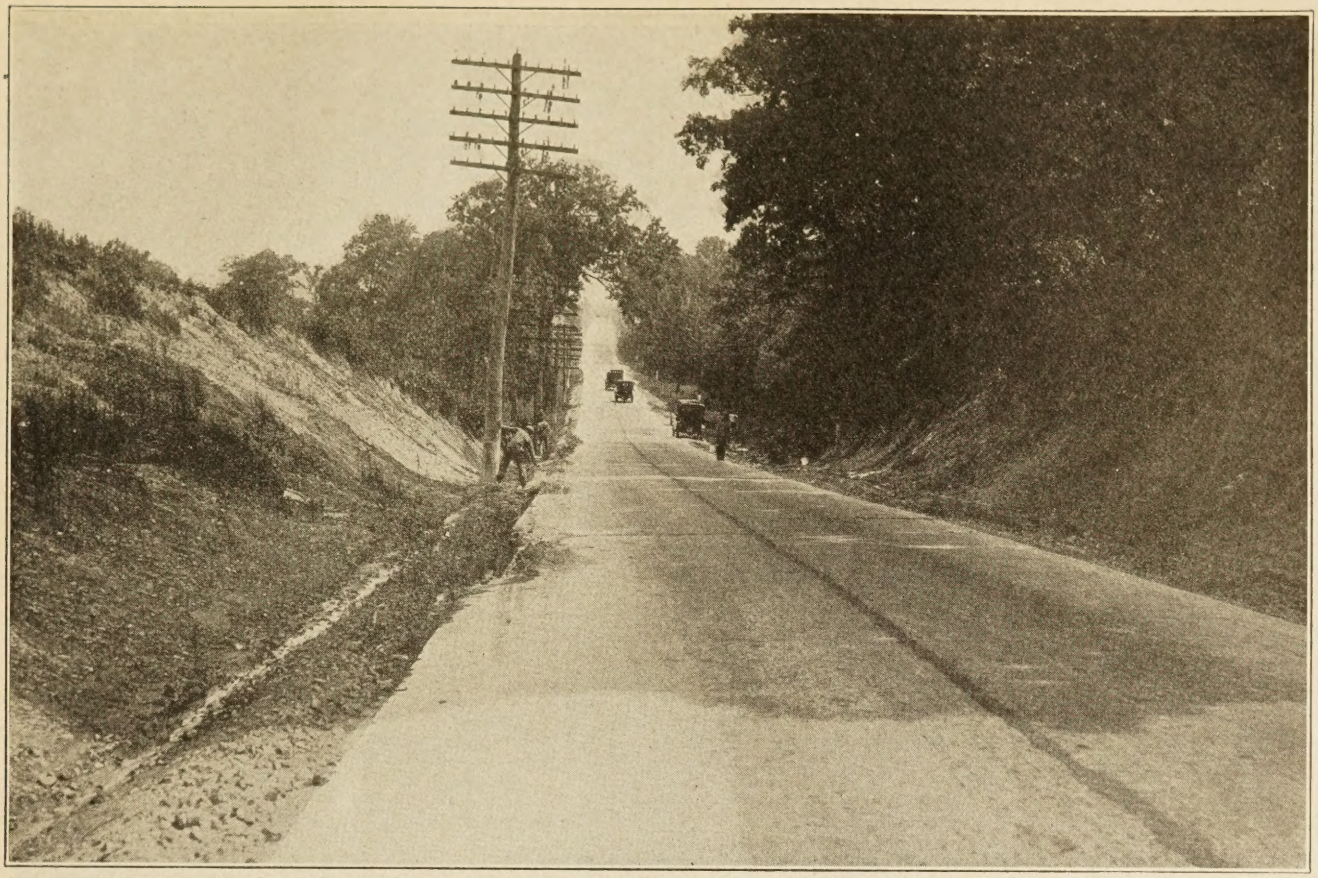
The surface of the shoulders is about 2 inches lower than the center of the road, and from 2 to 5 inches higher than the old surface of the macadam adjacent to the shoulders. The road surface has been brought up to the height of the shoulders by the addition of a wedge of bituminous macadam material which has a depth of from 2 to 5 inches adjacent to the concrete, and tapers off to a featheredge at 2 to 6 feet from the shoulder.

WIDENED ROADS GIVE SATISFACTION.

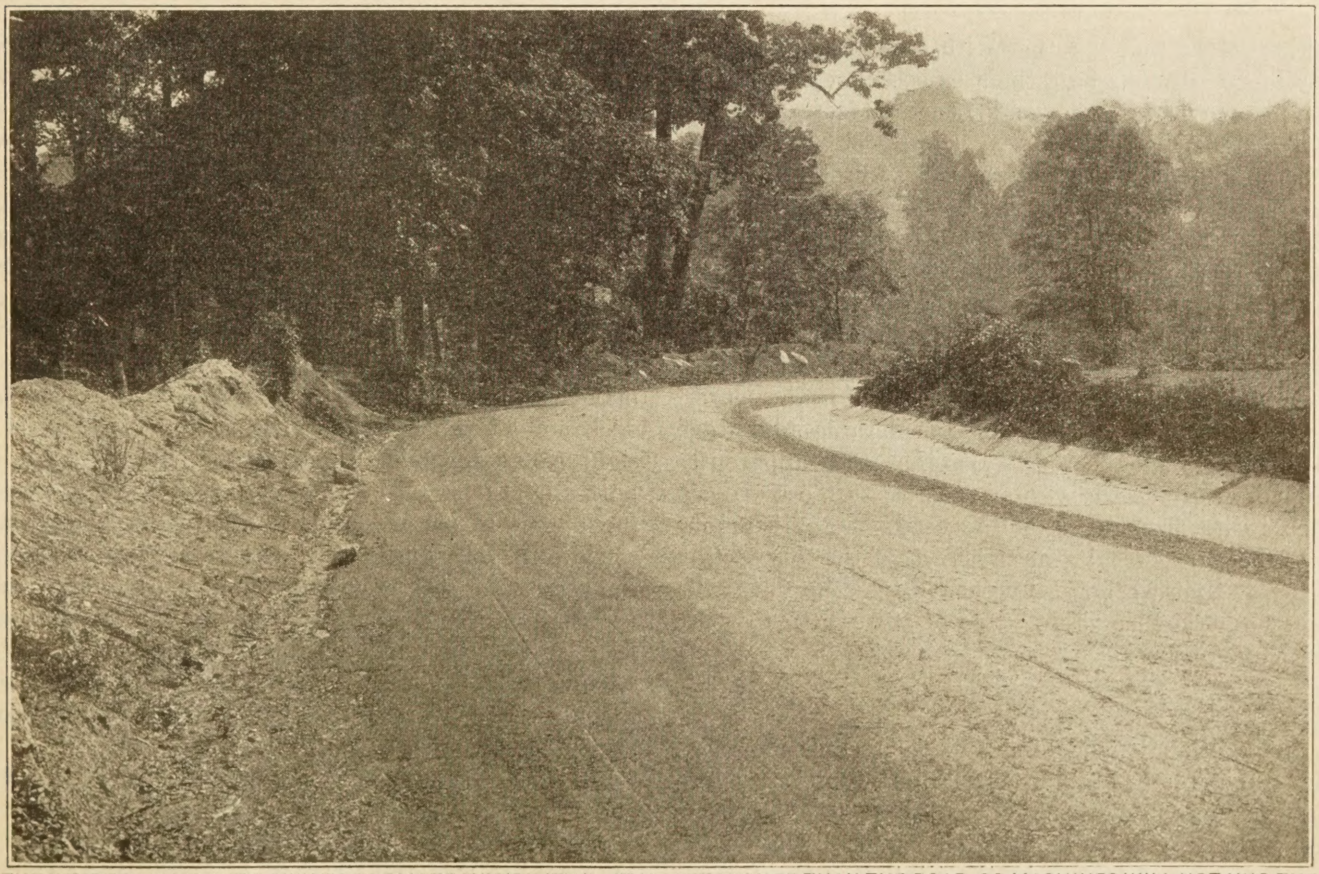
This unusual construction has given eminent satisfaction. No difficulty whatever has been experienced in keeping the macadam in place. The concrete on the side prevents the spreading disintegration of the macadam, and the macadam is thickened on the edges where it is normally weakest. Some of these sections have since been surface treated over the entire width, and it is impossible now to tell which part of the surface is the original macadam, and which is the section filled in. The method of treatment enabled traffic to use the road at all times during construction, and best of all resulted in a road surface which is satisfactorily carrying the heaviest of modern traffic without abandoning a dollar's worth of the original construction.

NEW ROADS BUILT WITHOUT DETOURS.

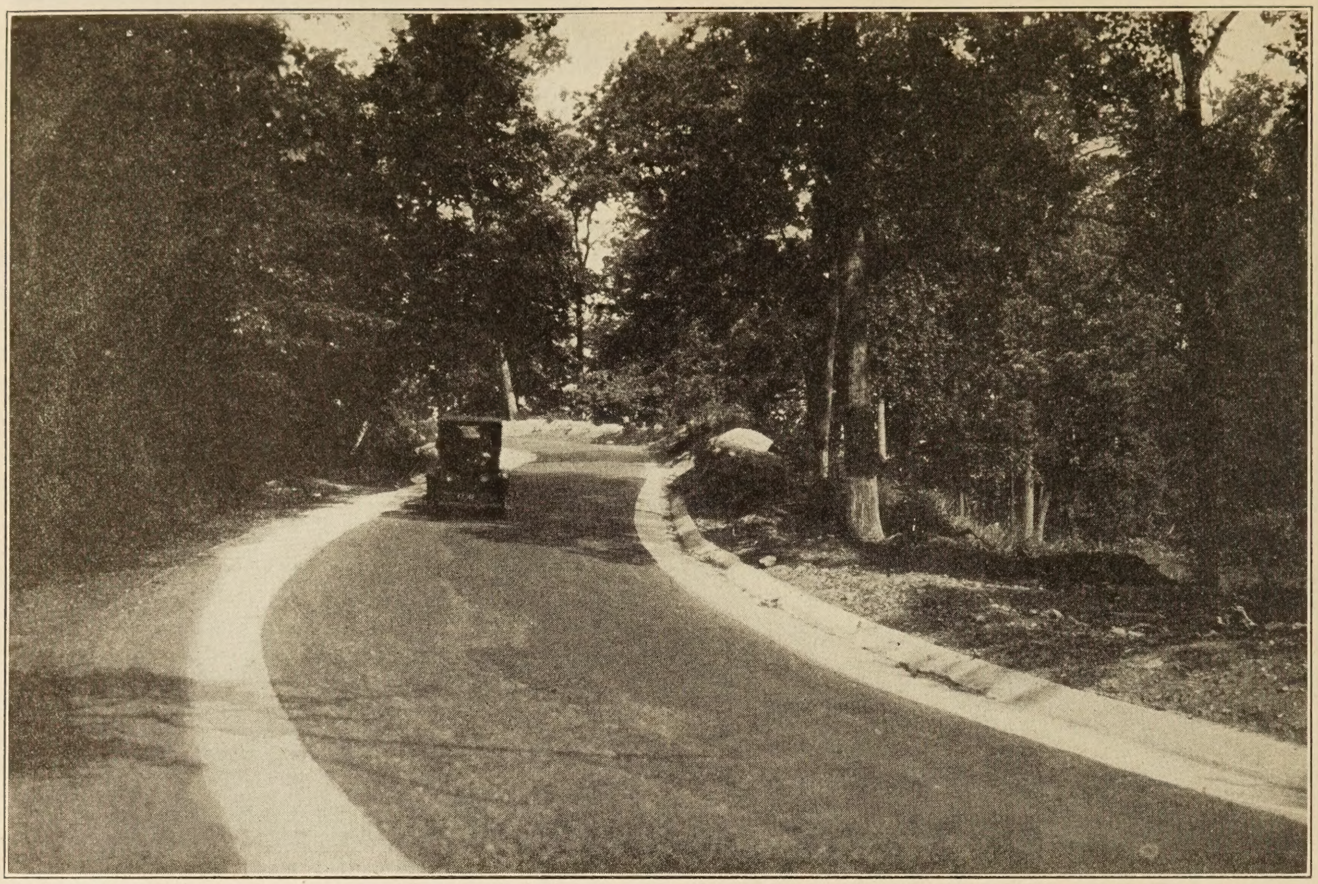
The principle of improving the roads of the system without interruption to traffic is one to which we try to adhere in all of our work, even when the old road is to be entirely reconstructed. When the new section of road is to be of concrete, we have adopted the plan of building the surface in two longitudinal sections with a joint running along the center. This form of construction was used on parts of the Washington-Baltimore road, several sections of which were completely destroyed during the spring of 1918. One half of the 20-foot roadway was constructed at a time, allowing the traffic to use the other half of the road simultaneously with construction, first on the old roadbed, then on the new concrete. The two



IN MARYLAND WIDE CONCRETE ROADS ARE BUILT IN TWO LONGITUDINAL SECTIONS WITH A JOINT IN THE CENTER. TRAFFIC IS NEVER TURNED OFF THE WAY DURING CONSTRUCTION.



THE INSIDE BANK IS CUT DOWN TO PROMOTE "VISIBILITY." IT IS LEFT HIGHER THAN THE ROAD, SO MACHINES WILL NOT HUG THE NEW BANK AND LOSE THE BENEFIT OF THE IMPROVEMENT.



CONCRETE SHOULDERS AND GUTTER AND EARTH EMBANKMENTS ON THE OUTSIDE OF THE CURVE ARE MAKING MARYLAND ROADS SAFE AND ADEQUATE. WHITEWASHED BOULDERS AND TREES BY THE ROADSIDE MARK THE WAY FOR THE TRAVELER AFTER DARK.

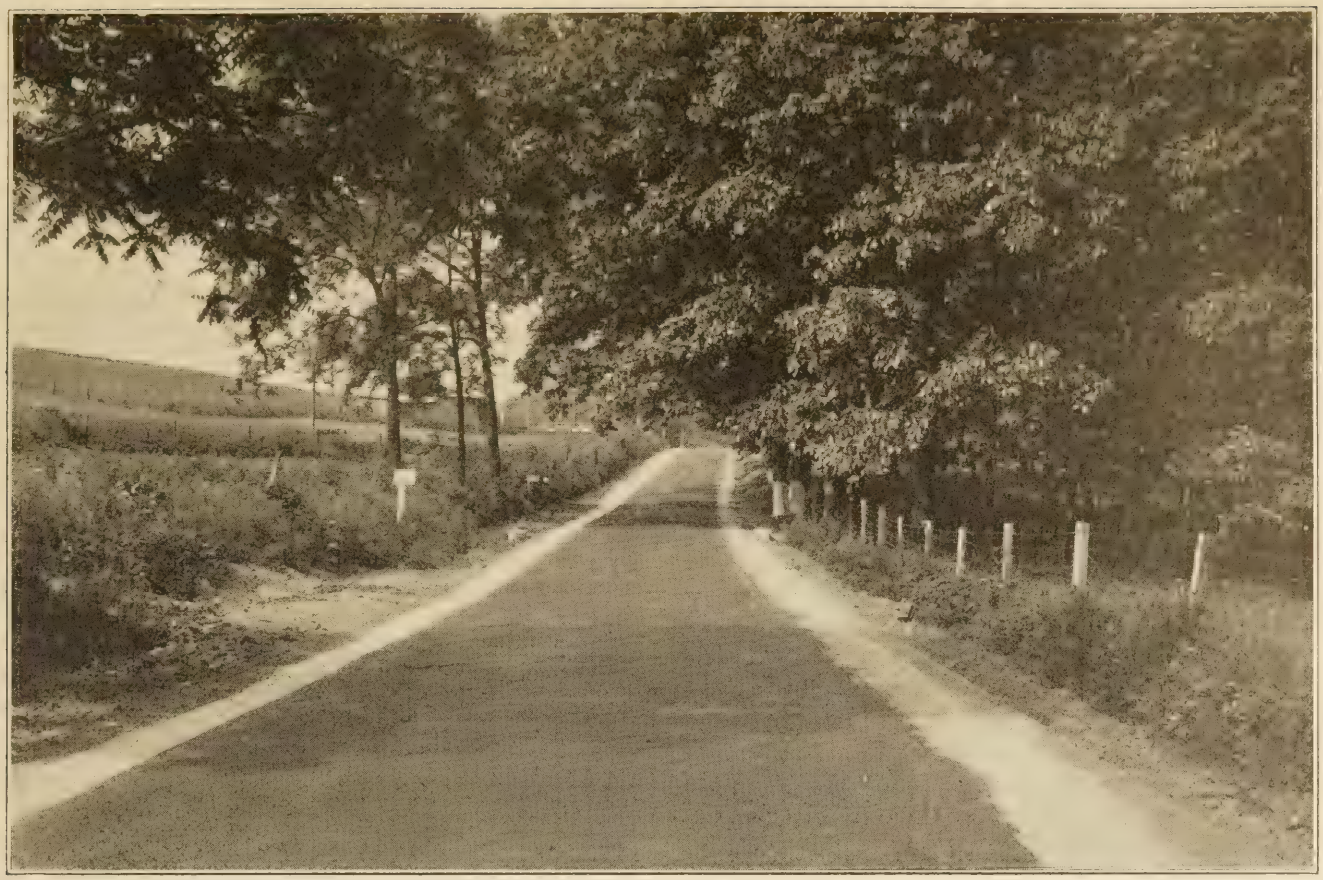
sections were tied together with ½-inch round rods, 4 feet long with one-half their length in each half of the pavement. They were spaced 2 feet center to center along the road.

Some difficulty was experienced at first in keeping the traffic from running against the projecting rods before the second section was laid; but this was overcome by laying old railroad ties or sticks of wood along the edge of the concrete to protect them. There has been no difficulty in maintaining the joint in the center of the road, as the 20-foot width permits traffic to travel on each side of the road instead of in the center. In fact the joint has been of considerable advantage in an entirely unexpected way, in that it has apparently tended to divide the two streams of traffic and keep each to its proper side of the road. So satisfactory have been the results in this respect on this section of road, that we have drawn a black line down the center of other concrete roads of this width to serve the same purpose.

DANGEROUS DEAD MAN'S CURVE IMPROVED.

In addition to widening and thickening the roads the commission is taking every opportunity to eliminate dangerous curves and grades, or to treat them in such a way as to remove the danger. One of the most dangerous curves in the State was the famous "Dead Man's Curve," south of Elkridge, between Baltimore and Laurel. Hundreds of automobiles have been wrecked at this point, and there is a record of more than 30 deaths. The photograph on page 3 shows the road as improved, and also traces of the original location which lay to the left of the telephone poles. The high bank which shows at the right of the picture formerly extended to the left nearly to the line of poles and completely obscured the view around the sharp curve at the top of the hill. The danger was increased by the steep grade. While the relocation does not make the road straight, it reduces the curvature at each end of the reverse curve to 9°, and affords a sight ahead for more than 300 feet at all points in both directions. No accidents, serious or otherwise, have come to our attention since the curve was flattened, and it is apparently eliminated as a source of danger. The cost was $17,000, a considerable sum to spend on less than a quarter of a mile of improved road, other than for ordinary maintenance. Yet when we consider the toll of human lives and wrecked machines which has been taken at this point the cost seems small indeed.

Another place which was especially dangerous was the Winter's Run hill south of Belair. While not as many deaths occurred at this point, the wreckage of automobiles was greater than at Dead Man's Curve.



THE SURFACE-TREATED MACADAM ROADS OF MARYLAND WIDENED WITH CONCRETE SHOULDERS ARE GIVING EMINENT SATISFACTION. AT NIGHT THE WHITE MARGINS ADD GREATLY TO THE SAFETY OF TRAVELERS.

SUCH CURVES AS THIS TOOK HEAVY TOLL IN WRECKED MACHINES BEFORE THEY WERE "BANKED." NOT AN ACCIDENT HAS BEEN REPORTED IN THE TWO YEARS SINCE THE IMPROVEMENT WAS MADE.

The grade on this hill is 6 per cent, but the alignment is a series of reverse curves on the side of a hill. The total length of the dangerous section on both sides of the run involves approximately a mile. It was impossible on account of the grades to straighten the line on this road, but the "inside" of all curves was excavated to approximately 4 feet above the crown of the road for a sufficient distance to permit the driver of a machine to see at least to the next curve from 300 to 400 feet ahead, and the material so excavated was deposited on the "outside" of the curves so that vehicles would not skid over the bank.

It was felt that to excavate these banks to the grade of the road would defeat the purpose in view, which was to hold the traffic out from the bank a sufficient distance to permit drivers to see around it, and if the curves had been excavated to the grade of the road, traffic would unquestionably have "hugged" the bank, and made the place as dangerous as ever. The material deposited on the outside of the curves was placed along the shoulder, and for a height of at least 4 feet on a slope next to the road of about 1 to 1. The shoulders were surfaced over to the bank on the inside and on the outside the pavement was raised to extend up to the artificial embankment, thereby giving a superelevation sufficient to compensate for the curvature. The cost of this work was approximately $10,000, and in this case, as at Dead Man's Curve, there has not been an accident of any kind which has come to the attention of the commission since the improvement was completed, now nearly two years ago. Numerous other curves have been treated in a similar manner, but to a very much less degree than at this point.

MACADAM ROADS GIVE SPLENDID SERVICE.

Macadam roads, a number of which are only 6 inches in thickness, except on the very heavy traffic streets, have given splendid satisfaction, and are rendering a road service equal to that rendered by much more expensive highways in other sections of the country, but this service is only rendered by continuous, perfect maintenance at all seasons of the year. Perfect is probably a rather strong term, yet it is the only word which expresses the writer's idea. No hole of any size is permitted to remain in the surface of any road. A patrol system which works with the smoothness of a well-oiled machine is responsible for this condition. Holes can be repaired as soon as they appear, or before they appear, only by the patrolman, so the patrolman has been impressed with the fact that perfect maintenance on low-grade roads can only be brought about by the patrol system. If these roads are not patrolled and perfectly maintained, in an incredibly short time they become worn out, and soon impassable, as is demonstrated by numerous sections of roads built in the State by the counties, and maintained, or rather not maintained by them.

The macadam roads in particular must be surface-treated with the best material obtainable, a material which will render the surface at all time impervious to water, yet, one which will not cause the surface to roll, become wavy, and soon go to pieces. The accomplishment of this is not entirely a matter of the selection of the bituminous material and the application of it, but also the selection and application of the mineral aggregate covering.

COARSE STONE USED FOR SURFACE TREATMENT.

The commission has successfully used naphtha cut-back asphalt, water-gas tar, and coal-gas tar, so that it is not limited to any one bituminous material, but it does use a very large mineral aggregate covering in large quantities, and has it thoroughly rolled into the the surface. The specifications now require material to be free from dust, and to pass through a revolving screen having circular openings 1¼ inches in diameter. Of course, a material of this size could not be used because of the damage to tires, unless it were immediately and satisfactorily rolled into the surface. The commission, therefore, insists that from one to two rollers be used with every distributor, and on the Frederick Road out of Baltimore, during 1920, five rollers worked 16 hours per day with two distributors. It is necessary that these chips be rolled into the surface and be kept rolled into place until the material has set up. Sand or small chips have a tendency to form a mat on the surface, which invariably pulls off, or waves, whereas the larger chips are pressed down into the surface and "key" together the new and previous applications. On roads which have been treated for a number of years, an application of only from one-fourth to one-fifth gallon of bitumen to the square yard is used, and from 100 tons to 120 tons of stone chips to the mile for a 15-foot macadam road. There is great danger in too heavy or too frequent use of surface treatments. Applied too often or too heavily the bituminous material forms a mat of considerable depth on the surface. In warm weather, and under heavy traffic, the mat begins to move and makes a very wavy surface, and it has been demonstrated conclusively that the use of heavy trucks on a wavy surface very soon causes the road to break through. A comparatively smooth surface is absolutely essential to the maintenance of any road subjected to truck traffic.

STONE PILES AT ROADSIDE FOR MAINTENANCE.

Another requirement, and a very important one for adequate maintenance of macadam roads, is to have along the road at convenient points, for use of the patrolman, material for patching any holes as soon as they develop. Especially is this necessary in the spring. In a climate such as Maryland's, the roads are frequently covered with snow for a month or two during the winter, and the use of trucks and motor cars with chains form ruts in the surface, which must be patched as soon as the road thaws out in the spring. It is, therefore, absolutely necessary that material for this patching be delivered on the road in the fall. The need for early spring patching has eliminated from consideration as a patching material any emulsions

(Concluded on page 19.)

STATE HIGHWAY MILEAGE AND EXPENDITURES IN THE YEAR 1919

By ANDREW P. ANDERSON, Highway Engineer.

DURING the calendar year 46 States of the Union expended a total of over $400,000,000 on their rural roads and bridges. This total is made up of the actual cash expenditures for such items as labor, materials, supervision and administration, amounting to $389,455,931, and convict labor and statute labor, the value of which is not definitely known but which is estimated at about $12,000,000. So far as possible all expenditures on city streets within incorporated towns and cities and all items of sinking-fund payments or the redemption and interest payments on road and bridge bonds have been excluded.

The road and bridge expenditures for 1919 show an increase of approximately 33⅓ per cent over those of 1918 and 70 per cent over those of 1914. More striking, however, is the increase in the proportion of the total funds supervised by the several State highway departments. In 1918 the expenditures by or under the supervision of the State highway departments amounted to $117,285,268, while the local road funds, over which they exercised no control whatever, amounted to $168,812,925. In 1919, however, the State highway departments supervised the expenditure of $200,292,694 as against the total of $189,163,237 expended by the local road and bridge authorities.

The year 1919 was one of unusual activity in practically all lines of highway work. During the war all work of this nature had been curtailed in every possible way, often to the great inconvenience of the public. Consequently, at the close of hostilities road activities soon began to claim their full share of public attention. In fact, in every State ambitious plans were immediately mapped out and definite action to secure their approval was begun.

PROVIDING ROAD FUNDS.

The first and most striking development in this movement related to the provision of adequate funds. Between November 1, 1918, and December 31, 1919, State highway bonds amounting to a grand total of $234,800,000 were voted as follows:

Illinois	$60, 000, 000
Michigan	50, 000, 000
Pennsylvania	50, 000, 000
California	40, 000, 000
Oregon	12, 500, 000
Maine	10, 000, 000
South Dakota	4, 500, 000
Utah	4, 000, 000
Wyoming	2, 800, 000
Nevada	1, 000, 000

The voting of State highway bonds, however, was not confined to the year 1919. On February 16, 1920, the voters of Alabama ratified a State highway bond issue of $25,000,000 and in June the State of Oregon ratified a constitutional amendment increasing the maximum tax rate, thereby approving an additional bond issue of $10,000,000. The Legislative Assembly of Maryland during the regular session also provided for the issue of $3,000,000 of State highway bonds.

As a part of this movement eight other States made definite provisions for submitting to a vote of the electors at the general election in November, 1920, the issue of State highway bonds as follows:

Minnesota	$75, 000, 000
Missouri	60, 000, 000
West Virginia	50, 000, 000
Washington	30, 000, 000
Montana	15, 000, 000
Colorado	5, 000, 000
Idaho	2, 000, 000
New Mexico	2, 000, 000
Total	239, 000, 000

The State of Florida will also vote on the question of amending its constitution so as to permit the legislature to issue highway bonds in an amount not to exceed 5 per cent of the assessed valuation of the State. Kansas and Virginia will vote on removing constitutional barriers toward still greater State participation in road work.

Only two States have defeated by a vote of the electors the question of issuing State highway bonds during the period November 1, 1918, to October 1, 1920. On May 6, 1919 the electors of the State of Oklahoma defeated a proposed bond issue for $50,000,000, and on November 4, 1919, the electors of the State of Texas defeated a bond issue for $75,000,000.

During 1919 the Federal Government also made liberal provisions for continuing Federal-aid road work in cooperation with the several State highway departments. The Post Office appropriation act of February 28, 1919, carried an amendment to the original Federal-aid road act of July 11, 1916, amplifying somewhat its terms and providing an additional appropriation of $200,000,000 for post roads and $9,000,000 additional for forest roads. Of the post road appropriation, $50,000,000 was made immediately available and $75,000,000 available for each of the fiscal years 1920 and 1921, while the forest road appropriation was made available at the rate of

$3,000,000 for each of the fiscal years 1919, 1920, and 1921. This amendment also provided for the transfer to the Secretary of Agriculture of all available war materials, equipment, and supplies suitable for use in the improvement of highways which were not needed by the War Department. All equipment and material so transferred was to be distributed on a value basis—the same as provided in the original Federal-aid road act—among the highway departments of the several States, to be used on roads constructed in whole or in part by Federal aid.

about 223,000 miles were earth or graded roads. The 7,212 miles of earth road construction is divided among a large number of States, while the earth mileage maintained is located mainly in the states of Iowa, New York, Kansas, Missouri, and Oklahoma. In the States of Iowa and New York, the State highway departments have fairly definite supervision or control over all rural road work within the State, whether construction or maintenance.

The public rural roads of the United States as determined in 1914 had a total length of 2,478,552 miles,

TABLE 1.—ROAD AND BRIDGE EXPENDITURES, 1919.

State.	Source of funds expended under supervision of State highway departments.				Distribution of expenditures.						State funds available, 1920 (approximate)	Local road and bridge expenditures, 1919, not under State highway department (approximate).
	Federal.	State.	Local.	Total.	Construction. Roads.	Construction. Bridges.	Maintenance roads and bridges.	Engineering.	Administration.	Equipments, miscellaneous.		
Alabama	$284,430.88	$65,002.60	$262,979.91	$612,413.39	$501,374	$51,129	...	$36,358	$20,008	$3,543	$2,000,000	$1,200,000
Arizona [1]	66,738.99	1,451,336.71	(3)	1,518,075.70	1,023,215	33,920	$86,381	140,152	49,520	184,887	1,250,000	2,500,000
Arkansas	76,874.27	585,193.00	6,218,972.63	6,881,040.00	6,496,100	(3)	...	341,900	93,040	...	407,847	2,500,000
California	498,795.45	6,568,093.39	79,999.91	7,146,888.75	4,772,924	(3)	1,363,901	488,195	249,083	272,786	10,000,000	[4] 12,350,569
Colorado	20,000.00	1,775,000.00	500,000.00	2,295,000.00	1,020,000	(3)	1,000,000	80,000	65,000	130,000	2,200,000	2,000,000
Connecticut [5]	(12)	2,293,397.11	92,536.69	2,385,933.80	828,466	360,500	931,383	70,235	81,574	113,776	4,000,000	1,458,033
Delaware	(6)	1,147,080.26	646,464.70	1,793,544.96	1,638,227	57,558	4,614	56,309	16,373	20,464	1,500,000	200,000
Florida	...	...	...	...	...	...	...	...	...	...	...	...
Georgia	426,704.47	...	490,710.13	917,414.60	653,658	217,886	...	45,870	(7)	...	1,50 ,000	6,000,000
Idaho	410,000.00	850,000.00	540,000.00	1,800,000.00	1,095,000	118,000	176,000	283,000	48,000	80,000	1,000,000	2,500,000
Illinois	(12)	4,403,944.89	2,119,902.13	6,523,847.02	5,649,719	(3)	128,319	538,548	90,780	116,481	12,497,502	10,000,000
Indiana	236,288.89	400,691.10	565,000,00	1,201,979.99	995,221	10,000	...	110,352	7,593	78,814	5,294,000	17,500,000
Iowa	...	614,090.64	16,158,946.71	16,773,037.35	2,174,335	4,404,822	8,842,134	598,479	20,480	732,787	6,000,000	...
Kansas [10]	187,586.63	47,500.00	458,046.80	693,133.43	575,213	70,420	...	47,500	(7)	...	60,000	10,334,363
Kentucky	226,395.00	926,200.00	650,713.75	1,803,308.75	1,460,430	(3)	...	112,803	29,254	200,822	1,500,000	2,000,000
Louisiana	...	...	...	...	...	...	...	...	...	...	...	...
Maine	65,011.60	1,739,118.72	970,374.32	2,774,504.64	1,491,937	327,953	790,701	76,623	46,981	40,309	3,594,000	1,750,000
Maryland	590,555.28	2,237,184.79	636,767.92	3,464,507.99	1,857,649	...	1,464,867	96,995	22,809	22,189	2,900,000	3,500,000
Massachusetts	10,119.00	3,619,849.00	[2] 589,915.00	4,219,883.00	1,181,172	(3)	2,228,706	259,902	63,242	486,861	6,920,227	6,005,000
Michigan	618,218.42	4,245,593.23	1,645,288.54	6,509,100.19	4,990,215	551,280	408,038	232,059	165,766	161,742	5,000,000	10,015,644
Minnesota	739,138.09	2,690,585.65	4,667,961.47	[8] 8,097,685.21	5,129,769	806,925	1,582,834	538,967	39,190	...	2,371,343	5,125,000
Mississippi [2]	98,000.00	40,000.00	252,000.00	390,000.00	350,000	(3)	...	30,000	10,000	...	...	2,500,000
Missouri [2]	100,000.00	684,000.00	440,000.00	1,224,000.00	820,000	(3)	200,000	188,000	(7)	16,000	1,500,000	6,500,000
Montana	14,900.45	396,519.84	228,461.28	639,881.57	210,596	98,673	1,210	123,939	55,754	149,710	450,000	1,943,037
Nebraska	358,683.50	1,097,586.24	95,164.98	1,551,434.72	858,619	190,330	20,852	131,394	218,712	131,528	3,608,000	4,000,000
Nevada	179,685.15	342,250.48	105,428.10	627,363.73	442,034	38,426	29,330	46,338	59,185	12,050	500,000	275,000
New Hampshire	9,574.83	1,360,710.01	511,453.68	1,881,738.52	1,034,856	24,952	686,957	32,174	102,800	...	2,262,003	1,000,000
New Jersey	(12)	6,320,000.00	9,000,000.00	15,320,000.00	5,500,000	30,000	9,210,000	200,000	230,000	150,000	7,200,000	(8)
New Mexico	39,739.12	839,053.56	330,473.32	1,209,266.00	602,784	183,462	201,180	22,700	15,900	183,240	1,800,000	375,000
New York	298,938.07	13,714,312.32	10,434,517.70	24,447,768.09	12,736.231	1,353,196	9,405,979	654,193	298,169	...	34,775,667	...
North Carolina [1]	254,731.89	1,010,442.76	452,170.22	1,717,344.87	1,158,015	(3)	144,632	199,838	82,945	131,915	1,750,000	5,000,000
North Dakota	250,000.00	233,128.47	500,000.00	983,128.47	578,741	(3)	[2] 250,000	54,801	65,259	34,327	524,000	5,253,177
Ohio	694,921.36	4,603,771.72	5,414,645.28	10,713,338.36	8,236,769	326,196	1,562,359	436,559	151,455	...	7,361,000	7,500,000
Oklahoma [2]	40,000.00	2,125,000.00	1,386,500.00	3,551,500.00	1,204,000	885,000	875,500	196,000	20,000	371,000	3,000,000	5,500,000
Oregon [9]	224,851.60	5,922,825.67	243,158.14	6,390,835.41	5,399,926	(3)	15,523	568,639	146,753	259,993	13,600,000	4,000,000
Pennsylvania	2,141,267.46	16,719,267.44	1,361,645.17	20,222,180.07	10,330,742	224,694	6,554,646	772,521	493,718	[11] 1,845,859	25,000,000	8,000,000
Rhode Island	65,000.00	1,131,720.69	...	1,196,720.69	725,810	85,545	280,044	66,707	7,500	31,114	1,485,000	650,000
South Carolina	246,024.08	80,406.25	268,343.57	594,773.90	458,195	56,172	309	58,815	12,594	8,688	756,060	1,840,000
South Dakota	94,247.41	319,225.91	117,195.84	530,669.16	396,448	(3)	...	49,704	37,205	47,312	2,324,000	3,713,719
Tennessee [2]	82,857.91	794,464.09	90,888.52	968,210.52	481,000	100,000	225,811	80,700	80,700	...	2,090,000	3,500,000
Texas	442,231.66	649,604.96	[2] 3,000,000.00	4,091,836.62	3,974,275	(3)	...	79,730	35,545	2,287	10,000,000	10,000,000
Utah	52,507.23	2,445,238.36	547,284.67	3,045,030.26	2,146.559	182,784	505,013	(3)	...	210,674	1,500,000	2,500,000
Vermont	46,749.52	901,135.70	492,590.41	1,440,475.63	558,913	77,442	714,754	10,452	50,586	28,330	900,000	700,000
Virginia	146,906.64	2,262,192.18	980,836.01	3,389,934.83	1,832,745	123,442	1,120,198	109,037	42,581	161,933	4,941,260	1,750,000
Washington	616,687.30	2,894,969.96	415,355.41	3,927,012.67	3,289,557	350,000	...	245,700	23,238	18,518	6,006,473	7,689,400
West Virginia	325,000.00	480,000.00	985,000.00	1,790,000.00	1,750,000	(3)	...	40,000	(7)	...	440,000	3,500,000
Wisconsin	204,962.44	3,062,638.89	6,689,434.07	9,957,035.40	1,551,684	1,348,918	1,854,523	100,496	101,414	...	4,839,000	3,700,000
Wyoming	244,732.39	770,726.26	64,456.79	1,079,915.44	766,183	(8)	96,196	62,986	55,442	99,108	2,637,378	835,295
Total	11,730,056.98	106,861,052.85	81,701,583.77	200,292,693.70	115,929,306	12,689,626	52,962,894	8,715,670	3,456,149	6,539,047	211,244,760	189,163,237

[1] Fiscal year.
[2] Estimated by Highway Department.
[3] Included under Roads.
[4] Does not include San Francisco Co.
[5] Nine months only.
[6] Included under State.
[7] Included under Engineering.
[8] Included in State Funds.
[9] Eleven months only.
[10] Only 83 out of 105 counties shown.
[11] Includes $1,135,431.08 bonus for townships and $200,351.30 for purchase of turnpikes.
[12] Reimbursement for Federal-Aid work carried over to 1920.

WORK OF STATE DEPARTMENTS.

The several State highway departments during 1919 supervised the construction of 18,300 miles and the maintenance of 320,446 miles of public highways. Of the total mileage constructed, 7,212 miles, or nearly 40 per cent, consisted of grading or earth road construction, while of the 320,446 miles maintained under the supervision of the State highway departments

of which 300,000 miles are now improved with some form of surfacing. A large portion of this mileage, however, is composed of sand-clay, gravel, or water-bound macadam, much of which is proving entirely inadequate for present-day traffic. That these facts are clearly recognized by the State highway departments is shown by the ever increasing total expenditures for high-grade construction, and while the work for the year 1919 shows a very large mileage of grading or earth road most of this must be considered as preparatory to later surfacing.

The expenditures for 1919 by or under the various State highway departments are shown in Table 1, and the work accomplished is shown in Table 2. Table 3 shows the expenditures from purely State funds for the years 1904, 1914, 1917, 1918, and 1919, and also the total combined State and local expenditures for the same years. In Table 1 the columns under "Administration and engineering" show a considerable variation in the percentage devoted to these purposes in each of the several States. These variations are probably due more to differences in bookkeeping and the absence of any clear definition as to what items should be included under each of these heads than to any other cause. There is a great need for common standards in regard to these items, so that such expenditures may be fairly comparable as between the several States. This also applies to the term "Reconstruction and maintenance." In some States practically all reconstruction work is classed under "Maintenance," while in others it is classed entirely under "Construction," and in still others it is kept as a separate item and designated as "Reconstruction."

These compilations include no expenses for road or street work by the War or Navy Departments and similar agencies in or at military reservations or stations.

TABLE 2.—CLASSIFICATION OF ROAD MILEAGE SUPERVISED BY STATE HIGHWAY DEPARTMENTS, 1919.

State.	Kind of work.	Types.										Total rural road mileage 1914.	State.
		Earth or grading.	Sand clay.	Gravel.	Macadam.	Bituminous.	Concrete.	Brick.	Asphalt.	Miscellaneous.	Total.		
Alabama	Construction		$46.09	$31.55	$5.60				$1.00		$84.24	55,446	Alabama.
	Maintenance												
Arizona	Construction						$7.50		10.00	$52.50	70.00	12,075	Arizona.
	Maintenance									400.00	400.00		
Arkansas	Construction	$750.00		212.00	23.00	$24.00			26.00		1,035.00	50,743	Arkansas.
	Maintenance												
California	Construction	76.00					109.00		2.00		187.00	61,039	California.
	Maintenance	1,186.00			202.00	16.00	1,234.00		56.00		2,694.00		
Colorado	Construction	40.00		13.00	40.00		7.00				100.00	39,780	Colorado.
	Maintenance			15.00			5.00				20.00		
Connecticut	Construction										[1] 49.59	14,061	Connecticut.
	Maintenance	340.00	22.70	365.78	653.99	53.36	41.96	$0.64	32.40		1,510.83		
Delaware	Construction				2.00		28.50	2.42			32.92	3,674	Delaware.
	Maintenance						35.00	3.05			38.05		
Florida	Construction											17,995	Florida.
	Maintenance												
Georgia	Construction	21.00	70.00	2.40	1.60		13.70	3.00			111.70	80,669	Georgia.
	Maintenance												
Idaho	Construction	65.00		102.00		3.60					170.60	24,396	Idaho.
	Maintenance	381.00		174.00	17.00	2.00	3.00				577.00		
Illinois	Construction	83.00		3.50		4.50	167.00	5.50			263.50	95,647	Illinois.
	Maintenance	414.25		42.36	26.95	43.45	366.15	86.90			980.06		
Indiana	Construction					8.00	19.50	3.00			30.50	73,347	Indiana.
	Maintenance												
Iowa	Construction	372.83		296.99				4.10			673.92	104,074	Iowa.
	Maintenance	102,715.00		1,260.00			14.00	11.00			105,000.00		
Kansas	Construction			6.728			7.851	3.093			17.672	111,052	Kansas.
	Maintenance	30,974.00									30,974.00		
Kentucky	Construction	31.98		17.26	72.53	54.85	7.54	7.75	7.09		199.00	57,916	Kentucky.
	Maintenance												
Louisiana	Construction											24,563	Louisiana.
	Maintenance												
Maine	Construction	.53		201.43	.11	4.07	.71	.54			207.39	23,537	Maine.
	Maintenance									4,358.60	4,358.60		
Maryland	Construction	3.51					40.91				44.42	16,459	Maryland.
	Maintenance			146.57	904.14	34.21	285.21	1.76	4.50	64.83	1,441.22		
Massachusetts	Construction	2.10		26.19	1.64	90.48	8.98			19.29	148.68	18,681	Massachusetts.
	Maintenance	110.00		660.00	240.00	805.00	28.00			5.00	1,848.00		
Michigan	Construction	63.80		578.00	67.00	144.00	97.00	5.30			955.10	74,190	Michigan.
	Maintenance	225.30		4,717.00	581.00	1,750.00	324.00	7.20			7,604.50		
Minnesota	Construction	1,053.00		723.00			16.00		9.00		1,801.00	93,517	Minnesota.
	Maintenance	3,848.00	281.00	3,399.00	10.00	37.00	37.00	3.00	12.00	4,735.00	12,362.00		
Mississippi	Construction											45,779	Mississippi.
	Maintenance												
Missouri	Construction	300.00		82.90	20.00	7.80	6.50		2.70		419.90	96,041	Missouri.
	Maintenance										[2] 11,000.00		
Montana	Construction	15.00		55.00							70.00	39,204	Montana.
	Maintenance	50.00									50.00		
Nebraska	Construction	320.00		68.00			1.00	5.50			394 50	80,272	Nebraska.
	Maintenance	250.00	1.00					5.50			256.50		
Nevada	Construction	75.00		100.00			4.00				179.00	12,182	Nevada.
	Maintenance										[1] 300.00		
New Hampshire	Construction			98.40	2.42	1.06			5.66		107.54	14,020	New Hampshire.
	Maintenance										[2] 1,500.00		
New Jersey	Construction	.158		69.67	60.14	21.33	105.11			9.95	266.35	14,817	New Jersey.
	Maintenance									2,851.00	2,851.00		
New Mexico	Construction	403.00		424.00			5.00				832.00	43,091	New Mexico.
	Maintenance	2,140.00		860.00							3,000.00		
New York	Construction	9.32		333.00	906.23	245.67	318.52	.42		33.42	1,846.58	79,398	New York.
	Maintenance	58,817.00		7,211.00	9,544.00	3,185.00	622.00	288.00		333.00	80,000.00		
North Carolina	Construction	137.80			11.84	10.78	5.22		12.41		178.05	50,758	North Carolina
	Maintenance	1,052.10	2,139.50		155.80	43.90			47.90	1,363.70	4,802.90		
North Dakota	Construction	200.00									200.00	68,796	North Dakota.
	Maintenance	3,500.00									3,500.00		
Ohio	Construction	9.81			81.38	49.605	49.562	93.23	31.645	9.39	324.62	86,354	Ohio.
	Maintenance	3.12		148.22	1,427.22	54.96	400.53	710.44			2,744.49		
Oklahoma	Construction	1,752.00	200.00	40.00		4.50	3.25				1,999.75	107,961	Oklahoma.
	Maintenance	9,000.00	1,000.00	10.00							10,010.00		

[1] No definite data given as to types.

[2] Mostly earth roads.

TABLE 2.—CLASSIFICATION OF ROAD MILEAGE SUPERVISED BY STATE HIGHWAY DEPARTMENTS, 1919—Continued.

State.	Kind of work.	Types.										Total rural road mileage 1914.	States.
		Earth or grading.	Sand clay.	Gravel.	Macadam.	Bituminous.	Concrete.	Brick.	Asphalt.	Miscellaneous.	Total.		
Oregon	**Construction**										**[1] 544.00**	36,819	Oregon.
	Maintenance												
Pennsylvania	**Construction**										**[1] 253.10**	91,556	Pennsylvania.
	Maintenance										[1] 9,493.00		
Rhode Island	**Construction**					**8.20**	**2.20**		**9.70**		**20.10**	2,170	Rhode Island.
	Maintenance				183.20	129.80	3.20		9.70		326.10		
South Carolina	**Construction**	**9.70**	**55.00**	**4.50**		**2.14**	**8.08**				**79.42**	42,226	South Carolina.
	Maintenance		18.00								18.00		
South Dakota	**Construction**										**60.00**	96,306	South Dakota.
	Maintenance												
Tennessee	**Construction**	**13.60**		**14.90**	**11.60**	**2.50**	**4.40**				**47.00**	46,050	Tennessee.
	Maintenance	2,000.00		800.00	1,400.00	300.00					4,500.00		
Texas	**Construction**	**19.80**	**260.00**	**844.42**		**197.50**	**40.85**				**1,362.57**	128,960	Texas.
	Maintenance		109.63	198.02		75.70	4.20				387.55		
Utah	**Construction**	**30.00**				**14.50**	**24.50**				**69.00**	8,810	Utah.
	Maintenance												
Vermont	**Construction**			**89.70**	**.67**	**1.00**	**.90**			**64.42**	**156.69**	14,249	Vermont.
	Maintenance										[1] 4,378.00		
Virginia	**Construction**	**37.34**	**163.79**	**41.81**	**77.23**	**6.40**	**9.26**			**11.71**	**347.54**	53,388	Virginia.
	Maintenance	148.36	2,027.54	498.30	909.98	97.12	41.12			146.18	3,868.60		
Washington	**Construction**	**174.20**					**59.50**		**1.00**		**234.70**	42,428	Washington.
	Maintenance												
West Virginia	**Construction**	**100.00**		**2.00**		**25.00**	**45.00**	**10.00**	**10.00**		**192.00**	32,024	West Virginia.
	Maintenance												
Wisconsin	**Construction**	**771.70**	**48.60**	**432.10**	**61.00**	**12.10**	**138.50**	**1.00**		**92.70**	**1,557.70**	77,280	Wisconsin.
	Maintenance	3,603.00		1,402.00	791.00		158.00	12.00		34.00	6,000.00		
Wyoming	**Construction**	**271.00**		**120.62**		**1.25**	**13.00**				**405.87**	14,797	Wyoming.
	Maintenance	1,082.00		120.00			500.00				1,702.00		
Totals and averages.	**Construction**	**7,212.178**	**843.48**	**5,035.068**	**1,445.99**	**944.835**	**1,375.543**	**144.85**	**128.205**	**293.38**	**18,260.219**	2,478,552	Totals and averages.
	Maintenance	222,839.13	5,599.37	22,027.25	17,046.28	6,627.50	4,102.37	1,129.49	162.70	14,291.31	320,446.400		

[1] No definite data given as to types.

TABLE 3.—CASH ROAD AND BRIDGE EXPENDITURES FOR CALENDAR YEARS 1904, 1914, 1917, 1918 AND 1919.

State.	Year in which first State-aid law passed.	State funds expended by or under State highway department.					Total cash expenditure from all sources (approximate).				
		1904	1914	1917	1918	1919	1904	1914	1917	1918	1919
Alabama	1911		$170,232	$89,511	$103,285	$65,003	$378,040	$3,949,019	$2,669,022	$2,371,214	$1,812,413
Arizona	1909			543,422	975,802	1,451,337	67,591	982,721	1,569,422	2,017,750	4,018,076
Arkansas	1913		115,000	80,262	221,831	585,193	681,934	1,522,696	3,335,262	1,963,609	9,381,040
California	1895	$11,251		3,058,030	6,941,192	6,568,093	2,157,396	19,171,985	18,245,200	21,646,638	19,497,458
Colorado	1909		301,274	703,000	800,000	1,775,000	635,395	1,937,546	2,570,000	3,300,000	4,295,000
Connecticut	1895	219,165	1,307,381	2,197,264	3,172,706	2,293,397	1,195,125	3,640,963	4,004,225	5,018,820	3,843,967
Delaware	1903	14,000	31,000	21,600	429,734	1,147,080	90,803	511,628	321,600	943,377	1,993,545
Florida	1915			23,797	179,807	(2)	437,184	2,280,255	6,384,797	5,764,205	
Georgia	1908			1,910	15,000		894,936	3,688,172	4,318,350	5,792,056	6,917,415
Idaho	1905		49,812	473,132	491,342	850,000	201,648	1,371,469	2,092,723	3,519,920	4,300,000
Illinois	1905		387,989	1,258,338	860,911	4,403,945	3,844,424	8,734,713	10,083,728	10,183,353	16,523,847
Indiana	1917			14,000		400,691	3,438,389	14,233,986	14,014,000	13,000,000	18,701,980
Iowa	1904		74,000	89,787	113,488	614,091	2,344,107	10,187,507	15,625,406	14,549,622	16,773,037
Kansas	1911		9,080	10,000	25,000	47,500	692,823	5,544,048	6,010,000	5,018,117	11,027,496
Kentucky [1]	1912		18,000	1,501,650	1,000,000	926,200	1,161,194	2,474,621	4,923,651	3,380,000	3,803,309
Louisiana	1910		161,186	182,295	182,295	(2)	345,452	1,777,572	3,540,976	3,540,976	
Maine	1901	44,885	467,149	1,112,675	1,570,494	1,739,119	1,472,383	2,642,007	3,244,982	3,859,416	4,524,505
Maryland	1898		356,845	2,804,707	2,681,142	2,237,185	873,471	6,000,652	6,083,682	5,750,135	6,964,508
Massachusetts	1892	575,606	242,560	4,231,802	3,522,494	3,619,849	2,871,222	6,091,875	9,494,802	9,124,304	10,224,883
Michigan [1]	1905		657,264	1,704,359	1,704,359	4,245,593	1,816,504	9,261,998	11,190,153	10,673,153	16,524,744
Minnesota	1905		1,309,956	1,429,865	1,870,336	2,690,586	1,607,417	6,458,940	8,024,760	10,567,711	13,222,685
Mississippi	1915			6,500	10,000	40,000	339,669	3,960,377	3,256,500	760,000	2,890,000
Missouri	1907		277,253	367,913	704,400	684,000	1,570,801	5,513,049	7,374,933	7,154,400	7,724.000
Montana	1913		13,516	25,729	133,548	396.520	308,744	2,888,401	3,356,869	3,924,951	2,582,919
Nebraska	1911			9,500	201,202	1,097,586	494,886	1,796,278	4,603,400	3,855,829	5,551,435
Navada	1911			36,796	75,328	342,250	46,876	245,014	336,796	474,770	902,364
New Hampshire	1903	44,000	491,520	589,254	651,594	1,360,710	872,606	1,590,464	2,238,705	2,004,685	2,881,739
New Jersey	1891	250,000	1,306,596	1,501,902	1,848,932	6,320,000	3,274,811	7,208,287	6,280,897	6,708,933	15,320,000
New Mexico	1909		115,732	280,578	527,072	839,054	35,458	556,399	845,867	1,314,192	1,584,266
New York [1]	1898	1,056,460	8,544,126	9,432,679	9,432,679	13,714,312	3,937,729	23,231,964	21,685,131	20,715,131	24,447,768
North Carolina [1]	1901		5,000	20,000	20,000	1,010,443	624,381	5,215,491	5,520,000	4,020,000	6,717,345
North Dakota	1909			28,638	83,000	233,128	456,130	2,402,384	2,867,979	3,208,000	6,236,305
Ohio	1904		1,855,338	2,835,649	4,670,270	4,603,772	4,776,318	14,334,246	12,017,104	14,499,833	18,213,338
Oklahoma	1911			286,922	1,046,893	2,125,000	447,320	2,112,681	3,722,355	3,131,530	9,051,500
Oregon	1913		10,697	711,000	2,120,551	5,922,826	649,718	5,310,467	5,711,000	6,830,275	10,390,835
Pennsylvania	1903	127,767	1,976,768	4,351,566	8,041,834	16,719,267	4,887,266	10,424,580	11,463,333	14,753,876	28,222,180
Rhode Island	1902	79,397		486,725	745,674	1,131,721	376,812	446,496	861,725	1,135,672	1,846,721
South Carolina	1917			27,161	49,239	80,406	334,082	1,024,480	1,277,161	1,676,239	2,434,774
South Dakota	1911			5,000	30,473	319,226	268,723	1,217,809	2,755,000	3,031,709	4,244,388
Tennessee	1915			231,500	403,000	794,464	729,141	2,370,560	2,481,500	2,978,000	4,468,211
Texas	1917			10,000	295,567	649,605	2,543,613	9,920,079	10,010,000	11,325,727	14,091,837
Utah	1909		157,732	120,200	1,546,843	2,445,238	158,286	803,071	1,893,129	2,770,491	5,545,030
Vermont	1898	127,381	458,456	578,883	778,075	901,136	567,397	1,023,941	1,680,489	1,606,075	2,140,476
Virginia	1906		523,578	695,171	861,031	2,262,192	687,751	3,224,529	4,136,779	3,708,353	5,139,935
Washington	1905		1,343,431	2,031,392	2,922,436	2,894,970	1,344,842	7,944,717	7,115,691	7,256,306	11,616,413
West Virginia	1909				171,581	480,000	587,870	2,483,747	8,200,000	5,056,455	5,290,000
Wisconsin	1911		1,482,379	1,050,888	2,051,455	3,062,639	1,924,026	9,880,240	9,886,554	9,284,175	13,657,035
Wyoming	1911			37,845	67,582	770,726	74,476	669,661	589,691	929,215	1,915,210
Total		2,549,912	24,220,850	47,290,797	66,351,477	106,861,053	59,527,170	240,263,784	279,915,332	286,101,198	389,455,932

[1] Data for 1918 not available; State expenditures shown in 1918 column are for the year 1917.

[2] Data not available.

HIGHWAY ADMINISTRATION AND ROAD CONDITIONS IN CANADA.

THE previous articles in this series have entered upon a brief exposition of the character and relations of national and local governments in the country under consideration, and a comparison with corresponding American governmental units. A working knowledge of the powers and duties of the principal members of the governmental structure is, of course, essential to anyone who would understand clearly the methods of highway administration in vogue in a foreign country. The same method will be followed in this article, though, naturally, the more widespread understanding of Canadian institutions makes such a course less desirable in this article than in its predecessors which have dealt with France and England.

UNITS OF GOVERNMENT.

In all essential particulars the various Canadian governmental agencies have their exact parallels in the United States. The Dominion or Federal Government corresponds to the Government of the United States. The provincial governments of which there are nine correspond to our States. The Provinces in turn are divided into counties which differ from those in this country only in the detail that all cities and certain towns are not included under the jurisdiction of the county government. The townships into which the counties are divided are similar to the corresponding units here.

HIGHWAY ADMINISTRATION—NATIONAL, PROVINCIAL, AND LOCAL.

National.—As in the United States, the Federal or Dominion Government exercises no direct control over the construction and maintenance of highways, but in July, 1919, the Governor General assented to an act of Parliament known as the Canada highways act which provides that the Dominion Government may aid the Provinces in the construction and improvement of highways. Twenty million dollars was appropriated to be expended during a period of five years from April 1, 1919. The money is to be allotted to the Provinces in two ways, (1) $80,000 is to be paid each year to the government of each Province, (2) the remainder is to be allotted in proportion to population. The amount to be apportioned to particular highways is to be 40 per cent of the cost.

The rules and regulations established by the government provide that the highways to be aided must be main or market roads included in a five-year program of construction which must previously have been approved. The highways must be built in acordance with plans and specifications approved by the minister of railways and canals who is charged with the administration of the act; but the onus of supervision is placed upon the provincial highway department, which must also agree to maintain the roads constructed.

The methods of government control and the general nature of the cooperative arrangement are similar to those which exist in this country under the Federal aid act; indeed their system is patterned after ours in all essential details. The most important difference between the methods in the two countries is that the Canadians have no organization corresponding to our Federal aid district offices. It so happens that there is not the corresponding need for such agencies. The number of cooperating governmental units is only 9 instead of 48 as in the United States; and the 9 Provinces deal directly with the Domi ion authorities at Ottawa.

The plan represented as great a departure from prevailing methods of highway administration as did the Federal aid plan in the United States; and the first year of operation has been devoted largely to the development of methods of cooperation. In this respect also the Canadian operations are following very closely the development of Federal aid in the United States. The organization and methods of procedure have by this time reached a workable stage, however, and it is expected that this year's work will show substantial beginnings of actual construction.

Up to June 1, eight of the nine Provinces had submitted program maps of the selected systems of highways. The total length of designated Federal aid roads was about 18,000 miles; and the sum of $73,000,000 was being raised by the several Provinces to be applied on this system during the next five years.

Provincial.—The extent of highway control exercised by the provincial governments is of two orders. In one group, which includes the Provinces of Prince Edward Island, Nova Scotia, New Brunswick, and British Columbia all roads are under the control of the central provincial government, both as to construction and maintenance. In the other five Provinces of Ontario, Quebec, Manitoba, Saskatchewan, and Alberta the counties or townships share in the control of certain highways to varying degrees.

Administration in British Columbia.—Taking British Columbia as a type of the Provinces which exercise complete control, the entire road system outside of municipalities is administered by the provincial department of public works; at the head of which is the minister of public works, who is also a member of Parliament. Under the minister is a deputy minister who is a permanent official, not subject to removal with changes of administration. The roads branch of the public works department is controlled directly by a public works engineer and his staff consisting of an assistant public works engineer, an office engineer and a designing engineer, together with eight district engineers and their assistants, one in each of the eight districts into which the Province is divided. The organization is shown graphically in the chart on page 15.

Annual estimates of the funds required for anticipated work in each district are prepared by the district engineer and submitted to the public works engineer. After inspection and possible revision they are submitted to the Provincial Legislative Assembly for inclusion in the budget. The completed budget assigns to each district a certain amount, which is apportioned to various works by the district engineer subject to the approval of the public works engineer. The work is carried out under the direction of the district engineer, who is responsible, and accountable for all expenditures. All accounts are vouchered and approved by the district engineer or his assistant and paid by a Government agent. Copies of vouchers are forwarded to the public works engineer for approval, thence to the deputy minister of public works for the same purpose, then to the audit department and finally to the treasury department where the expenditures by the Government agent must be approved. In some of the districts most of the road work is done by day labor, but in general new work is usually undertaken by contract. There is no ''statute labor.''

Administration in Ontario.—One of the second group of Provinces, in which road control is not entirely in the hands of provincial officials, is Ontario. The units of government sharing in road control in this Province are the Province, the county and the township.

Road construction and repair was originally a local government function. The roads of least importance, generally those of purely township significance, are still, in this Province, maintained by the townships from township rates, and accounted for solely by the township council, with the exception of the salary of the township road overseer, of which 25 per cent up to $150 per year is paid by the Province.

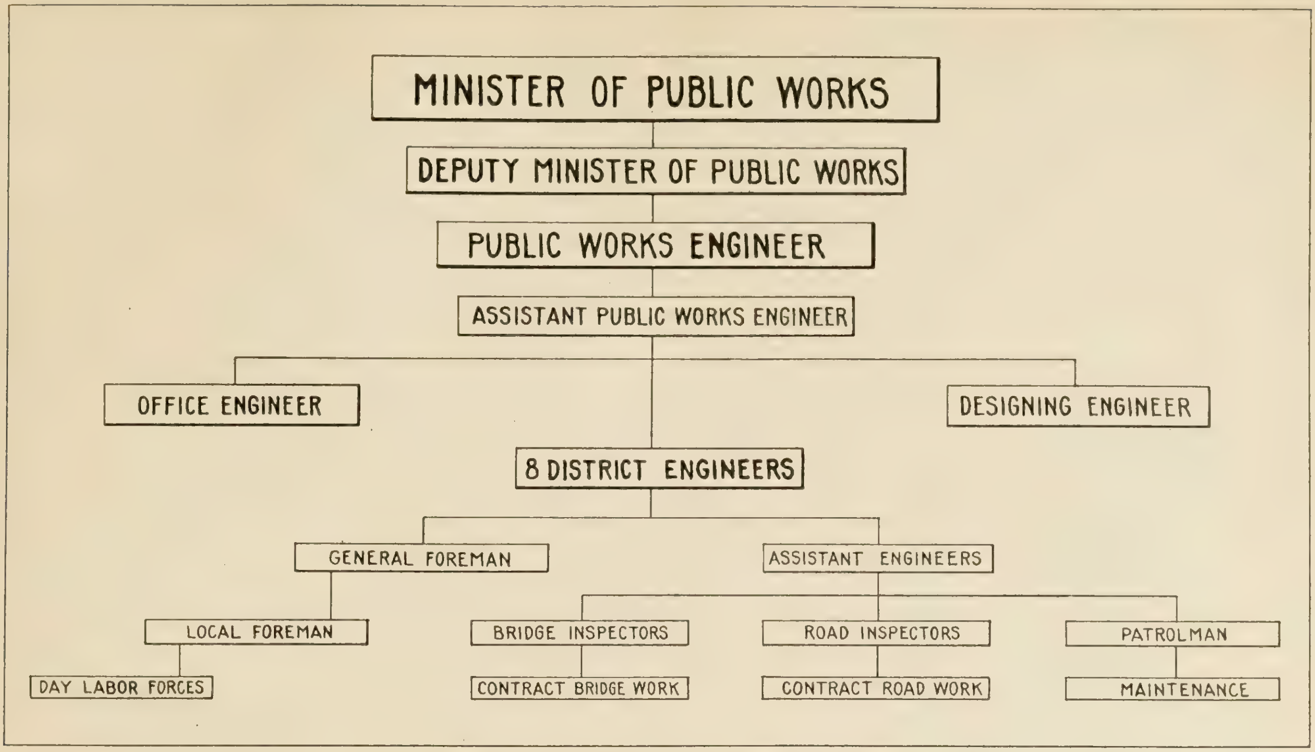
As in this country very little progress was made in road improvement while it was in the hands of local authorities. The first steps toward real progress were made in 1901 when the passage of the highway improvement act provided for the extension of provincial aid to the counties.

County roads.—The condition introduced by this act was very similar to the systems of State aid in the United States. Briefly the act authorizes county councils to assume systems of roads to be known as county roads, which, upon approval by the provincial authority, may receive provincial aid in construction and maintenance. The county system must be adopted by by-law passed by a two-thirds majority of the county council representing at least one-half of the total equalized assessment of the county. When roads are assumed by the county in this manner the township councils cease to have control over them, nor should they make any expenditure on them. The county council is thereafter responsible for construction and maintenance. A county road superintendent, appointed by county by-law and approved by a provincial order in council, is placed in actual charge of road work; but all plans, specifications, and accounts must be approved by the department of public highways before the provincial grant is made. To roads selected and constructed in this manner the Province grants 40 per cent of the expenditure on construction and 20 per cent of the cost of maintenance.

A city may cooperate with the county council in improving the leading county roads adjacent to the city, and thereby obtain a more substantial type of construction for such suburban roads. In such a case the contribution of the Province remains 40 per cent and 20 per cent for construction and maintenance, respectively, but the county and city divide the balance of the cost in each case between them.

Provincial county roads.—Certain county roads of more than local importance, which carry a considerable portion of through traffic, but which are not of sufficient importance to be classed as provincial highways, are classified as provincial county roads. Such roads continue under county control, but because of the through traffic they receive an increased provincial subsidy. In general, they form branches of the "provincial highway system," joining cities and other important terminal points of traffic. To roads of this character the Province grants 60 per cent of the cost of construction and maintenance.

Provincial highways.—In addition to the roads of the classes described above, a system of provincial highways was authorized in 1917, with a view to bringing the construction and maintenance of the principal highways of the Province under the immediate control of the provincial highways department. The department, with the approval of the lieutenant governor in council, is authorized to take over any public highway on behalf of the Crown. The department, thereafter, makes itself responsible for the proper construction and maintenance of the highways assumed. Adjacent to cities the costs of such highways are borne in the proportion of 40 per cent by the Province, 30 per cent by the city, and 30 per cent by the township through which the road passes; outside suburban areas, the Province pays 70 per cent and



BRITISH COLUMBIA HIGHWAY ORGANIZATION.

the township 30 per cent. Provincial control is vested in the department of public highways, with a construction engineer acting under the chief engineer of the department, and resident engineers in charge of the several sections of road, who employ foremen and day labor gangs. For special work contracts may be let on authority of the minister of public highways.

SOURCES OF REVENUE AND EXPENDITURES.

The Dominion.—The $20,000,000 available for Federal aid is derived from the Federal treasury by appropriation made in the Canada highways act passed in July, 1919. Expenditures from this appropriation are to be made over a period of five years and are to take the form of grants to the several Provinces upon condition that they shall expend at least half again as much as the Dominion grant. The allotment of the Dominion funds to the several Provinces made in the manner described elsewhere in this article is substantially as shown in the following table. The minimum amount which the Provinces must contribute in order to receive the Federal money is shown in the third column.

Province.	Federal grant.	Required of Province.
Alberta	$1,477,810	$2,216,715
British Columbia	1,251,955	1,877,932
Manitoba	1,602,265	2,403,397
New Brunswick	1,168,845	1,745,767
Nova Scotia	1,468,720	2,203,080
Ontario	5,877,275	8,815,912
Quebec	4,748,420	7,122,630
Prince Edward Island	603,455	905,182
Saskatchewan	1,806,255	2,709,382

The grants will be made and the work directed by the department of railways and canals. Regulations governing the expenditures have been drawn up by an honorary advisory commission consisting of C. A. Magrath, Ottawa; J. P. Mullarkey, Montreal; and Horne Smith, Toronto.

Up to the present time very little, if any, of the money has been actually expended, but it is expected that the coming year will show very active disbursements as the work already planned gets under way.

The Provinces.—In respect to the methods of raising revenue there is no uniformity among the Provinces of Canada. In this they resemble our own States. Perhaps the nearest approach to a generalization that can be made is that none of them employ that method which is so common in our own system—the taxation of abutting property. Nowhere in Canada is such a tax levied, though in Ontario land adjacent to an improved road is supposed to be assessed 20 per cent higher by virtue of the improvement.

Nor have the automobile revenues been devoted to road construction to any degree corresponding to the practical unanimity among our States. Provincial road revenues are provided by appropriation by the legislature from the consolidated revenue funds, which are made up in part of the motor-vehicle revenues, but apparently the latter are not definitely set aside for road purposes as in this country; and the principle of applying them to road maintenance as distinguished from construction is not recognized.

In British Columbia and Prince Edward Island, two of the group of four Provinces in which road authority is solely a function of the provincial government, road revenues are collectible only by the Province. In British Columbia there is, in fact, no special levy for road improvement, funds for construction and maintenance being derived by appropriation from the general revenues of the Province. In this Province an act of the legislature in March, 1919, provided for a loan of $3,500,000 for road purposes, of which it is stipulated no more than $1,500,000 is to be expended in any one year.

Prince Edward Island levies a special road poll tax, but derives the larger part of its highway revenues from the taxes on motor vehicles and stock.

In Nova Scotia and New Brunswick, the other two Provinces of this group, taxes for road improvement are levied upon the towns and counties, though they have no control over the expenditure of the money raised. In Nova Scotia, for example, each town is taxed for highway purposes one-tenth of 1 per cent on all property assessed for taxation. Each county pays a tax of not less than 40 cents on each $100 of taxable property, and in addition each male between the ages of 21 and 60 pays a poll tax for highway purposes. Both the towns and the counties turn the amounts received over to the provincial treasurer who in turn remits them to the provincial highways board. The law requires, however, that taxes collected in this manner must be spent in the county in which they are raised. In addition to the money derived from the county and town taxes, the provincial government appropriates annually from the general provincial funds a sum of money which may be expended for road purposes in the Province at large.

In the remaining Provinces funds are raised for highway purposes by the towns and counties as well as by the Provinces, and the moneys collected are expended by the unit of government which collects them.

Ontario's provincial expenditures are made from appropriations from the consolidated revenues of the Province. The appropriations are based on the automobile revenues but are not confined to them. The local revenues are derived from county taxes and bond issues, and from township taxes, which by bylaw of the township councils may be commuted into statute labor.

In Manitoba provincial revenues for construction are derived from the sale of debentures. The consolidated revenues and general road tax funds are usable for maintenance only. Local road construction under the control of the municipal councils may be financed in three ways, either from the current revenues of the municipality (town); or from a special tax for road construction, which can be no larger than 5 mills on the assessed valuation; or by the sale of bonds. In case it is decided to resort to a bond issue, the amount to be raised must conform to the engineer's estimate, the issue must be assented to by the taxpayers, and the amount of the issue is limited to 10 per cent of the assessed valuation.

Provincial funds for road purposes in Saskatchewan are in two accounts, known, respectively, as the revenue account and the capital account. The revenue account consists of money derived from the general revenues of the Province and is usable for surveying, construction, and maintenance of roads and for the construction and maintenance of small timber bridges. Funds for the capital account are derived from the sale of bonds, and may be devoted to the construction of permanent roads and bridges of steel or concrete. Local funds in Saskatchewan are obtained by taxation of municipal property.

One of the most interesting methods of financing road improvement is that which obtains in Quebec. The provincial government was authorized in 1912 to borrow $20,000,000 for road purposes. This money is being used to assist the municipalities in two ways. One way is by the extension of a grant covering 50 per cent of the cost of the cooperative roads built, up to a certain amount fixed by the minister of roads. The second and more interesting method permits the municipality to borrow the whole cost of the improvement from the Province, paying for the loan at 3 per cent interest for 41 years, the government contributing the principal. Obviously, the annual cost to the Provincial government under this method of delayed payment is slightly less than 2½ per cent of the initial cost of the improvement, while the municipality pays 3 per cent of the cost each year. It is reported that the plan is working out in a highly satisfactory way. The assistance of the government has stimulated municipal enterprise, and a splendid reform, now well under way, is the result.

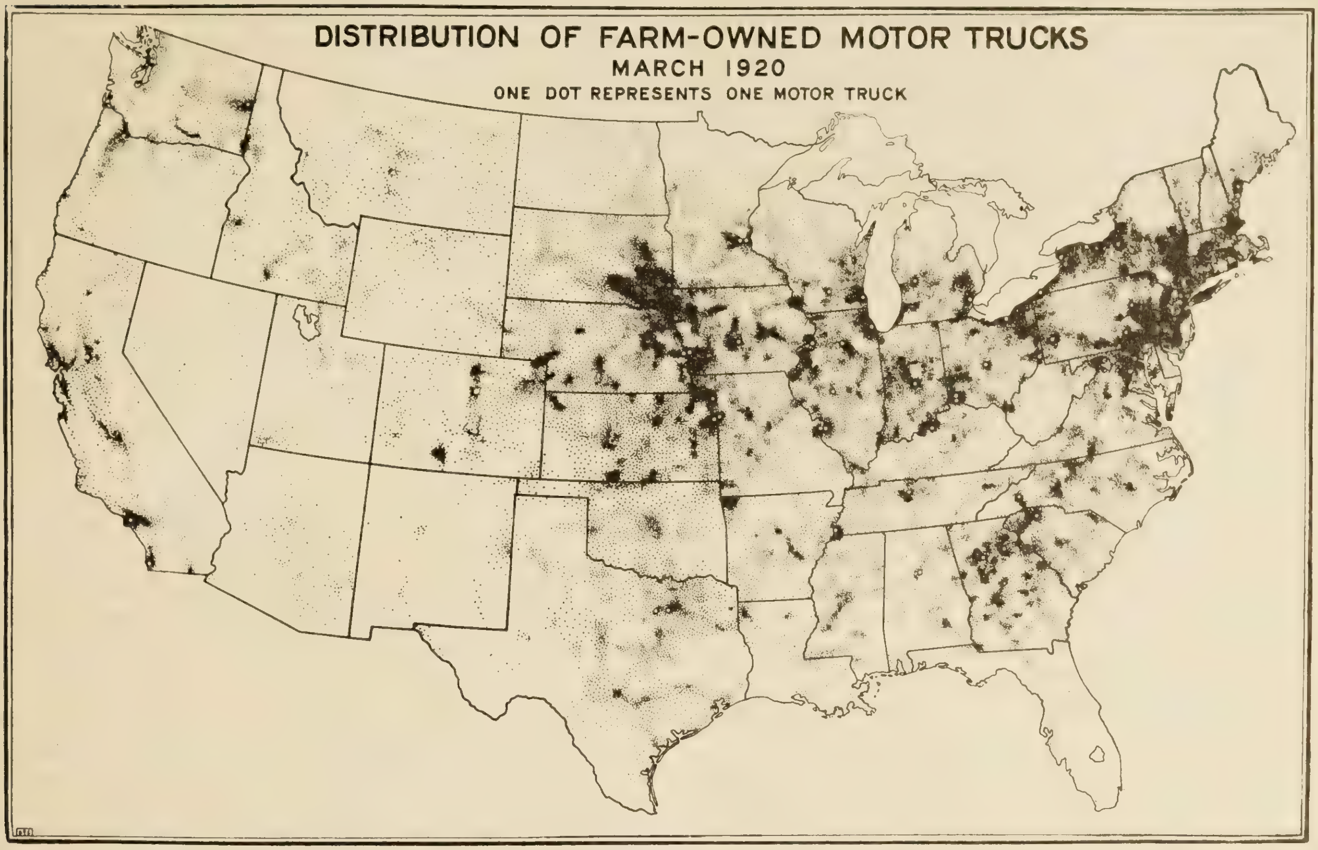
MILEAGE AND CHARACTER OF ROADS.

According to the minister of railways and canals there are approximately 250,000 miles of road in the Dominion of Canada, which is about one-tenth of the mileage in the United States. Reports from the various consuls indicate that the total mileage is slightly in excess of the minister's figure, the reported mileages by Provinces being as shown in the following table:

Province.	Mileage of road.
Alberta	30,000
British Columbia	14,600
Manitoba	68,000
New Brunswick	15,000
Nova Scotia	18,000
Ontario	42,000
Prince Edward Island	3,800
Quebec	40,000
Saskatchewan	30,000
Total	261,400

(Concluded on page 22.)

CHARACTER OF FEDERAL-AID ROADS CONSISTENT WITH TRAFFIC DEMANDS



DISTRIBUTION OF FARM-OWNED MOTOR TRUCKS IN THE UNITED STATES.

THE provision of the Federal-aid road act which requires that the roads constructed with the aid of Federal funds must be "substantial in character" has been construed in its application by the Secretary of Agriculture in accordance with the following principles:

1. That the proposed highway must be an improvement upon the existing highway, and at least as durable as other roads in the section in which it lies;
2. That the type of surfacing must be adequate to serve present and probable future traffic as determined by a traffic census and an estimate of probable development.

Guided by these principles the Secretary has approved roads of all types from the lowly earth road to expensive surfaces of bituminous and cement concrete and brick. No attempt has been made to enforce the construction of the higher types under all circumstances, because it has been realized that the conditions in all cases do not require the great outlay which the construction of such roads entails.

The department and the several State highway departments have often been criticized upon the score of this policy, the critics pointing to the total mileage of roads of low type as proof that the roads constructed under Federal aid are inadequate to serve modern conditions.

Those who have been familiar with the true conditions have been confident that the selection of the lower type surfaces has been justified by the circumstances of each individual project, but in the aggregate, the large mileage of earth, sand-clay, and gravel roads which has been approved has appeared to substantiate the unfavorable criticism of those who have dealt only with total figures.

The roads constructed have been classified as to type of construction, and the situation with regard to the selection of types in the several States and in the United States as a whole has been clearly shown in simple tabular form which could be comprehended at a glance. But no similar means of presenting the related traffic conditions has been available; and it has not been possible, therefore, to demonstrate the injustice of the criticisms without going into the circumstances of each particular case.

MOTOR TRUCK AND ROAD TYPE CHARTS.

The valuable survey of the distribution of farm-owned motor trucks recently made by the Office of Farm Management of the Department of Agriculture has supplied the desired comparative data in a simple graphical form. The map prepared by the Farm Management experts is reproduced on page 17. On it each dot represents one motor truck, and the density of the shading conveys at a glance the extent of motor truck usage in the various sections of the country.

Obviously the necessity for the construction ot such hard-surfaced types of pavement as brick, concrete, and bituminous concrete is a direct function of the number of motor trucks the pavement will be called upon to withstand when it is constructed. Where motor truck traffic is light, the chances are that automobile traffic is also light, and in the absence of these two forms of traffic there is no necessity for a stronger surface than is afforded by such materials as sand-clay, or gravel, or broken stone at best.

It it interesting, therefore, to compare the distribution of motor trucks and the relative density of motor truck traffic in various places, as revealed by this chart, with the character of the surfaces which have been selected for Federal-aid roads in the corresponding places as shown by the other chart on page 19.

The second chart has been prepared by the Bureau of Public Roads to show the mileage of the various types of road under agreement for construction in the several States. The principal types of road have been grouped into three classifications, designated as high, intermediate, and low types respectively. The high-type classification includes brick, cement concrete, bituminous concrete, sheet asphalt, and similar pavements. The intermediate class includes bituminous macadam and surface treated and plain water-bound macadam; and the low-type group is composed of earth, sand-clay, gravel, shell, and similar miscellaneous constructions. The mileage of road of each of the three classes in each State is shown by the length of the sections of the bars in each State hatched to represent the particular types. The approximate mileage of roads of each type can be determined by reference to the scale of miles. In this connection, however, the relative mileages of the three types in each of the States are of greater interest than their numerical equivalents.

ROAD TYPES AND TRAFFIC DEMANDS.

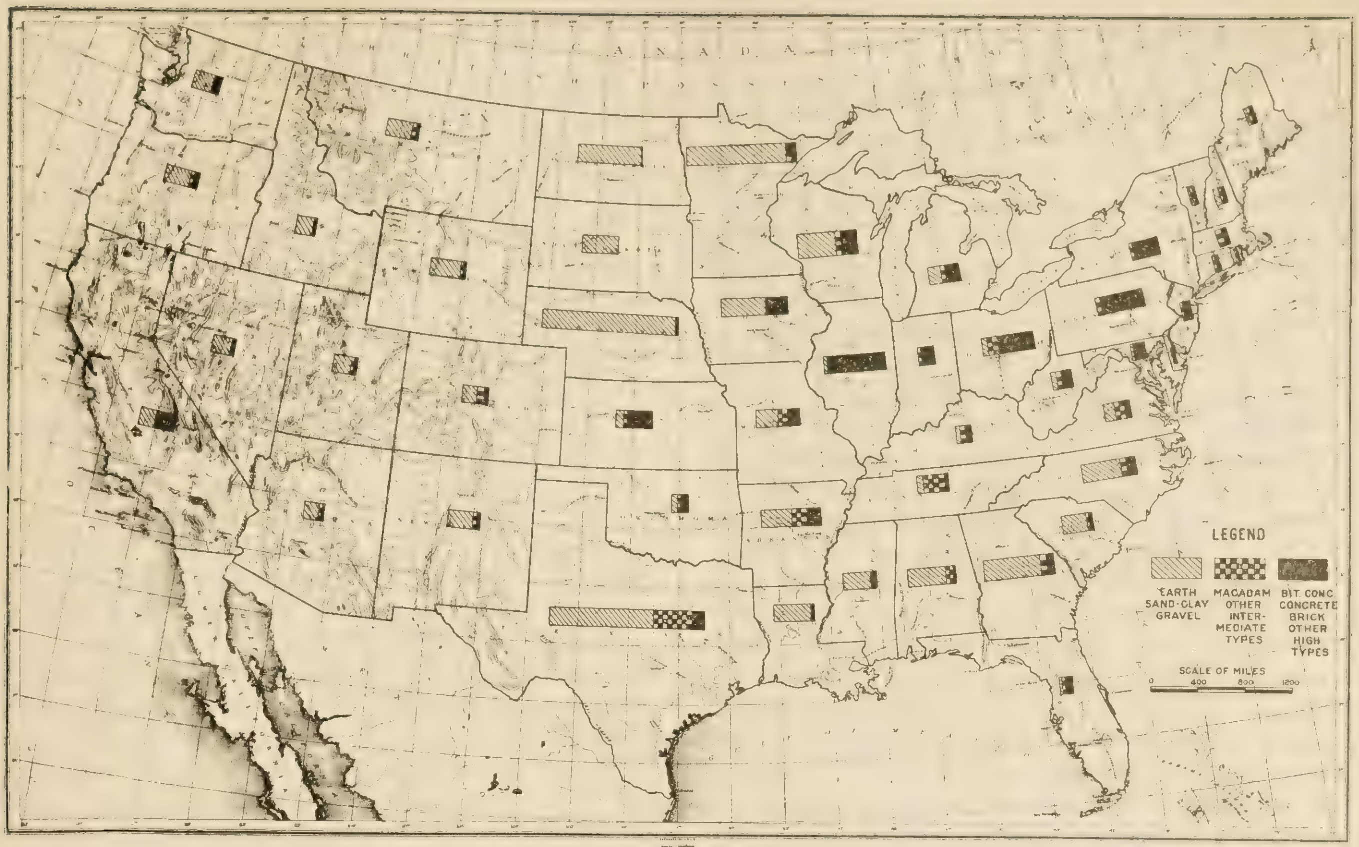
The fact that stands out most clearly by a comparison of the two charts is that the areas of greatest concentration of motor trucks are practically identical with the territory in which Federal-aid roads are predominantly of the higher types. The salient features of the highway map are: The belt of roads of the higher types which extends from the New England and Middle Atlantic States westward north of the Potomac and Ohio Rivers to the Mississippi; the beginnings of a movement toward the acquisition of roads of these classes in the other Atlantic seaboard and Pacific Coast States; and the great preponderance of low-type roads in the Great Plains and Rocky Mountain States.

Turning to the motor-truck chart it is evident at once that the same areas which hold the bulk of high-type Federal-aid roads are those which have the largest numbers of farm-owned motor trucks; and the scarcity of the motor trucks in the Plains and Mountain States offers the most convincing reason possible for the selection of the low-type roads in those sections.

Naturally there are exceptions to the general agreement of the two maps. In the State of Florida, for example, no great concentration of motor trucks appears, yet the high and intermediate types of highway predominate. This condition is explained, of course, by the heavy tourist automobile traffic, the consequent necessity of providing some sort of surfacing for the sand roads, the dearth of local road building material of the cheaper sort, which has resulted in a general resort to brick and concrete throughout the State.

On the contrary, the States of Nebraska, Iowa, and South Dakota do not appear to have as great a mileage of high-type road as the concentration of trucks would indicate to be desirable. The explanation in this case is that these States have a well-defined policy in accordance with which they are expending their funds for the most part to grade and drain the native road bed with the fixed purpose of adding the surfacing material at the earliest possible date. The almost entire absence of roads with any improvement whatever, and the large mileage which required improvement, when these States set out upon their work of highway improvement only three or four years ago, makes this policy an eminently wise one. The money expended for grading and drainage—every dollar of it—goes into a lasting improvement, an improvement which, small though it may be in Eastern eyes, is yet a substantial improvement over previous conditions, and is moreover the ground-work for future surfacing, when the whole territory which must benefit has been lifted out of the deepest mud by adequate drainage and grading.

These are the outstanding exceptions to the general agreement of the two charts. On the other hand, in a State like Ohio, where, according to the motor-truck chart the roads must bear a heavy concentration of trucks, Federal aid has resulted in the construction of types of road which are designed to meet the requirements of truck traffic. Sixty-nine per cent of them



MAP SHOWING TYPES OF FEDERAL-AID ROADS UNDER CONSTRUCTION IN 1920.

are high-type roads, 20 per cent are of intermediate type, and only 11 per cent are included in the low-type classifications. This represents not only a strong effort to provide roads suitable for the loads, but is, in every respect, an advance from the conditions which existed in the State just before the passage of the Federal-aid act, when 81.8 per cent of all the roads of the State were of low types, 16.6 per cent were intermediate type, and only 1.6 per cent could be classified as high type.

It is recognized, of course, that the number of rural-owned motor trucks is only a portion of all the trucks owned in the United States. But the great majority of city-owned trucks are operated in the States which show the greatest preponderances of high-type roads, and those that are owned in other sections, it is safe to say, impose no demands upon the highways of those sections beyond a radius of 60 miles from their city homes. And as it happens that these are sections where the distances between cities are great, the bearing of the city trucks upon the highway problems of the States as a whole is not great.

In the main these charts present a complete and very convincing answer to the criticisms that have been directed against the types of highway approved for Federal-aid projects.

IMPROVING IMPROVED MARYLAND ROADS.

(Continued from page 8.)

which deteriorate from freezing, Regardless of how well these emulsions are adapted to summer and fall patching they are not used, because the possibility of not having material when it is needed in the spring more than offsets any advantage they possess at other seasons.

In conclusion, the writer believes that Maryland's policy which makes it necessary from time to time to improve her improved roads is fundamentally sound and correct. Under it she has become one of the "best roaded" States of the Union. The improvements which keep her moderate-priced roads continually up to date cost far less than the high type roads which elsewhere are being built to carry traffic no heavier than her roads carry. The Maryland plan starts with a relatively small investment in admittedly low-type road. By a process of gradual improvement, by selective treatment of the weak places, it builds up a better road from year to year, always conserving the bulk of the previous investment. It is a plan which is more like the French plan than is to be found anywhere else in the United States. It differs sharply from the method which attempts by expenditure of vast sums to build at once, forever.

Marylanders often wonder whether the public which elsewhere pays the huge cost of the so-called high-type roads fully understands that the best pavements built to-day are not going to give the service implied by the catch word "permanent." We wonder whether there exists in the public mind that wholesome doubt of the "permanence" of such roads which in Maryland makes "maintenance" a bigger word than "construction." Certainly, if this be not the case, if sufficient funds are not provided for maintenance, and for reconstruction, when necessary, this country is due for a tremendous set-back in road construction.

HIGHWAYS IN THE HIGH SCHOOLS.

By C. J. TILDEN, Professer of Engineering Mechanics, Yale University.

SCHOOLS make citizens. Whatever has to do with community life and development is a proper subject for study, if it can be fitted to the intellectual status of the child. Our highway systems—State, county, and municipal—have recently become so important throughout the country that the future citizen may well be required to learn something about them. Within the past year or two the annual appropriation of public moneys for highway construction and maintenance has increased fivefold. Pleasure cars are multiplying with astonishing rapidity, and motor transport is becoming an industrial necessity in many communities. Not only must new roads be built, but old roads must be rebuilt to meet the increasing demands of traffic. This, of course, spells more money and the need for more wide-spread efficiency and wisdom in spending it.

In attempting to put some sort of instruction in highway matters into schools of high and grammar grades, it is not necessary to think in terms of a text-book or set courses of study. Training the powers of observation and of expression is one of the chief objects of education. Let the student look at something, with more or less guidance as to what he is to look for, then tell or write about what he sees, and he has gained both in knowledge and intellectual power. Hence the many exercises in "composition," "essays" or "themes," on topics which may either be assigned by the teacher or chosen by the student.

OUTLINE FOR STUDY OF HIGHWAYS.

In the following outline, which has the highway as a basis, a series of such topics is suggested, planned to stimulate observation and provoke interested and fruitful discussion. One advantage in the general subject of highways is that the study and observation can begin at home. Both economic and construction problems have been solved (or else are more or less obviously still to be solved) in building the road, street, or boulevard that runs past the schoolhouse. The study of these questions—finding the answers—can not only be made of interest to the schoolboy, but will lead by a logical path, albeit with many ramifications, to the bigger problems of county, State, and national systems of transportation and communication. Most of the topics in the following outline have been put in the form of questions. Some of these may be answered by direct observation, others (as, for example, those of an economic nature) require further investigation, study of maps, town or county records, collateral reading, etc.

THE ROAD BY THE SCHOOLHOUSE.

Where does it come from?
Where does it go?
What is "the right of way"?
- To whom does it belong?
- How was it acquired?
- The fences or walls—what is their purpose?

The road itself, that is, the traveled way.
- How was it made?
- What material was used?
- How is it maintained?
- What pays for it?
- Who has charge of it?
- The alignment, or changes in direction; curves and turns.
- The grade, or differences in elevation.
- Side ditches and drainage.

The nearest crossroads in each direction.
- Where do they lead?
- Which is the "main" road?
- Of what general system—city, county, or State—are these roads a part?

How could you measure the usefulness and importance of these roads? (Approximate number of vehicles per hour, or per day, or per season: beauty of scenery; historic associations; transfer or delivery to or from markets of farm produce, coal, provisions, manufactures, etc.)

Other topics will readily suggest themselves and various rearrangements and combinations may be made. The list above, as will be seen, is designed to stimulate interest in the highways right at home, but the boy or girl who has carefully considered such questions and thoughtfully answered them from personal observation and study is in better shape to deal intelligently with similar questions of much wider scope.

For older students these topics may be extended and broadened considerably. Valuable lessons in geography may be learned in connection with the "how" and "why" of road building. There is no reason why certain elementary phases of highway engineering, particularly those which lend themselves readily to observation in the field, should not be studied with profit and interest by high-school students. By no means the least of the many advantages of such study would be the stimulation of interest in highway engineering, or transport engineering, as a life work. There can be no question that the opportunities in these fields during the next decade or two will be unusually attractive.

USING CONTOUR MAPS.

The ability to read contour maps intelligently is an accomplishment of considerable value, and adds greatly to the interest and enjoyment of motoring, hiking, or any other kind of outdoor activity. It may be acquired by any intelligent boy or girl of 12 to 14. The topographic atlas sheets of the United States Geological Survey are particularly useful in studying actual conditions of highway location—lines, grades, economic and industrial relations, etc.—and most of the important areas of the United States have been mapped. The sheets may be had at a nominal cost. Many individual exercises on these maps—such as the grade or profile of a given road, why it does not run in a straight line, its relation to railways, streams, and other roads, the visibility of natural objects from various points on it, etc.—are quite within the interested grasp of high-school students.

Among the exercises which may be followed out on these maps, and, where conditions permit, extended to observation in the field, are those relating to the way roads are laid out. Some of the older highways of New England appear on the map as straight lines between towns, the line following for miles over hills and through valleys without regard for such obstacles. By far the more usual way is to follow approximately along the contour lines, going around hills instead of over them, thereby avoiding undesirable hills. In many places in the Middle West where public-land surveys have been made the public roads follow the north-south and east-west section lines. Then there are roads that "just growed," like Topsy, or developed from buffalo tracks or cow paths. A comparative study, on the topographic map sheets, of roads in flat country and roads in hilly country will bring out most interesting and instructive differences. The relation of roads and contour lines is strikingly shown on the maps of the big mountains, such as Mount Ranier, Pike's Peak, Mount Washington, and others. For more mature students some elementary studies of the economic significance of grades on streets in the vicinity of the school could well be made.

LEARNING FROM ROAD CONSTRUCTION.

Where road construction is in progress a great deal of useful information may be gathered. The way in which the roadbed or "subgrade" is prepared, the desirability of balancing cuts and fills, the material used to make the road surface and where it comes from—what part if any has to be brought from a distance and what is obtained locally—may all be noted from observation supplemented by a few questions. In general, the engineers and superintendents on such work will welcome intelligent questioning and gladly give all the information they can.

The whole question of crossing steams and rivers, road drainage, etc., offers many topics for observation and study. Taking care of water that would otherwise destroy the road is a problem that every road builder has to face. To the boy or girl with a creative imagination—and most children have this quality until it is educated out of them—bridges and culverts are delightful and fascinating structures. The impression on one small child is charmingly given in The Story of Opal.[1] "Long time ago, this road did have a longing to go across the rivière. Some wise people did have understandings and they did build it a bridge to go across on. It went across the bridge and it goes on and on between the hills."

[1] Atlantic Monthly, March, 1920.

A knowledge of some of the simple terms in bridge nomenclature—a beginning of the "anatomy" of bridges—would stimulate the interest and greatly quicken the power of observation. The various ways of classifying bridges, as "through" or "deck" spans; or on the basis of the material used—stone, concrete, steel, timber, combination; or with respect to the structural form—beam or girder, truss, cantilever, arch, suspension, or pontoon—may be readily learned by children of high-school age. Even the principal steps in bridge building may be studied and written about by a bright youngster, if there is some work of the sort on in the neighborhood.

SAFETY WILL FURNISH TOPICS.

The many requirements for safety will furnish a variety of topics for school children's essays and oral discussions. The dangers of railroad crossings at grade and the economic justification for abolishing them, the importance of an unobstructed view up and down the track as a vehicle approaches, the disadvantages of sharp turns, etc., are suggestive subjects. Similarly there might also be mentioned the questions raised by street intersections and turns. In every town there are many crossings where the autoist's view is unnecessarily limited by fences, shrubbery, or buildings, or where sharp curves with limited visibility invite serious accidents. Guideposts, markers, and other signs for the most efficient guidance of traffic through thickly-settled communities are also a part of the bigger and more inclusive topic of the economic importance of safety and guidance—the actual money value of human life and of accident prevention.

Another question, in solving which the engineer and economist will need the help of enlightened public opinion (and this enlightenment should start in the public schools), is that of the relation of the public highways to railroads and canals. The advantage of long hauls by rail and short hauls by motor trucks, feeding into main terminal points by radiating systems of highways, a division of the transportation burden by parallel systems of water, rail, and road transportation, are some of the subdivisions of this general heading.

This listing of topics is not intended to be complete or exact, but merely suggestive. Those that refer to construction could best be utilized when construction work happened to be in progress in the vicinity of the school. Many of the other topics may be studied from maps, of which the students might be required to make tracings or free-hand sketches showing the particular features which it is desired to emphasize, or about which the exercise is being written. State highway departments often feel the need of a better popular understanding of the problems of road construction, and their officials would doubtless cooperate in a hearty manner. Looking ahead, it is easy to see an actual shortage of men qualified to carry on the work of highway development, so rapid is the growth of the good-road movement. Highway instruction in high schools offers opportunity to State highway departments to develop a body of future citizens equipped with a better understanding of the need for roads and the problems likely to be met in building them, and, at the same time, to stimulate interest in the profession of highway engineering.

ASSISTANCE BY HIGHWAY DEPARTMENTS.

State departments and county engineers can help teachers (1) by assigning members of their staffs to deliver occasional lectures, simple in text and preferably illustrated with lantern slides; (2) by furnishing photographs of highways and construction work for classroom or reference use; (3) by assisting teachers in the explanation of work in progress which can be inspected by classes of students. Many States also issue bulletins or reports which are valuable for reference.

The Federal Bureau of Public Roads has a large amount of material which is available for assisting in school work of this kind. In addition to bulletins, circulars, and other printed matter which will be sent free to teachers and others who are interested, lantern slides and motion-picture films may be loaned, without charge, to schools equipped to make use of them. Other material, of a graphical or pictorial nature, will be developed from time to time and will be available for use in connection with public-school instruction.

But the best equipment for such high-school work as this is a live, wide-awake community which believes in building good roads and keeping them in good shape. Under such conditions there will never be any lack of material for making interesting studies of the economic, social, and constructional problems of highway communication. A collection of maps, some good photographs, and a carefully-chosen list of books and magazines would complete a useful educational outfit. The assumption must, of course, be made that these facilities are at the command of an interested, active-minded, and inspiring teacher.

HIGHWAY ADMINISTRATION AND ROAD CONDITIONS IN CANADA.

(Continued from page 16.)

About 30,000 miles of the entire system are surfaced with some material, varying from sand-clay to concrete and bituminous concrete, but only about 10,000 miles are included in what may be called roads of the first class—that is, heavily traveled main thoroughfares.

Roads surfaced with concrete and bituminous materials are confined almost entirely to the eastern Provinces of Nova Scotia, Quebec, and Ontario. Prince Edward Island and Alberta have no surfaced roads at all. British Columbia, Manitoba, Saskatchewan, and New Brunswick have very little surfaced mileage, and such as they have is almost entirely gravel or sand-clay. These Provinces constitute a sparsely settled region in which the traffic has not yet become heavy enough to warrant the surfacing of roads. There are thousands of miles of trails in these Provinces, however, which are not included in the mileage of roads reported.

Methods and standards of construction for the various types of roads are practically identical with those prevailing in the United States, as are the costs of construction and maintenance.

TRAFFIC AND ROAD CONDITIONS.

In 1918 there were in the entire Dominion of Canada approximately 262,000 motor vehicles. The numbers of motor trucks, automobiles, and motor cycles were not reported separately, and no estimate of the numbers of each in the Dominion can be given.

However, nearly one-half of the total number were registered in Ontario, in which the number of the several classes of vehicles were passenger automobiles, 101,599; motor trucks, 7,529; and motor cycles, 5,002. In 1917, the year previous, it was found that approximately 25 per cent of all motor vehicles registered were in the hands of farmers. The same year it was reported that there was one car for each 39 of the population in Ontario and one for each 12 persons in Saskatchewan. These figures compare very closely with the figures expressing the same relation for the same year in the States of New York and Montana, which border upon the two Canadian Provinces. New York had one car for each 30 persons and Montana 11, according to data compiled by the Bureau of Public Roads.

The Ontario reports for 1917 show that nearly 75 per cent of all motor trucks registered were classed as having a capacity of 1 ton or less, over 97 per cent were 3½ tons or less, and less than 3 per cent were of 4 tons' capacity and upward. In 1918 there were in the Province only 18 trucks capable of carrying 6 tons or more of load.

Except in Ontario and Quebec, and in parts of British Columbia motor traffic has not yet grown to proportions which justify extensive construction of the higher types of roads. Conditions in these Provinces or, at any rate, in parts of them are very similar to the traffic conditions in the border States of the United States. Parts of them are still in an undeveloped state, and very large parts of the other Provinces are still very sparsely settled. In the whole Province of Prince Edward Island in 1918 there were only 35 motor trucks. Still this country is developing with great rapidity, and Canadian road builders are attempting to make their work safe for the foreseen future. In this they are fortunate in having as a guide the experience of the United States, which has recently trod the same path.

FEDERAL AID ALLOWANCES.

PROJECT STATEMENTS APPROVED IN AUGUST, 1920.

State.	Project No.	County.	Length in miles.	Type of construction.	Project statement approved.	Estimated cost.	Federal aid.
Alabama	79	Dallas	3.144	Gravel	Aug. 4	$39,374.54	$19,687.27
Arkansas	78	Lincoln	9.980	do	Aug. 12	21,039.48	10,500.00
	112	St. Francis	4.180	do	Aug. 13	40,956.30	10,000.00
	82	Little River	6.570	do	Aug. 14	55,775.77	20,000.00
Colorado	40	Yuma	3.504	do	Aug. 3	29,767.69	14,883.84
	120	Jefferson	1.491	Concrete	Aug. 28	59,621.48	29,810.74
Georgia	180	Gwinnett	2.300	Sand-clay	Aug. 3	38,338.14	19,169.07
	181	De Kalb	1.913	Hard surface	Aug. 13	77,000.93	5,000.00
	186	Johnson	3.100	Gravel	Aug. 28	27,665.44	13,832.72
	178	Murray	6.500	Topsoil	Aug. 31	43,749.20	21,874.60
Idaho	47	Kootenai	8.250	Gravel	Aug. 17	20,000.00	10,000.00
Illinois	13	Sangamon	9.710	Various hard types	Aug. 3	222,480.50	55,620.12
	14	Fayette, Marion, Washington, Perry, Jackson, Union, Alexander.	54.000	Earth	Aug. 11	1,400,568.30	350,142.07
Iowa	45	Mitchell		Gravel	Aug. 21		[1]40,000.00
	52	Audubon		Earth	do		[1]60,000.00
	57	Cedar		do	do		[1]30,000.00
	64	Jasper		do	do		[1]50,000.00
	70	Mahaska		do	do		[1]60,000.00
	74	Clayton		do	do		[1]70,000.00
	75	Marion		do	do		[1]50,000.00
	76	Chickasaw		Gravel	do		[1]30,000.00
	81	Taylor		Earth	do		[1]60,000.00
	83	Union		do	do		[1]80,000.00
	86	Jones		do	do		[1]40,000.00
	90	Iowa		do	do		[1]50,000.00
	98	Winneshiek		do	do		[1]60,000.00
	103	Delaware		Gravel	do		[1]40,000.00
Kansas	66	Crawford	11.500	Earth	Aug. 13	239,674.02	57,500.00
Louisiana	78	St. Martin	5.600	Gravel	do	73,641.73	36,820.86
Missouri	98	Hickory	7.000	do	Aug. 11	39,002.48	19,501.24
	104	Webster	8.500	do	do	30,200.00	15,100.00
	141	Montgomery	6.000	Macadam	Aug. 12	53,694.36	26,847.18
	146	McDonald	7.750	Gravel	do	27,900.00	13,950.00
	152	do	3.680	do	do	13,260.50	6,630.25
	148	Phelps	20.000	do	Aug. 13	82,736.00	41,368.00
	156	Polk	8.300	do	do	40,743.23	20,371.61
	139	Pulaski	18.670	do	do	84,297.93	42,148.96
	149	Green	7.000	Earth	do	34,999.99	17,499.99
	153	Christian	9.000	Gravel	do	17,568.00	8,784.00
	154	Barry	5.500	do	do	21,500.00	10,750.00
	158	Christian	6.500	do	do	16,978.00	8,489.00
	135	McDonald	7.000	Earth	Aug. 12	34,799.60	17,399.80
	137	Marion	6.500	Gravel	Aug. 31	55,374.00	27,687.00
	160	Washington	8.240	Earth	do	43,093.03	21,546.51
Montana	127	Sweet Grass	7.617	Earth and gravel	Aug 9	37,885.65	18,942.82
	111	Stillwater	0.510	Concrete	Aug. 11	20,483.33	10,200.00
	117	Sweet Grass	6.300	Gravel	Aug. 28	69,215.73	34,607.86
	134	Yellowstone	3.230	do	do	26,143.67	13,071.83
	137	Lincoln	4.000	Earth	Aug. 30	19,965.00	9,982.50
New Hampshire	127	Sullivan	1.040	Bituminous macadam	Aug. 12	40,000.00	20,000.00
	128	Merrimack	0.660	Gravel	Aug. 30	18,000.00	9,000.00
	130	Grafton	0.460	do	Aug. 31	8,000.00	4,000.00
North Carolina	125	Alleghany	13.550	Macadam	Aug. 11	195,125.70	97,562.85
Ohio	127	Montgomery	5.130	Concrete or bituminous macadam	do	220,000.00	61,000.00
	142	Summit	4.980	Concrete	do	285,016.60	75,000.00
	164	Richland	3.144	Concrete, bituminous macadam or brick.	do	153,000.00	33,000.00
	167	Vinton	2.980	Earth	do	67,000.00	27,000.00
	169	Holmes	2.180	Monolithic brick	do	82,000.00	25,000.00
	170	do	1.987	Concrete or monolithic brick	do	63,000.00	20,000.00
	159	Wood	3.370	Macadam	Aug. 12	114,400.00	20,000.00
Oklahoma	30	Nowata	5.000	Gravel	Aug. 28	[2]41,800.00	[2]20,900.00
South Carolina	98	Greenville	2.159	Concrete or asphaltic concrete	Aug. 4	103,750.53	43,180.00
	66	Richland	15.155	Concrete	do	691,535.51	85,497.05
	100	Union	3.728	Topsoil	Aug. 11	39,077.56	13,828.38
South Dakota	64	do	7.000	Gravel	do	69,388.00	34,694.00
	65	Yankton	13.110	Earth	do	54,923.00	27,461.50
	66	Union	10.930	Gravel	Aug. 28	102,725.70	51,362.85
Texas	199	Stephens	31.800	Bituminous concrete	Aug. 4	1,251,645.29	200,000.00
	198	Nacogdoches	23.170	Gravel	do	288,143.90	100,212.35
	197	Smith	2,450	Gravel-clay	do	45,115.85	22,357.91
	191	Milan	14.557	Gravel	Aug. 12	107,544.14	32,685.48
	194	Coleman	18.400	do	Aug. 13	263,832.80	90,000.00
	196	do	22.500	do	do	320,426.72	100,000.00
	201	Nacogdoches	32.680	do	Aug. 30	364,291.40	141,344.04
	202	Bowie	16.354	do	Aug. 28	181,844.33	90,000.00
	200	Travis	4.000	Bituminous surface	Aug. 30	57,398.00	28,699.00
Virginia	108	Henrico	3.280	Macadam	Aug. 12	69,079.45	34,539.72
	69	Augusta	3.000	Waterbound macadam	Aug. 30	69,850.00	34,925.00
	32	Fairfax	1.730	Macadam	Aug. 11	[3]94,799.59	[3]47,399.80
	41	Alleghany	9.500	do	Aug. 24	[2]164,609.50	[2]82,304.76
	38	Accomac	2.590	do	Aug. 14	[2]36,080.00	[2]18,040.00
Washington	71	Columbia and Garfield	8.620	Crushed rock	Aug. 3	38,940.00	19,470.00
	72	Grays Harbor	1.710	Concrete	do	71,956.83	34,200.00
West Virginia	100	Tucker	1.900	do	do	76,128.80	24,040.00
	101	Randolph	4.410	Earth	Aug. 11	68,000.00	32,320.00
	102	Boone	3.080	do	Aug. 12	65,500.00	30,080.00
Wisconsin	177	Sauk	3.660	Gravel	Aug. 13	40,683.86	15,000.00
	124	Polk	2.190	Earth	Aug. 12	41,203.64	15,000.00
	178	Ashland	5.980	do	Aug. 14	41,033.96	14,000.00
Wyoming	92	Natrona	10.795	Selected material	Aug. 12	149,600.00	74,800.00
	96	Goshen	3.250	do	Aug. 13	28,413.00	14,206.50

[1] Revised statement. Figures given are decreases from those in the original statement. [2] Withdrawn.
[3] Revised statement. Figures given are increases from those in the original statement.

PROJECT AGREEMENTS EXECUTED IN AUGUST, 1920.

State.	Project No.	County.	Length in miles.	Type of construction.	Project agreement signed.	Estimated cost.	Federal aid.
Alabama	46	Jackson	6.000	Waterbound macadam	Aug. 2	$53,360.47	$26,680.23
	51	Russell	5.440	Sand-clay	Aug. 31	32,185.04	16,092.52
Georgia	65	Dade	2.335	Chert	Aug. 18	65,791.55	32,895.77
	78	Pulaski		Bridge	do	246,121.42	123,060.71
	80	Glynn	4.200	Concrete	do	167,318.84	83,659.42
	83	Walton	5.830	Topsoil	do	40,655.46	20,327.73
	85	Haralson	5.000	Sand-clay	do	39,820.19	19,910.09
	86	do	4.860	Topsoil	do	54,515.08	27,257.54
	109	Dawson	7.505	Gravel	do	105,900.90	52,950.45
	112A	Laurens		Bridge	do	73,049.81	36,524.90
	113	Pulaski		do	do	121,974.30	30,000.00
	116	Walton	6.997	Topsoil	do	58,342.58	29,171.29
	117	Gwinnett	8.049	do	do	61,081.37	25,000.00
	123	Grady		Bridge	do	36,158.07	18,079.03
	60	Stephens		Topsoil	do	[1] 11,435.76	[1] 5,717.88
	23	Forsyth		Topsoil	do		[2] 6,861.72
	64	Glynn		Hard surface	do	[1] 6,321.20	[1] 3,160.60
	20	Carroll		Topsoil	do	[2] 60,454.30	[2] 3,579.47
	11	Lowndes		Bridge (concrete)	do	[1] 12,785.60	[1] 6,392.80
	16	Meriwether		Sand-clay	do	[1] 12,761.92	[1] 6,380.96
	125A	Lee	5.681	do	do	40,000.00	20,000.00
	139	Taliaferro	5.530	do	do	31,335.39	12,000.00
	144	Macon	3.785	do	do	9,975.84	4,987.92
	147	Troup	13.240	Topsoil	do	121,578.42	50,000.00
	89	Baker and Mitchell		Bridge	Aug. 31	94,600.00	47,300.00
	55A	Walker	19.865	Waterbound macadam	do	195,411.31	90,000.00
Louisiana	17	Tangipahoa	4.910	Gravel	Aug. 23	65,541.08	32,770.54
	41	Jefferson	2.940	Shell	do	30,053.21	15,026.60
	52	Rapides	13.300	Gravel	do	163,803.58	81,901.79
	53	Madison	10.490	do	do	133,522.67	66,761.33
	56	La Salle	12.980	do	Aug. 24	111,820.83	55,910.41
	62	Beauregard	34.980	do	Aug. 23	435,997.60	200,000.00
	54	St. Bernard	3.220	Tarvia macadam	Aug. 24	73,282.22	36,641.11
	14	Caldwell	3.720	Sand-clay and gravel	Aug. 23	[2] 92,181.10	[2] 42,000.00
	45	Caddo		Gravel	do	[2] 18,702.81	[2] 9,351.41
Minnesota	97	Olmstead	14.540	Earth	Aug. 31	175,765.86	87,882.93
	114	Sherburne	7.320	Concrete	do	285,039.40	142,519.70
	98	Todd	15.700	Gravel	Aug. 18	100,107.09	50,000.00
	103	Renville	14.560	do	do	117,887.80	50,000.00
	110	Redwood	10.810	do	do	45,962.40	19,000.00
	120	Aitkin	8.060	do	do	63,880.22	20,000.00
	63	Stevens	10.008	Concrete	Aug. 19	347,985.48	173,992.74
	89	Le Sueur	7.445	Earth	do	101,854.31	50,927.15
	92	Anoka	22.500	Gravel and concrete	do	346,300.28	161,548.91
	107AB	Watonwan	13.969	Concrete or brick or asphalt	do	582,941.55	200,000.00
	163	Rock	6.010	Gravel	do	76,935.88	25,000.00
	164	Traverse	15.400	do	do	126,919.39	40,000.00
	125	Wabasha	1.510	do	do	75,767.07	30,200.00
	40ABC	Meeker	12.256	do	do	104,017.65	50,000.00
	159	Ottertail	9.720	do	do	79,518.16	39,000.00
	121	Freeborn	9.850	do	Aug. 31	100,603.91	25,000.00
	135	Beltrami	2.960	do	do	20,884.47	10,000.00
	137	Fillmore	6.250	do	do	34,296.24	17,148.12
	21	Wabasha		Earth	Aug. 19		[1] 4,800.00
	139	Lyon	8.110	Gravel	Aug. 31	111,046.90	50,000.00
	19	Goodhue	1.480	Gravel and concrete	do	[2] 131,504.56	[2] 71,769.46
Mississippi	41A	Wilkinson	7.500	Gravel	Aug. 2	89,617.40	44,808.70
Nebraska	33	Knox	11.410	Gravel and sand-clay	Aug. 5	92,382.11	46,191.05
	113A	do	6.740	Earth	do	95,171.49	47,585.74
	128A	Seward	7.180	do	do	65,795.78	32,897.89
	134AB	do	18.115	do	do	98,303.74	49,151.87
	136A	Pierce	2.110	Sand-clay	do	33,075.90	16,537.95
	139A	Madison	3.224	Gravel	do	24,926.08	12,463.04
	43	Johnson	13.857	Earth	Aug. 31	86,286.72	43,143.36
North Carolina	84A	Burke and MacDowell	8.371	do	Aug. 3	128,193.76	64,096.88
	71	Durham	6.670	Rock asphalt on stone base	Aug. 2	290,329.43	142,570.64
	114	Rowan	2.543	Concrete	do	107,293.17	50,860.00
	69	Transylvania	9.384	Topsoil	Aug. 3	144,599.13	72,299.56
Washington	40	Walla Walla	3.788	Concrete	Aug. 20	148,821.09	74,410.54
	50	Spokane	4.110	do	Aug. 3	145,087.23	72,000.00
West Virginia	92	Brooke	.960	do	Aug. 12	24,324.30	10,240.00
	62	Hardy	6.700	Gravel	do	57,036.00	28,518.00
	71A	Tucker	2.500	Earth	do	57,150.00	28,575.00
Wyoming	31	Natrona	1.225	Warrenite, concrete base	do	161,433.91	73,412.17
	44	Carbon	12.214	Selected material	Aug. 4	62,602.87	31,301.43
	49	Sweetwater	43.921	do	do	165,388.08	82,694.04
	63	Park	6.084	do	do	52,408.43	26,204.21
	59A	Carbon	9.205	Earth	do	42,107.84	21,053.92
	62	Sweetwater	16.189	Selected material	do	57,288.52	28,644.26
	73	Laramie	9.476	do	do	73,479.14	36,739.57
	67	Johnson	7.360	do	do	66,205.52	33,102.76

[1] Modified agreements. Amounts given are increases over those in the original agreements. Second revision.
[2] Modified agreements. Amounts given are increases over those in the original agreements. First revision.

CORRECTION.

It has been called to our attention that a statement in the article on Asphalt Filler in Granite Block Work, which appeared on page 14 of Volume 3, No. 26, of Public Roads, is misleading. The incorrect statement is as follows: "Granite block with asphalt filler was the type selected by the street department to conform with the rest of Battery Place." The facts are that the rest of Battery Place is paved with granite block, but the filler used is pitch instead of asphalt.

ROAD PUBLICATIONS OF BUREAU OF PUBLIC ROADS.

Applicants are urgently requested to ask only for those publications in which they are particularly interested. The Department can not undertake to supply complete sets, nor to send free more than one copy of any publication to any one person. The editions of some of the publications are necessarily limited, and when the Department's free supply is exhausted and no funds are available for procuring additional copies, applicants are referred to the Superintendent of Documents, Government Printing Office, this city, who has them for sale at a nominal price, under the law of January 12, 1895. Those publications in this list, the Department supply of which is exhausted, can only be secured by purchase from the Superintendent of Documents, who is not authorized to furnish publications free.

REPORTS.

*Report of the Director of the Office of Public Roads for 1916. 5c.
*Report of the Director of the Office of Public Roads for 1917. 5c.
Report of the Director of the Bureau of Public Roads for 1918.
Report of the Chief of the Bureau of Public Roads for 1919.

DEPARTMENT BULLETINS.

Dept. Bul. 105. Progress Report of Experiments in Dust Prevention and Road Preservation, 1913.
136. Highway Bonds.
220. Road Models.
230. Oil Mixed Portland Cement Concrete.
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