



Old Macadam Resurfaced with Amiesite, Morris County Turnpike.

EIGHTEENTH ANNUAL REPORT

OF THE

Commissioner of Public Roads

For the Year ending October 31st

1911



TRENTON, N. J.:

STATE GAZETTE PUBLISHING Co., Printers.

1912.

Letter of Transmittal.

OFFICE OF COMMISSIONER OF PUBLIC ROADS,

TRENTON, NEW JERSEY, January 2, 1912.

To His Excellency Woodrow Wilson, Governor, and the Legislature of New Jersey:

I have the honor to submit the Eighteenth Annual Report of the Commissioner of Public Roads for the fiscal year ending October 31, 1911, with such comments and suggestions as existing circumstances seem to require.

E. A. STEVENS,
Commissioner of Public Roads.

FINANCIAL STATEMENT.

DR.

Balance, November 1, 1910:			
of motor vehicle fund, general.....	\$46,466	85	
of motor vehicle fund, for Ocean Highway..	27,000	00	
of motor vehicle fund, for cautionary signs.	888	45	
			\$74,355 30
of appropriations against which were filed liabilities on contracts:			
for year ending October 31, 1908.....	\$15,242	84	
for year ending October 31, 1909.....	99,050	38	
for year ending October 31, 1910.....	173,590	82	
			287,884 04
Appropriations for year ending October 31, 1911:			\$362,239 34
Construction, regular	\$300,000	00	
Construction, supplemental	105,903	91	
			\$405,903 91
Salaries and expenses, regular		15,600	00
Experiments and automobile, supplemental..		10,000	00
			431,503 91
Motor vehicle receipts:			
set aside for salaries and expenses (assistant supervisors)		\$6,000	00
set aside for Delaware River Drive survey..		15,000	00
balance for maintenance of roads.....		320,939	21
			341,939 21
			\$1,135,682 46

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Cost of work and supervision:			
Aid in construction, general	\$277,750	78	
Aid in Ocean Highway	17,414	56	
Paid on contract for Chestnut Neck road..	4,650	74	
Cautionary signs		35	00
Aid in maintenance	232,184	03	
			\$532,035 11
Supervision		25,996	20
			\$558,031 31
Cost of automobile			3,925 00
Cost of experimental work; construction...	\$4,878	45	
Cost of experimental work; laboratory....	979	31	
Cost of report on English roads.....	200	00	
			6,057 76
Cost of Delaware River Drive survey.....			8,498 90
			\$576,512 97

Expense of administration:	Paid from			
	Appropriation.	Motor Vehicle Fund.		
Salaries, regular	\$8,600 00	\$3,000 00	\$11,600 00	
Wages, temporary employment	1,680 00	373 99	2,053 99	
Travel and hotel	386 91	2,079 78	2,466 69	
Automobile, etc.	3,503 41	265 57	3,768 98	
Office, printing, sundries, etc.....	959 64	275 51	1,235 15	
Deficit, November 1, 1910.....	470 04		470 04	
	<u>\$15,600 00</u>	<u>\$5,994 85</u>	<u>21,594 85</u>	
Balance, October 31, 1911.....				\$598,107 82
				<u>537,574 64</u>
				<u>\$1,135,682 46</u>
Balance, November 1, 1911.....				<u>537,574 64</u>
This balance is accounted for as follows:				
Account of motor vehicle fund, general (in-				
cluding Chestnut Neck road).....	\$130,571 29			
Account of motor vehicle fund, for Ocean				
Highway	9,585 44			
Account of motor vehicle fund, for caution-				
ary signs	853 45			
Account of motor vehicle fund, for Dela-				
ware River Drive survey	6,501 10			
	<u></u>	\$147,511 28		
Amount reverting to motor vehicle fund...	\$5 15			
Amount reverting to treasury, from experi-				
mental appropriation	17 24			
general road appropriation for year end-				
ing October 31, 1908.....	5,903 91			
	<u></u>	5,926 30		
Amounts of liabilities on contracts filed,				
against appropriations:				
for year ending October 31, 1909.....	\$34,757 11			
for year ending October 31, 1910.....	73,895 91			
for year ending October 31, 1911.....	275,484 04			
	<u></u>	384,137 06		
				<u>\$537,574 64</u>
				<u>\$537,574 64</u>

Cost of Roads.

In compliance with the act of March 27, 1905, the following statement of cost of roads is submitted:

BURLINGTON COUNTY.

	Miles.		
Smalley's Corner and Vincentown road..	2.900		
Cost		\$23,511 76	
State's share.....			\$7,837 25

CAMDEN COUNTY.

	Miles.		
Chapel avenue.....	.855		
Cost		\$12,114 32	
State's share.....			\$4,038 11

ESSEX COUNTY.

	Miles.		
Fairview avenue.....	2.344		
Cost		\$20,193 25	
State's share.....			\$6,731 08

GLOUCESTER COUNTY.

	Miles.		
Railroad avenue, Swedesboro.....	.163		
Cost		\$4,389 82	
State's share.....			\$1,463 27

MERCER COUNTY.

	Miles.		
Portion of Brunswick pike, second part..	1.104		
Cost		\$9,953 65	
State's share.....			\$3,317 88
Yardville and Allentown road.....	3.408		
Cost		31,733 84	
State's share.....			10,577 95
Rocky Hill road.....	.796		
Cost		8,394 89	
State's share.....			2,798 30
	5.308	\$50,082 38	\$16,694 13

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MONMOUTH COUNTY.

	Miles.		
Allentown and New Egypt road, second section	1.946	\$13,963 68	\$4,654 56
Cost			
State's share.....			
Red Bank and Holmdel road, second section	1.550	13,441 00	4,480 33
Cost			
State's share.....			
Lakewood and Adelphia road, fourth section	.980	3,163 80	1,054 60
Cost			
State's share.....			
	4.476	\$30,568 48	\$10,189 49

OCEAN COUNTY.

	Miles.		
Seaside Park and Bayhead road, southerly section	5.379	\$41,709 92	\$13,903 31
Cost			
State's share.....			

PASSAIC COUNTY.

	Miles.		
Main street Storm Water Drain.....		\$32,573 76	\$10,857 92
Cost			
State's share.....			
Main street extension.....	.223	4,107 00	1,369 00
Cost			
State's share.....			
	.223	\$36,680 76	\$12,226 92

SOMERSET COUNTY.

	Miles.		
Watchung road.....	3.172	\$38,743 65	\$12,914 55
Cost			
State's share.....			

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UNION COUNTY.

	Miles.		
Springfield avenue.....	1.584		
Cost		\$26,559 40	
State's share.....			\$8,853 13

WARREN COUNTY.

	Miles.		
Buttzeville road.....	3.678		
Cost		\$28,717 30	
State's share.....			\$9,572 43
Total number of miles.....	30.082		
Total cost allowed.....		\$313,271 04	
Total paid on contracts from 1911 appropriation.....			\$104,423 67
Total paid supervisors.....			25,996 20
Total paid out.....			\$130,419 87
Appropriation			405,903 91
Balance due, against which contracts were filed October 31, 1911			275,484 04

The following roads were paid for from the appropriation for 1910 after the close of the fiscal year:

ESSEX COUNTY.

	Miles.		
Runnymede road.....	1.701		
Cost		\$18,883 76	
State's share.....			\$6,294 59
Mountain avenue.....	.061		
Cost		561 00	
State's share.....			187 00
	1.762	\$19,444 76	\$6,481 59

GLOUCESTER COUNTY.

	Miles.		
Swedesboro and Auburn road.....	3.431		
Cost		\$44,835 30	
State's share.....			\$14,945 10

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HUNTERDON COUNTY.

	Miles.		
Ringoes-Woodsville road.....	4.081		
Cost		\$35,106 33	
State's share.....			\$11,702 11
Milford road.....	5.126		
Cost		39,106 66	
State's share.....			13,035 55
	9.207	\$74,212 99	\$24,737 66

MIDDLESEX COUNTY.

	Miles.		
Kingston Lane.....	.721		
Cost		\$6,276 61	
State's share.....			\$2,092 20
Main street, Milltown.....	1.303		
Cost		15,041 17	
State's share.....			5,013 72
Somerset street.....	.386		
Cost		4,142 50	
State's share.....			1,380 83
	2.410	\$25,460 28	\$8,486 75

MONMOUTH COUNTY.

	Miles.		
Cedar avenue and Monmouth road boulevard	2.615		
Cost		\$17,025 00	
State's share.....			\$5,675 00
Lakewood and Adelpia road, third section	2.516		
Cost		6,901 00	
State's share.....			2,300 33
	5.131	\$23,926 00	\$7,975 33

MORRIS COUNTY.

	Miles.		
Pompton and Newark turnpike.....	2.938		
Cost		\$16,272 90	
State's share.....			\$5,424 30

SALEM COUNTY.

	Miles.		
Elmerborough road.....	1.779		
Cost		\$7,406 75	
State's share.....			\$2,468 92

SOMERSET COUNTY.

	Miles.		
Greater Cross Roads road.....	1.983		
Cost		\$19,521 00	
State's share.....			\$6,507 00

SUSSEX COUNTY.

	Miles.		
Frankford and Sandyston road, third section	3.278		
Cost		\$22,892 97	
State's share.....			\$7,630 99

UNION COUNTY.

	Miles.		
Raritan road and Lake avenue.....	2.465		
Cost		\$40,429 74	
State's share.....			\$13,476 58
Washington avenue and Edgar road, con- nection	.246		
Cost		3,209 00	
State's share.....			1,069 67
Edgar road, Lennington street and Milton avenue, connection.....	.132		
Cost		1,473 05	
State's share.....			491 02
	2.843	\$45,111 79	\$15,037 27
Total number of miles.....	34.762		
Total cost.....		\$299,084 74	
Total paid by State.....			\$99,694 91

The following roads were paid for from the appropriation for 1909, but they were completed and payment made during the fiscal year 1911:

CAMDEN COUNTY.

	Miles.		
Haddonfield and Camden turnpike.....	4.122		
Cost		\$68,028 26	
State's share.....			\$22,676 09

ESSEX COUNTY.

	Miles.		
River road.....	1.223		
Cost		\$13,491 17	
State's share.....			\$4,497 06

MIDDLESEX COUNTY.

	Miles.		
Deans and Franklin Park road.....	2.748		
Cost		\$8,984 00	
State's share.....			\$2,994 66

PASSAIC COUNTY.

	Miles.		
Main street.....	2.563		
Cost		\$39,868 83	
State's share.....			\$13,289 61

WARREN COUNTY.

	Miles.		
Beattystown road.....	8.587		
Cost		\$62,507 54	
State's share.....			\$20,835 85

Total number of miles.....	19.253		
Total cost.....		\$192,879 80	
Total paid by State.....			\$64,293 27



Blackwell's Mills and Millstone Road, Second Section, Nearing Completion,
Somerset County.



Blackwell's Mills and Millstone Road, Second Section, Somerset County.

The following road was paid for from the appropriation for 1908, but it was completed and payment made during the fiscal year 1911:

ESSEX COUNTY.

Central avenue and Green Brook avenue,	Miles. 2.828	
Cost		\$28,016 80
State's share.....		\$9,338 93

The total length of improved roads added to our mileage during the year 1911 is as follows:

Paid from the 1911 appropriation.....	30.082	miles.
Paid from the 1910 appropriation.....	34.762	"
Paid from the 1909 appropriation.....	19.253	"
Paid from the 1908 appropriation.....	2.828	"
Total	86.925	"

The following roads are approaching completion, but were not finished in time to be reported in the preceding lists:

BERGEN COUNTY.

	Miles.	Cost.
Franklin turnpike, second section.....	.857	\$18,392 18
Franklin turnpike, third section.....	2.798	76,900 59
Essex street.....	1.604	34,334 00
	5.259	\$129,626 77

BURLINGTON COUNTY.

Atsion road.....	4.261	\$23,995 76
North Church road, portion of.....	.758	5,615 38
Central avenue, Moorestown.....	.287	2,316 45
Lewistown-Pemberton road.....	2.789	9,248 95
	8.095	\$41,176 54

CAPE MAY COUNTY.

Sea Shore road, second section.....	11.000	\$49,802 91
Sea Shore road, third section.....	6.589	24,751 61
	17.589	\$74,554 52

CUMBERLAND COUNTY.

Vineland and Malaga road.....	5.395	\$9,134 01
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ESSEX COUNTY.

Cedar street.....	1.666	\$21,395 52
Green Brook road.....	.253	1,297 00
Union avenue.....	1.161	13,435 68
Gregory avenue.....	1.675	13,833 13
Normal avenue.....	.755	35,040 20
	5.510	\$85,001 53

GLOUCESTER COUNTY.

Woodbury and Mantua Grove road.....	2.170	\$26,639 92
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HUDSON COUNTY.

Belleville turnpike.....	1.570	\$32,317 02
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HUNTERDON COUNTY.

Lebanon-Clinton road.....	3.371	\$33,763 72
Ringoes-Ringoes station road.....	.554	4,766 15
	3.925	\$38,529 87

MERCER COUNTY.

Pennington and Harbourton road, portion of.....	2.791	\$27,409 94
Pennington and Washington Crossing road, extension of,	2.715	26,963 06
	5.506	\$54,373 00

MIDDLESEX COUNTY.

Perth Amboy and Keasbey road.....	2.363	\$28,161 21
Kingston and Aqueduct road.....	2.557	25,027 13
Spottswood and Englishtown road, first section.....	2.015	8,864 75
	6.935	\$62,053 09

SALEM COUNTY.

Woodstown road.....	.459	\$14,198 49
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SOMERSET COUNTY.

Liberty Corner road, second section.....	1.980	\$18,640 22
Blackwell's Mills and Millstone road, first section.....	2.653	21,999 74
Blackwell's Mills and Millstone road, second section.....	2.765	29,872 96
	7.398	\$70,512 92

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SUSSEX COUNTY.

Newton and Stanhope road.....	9.780	\$83,453 16
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UNION COUNTY.

Palisade avenue and Madison Hill road.....	2.389	\$36,992 51
Springfield avenue and Shunpike road.....	1.131	14,551 03

	<u>3.520</u>	<u>\$51,543 54</u>
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Total number of miles.....	83.111	
Total cost.....		\$773,114 38
Total to be paid by State.....		\$257,704 79

Miles and Cost.

The total amount expended by the State and the number of miles paid for in each county from the passage of the State Aid Law to October 31st, 1911, are as follows:

County.	Miles.	Amount.
Atlantic	111.175	\$110,686 18
Bergen	34.303	118,418 33
Burlington	187.723	309,990 65
Camden	107.550	257,703 88
Cape May	42.685	94,218 06
Cumberland	1.220	14,773 23
Essex	114.303	294,279 64
Gloucester	85.659	105,840 17
Hudson	4.760	40,135 27
Hunterdon	33.472	87,419 24
Mercer	137.802	353,367 37
Middlesex	164.810	326,239 36
Monmouth	126.218	230,120 19
Morris	76.658	165,345 55
Ocean	59.022	78,986 55
Passaic	65.814	152,177 60
Salem	37.262	59,196 21
Somerset	89.197	185,488 37
Sussex	14.331	33,254 31
Union	28,965	92,299 33
Warren	55.467	120,397 02
	1,578.396	\$3,230,336 51

TOTAL NUMBER OF SQUARE YARDS OF EACH CLASS OF ROAD BUILT IN EACH COUNTY SINCE THE PASSAGE
OF THE STATE AID LAW.*

	Macadam.	Telford.	Asphalt Binder.	Tar Binder.	Amiesite.	G. F. B.	Filbertine.	Bitulithic.	Gravel.	Shell.	Bog Ore.	Totals.
Atlantic	28,776								1,077,988			1,106,764
Bergen	239,295		24,125	29,087								292,507
Burlington	840,505	255,180							230,373			1,326,058
Camden	381,214	193,623	19,712		104,116				185,481			884,146
Cape May									415,758			415,758
Cumberland									13,409			13,409
Essex		1,046,081	12,136									1,058,217
Gloucester	239,313						35,084		494,281			768,678
Hudson		55,665										55,665
Hunterdon	228,086		18,355									246,441
Mercer	1,069,720	48,792	66,677									1,185,189
Middlesex	937,584	37,752	86,916		15,981				188,086			1,266,319
Monmouth	481,678	16,498							561,341		52,264	1,111,781
Morris	485,906	6,275	24,818		54,550							571,549
Ocean									756,715			756,715
Passaic	595,980		12,151			39,280						647,411
Salem	44,124							16,115	195,889	89,584		345,712
Somerset		637,109	36,976									674,085
Sussex	76,113	10,560	26,793									113,466
Union	149,297		49,991		70,204							269,492
Warren	285,045	86,453	70,530									442,028
Total	6,082,636	2,393,988	449,180	29,087	244,851	39,280	35,084	16,115	4,119,321	89,584	52,264	13,551,390

*In case of some of the early roads this yardage is approximate only.

Summary of Roads Described in 1910 Report and Paid for in 1911.

Certain roads paid for after October 31st, 1910, were described in the 1910 report.

While it is necessary to include such roads in the preceding lists, to avoid repetition we do not include the descriptions and statements of cost published last year. The names of the roads above referred to are as follows:

ESSEX COUNTY.

	Miles.
Runnymede road.....	1.701
Mountain avenue.....	.061
Central avenue and Green Brook avenue.....	2.828
River road.....	1.223

HUNTERDON COUNTY.

Ringoes-Woodsville road.....	4.081
Milford road.....	5.126

MIDDLESEX COUNTY.

Kingston Lane.....	.721
Main street, Milltown.....	1.303
Somerset street.....	.386
Deans and Franklin Park road.....	2.748

MORRIS COUNTY.

Pompton and Newark turnpike.....	2.938
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SUSSEX COUNTY.

Frankford and Sandyston road, third section.....	3.278
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UNION COUNTY.

Raritan road and Lake avenue.....	2.465
Washington avenue and Edgar road, connection.....	.246
Edgar road, Lennington street and Milton avenue connection.....	.132

WARREN COUNTY.

Beattystown road.....	8.587
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Description and Statement of Cost of Roads Improved in 1911.

BURLINGTON COUNTY.

Smalley's Corner and Vincentown Road, 2.90 Miles Long.

This improvement begins at the Pemberton stone road and runs southerly to and through the town of Vincentown. The old road was so very heavy and sandy that it was only usable for very light loads, and for a portion of the year was impassable for heavily loaded teams. Though there was but little grading on this line the change in conditions is most marked, as what was formerly a deep, sandy wagon track is now a smooth, hard road, over which the farmers haul three times the weight that they were formerly able to move, and that the effort expended is much less is shown in the improved condition of the horses. The completion of this road also adds greatly to the pleasure and comfort of the people of Vincentown.

The pavement consists of water bound macadam, fourteen and sixteen feet wide, which, after its completion, was treated with a coat of light asphaltum oil, the result of which treatment was very satisfactory.

Detailed statement of the cost of the Smalley's Corner and Vincentown road, township of Southampton, county of Burlington. Total length, 15,313 feet, or 2.900 miles.

Width of stone-bed, 14 and 16 feet.

Length of stone-bed, 15,313 feet.

Depth of stone-bed, 6 and 10 inches.

* Macadam, Sta. 34 + 46 to Sta. 67 + 91, 22,359.78 square yards, at 75 cents; total.....	\$16,769 83
Telford, 2,092.22 square yards, at \$1.10; total.....	2,301 44
Earth excavation, 9,357 cubic yards, at 30 cents; total.....	2,807 10
Drain, 1,300 lineal feet, at 35 cents; total.....	455 00
Macadam in driveways, 681.75 square yards, at 75 cents; total..	511 31
Earth excavation in driveways, 300 cubic yards, at 30 cents; total	90 00
Rubble stone gutter, 577.08 square yards, at \$1.00; total.....	577 08
Total	\$23,511 76
Supervisor's salary.....	433 50
Engineering expenses.....	1,115 67
Total cost of road.....	\$25,060 93
Lump sum, contract price.....	\$22,452 65
Total allowed by the State.....	\$23,511 76
One-third of above, amount paid by the State.....	\$7,837 25
Maximum grade before.....	4.0 per cent.
Maximum grade after.....	3.3 per cent.

EARL THOMSON,
Engineer.
 ANDREW WRIGHT,
Supervisor.

*1,640.78 square yards macadam substituted for telford.

CAMDEN COUNTY.

Chapel Avenue, .855 Miles Long.

This work begins at the Camden and Moorestown turnpike or the main street of Merchantville and runs southeasterly to the railroad. It is built of Amiesite, or cold mixed asphalt concrete, fourteen feet wide and eight inches thick.

Detailed statement of the cost of Chapel avenue, borough of Merchantville, townships of Pennsauken and Delaware, county of Camden. Total length, 4,514.5 feet, or .855 miles.

Width of stone-bed, 14 feet.
 Length of stone-bed, 4,514.5 feet.
 Depth of stone-bed, 8 inches.

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Macadam, with Amiesite surface, 7,348.5 square yards, at \$1.24; total	\$9,112 14
Earth excavation, 3,349.1 cubic yards, at 35 cents; total.....	1,172 18
Tile drain, 1,000 lineal feet, at 15 cents; total.....	150 00
Rubble stone gutter, 1,866 $\frac{2}{3}$ square yards, at 90 cents; total....	1,680 00
Total	\$12,114 32
Supervisor's salary.....	204 00
Engineering expenses.....	363 43
Total cost of road.....	\$12,681 75
Lump sum, contract price.....	\$12,114 32
Total allowed by the State.....	\$12,114 32
One-third of above, amount paid by State.....	\$4,038 11
Maximum grade before.....	6.02 per cent.
Maximum grade after.....	5.00 per cent.

J. J. ALBERTSON,
County Engineer.
JOHN W. COX,
Supervisor.

Haddonfield and Camden Turnpike, 4.132 Miles Long.

This old turnpike was formerly paved with rubble and was a shining example of how not to improve a highway. It was hard, rough and unpleasant to travel over. Now all this is changed, and the road is what the old charter said it should be, smooth, hard and convenient for travel. The pavement is of asphalt concrete, laid cold, and extends from the curb on each side to the trolley tracks in the center. The improvement is of great value to the truck and dairy farmers about and beyond Haddonfield, as it is the most direct route to Camden and to the ferry to Philadelphia. It is well known that South Jersey feeds the people of the City of Brotherly Love, furnishes many of them with suburban homes and is a playground for hundreds more; hence the value of this good road is measured in thousands of dollars to Camden county.

Detailed statement of the cost of the Haddonfield and Camden turnpike, township of Haddon and boroughs of Haddonfield and Collingswood and City of Camden, county of Camden. Total length, 21,817.2 feet, or 4.132 miles.

Width of stone-bed, in Camden city, 21.6 feet, balance, 22 feet.
Length of stone-bed, 21,739.4 feet.
Depth of stone-bed, 8 inches.

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Macadam, with Amiesite, 34,436.45 square yards, at \$1.12; total,	\$38,568 82
Telford, with Amiesite, 18,553.94 square yards, at \$1.19; total..	22,079 19
Macadam foundation built but not used, 1,432.81 square yards, at 50 cents; total.....	716 41
Earth excavation, 11,775.57 cubic yards, at 23 cents; total.....	2,708 38
Extra excavation, 5,754.88 cubic yards, at 25 cents; total.....	1,438 72
Terra cotta pipe in place, 426 lineal feet, at 36.235 cents; total..	154 36
Refilling trench, stone used, 147.7 tons, at \$1.55; total.....	228 93
Labor on same, by the day.....	233 03
Brick and iron top inlets, 4, at \$35.00; total.....	140 00
Lowering curbs, removing ballast, replacing same, as per time sheet	1,760 42
Total	\$68,028 26
Supervisor's salary.....	1,149 00
Engineering expenses.....	2,045 55
Extras, paid by county, 12-inch cast iron drain pipe in place, 216 feet, at 72.61 cents; total.....	156 85
Total cost of road.....	\$71,379 66
Lump sum, contract price.....	\$62,455 33
Total allowed by the State.....	\$68,028 26
One-third of above, amount paid by the State.....	\$22,676 09
Maximum grade before.....	1.66 per cent.
Maximum grade after.....	1.66 per cent.
J. J. ALBERTSON, <i>Engineer.</i>	
WM. WYAND, <i>Supervisor.</i>	

ESSEX COUNTY.

Fairview Avenue, 2.344 Miles Long.

This improvement begins at Bloomfield avenue in the borough of Verona, and extends along the side of the Second Watchung Mountain, passing the county buildings at Overbrook, thence to the Pompton turnpike. This may be truly called a county road, as its principal value lies in the fact that it furnishes a good improved highway to the large group of county buildings.

The pavement is telford, sixteen feet wide and eight inches thick. The steepness of the grades necessitated the laying of several hundred feet of cobble gutters.

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Detailed statement of the cost of Fairview avenue, townships of Cedar Grove and borough of Verona, county of Essex. Total length, 12,375 feet, or 2.344 miles.

Width of stone-bed, 16 feet.

Length of stone-bed, 12,347 feet.

Depth of stone-bed, 8 inches.

Telford, 21,987 square yards, at 55 cents; total.....	\$12,092 85
Earth excavation, 18,852 cubic yards, at 30 cents; total.....	5,655 60
Cobble stone gutter, 3,056 square yards, at 80 cents; total.....	2,444 80
Total	\$20,193 25
Supervisor's salary.....	939 00
Total cost of road.....	\$21,132 25
Lump sum, contract price.....	\$17,748 45
Total allowed by the State.....	\$20,193 25
One-third of above, amount paid by the State.....	\$6,731 08
Maximum grade before.....	8.51 per cent.
Maximum grade after.....	5.00 per cent.

JAS. OWEN,

Engineer.

HARRY R. BALDWIN,

Supervisor.

GLOUCESTER COUNTY.

Railroad Avenue, Swedesboro, .163 Miles Long.

This pavement, though laid on a short street in Swedesboro, is really a farmer's road, its principal service being that of a public market place for the farmers of southwestern Gloucester, Swedesboro being one of the largest shipping points for sweet potatoes in New Jersey. During the height of the season this short street is filled from end to end with loaded truck wagons. For this reason a pavement of a more durable nature than macadam was deemed advisable; consequently, Filbertine, a hot mixed asphalt concrete, was used, and was laid over the entire width of the street, or an average of thirty feet.

EIGHTEENTH ANNUAL REPORT.

Detailed statement of the cost of Railroad avenue, borough of Swedesboro, Gloucester county, New Jersey. Total length, 859 feet, or .163 miles.

Width of stone-bed, 29 and 31 feet.

Length of stone-bed, 859 feet.

Depth of stone-bed, 8 inches.

Earth excavation, 626 cubic yards, at 40 cents; total.....	\$250 40
Filbertine on macadam base, 2,978 square yards, at \$1.39; total..	4,139 42

Total	\$4,389 82
Supervisor's salary.....	66 00
Engineering expenses.....	131 69
Advertising and printing proposals.....	124 95

Total cost of road.....	\$4,712 46
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Lump sum, contract price.....	\$4,389 82
Total allowed by State.....	\$4,389 82
One-third paid by State.....	\$1,463 27

Maximum grade before.....	.60 per cent.
Maximum grade after.....	.50 per cent.

WM. C. CATTELL,
County Engineer.
JOHN D. WALLACE,
Supervisor.

Swedesboro and Auburn Road, 3.431 Miles Long.

This road begins at the junction of Main street in the borough of Swedesboro and runs southwesterly to the county line of Salem county. It is built over and through a very fertile farming section. Before its improvement this road was a striking illustration of the fact that the richer the soil the worse the road; in fact, at some seasons of the year the road was almost impassable for a loaded team.

The pavement is of Filbertine, sixteen feet wide, and nearly approaches what the law prescribes, that is, that it must be smooth, hard and convenient for travel at all seasons of the year.

Detailed statement of the cost of the Swedesboro and Auburn road, borough of Swedesboro and township of Woolwich, county of Gloucester. Total length, 18,115 feet, or 3.431 miles.

Width of stone-bed, 16 feet.

Length of stone-bed, 18,115 feet.

Depth of stone-bed, 5½ inches.

COMMISSIONER OF PUBLIC ROADS.

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Filbertine on macadam base, 32,439 square yards, at \$1.26; total,	\$40,873 14
Earth excavation, 10,083 cubic yards, at 34 cents; total.....	3,428 22
Tile drain, 2,427 lineal feet, at 22 cents; total.....	533 94
Total	\$44,835 30
Supervisor's salary.....	348 00
Engineering expenses.....	450 00
Total cost of road.....	\$45,633 30
Lump sum, contract price.....	\$44,105 10
Total allowed by the State.....	\$44,835 30
One-third of above, amount paid by the State.....	\$14,945 10
Maximum grade before.....	5.25 per cent.
Maximum grade after.....	4.00 per cent.

WM. C. CATTELL,
Engineer.
 JOHN D. WALLACE,
Supervisor.

MERCER COUNTY.

Portion of Brunswick Pike, Second Part, 1.104 Miles Long.

This is the Trenton end of the improvement of the eighteen mile tangent extending from the city through the Sand Hills. The completion of this section gives the traveler eleven and one-half miles of straight, wide improved highway. It is in fact a very important part of the State road between Trenton and New Brunswick.

The pavement consists of macadam treated with heavy asphaltum oil by the penetration method, the better to enable it to withstand the action of the heavy motor vehicle traffic over it.

Detailed statement of the cost of the improvements to the public highway in Mercer county, New Jersey, known as portion of Brunswick Pike road, second part, beginning at Strawberry street and extending to Shabakunk creek bridge, in the township of Lawrence. Total length of road, 5,828 feet, or 1.104 miles.

Length of stone-bed, 5,828 feet.

Width of stone-bed, 16 feet.

Depth of stone-bed, class B, or not less than 6 inches deep.

Average width of shoulders, 10 feet.

Average total width of improved roadway. 36 feet.

Excavations, 2,200 cubic yards, at 30 cents; total.....	\$660 00
Macadam, 10,655 square yards, at 83 cents; total.....	8,843 65
1,500 cubic yards shortage in excavation to be supplied by the contractor, at 30 cents; total.....	450 00
Total cost.....	\$9,953 65
Supervisors' salary,	
Jas. Stephens.....	168 00
J. C. Brickell.....	129 00
Total of all costs.....	\$10,250 65
Lump sum, contract price.....	\$9,953 65
Portion approved by the State.....	\$9,953 65
Total allowed by the State.....	\$9,953 65
One-third of above, paid by the State.....	\$3,317 88
Maximum grade before.....	3.5 per cent.
Maximum grade after.....	2.13 per cent.

FRANK J. EPPELE,
Engineer.
 JAMES C. BRICKELL,
Supervisor.

Yardville and Allentown Road, 3.408 Miles Long.

This is an old turnpike which was built to connect Allentown with the White Horse Pike, the main thoroughfare between Trenton and Bordentown. The line, like that of most of these old turnpikes, is very straight, and, since the asphaltum treated macadam pavement has been laid, has proven of great value and convenience to the farmers and others along its line. There was very little change in grade, only such alterations being made as were necessary to dispose of the surface water.

This route also brings Allentown more than a mile nearer the business centre of Trenton.

Detailed statement of the cost of the improvement to the public highway in Mercer county, New Jersey, known as the Yardville and Allentown road, beginning at Yardville and extending to Monmouth county line, in the township of Hamilton. Total length of road, 17,992.5 feet, or 3.408 miles.

Length of stone-bed, 17,992.5 feet.

Width of stone-bed, 14 feet.

Depth of stone-bed, class B, or not less than 6 inches deep.

Average width of shoulders, 7 feet.

Average total width of improved roadway, 28 feet.



Mercer County, Yardville-Allentown Road, Before.



Mercer County, Yardville-Allentown Road, After. Water-bound Macadam ; Surface, Oil.

COMMISSIONER OF PUBLIC ROADS.

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Excavations, 8,150 cubic yards, at 50 cents; total.....	\$4,075 00
Macadam, 28,736 square yards, at 94 cents; total.....	27,011 84
Macadam driveways, 564 square yards, at 50 cents; total.....	282 00
Underdrains, extra, approved by State, 1,500 lineal feet, at 20 cents; total.....	300 00
Extra, reconstructing class B macadam, $42\frac{2}{3}$ square yards, at 94 cents; total.....	40 11
Extra, reconstructing driveway, macadam, $16\frac{1}{2}$ square yards, at 50 cents; total.....	8 06
Extra, reconstructing driveway, macadam, $33\frac{3}{8}$ square yards, at 50 cents; total.....	16 83

Total cost.....	\$31,733 84
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The original lump sum contract price was \$33,093.00, and the original price bid for class B macadam was \$1.00 per square yard, but under a supplemental agreement accepted by the Board of Freeholders and approved by the State Road Department, the method of construction was changed and under this agreement class B macadam was to cost 94 cents per square yard, making the lump sum contract price.....		\$31,368 84
Total of all extras.....		365 00
Supervisor's salary.....		663 00

Total of all costs.....	\$32,396 84
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Portion approved by the State.....	\$31,368 84
Extras approved by the State.....	\$365 00
Total allowed by the State.....	\$31,733 84
One-third of above, paid by the State.....	\$10,577 95

Maximum grade before.....	3.00 per cent.
Maximum grade after.....	2.35 per cent.

FRANK J. EPPELE,
Engineer.
 W. B. WIDMANN,
Supervisor.

Rocky Hill Road, .796 Miles Long.

This short piece of pavement is of much more value than would at first appear, because it is the last link in the chain of improved roads between Morristown and Trenton. Owing to its importance as a part of a great north and south line, its intersection with the Kingston road was made as wide and as gradual as possible.

The line of the road follows the valley of the Millstone river; hence, owing to the heavy nature of the soil, it was necessary to run underdrains along the greater part of the length of the road.

The pavement proper on this road was treated with heavy asphaltum oil, applied hot. At first the results were very satisfactory, but later the surface developed a wavy character, due to a portion of the asphalt being drawn to the surface by the rays of the sun. The road was treated with a coating of clean, sharp sand. The result of this treatment was very satisfactory.

Detailed statement of the cost of the improvement to the public highway in Mercer county, New Jersey, known as the Rocky Hill road, beginning at Kingston and extending to Somerset county line, in the township of Princeton. Total length of road, 4,200 feet, or 0.796 miles.

Length of stone-bed, 4,200 feet.

Width of stone-bed, 14 feet.

Depth of stone-bed, class B, or not less than 6 inches deep.

Average width of shoulders, 7 feet.

Average total width of improved roadway, 28 feet.

Excavations, 2,770 cubic yards, at 60 cents; total.....	\$1,662 00
Macadam, 7,080 square yards, at 77 cents; total.....	5,451 60
Underdrains, 2,338 lineal feet, at 20 cents; total.....	467 60
1,000 cubic yards shortage in excavation, at 60 cents; total....	600 00
Authorized extra 100 lineal feet underdrains, at 20 cents; total..	20 00
Authorized extra for additional binder, 1,562 gallons, at 12 ² / ₅ cents; total.....	193 69
Total cost.....	\$8,394 89
Lump sum, contract price.....	\$8,181 20
Total of all extras.....	213 69
Supervisor's salary.....	349 50
Total of all costs.....	\$8,744 39
Portion approved by the State.....	\$8,181 20
Extras approved by the State.....	\$213 69
Total allowed by the State.....	\$8,394 89
One-third of above, paid by the State.....	\$2,798 30
Maximum grade before.....	7.2 per cent.
Maximum grade after.....	4.0 per cent.

FRANK J. EPPELE,

Engineer.

REUBEN FORT,

Supervisor.

MONMOUTH COUNTY.

Allentown and New Egypt Road, Second Section, 1.946 Miles Long.

Beginning at the macadam road in Davis Station, this gravel road was built parallel with the railroad to Cream Ridge; here it branched to the left to the railroad and to the right of Holmes' Corner on the main road to New Egypt, thence down this road 250 feet to the end.

As now built this road is simply of value to the farmers along its line, but when the improvement is carried to New Egypt it will form a link in the line of improved highways between Trenton, Lakewood and the southern seashore resorts.

Detailed statement of the cost of the Allentown and New Egypt road, second section, also called Cream Ridge and New Egypt road, township of Upper Freehold, county of Monmouth. Total length, 10,276.4 feet, or 1.946 miles.

Width of gravel-bed, 18 feet.

Length of gravel-bed, 10,234.6 feet.

Depth of gravel-bed, 8 inches.

Gravel, class A, 2,284 cubic yards, at \$3.10; total.....	\$7,080 40
Gravel, class B, 2,284 cubic yards, at \$1.10; total.....	2,512 40
Earth excavation, 12,601 cubic yards, at 30 cents; total.....	3,780 30
Drain, 3,500 lineal feet, at 25 cents; total.....	875 00

Total	\$14,248 10
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Less excess of calculation by quantities over lump sum.....	298 10
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Total	\$13,950 00
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Supervisor's salary.....	375 00
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Engineering expenses.....	418 50
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Extras allowed by State:

Intersection Walesford road, gravel.....	\$13 44
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Intersection Hornerstown road, gravel.....	29 40
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Hendrickson entrance, grade and gravel.....	20 10
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Schaffers entrance, gravel.....	13 44
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	76 38
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Total cost of road.....	\$14,819 88
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Lump sum, contract price.....	\$13,950 00
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Total allowed by the State, \$14,026.38, less \$62.70 for excavation not done.....	\$13,963 68
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One-third of above, amount paid by the State.....	\$4,654 56
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Maximum grade before.....	9.25 per cent.
Maximum grade after.....	4.2 per cent.

GEO. K. ALLEN, JR.,
Engineer.

GEO. B. HOLMES,
Supervisor.

Red Bank and Holmdel Road, Second Section, 1.55 Miles Long.

This is an extension of the gravel road which was built last year from Red Bank, and it is hoped that the coming year will mark its completion to Holmdel, where it will connect with the improved roads to Freehold on the south and Matawan on the north.

Detailed statement of the cost of the Red Bank and Holmdel read, second section, townships of Middletown and Holmdel, county of Monmouth. Total length, 8,187 feet, or 1.550 miles.

Width of gravel-bed, 18 feet.
Length of gravel-bed, 8,187 feet.
Depth of gravel-bed, 8 inches.

Gravel, class A, 1,819.3 cubic yards, at \$5.00; total.....	\$9,096 50
Gravel, class B, 1,819.3 cubic yards, at \$2.50; total.....	4,548 25
Earth excavation, 6,588 cubic yards, at 35 cents; total.....	2,305 80
Drain, 3,300 lineal feet, at 18 cents; total.....	594 00
Total	\$16,544 55
Less difference between items and lump sum.....	3,108 55
Total	\$13,441 00
Supervisor's salary.....	315 00
Engineering expenses.....	403 23
Total cost of road.....	\$14,159 23
Lump sum, contract price.....	\$13,441 00
Total allowed by the State.....	\$13,441 00
One-third of above, amount paid by the State.....	\$4,480 33
Maximum grade before.....	4.4 per cent.
Maximum grade after.....	3.0 per cent.

GEO. K. ALLEN, JR.,
Engineer.
MATTHEW MULLIN,
Supervisor.

COMMISSIONER OF PUBLIC ROADS.

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Lakewood and Adelphia Road, Third and Fourth Sections, 3.496 Miles Long.

This new gravel road begins at the end of the portion built in 1910 and extends northerly to the old turnpike in Adelphia.

The completion of this improvement brings Lakewood at least five miles nearer Freehold and all points north and west. It also cuts out four railroad grade crossings and numerous sharp turns.

This line was formerly the old stage road, but, owing to the deep sand, it had been abandoned by everyone except the few that were compelled to use it. Now all this is changed. The neglected and avoided road is the one most used; in fact, the traffic is so great on Saturdays and Sundays that Adelphia has to station an officer at the end of the road to regulate traffic.

The road is also the last section of the inter county route between the county seats of Monmouth and Ocean. Possibly no section of road improved in Monmouth county, in recent years, is of such great general benefit as this.

Detailed statement of the cost of the Lakewood and Adelphia road, third section, township of Howell, county of Monmouth. Total length, 13,284 feet, or 2.516 miles.

Width of gravel-bed, 14 feet.

Length of gravel-bed, 13,284 feet.

Depth of gravel-bed, 8 inches.

Gravel, 4,600 cubic yards, at 75 cents; total.....	\$3,450 00
Earth excavation, 21,675 cubic yards, at 20 cents; total.....	4,335 00
Drain, 800 lineal feet, at 12 cents; total.....	96 00
Grubbing, 4½ acres, at \$40.00; total.....	180 00
Total	\$8,061 00
Less difference between items and lump sum.....	1,160 00
Total	\$6,901 00
Supervisor's salary.....	469 50
Engineering expenses.....	207 03
Total cost of road.....	\$7,577 53
Lump sum, contract price.....	\$6,901 00
Total allowed by the State.....	\$6,901 00
One-third of above, amount paid by the State.....	\$2,300 33

EIGHTEENTH ANNUAL REPORT.

Maximum grade before..... 6.7 per cent.
 Maximum grade after..... 3.77 per cent.

G. K. ALLEN, JR.,

Engineer.

ARTHUR G. PATTON,

Supervisor.

Detailed statement of the cost of the Lakewood and Adelphia road, fourth section, township of Howell, county of Monmouth. Total length, 5,175 feet, or .980 miles.

Width of gravel-bed, 14 feet.

Length of gravel-bed, 5,175 feet.

Depth of gravel-bed, 8 inches.

Gravel, 1,789 cubic yards, at \$1.00; total.....	\$1,789 00
Earth excavation, 4,916 cubic yards, at 30 cents; total.....	1,474 80
Drain, 300 lineal feet, at 25 cents; total.....	75 00

Total	\$3,338 80
Less difference between items and lum sum.....	100 00

Total	\$3,238 80
Deduct for 300 feet tile, at 25 cents, not laid.....	75 00

Total	\$3,163 80
Supervisor's salary.....	219 00
Engineering expenses.....	97 16

Total cost of road.....	\$4,479 96
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Lump sum, contract price.....	\$3,238 80
Total allowed by the State.....	\$3,163 80
One-third of above, amount paid by the State.....	\$1,054 60

Maximum grade before..... 2.7 per cent.
 Maximum grade after..... 1.15 per cent.

GEO. K. ALLEN, JR.,

Engineer.

LEVI W. FARRY,

Supervisor.

Cedar Avenue and Monmouth Road Boulevard, 2.615 Miles Long.

This improvement begins at Norwood avenue in West End and extends westerly through West Long Branch and Eatontown township to the Long Branch and Eatontown boulevard.



Monmouth County, Cedar Avenue and Monmouth Boulevard, Before.



Monmouth County, Cedar Avenue and Monmouth Boulevard, Gravel, After.

While of value to the local people the greater importance of the road lies in the fact that it cuts off the detour through Long Branch for those who are traveling from the northern part of the State to the coast resorts from Deal southward.

The gravel of which the road was built was spread to a width of from sixteen to eighteen feet, and the entire roadway was graded to a width of thirty feet.

The value of this improvement is well attested by the almost constant, continuous traffic passing over it.

Detailed statement of the cost of the Cedar avenue and Monmouth road boulevard, townships of Eatontown and Ocean, county of Monmouth. Total length, 13,809 feet, or 2.615 miles.

Width of gravel-bed, 16 and 18 feet.

Width of gravel shoulders, 6 feet.

Length of gravel-bed, 13,809 feet.

Depth of gravel-bed, 8 inches.

Depth of gravel shoulders, 4 inches.

Gravel (A), 6,081 cubic yards, at \$2.25; total.....	\$13,682 25
Gravel shoulders (B), 1,729 cubic yards, at \$2.25; total.....	3,890 25
Earth excavation (A), 10,944 cubic yards, at 25 cents; total.....	2,736 00
Earth excavation (B), 1,164 cubic yards, at 25 cents; total.....	291 00
Drain, 4,000 lineal feet, at 12 cents; total.....	480 00
12-inch pipe relaid, 425 lineal feet, at 8 cents; total.....	34 00
Total	\$21,113 50
Less difference between items and lump sum.....	113 50
Total	\$21,000 00
Supervisor's salary.....	606 00
Engineering expenses.....	630 00
Extras, 371 cubic yards excavation, at 25 cents; total.....	92 75
Total cost of road.....	\$22,328 75
Lump sum, contract price.....	\$21,000 00
Paid by borough of West Long Branch.....	\$4,067 75
Total allowed by the State, \$16,932.25 and \$92.75.....	\$17,025 00
One-third of above, amount paid by the State.....	\$5,675 00
Maximum grade before.....	3.25 per cent.
Maximum grade after.....	2.75 per cent.

GEO. K. ALLEN, JR.,

Engineer.

N. V. WHITE,

Supervisor.

OCEAN COUNTY.

Seaside Park and Bayhead Road, Southerly Section, 5.379 Miles Long.

This work consisted in building a road where none existed before, on the strip of sand lying between the ocean and Barnegat bay. The fast growing borough of Seaside Park was practically cut off from vehicular traffic. This was a condition not to be tolerated, hence the demand had to be met, though at heavy expense.

The completion of this gravel road from Bayhead to Seaside Park early in the year caused a most marked increase of travel up and down the beach. In fact this is one of the most marked changes to be noted anywhere in the State.

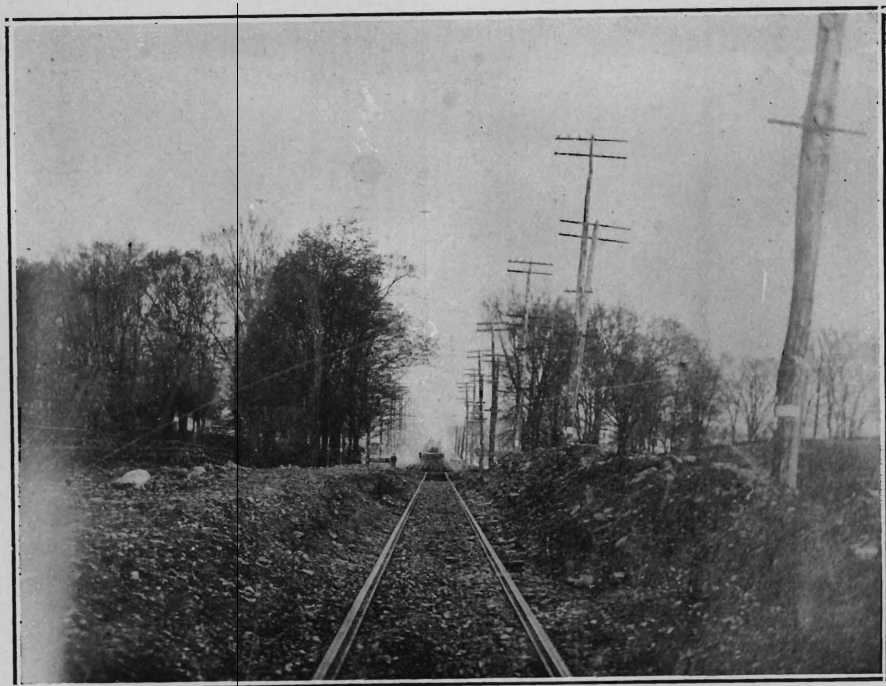
Owing to the fact that the sand over which this road was built is of such a nature that it is practically impassable for motor driven vehicles, it was necessary to lay the gravel for a width of twenty-four feet.

Detailed statement of the cost of the Seaside Park and Bayhead road, southerly section, townships of Berkeley and Dover, county of Ocean. Total length, 28,400 feet, or 5.379 miles.

Width of gravel-bed, 24 feet.

Length of gravel-bed, 28,400 feet.

Depth of gravel-bed, 9 inches in center, 3 inches at sides.



Main Street, Passaic County, Before Improvement.



Main Street, Passaic County, After Improvement.

COMMISSIONER OF PUBLIC ROADS.

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Gravel, 12,622 cubic yards, at \$2.16; total.....	\$27,263 52
Earth excavation, 28,587 cubic yards, at 35 cents; total.....	10,005 45
Extra embankment, on account of change in grade, 11,773 cubic yards, at 35 cents; total.....	4,120 55
Drain, 470 lineal feet, at 25 cents; total.....	117 50
Grubbing, 6.91 acres, at \$30.00; total.....	207 30
Total	\$41,714 32
Less difference between items and lump sum.....	4 40
Total	\$41,709 92
Supervisor's salary.....	633 00
Total cost of road.....	\$42,342 92
 Lump sum, contract price.....	 \$37,601 87
Less 50 feet drain, at 25 cents (not laid).....	12 50
	\$37,589 37
Total allowed by the State.....	\$41,709 92
One-third of above, amount paid by the State.....	\$13,903 31
 Maximum grade before.....	 1.88 per cent.
Maximum grade after.....	.83 per cent.

WM. SEGOINE,
Engineer.
 I. B. OSBORN,
Supervisor.

PASSAIC COUNTY.

Main Street, 2.563 Miles Long.

This pavement begins in Paterson and extends through Acquackanonck township to the city of Passaic. It is built on each side of the road from the curb to the trolley tracks in the centre. The material used was a hot mixed asphalt concrete. Owing to the fact that this country district is fast building up with factories, plain macadam was not deemed suitable, hence the county authorities selected the best pavement, in their judgment, that they felt able to pay for.

There was comparatively little grading done, hence it was necessary to build a storm drain with frequent inlets to take care of the surface water. This drain extends under the road for more than one-half of its length.

EIGHTEENTH ANNUAL REPORT.

Detailed statement of the cost of Main street, township of Acquackanonck, cities of Passaic and Paterson, county of Passaic. Total length, 13,533.5 feet, or 2.563 miles.

Width of stone-bed, 17 to 25 feet.

Length of stone-bed, 13,533.5 feet.

Depth of stone-bed, 7 inches.

Macadam, with G. F. B. compound asphaltum binder, 30,398.4 square yards, at \$1.19; total.....	\$36,174 10
Excavation, 18,789 cubic yards, at 39 cents; total.....	7,327 71
Concrete, 58 cubic yards, at \$8.00; total.....	464 00
Broken stone, 50 cubic yards, at \$2.47½; total.....	123 75
Total	\$44,089 56
Rebate from Public Service Corporation.....	4,220 73
Total	\$39,868 83
Supervisor's salary.....	691 50
Extras, paid by county.....	5,911 08
Total cost of road.....	\$46,471 41
Lump sum, contract price.....	\$43,582 05
Total allowed by the State.....	\$39,868 83
One-third of above, amount paid by the State.....	\$13,289 61
Maximum grade before.....	4.00 per cent.
Maximum grade after.....	4.00 per cent.

GARWOOD FERGUSON,
Engineer.
WILLIAM MILLAR,
Supervisor.

COMMISSIONER OF PUBLIC ROADS.

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Detailed statement of the cost of the Main street Storm Water Drain, in the township of Acquackanonk, county of Passaic.

10-inch drain 98 lineal feet, at 35 cents; total.....	\$34 30
12-inch drain, 116 lineal feet, at 40 cents; total.....	46 40
18-inch drain, 290 lineal feet, at 55 cents; total.....	159 50
20-inch drain, 708 lineal feet, at 70 cents; total.....	495 60
24-inch drain, 782 lineal feet, at 90 cents; total.....	703 80
30-inch drain, 1,000 lineal feet, at \$1.80; total.....	1,800 00
33-inch drain, 1,868 lineal feet, at \$2.45; total.....	4,576 60
40-inch drain, 2,332 lineal feet, at \$2.85; total.....	6,646 20
42-inch drain, 977 lineal feet, at \$2.90; total.....	2,833 30
Catch basins rebuilt, 4, at \$40.00; total.....	160 00
Catch basins rebuilt, 13, at \$3.00; total.....	39 00
Catch basins, small, 18, at \$50.00; total.....	900 00
Catch basins, large, 20, at \$100.00; total.....	2,000 00
Manholes, 20, at \$30.00; total.....	600 00
16 cubic yards broken stone, at \$2.00; total.....	32 00
16 cubic yards spreading underpipe, at \$1.00; total.....	16 00
375 feet B. M. Hemlock, at \$30.00; total.....	11 25
4.6 cubic yards concrete, at \$7.00; total.....	32 20
9,603 lineal feet rock excavation, at 50 cents; total.....	4,801 50
Cutting down 5 trees, at \$9.00; total.....	45 00
894 lineal feet earth excavation, 0-4½, at 50 cents; total.....	447 00
998 lineal feet earth excavation, 4½-6½, at 60 cents; total.....	598 80
3,728 lineal feet earth excavation, 6½-8, at 70 cents; total.....	2,609 60
1,371 lineal feet earth excavation, 8-10, at \$1.00; total.....	1,371 00
1,022 lineal feet earth excavation, 10-16, at \$1.25; total.....	1,277 50
98.5 cubic yards extra earth excavation, at 50 cents; total.....	49 25
872.6 cubic yards extra earth excavation, at 33 cents; total.....	287 96
Total	\$32,573 76
Supervisor's salary.....	429 00
Total cost of the road.....	\$33,002 76
Contract price by items, about.....	\$33,000 00
Total allowed by the State.....	\$32,573 76
One-third of above, amount paid by the State.....	\$10,857 92

GARWOOD FERGUSON,

Engineer.

WILLIAM H. FLOYD,

Supervisor.

Main Street Extension, 0.223 Miles Long.

This extension connects the pavement laid under the original contract with the permanent pavement in the city of Paterson. This was not included in the original contract because several short stretches of experimental pavement were laid on this piece to determine their comparative value.

The experiments having served their purpose, it was decided to connect the two pavements by means of this small piece of work.

The pavement is of hot mixed asphalt concrete and was laid from the curb on each side to the trolley tracks in the center.

Detailed statement of the cost of the Main street extension, city of Paterson; county of Passaic. Total length, 1,146 feet, or .223 miles.

Width of stone-bed, 25.3 feet (excepting a strip 356 x 8.5 feet).

Length of stone-bed, 1,146 feet.

Depth of stone-bed, 7 inches.

G. F. B. compound, 3,150 square yards, at \$1.19; total.....	\$3,748 50
Earth excavation, 597.5 cubic yards, at 60 cents; total.....	358 50
Total	\$4,107 00
33 yards of pavement included in contract was built by the city of Paterson, making a saving of \$39.27.	
Supervisor's salary.....	117 00
Extras, paid by county.....	79 49
Total cost of road.....	\$4,303 49
Lump sum, contract price.....	\$4,146 27
Total allowed by the State.....	\$4,107 00
One-third of above, amount paid by the State.....	\$1,369 00
Maximum grade before.....	3.00 per cent.
Maximum grade after.....	3.00 per cent.

GARWOOD FERGUSON,

Engineer.

WILLIAM MILLAR,

Supervisor.

COMMISSIONER OF PUBLIC ROADS.

43

SALEM COUNTY.

Elmer Borough Road, 1.779 Miles Long.

This is an extension of the Barnsboro turnpike through the borough of Elmer to the Aldine road, and completes the line of improved highways from the northeastern corner of the county to the county seat.

The gravel was spread over the entire width of the road through the center of the town, and in the outskirts to a width of eighteen feet.

Detailed statement of the cost of the Elmer borough road, borough of Elmer, county of Salem. Total length, 9,392 feet, or 1.779 miles.

Width of gravel-bed, 18 to 42 feet.

Length of gravel-bed, 9,392 feet.

Depth of gravel-bed, 9 inches in center, 6 inches at sides.

Gravel, 6,911 cubic yards, at 89 cents; total.....	\$6,150 79
Earth excavation, 3,694 cubic yards, at 34 cents; total.....	1,255 96
Total	\$7,406 75
Supervisor's salary.....	327 00
Engineering expenses.....	315 00
Total cost of road.....	\$8,048 75
Lump sum, contract price, \$7,418.32, less 13 cubic yards gravel, at 89 cents (not laid).....	\$7,406 75
Total allowed by the State.....	\$7,406 75
One-third of above, amount paid by the State.....	\$2,468 92
Maximum grade before.....	2.62 per cent.
Maximum grade after.....	1.16 per cent.

H. B. KEASBEY,

Engineer.

WILLIAM OVERS,

Supervisor.

SOMERSET COUNTY.

Watchung Road, 3.172 Miles Long.

The value of this improvement lies in the fact that it connects the system of improved roads lying east of the Watchung mountain with that constructed some years ago on the west. The old road was a typical mountain road, steep and stony and so rough that it was avoided when possible. Now all this is changed. The increase of travel is most marked and hundreds drive over it daily for both business and pleasure.

The view obtained from the top of the Second mountain is well worth going miles to see. The road also possesses great utilitarian advantages, inasmuch that more than double the load can be hauled over the route since its improvement.

The graded width of this road from gutter to gutter is thirty-three feet. This, with the fourteen foot pavement in the center, completes the metamorphosis of an old mountain road into a modern improved highway. The macadam surface was finished with a coat of light asphaltum oil, with the aim in view of making the road not only smooth but dustless.

Detailed statement of the cost of the Watchung road, townships of North Plainfield and Warren, county of Somerset. Total length, 16,725 feet, or 3.172 miles.

Width of stone-bed, 14 feet.

Length of stone-bed, 16,725 feet.

Depth of stone-bed, 10 inches.



Watchung Road, Somerset County, Before.



Watchung Road, Somerset County, After.

Telford, 26,475 square yards, at 75 cents; total.....	\$19,856 25
Four-inch macadam, 680 square yards, at 50 cents; total.....	340 00
Earth excavation, 28,373 cubic yards, at 60 cents; total.....	17,023 80
Drains, 5,841 lineal feet, at 20 cents; total.....	1,168 20
Cobblestone gutter, 222 square yards, at 70 cents; total.....	155 40
Item to balance contract as awarded.....	200 00

Total	\$38,743 65
Supervisor's salary.....	661 50
Engineering expenses.....	852 98

Total cost of road.....	\$40,258 13
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Lump sum, contract price.....	\$39,187 75
Total allowed by the State.....	\$38,743 65
One-third of above, amount paid by the State.....	\$12,914 55

Maximum grade before.....	17 per cent.
Maximum grade after.....	7½ per cent.

JOSHUA DOUGHTY, JR.,
Engineer.

G. A. SCHMIDT,
Supervisor.

Greater Cross Roads Road, 1.983 Miles Long.

This is an extension of the Far Hills road through Bedminster to Greater Cross Roads. The present improvement begins at the Pluckamin road in the center of the village of Bedminster and extends westerly nearly two miles to the Greater Cross Roads. It is the intention in the near future to extend this improvement to the Hunterdon county line and thence to White House.

The present pavement is of macadam, fourteen feet wide, which, after thorough consolidation four months later, was treated with a coat of light asphaltum oil.

Detailed statement of the cost of the Greater Cross Roads road, township of Bedminster, county of Somerset. Total length, 10,479 feet, or 1.983 miles.

Width of stone-bed, 14 feet.
Length of stone-bed, 10,470 feet.
Depth of stone-bed, 8 inches.

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Macadam, 16,424 square yards, at 87 cents; total.....	\$14,288 88
Four-inch macadam, 207 square yards, at 70 cents; total.....	144 90
Opening ditches along and outside of road.....	14 52
Earth excavation, 11,046 cubic yards, at 45 cents; total.....	4,970 70
Earth excavations, outside, 180 cubic yards, at 45 cents; total...	81 00
Drain, 150 lineal feet, at 14 cents; total.....	21 00

Total	\$19,521 00
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Items in contract not included in construction:

Asphalt on 16,337 square yards, 8 inches, at 6 cents; total....	\$980 22
Drains, 850 lineal feet, at 14 cents; total.....	119 00
Cobble stone gutter, 462 square yards, at 70 cents; total.....	323 40

Total deductions from original contract.....	\$1,422 62
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Items additional to contract:

87 square yards, 8 inches, at 87 cents; total.....	\$75 69
90 cubic yards outside excavation, at 45 cents; total.....	40 50
Opening ditches outside road.....	14 52

Total additional to contract.....	\$130 71
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Net deduction from contract.....	\$1,291 91
Supervisor's salary.....	330 00
Engineering expenses.....	540 00
Extras, paid by county.....	112 00

Total cost of road.....	\$20,503 00
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Lump sum, contract price.....	\$20,812 91
Total allowed by the State.....	\$19,521 00
One-third of above, amount paid by the State.....	\$6,507 00

Maximum grade before	7.00 per cent.
Maximum grade after.....	5.00 per cent.

JOSHUA DOUGHTY, JR.

Engineer.

CHAS. H. WIKOFF,

Supervisor.

UNION COUNTY.

Springfield Avenue, 1.584 Miles Long.

This new asphalt concrete pavement begins at the Cranford line and extends to the Turkey road. It forms part of a new line between Cranford and Summit. It was completed last year, but too late to be reported.

The pavement is sixteen feet wide while the road is graded to a width of from thirty-three to thirty-six feet.

Detailed statement of the cost of Springfield avenue, town of Westfield, township of Springfield and borough of Mountainside, county of Union. Total length, 8,362 feet, or 1.584 miles.

Width of stone-bed, 16 feet.
Length of stone-bed, 8,362 feet.
Depth of stone-bed, 7 inches.

Amiesite, 15,715.1 square yards, at \$1.29; total.....	\$20,272 48
Macadam at driveways, 680.3 square yards, at 55 cents; total....	374 17
Earth excavation, 16,460.2 cubic yards, at 35 cents; total.....	5,761 07
Cobble stone gutter, 252.8 square yards, at 60 cents; total.....	151 68
Total	\$26,559 40
Supervisor's salary.....	321 00
Extras, paid by county, relaying pipe and moving stone pile.....	85 12
Total cost of road.....	\$26,965 52
Lump sum, contract price, original, \$31,836.45, less Turkey road end, \$5,591.83.....	\$26,244 62
Total allowed by the State.....	\$26,559 40
One-third of above, amount paid by the State.....	\$8,853 13
Maximum grade before.....	8½ per cent.
Maximum grade after.....	5.24 per cent.

J. L. BAUER,
Engineer.
ALLEN C. FITCH,
Supervisor.

WARREN COUNTY.

Buttzville Road, 3.678 Miles Long.

This improvement begins at the Belvidere line and extends easterly along the Pequest river to Buttzville. The work was stopped at this point to give the Lackawanna railroad an opportunity to build an underneath crossing. This is now nearing completion. It is the intention of the county to extend this improvement to Danville, six miles beyond, where it will join the improved road to Hackettstown. When this line is completed it will form the most direct route from Newark and Morristown to the Delaware Water Gap.

The pavement is of water bound macadam, treated with a light asphalt oil, the method of applying which was as follows:

The road was finished as an ordinary macadam road, thoroughly wet and rolled, after which the road was thrown open to travel for four months. The surface was then swept with a rotary horse sweeper until the surface of the stone was exposed, when the oil was applied by means of an ordinary oil distributing wagon.

Detailed statement of the cost of the Buttzville road, township of Oxford, county of Warren. Total length, 19,418 feet, or 3.678 miles.

Width of stone-bed, 14 feet.

Length of stone-bed, 19,418 feet.

Depth of stone-bed, 6 inches.

Macadam, 30,138 square yards, at 65 cents; total.....	\$19,589 70
Earth excavation, 17,405 cubic yards, at 42 cents; total.....	7,310 10
Extra excavation, borrow, 1,810 cubic yards, at 50 cents; total..	905 00
Extra excavation (driveways), 1,825 cubic yards, at 50 cents;	
total	912 50

Total	\$28,717 30
Supervisor's salary.....	273 00
Engineering expenses.....	695 00
Extras, paid by county.....	1,686 69

Total cost of road.....	\$31,371 99
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Lump sum, contract price.....	\$29,067 80
Total allowed by the State.....	\$28,717 30
One-third of above, amount paid by the State.....	\$9,572 43

Maximum grade before.....	9.00 per cent.
Maximum grade after.....	4.84 per cent.

F. W. SALMON,

Engineer.

SAMUEL S. STEWART,

Supervisor.

Cost of Repairs.

In compliance with the act of April 12, 1906, amended April 21, 1909, also the act of April 9, 1910, moneys from the motor vehicle fund have been sent during the ten months, from January 1 to October 31, 1911, to the various local authorities for repairs on the following roads:

Name of road.	County.	Amount.
Branchville to Tuttle's Corner.....	Sussex	\$1,500 00
Broadway, Saddle River township.....	Bergen	3,500 00
Bloomfield avenue.....	Essex	13,614 14
Burlington	Burlington	16 80
Cresskill borough.....	Bergen	150 00
Chestnut Neck.....	Burlington	4,650 74
Cedarville to Newport.....	Cumberland	150 00
Columbus	Burlington	135 49
Davidson's Bridge.....	Somerset	48 10
Elmer, Alloway, Pittsgrove.....	Salem	800 00
Edgewater borough.....	Bergen	1,500 00
Edgewater Park.....	Burlington	76 80
Flemington to Lambertville.....	Hunterdon	1,500 00
Flemington to White House.....	Hunterdon	1,500 00
Freehold and Farmingdale.....	Monmouth	2,000 00
Farnsworth avenue.....	Burlington	9,399 99
Grove street.....	Essex	3,836 50
Hightstown, Manalapan and Freehold...	Monmouth	4,000 00
Harlingen	Somerset	533 00
Highland Park, Metuchen.....	Middlesex	3,569 27
Hammonton	Atlantic	1,700 00
Little Falls turnpike.....	Passaic	797 20
Long Hill.....	Passaic	4,814 58
Lower Penn's Neck.....	Salem	1,700 00
Lakewood to Point Pleasant.....	Ocean	1,238 38
Lumberton	Burlington	84 16
Midvale and Greenwood Lake.....	Passaic	1,300 00
Mullica Hill-Woodstown.....	Salem	1,500 00
Mine Brook.....	Somerset	1,222 00
Main street, Flemington.....	Hunterdon	187 00
Mercerville and Edinburgh.....	Mercer	1,704 52
Metuchen, Iselin, Colonia.....	Middlesex	4,259 76
Main Shore.....	Ocean	3,900 00

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Name of road.	County.	Amount.
Mays Landing and Tuckahoe.....	Atlantic	\$980 22
Mount Holly, Burlington.....	Burlington	614 56
Moorestown	Burlington	726 98
Mannington	Salem	1,000 00
Mount Holly.....	Burlington	466 76
Newark and Pompton turnpike.....	Passaic	5,223 85
Naachtpunk	Passaic	1,713 00
Neshanic	Somerset	358 80
North Branch.....	Somerset	1,082 25
Newark turnpike.....	Hudson	5,352 36
New Brunswick, Old Bridge, Spotts- wood	Middlesex	1,625 86
Norwood avenue.....	Monmouth	6,000 00
Newport to Dividing Creek.....	Cape May	350 00
Ocean avenue.....	Monmouth	3,000 00
Pemberton	Burlington	152 11
Paterson and Hamburg turnpike.....	Passaic	200 00
Pluckamin	Somerset	981 50
Peapack	Somerset	560 95
Perth Amboy and Metuchen.....	Middlesex	3,076 44
Perth Amboy, Woodbridge.....	Middlesex	5,550 27
Riverton	Burlington	373 34
River road.....	Passaic	3,951 37
Rocky Hill.....	Somerset	279 50
Rivervale township.....	Bergen	750 00
River road.....	Middlesex	1,918 40
Red Bank and Eatontown.....	Monmouth	3,000 00
Riverside	Burlington	85 60
South Somerville.....	Somerset	1,033 50
Sea Shore.....	Cape May	4,000 00
Springfield avenue.....	Essex	7,549 36
Smithville	Burlington	67 58
Union avenue.....	Somerset	400 40
Upper Saddle River borough.....	Bergen	150 00
Upper Macopin.....	Passaic	1,000 00
Van Houten avenue.....	Passaic	1,000 00
White Horse pike, first section.....	Camden	13,843 65
White Horse pike, second section.....	Camden	21,156 35
Windsor and Edinburgh.....	Mercer	1,500 00

 \$177,963 39

Repairs from County Funds During the Year 1911.

In some counties it is difficult to secure accurate returns, consequently the figures in this table are approximate only:

County.	Amount.
Atlantic	\$46,014 03
Bergen	108,032 56
Burlington	23,000 00
Camden	88,141 38
Cape May	13,136 87
Cumberland .....	.....
Essex	126,000 00
Gloucester	11,693 64
Hudson	273,590 00
Hunterdon	12,000 00
Mercer	106,475 87
Middlesex	66,660 00
Monmouth	101,500 00
Morris	101,350 00
Ocean	11,000 00
Passaic	73,000 00
Salem	10,617 54
Somerset	11,413 11
Sussex .....	.....
Union	58,875 00
Warren	12,500 00
	\$1,255,000 00

MOTOR VEHICLE FUND—RECEIPTS AND DISBURSEMENTS.

Receipts.

Balance on hand November 1, 1910.....	\$74,355 30
Receipts, November 1, 1910, to October 31, 1911....	335,939 21
	\$410,294 51

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Disbursements.

Maintenance of roads, November 1 to December 31, 1910, as shown in 1910 report.....	\$58,871 38	
Ocean Highway, November 1 to December 31, 1910, as shown in 1910 report.....	4,312 90	
Maintenance of roads, January 1 to October 31, 1911, as per detailed report.....	177,963 39	
Ocean Highway, January 1 to October 31, 1911,....	13,101 66	
Delaware River Drive.....	8,498 90	
Warning signs.....	35 00	
	\$262,783 23	
Balance on hand November 1, 1911.....	147,511 28	
		\$410,294 51

EXPERIMENTAL FUND.

By a supplemental appropriation act, approved April 12, 1910, the sum of ten thousand dollars was appropriated for experimental road work and for the purchase of an automobile for use of the department.

This fund was disposed of as follows:

Experiments on road near Quinton, Salem county.....	\$372 44	
Experiments on Centreton road, Burlington county.....	482 84	
Experiments on White Horse and Hamilton Square road, Mercer county	1,761 50	
Experiments on Edinburgh road, Mercer county.....	16 95	
Experiments on Bellevue avenue, Hammonton, Atlantic county..	800 00	
Experiments on Young Orchard Hill road, Monmouth county....	74 91	
Experiments on Hartford road, Burlington county.....	1,369 81	
Report on English roads.....	200 00	
Laboratory tests of materials.....	979 31	
Automobile	3,925 00	
Returned to State Treasury.....	17 24	
Original appropriation.....		\$10,000 00

TOTAL COST OF REPAIRS ON ROADS IN NEW JERSEY DURING 1911.

Motor Vehicle Funds, as per statement.....	\$262,783 23	
Experimental Fund.....	9,982 76	
Amounts paid from county funds.....	1,255,000 00	
		\$1,527,765 99

Ocean Highway.

Pursuant to the provisions of chapter 220, laws of 1910, the State Highway Commission has appropriated and made payments as follows:

	Appropriation.	Payments during 1910.	Payments during 1911.
For the improvement of a road along the bluff at Atlantic Highlands, conditioned upon the county expending a like amount	\$10,000 00		
For filling in the head of Wesley Lake and the construction of a roadway between Ocean Grove and Asbury Park	5,700 00		\$5,700 00
For the acquisition of land and the opening up and improvement of the road known as the extension of Ocean avenue in the borough of Spring Lake..	4,300 00	\$4,312 90	
For the improvement of the road between Lakewood and Tom's River.....	11,000 00	11,000 00	
For the improvement of the road between New Gretna and the Mullica River Bridge	7,000 00	7,000 00	
For the straightening, widening and improvement of the road between Chestnut Neck and Absecon.....	5,000 00	5,000 00	
For the improvement of the Main Shore road between Cape May Court House and Cape May, and the road between Petersburg and Seaville.....	7,000 00		7,401 66
Amount appropriated	\$50,000 00		
Amount expended during 1910.....		\$27,312 90	
Amount expended during 1911.....			\$13,101 66
Unexpended balance.....			9,585 44

Report.

GENERAL ADMINISTRATION.

On assuming office I found an incomplete set of records. There was a map showing the roads improved with State aid, but there was no record to show the behavior of a road in service. Full information of work done had to be derived from the original plans and specifications. These were in many cases very defective. There had never been a sufficient force available to compile the data. There had been published in the annual report of the department a table showing the number of miles of road built in each county since the passage of the State Aid law. This was about the only compilation of work in the department. Upon checking back the original records, it was found that slight errors had crept into this table. These have been corrected.

I also found that the Assistant State Supervisors, who were appointed to oversee the maintenance work, were employed much of their time in checking calculations.

As soon as feasible a competent calculator was employed for this work, and to plot out the exact location of State aid roads, and the Assistant State Supervisors returned to their statutory duties. I was also able to get some volunteer assistance in the plotting and calculation. This plotting has been finished in preliminary form.

The increase in office expense due to this extra work, and to the increase in field work performed by the Assistant Supervisors, exhausted the expense fund before the end of the year. The necessity of keeping records, in any proper system of maintenance, and of carefully planning the work, led me to assume the responsibility of this excess expenditure. A statement thereof and a request for a supplemental appropriation to cover the same will be laid before the Appropriation Committee.

The office room at the disposal of the department has for some time been deficient. With the probable increase of work it will

soon become impossible to carry on the department's work in the present quarters.

The work is now being done under conditions which entail a loss of efficiency.

EXPERIMENTAL WORK.

An appropriation was made by the Legislature of 1911 for experimental work. Besides this, considerable work of an experimental character was done with money drawn from the motor vehicle fund, as part of maintenance work. The period elapsed is too short to allow of any conclusions. It may, however, be said that at least two methods of construction are sufficiently promising to warrant further trial on a more extended scale on our more important roads. I would refer to the report of the Chemist to the Geological Survey hereto attached.

The work done covers a series of experiments with coal tar, water gas tar, glutrin and oil, as dust layers, the binding of inferior and hitherto worthless gravels with tar, the binding of oyster shells with tar, the treatment of gravel roads with glutrin and with Trinidad liquid asphalt.

LABORATORY WORK.

The authorities of the Geological Survey have co-operated with this department in testing road materials and in experimental construction. The Chemist of that department has taken much interest and has rendered most efficient service in this work. His report is attached hereto and merits careful study.

DELAWARE RIVER DRIVE.

A report of progress on this work by Mr. F. S. Tainter, Engineer in charge, is attached. This work will be completed in time to submit to the Legislature, at which time a complete report will be made.

MAINTENANCE WORK IN ENGLAND.

Arrangements were made with Mr. Tainter whereby, during a trip to England, he gathered information as to maintenance work in that country. His report is appended. The expenditure for this work was paid from the experimental fund.

The English experience as to the comparative value of asphalt and tar as binders is so different from American practice as to suggest that either climatic influences enter more largely into the problem than is usually supposed, or that the English tar is a much better road material than ours.

Experimental application of the English practice to our roads is now being made, but no results can as yet be reported. There is, in our case, but little, if any, difference in price between tar and asphalt, but the widening of the field of competition is in itself an advantage.

GRAVEL ROADS.

The gravel roads of South Jersey are the best maintained and the most economical roads in the State. They are, except in winter, almost unsurpassed.

They are not, however, as required by the statute, "at all seasons of the year, firm, smooth and convenient for travel."

The experimental fund has largely been used to treat several of these roads in the hope of economically rendering these magnificent highways satisfactory in winter. It is as yet too early to speak of the results.

PIPES IN GUTTERS AT ENTRANCES.

The department is advised that, as usually installed, these pipes, being obstructions, are, as such, illegal. The department has, however, no power in this matter beyond that of refusing to accept a new road with such obstructions. This power it has exercised.

Several accidents have been reported as due to these pipes, one of them involving loss of life.

The entrances thus built usually drain on to the paved way or shoulders; the pipes become frequently clogged. Both of these features add materially to the cost of road maintenance.

MAINTENANCE.

The work done under this head is given in the reports of the Assistant Supervisors of Roads, hereto appended.

The importance of this work, as compared with construction, is daily growing. Not only does the amount of maintenance work increase with the mileage of improved roads, but the change in traffic conditions has made the problem a serious one. This is true whether the question is taken as a financial or an engineering one. Many of the counties have made liberal appropriations for this object. The results in the State at large are, however, not satisfactory, while the burden on the taxpayers is becoming a heavy one. The problem of providing efficient maintenance work at a reasonable cost is one requiring systematic treatment. For this purpose a regularly organized force and a careful and accurate method of cost-keeping are needed. It is submitted that the county is too small a unit to warrant the overhead charges necessary for this purpose. We have no traffic census, such as have been taken by leading foreign nations. The Department of Agriculture, however, has made observations on this subject. The results show that as a general rule 25 per cent. of the roads carry about 75 per cent. of the traffic. To meet these conditions, a system of State Highways, recommended by the State Highway Commission of 1910, has been extended by the addition of the Delaware River drive and of certain roads subject to specially heavy traffic, and is submitted with this report.

The adoption of the principle of State Highways would be basing our road system on that of France, which is composed of National, Departmental and Communal roads, corresponding with a division in this State into State Highways, county roads and township or borough roads.

Any legislation adopted to give effect to such a system should be sufficiently elastic in character to provide for the present system of State aid and to allow of the Department of Public Roads extending help in the way of advice to communities contemplating road improvement.

ENCROACHMENTS.

There are many encroachments on our rights of way. The most serious of these are the abutments and piers of railway bridges passing over the highway. Some of these encroachments do not make obstructions in the road. Others are very dangerous.

There is no power in the department to deal with these encroachments.

OVERHEAD CROSSINGS.

Many of the overhead crossings, where the highway passes over the railroad or canal, were built before the days of automobiles. With modern road traffic many of these crossings have become dangerous and should be rebuilt to meet present day conditions.

GRADE CROSSINGS.

The department has adopted the policy of eliminating grade crossings wherever possible. The cost of such elimination is often prohibitive, specially in view of the appropriations available and of the necessity of the county paying at least two-thirds of the cost.

WEIGHT OF VEHICLES.

Some legal limit should be set to the weight of vehicles. These weights are increasing rapidly and are often carried at considerable speed. Not only does considerable wear to the road ensue, but many bridges are severely taxed and serious accidents from this source are not unlikely.

SIGNS.

The department has not done anything this year as to signs. The work in the past has been limited to cautionary signs.

A good system must include both direction and cautionary signs. The design of such a system involves work which the department has not had the force to handle.

There is no law protecting a sign erected by the State. Such protection is necessary to proper maintenance, and legislation to that end is suggested.

The systematic design and setting of signs is now being studied, and it is hoped that a beginning of such a system can be installed during the coming year.

MONUMENTS.

There is no marking by monuments the lines of the rights of way of our roads. Such marking is a feature of European and of the best American practice. Without some provision of this kind, it is very hard to prevent or detect encroachments. I suggest beginning such a system on all new work and an appropriation to begin putting in monuments on roads already built.

SUPERVISION OF CONSTRUCTION.

Our present system of employing men at three dollars a day for the job is unsatisfactory. The cost of this work is now paid by the State.

By the time a man learns his business his work ends. It is hard to get good men, though as a class these officials do better work than one would expect.

This work should be done by men regularly employed, appointed and serving under the Tenure of Office act.

The cost of supervision should be charged to the work and shared in by the State.

BRIDGES AND CULVERTS.

These structures are very essential portions of any road. They are, however, not included in the cost shared by the State and are subject to no State supervision. They are, when badly designed, the most dangerous parts of a road, not so much from their failing under load, but because of the obstructions they offer to traffic at dangerous places.

Another frequent cause of complaint arises when bridges are to be rebuilt while a road is being improved. The work is often done in such a way, or delayed to such an extent as to cause the contractor increased expense and inconvenience. In our present specifications the county reserves the right to do this work in just this way.

SHADE TREES AND FIRE LINES.

There is no provision of the law giving the department any power to plant trees along the highway or any control whatever of the work by other bodies or by abutting owners. While there may be some difference of opinion as to the desirable amount of planting along highways, it is sure that a certain amount is, from engineering reasons, at least unobjectionable, and most desirable for reasons of comfort and beauty.

Whatever work is done in this line should be done systematically, with proper consideration of the physical conditions of the highway and with some provision for care of trees after planting.

With fuller engineering data, collected and applied in the original design, it will be possible to save fine trees without increasing costs. In the past such trees have usually been sacrificed, because saving them was not considered until too late to do so without incurring an extra charge on the work.

There is no reason why the Forest Commission and this department cannot co-operate in this matter; in fact such co-operation as is possible is now an accomplished fact.

This co-operation should extend to utilizing roads through forest lines as fire stops. The increased cost of this feature would be small if the work can be done in connection with the road construction.

I suggest an appropriation for these purposes to be expended under the direction of both departments.

ENGINEERING.

All designs for construction are prepared by the county engineers, subject to the approval of this department. The county bears all of the engineering cost. The results are by no means satisfactory. By this no criticism of the county engineers is intended.

At the very low cost of engineering it would be unreasonable to expect more than is now given. The departmental force available for the oversight of this work is barely sufficient to check the calculations and can make no such inspection of the site as would be advisable.

Insistence on more thorough work would generally result in penalizing the engineer. It is always met by the argument that the State pays no part of this expense.

I urgently recommend such change in the law as will make the cost of engineering a part of the cost of the road in which the State will share, and will give the department more power in this respect.

Inadequate engineering results in extra charges or in placing on the contractor an expense that he could not be expected to foresee. Either of these is, in the long run, expensive to the public.

More thorough engineering work will result in an overall economy—better roads for less money.

CHAINS.

The law prohibits the use of chains on improved country roads except when there is snow on the ground, while it permits their use on city pavements and dirt roads at all times. As a consequence, many motorists violate the law rather than trouble themselves to remove the chains every time they pass from one class of road to the other.

Owing to this peculiar condition the law should either be amended so as to permit the use of chains, or better means should be provided for the enforcement of the penalty.

PUBLIC POWERS.

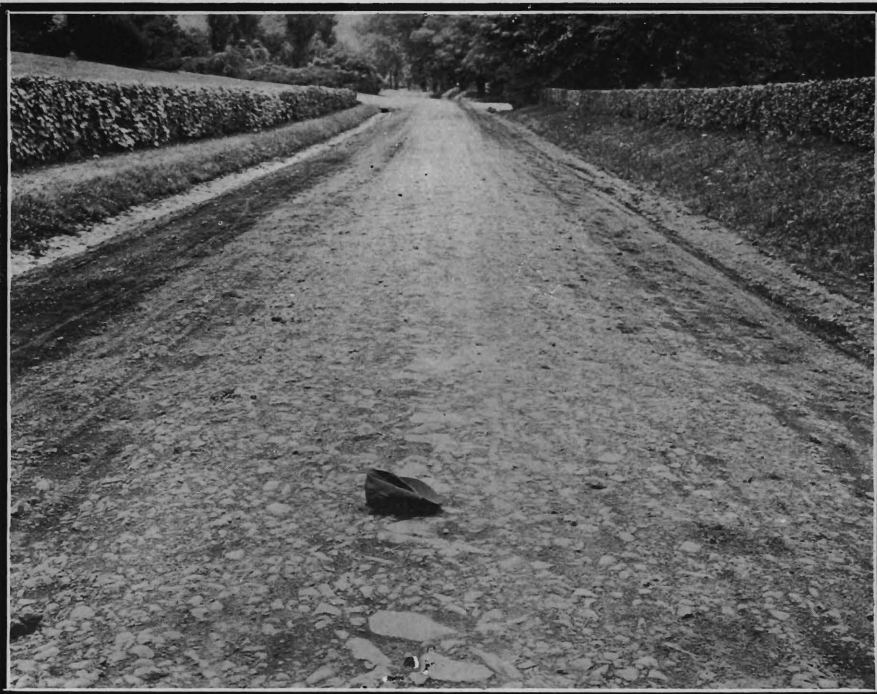
There is no power vested in the department officials to enforce the law as to the use of roads. Frequent violations come to the notice of both State and county road officials; appeals to the local authorities are not usually effective.

I recommend giving the department officials and the county supervisors of roads adequate police powers.

E. A. STEVENS,
Commissioner.



Bituminous Concrete. Laying Bottom Course.



Road Worn Down to Telford by Combined Motor Vehicle and Horse-Drawn Traffic.
Resurfacing is Necessary to Save even the Base Course.

Report on Road Construction.

By ROBERT A. MEEKER, *State Supervisor of Public Roads.*

The new work done during the past year consisted, to a large extent, in extending and connecting the improvements made in previous years and in building lines parallel with existing improved roads, in order to distribute the travel and thus reduce the wear on both the old and new.

The Shore road improvement in Cape May county has been pushed northward from Cape May Court House to Seaville, and the last section, ending at Beesley's Point, will be completed early in the coming year. Thus, before the summer season opens, Cape May county will have an improved gravel highway, twenty feet in width, from one end of the county to the other. It is proposed to connect this road by means of a bridge across Great Egg Harbor with the Shore road that is being improved in Atlantic county. This latter road is subjected to such heavy traffic that it was deemed wise to pave it for its entire width of thirty feet with cold mixed asphaltum concrete, that it might the better withstand the heavy demands of the constantly growing travel.

The different surfacing used on these two sections demonstrates what changes are being forced upon us by the constantly increasing demands of modern travel. Our gravel, that makes the ideal road for pleasure and medium heavy traffic for nine months in the year, will not withstand the wear of heavy horse drawn vehicles, nor will it withstand the action of the frost during the late winter and early spring. We are making a number of experiments with bituminous and glutinous materials, in the hope of discovering something that will overcome this serious objection. It is still too early to draw any conclusions from these experiments.

The penetration method of applying bituminous binders to stone roads has met with indifferent success thus far, the surface being

more or less wavy. At first we attributed this to the uneven distribution of the bitumen, but tests made by the State Chemist disclosed to us that the real reason was that the density of the stone aggregate was not uniform. The percentage of voids in the mass has a greater influence upon the uniformity of the surface than any other factor. Following these lines we hope to obtain better results by thoroughly compacting the stone and then sweeping and cleaning the surface before applying the bitumen or other artificial binder.

The coating of the stone, either hot or cold, with melted bitumen in an asphalt mixer has thus far yielded the most satisfactory results. Two objections are made against this type of pavement, first its cost, and second its slipperiness. The first will be reduced as the methods of manufacture are perfected, and the second is overcome by using a larger size of stone for the finishing course. The quantity and quality of bitumen to be used has had to be determined by the tests of actual use, consequently this process has been slow, but each year has added to our knowledge and we hope ere long to be able to specify just what we want.

With the introduction of bituminous binders for the surface, problems of grade and cross section force themselves upon us. The maximum grade on bituminous roads should not exceed four per cent., nor should the slope from centre to side be more than one-half inch per foot. Where it is necessary to exceed the longitudinal grade, the surface would better be of stone, on the score of safety. The constantly increasing demands of traffic call for wider and straighter roads, easier gradients and more permanent surface. Roads that amply supplied the needs of the traveling public six years ago are entirely inadequate to-day. The old method of following the centre of the traveled way for the line, turning aside to avoid obstacles or to please some property owner, must be abandoned. Though the department has seen the necessity for better alignment and grade for years, it is only of late that the local officials have awakened to a realization of it.

The demands upon our small office force have nearly overwhelmed us, and it has been found necessary to employ additional help in order to keep up with the work. Many necessary things have had to be left undone or taken up at odd times. This has led to some confusion because there was not a general indexing of the records. As long as those who had been familiar with

the progress of the work for years were present, the missing links could quickly be supplied, but as the volume of the work is increasing so rapidly the necessity for a more thorough and complete systemization of the records becomes imperative. To carry out this plan and make the office of the Department of Public Roads that of original instead of secondary record, will require a considerable increase in the office force.

The weakest point in our present system is that of inspection. The local supervisor, though honest, is often ignorant of the principles of road building, and by the time he becomes competent the work is done. It would be far better for the work and for everyone connected with it if a trained body of inspectors was constantly employed. The misunderstandings due to a go-as-you-please policy would then be avoided.

Bridges and culverts have always been built by the counties, and much delay and dissatisfaction have been caused by the failure to push this branch of construction. The State does not participate in any portion of the cost of bridges, and, in consequence, has no voice in either their plan or construction. This is not as it should be, because the bridges are a very important part of road improvement and should be treated as a part of the complete design.

With the entire change in the character of traffic over our roads, due to the perfection of the motor driven vehicle, the necessity for a classification of our improved roads has arisen. This involves the questions of alignment, width, grade and pavement, suited to these several classes. By dividing our highways into through, cross and local we can the better arrive at the kind of improvement a certain road demands, thus saving much in both time and money.

Another much mooted question is that of trees along or in the roadway. Their advantages and benefits to the highway, when properly placed, is beyond question, but when this is not properly done the damage is equally great. Trees should, both for their own good and the good of the roads, be planted at the fence and not the gutter line of the highway. They should be at least fifty feet apart to permit growth, and for the preservation of the road should never be allowed to grow closely together on the south side of it. The dense shade thus formed keeps the road wet and deep ruts are cut into what is elsewhere a good pavement. The ad-

ditional cost of maintenance, due to excessive shade, is one of the tree problems that has not been given sufficient study by the general public.

Pipes and culverts at private entrances, in addition to being obstructions in the highway, are a serious detriment to the proper drainage of the road, and the damage that has been caused by the stopping up of these pipes has amounted to hundreds of dollars. The pushing of road improvement into the country districts has brought to light many railroad encroachments, such as abutments and even piers in the center of the road that never should have been permitted. There are likewise many grade crossings that are a positive menace to life. Some general legislation to remedy these evils should be enacted at once.

One of the worst obstructions to travel on our improved roads are the bridges across the Morris canal. Many of the approaches to these bridges are built on a ten per cent. grade, while the bridges themselves are built at right angles to the line of the canal, without any regard to the line of the road; consequently, in many cases there is an abrupt turn at the top of the grade from the road to the bridge. This condition has caused several accidents and more than one death. If the canal is not to be abandoned, the highway bridges crossing the canal should be rebuilt in line with the road.

After each road is finished it should be monumented on each side at the end of every tangent; then there would be no excuse for encroaching upon the right of way, and where there was such an encroachment it could easily be determined and removed. The fact that nearly all deeds in the country convey title to the center of the road, causes many property owners to think that they have a right to disregard the rights of the public to free and unobstructed use of the highway, notwithstanding the express statement of the statute to the contrary.

As soon as a road is completed, inspection and repair should begin, and to this end the department should be vested with police powers, to enable it to enforce necessary traffic regulations, the erection and protection of cautionary and direction signs, and the removal of obstructions.

Repairs in Northern New Jersey.

By E. M. VAIL, *Assistant State Supervisor Public Roads.*

The following gives a general idea of the methods of repair commonly employed in the northern section.

Similar failures and successes have occurred in many of the counties. It is therefore wise to mention only a few of the important features in each county, endeavoring, as far as possible, to avoid repetition.

Representatives of one community in reading the reports from another will undoubtedly note practices identical with their own.

In some cases it has been taken for granted that changes would be made in their manner of working next year, when only general discussion has been had with the representatives of the county.

It is natural to suppose that like changes will be made in other counties laboring under similar conditions.

BERGEN COUNTY.

Bergen county has no county supervisor of roads or central organization to take care of repairs.

There have been but two or three miles of county roads proper. The several hundred miles of stone roads in the county have all been built and are maintained by cities, boroughs and other local municipalities.

State aid has been extended in the construction of thirty miles of this work, and, in some instances, motor vehicle money has been sent to various boroughs to aid in repairs. In most cases the work has been done by contract, but under unsatisfactory conditions.

During the past year the county engineer has taken hold of the work, which has resulted in the partial establishment of two or

three trunk line roads, built of asphalt concrete, under the care of the county.

Most of the repair work done in the past year has been resurfacing with a good class of material, in keeping with the general prosperity of the county.

In view of these facts the problem of repair of county roads, as such, has really not yet arisen in Bergen county.

ESSEX COUNTY.

Each year the county supervisor gets to every road, cleans up the gutters and shoulders, and, to some extent, the overhanging limbs of trees. Whenever necessary the rough places are scarified, crushed trap rock, one and three-quarter inches and finer, spread, and the whole road receives a coating of about one-half inch of sandy clay. Where an inch or more of stone is spread the whole is watered and rolled with a steam roller.

The roads receive one or two applications of dust layer per year, depending on the amount of travel. This work is done by a skilled crew of workmen that travels about the county and has generally proven quite satisfactory.

Bituminous bound roads, penetration method, have not given good satisfaction in Essex county. During the past few months on two of these roads receiving heavy traffic, the material has been entirely removed from the road and asphalt concrete, mixing method, has been substituted.

The cost of maintenance is divided between county and city on some of the main roads located within the city limits. Traffic has become so heavy on a part of these city roads that square cut granite block has been laid on a concrete foundation.

There are many narrow, crooked roads in Essex county, which could be much benefited by the removal of trees, and many dangerous private entrances and receiving basins of various kinds which obstruct the gutters and shoulders.

The greater part of the work on the old fashioned macadam is in charge of the county supervisor, who has made the necessary repairs by days' work. The entire balance of the work has been done by contracts drawn by the county engineer and road committee.

HUDSON COUNTY.

No county engineer or county supervisor of roads is appointed in Hudson county.

The county is naturally divided into two parts—the high ground, which is thickly populated with cities, and the salt marsh, a practically undeveloped section lying between the two strips of high ground.

The Main road, running north and south, which might otherwise be properly considered a county road, is cared for by a special boulevard commission which, each year, expends large sums of money for its maintenance, and, in spite of the unusually heavy traffic, manages to keep it in good condition. This leaves for the county only one partially abandoned road along the Passaic river and the roads crossing the meadows to be maintained.

The River road receives very little attention, but, during the past two years, county and State have joined in putting good, substantial pavements on a part of the meadow roads, and contracts are let for extending the work next year. As usual in such cases, much difficulty is encountered in getting good work so near to the water level and paralleled by the constantly vibrating street car tracks.

All the work is done by contract, but men employed regularly by the county do much good in removing rubbish from the roads.

HUNTERDON COUNTY.

Hunterdon county was among the last counties in the State to take up the building of county roads, the first mile not being completed until 1906. During 1911 there were twenty-three miles of road for the county to maintain, all plain macadam.

The traffic on these roads is moderate, and the county supervisor has managed to keep them in fairly good shape at small cost by carefully distributing the smaller sizes of crushed stone over the road, and cleaning the gutters and shoulders.

After allowing a suitable time for the roads to wear tight and waterproof, the entire mileage was oiled by contract.

Asphalt binder road will come into maintenance next year, and the work will become much more complicated.

MIDDLESEX COUNTY.

The roads are built over clay banks or through red shale, both of which materials mingle with the binders and cause ravelling and cupping. The county owns steam rollers and scarifiers with which some of the old surface has been broken, after which sufficient new stone has been added to shape up the work. The water wagons have also been used to good advantage in connection with the rollers, and quite satisfactory results obtained on many of the roads.

Two contracts were let for the same class of work, but it is evident that they have started so late in the season that most of the work will have to be left until next spring to insure good results.

Many of the side banks have been left too steep, thereby causing continual gutter work.

Some of the roads which were originally built with stone have, from time to time, been patched with gravel. Except where gravel has been put on several inches deep, the results have not been satisfactory. Even where the two materials have bound together, the wear has been uneven, the gravel wearing down and leaving the stone high.

The supervisor in this county, although a new man, has demonstrated his ability to handle the work, and it is probable the board of freeholders next year will show its appreciation by furnishing him more machinery.

MORRIS COUNTY.

Many of the county roads in Morris have been built only about six inches in depth of stone. The demand, up to the present year, has been for mileage, and in fact several petitions were favorably looked upon for construction in 1911. It was, however, found necessary to expend all the available road money for repairs this year.

Trunk lines, extending through the principal cities, are being resurfaced with asphalt binder applied by the mixing method. A little penetration work is used on the secondary roads. The remainder are being scarified and resurfaced where necessary,

and the whole covered with a thin coating of fine stone. A great deal of shoulder and gutter work has been found necessary on these roads.

The supervisor has done some of the light repairs by force account; the remainder has been let by contracts prepared by the supervisor, under the direction of the county engineer.

It seems to be the general feeling, especially in the Morristown section, that roads should be resurfaced with asphalt binder, applied by the mixing method, as fast as possible, but it is evident that it will be years before all of the roads in the outlying districts can be treated in this way. It will, however, be wise to widen and straighten many places soon.

Light repairs seem to have been quite satisfactory, and it is probable that a large mileage will be handled in this way next year.

Several miles of permanent pavement have been laid by the cooperation of the street railway company on roads adjoining its tracks.

Some of the penetration work which was done in 1910 became wavy and bumpy during the summer of 1911, and the contractor, for this part of the work, designed and put into operation a combination harrow and planer which gave quite satisfactory results in reducing the waves.

PASSAIC COUNTY.

Passaic has more miles of county roads than any other county in the State; in fact many miles should, and probably will, soon be turned over to the cities of Paterson and Passaic for maintenance.

Many of these roads follow somewhat the windings of the streams, and, being rather narrow and hilly, have abrupt turns which are not only dangerous but expensive to maintain. A few of these bad places are improved each year, but there is much more important work still to be done in that line.

For the most part the roads have been fairly well repaired, but in some places too much of a poor quality of clay binder has been used. The gutters and overhanging limbs of trees should also receive more attention.

Some of the more important repairs have been let by contract, but the county supervisor has a pretty good equipment and handles much of the work.

SOMERSET COUNTY.

Somerset county has been building roads at the rate of six or seven miles a year since 1897.

The county officials have expended very little money in furnishing a proper working outfit for the county supervisor.

Like many other counties, they let contracts for crushed stone, but are seldom able to get deliveries exactly at the time required, in the spring and fall of the year. Having no machinery to aid them in binding the road materials together, they are dependent upon the traffic and the dampness of the spring and fall, and are therefore obliged to waste stone which is scattered during the dry weather. A little stone delivered at the side of the road during the winter or early spring months, and the use of a couple of steam rollers, when the frost is coming out of the ground, would enable the county supervisor to shape up many miles of their roads with much less stone than has formerly been used.

Most of the roads in the county have received an application of dust layer applied by the oil company.

The road committee of Somerset discharges most of the duties of county supervisor. The latter works a few months as foreman in charge of a small gang of workmen and is paid by the day.

SUSSEX COUNTY.

The county of Sussex covers a large area of beautiful rolling country, much of which is still wooded. But few miles of improved roads are as yet under the care of the county, and all of the road money which the county has been able to raise has been expended on new work.

The small amount of motor vehicle money apportioned to this county has been used by the county supervisor in the upkeep of the portable crusher and roller and in the scarifying, stoning and shaping of the roadbed and shoulders. All of the roads now under maintenance are of plain macadam and in pretty good condition.

Next year some asphalt binder roads will come into maintenance and a different class of repairs will be required.

UNION COUNTY.

Considerable money has been expended on resurfacing with asphalt concrete the main trunk line leading from New York south, which passes through Elizabeth and Rahway, also a part of the lines running west.

The other roads throughout the county have received light repairs. On one section some heavy asphalt oil was used after scarifying and before the road had been consolidated, but so much dirty stone became mixed with the work that the result was far from satisfactory.

The county supervisor keeps a small gang on patching, light repairs and gutter work, but most of the heavy work is done by contract under the care of the road committee and county engineer.

WARREN COUNTY.

The county supervisor resigned early in the year, which has caused most of the work of supervision to fall on Director Thatcher.

For the size of the county there is a pretty good outfit of machinery, including a crusher, water wagon and roller. They have crushed stone, and, with the aid of a fairly well organized gang of workmen, put most of the roads of the county in order, in some cases applying a small quantity of dust layer.

Next year the county will probably procure a scarifier, which will reduce the amount of stone necessary and leave a little more money to be expended for gutter work and widening.

Several miles of asphalt binder road will come into maintenance next year.

Some Conditions Affecting the Maintenance of Roads in Southern Counties.

By EDWARD E. REED, *Assistant State Supervisor Public Roads.*

When a new road is built it is maintained by the contractor, under the terms of the contract, for a period of one year from the date of its acceptance by the county and State authorities. At the end of that period its maintenance devolves upon the county, and it is then placed in charge of the county supervisor of roads.

The county supervisor is elected by the board of chosen freeholders, and holds office for three years. Owing to the inefficient organization in many counties the best results in the maintenance of roads have not been secured. The organizations are developed generally along the following lines, each county acting independently. The county supervisor and local freeholders, after consultation, appoint certain men to care for given sections of road. These men may employ others to assist them in their work.

In counties where freeholders receive a per diem salary, many of them superintend the road work in their townships. If these men are not re-elected it means breaking in a new man, which is a costly proceeding. As this occurs in many places at not infrequent intervals, the total in lost efficiency is considerable.

Another difficulty is to get men living along the road to work on it at the proper time, that is, when the road most needs it. Men cannot be expected to leave important work on the farm for something that is to them of secondary value. It naturally follows that only those should be employed who can work on the roads at the proper time. One would have to be assured of more than a few days' work each month to make it worth while for him to undertake it.

The most practical and efficient solution seems to be the patrol system for small repairs, and for those of a more permanent nature a regular force of experienced men that the supervisor could send anywhere in the county.

A very objectionable practice, quite common in several counties, is the spreading of material from the shoulders over the centre of the road, two or three inches deep and twelve or twenty-four inches wide. No care is taken to keep sod or vegetable matter from being spread on the road, and owing to the absorbent nature of this material the tendency is to soften the pavement thus causing the surface to rut. Ravelling is prevented, but the road is covered with dust in dry weather and mud in wet weather. The tractive force is greatly increased.

The chief objections to the present system are: The short term of office of the county supervisor; his election by the board of freeholders; the fact that he may be elected to the position without any training for it whatever; the ever-changing personnel of the road force.

These objections may be eliminated to a great extent in the following manner: The supervisor should be protected by civil service and removed only for incompetence or neglect of duty. He should be especially qualified by experience for the position, as the maintenance of roads is a big problem. It is necessary to collect data regarding the amount and kind of traffic and its effect on the various, almost multitudinous, road surfaces, in order to best know how to care for the roads we have and how to construct for the future. The man for such a position should have had considerable road experience, and if he be an engineer, so much the better. There should be co-operation between the county engineer and county supervisor. There should be a permanent road force, which would prove to be a much more efficient and economical means of caring for our roads than the constantly changing force in use at the present time.

Laboratory Work.

*Colonel E. A. Stevens, State Commissioner of Public Roads,
Trenton, New Jersey:*

DEAR SIR—In response to your request regarding the work done for your department during the past year, I will give herewith a short synopsis of the same.

There have been analyzed during this time about one hundred and forty samples of dust oils, oil binders, asphalts and tars. In addition to these tests many have been made on similar materials to determine one or more facts relative to their value for road work.

Some twenty-five samples have been analyzed in full and thirty samples of pavement mixtures tested for bituminous content to determine if the material came up to our requirements.

During this time many laboratory experiments have been made with different bitumens and a single mineral aggregate or a given bitumen and different aggregates. Over one hundred such experiments have been made to date and several more are not completed as yet.

I have no record of the time given to helping with the specifications, but much more has been done than shown by the results secured, for often several days are required to determine a certain point that is represented by a couple of words or figures. The same is also true of trips made to inspect materials or pavements.

I am sorry to say that our work has not been as thorough as I should like to see, for no doubt much is to be gained by a proper system of keeping a closer check on the quality of materials being used than has been done in the past. I am also quite sure that the supervisors allow material to be used that would be rejected by your department. Very seldom does a supervisor ever send any samples to be tested other than oils or asphalts. As a rule they have a very poor knowledge of the nature of the materials used and do not realize the importance of keeping the materials and pavement produced up to a definite standard.

There is no doubt whatever that if bituminous roads are going to be a success, they must contain sufficient bitumen to hold the mineral ingredients together and form a waterproof mixture. These points can be determined only by making frequent tests during construction. I have tried to do as much of this kind of work as possible but am sure that not half enough such tests have been made. The total cost of this protection is practically nothing when compared with the total cost of such pavements, and if the life of the pavement is only lengthened by a few months the cost of making these tests has been repaid. Personally I feel that we can materially lengthen the life of many of these bituminous pavements, if not double them, by a better system of inspection and testing.

The required amount of the different ingredients needed for a certain type of pavement, and the manner in which they will stand up under travel, can generally be determined in the laboratory. This was done with the Lawrenceville-Trenton road, and the paving mixture often tested during construction to see if the proper proportions were maintained. Considering the material which was used and the cost of the finished pavement, I am sure no better proof is needed of the value of determining experimentally just what is required before construction is commenced and then making sure we get just what is agreed upon.

Since the work of the laboratory has been so closely connected and interwoven with two of the experimental roads constructed during the summer, I will also give a short account of the manner in which these experiments were carried out and the results secured.

Experimental road near Hartford, Burlington county.

The tar road near Hartford, N. J., was built with the object of using the adjacent bank sand as the bottom course or base when cemented together with a cut back tar. The consistency of the tar desired was carefully determined in the laboratory, but on account of some misunderstanding, this grade was not shipped. The tar used was much thicker and required hotter weather than that which we had when it was applied.

The foundation of this road was a clay-gravel which was rolled until firm and hard before the tar was applied. Three applications of tar were made, and, in each case, were at once covered with sand. The quantity of sand added should not be in excess of what the tar will absorb. It is very difficult to determine this point, but an excess is always to be avoided. In places too much was added; the weather turned cold and rainy shortly after the tar was applied and consequently the tar absorbed but very little sand. In many places the road now consists of three separate layers of tar with loose sand between. The travel soon ruins the pavement at such points.

A second car of tar of the grade and consistency first specified by us was ordered with the object of refluxing and cementing these layers of tar into one solid sheet. In many places this was accomplished and at such points the pavement appears to be all that was expected of it.

This experiment has shown what can be done with a tar of the proper consistency when correctly applied. If the road is constructed by the penetration method great care must be used to get a uniform application of tar and sand, without which weak points will surely develop. Also the foundation should be nearly flat or crownless, for it is impossible to keep the tar in its proper place until it has penetrated the sand if the road has a crown.

This class of roads should be constructed only during very warm weather and sealed with an oil-sand coating, for there is little doubt but that they will get brittle if left exposed. While the results secured were not what we should have liked to have had, yet they can be much improved if a mixing method is used. The cost in this case would no doubt be somewhat higher, but uniform results would be secured and the difference in the results obtained would, I am sure, be more than the difference in cost.

The cost of this experiment per square yard is much in excess of what the same work could be duplicated for and since it means nothing, no effort has been made to secure it. A road with a tar-sand base two inches thick, covered with a sand-oil pavement about one inch thick, should be constructed under favorable conditions at a cost not to exceed 60 cents per square yard, and, it may be, less.

White Horse-Maple Shade Experimental Road.

The old road used for this experiment was an ordinary sand road with a sandy-loam base or foundation. It was graded for a distance of 3,300 feet, which exposed a few red gravel deposits in the cuts. The distance thus improved was divided into three sections of 1,100 feet each.

The east section was rolled until quite firm and then harrowed to loosen the surface to a depth of about two inches at the maximum. Glutrin (diluted with water 1-1) was then applied at the rate of about $\frac{1}{8}$ of a gallon to the square yard until about 0.8 of a gallon per square yard had been applied. An ordinary street sprinkling wagon was used to apply this material and appeared to work quite well until about the fourth or fifth application, when much of the glutrin previously used adhered to the wheels or horses' feet.

Many laboratory tests were made with this material and also the sodium silicate, and it was shown beyond a doubt that either of these materials could be made to bind sand firmly together, but to secure such results these materials must be dehydrated and if possible kept in this condition. Since both of these binders are more or less deliquescent and soluble in water, they soon lose their binding power if not thus protected from surface waters. This protection can be secured in two ways: first, by applying a waterproof coating to the surface of a road thus treated; second, by making them waterproof after being applied, by the addition of other materials. It is doubtful if the glutrin can be rendered waterproof by the addition of any foreign compound, but there is every reason to believe the sodium silicate can be converted into an insoluble calcium silicate by the addition of hydrated lime or a basic slag rich in lime. This latter silicate will also be a cementing compound and waterproof. Experiments are now being made to determine what amount of foreign materials are needed to secure the best results.

Unfortunately the glutrin was applied just at the commencement of the fall rains, consequently the condition which was necessary to secure the best results from this compound was impossible to obtain. This section to-day shows little, if any, improvement over the second section which was not treated in any

way. The glutrin colors the surface waters after each rain and it is a question whether it will not all be leached from the road surface before spring.

The middle section of 1,100 feet was to be treated in the same manner as the former with glutrin, but was to have an oil-sand coating. On account of the weather this experiment was postponed until spring.

The west section was subdivided into sections of 300 feet in length. The west one of these smaller sections has a tar base constructed in the same manner as the tar road at Hartford. After the tar was applied, the road was closed for a week to allow this tar to set. On account of the rainy weather very little hardening took place during this time. Bituminous mortar, containing about 10 per cent. of asphaltum cement, was mixed and laid hot by hand upon this base to a depth of two inches after compression. This pavement while yet hot should have been rolled with a tandem roller, but no such roller could be secured, consequently a small hand one was used. This section is in good condition to-day even with its soft base and faulty rolling.

The only other experiment completed was the 300-foot section with the sand concrete base. This concrete was mixed by hand on boards at the roadside, using one part Portland cement to six parts sand by weight, and gave a very good mixture. It was laid two inches thick and when set covered with a bituminous sand mortar of the same thickness. This mortar was also mixed and laid hot by hand. This pavement is in good condition to-day and is far the best one of the experiments, if judged by their condition, at the present time.

From the results secured by mixing these bituminous mortars by hand, I am firmly of the opinion that if any kind of uniform results are to be secured, this material will have to be mixed in a regular asphalt mixer. This is also true of any material which has to be prepared at a temperature above normal, for when spread out on boards, it cools quickly and gets stiff before the proper mixture is obtained. Cements which do not need heating to secure fluidity can no doubt be mixed by hand with uniform results and at a low cost compared with the other class.

These experimental pavements were all laid 14 feet wide with five-foot shoulders. There is little use of giving any cost data, for the conditions were experimental and hence abnormal.

I have much faith in two of the materials used in these various experiments and am very optimistic regarding their future use for road work. They are the "Bituminous Mortars" and "Sand Concrete." Of the former several experiments will be completed in the spring which will give us some definite data.

I now feel that there is promise that these methods will reduce the cost of construction and maintenance. When these experiments are completed the cost and results secured will be given you in another report.

I doubt whether tar, glutrin or sodium silicate can be used as a base at as low a cost or with as good results as can be secured with sand concrete. If tar is used, from $1\frac{1}{2}$ to 2 gallons per square yard will be required for a base two inches thick. If glutrin or sodium silicate is used, no doubt about the same quantity will be required, perhaps slightly less. The tar at six cents per gallon will cost from nine to twelve cents per square yard; the glutrin at twelve cents per gallon will amount to from eighteen to twenty-four cents per square yard. Sodium silicate will cost somewhat less than glutrin but more than tar.

Portland cement can be bought by the carload at from \$4.50 to \$5.00 per ton, f. o. b. Trenton, N. J. Taking the weight of a layer of sand a yard square and two inches thick at 175 pounds, and the mixture 1 to 6 by weight for the sand concrete, the cost of the cement will be from 7 to 10 cents per square yard. The cost to prepare bases from these different materials is no doubt lower with the Portland cement since no heat or special apparatus is required to secure a uniform product, and the results are more stable and permanent.

Its use will no doubt be greatest in localities where the foundation is a loose sandy soil with good drainage and the chances of damage by frost are least.

Respectfully yours,

R. B. GAGE.

Delaware River Drive.

*Colonel E. A. Stevens, Commissioner of Public Roads, Trenton,
New Jersey:*

DEAR SIR—I make the following report on work accomplished to November first on the Delaware River Drive Survey. As the plotting work has not been entirely completed, I am unable to give you the exact number of sheets which will finally represent the entire line, but the estimated number which I will mention will be a very close approximation.

The field work which was started in June was divided in four sections, one for each county through which the proposed line was to pass. These counties were respectively Mercer, Hunterdon, Warren and Sussex, and the county engineers of each county were put in charge of the section within the confines of their county. With the exception of Mr. Eppele of Mercer county, who, because of great rush of other work, was forced to designate another engineer to represent him, these several county engineers were in active charge of the field work, and all proved capable, intelligent, faithful and conscientious.

At the inception of the work, and after a careful study of the wording of the act under which the survey and report was to be made and the physical conditions likely to be encountered, it was decided to handle the entire work as a pure preliminary line through a new country, and to that end orders were given to division engineers to run on random lines, following, however, as nearly as practicable, the line likely to be chosen for the final location, and observing and noting all topographical points of interest within reasonable distance of such line, together with a comprehensive notation of inequalities in elevations covering the same scope of area, the intention being to accumulate sufficient data to insure a faithful map representation of the existing conditions, so as to allow of an intelligent study for said final location line, with the idea of deducing a close estimate of quanti-

ties and consequent cost. Wherever difficulty was apprehended in following the main preliminary line, alternate lines were carefully studied out and run, and wherever possible the lateral observations on such lines were tied into the main line, thus giving a particularly wide and valuable belt or area of topography to assist in the study for the contemplated location. In all cases such alternate lines were swung back to the main line, so as to form a tie and prove the traverse.

The actual distance covered amounts to about 111 miles of main line and 7+ miles of alternate line, and this plotted on the scale of 100' to 1" will give us about 155 sheets of the standard size of 42" x 22". These sheets will be represented by original vellum tracings from the original detail plottings, and from them can be made as many prints and of such style as may be desired. They will show absolutely every feature of interest to the location which could possibly be desired, and will, of course, have the recommended location line properly indicated.

In addition to the maps, I am preparing profiles and cross sections to accompany my report. The profiles will show all inequalities in elevations on the proposed centre line of proposed location, and the cross sections will be shown at all important points. From the profile and location will be deduced the estimates on cuts and fills.

Careful observations have been made at all points where bridges, culverts or pipes will be needed, and these will be given and explained in my report.

At present rate of progress, I believe we will be able to complete the entire work by about the middle of January.

Very truly yours,

F. S. TANTER.

Maintenance Work in England

*Colonel E. A. Stevens, State Commissioner of Public Roads,
Trenton, New Jersey:*

DEAR SIR—As you have requested me to report particularly on maintenance, I shall confine myself mainly to that subject, but, as in my opinion, construction, either old or new, has a very distinct relation to method and cost of surfacing and dust-proofing, both of which branches are generically included under the main heading, a short description of English methods would seem a warranted digression, indeed such a description might seem a proper base from which to erect the desired theory or practice of maintenance.

Of the 175,000 miles of improved roads in Great Britain, by far the largest amount represents ancient construction, the locations and foundations of which date back at least one hundred years, and in some extreme cases one thousand years. As, in nearly all cases, the locations were chosen with singular intelligence, little or no attempt has been made to change the alignment other than to cut out a few extremely bad curves and corners, but the grades have been constantly improved and are ever being changed for the better.

The old macadam, and by old everything of construction prior to the advent of the modern motor traffic is to be understood, is in all cases made up of broken stone, water-bound with small screening stone and fine gravel used to fill all interstices between the large stone which run from $2\frac{1}{2}$ " mesh on the bottom course to $1\frac{1}{2}$ " mesh for the top courses. No dust whatever is used in surfacing, and no fine screening is used except as above stated. The idea seems to have been that dust, being the greatest enemy of road surface, should be religiously avoided.

Drainage of roads is in all cases cared for intelligently. Gutters are proportioned to the size shed they are called upon to serve,

and, in like manner, underdrains are spaced and sized with due regard to the amount of water they are expected to carry.

The old fashioned method of maintaining the roads (and in some rural parts of England and all of Scotland this is still done) was to subdivide the highways into sections of about four miles each, and place same under the charge of one man (generally an elderly man) whose duty it was, or is, to patrol the road, remove all foreign or organic matter, and wherever and whenever necessary make repairs at the very inception of demand for same, the theory being the old fashioned one of a "stitch in time saves nine." The equipment used by this man has always been a small cart drawn usually by a donkey, the cart containing the usual tools for road repairs, and, in addition, two large jugs of water and a pail. The use of these latter will be described a few lines below. The base of operations for the caretaker is invariably a small and attractive looking, vine-covered shed, built well on one side of the highway. Under this shed is kept, in a locked portion, the car and tools, and under an open section is usually a pile of large stone. In dry weather, when nothing else of importance occurs to be done, the caretaker accumulates a supply of ordinary field stone of sufficient toughness to use for surfacing or building roadways. This is usually in England a flint rock, tougher, if anything, than our trap rock. In wet weather the caretaker breaks up the large stone to sizes which will pass as a minimum through a one and one-half inch ring. With a supply of this cracked material on hand he is in shape to take to the road and make such repairs as may be necessary at different points.

His usual method is to drive down the road with his little cart filled with a certain amount of stone and the tools above mentioned. When he gets to a point which to the eye looks low, he puts some water from one of the jugs in his pail, dashes it on the road at the apparent low spot, and if the water holds and does not run off then he knows that a repair must be made. He then starts in and ravel up the road sufficiently to incorporate the low point and resets and re-tamps by hand the macadam, adding a sufficient amount of new material to bring the grade up to a perfect surface. This is all done by hand, including the hammering, which takes the place of a roller. When he gets entirely through he again tries it out with water, and if the water runs off his job is complete, and he goes on to the next place.

It is also his duty to watch carefully for any accumulation of dust or dirt along the metalled roadbed and remove same. He is particularly vigilant in keeping his eye open for any organic matter which, in the opinion of all the highway engineers of England, is more objectionable and more destructive than any other material or all other materials combined. The cost of this sort of maintenance figures out one-half penny per square yard of road surface, and this, of course, is equal in our money to one cent per square yard.

Wherever new roads are being built through a new country, what is known as "tar macadam" is used.

Great care is taken to insure a proper cross-sectional drop for all gutters. The gutters are, as a rule, at least two feet below the road at crown and they are usually grassed. The turf is usually allowed to grow up to the side of the macadam, but is kept closely cropped. This, by the way, is one of the duties of the caretaker. Five per cent. grade is the maximum allowed for any highway.

Where an old road is to be resurfaced, two methods are used, one to scarify the surface to a depth of three or four inches and re-screen all old stone to the elimination of any fine dust or dirt, and then to relay same with sufficient new metal to insure a good bond and surface. This bond, by the way, is accomplished entirely without the use of clay, a fine gravel or a rock screening being used. A full description of this method will be found on page 9 of the report of Professor Henry P. Maybury attached hereto, and it will be noted in this connection that the aggregate is composed of 60 per cent. of stone ranging from two and one-half inches to one and three-quarters inches, and 35 per cent. from one and three-quarters inches to one and one-quarter inches, and five per cent. three-quarter-inch chippings; in other words, that no fine screenings and absolutely no dust whatsoever is used in connection with the work. The tar or pitch is applied as a grout, and the full directions for this application will be found in the specifications attached hereto.

The second method which, I am informed by Colonel Crompton, is, in his judgment, if anything, superior to the scarification method, is to surface the ordinary water-bound macadam in the following manner:

First. The road is looked over carefully and all inequalities in cross-sectional grade taken up and its surface restored to the proper camber.

Second. The road is washed thoroughly after having been swept with a horse broom. It is then allowed to dry and once more is swept by a horse broom and followed up by hand sweeping just prior to the application of the tar. This tar is mixed as per instructions in the attached specifications and is applied exactly in accordance with such instructions. The *sine qua non* is cleanliness. It must be absolutely known beyond peradventure that the road is perfectly clean to the point of being wholesome and sweet. No animal matter or organic substance of any kind must be allowed to be on the surface, and no dust whatsoever when the tar is applied. When possible, the application of the tar shall be made over the road as a whole, and all traffic kept off until acceptance of surface is indicated by the engineer. Where this is not possible, it is to be treated one-half at a time, and that half is to be fenced off by a portable fencing during the operations. As described in the specifications, after an application of the tar surface, the whole may be covered with a coating of grit or fine gravel very thinly applied, in fact, being of just sufficient body to prevent the tar adhering to the wheels of passing traffic.

Colonel Crompton took me out in his car several times over miles and miles of road thus treated, some of which had not been touched in nearly four years from the time the surface was applied, and he expressed himself at that time and subsequently as being satisfied that a surface could be maintained with perfect integrity for a period of from two to three years, and, if so, that he was satisfied that the cost of maintenance, including the caretaker, could be kept below one penny per superficial yard, this price to include the actual cost of surfacing with tar and grit or gravel. With Colonel Crompton, on one of my trips over the roads with him, was the Chief Engineer of Copenhagen, namely, M. Edward Suhr, and I found that this gentleman was a disciple of the Colonel's and had built a great many miles of road and mended a great many miles more under his guidance. He backed the Colonel up in the statements which I have just quoted as to cost. In comparing these statements with the statements contained in Professor Smith's article, which is attached, or Professor Maybury's article, which is attached, you will find that the cost is less than either of those gentlemen give, but it must be borne in mind that the statement just quoted is that of the most practical man in England as against a statement prepared to be

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read before the Institute of Engineers. In other words, both Professor Smith and Professor Maybury, while knowing their subject very thoroughly, have played safe in their statements to the point of adding a safety factor, while Colonel Crompton gave me his figures and data just as they occurred to him out of mind while passing over the road where the actual cost was represented in construction done under his guidance and charge.

Several days after my trips with Colonel Crompton, I had occasion to run out in a motor car to the Ascot races, some twenty-five miles outside of London, and finding the road to be in excellent shape in spite of the enormous traffic which it was called upon to stand at this particular time, I asked the Colonel whether or not these roads had been rebuilt, or whether they had been merely surfaced. He told me that they were very old roads, constructed on the water-bound principle, and that they had been merely resurfaced and that the resurfacing had been applied nearly three years before, that they had borne two such experiences of traffic as I saw with my own eyes, for two consecutive years, beside their ordinary heavy traffic, and that in his opinion they would stand for at least another year before anything need be done.

In connection with the surfacing of roads, or, if you choose to call it so, dust proofing, because that is really what it accomplishes, Colonel Crompton tells me that beside being sure of the cleanliness of the road, it would be well to apply the surface rather thinly, with the idea of resurfacing a second time either within the year or at latest within a year from the first application. He says that if this were done, and in his experience he has had it done several times, he is quite sure that the results will be found most gratifying and that the life of the surface will be added to very greatly, in his estimation probably 50 per cent.

I omitted to state above that for the purpose of getting at the depth of macadam for new roads, and also for the purpose of working out a statistical report concerning the surfacing of roads, a form was gotten up by the road board and sent to certain people, generally officials, in sections through which roads run, with a request that a count be made and a careful list of all kinds of traffic using the highway. I procured from Colonel Crompton one of these blanks and am attaching same to this report. From these blanks, properly filled in, a tonnage is deduced and the thickness of the macadam is arranged so as to be in direct pro-

portion to the tonnage that it is called upon to bear. The frequency with which the surfacing will be obliged to be applied will be a matter of future consideration, but will be worked up undoubtedly from these statistical reports, and from data obtained in the following manner:

At certain important points throughout the country, varying in frequency with the amount of traffic handled by the road, is established on each side of the roadway at equal readings Government Highway Bench Marks, and from these the cross section is read and known, and as the readings are repeated at regular intervals the wear of surface is known and recorded. From this it will be seen that no rule of thumb, or hit or miss method, such as is used only too frequently in our country, is allowed, but that the whole thing is the result of not only a careful observation but of careful and consistent study and calculation.

One very important recommendation by the English engineers is against sprinkling; in fact, even in the cities sprinkling has been abolished, the only use of water being the absolute washing down of the streets between the hours of two and five in the morning. The country roads are, of course, not sprinkled, and wherever the surface of the macadam has been treated under the attached specifications there is no need, as the roadway is practically dustless.

The use of asphaltum has been generally condemned and abandoned, the reason being that in the opinion of the English experts it invariably works short, that is oxidizes. It also costs more and, being thinned down, is apt to encourage the use of volatile oils which not only adds to the cost but introduces a dangerous element in the shape of a lubricant to the road.

General opinion in England is also against the use of petroleum products, it being considered that they too act as a lubricant and retard rather than encourage the natural bond of the metal in roadbed.

Before closing, I wish to emphasize what you will find explained at length in the attached reports and specifications in regard to the application of tar, that is, the necessity for applying it hot. Under no circumstances would the application of such a material, for instance as Amiesite, be tolerated. In every case tar must be thinned, dehydrated by heating, etc., immediately at the site of the work and applied by means explained in speci-

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fications at 250° Fahrenheit. In this way a perfectly satisfactory surfacing is produced, and it has been found that it is equally good at either high or low temperature. For instance, in Scotland, where the temperature drops at times quite as low as it does in this country, the surface has been found to wear perfectly through the winter and withstand the frost action in a perfectly satisfactory manner. Again, in the southern part of England, say Devon and Kent, where the temperature rises as high as it does here at times, it has been equally satisfactory.

Where the road runs through low and swampy ground, it has been found to be an extremely good plan to plant trees at frequent intervals as near the outside edge of the gutters or ditches as possible, the idea being that the rootage of such trees, particularly if they are deciduous, takes up any stagnant water which ordinarily would lie foul without flowing in the bottom of the ditches. The roots also tend to hold the gutters in place and really act as a berm protection for the road proper.

Trusting that the data which I have procured may prove of assistance to you in the good work which you are doing, and that it may be of some slight help in restoring our State to the banner place in the country in the line of road construction, I have the honor of being,

Respectfully yours,

F. S. TAINTER.

STATE OF NEW JERSEY

STANDARD Specification, Proposal, Contract and Bond

FOR CONSTRUCTION OF A PUBLIC ROAD.

Known as
From
To
In the county of.....
By.....

(Hereinafter called the Governing Body.)

WITH THE AID OF THE

STATE OF NEW JERSEY.

Specification, &c., approved
Award of contract approved
Contractor

DESCRIPTION OF ROAD.

Beginning at
in the county of
Ending at
in the county of
Length.....feet.....miles.
Width of right of way.....
Width graded between curbs.....
Width paved
Depth of pavement

HISTORY OF THE ROAD.

NOTE.—Beginning and ending points must be accurately located by reference to fixed landmarks. History of road must include reference to any documents of record.

Standard Specifications, Etc., for State Aid Roads.

I. CONDITIONS FOR APPROVAL AND ACCEPTANCE.

1. COMPETITION.

The Department of Public Roads will approve of no specifications which unduly limit competition between bidders.

2. RIGHTS OF WAY.

The department, as a consideration of approval of award of any contract, will insist on proper grants of rights of way for all lands necessary for the road and for releases from any claims for damage by construction and by forming the slopes shown in drawings both in cut and fill. Where such grants and releases cannot be secured there must be filed with the department an undertaking by the governing body to begin condemnation proceedings within thirty days of said approval against all lands as to which grants and releases have not been secured.

There will be required a certificate that the grants, releases and lands to be condemned embrace all the property needed for the road and for slopes.

3. DRAWINGS.

All drawings filed with the department must be black prints on white ground, either on cloth or cloth backed.

Size of sheets.....	22" x 42"
Scales, Plan.....	80' = 1"
Profile, horizontal.....	80' = 1"
vertical	4' or 8' = 1"
Cross sections.....	4' = 1"
Details, cross roads, entrances, &c.....	40' = 1"

Where there are several sheets and a key map is submitted therewith any scale may be used for such key; sheet must be 22" x 42". All cross roads and entrances to private property will be shown on plan, and, where the proper connection thereof with the road requires fill or cut, by profiles and cross sections on separate detail sheets. These must contain all the data necessary for calculation of the quantities involved, which quantities must be given in the calculations under head of excavation outside road.

At such points drainage will preferably be carried in paved gutters.

Drawings must show all important trees within the right of way of the road and in the slopes. Such trees as are to be removed must be indicated. This does not apply to trees less than four inches in diameter, nor in woodland where area to be cleared will be indicated.

The center and side lines of the roadway, the exterior lines of the right of way, the location of all buildings within fifty feet of the center line, and all encroachments of whatever character or description on the right of way must be shown on the drawings.

Details of retaining walls, where the same are included in the road contract, will be shown on the plan and cross-sections.

Whenever the slopes extend beyond the right of way such extensions will be shown on the plan and the names of property owners indicated.

Where the road is diverted from the previous right of way, and property taken for the new location, its ownership will be shown.

4. CHANGES AND MODIFICATIONS.

Any desired change or modification must be evidenced by an agreement in writing by the contracting parties, accompanied by the drawings necessary to show the same and, where the change involves any change in price, by a supplemental contract fixing the amount. Additions or changes, hereafter provided for, must be evidenced by written orders of the engineer. All such agreements, contracts and orders must have the approval in writing of the State Commissioner of Public Roads.

5. CONDITIONS OF ACCEPTANCE.

The road must comply with the drawings and specifications, as the same may have been modified as herein provided.

There can be no obstruction to traffic within the graded width of the road, nor any encroachment on the right of way. Sign posts, letter boxes, lamp posts, telegraph or telephone poles, must be removed outside of the gutter lines. Fences must be set back to the exterior lines of the right of way unless otherwise specified or shown on drawings. Pipes or cross bridges in and over gutters must be removed where they offer any obstruction to traffic or interfere with the cross-section, as shown on drawings.

Intersecting roads and entrances must be so graded as not to drain on the road or its shoulders or interfere with the drainage of the gutters.

Bridges, viaducts, ropes, wires, branches of trees, &c., crossing or overhanging the road, must be at least fourteen feet above the graded surface.

II. GENERAL PROVISIONS.

6. WORK TO BE PERFORMED.

The work to be performed will consist in furnishing all material, tools, machinery and labor necessary for the efficient and proper grading of roadway, side ditches and side banks, laying, spreading material and rolling of road, and all other work of construction incidental thereto. The roadway will be left complete in every manner, free from obstruction and ready for immediate

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use. The maintenance of the road in condition for one year after the date of acceptance by the State Commissioner of Public Roads is a part of the work.

7. DRAWINGS.

The plans, profile and cross-sections on file in the office of the State Commissioner of Public Roads and at the office of.....
engineer,New Jersey, show
 general location, profile, details and dimensions. The work will be constructed in all respects according to the above-mentioned plan, profile and cross-sections, which form part of these specifications.

On all drawings, figured dimensions are to govern in cases of discrepancy between scale and figures.

8. ENGINEER.

The engineer shall be selected by the governing body. He shall furnish all surveys, drawings, specifications and estimates of quantities. He shall set stakes for all lines and grades required for the completion of the work as may be required by the State Commissioner of Public Roads. He shall furnish certificates of the quantities of work done before partial payments can be made, the quantity of road laid being determined by surface measurements. Should any difference arise between the contracting parties as to the meaning or intent of these specifications, his decision on these matters, when approved by the State Commissioner of Public Roads, is to be final and conclusive.

All instructions necessary to give due and full effect to any of the provisions of these specifications shall be given by him.

All material and workmanship of any kind shall be subject at all times to his inspection. Whenever unfaithful or imperfect work or unsuitable material is discovered, he will immediately condemn it and it will at once be repaired or removed from the work and replaced with proper material.

9. INSPECTOR.

Nothing in these specifications relating to the duties of the engineer shall be taken or construed in any manner to conflict with the duties of the inspector, as specifically set forth in the act entitled "An act to provide for the permanent improvement and maintenance of public roads in this State," approved..... He will verify the engineer's estimates of quantities and must sign the certificates thereof required for payments.

10. STOPPING WORK ON ACCOUNT OF WEATHER.

The State Commissioner of Public Roads, engineer or inspector may stop any portion of the work, if, in their judgment, the weather is such as to prevent the same being done properly. No allowance of any kind will be made for such stoppage, except an extension of the time for the completion of the work as herein provided. All bituminous pavements, built by penetration or mixing methods, laid either hot or cold, must be constructed after the first

day of May and before the fifteenth day of October, unless permission is given by the State Commissioner of Public roads in writing to lay these before or after the above dates.

11. ABANDONMENT OF CONTRACT.

If at any time the work under contract should be abandoned, or if at any time the engineer or State Commissioner of Public Roads should judge and so certify in writing to the governing body that said work, or any part thereof, is unnecessarily delayed, or that the contractor is willfully violating any of the conditions or covenants of this contract, or is executing the same in bad faith, then, in that case the engineer or governing body shall notify the said contractor to discontinue all work under this contract. The governing body may employ other parties to complete the work in such manner as it may decide, and use such material as may be found upon the line of aforesaid work, and, if necessary, procure other material for its completion, and charge the expense of the said labor and material to the contractor, which expense shall be deducted from any moneys due him under contract. In case these expenses shall exceed the sum which would have been payable under contract, if the same had been completed by said contractor, he or his bondsmen shall pay the amount of the excess to the governing body, on demand.

12. DUTIES OF CONTRACTOR.

He shall maintain sufficient guards by day and night to prevent accidents from travel, and will be liable for any damage which may arise from any negligence on his part or that of his agents and employees.

He is to commence and prosecute the work upon the road at the end farthest from the source of supply of material, unless otherwise ordered by the engineer, withindays from the approval of the contract by the State Commissioner of Public Roads and shall continue work thereon until completion, except as herein provided.

The contractor will be required to preserve all stakes and bench-marks made and established on the line of work until duly authorized by the engineer to remove the same. All stakes or bench-marks disturbed or removed by the contractor or his agents without the permission of the engineer shall be replaced at the expense of the contractor.

The contractor shall not disturb the position of title stones (the corners of properties adjacent to the road), but where they appear he will either lift or lower them, under the personal supervision of the engineer.

The contractor must also preserve the roadway on which he is working from needless obstruction, and where necessary he must construct and maintain safe and commodious crossings for the residents along the line of the road.

All loss or damage arising from the nature of the work to be done, from the action of the elements or from any unforeseen or unusual obstruction or difficulty, which may be encountered in the prosecution of said work or during the period of maintenance, shall be borne by the contractor.

The contractor shall employ competent men to do the work. Whenever the engineer and inspector shall inform him or his representatives in charge, in writing, that any man on the work is unfitted for the place, or is working contrary to the provisions of the specifications or the instructions of the engineer and inspector, he shall thereupon be discharged.

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The contractor shall not assign or sub-let any portion of this contract without the written consent of the governing body and the State Commissioner of Public Roads.

13. COMPLETION AND MAINTENANCE, &C.

The work is to be completed on or before the..... day of....., A. D..... Twenty dollars for each day that the work shall remain uncompleted, after the time allowed by contract, shall be deducted, as liquidated damages, from any moneys due contractor, unless the date of completion is extended by the governing body, with the written approval of the State Commissioner of Public Roads, after presentation of certificate of the engineer recommending such extension.

The contractor shall keep the finished roadway, shoulders, side slopes, ditches and underdrains in repair and free from obstructions, and shall make good any settlement in the work or other defect therein for the period of one year from the date of its completion and acceptance by the State Commissioner of Public Roads, and, in addition thereto, for as much longer as for any period or periods during said year it shall be out of proper condition. If, during that time, the roadway or any part of the work shall, in the judgment of the engineer and the governing body, require repairing, and they shall duly notify the contractor to make such repairs as required, and if the contractor should refuse or neglect to do so, within five days from the date of service of notice, then the said body shall have the right to have the work done as it may see fit, and to recover the cost thereof by deducting the same from any moneys due to said contractor, or by an action at law against the contractor or his surety, or by both methods. Such work of maintenance as the engineer shall certify to be necessary must be done before the payment of the remainder. In case of the contractor's failure to do such work, the governing body, shall have the work done as it may see fit and recover the cost as above provided.

14. BIDS.

Bids will be received under these specifications for the completion of the whole work. The total or lump sum bid will govern in the awarding of the contract. The contractor must give separate prices per unit of measure for each of the several classes of work to be performed, as given in the estimate of quantities. The sum of the estimated quantities multiplied by the prices per unit of measure, should equal the lump sum bid for the entire work. No bids will be considered in which all of the necessary items are not filled out for at least one complete method of construction.

The right is reserved to reject any or all bids, if deemed to the interest of the.....or State.

15. CHECK ACCOMPANYING BIDS.

Each bidder will accompany his bid with a certified check, payable to the order of the financial officer of the governing body, in the sum of one thousand dollars (\$1,000), as a guarantee that if the contract shall be awarded to him

he will, within thirty days of said award, execute the form of contract hereto attached and the bond hereinafter required. Upon failure by the contractor to enter into said contract and to deliver said bond, the certified check shall be forfeited as liquidated damages.

16. BOND OF CONTRACTOR.

The contractor will be required to execute and deliver, within thirty days of awarding of contract, and as condition of approval of said award, a bond with such sureties as shall be approved by the governing body to secure the faithful performance of the contract and to indemnify and save harmless the said body from all suits or actions of any name or description brought against it on account of any act or omission of the contractor or his agents, also to secure the payment of all laborers and material men who have performed work or furnished material to the contractor in the prosecution of the work. Said bond shall be in a sum of not less than the estimated cost of the road. Any change made in the plans, specifications, agreements or quantities without the consent of the bondsmen shall in no way vitiate said bond.

17. PAYMENTS.

Monthly payments will be made by the governing body to the contractor for work performed to an amount not to exceed eighty per cent. of the amount then due, upon presentation by him of the proper certificates of the engineer and inspector. Upon completion and presentation of a final estimate, signed by the engineer and inspector, and the written acceptance of the work by the State Commissioner of Public Roads, fifteen per cent. will be paid by the governing body. The remainder, or five per cent., will be retained by said body for a period of one year as further security for the faithful performance of Article 13, and will be paid on certificate of the engineer, approved in writing by the State Commissioner of Public Roads.

Whenever work is stopped, as provided in section 10, the engineer and inspector may issue a certificate for the full contract price less one hundred and twenty-five per cent. of the value of the portion of the work remaining undone and the said five per cent.

The contractor must, before receipt of any certificate calling for a payment, furnish the engineer with satisfactory evidence, verified under oath, that all persons who have done work, or furnished material for this contract, or who have sustained damage or injury by reason of any act, omission or carelessness on his part or his agents in the prosecution of the work, have been duly paid or so secured that no liability can attach to said body on account of any such claim.

18. RIGHT TO BUILD BRIDGES, CULVERTS, ETC.

The right of the county to build bridges, culverts, and place guard rails in said road during the progress and prior to the completion of the work is expressly reserved.

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III. EARTH WORK, WORKMANSHIP, &c.

19. GENERAL.

Under this head will be included all excavation and embankment required for the formation of the highway, cutting all ditches or drains about or contiguous to the road, removing all fences, walls, buildings, trees, poles or other obstructions, the excavation and embankment necessary for reconstructing cross or branch roads or entrances to dwellings and all other excavation and embankment connected with the construction of the said road, including the rolling of the sub-foundation and construction of retaining walls.

20. EXCAVATION.

The roadway, intersecting, cross or branch roads, and entrances to dwellings are to be excavated or built to the widths and depths as shown on the drawings. The crown, from center to sides, must not exceed three-quarters of an inch per foot.

The grading shall be completed for the full width of the road, between outer edges of slopes, before any second course work is commenced.

21. EMBANKMENT.

Material taken from excavation, except when otherwise directed by the engineer, shall be deposited in embankment, either on the roadway or sidewalks. Rejected or excess material will be used to increase the width of embankment, or deposited in spoil banks or waste piles, as and where the engineer may direct, either within or without the road. In case there is not sufficient material in the excavation to form the embankment, the deficiency shall be supplied by the contractor from without the line of the road. The character of said material and place of excavation must be approved by the engineer.

The use of vegetable matter will not be permitted excepting on the outer edge of slopes.

The embankment will be formed in layers not to exceed one (1) foot in depth. The required allowance for settling must be added. Each layer shall be carried across the entire width of the embankment and completed before commencing another, and this method shall be followed with each succeeding layer until the established grade is reached.

22. SLOPES.

Slopes in both excavation and embankment shall be one and one-half ($1\frac{1}{2}$) horizontal to one (1) vertical, unless otherwise shown on cross sections.

23. GRUBBING.

The contractor will also be required, when the engineer so directs, to grub and remove from a strip of land.....feet on outside of curb-lines, all objectionable material, such as trees, stumps, roots and brush, and refill the holes with earth. This work will not be required unless a figure is given therefor in the Estimate of Quantities.

24. SUB-FOUNDATIONS.

The cross-section of sub-grade must conform in every respect to the cross-section of the road on plans, and will be rolled when possible, until smooth, firm and hard. If any depressions form under such rolling, the same shall be filled; any improper material shall be removed and good earth or other acceptable material substituted.

The sub-foundation of intersecting roads and of driveways leading to dwellings located along the road, if indicated on the plans, shall be properly graded and sub-foundations rolled.

Grading will not extend beyond the right-of-way of the road, excepting where otherwise shown in drawings.

After the road-bed has been prepared and properly rolled the same shall beinches below the intended surface of the roadway; the surface thereof shall not be disturbed by any unnecessary carting or hauling upon it, but if the surface is disturbed the same shall be re-formed and re-rolled before the spreading of foundation material.

25. FINAL FINISH OF SLOPES AND SHOULDERS.

The final finish of slopes and shoulders, in both excavation and embankment, must be completed before the spreading of the second course of road surface material. After such spreading no work will be allowed upon either slopes or shoulders that will tend to deposit any earth upon the work.

26. SHOULDERING.

A shoulder of firm earth or gravel, found anywhere along the line of the road, is to be left or made on each side, extending at the same grade and curvature of road to side ditches or gutters. This shoulder is to be thoroughly rolled and compacted.

27. SIDE DITCHES OR GUTTERS.

The side ditches or gutters are to be excavated as per stakes furnished by engineer, in order to give an easy flow of water; no water shall be left standing on the road or in the ditches.

28. PAVED GUTTERS.

Gutters shall be paved with concrete, stone blocks or cobble stones for the lengths and widths as shown on plans. The engineer may, however, change the location of paved gutters; he may increase the amount, which excess will be paid for as extra at the unit price bid therefor. See section 4.

If concrete gutters are used they shall rest on a sub-foundation of cinders or sharp sand, not less than six inches thick; the concrete shall be composed of broken stone, or screened gravel, and sand and Portland cement, in ratio of 5, 3 and 1, and shall be not less than 4 inches in thickness.

If stone blocks are used, they must rest on a bed of good sharp sand or gravel of a depth not less thaninches below the blocks.

The blocks shall be laid vertically on edge and parallel with the line of the gutter. All end joints must be broken by a lap of at least three (3) inches.

After the blocks are laid as above specified, the surface of the blocks must be covered with fine, dry sand, which shall be swept until the joints are completely filled. The blocks shall be then carefully rammed to a firm, unyielding bed, with a uniform surface and with the proper grade and curvature. After ramming the blocks the surface of the same shall be again covered with fine, dry sand, and again swept until all the joints are filled.

If cobble stones are used, the contractor shall proceed as above provided. The stones are to be set upon their small ends, with their greatest dimensions vertical and with their greatest horizontal dimensions parallel with the line of the gutter.

After the cobbles are laid as above specified, the same are to be covered with sand, rammed and again covered with sand, as provided above. All stones broken in ramming shall be removed and replaced with perfect stones.

The cost of excavating for gutters must be included in the price bid for paving.

29. UNDERDRAINS.

Tile underdrains, as shown on plans, shall be constructed by the contractor of good.....inch round, porous tile. The top of the tile shall be at least.....inches deep, unless otherwise directed by the engineer; the joints shall be covered with salt hay, or material equally as good, and the trench filled with pervious earth. Additional underdrains, if found necessary, may be ordered in by the engineer, and when so ordered will be paid for as an extra at the unit price bid therefor, which will include the necessary excavation.

When directed by the engineer, a stone drain may be used in place of the tile drain. A trench.....wide and.....deep shall be excavated below the sub-grade, said excavation to be filled with loose broken stone to within.....inches of finished grade, then covered with salt hay or brush and fill completed with porous soil.

When directed by engineer, a French drain may be used. The trench shall bewide and.....deep below sub-grade; at the bottom shall be placed a.....inch round, porous tile as above specified. The trench shall be filled with broken stone and finished as above specified.

30. PROVISION FOR DRAINAGE.

If it be necessary in the prosecution of the work to interrupt or obstruct the natural drainage of the surface, or the flow of artificial drains, the contractor shall provide for the same during the progress of the work in such a way that no damage shall result to either public or private interests. He shall be held liable for all damages which may result from any neglect to provide for either natural or artificial drainage, which he may have interrupted.

31. MANNER OF ROLLING.

In rolling, the roller must start from the side lines and work towards the center, unless otherwise directed. The rolling shall at all times be subject to the directions of the engineer and inspector. The rolling will, in all cases, be carried on until the work is approved by the inspector or engineer.

All rolling of stone work must be done with a ten (10) ton standard steam macadam roller, so constructed as to give a compressing power of not less than four hundred (400) pounds per lineal inch on drivers; said roller must meet the approval of the engineer. Bituminous pavements may be rolled with an approved tandem roller, if the engineer so directs.

Rolling in gravel roads may be done with a horse-roller, acceptable to the engineer.

32. BROAD-TIRE WAGONS.

All wagons and carts used during the construction for hauling stone, earth, or any other materials must have tires not less than three and one-half ($3\frac{1}{2}$) inches in width.

33. OBSTRUCTIONS.

All obstructions to traffic between the curb lines must be removed by the contractor. (See section 5.) The contractor will replace in proper position outside of said lines any obstruction so removed that is the property of any municipal body, also letter boxes. He will be required to reset all fences moved during the work that did not encroach on the right of way when work was begun, but not otherwise, unless the same are specifically mentioned.

33a. RETAINING WALLS.

Retaining walls will be of concrete or rubble masonry.

Concrete will be composed of one part Portland cement..... parts sharp sand and parts of..... will be mixed on boards by hand or in an approved batch mixer and used while fresh and without tempering. Masonry walls will be laid in cement mortar of one part cement and three parts of sharp sand. The stones will break joints longitudinally and transversely and the walls be thoroughly bonded. The wall will be drained by weep holes of 4" tile spaced..... feet apart.

IV. MATERIALS.

34. GENERAL.

All materials used in building the road are to be furnished by the contractor. Bidders will submit samples of such materials as are hereinafter designated, to the engineer at his office and to the State Commissioner of Public Roads at the Road Department in Trenton. This should be done at least ten days before the opening of bids so as to allow time to submit new samples in case of rejection. No samples will be received for examination after bids have been opened.

The following materials when used must be submitted by samples which will be plainly labelled with the bidder's name, the class of material and its origin:

Broken stone in two-pound bags or boxes.

Binder, gravel and sand in two-pound bags or boxes.

Bituminous cements, fluxed and ready for use, in one-pound tins.

Bidders may adopt approved samples on file by giving the State Commis-

sioner of Public Roads notification of such desire in writing before bids are opened.

Bidders will, in addition, submit samples of bituminous concrete pavement.

These samples must represent the physical structure and composition of the pavement as laid; they must be three in number for each style of pavement proposed, of the specified thickness and four inches square.

All bituminous cements hereinafter specified, shall be shipped ready for use without further fluxing at the mixing plant or roadside. No bituminous materials shall be used until tested and released by the Department of Public Roads.

Samples of each car load or tank must be submitted. Such samples may be taken before shipment, under special arrangement in each case with the department, or in default thereof must be taken by the engineer or inspector on arrival at the terminal nearest the work or at any other convenient point.

35. TELFORD.

Telford base stone must be hard and tough.

No stone of greater length than ten (10) inches or width of four (4) inches shall be used, except each alternate stone on outer edge, which shall be double the length of the others and well tied into the bed of the road. All stones with a flat, smooth surface must be broken.

36. BROKEN STONE.

All stone must be as nearly cubical as possible, broken with the most approved modern stone crushing machinery. It must be of trap or approved native rock, free from all screenings, clay, soil or other objectionable substances, of uniform size and of the same kind and quality as sample. It must show a fresh, crystalline surface.

Macadam Foundation or two and one-half-inch stone shall be broken stone, which must pass through a three-inch ring and catch on a two-inch ring.

Macadam Second Course or one and one-half-inch stone shall be broken stone, which must pass through a two-inch ring and catch on a one-inch ring.

Macadam Surface or three-quarter-inch stone shall be broken stone, containing not over 5 per cent. of material retained on one-inch circular openings or 8 per cent. which will pass one-half-inch circular openings.

Dustless Screenings shall be broken stone containing not over 5 per cent. of material retained on $\frac{5}{8}$ -inch circular openings or 8 per cent. which will pass one-quarter-inch circular openings.

Dust shall be broken stone and include all material which will pass one-quarter-inch circular openings, but must be free from soil, loam or clay.

37. GRAVEL AND SAND.

Road Gravel A is to be composed of pebbles, chert, sand, clay and oxide or hydrate of iron, in such quantities that the gravel will pack under pressure into a hard, dense pavement. It will be judged solely by comparison with the samples furnished.

Road Gravel B is gravel not deemed suitable for surface work, but may, on approval of sample by the Engineer and State Commissioner of Public Roads, be used for foundations of gravel roads.

Sand and gravel not containing enough clay or earthy material to pack satisfactorily may be used as binder with stone on approval of engineer.

No gravel shall contain over 20 per cent. of material which will not pass one-inch circular openings.

Sand, unless otherwise specified, shall be hard-grained quartz sand, moderately sharp, free from loam, clay or other foreign materials, uniformly graded in size.

38. STONE BLOCKS.

They shall be of the best quality of rock and subject to the approval of the engineer and inspector. Each block shall measure not less than eight (8) nor more than twelve (12) inches in length, not less than three and one-half ($3\frac{1}{2}$) nor more than four and one-half ($4\frac{1}{2}$) inches in width, and not less than seven (7) nor more than eight (8) inches in depth. All blocks shall be of the same quality as to hardness, color and grain. No outcrop, soft, brittle or laminated stone will be accepted. The blocks must be split and dressed so as to form, when laid, close end joints not exceeding one-half ($\frac{1}{2}$) inch in width, top and bottom, with fair and true surfaces on top, bottom and ends.

39. COBBLE STONES.

The cobbles must be good, hard, sound stone and of as uniform size as practicable. Medium size stone, not over five (5) inch face on its longest diameter, must be used, excepting for center line and side lines of gutter, where eight (8) inch stone may be used.

40. TILES.

Round, porous tile shall be well burnt and true in form and size, free from cracks, chipping or other defects.

Vitrified tile shall be well burnt, true to form and size, free from cracks, blisters or other defects, and of sufficient strength for the work.

41. BITUMINOUS CEMENTS.

Must be free from water, uniform and homogeneous. They must pass the requirements designated below for the respective type of pavement for which they are intended to be used.

42. ASPHALT CEMENTS.

Asphalt cements may be made from petroleum or from fluxed or unfluxed refined natural asphalts, and must be free from tar or tar products. Their chemical constituents and physical properties may vary with the character of the road surface for which they will be used.

GRADES.

	A.		B.		C.		D.		E.		F.		G.		H.		I.		J.		K.	
	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.
1. Specific Gravity	.990	.....	.995	.....	1.00	.....	1.015	.....	1.010	.....	0.98	.....	0.99	.....	1.00	.....	1.01	.....	.....	.....	.....	.....
2. Penetration .....	.....	.....	.....	.....	120	140	60	90	140	160	120	140	90	110	90	100	60	70	.....	.....	.....	.....
3. Penetration after Evapora- tion	65	.....	65	.....	50	85	45	65	50	90	70	100	65	95	65	85	45	60	.....	.....	.....	.....
4. Evaporation Loss .....	.....	0.5%	.....	15.%	.....	5.%	.....	5.%	.....	5.%	.....	1.0%	.....	1.0%	.....	1.0%	.....	1.%	.....	.....	.....	.....
5. Solubility in CS ₂ , Residual Asphalts	99.5%	.....	99.5%	.....	99.5%	.....	99.5%	.....	99.5%	.....	99.5%	.....	99.5%	.....	99.8%	.....	99.8%	.....	.....	.....	.....	.....
6. Flash Point, C.	85°	.....	85°	.....	175°	.....	175°	.....	175°	.....	175°	.....	175°	.....	175°	.....	175°	.....	.....	.....	.....	.....
7. Ductility at 50 Penetration..	.....	.....	20	.....	15	.....	25	.....	25	.....	3.5	.....	3.5	.....	25	.....	30	.....	.....	.....	.....	.....
8. Viscosity at 90° C.	480	660	540	720	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
9. Paraffin Scale .....	.....	3.%	.....	3.%	.....	3.%	.....	3.%	.....	3.%	.....	4.0%	.....	4.0%	.....	1.0%	.....	1.0%	.....	.....	.....	.....

The above tests are to be made in the manner designated herein below :

1. "Specific Gravity" is taken at 15.5° C. in a regular picnometer bulb, on grades C and E at 100 penetration. The bulb is first filled nearly full of the hot bitumen and, when cool, weighed. It is then placed in a bath of water kept at 15.5° C. for two hours, filled with distilled water at the same temperature and re-weighed.
- 2-3. "Penetrations" are taken at 25° C. with a Dow Penetration Machine, using a No. 2 needle applied for five seconds under a 100-gram load.
4. "Evaporation Loss" is determined by heating continuously twenty grams of the bitumen in a tin dish two and one-quarter inches in diameter by one inch deep for a period of five hours in a closed air bath kept at 163° C.
5. "Solubility" is the bitumen soluble in cold C. P. carbon bisulphide.
6. "Flash Point" is determined in a New York State Closed Oil Tester.
7. "Ductility." These tests are all taken at 25° C. on a Dow Ductility Machine. The briquette pulled is cast in a regular Dow mold. It is kept at 25° C. for two hours before testing. When softer than desired, the bitumen must not be heated above 204° C. during concentration.
8. "Viscosity." An Engler Viscosimeter is used. The first 50 cm.³ only are recorded.
9. "Paraffin Scale" is determined by the distillation modification of the Holde Method.

43. TAR CEMENTS.

Tar may be either coal tar or petroleum tar. The former will be known as bituminous material L, M and N, and the latter R, S, T and U. They must be free from water and comply with the following requirements:

GRADES.

	L.		M.		N.		O.		R.		S.		T.		U.		V.	
	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.
1. Specific Gravity	1.17	1.24	1.22	1.30	1.15	1.22	.....	.....	1.120	1.155	1.14	1.16	1.155	1.175	1.120	1.155	.....	.....
2. Penetration											350		240	260				
3. Float Test, seconds.....			150	210					30	70	80	120	140	180	30	70		
4. Viscosity at 90° C.....	45	85			40	80			40	80	210	300	480	540	40	80		
5. Free Carbon	10.%	20.%	15.%	25.%	10.%	20.%				15.%		2.0%		2.0%		1.5%		
6. Evaporation Loss		20.%		10.%		30.%				10.%		7.%		5.%		25.%		
7. Penetration of Residue.....									80		100		40		70			
8. Distillation 0°-170° C.....		0.1%		0.1%		5.0%	0.1%			0.1%		0.1%		0.1%		5.0%		
9. Distillation 170°-300° C.....		35.0%		15.0%		35.%				17.0%		15.0%		15.0%		25.%		
10. Naphthalene content of total Distillates.....		7.0%		5.0%		5.0%				2.0%		2.0%		2.0%		2.0%		

The above tests are to be made in the manner designated herein below:

1. Same as for asphalt cements.
2. Same as for asphalt cements.
3. The New York Testing Laboratory Viscosimeter is used. The water must be kept at 50° C.
4. The cement is first passed through a 20-mesh sieve, then tested as given for asphalt cements.
5. Carbon bisulphide is the solvent used, the material is filtered as soon as in solution.
6. Same as for asphalt cements, but for 21 hours at 105° C.
7. Same as for asphalt cements.
- 8-9. One hundred grams of the cement are distilled in a standard 250 cm.³ Engler Distilling Flask. The per cent. of distillate is determined by weight, and the heating is continuous.
10. The distillate is cooled to 0° C, and the naphthalene is filtered off and determined by weight.

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LEGEND.

Bituminous cements A & B are heavy liquid asphalts, and can be used in constructing road surfaces, B, C, D, E & F.

Bituminous cements C, E, F & G are soft asphalt cements, and can be used in constructing road surfaces, Types C, E & F.

Bituminous cement D is a medium soft asphalt cement to be used in constructing road surface, Type G.

Road surface Type H will be constructed with bituminous cement E.

Bituminous cements L, N, R & U are soft tars (N & U being "cut backs"), and can be used in constructing road surfaces, Types B, C, D, E & F.

Bituminous cements M & S are soft tar pitches, and can be used in constructing road surfaces, Types C, E & F.

Road surface Type G can be constructed with bituminous cements M & T.

44. CEMENT.

Cement will be Portland cement, meeting in all respects the standard of the American Society of Civil Engineers.

V. FOUNDATIONS.

45. GENERAL.

The roadbed, having been formed and rolled as hereinbefore specified, must be inspected and approved by the engineer and inspector before any material is placed thereon.

The foundation will be of any of the following types, as designated in the Estimate of Quantities.

46. TYPE A.

Concrete foundation to be composed of one part of Portland cement, of sharp sand, and of by weight and inches in depth. The concrete must be freshly mixed when applied, no rettempering being allowed. It must be thoroughly mixed, either by hand on mixing boards or in an approved concrete mixer, and must be thoroughly wet. As soon as laid the concrete will be thoroughly rolled or tamped until consolidated.

This foundation must be laid true to the required curvature as determined by a template applied to the surface.

47. TYPE B. TELFORD FOUNDATION.

A bottom course of stone, of an average depth of inches, is to be set by hand as a close, firm pavement, the stones to be placed on edge, broadest edge down, lengthwise across the road in such manner as to break joints as much as possible, the breadth of the upper edge not to exceed four (4) inches. The interstices are then to be filled with stone chips, firmly wedged by hand with a hammer, and projecting points broken off.

48. TYPE C. MACADAM FOUNDATION.

A bottom layer of broken stone, consisting of two and one-half ($2\frac{1}{2}$) inch stone, shall be deposited in a uniform layer, having a depth of inches, and rolled repeatedly until compacted to the satisfaction of the engineer and inspector.

The depth of loose stone in this and all other courses must be measured by blocks the required thickness of the said loose stone. These blocks must be placed at frequent intervals amid the loose stone when being spread.

49. BINDER ON THE FOUNDATION.

On the first course of stone, whether type B or C, a quantity of stone screenings, gravel or sand, or mixture thereof, will be spread in a uniform layer, and the whole rolled until the stone ceases to sink or creep in front of the roller. The binder shall not be applied in sufficient quantity to completely cover or form a coating upon this course of stone. Before, and until the second course of stone is spread, the first course must be firmly bound together, of the proper grade and curvature, and free from all ruts or loose surface stone.

50. TYPE D. GRAVEL B FOUNDATION.

When road gravel B is to be used as foundation material it will be spread over the sub-foundation to a depth of inches in the middle and inches at the shoulders. The material will then be brought to a smooth, even and hard surface by rolling and scraping, as directed by the engineer, and, if deemed necessary by him, shall be watered so as to secure proper consolidation.

VI. ROAD SURFACES.

51. GENERAL.

Under this heading will be included all work and material necessary to complete the road from the foundation up. In all cases where bituminous cement is used the foundation must be dry and swept clean of superfluous binder or loose stone when the surface pavement is laid. No travel will be allowed on or over the bituminous material until the work is complete.

The furnaces or ovens used for heating all mineral aggregates must be so constructed that the latter will be uniformly heated and be approved by the State Department of Public Roads. The temperature of these mineral aggregates when ready to be coated with the bitumen, must not be less than 120° C. or over 200° C. The mixing of all mineral aggregates with a bitumen, must be done in an approved asphalt mixer which will uniformly coat these aggregates with the bitumen.

All bituminous cements having a penetration of less than 300 at 25° C. must be heated in approved heaters which will heat them uniformly without burning or coking. The bitumen must have a temperature of not less than 120° C. when used and be free from unmelted lumps, but at no time shall it be heated above 200° C.

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The contractor must keep on hand a regular asphalt thermometer and provide such measures or scales as the department may deem necessary to secure the required amount of bitumen or to determine the amounts of the various ingredients composing the mineral aggregate, needed to make the pavement of the proper composition.

52. TYPE A. MACADAM.

Shall consist of one and one-half ($1\frac{1}{2}$) inch stone. This shall be spread in a uniform layer having a depth of.....inches, loose measure, and rolled until thoroughly settled into place to the satisfaction of the engineer and inspector.

Binder on this course of stone must be applied in the same manner as binder on foundation.

When the one and one-half ($1\frac{1}{2}$) inch stone has been rolled, a coat of fifty (50) per cent. of three-quarters ($\frac{3}{4}$) inch stone and fifty (50) per cent. of screenings, properly mixed, is to be spread, of sufficient thickness to make a smooth and uniform surface, then again rolled until the road becomes thoroughly consolidated, hard and smooth.

Any depressions formed during the rolling, or from any other cause, are to be filled with one and one-half ($1\frac{1}{2}$) inch stone, or three-quarters ($\frac{3}{4}$) inch stone, or both, and screenings, approved by the engineer, and the roadway brought to the proper grade and curvature, as determined by him.

Water must be applied in such quantities, at such times and in such manner as directed by the engineer or inspector.

53. TYPE B. MACADAM WITH A BITUMINOUS DRESSING.

The second course of one and one-half ($1\frac{1}{2}$) inch stone shall be spreadinches thick, loose measure, and rolled as directed for Type A. It shall be bound with screenings or sand. This binder should be dry when spread and rolled until it has fallen into the voids. Just enough should be added to fill the voids, but not sufficient to form a layer on top of the one and one-half ($1\frac{1}{2}$) inch stone. Water shall be applied as directed in Type A. Bituminous cement.....will then be applied from an approved pressure distributor at a temperature of not less than 80° C. and at the rate of five pounds of bitumen per square yard. This cement may be spread in two coatings if so ordered by the department, but can only be applied during clear, hot weather, and the road surface moistened just before it is applied. Sand or screenings previously distributed along the work will then be applied to a thickness of three-quarters ($\frac{3}{4}$) of an inch. The road should not be rolled until the sun has drawn the bituminous cement as near the surface as possible. Should bituminous material appear on the surface, more sand or screenings will be applied at these points and the road rerolled. A thin coating of sand or screenings must cover the finished work.

54. TYPE C. BITUMINOUS MACADAM.

The second course of one and one-half ($1\frac{1}{2}$) inch stone shall be spreadinches thick, loose measure, and rolled as directed for Type A. The voids shall then be filled with dustless screenings and three-quarter ($\frac{3}{4}$)

inch stone until about 75 per cent. of them have been filled. This material must be dry when spread and the road rolled repeatedly until the fine stone has settled into the voids. Bituminous cement.....shall then be spread by hand or by an approved pressure distributor in a uniform layer at the rate of 10 pounds of bitumen per square yard. A layer of three-quarter ($\frac{3}{4}$) inch stone and dustless screenings shall be spread at once and the road rolled until firmly consolidated. A second application of bitumen shall then be made at the rate of 5 pounds per square yard, covered at once with a coating of screenings and the road again rolled until it has the proper density and surface.

The stone must be dry when coated with the bitumen and the road protected from travel from the time the top course is spread until the bitumen has been applied.

The bitumen must have a temperature of not less than 120° C. or over 180° C. when applied.

55. TYPE D. BITUMINOUS MACADAM.

The second course of one and one-half ($1\frac{1}{2}$) inch stone shall be spreadinches thick, loose measure, and rolled as directed for Type A. About 50 per cent. of the voids shall then be filled with clean, dry quartz sand and the road rolled as directed for Type C. This sand must be free from loam, clay or lumps of ferruginous cemented sand, and contain not over 5 per cent. of material retained on $\frac{1}{2}$ -inch circular openings or over 20 per cent. which will pass a 120 mesh sieve. Bituminous cement.....shall then be applied in the same manner and quantity as specified for Type C. A layer of $\frac{3}{4}$ -inch stone shall be spread at once, the road rolled until consolidated, and finished in the same manner as given for Type C, except the minimum temperature limit of the bitumen is 85° C. when applied.

When the bitumen is applied, the sand must be in the bottom voids, which in no case shall be filled over 75 per cent. full. The sand must be dumped on the sides of the road and then spread. It must not be spread from the wagon or dumped on the second course of stone.

56. TYPE E. BITUMINOUS MORTAR MACADAM.

The second course of one and one-half ($1\frac{1}{2}$) inch stone shall be spread two inches thick, loose measure, and rolled until firmly settled into place. Bituminous mortar as specified in Type F shall be spread in two courses at the rate of 75 pounds per square yard. The first application shall be about 50 pounds per square yard and rolled well into the voids before the second application is made. The stone must be dry and clean when this mortar is spread. After being rolled, all travel must be kept off these stones until they have been covered with the mortar.

TYPE E-E.

Upon the soft, fresh concrete foundation there shall be spread a single layer of cubical one and one-half inch stone, which shall be tamped into the concrete until the upper edges and corners are about one-quarter of an inch below the finished surface of the road and three-quarters of an inch above the concrete. As soon as the concrete has set so that these stones are held

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firmly in place, a layer of bituminous mortar shall be spread over them and rolled at once. This mortar shall be prepared and rolled in the same manner as specified in Type F. The final bituminous pavement shall be not less than one inch thick after ultimate compression.

57. TYPE F. BITUMINOUS MORTAR.

When the foundation is macadam or telford the binder in the top portion of the voids will be removed by sweeping, to a depth of about one-half inch. Upon the surface thus prepared, a layer of bituminous mortar shall be spread in sufficient quantity to fill all the voids in the base and form a layer of this material having a thickness of not less than one and one-half inches after ultimate compression.

This will be rolled firmly into place, covered at once with dry, clean sand, again rolled, leaving a thin coat of sand on the surface. The road must be protected from all travel and kept clean until the bituminous surface coat has been given its final rolling. The bituminous mortar must contain not less than eight or more than eleven per cent. of bitumen soluble in carbon bisulphide. The exact amount of bitumen to use between these limits shall be determined by the State Department of Public Roads. Bituminous cements..... shall be used.

The mineral aggregate will consist of clean quartz sand, and must be dry when coated. This sand must be free from loam, clay or lumps of ferruginous cemented sand, and contain not over five per cent. of material retained on one-half-inch circular openings or over twenty per cent. which will pass a 120-mesh sieve.

The bituminous mortar must have an average temperature of not less than 110° C. when delivered on the road if prepared by the hot mixing method. It must be prepared in a manner approved by the State Department of Public Roads.

58. BITUMINOUS CONCRETE PAVEMENTS.

Bituminous concrete pavements are defined as pavements composed of stone, clean sand and a satisfactory filler, bound together with bituminous cement.

The mineral aggregate must not contain any material but what will pass an opening two inches in diameter.

The proportion of the different sized ingredients forming the mineral aggregate which the contractor desires to use, must be submitted to and be approved by the State Department of Public Roads.

These pavements must present an even surface, free from depressions which will hold water.

Porous spots which remain wet after the surrounding surface has dried must be replaced with proper material.

These pavements must be of uniform composition, thoroughly bonded together and water-tight.

They must be not less than two inches thick after ultimate compression.

59. TYPE G. HOT MIXED.

All pavements which are composed of a mineral aggregate held together with a bituminous cement and are mixed and laid while hot, must conform to the following additional requirements:

The pavement must be prepared from bituminous cement D.

When composed of an aggregate graded downwards from $1\frac{1}{2}$ " stone, it must contain not less than $6\frac{1}{2}$ per cent. nor more than $8\frac{1}{2}$ per cent. of bitumen by weight, but when all the aggregate will pass $\frac{5}{8}$ " circular openings the pavement must contain not less than 8 nor more than 10 per cent. of bitumen by weight. The consistency of the bitumen between the limits of 60-90, will depend on the character of the mineral aggregate and be determined by the State Department of Public Roads.

The paving mixture, when dumped on the roadbed ready to be spread, must have a temperature of not less than 120° C. If any segregation of the mineral aggregate takes place during hauling from the mixing plant, it must be uniformly mixed before any part of this load is spread. If the temperature of the mixture has fallen below 110° C. before it is in the proper condition to spread, it must be reheated.

The paving mixture shall be spread evenly on the foundation with hot iron rakes and shovels. The rolling shall be done as quickly as possible after the material is spread, while it is still hot and pliable. When the paving mixture is hauled on the road in dump wagons it shall be kept covered in transit, dumped on platforms and shoveled into place. As soon as spread the paving mixture shall be rolled. Rolling must be steadily kept up until all roller marks shall disappear, and the surface gives indications of no further compressibility.

The paving shall be done so that the number of joints between the hot and cold material may be reduced to the minimum. When it is not practicable to lay it continuously and a joint is unavoidable, the edge of the cold material shall be trimmed down to a rough feather edge, and the surface, where the joint is to be made, painted over with bituminous cement, the hot material raked over the feathered edge and thoroughly rolled. The faces of the curb and gutter, iron castings, etc., shall be painted with the bituminous cement before the paving mixture is laid.

As soon as possible after the rolling of the mixture is finished, and while the surface is still fresh and clean, and, if possible, while warm, a seal coat of bituminous cement of a proper consistency to be flexible when cold, shall be spread over the surface. It shall be applied while at a temperature, to be fixed by the State Department of Public Roads, of from 135° to 200° C., depending on the bituminous cement used, and evenly spread with rubber squeegees. Only a sufficient coat shall be spread to flush the surface voids without leaving an excess. Immediately over this a top dressing of sand, fine clean gravel, or screenings, or a mixture thereof, free from dust, which must be perfectly dry and heated in cold weather, shall be uniformly spread and thoroughly rolled into the surface. A small surplus of this dressing shall be left upon the surface.

When the work has been completed as specified above, additional compression in the wearing surface shall be secured by rolling with a ten (10) ton steam macadam roller if ordered by the State Department of Public Roads or the engineer.

60. TYPE H. COLD MIXED.

All pavements which are composed of a mineral aggregate held together with a bituminous cement, and are mixed without heating the mineral aggregate, and laid while cold, must conform to the following additional requirements:

Pavements of this type must be prepared from bituminous cements..... and may be laid either in one or two courses. When laid in two courses the bottom course must not be less than $1\frac{1}{2}$ inches thick after ultimate

compression and contain not over 30 per cent. of material which will pass openings one-half inch in diameter. This course of stone must be uniformly coated with sufficient asphalt to bind it firmly together. It must be laid and rolled to the proper grade and curvature before the top course is applied.

The top course must not contain any material which will not pass openings three-quarter-inch in diameter. It must contain not less than five per cent., nor more than nine per cent., by weight, of bitumen soluble in cold carbon bisulphide, the exact amount to be determined between these limits by the State Department of Public Roads.

After the bottom course has been spread, it must be protected from all travel and kept free from dust or dirt until the top course has been spread and rolled into place or sealed in the manner specified hereinbelow. If the bottom course gets wet after being spread, it must be allowed to dry out before being rolled or covered with the top course. When dry it must always be covered with the top course at once, after being properly rolled, and in no case shall the bottom course be spread over three hundred feet in advance of the top course, nor shall over fifty feet be left uncovered during the night.

When pavements of this type are laid in one course, they will be sealed by painting the surface with a squeegee coat of hot bituminous cement, when required by the State Department of Public Roads. This cement must be the same used in preparing the pavement, and must be applied at a temperature between 135° C. to 180° C. by a distributor which has been approved by the State Department of Public Roads. Immediately after this coat of bitumen has been spread, and while the same is yet hot, sand, fine clean gravel or screenings, or a mixture thereof, shall be spread over its surface and rolled at once.

61. TYPE I. GRAVEL.

If road gravel A is used for the whole construction, from sub-foundation up, it will be spread over the road at a depth of about inches at the center and at the shoulders, loose measure, and shall be thoroughly consolidated by rolling and scraping as directed by engineer until the surface is hard, smooth and the whole thoroughly compacted to a depth of inches on center line and of at the shoulders.

If road gravel B is used as a foundation, a coating of road gravel A will be applied of about inches all over the road and consolidated as above provided to a total depth of inches on center line and inches at the shoulders.

62. TYPE J. GRAVEL WITH BITUMINOUS BINDER.

The surface of the road prepared as for Type I will be scraped and brought true to crown grade.

On this surface.....lbs. of bitumen.....per square yard will be applied from an approved pressure sprinkler. After the bitumen has hardened to the satisfaction of the engineer a bituminous dressing will be applied as specified for Type B, bituminous cement..... being used.

63. PAVING OF CROSS-ROADS AND ENTRANCES.

This work will be done in the case of roads using stone as mineral aggregate, as described for type A, the one and one-half ($1\frac{1}{2}$) inch stone being laid on the sub-foundation to a depth of four (4) inches, loose measurement.

In the case of gravel roads, the paving will be of gravel A and inches deep compacted. In both cases the paving will extend to the lines of right of way, except where otherwise shown on drawings.

VII.

64. ESTIMATE OF QUANTITIES.

<i>Items.</i>	<i>Descriptions.</i>	<i>Quantities.</i>
Excavation,	In road unclassified	cubic yds.
	Outside road unclassified	"
	Rock	"
	Extra embankment, in place.....	"
Foundation,	Foreign material for sub-grade, in place.....	"
	Type	square yds.
		"
		"
Road Surface Type	.....	"
		"
		"
		"
		"
		"
		"
		"
Paved Gutters,	Concrete	"
	Stone Block	"
	Cobble Stone	"
Underdrains, Tile	.....	lineal ft.
	Stone	"
	French	"

These quantities are the result of careful calculation, but are to be considered as approximate. The governing body will only pay the contractor for the actual amount of work performed, which will be determined after the completion of the contract, and at the prices bid for the same. The governing body reserves the right to increase or decrease any of the items in the above estimate of quantities, subject, however, to the provisions of Section 4. If there be any increase in the quantities as given, they will be paid for at the rate bid. The contractor is expected to satisfy himself as to the nature, character and quantity of the material and labor required by a personal examination of the work contemplated.

The above-named items will be the only ones on which the price of the work will be figured.

Excavation will be unclassified unless the engineer shall deem it to the best

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interest of the governing body to classify the same. In such case, with the approval of the State Commissioner of Public Roads, he may classify the excavation into unclassified excavation and rock. Rock will consist of ledge or boulders over one-half ($\frac{1}{2}$) cubic yard in volume of such nature as to require blasting for removal. Unless an estimate of rock yardage is entered in above estimate of quantities, bidders will give no figure therefor.

The lump sum will be the amount paid for the work excepting where excavation is classified, in which case the lump sum will be increased or decreased according as the rock runs over or under the estimated yardage. Attention is called to sections 15 and 16.

65. INVITATION TO BID.

Bidders are requested to bid on any or all of the following combinations, using the blank hereto attached for that purpose. The broken stone when used will be trap rock; an alternative bid may be made on approved native rock,

Foundation Material.

1. Type.....
2. Type.....
3. Type.....
4. Type.....
5. Type.....

Road Surface Material.

- Type.....
- Type.....
- Type.....
- Type.....
- Type.....

.....

Engineer.

Approved.....19.....

The.....

.....County.

.....

.....

Approved.....19.....

.....

State Commissioner of Public Roads.

PROPOSAL.

To the.....

County of.....and State of New Jersey:

GENTLEMEN—The undersigned hereby declare.. that..... he..... ha.... carefully examined the annexed specifications and the drawings therein referred to, and will provide all necessary machinery, tools, apparatus and other means of construction, and do all the work and furnish all the material called for by said specifications in the manner prescribed by the specifications and the requirements of the engineer and inspector under them, for the following prices:

Work.		Quantity.	Unit Price.		Price.
Excavation,	in road.....	<i>Cubic Yards.</i>	\$.....		\$.....
	outside road...				
	rock				
Extra embankment, Foreign material for sub-grade,	in place.....				
	in place.....				
Foundation,	<i>Type.</i>	<i>Square Yards.</i>			
					
Surface,	.....				
					
Gutters,	Concrete				
	Stone block...				
	Cobblestone				
Underdrains,	<i>Lin. Feet.</i>				
	Tile				
	Stone				
	French				
Grubbing,	<i>Acres.</i>				
					
					

Lump sum prices for all work and material necessary for the complete and finished road, including maintenance for one year from date of acceptance:

Material for Foundation, Trap rock or.....
 Material for Road Surface, Trap rock or.....

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<i>Foundation.</i>	<i>Road Surface Type.</i>	<i>Lump Sum Bid.</i>
Type.....	{	\$.....
Type.....	{	
Type.....	{	

Accompanying this proposal is a certified check for the sum of one thousand (\$1,000) dollars, payable to the order of your financial officer, which check is to be forfeited as liquidated damages if, in case this proposal is accepted, the undersigned shall fail to execute a contract with your honorable body, under the conditions of this proposal, within the time provided for by the foregoing advertisement for proposals, otherwise said check is to be returned to the undersigned.

Signed:

..... Address.....

NOTE.—Opposite items where no quantities are specified, the contractor will name price per unit of measure for each class of work called for, but will not include same in his total column.

Certificate for Rights of Way.

I hereby certify that, as to the road described in the foregoing specifications and shown in the drawings therein named, I hold for the benefit of all the necessary conveyances, grants, &c., for all lands needed for said road, and releases of damages by reason of the construction of said road, excepting as to the lands of.....
.....
and that as to these lands, the said.....
has by resolution, ordered its solicitor to proceed at once, on the approval by the State Commissioner of Public Roads, of the contract herewith, to condemn all such rights in said lands as are needed for the said construction.

.....

CONTRACT.

This agreement, made the.....day of.....
in the year of our Lord one thousand nine hundred.....
between THE
....., party of the first part, and.....
.....
party of the second part,

Witnesseth, That the said party of the second part, for and in considera-
tion of the payments hereinafter specified and agreed to be made by the
party of the first part, hereby covenants and agrees to furnish and deliver
all the materials and to do and perform all the work and labor required to be
furnished and delivered, done and performed in and about the improving of
.....
beginning at
and extending to
.....
in the township of a distance of
.....
in strict and entire conformity with the plans on file in the engineer's office
and with the specifications hereto annexed and duly approved by resolution of
.....
.....adopted the.....day of
.....in the year of our Lord one thousand
nine hundred.....and approved by the State Commissioner
of Public Roads on theday of.....
in the year of our Lord one thousand nine hundred.....
which said plans and specifications are hereby made part of this agreement
as fully and with the same effect as if the same had been set forth at length
in the body of this agreement.

The party of the second part will make payment of all proper charges for
labor and materials required in the aforementioned work, and indemnify and
save harmless the party of the first part, its officers, agents and servants, and
each and every of them, against and from all suits and costs of every name
and description, and from all damages to which the said party of the first part
or any of its officers, agents or servants may be put, by reason of injury to
the person or property of others resulting from carelessness in the performance
of said work or through the negligence of said party of the second part, or
through any improper or defective machinery, implements or appliances used
by the said party of the second part in the aforesaid work, or through any act
or omission on the part of the said party of the second part, or his agent or
agents.

In consideration of the premises the party of the first part hereby agrees
to pay to the party of the second part for said work, when completed in
accordance with the said specifications, the sum of.....
.....
payments to be made as provided in said specifications upon presentation
of the proper certificates of the engineer and inspector and upon the terms
set forth in the annexed specifications.

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This contract to be binding upon.....
....., the party of the first part, its successors or assigns, and upon
the party of the second part.....

In Witness Whereof,
....., has caused this instrument to be signed
by its....., attested by its clerk and its corporate seal to be
hereunto affixed, pursuant to a resolution of said.....passed
for that purpose, and the said party of the second part ha.....hereunto
set..... hand.... and seal.... the day and year first above written.

[SEAL.]

Attest.....

[SEAL.]

Clerk.

Signed, sealed and delivered
in the presence of
.....

This contract approved this.....day of....., 19....
Any changes in the terms, quantities, materials or methods hereinbefore
described must have the written approval of the State Commissioner of
Public Roads.

State Commissioner of Public Roads.

BOND.

KNOW ALL MEN BY THESE PRESENTS, That we,.....
 and of the County
 of and State of New Jersey, are
 held and firmly bound unto
, in the sum of
dollars, lawful money of the United States,
 to be paid to the.....
 its successors or assigns, to which payment well and truly to be made, we
 bind ourselves, our heirs, executors and administrators, jointly and severally,
 firmly by these presents.

Sealed with our seals and dated this.....day of
A. D. nineteen hundred and.....

THE CONDITION OF THIS OBLIGATION IS SUCH, That if the above bounden

 shall well and truly perform his part of the contract hereto annexed, and
 make payment of all proper charges for labor and materials required in the
 aforementioned work, and indemnify and save harmless the party of the first
 part, its officers, agents and servants, and each and every of them, against and
 from all suits and costs of every name and description, and from all damages
 to which the said party of the first part or any of its officers, agents or
 servants may be put, by reason of injury to the person or property of others
 resulting from carelessness in the performance of said work, or through the
 negligence of said party of the second part, or through any improper or de-
 fective machinery, implements or appliances used by the said party of the
 second part in the aforesaid work, or through any act or omission on the part
 of the said party of the second part, or his agent or agents, and all the cove-
 nants and conditions of said contract perform, as the said contract, covenant
 and conditions may have been changed or modified as therein provided, then
 this obligation to be void, otherwise to remain in full force and virtue.

SIGNED, SEALED AND DELIVERED
 IN THE PRESENCE OF

This Bond approved this.....day of.....A. D. 19

Director.

BE IT REMEMBERED, on this.....day of
in the year of our Lord one thousand nine
 hundred and.....before me, a Master in Chancery of
 the State of New Jersey, personally appeared.....

 who acknowledged that they signed, sealed and delivered the foregoing bond
 as their voluntary act and deed for the uses and purposes therein expressed.

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JUSTIFICATION OF SURETY.

STATE OF NEW JERSEY,
COUNTY OF..... } ss.

On this.....day of.....A. D. 19.....
before me, a Notary Public in and for the County and State aforesaid,
personally appeared
who, being duly sworn, on his oath declares that he is a resident of the
County of.....in the State of New Jersey; that he is
a freeholder in said County, and that he owns real estate in said County, in
his own right, to the amount of.....
.....
over and above all his indebtedness and after all his debts are paid, and
over any contingent liability by reason of being bail, surety, endorser or
guarantor.

.....
Subscribed and sworn to before me, this.....day of
.....A. D. 19..... I hereby certify that the contents of
the above have been carefully made known to affiant before execution.
.....

STATE OF NEW JERSEY,
COUNTY OF..... } ss.

On this.....day of.....A. D. 19.....
before me, a Notary Public in and for the County and State aforesaid,
personally appeared.....
.....
who, being duly sworn, on his oath declares that he is a resident of the
County of.....in the State of New Jersey; that he is
a freeholder in said County, and that he owns real estate in said County, in
his own right, to the amount of.....
.....
over and above all his indebtedness and after all his debts are paid, and
over any contingent liability by reason of being bail, surety, endorser or
guarantor.

.....
Subscribed and sworn to before me, this.....day of
.....A. D. 19..... I hereby certify that the contents of
the above have been carefully made known to affiant before execution.
.....

Appendix B.

NUMBER OF TONS OF STONE PER MILE REQUIRED TO BUILD THE FOLLOWING DEPTHS AND WIDTHS.

For the information of intending road builders, we have compiled the following tables, which approximate the number of tons of thoroughly rolled stone necessary to construct each mile at the designated depths and widths.

The basis is 3,000 tons of loose stone or 3,500 tons of compressed stone for a road one mile long, sixteen feet wide and eight inches deep. A road eight inches deep, when finished, will have required at least ten inches of stone. It should be placed in two layers of five inches each, and each layer rolled down to four inches. Then the application of the three-quarter inch and screenings will bring the road to the prescribed depth; for other thickness the stone should be placed in proportion to the intended finished depths.

An observance of this rule will insure the contract thickness for the roadbed, and save the sometimes necessary expense of resurfacing before acceptance from the contractor.

A road 8 feet wide and 4 inches deep will require 875 tons of stone per mile.

" 8	"	" 6	"	"	1,312½	"	"	"
" 8	"	" 8	"	"	1,750	"	"	"
" 8	"	" 10	"	"	2,187½	"	"	"
" 8	"	" 12	"	"	2,625	"	"	"
" 9	"	" 4	"	"	984⅔	"	"	"
" 9	"	" 6	"	"	1,476 ⁷ / ₁₈	"	"	"
" 9	"	" 8	"	"	1,968¾	"	"	"
" 9	"	" 10	"	"	2,460 ¹⁵ / ₁₈	"	"	"
" 9	"	" 12	"	"	2,953⅓	"	"	"
" 10	"	" 4	"	"	1,093¾	"	"	"
" 10	"	" 6	"	"	1,640⅝	"	"	"
" 10	"	" 8	"	"	2,187½	"	"	"
" 10	"	" 10	"	"	2,734⅔	"	"	"
" 10	"	" 12	"	"	3,281¼	"	"	"

A road 11 feet wide and 4 inches deep will require $1,203\frac{1}{8}$ tons of stone per mile.

"	11	"	"	6	"	"	$1,804\frac{11}{16}$	"	"	"
"	11	"	"	8	"	"	$2,406\frac{1}{4}$	"	"	"
"	11	"	"	10	"	"	$3,007\frac{13}{16}$	"	"	"
"	11	"	"	12	"	"	$3,609\frac{3}{8}$	"	"	"
"	12	"	"	4	"	"	$1,312\frac{1}{2}$	"	"	"
"	12	"	"	6	"	"	$1,968\frac{3}{4}$	"	"	"
"	12	"	"	8	"	"	2,625	"	"	"
"	12	"	"	10	"	"	$3,281\frac{1}{4}$	"	"	"
"	12	"	"	12	"	"	$3,937\frac{1}{2}$	"	"	"
"	13	"	"	4	"	"	$1,421\frac{7}{8}$	"	"	"
"	13	"	"	6	"	"	$2,132\frac{13}{16}$	"	"	"
"	13	"	"	8	"	"	$2,843\frac{3}{4}$	"	"	"
"	13	"	"	10	"	"	$3,554\frac{11}{16}$	"	"	"
"	13	"	"	12	"	"	$4,265\frac{5}{8}$	"	"	"
"	14	"	"	4	"	"	$1,531\frac{1}{4}$	"	"	"
"	14	"	"	6	"	"	$2,296\frac{7}{8}$	"	"	"
"	14	"	"	8	"	"	$3,062\frac{1}{2}$	"	"	"
"	14	"	"	10	"	"	$3,828\frac{1}{8}$	"	"	"
"	14	"	"	12	"	"	$4,593\frac{3}{4}$	"	"	"
"	15	"	"	4	"	"	$1,640\frac{5}{8}$	"	"	"
"	15	"	"	6	"	"	$2,460\frac{15}{16}$	"	"	"
"	15	"	"	8	"	"	$3,281\frac{1}{4}$	"	"	"
"	15	"	"	10	"	"	$4,101\frac{9}{16}$	"	"	"
"	15	"	"	12	"	"	$4,921\frac{7}{8}$	"	"	"
"	16	"	"	4	"	"	1,750	"	"	"
"	16	"	"	6	"	"	2,625	"	"	"
"	16	"	"	8	"	"	3,500	"	"	"
"	16	"	"	10	"	"	4,375	"	"	"
"	16	"	"	12	"	"	5,250	"	"	"
"	17	"	"	4	"	"	$1,859\frac{3}{8}$	"	"	"
"	17	"	"	6	"	"	$2,789\frac{1}{16}$	"	"	"
"	17	"	"	8	"	"	$3,718\frac{3}{4}$	"	"	"
"	17	"	"	10	"	"	$4,648\frac{7}{16}$	"	"	"
"	17	"	"	12	"	"	$5,578\frac{1}{8}$	"	"	"
"	18	"	"	4	"	"	$1,968\frac{3}{4}$	"	"	"
"	18	"	"	6	"	"	$2,953\frac{1}{8}$	"	"	"
"	18	"	"	8	"	"	$3,937\frac{1}{2}$	"	"	"
"	18	"	"	10	"	"	$4,921\frac{7}{8}$	"	"	"
"	18	"	"	12	"	"	$5,906\frac{1}{4}$	"	"	"
"	19	"	"	4	"	"	$2,078\frac{1}{8}$	"	"	"
"	19	"	"	6	"	"	$3,117\frac{3}{16}$	"	"	"
"	19	"	"	8	"	"	$4,156\frac{1}{4}$	"	"	"
"	19	"	"	10	"	"	$5,195\frac{5}{16}$	"	"	"
"	19	"	"	12	"	"	$6,234\frac{3}{8}$	"	"	"

A road 20 feet wide and 4 inches deep will require	2,187½ tons of stone per mile.
" 20 " " 6 " "	3,281¼ " " "
" 20 " " 8 " "	4,375 " " "
" 20 " " 10 " "	5,468¾ " " "
" 20 " " 12 " "	6,562½ " " "

TABLES.

As many persons interested in the construction of stone roads are asking questions about their cost, we enclose a table to show at a glance the number of square yards at different widths in a mile of road; also the cost at different widths, and various prices per square yard. Any variations from these prices can be quickly ascertained by adding, subtracting, multiplying and dividing for a less or greater width. For example, a road eight feet wide has 4,693 1-3 square yards in one mile. To obtain the number of square yards in a road having a width of nine feet, add one-eighth to the foregoing figures, and in one having a width of seven feet, subtract one-eighth; in one of twice the width given in the table, multiply by two.

SQUARE YARDS IN ONE MILE OF

8 feet in width.....	4,693⅓ square yards.
10 "	5,866⅔ " "
12 "	7,040 " "
14 "	8,213⅓ " "
16 "	9,386⅔ " "
18 "	10,560 " "
8 feet wide, or 4,693⅓ square yards, at 25c. per sq. yd.....	\$1,173 33⅓
10 " 5,866⅔ " 25c. "	1,466 66⅔
12 " 7,040 " 25c. "	1,760 00
14 " 8,213⅓ " 25c. "	2,053 33⅓
16 " 9,386⅔ " 25c. "	2,346 66⅔
18 " 10,560 " 25c. "	2,640 00
8 " 4,693⅓ " 30c. "	1,408 00
10 " 5,866⅔ " 30c. "	1,760 00
12 " 7,040 " 30c. "	2,112 00
14 " 8,213⅓ " 30c. "	2,464 00
16 " 9,386⅔ " 30c. "	2,816 00
18 " 10,560 " 30c. "	3,168 00
8 " 4,693⅓ " 35c. "	1,642 66⅔
10 " 5,866⅔ " 35c. "	2,053 33⅓
12 " 7,040 " 35c. "	2,464 00
14 " 8,213⅓ " 35c. "	2,874 66⅔
16 " 9,386⅔ " 35c. "	3,285 33⅓
18 " 10,560 " 35c. "	3,696 00

8 feet wide, or	4,693 $\frac{1}{3}$	square yards, at 40c. per sq. yd.	.....	\$1,877	33 $\frac{1}{3}$
10 "	5,866 $\frac{2}{3}$	"	40c. "	2,346	66 $\frac{2}{3}$
12 "	7,040	"	40c. "	2,816	00
14 "	8,213 $\frac{1}{3}$	"	40c. "	3,285	33 $\frac{1}{3}$
16 "	9,386 $\frac{2}{3}$	"	40c. "	3,754	66 $\frac{2}{3}$
18 "	10,560	"	40c. "	4,224	00
8 "	4,693 $\frac{1}{3}$	"	45c. "	2,112	00
10 "	5,866 $\frac{2}{3}$	"	45c. "	2,640	00
12 "	7,040	"	45c. "	3,168	00
14 "	8,213 $\frac{1}{3}$	"	45c. "	3,696	00
16 "	9,386 $\frac{2}{3}$	"	45c. "	4,224	00
18 "	10,560	"	45c. "	4,752	00
8 "	4,693 $\frac{1}{3}$	"	50c. "	2,346	66 $\frac{2}{3}$
10 "	5,866 $\frac{2}{3}$	"	50c. "	2,933	33 $\frac{1}{3}$
12 "	7,040	"	50c. "	3,520	00
14 "	8,213 $\frac{1}{3}$	"	50c. "	4,106	66 $\frac{2}{3}$
16 "	9,386 $\frac{2}{3}$	"	50c. "	4,693	33 $\frac{1}{3}$
18 "	10,560	"	50c. "	5,280	00
8 "	4,693 $\frac{1}{3}$	"	55c. "	2,581	33 $\frac{1}{3}$
10 "	5,866 $\frac{2}{3}$	"	55c. "	3,226	66 $\frac{2}{3}$
12 "	7,040	"	55c. "	3,872	00
14 "	8,213 $\frac{1}{3}$	"	55c. "	4,517	33 $\frac{1}{3}$
16 "	9,386 $\frac{2}{3}$	"	55c. "	5,162	66 $\frac{2}{3}$
18 "	10,560	"	55c. "	5,808	00
8 "	4,693 $\frac{1}{3}$	"	60c. "	2,816	00
10 "	5,866 $\frac{2}{3}$	"	60c. "	3,520	00
12 "	7,040	"	60c. "	4,224	00
14 "	8,213 $\frac{1}{3}$	"	60c. "	4,928	00
16 "	9,386 $\frac{2}{3}$	"	60c. "	5,632	00
18 "	10,560	"	60c. "	6,336	00
8 "	4,693 $\frac{1}{3}$	"	65c. "	3,050	66 $\frac{2}{3}$
10 "	5,866 $\frac{2}{3}$	"	65c. "	3,813	33 $\frac{1}{3}$
12 "	7,040	"	65c. "	4,576	00
14 "	8,213 $\frac{1}{3}$	"	65c. "	5,338	66 $\frac{2}{3}$
16 "	9,386 $\frac{2}{3}$	"	65c. "	6,101	33 $\frac{1}{3}$
18 "	10,560	"	65c. "	6,864	00
8 "	4,693 $\frac{1}{3}$	"	70c. "	3,285	33 $\frac{1}{3}$
10 "	5,866 $\frac{2}{3}$	"	70c. "	4,106	66 $\frac{2}{3}$
12 "	7,040	"	70c. "	4,928	00
14 "	8,213 $\frac{1}{3}$	"	70c. "	5,749	33 $\frac{1}{3}$
16 "	9,386 $\frac{2}{3}$	"	70c. "	6,570	66 $\frac{2}{3}$
18 "	10,560	"	70c. "	7,392	00
8 "	4,693 $\frac{1}{3}$	"	75c. "	3,520	00
10 "	5,866 $\frac{2}{3}$	"	75c. "	4,400	00
12 "	7,040	"	75c. "	5,280	00
14 "	8,213 $\frac{1}{3}$	"	75c. "	6,160	00
16 "	9,386 $\frac{2}{3}$	"	75c. "	7,040	00
18 "	10,560	"	75c. "	7,920	00

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8 feet wide, or	4,693 ¹ / ₃	square yards, at	80c. per sq. yd.		\$3,754 66 ² / ₃
10 "	5,866 ² / ₃	"	80c.	"	4,693 33 ¹ / ₃
12 "	7,040	"	80c.	"	5,632 00
14 "	8,213 ¹ / ₃	"	80c.	"	6,570 66 ² / ₃
16 "	9,386 ² / ₃	"	80c.	"	7,509 33 ¹ / ₃
18 "	10,560	"	80c.	"	8,448 00
8 "	4,693 ¹ / ₃	"	85c.	"	3,989 33 ¹ / ₃
10 "	5,866 ² / ₃	"	85c.	"	4,986 66 ² / ₃
12 "	7,040	"	85c.	"	5,984 00
14 "	8,213 ¹ / ₃	"	85c.	"	6,981 33 ¹ / ₃
16 "	9,386 ² / ₃	"	85c.	"	7,978 66 ² / ₃
18 "	10,560	"	85c.	"	8,976 00
8 "	4,693 ¹ / ₃	"	90c.	"	4,224 00
10 "	5,866 ² / ₃	"	90c.	"	5,280 00
12 "	7,040	"	90c.	"	6,336 00
14 "	8,213 ¹ / ₃	"	90c.	"	7,392 00
16 "	9,386 ² / ₃	"	90c.	"	8,448 00
18 "	10,560	"	90c.	"	9,504 00
8 "	4,693 ¹ / ₃	"	95c.	"	4,458 66 ² / ₃
10 "	5,866 ² / ₃	"	95c.	"	5,573 33 ¹ / ₃
12 "	7,040	"	95c.	"	6,688 00
14 "	8,213 ¹ / ₃	"	95c.	"	7,802 66 ² / ₃
16 "	9,386 ² / ₃	"	95c.	"	8,917 33 ¹ / ₃
18 "	10,560	"	95c.	"	10,032 00
8 "	4,693 ¹ / ₃	"	\$1.00	"	4,693 33 ¹ / ₃
10 "	5,866 ² / ₃	"	1.00	"	5,866 66 ² / ₃
12 "	7,040	"	1.00	"	7,040 00
14 "	8,213 ¹ / ₃	"	1.00	"	8,213 33 ¹ / ₃
16 "	9,386 ² / ₃	"	1.00	"	9,386 66 ² / ₃
18 "	10,560	"	1.00	"	10,560 00

TABLE FOR GRAVEL.

Table showing number of cubic yards of gravel required in the construction of one mile of gravel road, of widths varying from 6 feet to 20 feet, and depths from 6 to 12 inches. The within quantities should be multiplied by $1\frac{1}{2}$ to give the number of cubic yards of loose gravel required to make the within depths of compact gravel.

ONE MILE IN LENGTH.	Number of feet in width.	Number of cubic yards in road 6 inches deep.	Number of cubic yards in road 7 inches deep.	Number of cubic yards in road 8 inches deep.	Number of cubic yards in road 9 inches deep.	Number of cubic yards in road 10 inches deep.	Number of cubic yards in road 11 inches deep.	Number of cubic yards in road 12 inches deep.
One mile.....	6 feet wide.....	586 $\frac{2}{3}$	684 $\frac{4}{3}$	782 $\frac{2}{3}$	880	977 $\frac{7}{3}$	1,075 $\frac{5}{3}$	1,173 $\frac{1}{3}$
One mile.....	7 feet wide.....	684 $\frac{4}{3}$	798 $\frac{1}{3}$	912 $\frac{1}{3}$	1,026 $\frac{2}{3}$	1,140 $\frac{2}{3}$	1,254 $\frac{2}{3}$	1,368 $\frac{2}{3}$
One mile.....	8 feet wide.....	782 $\frac{2}{3}$	912 $\frac{1}{3}$	1,042 $\frac{2}{3}$	1,173 $\frac{1}{3}$	1,303 $\frac{2}{3}$	1,434 $\frac{2}{3}$	1,564 $\frac{2}{3}$
One mile.....	9 feet wide.....	880	1,026 $\frac{2}{3}$	1,173 $\frac{1}{3}$	1,320	1,466 $\frac{2}{3}$	1,613 $\frac{1}{3}$	1,760
One mile.....	10 feet wide.....	977 $\frac{7}{3}$	1,140 $\frac{2}{3}$	1,303 $\frac{2}{3}$	1,466 $\frac{2}{3}$	1,629 $\frac{1}{3}$	1,792 $\frac{2}{3}$	1,955 $\frac{2}{3}$
One mile.....	11 feet wide.....	1,075 $\frac{5}{3}$	1,254 $\frac{2}{3}$	1,434 $\frac{2}{3}$	1,613 $\frac{1}{3}$	1,792 $\frac{2}{3}$	1,971 $\frac{2}{3}$	2,151 $\frac{1}{3}$
One mile.....	12 feet wide.....	1,173 $\frac{1}{3}$	1,368 $\frac{2}{3}$	1,564 $\frac{2}{3}$	1,760	1,955 $\frac{2}{3}$	2,151 $\frac{1}{3}$	2,346 $\frac{2}{3}$
One mile.....	13 feet wide.....	1,271 $\frac{1}{3}$	1,482 $\frac{2}{3}$	1,694 $\frac{2}{3}$	1,906 $\frac{2}{3}$	2,118 $\frac{1}{3}$	2,330 $\frac{2}{3}$	2,542 $\frac{2}{3}$
One mile.....	14 feet wide.....	1,368 $\frac{2}{3}$	1,597 $\frac{1}{3}$	1,825 $\frac{2}{3}$	2,053 $\frac{1}{3}$	2,281 $\frac{2}{3}$	2,509 $\frac{1}{3}$	2,737 $\frac{2}{3}$
One mile.....	15 feet wide.....	1,466 $\frac{2}{3}$	1,711 $\frac{1}{3}$	1,955 $\frac{2}{3}$	2,200	2,444 $\frac{2}{3}$	2,688 $\frac{2}{3}$	2,933 $\frac{1}{3}$
One mile.....	16 feet wide.....	1,564 $\frac{2}{3}$	1,825 $\frac{2}{3}$	2,083 $\frac{2}{3}$	2,346 $\frac{2}{3}$	2,607 $\frac{1}{3}$	2,868 $\frac{1}{3}$	3,128 $\frac{2}{3}$
One mile.....	17 feet wide.....	1,662 $\frac{2}{3}$	1,919 $\frac{2}{3}$	2,216 $\frac{2}{3}$	2,493 $\frac{1}{3}$	2,770 $\frac{2}{3}$	3,047 $\frac{1}{3}$	3,324 $\frac{2}{3}$
One mile.....	18 feet wide.....	1,760	2,053 $\frac{1}{3}$	2,346 $\frac{2}{3}$	2,640	2,933 $\frac{1}{3}$	3,226 $\frac{2}{3}$	3,520
One mile.....	19 feet wide.....	1,857 $\frac{1}{3}$	2,167 $\frac{1}{3}$	2,477 $\frac{2}{3}$	2,786 $\frac{2}{3}$	3,096 $\frac{2}{3}$	3,405 $\frac{2}{3}$	3,715 $\frac{2}{3}$
One mile.....	20 feet wide.....	1,955 $\frac{2}{3}$	2,281 $\frac{2}{3}$	2,607 $\frac{1}{3}$	2,933 $\frac{1}{3}$	3,259 $\frac{2}{3}$	3,585 $\frac{2}{3}$	3,911 $\frac{2}{3}$

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