(2)-Intermediate Development. (Twelve 10,000-h.p. Units.)

Capital Cost of Installation.
Dam and equipment\$ 542,000
Embankment (flood protection) 5,000
Ice shuces and roadway
Power station and equipment
Hudroulie installation
Flut in 1 installation L 280,000
Electrical installation
Railroad 150,000
Ferry 50,000
Permanent quarters 25,000
Contingencies, 10% 430,000
Engineering and inspection, 5% 236,000
Interest during construction, 5½% 273,000
0
Total intermediate cost
Twenty-four-hour power available at 75%
over-all efficiency $\dots = 78,500$ h.p.
Capital cost per 24-hour h.p. $\dots = 66.69
Capital cost per installed h.p. $\dots = 43.62$
Anguel Cost of Operation
Annual Cost of Operation.
Interest, sinking fund and depreciation charges.
Interest, $5\frac{1}{2}\%$ on $55,235,000$
Sinking fund, 4% (40-year bonds) 55,000
Depreciation: 1% on permanent works =
\$14,000; 4% on machinery, etc., = \$106,000 120,000
Operation charges: staff = $$27,000$; supplies
- \$22,000 59,000
= \$32,000 ·····
Total annual charge\$522,000
Appual cost per h pvear. 24-hour power = 6.65
Annual cost per h p-year machinery
Annual cost per n.pyear, machinery $= 4.25$
installed +35
Annual cost per kw. nour hosis of
Annual cost per kw. nour on basis of
50% load factor $\dots = 0.204$ cent
50% load factor = 0.204 cent (2) Final Development (Fourteen 10.000=h.p. Units.)
50% load factor = 0.204 cent (3)—Final Development. (Fourteen 10,000-h.p. Units.)
50% load factor = 0.204 cent (3)—Final Development. (Fourteen 10,000-h.p. Units.) Capital Cost of Installation.
50% load factor = 0.204 cent (3)—Final Development. (Fourteen 10,000-h.p. Units.) Capital Cost of Installation. Dam and equipment\$ 542,000
50% load factor6.204 cent(3)—Final Development.(Fourteen 10,000-h.p. Units.)Capital Cost of Installation.Dam and equipment542,000Embankment (flood protection)5,000
50% load factor6.204 cent(3)—Final Development.(Fourteen 10,000-h.p. Units.) Capital Cost of Installation.Dam and equipment542,000Embankment (flood protection)5,000Ice sluices and roadway72,000
50% load factor6.204 cent(3)—Final Development.(Fourteen 10,000-h.p. Units.) Capital Cost of Installation.Dam and equipment542,000Embankment (flood protection)5,000Ice sluices and roadway72,000Power station and equipment1,035,000
50% load factor= 0.204 cent(3)—Final Development.(Fourteen 10,000-h.p. Units.) Capital Cost of Installation.Dam and equipment542,000Embankment (flood protection)5,000Ice sluices and roadway72,000Power station and equipment1,035,000Hydraulic installation1,330,000
50% load factor = 0.204 cent (3)—Final Development. (Fourteen 10,000-h.p. Units.) Capital Cost of Installation. Dam and equipment 542,000 Embankment (flood protection) 5,000 Ice sluices and roadway 72,000 Power station and equipment 1,035,000 Hydraulic installation 1,330,000 Electrical installation 1,610,000
50% load factor = 0.204 cent (3)—Final Development. (Fourteen 10,000-h.p. Units.) Capital Cost of Installation. Dam and equipment \$ 542,000 Embankment (flood protection) \$ 5,000 Ice sluices and roadway 72,000 Power station and equipment 1,035,000 Hydraulic installation 1,330,000 Electrical installation 1,610,000 Raikoad 156,000
50% load factor = 0.204 cent (3)—Final Development. (Fourteen 10,000-h.p. Units.) Capital Cost of Installation. Dam and equipment \$ 542,000 Embankment (flood protection) \$ 5,000 Ice sluices and roadway 72,000 Power station and equipment 1,035,000 Hydraulic installation 1,330,000 Electrical installation 1,610,000 Railroad 156,000
50% load factor = 0.204 cent (3)—Final Development. (Fourteen 10,000-h.p. Units.) Capital Cost of Installation. Dam and equipment \$ 542,000 Embankment (flood protection) \$ 5,000 Ice sluices and roadway 72,000 Power station and equipment 1,035,000 Hydraulic installation 1,330,000 Electrical installation 1,610,000 Railroad 156,000 Ferry \$ 50,000
50% load factor = 0.204 cent (3)—Final Development. (Fourteen 10,000-h.p. Units.) Capital Cost of Installation. Dam and equipment \$ 542,000 Embankment (flood protection) \$ 5,000 Ice sluices and roadway 72,000 Power station and equipment 1,035,000 Hydraulic installation 1,330,000 Electrical installation 1,610,000 Ferry 50,000 Permanent quarters 25,000 Optimizer 2000 \$ 50,000 Permanent quarters \$ 25,000
50% load factor = 0.204 cent (3)—Final Development. (Fourteen 10,000-h.p. Units.) Capital Cost of Installation. Dam and equipment \$ 542,000 Embankment (flood protection) \$ 5,000 Ice sluices and roadway 72,000 Power station and equipment 1,035,000 Hydraulic installation 1,330,000 Electrical installation 156,000 Ferry \$ 50,000 Permanent quarters \$ 25,000 Contingencies, 10% \$ 265,000
50% load factor = 0.204 cent (3)—Final Development. (Fourteen 10,000-h.p. Units.) Capital Cost of Installation. Dam and equipment \$ 542,000 Embankment (flood protection) \$ 5,000 Ice sluices and roadway 72,000 Power station and equipment 1,035,000 Hydraulic installation 1,330,000 Electrical installation 1,610,000 Ferry \$ 50,000 Permanent quarters \$ 25,000 Contingencies, 10% 483,000 Engineering and inspection, 5% 265,000
50% load factor $=$ 0.204 cent(3)—Final Development.(Fourteen 10,000-h.p. Units.) Capital Cost of Installation.Dam and equipment $542,000$ Embankment (flood protection) $5,000$ Ice sluices and roadway $72,000$ Power station and equipment $1,035,000$ Hydraulic installation $1,330,000$ Electrical installation $1,610,000$ Railroad $156,000$ Ferry $50,000$ Permanent quarters $25,000$ Contingencies, 10% $483,0000$ Engineering and inspection, 5% $265,0000$ Interest during construction, $5\frac{1}{2}\%$ $307,0000$
50% load factor $=$ 0.204 cent(3)—Final Development.(Fourteen 10,000-h.p. Units.) Capital Cost of Installation.Dam and equipment $542,000$ Embankment (flood protection) $5,000$ Ice sluices and roadway $72,000$ Power station and equipment $1,035,000$ Hydraulic installation $1,330,000$ Electrical installation $1,610,000$ Railroad $156,000$ Ferry $50,000$ Permanent quarters $25,000$ Contingencies, 10% $483,000$ Engineering and inspection, 5% $265,000$ Interest during construction, $5\frac{1}{2}\%$ $307,000$ Whitemud Falls rock-cut $671,000$
50% load factor $=$ 0.204 cent(3)—Final Development.(Fourteen 10,000-h.p. Units.) Capital Cost of Installation.Dam and equipment $542,000$ Embankment (flood protection) $5,000$ Ice sluices and roadway $72,000$ Power station and equipment $1,035,000$ Hydraulic installation $1,330,000$ Electrical installation $1,610,000$ Railroad $156,000$ Ferry $50,000$ Permanent quarters $25,000$ Contingencies, 10% $483,0000$ Engineering and inspection, 5% $265,0000$ Interest during construction, $5\frac{1}{2}\%$ $307,0000$ Whitemud Falls rock-cut $671,0000$
50% load factor $=$ 0.204 cent(3)—Final Development.(Fourteen 10,000-h.p. Units.) Capital Cost of Installation.Dam and equipment $542,000$ Embankment (flood protection) $5,000$ Ice sluices and roadway $72,000$ Power station and equipment $1,035,000$ Hydraulic installation $1,330,000$ Electrical installation $1,610,000$ Railroad $156,000$ Ferry $50,000$ Permanent quarters $25,000$ Contingencies, 10% $483,000$ Engineering and inspection, 5% $265,000$ Interest during construction, $5\frac{1}{2}\%$ $307,000$ Whitemud Falls rock-cut $671,000$
50% load factor $=$ 0.204 cent(3)—Final Development.(Fourteen 10,000-h.p. Units.) Capital Cost of Installation.Dam and equipment $542,000$ Embankment (flood protection) $5,000$ Ice sluices and roadway $72,000$ Power station and equipment $1,035,000$ Hydraulic installation $1,330,000$ Electrical installation $1,610,000$ Railroad $156,000$ Ferry $50,000$ Permanent quarters $25,000$ Contingencies, 10% $483,000$ Engineering and inspection, 5% $265,000$ Interest during construction, $5\frac{1}{2}\%$ $307,000$ Whitemud Falls rock-cut $671,000$ Total final cost $$6,551,000$
50% load factor $=$ 0.204 cent(3)—Final Development.(Fourteen 10,000-h.p. Units.) Capital Cost of Installation.Dam and equipment $542,000$ Embankment (flood protection) $5,000$ Ice sluices and roadway $72,000$ Power station and equipment $1,035,000$ Hydraulic installation $1,330,000$ Electrical installation $1,610,000$ Railroad $156,000$ Ferry $50,000$ Permanent quarters $25,000$ Contingencies, 10% $483,000$ Engineering and inspection, 5% $265,000$ Interest during construction, $5\frac{1}{2}\%$ $307,000$ Whitemud Falls rock-cut $671,000$ Total final cost $$6,551,000$ Twenty-four-hour power available at 75% $=$ U $670,000$ Total final cost $$6,551,000$
50% load factor $=$ 0.204 cent(3)—Final Development.(Fourteen 10,000-h.p. Units.) Capital Cost of Installation.Dam and equipment $=$ Dam and equipment $=$ $542,000$ Embankment (flood protection) $=$ $5,000$ Ice sluices and roadway $=$ $72,000$ Power station and equipment $=$ $1,035,000$ Hydraulic installation $=$ $1,330,000$ Electrical installation $=$ $1,610,000$ Railroad $=$ $50,000$ Permanent quarters $=$ $25,000$ Contingencies, 10% $=$ $50,000$ Interest during construction, $5\frac{1}{2}\%$ $=$ $50,000$ Whitemud Falls rock-cut $=$ $50,000$ Total final cost $=$ $56,551,000$ Twenty-four-hour power available at 75% $0ver-all efficiency$ $=$ $568,600$
50% load factor $=$ 0.204 cent(3)—Final Development.(Fourteen 10,000-h.p. Units.) Capital Cost of Installation.Dam and equipment $542,000$ Embankment (flood protection) $5,000$ Ice sluices and roadway $72,000$ Power station and equipment $1,035,000$ Hydraulic installation $1,330,000$ Electrical installation $1,610,000$ Railroad $156,000$ Ferry $50,000$ Power station and equipment $1,610,000$ Railroad $156,000$ Ferry $50,000$ Permanent quarters $25,000$ Contingencies, 10% $483,000$ Engineering and inspection, 5% $265,000$ Interest during construction, $5\frac{1}{2}\%$ $307,000$ Whitemud Falls rock-cut $671,000$ Total final cost $$6,551,000$ Twenty-four-hour power available at 75% over-all efficiency $=$ $95,500$ h.p.Capital cost per 24-hour h.p. $=$ $$68.60$
50% load factor $=$ 0.204 cent(3)—Final Development.(Fourteen 10,000-h.p. Units.) Capital Cost of Installation.Dam and equipment $=$ Dam and equipment $=$ $542,000$ Embankment (flood protection) $=$ $5,000$ Ice sluices and roadway $=$ $72,000$ Power station and equipment $=$ $1,035,000$ Hydraulic installation $=$ $1,035,000$ Hydraulic installation $=$ $1,035,000$ Beterrical installation $=$ $1,035,000$ Railroad $=$ $50,000$ Permanent quarters $=$ $25,000$ Contingencies, $10%$ $=$ $25,000$ Contingencies, $10%$ $=$ $25,000$ Interest during construction, $5%$ $=$ $265,000$ Interest during construction, $5%$ $=$ $265,000$ Mittemud Falls rock-cut $=$ $71,000$ Total final cost $=$ $56,551,000$ Twenty-four-hour power available at $75%$ over-all efficiency $=$ $95,500$ h.p.Capital cost per 24-hour h.p. $=$ 868.60 Capital cost per installed h.p. $=$ 46.79
50% load factor $=$ 0.204 cent(3)—Final Development.(Fourteen 10,000-h.p. Units.) Capital Cost of Installation.Dam and equipment $=$ Dam and equipment $=$ $5,000$ Embankment (flood protection) $=$ $5,000$ Ice sluices and roadway $=$ $72,000$ Power station and equipment $=$ $1,035,000$ Hydraulic installation $=$ $1,035,000$ Hydraulic installation $=$ $1,035,000$ Beterrical installation $=$ $1,035,000$ Railroad $=$ $50,000$ Permanent quarters $=$ $25,000$ Contingencies, $10%$ $=$ $25,000$ Contingencies, $10%$ $=$ $25,000$ Interest during construction, $5%$ $=$ $265,000$ Interest during construction, $5%$ $=$ $265,000$ Mitemud Falls rock-cut $=$ $50,000$ Total final cost $=$ $50,000$ Twenty-four-hour power available at $75%$ over-all efficiency $=$ $95,500$ h.p.Capital cost per 24-hour h.p. $=$ $50,000$ Capital cost per installed h.p. $=$ 46.79 Annual Cost of Operation.
50% load factor $=$ 0.204 cent(3)—Final Development.(Fourteen 10,000-h.p. Units.) Capital Cost of Installation.Dam and equipment $=$ Dam and equipment $=$ $5,000$ $=$ Embankment (flood protection) $=$ $5,000$ $=$ Ice sluices and roadway $=$ $72,000$ Power station and equipment $=$ $1,035,000$ Hydraulic installation $=$ $1,330,000$ Electrical installation $=$ $1,50,000$ Railroad $=$ $50,000$ Permanent quarters $=$ $25,0000$ Contingencies, $10%$ $=$ $25,0000$ Contingencies, $10%$ $=$ $25,0000$ Interest during construction, $5%$ $=$ $265,0000$ Interest during construction, $5%$ $=$ $265,0000$ Interest during construction, $5%$ $=$ $95,500$ h.p.Capital cost per 24-hour h.p. $=$ $95,500$ h.p. $=$ Capital cost per 194-hour h.p. $=$ $95,500$ h.p. $=$ <t< td=""></t<>
50% load factor $=$ 0.204 cent(3)—Final Development.(Fourteen 10,000-h.p. Units.) Capital Cost of Installation.Dam and equipment $542,000$ Embankment (flood protection) $5,000$ Ice sluices and roadway $72,000$ Power station and equipment $1,035,000$ Hydraulic installation $1,330,000$ Electrical installation $1,610,000$ Railroad $156,000$ Ferry $50,000$ Permanent quarters $25,000$ Contingencies, 10% $483,0000$ Engineering and inspection, 5% $265,0000$ Interest during construction, $5\frac{1}{2}\%$ $307,0000$ Whitemud Falls rock-cut $671,0000$ Total final cost $$6,551,0000$ Twenty-four-hour power available at 75% over-all efficiency $=$ $95,500$ h.p.Capital cost per 24-hour h.p. $=$ 868.600 Capital cost per installed h.p. $=$ 46.790 Annual Cost of Operation.Interest, sinking fund and depreciation charges: $5260,000$
50% load factor $=$ 0.204 cent(3)—Final Development.(Fourteen 10,000-h.p. Units.) Capital Cost of Installation.Dam and equipment $=$ Dam and equipment $=$ Social Cost of Installation.Dam and equipment $=$ Social Cost station and equipment $=$ I,035,000Hydraulic installation $=$ Hydraulic installation $=$ Social Cost installation $=$ Social Social Cost installation $=$ Social Social Cost installation $=$ Social Cost installation $=$ Social Cost installation $=$ Social Social Cost installation $=$ Social Social Cost installation $=$ Social Cost installed h.p. $=$ </td
50% load factor $=$ 0.204 cent(3)—Final Development.(Fourteen 10,000-h.p. Units.) Capital Cost of Installation.Dam and equipment 5000 Embankment (flood protection) $5,000$ Ice sluices and roadway $72,000$ Power station and equipment $1,035,000$ Hydraulic installation $1,330,000$ Electrical installation $1,610,000$ Railroad $156,000$ Ferry $50,000$ Permanent quarters $25,000$ Contingencies, $10%$ $483,0000$ Engineering and inspection, $5%$ $265,0000$ Interest during construction, $51/2%$ $307,0000$ Whitemud Falls rock-cut $671,0000$ Total final cost $$
50% load factor $=$ 0.204 cent(3)—Final Development.(Fourteen 10,000-h.p. Units.) Capital Cost of Installation.Dam and equipment $=$ 5,000Embankment (flood protection) $=$ 5,000Ice sluices and roadway $=$ 72,000Power station and equipment $=$ 1,035,000Hydraulic installation $=$ 1,330,000Electrical installation $=$ 1,60,000Railroad $=$ 156,000Ferry $=$ 50,000Permanent quarters $=$ 25,000Contingencies, 10% $=$ 483,000Engineering and inspection, 5% $=$ 265,000Interest during construction, 5½% $=$ 307,000Whitemud Falls rock-cut $=$ 95,500 h.p.Capital cost per 24-hour h.p. $=$ 95,500 h.p.Capital cost per 24-hour h.p. $=$ \$68.60Capital cost per installed h.p. $=$ 46.79Annual Cost of Operation.Interest, sinking fund and depreciation charges:Interest, 5½% on \$6,551,000\$360,000Sinking fund, 4% (40-year bonds) $=$ 0Opereciation: $=$ 0
50% load factor $=$ 0.204 cent(3)—Final Development.(Fourteen 10,000-h.p. Units.) Capital Cost of Installation.Dam and equipment $=$ 5,000Embankment (flood protection) $=$ 5,000Ice sluices and roadway $=$ 72,000Power station and equipment $=$ 1,035,000Hydraulic installation $=$ 1,330,000Electrical installation $=$ 1,670,000Railroad $=$ 156,000Permanent quarters $=$ 25,000Contingencies, 10% $=$ 483,000Engineering and inspection, 5% $=$ 265,000Interest during construction, 5½% $=$ 95,500 h.p.Capital cost per 24-hour h.p. $=$ 95,500 h.p.Capital cost per 124-hour h.p. $=$ \$68.60Capital cost per 124-hour h.p. $=$ \$68.60Capital cost per 134-hour h.p. $=$ 46.79Annual Cost of Operation.Interest, sinking fund and depreciation charges:Interest, 5½% on \$6,551,000 $=$ \$360,000Sinking fund, 4% (40-year bonds) $=$ \$123,000 138,000Depreciation: $=$ \$15,000; 4% on machinery, etc., $=$ \$123,000 138,000
50% load factor $=$ 0.204 cent(3)—Final Development.(Fourteen 10,000-h.p. Units.) Capital Cost of Installation.Dam and equipment $=$ 542,000Embankment (flood protection) $=$ 5,000Ice sluices and roadway $=$ 72,000Power station and equipment $=$ 1,035,000Hydraulic installation $=$ 1,330,000Electrical installation $=$ 1,610,000Railroad $=$ 156,000Ferry $=$ 50,000Permanent quarters $=$ 25,000Contingencies, 10% $=$ 483,000Engineering and inspection, 5% $=$ 265,000Interest during construction, 5½% $=$ 307,000Whitemud Falls rock-cut $=$ 95,500 h.p.Capital cost per 24-hour h.p. $=$ \$68.60Capital cost per installed h.p. $=$ 46.79Annual Cost of Operation.Interest, 5½% on \$6,551,000Interest, sinking fund and depreciation charges:Interest, 5½% on \$6,551,000Sinking fund, 4% (40-year bonds) $=$ \$123,000 138,000Operation charges: staff\$30,000; supplies =
50% load factor $=$ 0.204 cent(3)—Final Development.(Fourteen 10,000-h.p. Units.)Capital Cost of Installation.Dam and equipment $5,000$ Embankment (flood protection) $5,000$ Ice sluices and roadway $72,000$ Power station and equipment $1,035,000$ Hydraulic installation $1,330,000$ Electrical installation $1,610,000$ Railroad $156,000$ Ferry $50,000$ Permanent quarters $25,000$ Contingencies, 10% $483,000$ Engineering and inspection, 5% $265,000$ Interest during construction, 512% $307,000$ Whitemud Falls rock-cut $671,000$ Total final cost $$

Total annual charge\$635,00

Volume 30.

Annual cost per h.pyear, 24-hour power	= 8	\$6.65	
Annual cost per h.pyear, machinery			
installed	=	4.54	
Annual cost per kw. hour	=	0.102 cent	C .
Annual cost per kw. hour on basis of			+
50% load factor	=	0.204 Cen	-
	The state		

COST OF MAINTAINING NEW YORK STATE **HIGHWAYS.***

By Fred W. Sarr,

Deputy Commissioner, New York State Highway Department.

PON receiving your kind invitation to be with you to-day and address you on the subject of highways, I was at first reluctant to accept same owing to the voluminous and important work which has been before the Commission during the past few months. In

finally accepting, however, I did so with the idea in mind of addressing you on the subject of the maintenance and repair of improved highways in the State of New York, which end of highway engineering in that State, I am at present associated with.

The proposition of maintenance of improved highways in New York State is an enormous one, practically ninety millions of dollars having been spent by the State for the construction of roads in the past seventeen years, and yet, with this huge expenditure, the experience gained and the system now in force, the maintenance of highways, even in our great State, is, I might say, still in its infancy. The . evolution in the kind of traffic to which our roads are subjected, particularly the adoption of the use of motor trucks carrying very heavy loads, and the general increased traffic necessitates a continuous study of individual cases.

General maintenance is comprised of keeping the paved roadway surfaces in as nearly uniform condition as possible, due regard being had for the relative importance of each particular road and the character of traffic it bears; keeping the earth shoulders smooth and safe for traffic; the drainage system free from obstructions; all structures in good repair and removing obstacles to vision, as brush or overhanging branches.

If the work of maintenance of improved highways is consistently performed throughout successive years, it is certain that the efficient life of such roads will be lengthened, and it would appear as though it could be prolonged almost indefinitely, if year by year the material added to the paved surface be equal or a little in excess of the material which has worn away during the same interval of time. This applies to the macadam type of construction which constitutes the vast bulk of the mileage under maintenance.

Maintenance should commence when construction leaves off, because in order to effectively and economically maintain improved roads it is necessary that the roadway be in a good state of repair at the time the maintenance work begins.

As an illustration of the magnitude of highway construction and maintenance in New York State, there were on April 1, 1915, 5,345 miles of improved and accepted state and county highways, and this mileage was increased as the season advanced, and on December 31, 1915, there were 5,926 miles of improved and accepted highways which has been maintained and repaired.

*Read before the Third Canadian and International Good Roads Congress, March, 1916.

repai sums 276 :

Jui

2,086

728

Exp

Exp Exp Exp

for eith whi pora resp min defi forr

tena the \$2, exp

mat too

me pas thre

pre or the \$3 and COS and

> to ior fre ag cos pe

> > m eff me de

672