Public Document - - No. 23

NINTH BIENNIAL REPORT

OF

THE STATE ENGINEER

TO THE

Governor of North Dakota

For the Biennial Period Ending June 30,

1920

LETTER OF TRANSMITTAL

Bismarck, North Dakota, September 1, 1920.

HONORABLE LYNN J. FRAZIER, Governor.

Sir: In compliance with the provisions o fthe law I have the honor to transmit herewith a report of the transactions of the daptrament of the state engineer for the biennial period, July 1, 1918, to June 30, 1920.

Respectfully submitted,

W. H. ROBINSON,

State Engineer.

Table of Contents

INTRODUCTION

On October 15, 1918, Mr. Jay W. Bliss, former state engineer, resigned from the office to enter the U. S. army as first lieutenant in the engineers. On that date the present engineer was appointed to complete Mr. Bliss' unexpired term and on April 1, 1919, was re-appointed and commissioned for the term ending April 1, 1923.

The office of state engineer was originally created to care for the irrigation needs of the state. Since that time numerous other duties and responsibilities have been added to the office until its original work has been entirely overshadowed.

The inspection of coal mines was formerly one of its important duties but the 1919 session of the legislature relieved the department by creating the office of State Coal Mine Inspector. It is still one of the duties of the state engineer to inspect state lands and determine whether they are coal bearing or not, when called upon by the Board of University and School Lands.

The duties and responsibilities falling upon the state engineer as Chief Engineer and Secretary of the Highway Commission are by far the most arduous imposed. Most of the difficulties enocuntered are due to lack of funds necessary to build up the organization required to furnish the preliminary engineering required to save the state's share of Federal Aid; to properly handle the surplus war equipment that has been allotted to the state; and to provide proper maintenance for the state highway system.

These difficulties have been increased during the last half of the biennium period due to the limit placed on the salaries of the engineers of the department by budget. From data on file in this office it is found that the salary of the chief engineer is $1,500 lower than the average paid in eleven neighboring states for the corresponding position. Other salaries paid in the department fall below the average in the same states for the corresponding positions in amounts ranging from the above sum down to the average in the minor positions. Owing to these conditions a considerable number of engineers left the department for a higher salary just as soon as sufficient experience had been obtained to warrant other states to take them on.

In addition to this the Highway Commission has been badly handicapped on account of lack of office room. This lack of space has made it necessary to move the drafting force down town and the blueprint machine is located in an open hallway a considerable distance from the blueprint room, where it is subject to the meddling of anyone who is so inclined. The main office is also entirely too crowded and in consequence of these conditions it is impossible to secure the greatet efficiency and economy in the department.

What has been said regarding salaries in the Highway Department is also true in the case of the salary of the Assistant State Engineer. On March 20, 1920 the assistant state engineer resigned and for the next

two months a successor with the necessary experience could not be obtained at the salary offered.

The 1919 session of the Legislature imposed additional responsibilities on the state engineer by making him an ex-officio member of the Flood Control Commission, as well as requiring him to investigate and report on artesian wells in the state. The problem confronting the Flood Control Board is a very great one and is complicated owing to the fact that three states, ,the Federal Government, and possibly Canada, are interested parties.

ACKNOWLEDGMENTS

Acknowledgment is hereby made to all the county officials who have co-operated with the state engineer, especially in the matter of highway improvements.

Acknowledgment is also made to the Bureau of Public Roads for the hearty co-operation received in connection with matters pertaining to Federal Aid and highway improvements in general.

Special credit is due the state engineer of South Dakota, the U. S. Geological Survey and Herbert A. Hard, Acting Flood Control Engineer, for the excellent assistance rendered in connection with the investigation of artesian wells in this state.

Special credit and thanks are also due to Professor E. F. Chandler for his usual cheerful co-operation and assistance in connection with hydrography and matters pertaining to irrigation.

Acknowledgment is also made to the many members of the departments coming under the direction of the state engineer, who have rendered cheerful and efficient service on all occasions.

LIST OF LAWS IMPOSING DUTIES ON THE STATE ENGINEER.

Chapter 38 of the Compiled Laws of 1913 and Chapter 115 of the 1917 Laws constitute the irrigation laws which impose specific duties on the state engineer. Chapter 116 of the 1919 Laws is also an irrigation law, which although it does not specifically mention the state engineer, probably comes under his supervision as general supervisor of the waters of the state.

Section 8301 of the Compiled Laws of 1913 makes it the duty of the state engineer to furnish the necessary engineering in connection with drainage projects when requested by any Board of County Commissioners.

Section 2648 of the Compiled Laws of 1913 provides that when two-thirds of the land owners subject to assessment for the construction of a drain file a protest, the state engineer shall be called upon to review

the assessments of benefits and the location of the drain and report on same to the Drainage Commission.

Sections 366 and 8239 of the Compiled Laws of 1913 provide for the examination of unsold school and state lands to determine whether they are coal bearing or not and to secure information regarding the topographical features, soil conditions, etc.

Article 7 of Chapter 6 of the Compiled Laws of 1913 provides that the state engineer shall have custody of maps, plats and field notes of the lands in the state.

Section 1990k of the Compiled Laws of 1913 requires the State Engineer, on request, to furnish any County Superintendent of Highways any information or bulletins available on road or bridge maintenance and construction. It is also his duty under this section to attend meetings of any County Board of Highway Improvements when requested.

Sections 1983 and 1984 of the Compiled Laws of 1913 make it the duty of the State Engineer to prepare plans for road or bridge work when requested by any Board of County Commissioners or any Board of Township Supervisors.

Chapter 131 of the Session Laws of 1917, as amended by Chapter 141 of the 1919 Session Laws, makes the State Engineer Chief Engineer and Secretary of the State Highway Commission.

Chapter 115 of the 1919 Session Laws makes the State Engineer a member of the Flood Control Commission.

RECOMMENDATIONS.

Irrigation.

The possibilities in western North Dakota for irrigation on an extensive scale are very limited indeed. There are, however, numerous opportunities for small projects along most of the streams. Occasionally where the topographical features are favorable for easily constructed reservoirs, the spring run-off from coulees and other small water courses may be stored for use on limited tracts. In addition to such projects pumping directly from streams may be carried on successfully in many places. It is believed that these small projects should be encouraged and all assistance possible rendered. During the last two seasons it has been necessary to divert the services of the Assistant State Engineer for a great part of the time from his regular duties to that of truckmaster in the Highway Department. This was absolutel ynecessary on account of the limited budget and the necessity of saving to the state its share of the surplus war equipment. It is therefore recommended that ample provision be made in the Highway Commission budget for a truckmaster and assistants, so that the Assistant State Engineer will be free to devote the necessary time to irrigation.

Highway Commission.

It is recommended that a scale of salaries be adopted for the em-

ployees of the Highway Department that is commensurate with the responsibilities and is on a par with what is being paid by neighboring states for similar positions. It has been a mistake in the past to attempt to prescribe the salaries of all employees. It appears that it would be necessary to prescribe only the salaries of the executive positions or heads of departments and allow the balance of the employees to be engaged at the salaries current at the time of employment. It appears that it would be just as reasonable to attempt to limit the wages for teamsters, engine men, grader men, etc., on our highways as to limit the wages paid to the men who supervise them.

It is also recommended that adequate provision be made for storing the miscellaneous surplus war equipment and the extra parts for the motor vehicles secured from the Government. At the present writing between twenty-five and fifty thousand dollars worth of these spare parts, etc., are being stored in tents on the ground and under such conditions there is very little check on them and it is probable that a large number of them are being stolen.

As soon as possible sufficient office room should be provided so that the various units of the department now scattered about can be brought together so that there will be opportunity for organizing all into a harmonious and efficient unit.

Artesian Wells.

A report on artesian wells made in compliance with a concurrent resolution passed by the Sixteenth Legislative Assembly will be found incorporated herein. The last few pages of that report include recommendations regarding the artesian wells of the state that may be summarized as follows:

It is recommended that laws be passed to compel the closing of wells when not in use; that well drillers be placed under adequate bond and be required to furnish the state authority who has general supervision of the artesian wells of the state, a log or record of the materials encountered in the drilling of each well; and that the State Engineer, who would be the logical authority in the matter as general supervisor of the waters of the state, be required to compile the best information obtainable regarding the proper materials and methods for use in connection with artesian wells and that the same be placed at the disposal of well drillers, well owners and those contemplating sinking wells.

OFFICERS AND EMPLOYEES FOR BIENNIAL PERIOD.

J. W. Bliss (July 1 to Oct. 15, 1918)	State Engineer
W. H. Robinson	State Engineer
J. M. Hansen	Asst. State Engineer
W. J. Smith	Asst. State Engineer
Rose Sell	Stenographer

Employed Temporarily as Needed.

T. R. Atkinson	Assistant Engineer
E. F. Chandler	Assistant Engineer
L. W. Dymond	Assistant Engineer
E. F. Dowd	Assistant Engineer
R. P. V. Marquardsen	Assistant Engineer
W. F. McGraw	Assistant Engineer
H. Pike	Assistant Engineer
J. N. Roherty	Assistant Engineer
Wm. Rommel	Assistant Engineer
D. R. Williams	Assistant Engineer
John N. Forister	School Land Inspector
Paul L. Grambs	Draftsman
E. Bond	Field Man
O. E. Burke	Field Man
O. B. Hoskins	Field Man
G. Reisland	Field Man
H. J. Simonson	Field Man
Mildred Crawford	Stenographer
Emily Dakin	Stenographer
Beulah R. Dow	Stenographer
Josephine Fogerty	Stenographer
Agnes Hoaglund	Stenographer
Catherine Paukert	Stenographer
Haldora Peterson	Stenographer
Mrs. Grant Hart	Clerk
Hortense Moore	Clerk
Flora Murray	Clerk
J. H. Nylen	Clerk

FINANCIAL STATEMENT.

July 1, 1918, to June 30, 1919.

Balance in fund June 30, 1918	$14,582.24
Less expenditures	10,890.51
Balance in fund June 30, 1919	$3,691.73

July 1, 1919, to June 30, 1920.

Balance in fund June 30, 1919	$3,691.73
Credit by appropriation	24,770.00
Contingent appropriation for workmen's compensation premiums	164.97
Refund on mileage book	9.22
	$28,635.92
Less expenditures	6,665.09
	$21,980.83
Credited to General Fund	12,970.83
Balance in State Engineer's Fund June 30, 1920	$9,010.00

Fees of State Engineer's Office

July 1, 1918, to June 30, 1920.

For field notes	$184.17
For special work	869.75
For water rights	252.25
Credited to General Fund	$1,306.17

FINANCIAL STATEMENT IN ACCORDANCE WITH THE SUBDIVISIONS OF THE APPROPRIATION FOR THE STATE ENGINEER'S OFFICE UNDER THE BUDGET BILL.

July 1, 1918, to June 30, 1919.

SALARY—STATE ENGINEER.

Balance July 1, 1918	$2,500.04
Less expenditures	2,500.00
Balance	$0.04

CLERK HIRE.

Balance July 1, 1918	$7,775.55
Less expenditures	5,331.12
Balance	$2,444.43

POSTAGE.

Balance July 1, 1918	$349.00
Less expenditures	349.00
Balance	$0.00

OFFICE SUPPLIES.

Balance July 1, 1918	$629.73
Credit by transfer from Traveling Expense	100.00
	$729.73
Less expenditures	681.84
Balance	$47.89

FURNITURE AND FIXTURES.

Balance July 1, 1918	$46.60
Less expenditures	9.97
Balance	$36.63

TRAVELING EXPENSE.

Balance July 1, 1918		$1,516.43
Less transfer to Office Supplies	$100.00	
Less expenditures	1,238.71	
		1,338.71
Balance		$177.72

SCHOOL LAND EXAMINATION.

Balance July 1, 1918	$555.73
Less expenditures	133.83
Balance	$421.90

HYDROGRAPHIC WORK.

Balance July 1, 1918	$394.50
Less expenditures	119.25
Balance	$275.25

PRINTING.

Balance July 1, 1918	$668.90
Less expenditures	389.69
Balance	$279.21

MISCELLANEOUS.

Balance July 1, 1918	$145.76
Less expenditures	137.14
Balance	$8.62

Note:—The balances in the foregoing funds, aggregating $3,691.73, were carried forward as State Engineers' Prior Fund.

FINANCIAL STATEMENT IN ACCORDANCE WITH THE SUBDIVISIONS OF THE APPROPRIATION FOR THE STATE ENGINEER'S OFFICE UNDER THE BUDGET BILL.

July 1, 1919, to June 30, 1920.

SALARY—STATE ENGINEER.

Credit by appropriation	$5,000.00
Less expenditures	2,499.96
Balance	$2,500.04

CLERK HIRE.

Credit by appropriation	$12,720.00
Less expenditures	2,731.61
Balance	$9,988.39

POSTAGE.

Credit by appropriation	$300.00
Less expenditures	4.80
Balance	$295.20

OFFICE SUPPLIES.

Credit by appropriation	$900.00
Less expenditures	314.33
Balance	$585.67

FURNITURE AND FIXTURES.

Credit by appropriation	$200.00
Less expenditures	62.55
Balance	$137.45

PRINTING.

Credit by appropriation	$700.00
Less expenditures	5.19
Balance	$694.81

MISCELLANEOUS.

Credit by appropriation	$200.00
Less expenditures	78.49
Balance	$121.51

TRAVELING EXPENSE.

Credit by appropriation	$1,950.00
Less expenditures	412.19
Balance	$1,537.81

SCHOOL LAND EXAMINATION.

Credit by appropriation	$200.00
No expenditures.	

HYDROGRAPHIC WORK.

Credit by appropriation	$800.00
Less expenditures	322.20
Balance	$477.80

The balances in the foregoing funds were credited to the General Fund and the following appropriations made for the State Engineer's

Office by the Special Session of 1919, for the year beginning July 1, 1920:

State Engineer's Salary	$2,500.00
Clerk Hire	4,560.00
Postage	150.00
Office Supplies	450.00
Printing	250.00
Miscellaneous	100.00
Traveling Expense	600.00
Hydrographic Work	400.00

APPLICATIONS FOR PERMITS TO APPROPRIATE WATER WITHIN THE STATE OF NORTH DAKOTA. UNDER CHAPTER 38, COMPILED LAWS OF 1913.

108. **Sanford Irrigation Project.**

Mr. I. Sanford of Banks filed an application on September 11, 1918, to appropriate water to irrigate 140 acres of land in Section 14, Township 153 North, Range 97 West. The source of supply is the Tobacco Garden Creek and the water is to be pumped direct to ditches. The estimated cost of the work is $2,500.

109. **Grantier Irrigation Project.**

Mr. Jay Grantier of Banks filed an application on September 5, 1918, to appropriate water for the irrigation of 376.6 acres of land lying in Sections 5, 6, 7 and 8, Township 152 North, Range 97 West. The source of supply is Clear Creek and water is to be diverted by an earth and rock dam ten feet in height. The distributing canals will be 2.18 miles in length and the total estimated cost of the work is $2,500.

110. **McCarty Irrigation Project.**

Mr. Wm. McCarty of Medora filed an application on December 12, 1918, to appropriate water from the Little Missouri River to irrigate 340 acres of land in Sections 10 and 15, Township 139, Range 102 West. The water is being lifted from the river about 22 feet to the ditches by means of a 15-inch centrifugal pump operated by a steam engine. The estimated cost of the works is $5,680.00.

111. **Hannaford Water Supply.**

On November 7, 1918, the Northern Pacific Railway Company applied for a permit to appropriate two cubic feet of water per second from Bear Creek in Section 5, Township 144 North, Range 59 West. The water is to be used for locomotive and other railway purposes. The works were completed and consist of a well, an eight-foot wooden dam, pipe line, and gasoline driven pumping equipment.

112. **Horace Water Supply.**

On November 7, 1918, the Northern Pacific Railway Company applied for a permit to appropriate two cubic feet of water per second from the

Sheyenne River in Section 24, Township 138 North, Range 50 West, to be used for locomotive and other railway purposes. The works were completed and consist of a well, tank, pipe lines and gasoline driven pumping equipment.

113. **Valley City Water Supply (Low Line).**

On November 7, 1918, the Northern Pacific Railway Company applied for a permit to appropriate three cubic feet of water per second from the Sheyenne River and a well in Section 21, Township 140 North, Range 58 West, to be used for locomotive and other railway purposes. The works were completed and consist of a well, pipe line, tank, and gasoline driven pumping equipment.

114. **Koldok Water Supply.**

On November 7, 1918, the Northern Pacific Railway Company applied for a permit to appropriate three cubic feet of water from a small stream in Section 22, Township 140 North, Range 56 West, to be used for locomotive and other railway purposes. The works were completed and consist of a ten-foot earth dam, pipe lines, seepage boxes and gasoline driven pumping equipment.

115. **Magnolia Water Supply.**

On November 7, 1918, the Northern Pacific Railway Company applied for a permit to appropriate three cubic feet of water per second from a small stream in Section 25, Township 140 North, Range 54 West, for locomotive and other railway purposes. The works were completed and consist of an earth dam 15 feet in height, pipe lines, tanks and gasoline driven pumping equipment.

116. **Grafton Water Supply.**

On November 7, 1918, the Northern Pacific Railway Company applied for a permit to appropriate two cubic feet of water per second from Park River in Section 13, Township 157 North, Range 53 West, for locomotive and other railway purposes. The works were completed and consist of a well, tank, pipe lines, and a windmill driven pumping equipment.

117. **Meckinock Water Station.**

On November 7, 1918, the Northern Pacific Railway Company applied for a permit to appropriate two cubic feet of water from Turtle River in Section 1, Township 152 North, Range 53 West, for locomotive and other railway purposes. The works were completed and consist of a wooden dam four feet in height, pipe lines, tank and steam driven pumping equipment.

118. **Lisbon Water Supply.**

On November 7, 1918, the Northern Pacific Railway Company applied for a permit to appropriate two cubic feet of water per second from the Sheyenne River in Section 11, Township 134 North, Range 56 West, for

locomotive and other railway purposes. The works were completed and consist of a well, pipe lines, tank and gasoline driven pumping equipment.

119. **Kathryn Water Supply.**

On November 7, 1918, the Northern Pacific Railway Company applied for a permit to appropriate two cubic feet of water per second from the Sheyenne River in Section 13, Township 137 North, Range 58 West, for locomotive and other railway purposes. The works were completed and consist of a well, pipe lines, tank and gasoline driven pumping equipment.

120. **Flasher Water Supply.**

On November 7, 1918, the Northern Pacific Railway Company applied for a permit to appropriate two cubic feet of water per second from Louse Creek in Section 3, Township 134 North, Range 84 West, for locomotive and other railway purposes. The works were completed and consist of an earth dam 22 feet in height, pipe lines, tank and gasoline pumping equipment.

121. **De Mores Water Supply.**

On November 7, 1918, the Northern Pacific Railway Company appplied for a permit to appropriate one cubic foot of water per second from Andrews Creek in Section 24, Township 140 North, Range 104 West, for locomotive and other railway purposes. The works were completed and consist of an earth dam eight feet in height, pipe lines and steam pumping equipment.

122. **Mandan Water Supply. (Auxiliary Supply)**

On November 7, 1918, the Northern Pacific Railway Company applied for a permit to appropriate three cubic feet of water per second from the Heart River in Section 27, Township 139 North, Range 81 West, for locomotive and other railway purposes. The works were completed and consist of intake, pipe lines and steam pumping plant.

123. **Sweet Briar Water Supply.**

On November 7, 1918, the Northern Pacific Railway Company applied for a permit to appropriate one cubic foot of water per second from Sweet Briar Creek in Section 28, Township 139 North, Range 83 West, for locomotive and other railway purposes. The works were completed and consist of a concrete dam ten feet in height, pipe lines and a steam pumping plant.

124. **Valley City Water Supply. (High Line)**

On November 7, 1918, the Northern Pacific Railway Company applied for a permit to appropriate three cubic feet of water per second from the Sheyenne River in Section 15, Township 140 North, Range 58 West, for locomotive and other purposes. The works were completed and consist of an intake crib, pipe lines and a gasoline driven pumping plant.

125. **Forest River Water Supply.**

On November 7, 1918, the Northern Pacific Railway Company applied

for a permit to appropriate two cubic feet of water per second from the Forest River in Section 21, Township 155 North, Range 53 West, for locomotive and other railway purposes. The works were completed and consist of a wooden dam, pipe lines, tank and a steam pumping plant.

126. **Sunny Water Supply.**

On November 7, 1918, the Northern Pacific Railway Company applied for a permit to appropriate one cubic foot of water per second from two wells which derive their supply from the Heart River in Section 30, Township 139 North, Range 81 West, for locomotive and other railway purposes. The works were completed and consist of two wells, pipe lines and steam pumping plant.

127. **Haggart Water Supply.**

On November 7, 1918, the Northern Pacific Railway Company applied for a permit to appropriate three cubic feet of water per second from the Sheyenne River in Sections 5 and 6, Township 139 North, Range 49 West, for locomotive and other railway purposes. The works were completed and consist of a concrete dam 7½ feet in height, pipe lines, tank, and a gasoline driven pumping plant.

128. **Pingree Water Supply.**

On November 7, 1918, the Northern Pacific Railway Company applied for a permit to appropriate two cubic feet of water per second from Pipestone Creek in Section 30, Township 143 North, Range 65 West, for locomotive and other railway purposes. The works were completed and consist of a well, pipe lines, tank, and a gasoline driven pumping plant.

129. **Belfield Water Supply.**

On November 7, 1918, the Northern Pacific Railway Company applied for a permit to appropriate one cubic foot of water per second from an intermittent tributary of the Hear River in Section 5, Township 139 North, Range 99 West, for locomotive and other railway purposes. The works were completed and consist of a reservoir, pipe lines, and a steam pumping plant.

130. **Tetley Irrigation Project.**

On September 8, 1919, Mr. L. Tetley of Medora filed an application for a permit to appropriate 1.8 cubic feet of water per second from the Little Missouri River in Sections 32 and 33 of Township 139 North, Range 102 West. The application covers 144 acres of land which it is proposed to irrigate by pumping directly from the river to distributing ditches. The estimate cost of the works is $2,500.

131. **Widmann Irrigation Project.**

On May 6, 1920, Mr. Jacob Widmann of Spring Brook applied for a permit to appropriate 1.62 cubic feet of water per second from Stony Creek in Sections 9 and 10, Township 155 North, Range 99 West, to irrigate 130 acres of land. It is proposed to pump from the stream to distributing ditches. The cost of the work is estimated at $725.

FILINGS MADE UNDER THE IRRIGATION CODE FOR IRRIGATION PURPOSES FROM JULY 1, 1918, TO JUNE 30, 1920.

No.	Name of Applicant.	Lands to Be Irrigated	Source of Supply	Amount of Water Claimed in Second Feet	No. of Acres	Date of Claim
108	I. Sanford	Part of SW¼ Sec. 14, T. 153 N., R. 97 W.	Tobacco Garden Creek	1.75	140	Sept. 11, 1918
109	Jay Grantier	Part of Secs. 5, 6, 7 and 8, T. 152 N., R 97 W.	Clear Creek	4.7	376.6	Sept. 5, 1918
110	Wm. McCarty	Part of Secs. 10 and 15, T. 139, R. 102 W.	Little Missouri River	4.25	340	Sept. 12, 1918
130	L. Tetley	Part of Secs. 32 and 33, T. 139 N., R. 102 W.	Little Missouri River	1.8	144	Sept. 8, 1919
131	Jacob Widman	Part of Secs. 9 and 10, T. 155 N., R. 99 W.	Stony Creek	1.625	130.07	May 6, 1920

*Total acres to be irrigated—1,130.67.

FILINGS UNDER THE IRRIGATION CODE FOR RAILROAD PURPOSES FROM JUNE 30, 1918, TO JULY 1, 1920.

No. of Permit	Name of Applicant	Location	Source of Supply	Amount of Water Claimed in Second Ft.	Date of Claim
111	N. P. Railway Co.	Hannaford	Bear Creek	2	Nov. 7, 1918
112	N. P. Railway Co.	Horace	Sheyenne River	2	Nov. 7, 1918
113	N. P. Railway Co.	Valley City (Low Line)	Sheyenne River	3	Nov. 7, 1918
114	N. P. Railway Co.	Koldock	Small stream	3	Nov. 7, 1918
115	N. P. Railway Co.	Magnolia	Small stream	3	Nov. 7, 1918
116	N. P. Railway Co.	Grafton	Park River	2	Nov. 7, 1918
117	N. P. Railway Co.	Meckinock	Turtle River	2	Nov. 7, 1918
118	N. P. Railway Co.	Lisbon	Sheyenne River	2	Nov. 7, 1918
119	N. P. Railway Co.	Kathryn	Sheyenne River	2	Nov. 7, 1918
120	N. P. Railway Co.	Flasher	Louse Creek	2	Nov. 7, 1918
121	N. P. Railway Co.	DeMores	Andrews Creek	1	Nov. 7, 1918
122	N. P. Railway Co.	Mandan	Heart River	3	Nov. 7, 1918
123	N. P. Railway Co.	Sweet Briar	Sweet Briar Creek	1	Nov. 7, 1918
124	N. P. Railway Co.	Valley City (High Line)	Sheyenne River	3	Nov. 7, 1918
125	N. P. Railway Co.	Forest River	Forest River	2	Nov. 7, 1918
126	N. P. Railway Co.	Sunny	Seepage from Heart River	1	Nov. 7, 1918
127	N. P. Railway Co.	Haggart	Sheyenne River	3	Nov. 7, 1918
128	N. P. Railway Co.	Pingree	Pipestone Creek	2	Nov. 7, 1918
129	N. P. Railway Co.	Belfield	Intermittent Tributary of Heart River	1	Nov. 7, 1918

DRAINAGE WORK

Verona Drain—LaMoure County.

Plans, specifications and supervision were furnished by the State Engineer's Office for this project which was under way at the beginning of the present biennial period. The work was completed in the spring of 1919 and cost approximately $20,000.

Thingvalla Drain No. 28—Pembina County.

The preliminary investigation for this drain was made in the summer of 1919 but no definite steps were taken to put the project under way until the present season, when the Pembina County Drainage Board requested the State Engineer's office to complete the preliminary engineering work. This project lies just southeast of Mountain and will benefit about 10,000 acres of land.

Fish Lake Investigation.

During the summer of 1919 members of the North Dakota Game and Fish Commission called on the State Engineer's office to investigate the feasibility of several methods proposed to raise and maintain the water level in Fish Lake located near St. John in the Turtle Mountains. The project was examined by Mr. J. M. Hanson, Assistant State Engineer, and he recommends the draining of several smaller lakes into Fish Lake as the most feasible of the methods proposed for increasing the water shed and maintaining the level of that lake. It appears that the lowering of the lake level by evaporation has caused the dying off of nearly all of the fish planted there by the U. S. Government.

RECONNAISSANCE REPORT
of
Proposed Improvements at the
STATE FISH HATCHERY
on
Fish Lake.
Township 163 North, Range 71 West.
By
J. M. Hansen, Assistant State Engineer.

For a number of years past the waters of Fish Lake, upon whose shore the State Fish Hatchery is located, have been diminishing until at the present time the water level has been reduced approximately three feet from its stage 15 or 20 years ago. This reduction in stage has caused the destruction of practically all fish life at different intervals and has encouraged the development and growth of various species of rank aquatic plant life which also are detrimental to the development of fish life.

Fish Lake is the largest lake in the vicinity of the hatchery and the only one which seems suitable for the development of fish life in connec-

tion therewith. Under normal conditions fish of all kinds, natives of the Northwest, thrive and develop in its waters.

From the foregoing it appears that well timed action and effort to relieve present conditions are necessary if the hatchery is to be efficiently operated and its existence on the shores of Fish Lake continued.

The improvements necessary to relieve present conditions must primarily supply sufficient quantity of water to bring the water stage of Fish Lake back to its original elevation. To bring about the desired result but two methods appear worthy of consideration; briefly as follows:

The first plan requires the using of Waukupa Creek Flat as a large storage reservoir, the water to be held in storage by the construction of a ten-foot dam, at a point in the saddle or overflow outlet between Fish and Walker Lakes. The water from the reservoir to pass by gravity into Fish Lake through control gates in the dam.

The second plan requires the draining of Crow, Big Garber, Little Garber, Gravel and "No. 35" Lakes into Fish Lake through open drainage ditches; such ditches to be constructed between the lakes in question, usually following old overflow channels. The plan will require the construction of timber control gates and quieting pools, in all probability.

Of the two plans under consideration it develops that the second plan only can be considered feasible and practicable in view of the fact that the gradient of Waukupa Creek valley is so slight that many acres of fertile meadow lands along the creek would be claimed by the reservoir and also the fact that the watershed of Waukupa Creek basin, which heads near De Mars is of insufficient size to furnish enough water to secure the desired elevation at the crest of the dam. It seems quite evident that after the spring run off has been collected the water surface of the proposed reservoir could not be raised more than approximately two feet, the amount required at the present time to allow flowage from the reservoir to Fish Lake. It is very probable that under the conditions the entire capacity of the reservoir would be claimed by evaporation and absorption as a result of its great exposed surface and shallow depth unless a pumping plant of large capacity were constructed at the dam to lift the water from the reservoir to Fish Lake during the spring run off. The pumping plant would be essential to insure a supply of water for Fish Lake during years of comparatively light percipitation.

As a result of the undesirable features of the first plan an investigation was made having in mind the draining of Gravel, Little Garber, Big Garber Lakes into Fish Lake; Crow Lake into Fish Lake, and, No. "35" Lake into Fish Lake, with the results shown on the accompanying plat. The plat was prepared from the U. S. Surveyor General's Field Notes and plats of the original survey, and the areas of the lakes in question as well as the drainage areas involved, computed therefrom. The depth of water in the lakes, annual water stage data, as well as other information was secured through the courtesy of Mr. Alfred Eastgate, who assisted in the hydrographic surveys thereof. The information thus secured furnishes

data for a reconnaissance report of the second plan which is respectfully recommended for consideration, and which follows:

SECOND PLAN.

General Data on Second Plan. Fish Lake had an area of 260.5 acres with a water surface elevation of approximately 76.83 feet (assumed elevation of 100.00 for water surface of Gravel Lake, August 8th, 1919) at the time of the original survey in 1897. Its drainage area includes approximately 879 acres, all in close proximity thereto. This area for the most part is heavily timbered and the slopes thereof are very abrupt.

The present area of Fish Lake is approximately 230.5 acres with a water surface elevation of approximately 73.83. After the spring rise in 1919 the stage of the water surface reached an elevation of 74.58, representing a rise of nine inches.

The precipitation in the Turtle Mountains averages 15.3 inches per annum; the annual evaporation loss may be stated as 32 inches; thus representing a net loss of 16.7 inches, providing of course the run off factor of the area is disregarded. However, the depth of annual run off from this basin is estimated to be about 60% of the annual precipitation or about 9.18 inches. This run off from the drainage area would represent a raise of two and one-half feet or thirty inches in Fish Lake which would under normal conditions very nearly balance the thirty-two inches lost through evaporation. Of course, during years when the precipitation is less than the average, which usually occurs in cycles of three or four years, the waters of the lake recede more rapidly.

As stated before, the water surface of Fish Lake has been reduced approximately three feet during a period of perhaps 15 or 20 years. During this period the reduction has not been gradual but has been subject to fluctuations dependent upon the amount of precipitation and evaporation. To restore the water surface to its original and desirable elevation, it will be necessary to supply approximately 736.5 acre feet of water, and to insure a maintenance of the original water level it will be necessary to approximately double the present drainage area of Fish Lake. To meet the above conditions it is probable that all or at least part of the following described ditches will have to be constructed.

Big Garber, Little Garber and Gravel Lake Ditches. To be constructed from the bottom of Big Garber Lake which has an approximate depth of eight feet; a surface elevation of 128.94, and, an area of 36.5 acres,—representing approximately 106.5 acre feet of water, to Little Garber Lake which in turn has an approximate depth of five feet; a surface elevation of 112.59, and, an area of 35.5,—representing approximately 71 acre feet of water; thence to Gravel Lake which has an approximate depth of 23 feet; a surface elevation of 100, and an area of 76 acres, representing approximately 380 acre feet of water; thence to Fish Lake.

Crow Lake Ditch to be constructed from Crow Lake which has an approximate depth of twelve feet; a surface elevation of 89.28 and an area of 50 acres representing 150 acre feet of water to Fish Lake. The construction of the above mentioned ditch would make available approxi-

mately 707.5 acre feet of water and provide an additional drainage area for Fish Lake of 685 acres.

No. "35" Lake Ditch to be constructed from No. "35" Lake which has an approximate depth of five feet; a surface elevation of 85.47, and, an area of approximately 60 acres, representing 120 acre feet of water, to Fish Lake. This ditch provides an additional drainage area for Fish Lke of 276.5 acres.

Summary. By constructing the above described ditches it is evident that all requirements will be met in view of the fact that approximately 827.5 acre feet of water would be immediately available for bringing the water stage of Fish Lake to its original elevation, and would provide an additional drainage area of 961.5 acres; thus doubling the drainage area of the original Fish Lake.

In addition to the actual construction of the open ditches it will be necessary in each case to use at least during construction timber head gates and quieting pools at the lower end of each lake to be drained.

Cost. Due to the fact that all investigations were of a preliminary nature, primarily to determine the feasibility of the project, sufficient data is not available at the present time for the preparation of proper estimates. However, a statement is offered that if it is necessary to construct the entire work the cost of same should not exceed $8,000.00. A proper estimate of the cost can only be prepared after a detailed survey of the work has been made.

It may be well to state at this time that it is very probable that all proposed ditches need not be constructed. However, it would be necessary to at least construct the Big Garber, Little Garber, and Gravel Lake ditch as well as the Crow Lake ditch.

During periods of overflow from Fish Lake, if the same should occur, a natural outlet is provided at the point between Fish and Walker Lakes where in plan one it was proposed to construct the dam. The flow of water during such periods can also be controlled by the construction of permanent head gates and quieting pools at the lower end of such lakes as may be deemed advisable.

The water supply for the fish hatchery, which at the present time is taken from Gravel Lake, can be pumped with a small pump at a nominal expense from Fish Lake. Water being required at stated intervals and for short periods only.

The immediate benefits of the fish hatchery are in part: The benefits that will be derived by the property holders abutting Fish Lake as well as those who can avail themselves of the fertile lake bottom land reclaimed by the draining of a portion of all of the lakes effected by the proposed improvement. The benefit to the state at large by the retaining of such a splendid summer resort and fishing grounds are immeasurable.

Report on
ARTESIAN WELLS
to the Governor of North Dakota
By W. H. Robinson, State Engineer—November 28, 1919.

The House of Representatives of the 16th Legislative Assembly in session on February 26th, 1919, by means of a concurrent resolution, directed the State Engineer "To investigate all matters and conditions connected with the construction, use and maintenance of artesian wells in the State of North Dakota, with a view to ascertaining whether there are any evil results consequent thereupon, such as impairment of the water supply of the state, infringement upon public or private rights, damage following such infringement, or otherwise incidental thereto or caused thereby; and with a view, further, to ascertain what, if any, remedies may be applied to such undesirable conditions as may be found to exist through such investigation; that the State Engineer be, and is hereby further instructed to submit a report of such investigation to the Governor of the State on or before the first day of January, 1920."

To those who are fairly familiar with the subject of artesian wells, it will be obvious that the task imposed is one of great magnitude, if all phases of the subject are to be examined, and further that the present force and facilities of the State Engineer are entirely inadequate to perform such a task thoroughly in the time specified. Fortunately for our state, however, the need for a similar investigation was impressed on the legislature of our sister state, South Dakota, at its 14th session and that body passed a bill empowering its State Engineer, Mr. Homer M. Derr, to make a detailed and exhaustive investigation of the subject. Since the reports of the U. S. Geological Survey show us that most of the artesian wells of North Dakota derive their supply from the same source as those of South Dakota, and since the same principles of construction, use and waste prevail in both states, it is very proper to use the report of that investigation in drawing conclusions on the subject of artesian wells in our state.

In addition to the above source of information we have the numerous reports, papers and folios that have been published from time to time by the U. S. Geological Survey.

The Washington officials of this body have kindly loaned their notes on the two quadrangles lying mostly in LaMoure and Dickey Counties, which have not yet been printed. This material was gathered by Mr. Herbert A. Hard, now Acting Flood Control Engineer of this State, for that department prior to the entrance of the United States into the late war. Owing to the curtailment of funds during that period, this report has not yet been published. During the last summer Mr. Hard has given hearty co-operation in this work and has gathered additional information that is of great value in this work. His former experience with the Geological Survey has placed him in a position to secure data that could not otherwise be obtained in so short a period.

Before going into the matter of data it will be advisable to briefly state a few general conditions necessary to the existence of artesian wells

CRIMINAL WASTE OF ONE OF OUR NATURAL RESOURCES.
(By Courtesy of the State Engineer of South Dakota.)

and show just what these conditions are in this and neighboring states as ascertained by geologists.

Artesian wells or "flowing wells" owe their existence to the fact that the water bearing strata tapped by the wells, extends under ground higher than where the flow occurs, and rises in that direction until it reaches a greater elevation than the surface where the well is located. If the well is to flow for any considerable length of time, this higher portion must be of considerable extent or have a constant source of supply if the flow and pressure are to be maintained. This water bearing strata must first, be more or less porous, and secondly, be enclosed between practically impervious layers. If the strata in question has no other outlet the well when closed will show a pressure equivalent to the difference in the height of the gauge and the highest point of the strata containing water. In other words, if the well casing were extended into the air high enough the water would rise in this pipe to the same elevation as the highest surface of the water in the water bearing area. The volume of the flow will mainly depend upon this pressure, the size of the pipe and the porosity of the material through which the flow passes.

In taking up the conditions which account for most of the artesian wells in our state it will be well to keep the above explanation in mind. From the examination of this matter by geologists it has been determined that practically all of North and South Dakota, part of Nebraska, Manitoba, and possibly portions of other states, are underlaid by a practically continuous sheet of water bearing sandstones and other materials. This sheet rises to the surface in a considerable area surrounding the Black Hills in South Dakota and possibly other points further west nearer the Rocky Mountains.

Where this outcrop occurs the porous material may easily absorb a great deal of the rainfall that occurs in that region but it will be shown later that this source of supply is not sufficient to counterbalance the quantity drawn from the eastern portion. The higher portions toward the west furnish the necessary head to produce flows in the lower territory in the eastern part of the two Dakotas. This great sheet of water bearing material is known as the Dakota Sandstone and derives its name from Dakota County in Nebraska, where another outcrop develops along the Missouri River. At this point where the strata is cut by streams numerous brackish springs occur. Strictly speaking, however, the name Dakota Standstone is restricted to the upper member of a series but for convenience the old designation will be applied to it and allied water bearing materials.

The Dakota Sandstone appears to extend under the Red River Valley into Minnesota, but the portion underlying the valley proper seems to be of too dense a texture, or perhaps for other reasons does not readily carry water, and wells penetrating it yield none, or at best only a meagre flow. Along the lower valley in Walsh County there occur "salt" lakes or sloughs fed by numerous springs, which are believed to have their origin in the Dakota Sandstone. The lower courses of the Forest River and Park River pass through such lakes and were formerly known as the Big and Little Salt Rivers.

The Dakota Sandstone usually lies directly on what is known in common parlance as "bedrock" and is usually directly overlaid by various kinds of shales. These shales and other overlying materials have all been classified by geologists, but since this explanation is intended for those not having had an opportunity to become acquainted with geology, as little use as possible is made of geological terms. This underlying bedrock and the overlying shale furnish the necessary impervious enclosure mentioned above.

The Dakota Sandstone varies in thickness from several hundred feet to nearly zero. Underlying the artesian basin of the James River Valley the sandstone seems to be separated into three or more layers, or "horizons" as they are designated by geologists. The water obtained from the upper one is called the "first flow," the next the "second flow" and the lower one the "third flow." The second flow is usually superior to the first in volume and pressure, and the third is superior to the second in the same respect.

In the vicinity of Bismarck this sandstone is believed to lie at least two thousand feet below the surface and has probably never been reached by well drillers. In the neighborhood of Jamestown the top of the sandstone lies between fifteen and sixteen hundred feet below the surface, or at approximately sea level. At Mapleton, which is located just beyond the eastern limits of the Dakota Sandstone giving a flow, it lies approximately six hundred feet below the surface. In the artesian basin surrounding Oakes it lies approximately one thousand feet below the surface and between three and four hundred feet above sea level. At Devils Lake it lies approximately fifteen hundred feet below the surface or near sea level.

Taking up the matter of pressure obtained from wells deriving water from the Dakota Sandstone, the earliest record seems to be that published in 1896 in Volume 25 of the Reports of the U. S. Geological Survey. Some of this was derived from other reports published as early as 1887. The table published in this report gives a list of wells distributed over the territory lying between Devils Lake and the southeast corner of South Dakota. It gives the depths of the wells, the elevation of the surface above sea level, the pressure, and also the computed artesian "head." The pressure of these wells ranges from fifty to one hundred eighty-seven pounds. When this pressure is reduced to "head," it is found to vary from about twelve hundred to two thousand feet above sea level. This varying head above sea level might well be called "effective head" to distinguish it from the uniform head that would occur in time if there were no leakage from the reservoir and all wells penetrating it had open casings extending above this head.

It may be well at this point to briefly explain what is meant by "head." Earlier in this report it was stated that the closed pressure of a well represented the difference between the elevation of the gauge and the highest point in the water bearing strata and that water would rise in an open casing to that height. This condition is true, however, only when there are no other outlets. Nevertheless, the height to which the water would rise in an open pipe can easily be computed from the gauge

pressure. A column of water exerts a pressure at its base of approximately forty-three hundredths of a pound per square inch for each foot of height in the column. In accordance with this, we refer to the table mentioned above and find that the Jamestown well gave a pressure of 95 pounds per square inch and that the surface elevation of the well is 1,408 feet above sea level. Reducing this pressure of 95 pounds to head, we have 95 divided by forty-three hundredths which gives 220, which is the artesian head above the surface of the well. Adding this head to the elevation of the surface, we have 220 plus 1,408, or 1,628, which is the approximate artesian head above sea level for this locality about thirty years ago. This would mean that had a well been drilled on the higher ground west of Jamestown, where the elevation of the surface is about 1,650 feet above sea level, into the same horizon of the sandstone as the Jamestown well receives its supply, the water would not have reached the surface.

It is noticed that this effective head above sea level declines very noticeably towards the southern extremity of the artesian basin. This is probably due to the loss of pressure which results from the water escaping at the outcrop along the west bank of the Missouri River in northern Nebraska that has heretofore been mentioned. It is also found that there is a gradual decrease in this head from west to east. An examination of the Jamestown Tower-Folio No. 168 of the U. S. Geological Survey which was prepared in 1909 shows that at that time the geologist considered all areas in western Stutsman County having an elevation of over 1,700 feet as being too high to yield flowing wells. In the neighborhood of Sanborn areas having an elevation of over 1,475 feet were too high to produce flows. Just east of Valley City portions of Alta Ridge, having an elevation of over 1,375 feet, were too high to produce artesian wells. This would indicate a fall in head of about 230 feet between Jamestown and Valley City, which may be considered a very rapid decline for this section of the artesian area. This decline must be accounted for partly by the relief of pressure afforded by the leakage along the Red River Valley which appears in some localities as "salt" springs. This rapid falling off may also have been materially increased by the relief of pressure afforded by the wells in the western portion of the basin. It seems very reasonable to the writer at least, that the pressure and flow of a well or group of wells would be materially reduced by other wells tapping the same horizon between them and their source of supply.

From the above figures it is fairly easy to locate the west limits of the artesian basin obtaining flows from the Dakota Sandstone as it existed ten or fifteen years ago. The west limit of the area lying south of the main line of the Northern Pacific Railroad passed through a point about twelve miles west of Jamestown and extended in a direction just a little east of south through a point about four miles west of Edgeley and on in the same approximate direction to the South Dakota line. Northward this limit has never been closely located but at the time in question it would probably have crossed the main line of the Great Northern Railroad just east of Rugby. It will be noticed that this limit in

the southern portion of North Dakota coincides quite well with the west border of the James River Valley. Further south, however, it extends beyond the James River Valley to the Missouri River and at many points in South Dakota flows are obtained just west of the Missouri River. This shows that by far the greatest part of this artesian basin lies in South Dakota.

North of the Northern Pacific Railroad in North Dakota we find comparatively few artesian wells tapping the Dakota Sandstone. This is probably due to the fact that this sandstone lies at so great a depth below the surface that all but a few have been deterred from the undertaking by the excessive cost.

At the time in question wells were found scattered over Barnes and western Cass Counties, increasing in number towards the south where the main basin in North Dakota occurs. Most of LaMoure and Dickey Counties east of the line described above, as well as most of Ransom and Sargent Counties, were pretty well dotted with wells for the most part receiving heavy flows from the Sandstone at depths varying from approximately 900 to 1,400 feet.

Referring to the maps and manuscripts furnished by the above mentioned body, covering field investigations made in 1915, we find that the line of no flow had moved eastward in LaMoure and Dickey Counties and coincides fairly close with the 1,600 foot contour line. This would indicate that the artesian head had fallen approximately 100 feet in from five to ten years. West of this new line of no flow are shown seventeen wells, in a strip of territory nineteen miles in length, which have ceased to flow.

At this point it might be well to call attention to the fact that artesian wells ceased to flow from various causes other than the general falling off of head throughout the artesian basin. Some of these causes are: clogging of the sandstone from which the well received its supply, clogging of the screen or casing, corrosion of the casing, caving of the shale overlying the water bearing strata, and loss of head, due to the escape of the flow into other porous stratas lying above the water bearing horizon. In an area not affected by a general falling wells and all those which had failed from any of these causes, a new well into the same horizon should show the same pressure as the original wells when new. It is very significant to note, however, that all the falling off of head, where wells have already failed lie along the higher ground where they would surely be affected by any general falling off of head.

In the same manuscript special reference is made to several of the seventeen wells mentioned above, and to several lying just east of the line of no flow. It reads as follows:

"The Vennum well, in Sec. 1, T. 130 N., R. 65 W., ceased to flow the spring of 1915. By cutting down the pipe to within six inches of the surface of the ground the well was made to flow a small stream. When drilled in 1902, this well had about 75 pounds pressure and a flow of over 1½ barrels per minute. The Cook well, in Sec. 12, T. 130 N., flowed 10 gallons per minute when dug ten years ago; now the flow is 1 2/3 gallons per minute. The Hafey well, in Sec. 35, T. 131, R. 65 W., flowed 20

gallons at first and has decreased to about ten gallons. The Bristol well, in Sec. 14, T. 130 N., R. 65 W., was drilled in 1914 and flowed for eight months. The water now stands two feet below the ground surface and is siphoned into a ravine. The Haez well, in Sec. 22, T. 130 N., R. 65 W., dug in 1911, flowed one and one-half years. The water now stands 18 feet below the surface of the ground in a well dug around it and into which the artesian pipes were opened. The Avery well, in Sec. 26, T. 130 N., R. 65 W., still flows but the pressure is insufficient to carry water to the house ten feet higher. Water stood 80 feet below the surface in the Mc Conville well in Sec. 4, T. 129, R. 65 W., in September 1914. The Weaver well, In Sec. 2, T. 129 N., R. 65 W., ceased flowing in 1914. In 1915 water stood 20 feet below the surface in the Chambers well in Sec. 6, T. 132 N., R. 64 W., in the Hassenger well in Sec. 21, T. 130 N., R. 65 W., and in the Halstead well in Sec. 22, T. 130 N., R. 65 W."

An examination of the above wells last month disclosed that all had ceased to flow and that all were being pumped except three which are "dead."

Before presenting more of this latest data, it seems very proper to explain that most of it was secured through co-operation with the Flood Control Commission. At a meeting of that body early in September it was agreed that Mr. Hard, Chief Engineer of the Commission, should co-operate with the State Engineer in this work as his flood control work would likely occasionally take him into portions of the artesian basin. It was also thought properly the work of that body to ascertain the loss occasioned by the flooding of some of these wells. It was hoped that my department would be able to secure one of the cars now owned by the State Highway Commission for the use of one of the surveying parties of Mr. Hard as soon as the surplus army cars were received. By this arrangement a considerable saving has been made by the state.

Following is a partial list of wells examined during October, 1919, by Mr. Hard's party. An examination of this table discloses several important facts. A large proportion of the wells where the original pressure is given has ceased to flow and in all cases the flow has been greatly reduced. In nearly all cases where the original pressure is known there has been a great reduction. It may be argued by some that this great falling off can be accounted for by other causes than the general falling off of artesian head. If this were true, as has been heretofore stated, new wells would obtain approximately the same flow and pressure as occurred in the original wells when new. Attention is called to several of these new wells. The old well of Mr. R. R. Davis gave a flow of 29 gallons per minute originally and is now dead, and the original pressure was 75 pounds per square inch. The new well originally gave a flow of seven gallons per minute and now gives but two gallons and a pressure of four pounds per square inch. This indicates a fall of over 70 pounds, which is equivalent to a decline of artesian head of 163 feet. The next new "second" well on the list is the Eckles well which flows but three-quarters of a gallon per minute. The next "second" well is the Thorn well which gives a flow of six gallons and a pressure of five pounds. The Walters

well, drilled in 1905, gave a flow of 20 gallons and a new well drilled in 1915 now gives a flow of seven gallons.

It will also be noted that the last six wells on this list are located towards the eastern limits of the artesian basin and all but one are being pumped. An examination of the Casselton-Fargo Folio No. 117 of the U. S. G. S., published in 1905, shows that practically all deep wells in that neighborhood were flowing wells.

These figures should convince the most skeptical that there is a gradual falling off in the artesian head in that portion of the artesian basin and that if such fall continues for a few years more there will be very few artesian wells obtained from the Dakota Sandstone. To those who have to depend upon this source of supply and to those who are deeply interested in the conservation of our natural resources this condition may be truly alarming.

LIST OF WELLS EXAMINED IN OCTOBER, 1919.

Name	Town	Location S. T. R.	Old Flow Gal. Per Min.	Flow Oct., 1919	Old P. No.	New P. No.	Acres Flooded	Pumped or Dead
Ziegenhagen, A. J.	Adrian	3-136-63	11	8	20	22	8	
Miller, Fred	Adrian	32-136-62	72	40	....	....	....	
Kreutzberg, J.	Medburry	34-135-63	....	0	....	0	30	D
Peak, Fred	Medburry	21-134-63	7	1½	70	....	50	
Davis, R. R.	Edgeley	24-134-64	29	0	75	0	10	D
Davis, R. R. (new)	Edgeley	24-134-64	7	2	....	4	....	
Carrow, A. H.	Edgeley	18-134-63	16	1	....	0	....	
Eckles, M. (new)	Edgeley	3-134-64	....	½	....	....	....	
Horsager, O.	Berlin	30-134-62	....	....	....	....	5	
Horsager, H.	Berlin	26-134-63	....	3	....	....	....	
Young, J.	Berlin	33-134-63	30	8	....	....	....	
Chambers, Geo.	Edgeley	6-132-64	9	0	....	0	....	D
Bartel, Daniel	Monango	18-131-64	50	0	....	0	....	DD
Bartel, Daniel (new)	Monango	18-131-64	1	0	....	0	....	DP
Hafy, Ed.	Merricourt		40	0	30	0	....	P
Fey, Chris	Merricourt	32-131-64	10	3	....	....	....	
Scott, Bruce	Merricourt	5-131-63	15	½	....	....	....	
Knox, W. B.	Merricourt	13-131-63	....	12	80	40	....	
Webb, Art	Merricourt	25-132-65	60	0	....	0	....	D
Glenn	Merricourt	36-132-65	....	0	....	0	....	DD
Peake, Burt	Monango	18-131-64	13	0	....	0	....	P
Eckles, M.	Edgeley	3-134-64	4	....	....	....	....	
Huper	Berlin	2-133-63	....	6	....	....	....	
Bristol, S. A.	Ellendale	14-130-65	3	0	....	0	....	P
Hafey, W.	Ellendale	35-131-65	20	0	....	0	....	PP
Clark, T.	Ellendale	15-130-65	....	0	60	0	....	P
Hass	Ellendale	22-130-65	5	0	....	0	....	PP
Weaver, H. C.	Ellendale	2-129-65	8	0	....	0	....	PP
Halstead, Chas.	Ellendale	22-130-65	20	0	....	0	....	PP
Vennum	Monango	1-130-65	34	0	75	0	....	P
Cook	Monango	12-130-65	10	0	....	0	....	P
Zinder, Fred	Ellendale	9-130-64	4	....	....	....	....	
Feathers (old)	Monango	4-131-63	....	....	....	....	....	
Thorn (new)	Monango	4-131-63	....	6	....	5	....	
Jensvold, Con	Monango	18-131-63	....	0	....	0	....	P
Daw, John	Fullerton	12-131-62	....	....	65	....	....	
Brown, Chas. E.	Edgeley	31-135-63	....	1½	....	....	....	
Walters, M.	Edgeley	8-133-63	20	0	....	0	....	D
Walters, M. (new)	Edgeley	8-133-63	....	7	....	....	....	
Slotten, Burt	Medburry	27-134-67	....	0	....	0	10	D
Fritchard	Edgeley	11-133-64	20	0	....	0	....	DD
Frosland, Mat.	Berlin	19-134-62	....	0	....	0	....	D
Nelson, Ole	Berlin	6-133-62	....	4	....	....	....	
Blatchford	Berlin	30-134-62	....	0	37	0	....	D
Blatchford (new)	Berlin	30-134-62	....	....	....	....	....	
Sullivan, C. W.	....	23-132-65	....	0	....	0	....	D
Ward, Bennet	....	24-132-65	....	0	....	0	....	D
Merricourt	Medburry	35-132-65	....	0	....	0	....	DP
McGannon, F. B.	Medburry	13-129-63	....	0	....	0	....	D
Peak, F. B.	....		....	0	65	0	....	D
Krause	....	35-131-65	....	0	....	0	....	DD
Squashneck	....	35-131-65	....	0	....	0	....	P
Davis	....	2-130-65	....	0	....	0	....	PD
Kern	....	33-130-65	....	0	....	0	....	P
Hassenger	....	22-130-65	....	0	....	0	....	DP
Colwell	....	13-131-65	....	0	....	0	....	P
Maurey	....	7-131-64	....	0	....	0	....	P
Colwell	Edgeley	20-131-63	....	0	....	0	....	PD
Keller	Buffalo	24-131-63	....	0	....	0	....	D
Eckles (old)	Buffalo		....	....	....	....	....	
Wilcox, Chas.	Buffalo		....	0	....	0	....	P
Wilcox, Chester	Buffalo		....	0	....	0	....	P
Grieve, Jas.	Wheatland		....	0	....	0	....	P
Long, Frank	Buffalo		....	0	....	0	....	P
Burns	....		....	0	....	0	200	
Budkke	....		....	....	....	....	....	

For further evidence on the matter let us now turn to the very interesting and instructive report of the State Engineer of South Dakota for 1915-16. The examination was made personally by Mr. Homer Derr, State Engineer, a fact which should give it additional weight, and to those especially interested in artesian wells this report is highly recommended. Thirty-one counties were visited in the artesian belt and several hundred wells were examined. Whenever possible the pressure and flow of the wells were tested and wherever records were available the former pressure and flow were ascertained. The altitude of each well was also ascertained. Therefore the approximate artesian head as it existed in 1915 and 1916 in South Dakota may be computed. Special attention was given in each case to determine what proportion of the water was being wasted.

Below is a table containing a portion of the wells tested. The wells listed in this table were usually selected on account of their records being sufficient at lēast to show either the former pressure and the pressure at the time of the inspection, or the former flow and the flow at the time of inspection.

The Gorge Cut by the 3,000-Gal. Well at Yankton Agency, Greenwood.

SOUTH DAKOTA ARTESIAN WELLS EXAMINED IN 1915 AND 1916

Location	Pressure		Flow in Gal.		Remarks
	1915-1916	Earlier	1915-1916	Earlier	
Hitchcock	40	150		1200	
32-112-6	25	120			
22-112-61	66	110 (1907)			Artesian Head has fallen at rate of 12 feet per annum.
2-112-63	25	60			
Springfield	0	86		3292	Formerly used to run mill and lighting plant.
34-95-60	12	40 (1909)	4		
6-94-59	0				Water now stands 40 feet below surface.
Groton	36	135			
Columbus	30	160			
Aberdeen	57	58 (1911)	60		Well sometimes closed for two weeks.
14-124-63	50	56 (1913)	13.8		Flow through 5/8 inch orifice.
5-124-62		60 (1910)			
Columbia	30	160 (1908)			
14-126-64	61				Just enough flow allowed to keep well from clogging.
Frederic		225 (1914)			
Warner	15	128 (1903)		96	
Kimball	0				First well drilled 1886; flowed 10 years and then was pumped. Artesian Head falls 6 feet per annum.
Ipswich	5	40			
32-121-68			7.5	125	
4-124-68		230			
Orient	210	210	50		
11-118-69	2		1	8	
28-119-69	5		17		
19-119-68	7		3	30 (1907)	
Miller	20		125		
Miller	20	24	125	150	
St. Lawrence	3½	40 (1906)			
St. Lawrence	27			285	About 95% wasted.
11-112-69	13	60 (1906)	12	100 (1906)	
Pierre	30	165		2648	
25-113-67 (old)	0	128 (1906)	0	400	
25-113-67 new			5		
Havold	5	27 (1906)	28	84	
Highmore	0	13 (1906)	0	9	
28-114-71	40		6		Small flow probably due to clogging.
30-114-71	0	30	trickle		
Lane	22	44 (1909)			
Kennebec	76	106 (1907)			
Copia			15	100	
26-106-76		51 (1912)	50	80	

14-106-76		25 (1912)	20	36 (1912)	
11-106-76	15	25 (1912)	21	55 (1912)	
31-108-78	0	20	0	40 (1912)	
Britton	30	60 (1913)			
Newark	45	125 (1908)			Formerly used to furnish power for flour mill.
3-127-58	45	120			
Conde	21	75 (1905)			
Doland	38	125 (1892)			
Redfield	15	125 (1900)			
9-115-64	35	100 (1902)			
28-114-62	54	150 (1900)			
Wendte	18		25	90	
Hopkins Ranch	5	20 (1912)	10	26 (1912)	
11-114-77	0	21			
32-113-79			8	200	
3-115-79			2	20	
17-116-77	0	14 (1903)			
Witten	15	19½ (1911)	½	former	
Selby	0-5	15	little	17	

An examination of the above table shows that the average pressure recorded in 1915-16 was about 32 pounds per square inch and that the average for the earlier pressure recorded was about 84½ pounds per square inch. Since the latter record covered a considerable period of years it is difficult to determine accurately how many years this general decline represents, but from such computations as can be made this period seems to have averaged about eight years. If this period is approximately correct, it indicates a fall in artesian head of nearly 15 feet per annum, or a total fall of approximately 122 feet in that time. This checks reasonably well with the figures obtained in North Dakota. As has been previously stated, a fall of 100 feet in head occurred in a period of between five and ten years. The above figures for North Dakota would indicate that this period would be more exactly seven years. The average flow from the wells that were tested in 1915-16 is approximately 28 gallons per minute while those for the earlier period average 282. It will be understood of course that these figures are approximate only, but after all due allowances there can be no doubt but that a very great fall in pressure and flow has occurred and that if it continues a few more years the artesian supply will be practically depleted so far as the Dakota Sandstone is concerned.

Since these above facts have been well established, let us now endeavor to locate the reason for this great falling off of head. A glance at the above table will show that in former years the wells in South Dakota were pouring out a veritable flood. It is estimated that there were nearly 10,000 artesian wells in the state of South Dakota at the time the above examination was made and it seems quite probable that there were at least half that number for the earlier period computed above. The average flow at that time seems to have been about 280 gallons per minute for each well, which would equal 403,200 gallons per day or sufficient water to cover nearly 1¼ acres one foot deep every day. With approximately 5,000 wells running day after day and year after year, is it surprising that the supply has diminished at such an alarming rate?

It now remains to be determined just how much of this water was necessary for beneficial use. For this purpose we again return to the South Dakota report. On pages 190, 191, and 192 are shown pictures of three 8-inch wells that were sunk for the purpose of replenishing the supply of a lake. The following pointed remarks regarding these wells have been copied verbatim:

"A glance at these pictures, taken October 13, 1915, is more convincing to the average person than any amount of words wasted. It is to be presumed that the wells have been drilled at these places so that their flows might replenish Red Lake, for certainly they are of no other earthly use, except to help deplete the artesian flow all over the artesian well belt faster than almost any other instance that can be cited. If it was their object to raise Red Lake appreciably, certainly they have failed in that respect, for a stratum of Tertiary sand carries away the surplus water, and the lake would not even be what it is today if it were not for the past few rainy seasons. Be that as it may and figure out the local benefits as high as you like, and then contrast the advantages

SECOND WELL DRILLED AT RED LAKE, BRULE COUNTY, S. DAK.
(By Courtesy of the State Engineer of South Dakota.)

with the value of the water you are taking from your fellow citizens and stockmen in counties like Sully, for instance, who are already on the ragged edge of the artesian flow, and many others who are fast coming to it. These wells are each eight inches in diameter, except the second one which has been reduced to six inches. The first well was put down to a depth of 1,100 feet and it was estimated that its flow was about 1,200 gallons per minute. The illustration shows conclusively that it has weakened in flow very much, and it has undoubtedly weakened the flow of all wells reaching that horizon in the Dakota Sandstone for miles around. When the second well was sunk to the same depth its flow was weak and became stronger only when continued to 1,200 feet. The picture at the third well was taken within a month after its completion—you will notice a part of the drillers' outfit still on the premises. The observer was not prepared to get the closed pressure on these large wells for they are running wide open and are not under control with valves; neither was he prepared at the time to measure the discharge of a river, so the exact amount of water being wasted from these wells is not known. A fair estimate, however, would be about 3,500 gallons per minute, or allowing 10 gallons per day per animal, enough water is being wasted at Red Lake alone to supply half a million head of stock. But some will say the formation of the lakes about the country will bring about a change of climate and increased rainfall. This is all balderdash, for it is a matter of scientific observation that dry air must travel over a surface of water for 1,500 miles to became saturated enough to fall in rain, and by that time it will have gotten so far away that it will do South Dakota no good. We are free to admit that the lakes of water are nice to look upon and are really beneficial in many ways to a few in their immediate vicinity; but the underground waters of South Dakota, like its streams on the surface, belong to all the people, and individuals should not be allowed to waste a great natural resource which if conserved would benefit many people many years to come, but which at the present rate of waste will soon become exhausted."

Illustrations are also shown of one 6" and one 8" well at Chamberlain, which were wasting water into the Missouri River at the estimated rate of 3,000 gallons per minute. Control of these wells had been entirely lost due to the rusting out of the casings. On pages 195 and 196 is shown the damage that has been wrought to a bridge and mill foundation by these wells. Regarding these and several other wells is found the following comment: "The state's allowing this condition of wastefulness to exist along the Missouri River and other places at low altitudes where pressures are good is responsible for the beginning of failing wells in counties like Sully, and it is a great pity that something is not done to stop it."

Special attention is next directed to a well at Yankton Agency which yielded 3,000 gallons per minute and which has been mostly wasted. It is estimated that this flow, if conserved, would have supplied 430,000 cattle with ten gallons of water daily.

Attention is next directed to three 8" wells used only in supplying a lake. Regarding these the following is quoted:

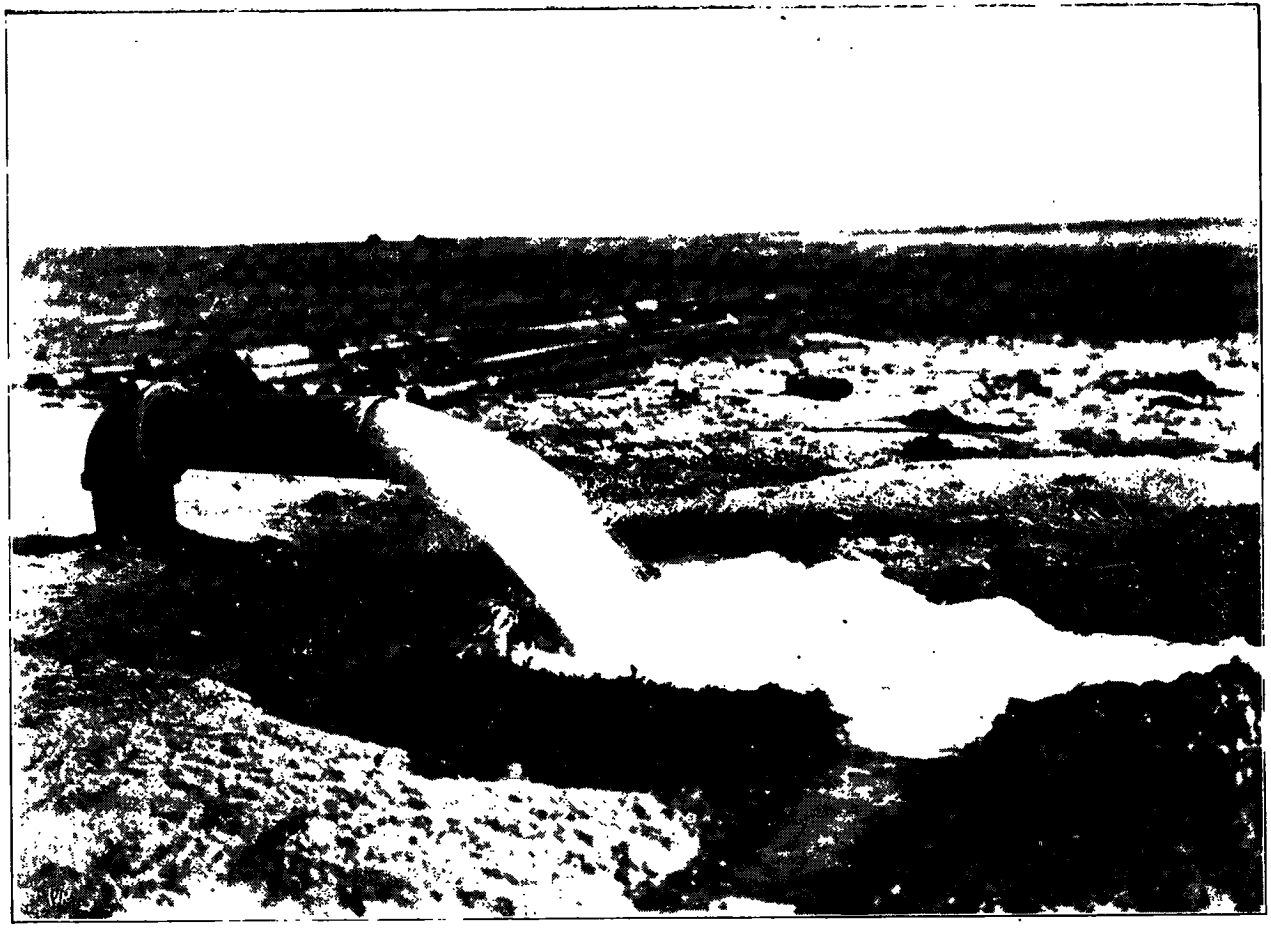
"The reader's attention is next called to the view showing one of the three 8-inch wells feeding Lake Andes, this particular one being located on the south side of the lake. There are two others of like size and capacity in the body of the lake and underneath its surface. Each of these wells have yielded about 1,500 gallons per minute, and taken together would supply drinking water for 648,000 cattle daily, at the rate of ten gallons per head. This is wanton waste of our artesian supply, and only one of many instances in the state where wells of large capacity are not doing any particular good, but are hastening the day when all artesian wells will cease to flow. In the first place, the citizens of this community petitioned the Government to sink these wells to insure Lake Andes not going dry. Now they want them closed, for the water is getting so high it is flooding much good agricultural land, but none of the wells are valved or under control, and two of them are in the lake. The lake is certainly nice and fishing is good, but can any such advantage to the community possibly offset untimely loss of flowing wells all over the artesian well belt of South Dakota?"

Another instance of waste is that of the Capitol well at Pierre where approximately 2,650 gallons per minute were wasted. It may be of interest to note that this well also supplies gas. The former yield was 85,000 cubic feet per day and now averages only about 15,000 cubic feet per day.

These are probably the most flagrant cases of waste in the state of South Dakota but the records show that the majority of smaller wells are also adding their quota of water to the great aggregate and together would exceed many, many times the waste specially mentioned above. In North Dakota, conditions are very similar to those in South Dakota and one has only to drive through the artesian belt to be convinced not only of the great waste of water, but also the great waste of land that has taken place by flooding.

After contemplating this great waste which is rapidly depleting one of our valuable natural resources, the first question that naturally arises in one's mind is "Why are these wells not put under control and the flow reduced to that necessary only for beneficial use?" Upon investigation, however, one finds a widespread and persistent notion that a well must be allowed to run wide open or it will soon clog up with sand or mud. This erroneous notion must have had its origin in the fact that some well drillers use a contract which provides that any closing down or test of the well invalidates the contract. There can be very little excuse for this kind of contract unless it is intended to prevent the detection of defective work. However, little fear need be entertained for any new well that has been properly constructed when any reasonable test is applied.

To prove that the reducing of flow of these wells to that necessary for beneficial use is not injurious, let us again refer to the South Dakota report. The first case noted is that of an Aberdeen well having a pressure of 57 pounds and a flow of 60 gallons per minute when open. Ordinarily the flow is reduced to a trickle and the owner states that the well had frequently been closed down entirely for two weeks at a time without any apparent damage. The next case noted is a well in Marshall County having a pressure of 48 pounds per square inch, regarding which the following is quoted: "Flow, as used, only what could get through a nail



THIRD WELL DRILLED AT RED LAKE, BRULE COUNTY, SOUTH DAKOTA.
(By Courtesy of the Engineer of South Dakota.)

hole in a wooden plug. It is worth noting in this connection that many farmers from this vicinity on to the Canadian line through Marshall County, only allowed as much water to flow from their wells as could pass through an ordinary nail hole in a wooden plug driven in the opening of a ¾ inch pipe. The observer took great pains to inquire about this matter, and invariably was told that it supplied sufficient water, kept the water in the stock watering troughs cool in summer, kept the water moving sufficiently in the well to prevent freezing in winter, did not make such a large lake around the farm buildings, and last of all, but not least, they could not in a single instance think that closing down a well to that extent had any effect in causing it to go out of business."

The next noted is one in the town of Lake Andes which has a pressure of 30 pounds and is shut down entirely during the winter. There are several other cases noted where the flow has been reduced to beneficial use. It is a deplorable fact to note, however, that for every well controlled there are nearly one hundred others that are allowed to run "wild."

For further evidence on this phase of the question, we have the opinion expressed in the various reports of the U. S. Geological Survey. Attention is first called to the following paragraph in Water-Supply and Irrigation Paper No. 90 published in 1904.

"Closing of Wells. Much damage is sometimes done by the free running of wells. In some cases large wells have been drilled with the intention of irrigating, and sufficient rainfall for a series of years has rendered that unnecessary. The water from such wells has been allowed to run to waste, thereby drawing unnecessarily upon the general supply. Moreover, it has often rendered considerable land in the vicinity unproductive. The practice, therefore, of closing wells when not needed should be recommended. The only objection to this is the possibility that wells when closed will become clogged. This danger may be avoided by the gradual closing of a well, even when it is known to carry some sediment. When the water runs clear, and especially where the well has never thrown sand, there is very little danger. Some large wells made to furnish power are habitually kept closed when not in use without serious injury. In case a well does become clogged by the settling of sand it may often be opened by letting down an iron rod and churning it up and down until the flow is started.

"To avoid producing too sudden changes in the flow, which may produce injurious effects at the bottom of the well, the opening and closing should be done gradually."

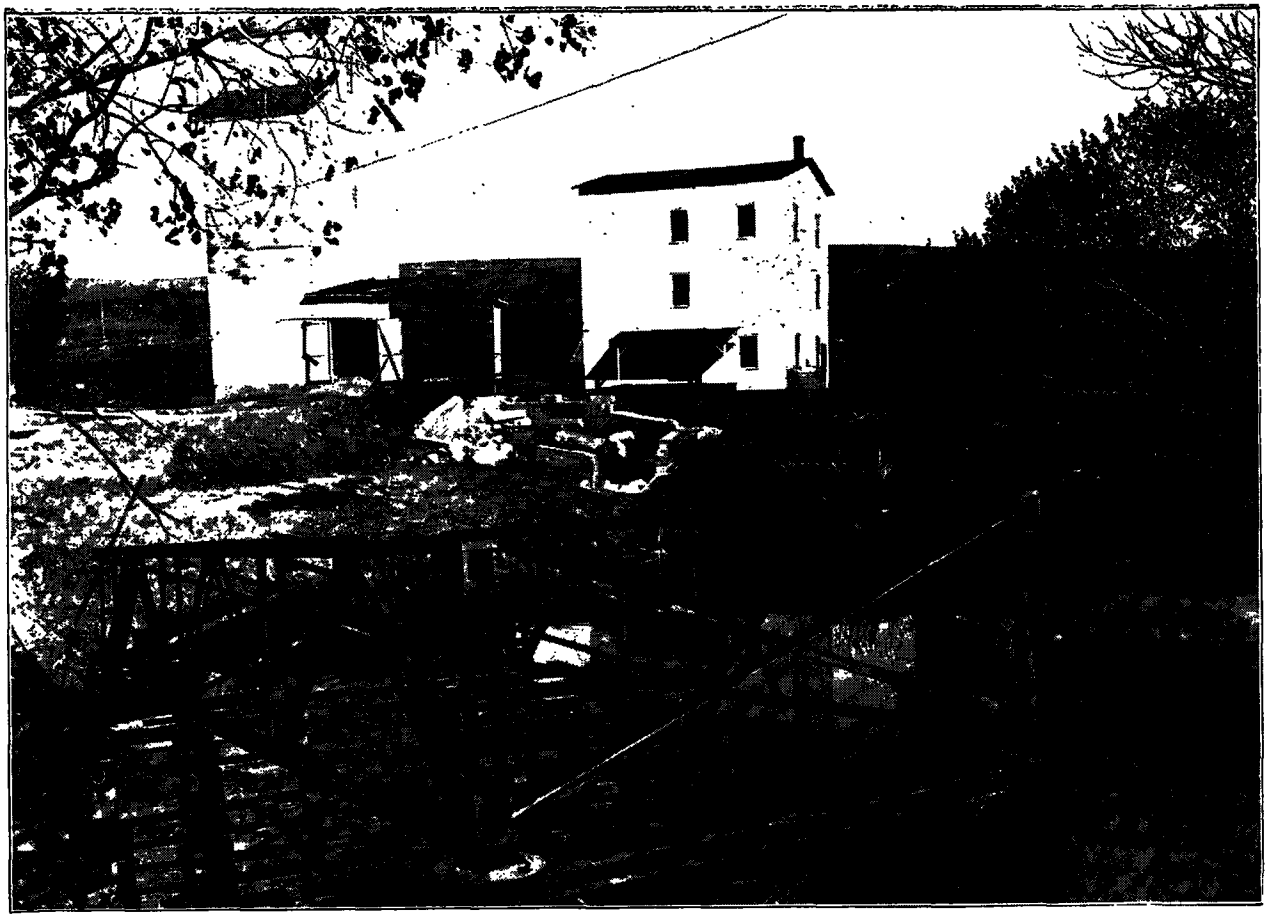
In Water-Supply Paper No. 257 of the same body we find the following recommendation: "In states where flowing artesian water is obtained, laws should provide for the closing of flowing wells when they are not in use so that the artesian basins may not be unnecessarily drained."

Thus we see that the highest authorities agree that it is practical to close down artesian wells to the amount necessary for beneficial use in the great majority of cases. This, however, presupposes that the well drilling methods used have been of the best. The usual defects

which prevent the proper control of a flowing well are lack of proper seal between the different sizes of casings, lack of proper seal between the casing and the caprock or shale which overlies the water bearing horizon, and the casings weakened or destroyed by corrosion. These defects allow the water to escape to the surface outside of the casing or to higher porous stratas. In a portion of another water-supply paper of the U. S. G. S. the first two defects mentioned above are emphasized in connection with other phases of general interest. Since this also briefly covers the essentials of artesian well drilling, it is deemed very proper to quote this portion of the paper to considerable length.

"Well boring is a mechanical art which has been practiced for so many years and by so many ingenious persons that it has reached a high stage of development. As in all other industries, a large number of skilled artisans are engaged in the business, as well as, on the other hand, many incompetent persons, whose methods are crude. It would be impossible to say to what extent the failure of certain wells are due to the lack of necessary knowledge of well boring on the part of their constructors or to conditions which, at the time, could not have been forseen. Many of the earlier wells were bored by men who were not at that time particularly skillful in their art, but who have since become expert to a high degree; but it is cause for regret that even now wells are occasionally sunk by men with whom the success or failure of a well is largely a matter of chance. Very few persons for whom wells are bored know what is going on underground or are adequate judges of the merits of the well borer. They must trust very largely to the reputation of the well borer or to the recommendations which he brings, and should, of course, endeavor to procure an experienced and skillful man rather than a cheap contract to be executed by a borer of whose success there is doubt. There are, however, a few features of well boring that can be pointed out in such a manner as to aid persons planning to sink wells, and at the same time afford to well borers some knowledge that has proved serviceable in other regions where the art of well boring is highly developed.

"In the first place, the enormous pressure, which the underground waters possess in most of the wells, must be borne in mind. This pressure is, in many wells, 500 pounds per square inch at the depth at which the water is struck. Strong casings, properly built machinery, and expert men are absolutely essential to cope with such pressures. The mere operation of boring to a depth of 500 to 1,000 feet or more is relatively simple, and its principle is presumably familiar to nearly all persons who have any interest in wells. A heavy iron rod with steel bit on its end is dropped a few feet at the rate of 20 to 40 strokes per minute, in such a manner as to break off and churn up the material which is to be penetrated. As the hole is made, pipe for its casing is passed down, more or less closely following the bit, particularly if the boring is in soft materials, where casing is always necessary to hold up the walls. The pipe is lowered or gently forced down length upon length, each new length being screwed tightly into the coupling of the preceding one, until the water is reached. The churned-up material is either forced out by a stream of water that is pumped into the boring under consider-



Destruction Wrought to Highway Bridge and Mill Site at Chamberlain by Two 6-Inch and One 8-Inch Well Breaking Through Casing at Some Depth Beneath the Surface
(By Courtesy of the State Engineer of South Dakota.)

able pressure, or baled out by a sand bucket—a short length of pipe with a large upward-opening valve in its bottom. It often happens that the casing will reach a certain point and go no farther; then a smaller size pipe must be introduced, and in some wells it has been found necessary to decrease the size of the pipe several times before reaching the water.

"With some of the improved machinery now in use this change in the size of the casing is not necessary so often as formerly, but it is expedient to make it to a certain extent for a reason that will now be explained. It is always desirable to have the casing of a well doubled for the greater part of its depth—that is, to have an outer pipe extending nearly to the water, and then to have an inner pipe extending to and into the water-bearing bed. The advantages of this arrangement are manifold, but the principal advantage is that when the inner pipe becomes in any way out of order, it may be easily withdrawn, repaired, and reinserted or replaced by a new pipe. The inner pipe will receive all the wear from suspended sand, etc., as well as the greater part of the corrosion from the water. These last two factors are not so important as might be imagined, and the life of a good, heavy pipe, particularly if it is galvanized, is exceedingly long. The principal difficulties occur at the lower end of the pipe, and it is for these mainly that it is desirable to have the inner pipe removable. It is very important to have the outer pipe rigidly fixed at its lower end in a hard bed, so that no water may reach the surface along its outer side. In a number of wells the waters have begun seeping up round the outer casing until they have finally made sufficient space to emerge in large volumes, and after that occurs the life of a well is usually soon terminated. In other wells the water has seeped up along the outer side of the well casing and found its way, in whole or in part, into some higher porous stratum, so as to decrease or totally lose its head and volume.

"The difficulties of working in water having a high pressure are very great, and the well may be damaging itself during the delay incident to its final completion; but there are now so many expedients known to the skillful well borer that he surmounts most of these difficulties with relative ease."

Numerous other authorities have been examined and might be quoted as evidence but it is believed that further additions of this kind would tend to make this report entirely too cumbersome. Therefore it is deemed more proper to briefly summarize the material already presented and to proceed directly with recommendations as to the "remedies to be applied to the undesirable conditions" disclosed.

Recommendations.

It has been shown conclusively that the artesian water supply furnished by the Dakota Sandstone and the allied water bearing stratas is being rapidly depleted; also that a very large portion of the supply drawn from this source is being wasted due to the lack of proper control of the wells. It has also been shown that there is a widespread notion that any reduction or stoppage of the flow would be injurious to the wells. It has been found, however, that this notion is entirely erroneous, since

numerous wells have been reduced to a comparatively small flow and in some cases entirely closed for weeks or months without any apparent injury. Numerous papers of the U. S. Geological Survey, which is one of the highest authorities on this subject, also show that artesian wells may be gradually closed down without injury in nearly all cases, providing the well has been properly cased and is in a condition to withstand the closed pressure, and they recommend that laws be passed to compel the closing of wells when not in use.

It is therefore recommended that legislation be enacted to control the flow of all artesian wells within the state. Since the report of the South Dakota State Engineer, which has been so often referred to herein, has been published, the legislature of that state has put into effect a law regulating the use of such wells. The copy of this bill as introduced seems to be practically identical to House Bill No. 419 which was introduced by Mr. Bowman in the 15th session of the legislative assembly of this state. This bill provides a registration tax of fifty cents for each well. Twenty-five gallons per minute flow is allowed free for each quarter section of land belonging to the owner of the well. For each 25 gallons per minute or fraction thereof exceeding that amount, a tax of ten dollars is assessed. County and township assessors are required to list all flowing wells in their respective territories. Well drillers are also placed under bonds ranging from one to ten thousand dollars and the State Engineer, who has general supervision of the water of the state, is empowered to administer the law.

It is believed that the allowance of 25 gallons per minute free is entirely too high, as it amounts to 36,000 gallons per day. It seems that it would be a better plan to place no limit on the amount beneficially used but limit the waste by a tax sufficiently heavy to discourage it. In addition to requiring a bond from each well driller it is believed that a log of each well drilled should be furnished to the state authority in charge of the administration of the law. This would furnish a record of inestimable value to the state, especially in the western portions which are underlaid with coal deposits. These records would also be of great value in sinking future wells, as anyone contemplating a well would have available the records of other wells in that vicinity and would be able to plan his operations accordingly.

It is not recommended at this time that the material used in these wells be specified by law but that the owner be made responsible for all damage resulting from inferior workmanship or materials. It is recommended that such laws as may be enacted for the regulation of artesian wells be also drawn to protect the well owner from any fraudulent practices that might be practiced by well drillers. It is also recommended that the state official placed in charge of the administration of such laws be required to gather together, as far as practicable, all the best information available on well materials, well drilling methods, and especially the latest successful methods used in closing or regaining control of "wild" wells, and that such information be placed at the disposal

ONE OF THE 8-INCH WELLS FEEDING LAKE ANDES.

(By Courtesy of the State Engineer of South Dakota.)

of artesian well owners or others contemplating the sinking of such wells.

In closing it is deemed advisable to emphasize the fact that this report deals entirely with artesian wells drawing water from the Dakota Sandstone series. There are numerous other wells in the section of the state where the above wells are located, as well as in nearly all other portions of the state, which draw their supply from other sources lying usually above the horizon of the Dakota Sandstone. These wells as a rule have a comparatively weak flow and in a good many sections of the state the artesian head is not sufficient to bring the water above the surface. These facts, however, do not in any manner lessen the necessity of the control recommended, as sources other than the Dakota Sandstone series are as apt to be depleted as the artesian belt specially covered by this report, if the same methods of construction and waste are allowed to continue.

RIVER RECORDS.

By E. F. Chandler.
Assistant Engineer, United States Geological Survey.

By permission of the United States Geological Survey, with which the office of the State Engineer has been co-operating in this work, the following tables of flow of the more important or typical streams in North Dakota and the Red River Valley have been selected and compiled from the records in the office of the Survey in advance of their regular publication by the Survey, for use here. The larger portion of the expense entailed in the continuous maintenance of these records for the past ten or twenty years has been provided for by Federal appropriations, but a part of the expense (in particular, the payment of gage-observers in each locality) has often at different times been carried appropriately from state funds of the states concerned.

Less such work has been maintained in North Dakota than in some other states where there is greater opportunity for irrigation or for water-power development, where navigation has importance, where land drainage has been more thoroughly extended, or where water supplies for municipal and domestic use have been more completely investigated. But development in all these lines is often proposed here or discussed, as well as flood protection and various other matters which essentially depend upon the flow of the streams and the quantity thereof. It is impossible to complete any defensible plan for local improvement in such matter without assuming fairly definite knowledge of the amount of water usually available in the streams and the extreme variations that may fairly be expected.

The differences in stream-flow from year to year are much greater than the variations in the rainfall; figures deduced from one region cannot be transferred to a far distant region, nor is a single year of record an adequate foundation for future predictions unless there are at least a few rivers in the near vicinity whose records have been continuous through a long series of wet and dry years so as to give opportunity for

comparison. Thus if there is to be well-planned development in North Dakota along any of the lines above mentioned, it is absolutely necessary that there be available for use a reasonably comprehensive knowledge of the facts concerning the streams of the state through a fairly long term of years; this is therefore a field of investigation and survey that especially concerns the office of the state engineer.

In North Dakota there are very few profitable opportunities for the use of water-power, and some other forms of stream-use are inconvenient in some parts of the state. Therefore it often happens that the evidence given by the river records is merely negative evidence, which, instead of assisting in the development of any project, absolutely forbids the making of any effort to carry it through. At first thought, the records seem in such case to have been of little use to the people of the state; but it is as truly a benefit to a locality to prevent the waste of money in efforts to carry through some ill-advised and unprofitable scheme which can terminate only in bankruptcy, as it is to assist in the extension of profitable plans in which the money of the people might well be expended.

The methods followed in this work were described in detail in the First Report of the North Dakota State Engineer (1905), pages 49 to 62, and also in the Second Report (1907), pages 47 to 49. A discussion of the conclusions which can be drawn from these records in regard to the available surface water supply in different parts of the state appears in the Third Report (1909), pages 53 to 66, although some of the conclusions there stated could now be modified slightly on the basis of the twelve years additional records now available. A brief summary of some of the long records is included in the Eighth Report (1918), pages 45 to 47. The following is a very short statement of the general method.

At each "river station" or "gaging station" a gage is established and an observer appointed who makes regular observations and records of the height of the water; if the river is varying at all in height, it is the usual custom to make observations daily, or even several times a day during a flood or other unusual condition when the height is changing quickly. The gage-heights are recorded in feet and tenths of a foot. It is intended to place the gage so that its zero shall be below the lowest known low water, and at most of the stations the zero has been set below the bottom of the river; but the height of the floods is easily seen by a comparison between the maximum gage-heights recorded during the floods and the minimum gage-heights recorded during low water periods.

At suitable intervals, an engineer or assistant (called in this work a "hydrographer") equipped with appropriate meters and other instruments makes measurements of the discharge (that is, of the actual number of gallons of water per day flowing by the gage) and records the discharge and gage-height found at that time. It is thus known how much water will be flowing whenever the river happens to be at the same gage-height again, provided the river channel does not suffer change in the meantime. In this region almost all channels change gradually; but if the changes are slow and checked by reasonably frequent measurements, the records can be corrected so as to eliminate all but small inaccuracies.

When enough such measurements have been secured at different heights of the river (low, medium, and flood), it becomes possible to determine by interpolation how much water flowed by the gage at any foot and tenth of gage-height between lowest and highest stages. Upon this basis, from the record of daily gage-heights that has been secured by the observer a computation is made of the actual daily quantities that have flowed by the gage, and these are tabulated in such form as needed for reference. In the following pages these results have been arranged as "Tables of Monthly Discharge" showing for each month the average flow (for the twenty-four hours) of that day in the month when the flow was the greatest or maximum, the flow for the minimum day, and the mean flow or average for the entire month taken as a whole.

All figures of discharge given here are in "second-feet." One second-foot is a flow that carries by the observer one cubic foot of water each second; a rapid current in a small channel, or a slow current in a large channel, can carry the same amount of water past the observer each second. For example, a stream five feet wide and one foot deep flowing with a velocity of six feet per second, and a stream twenty feet wide and three feet deep flowing with a velocity of one-half foot per second, would each carry thirty second-feet of water. According to North Dakota law, fifty "miner's inches" of water is the same quantity as one second-foot.

One second-foot amounts to 646,272 gallons per day, and will cover almost two acres one foot deep in twenty-four hours.

As successive years vary very much, an absolutely exact record of the quantity of flow of a river through one year would not tell how much might flow the next year; it sometimes happens that the flow of one year is five or ten, or even twenty, fifty, or a hundred times as great as the total entire flow of a previous year; nor can these records be blindly transferred to adjoining rivers, for no two rivers are precisely alike in their conditions and behavior so that the records of as many streams as practicable should be secured if dependence is to be placed on them for all uses. Therefore, rather than to spend a large appropriation in making a very precise record of a single stream for a single year, it is very much more advantageous to extend the work to as many streams through as long a period of years as the available funds will possibly permit; provided of course that care is taken that the work and attention devoted to each station are not too greatly reduced so as to bring about a disproportionate or inexcusably great loss of accuracy.

The column headed "accuracy" in the tables of monthly discharge applies to the mean flow for the month, but not always to the maximum or minimum (which might have been affected by accidental error applying to only a single day, such for example as the brief absence of the observer). It depends on the reliability of the daily observer, on the permanency of the stream channel and of the gage, and upon the number and consistency of the measurements of discharge, and on various other less evident factors. After a sufficient assortment of measurements of discharge at different gage-heights has been secured, few would be needed in following years if the channel were absolutely permanent, and less than during the first few seasons even if the channel is gradually changing

according to the custom of most North Dakota streams. However, stating it in a single sentence, the accuracy of the final results depends on the accuracy and frequency both of the gage observations and of the discharge measurements.

The mean for any month marked A in these tables may properly be assumed as accurate within five per cent; of any month marked B, within ten per cent; C, within 15 per cent; D, within 25 per cent; E indicates a rough estimate which is presumably within 50 per cent of the truth, although in the case of some of the estimates of winter months, when the flow was known to be certainly so very small as not to exceed the estimate by more than 50 per cent, perhaps the actual flow was even more than 50 per cent under the estimate.

Included in the following pages are summaries of the records of these streams:

Red River at Grand Forks, N. D.
Red River at Fargo, N. D.
Red Lake River at Crookston, Minn.
Thief River near Thief River Falls, Minn.
Bois des Sioux River near Fairmount, N. D.
Mustinka River above Wheaton, Minn.
Pembina River at Neche, N. D.
Mouse River at Minot, N. D.
Grand River (North Branch) at Haley, N. D.
Heart River near Richardton, N. D.
Knife River near Broncho, N. D.

The tables run from the close of the tables published in the last biennial report of the State Engineer (September 1, 1918 to August 31, 1920.) The portions of the summaries for the year 1920 have been extracted from the official records in advance of the completion of the final computations of the season's work as made for regular publication by the U. S. Geological Survey, and are therefore to be considered as "preliminary computations" still subject to minor revisions. But in no case is it to be expected that the final revisions will introduce any large changes in the figures here given, and in most of these tables the changes later will be so small as to be inappreciable or final publication will be without change.

Similar summaries of the most important river records for this region can be found in the following reports:

North Dakota Geological Survey, for years 1903-04, in Third Report.

North Dakota State Engineer, for years 1905-06, in Second Report; 1907-08, in Third Report; 1909-10, in Fourth Report; 1911-12, in Fifth Report; 1913-14, in Sixth Report; 1915-16, in Seventh Report; 1917-18, in Eighth Report.

More complete records are published from year to year in the Water Supply Papers Series of the United States Geological Survey, in which all the methods and other details are fully itemized.

These summaries and records and many other less important ones are on file in the office of the State Engineer at Bismarck. The original data of every kind on which all the publications are based are filed in

the Washington office of the U. S. Geological Survey. Copies of all the data are also kept on file in the office of the resident hydrographer of the Survey, under whose general supervision almost all the field work in this region for the past seventeen years has been done and the computations made; this is E. F. Chandler, at the postoffice address University, N. D. On request to any of these offices full information can be obtained if desired by anyone who has reason for interest in any of these records or investigations.

RED RIVER AT GRAND FORKS, N. D.

Gagings of the flow of the Red River of the North at Grand Forks, N. D., were begun by the U. S. Geological Survey in 1901, but a gage height record was kept under the direction of the Corps of Engineers (War Department), by whom the dredging fleet was operated for the improvement of the river, for about twenty years previously, and a few discharge measurements were made by them; thus fairly good run-off summaries begin with the year 1882. The gaging station is located below the confluence of the Red and Red Lake Rivers. The total drainage area is 25,000 square miles, of which about half is in Minnesota.

The tables of discharge, based on gage observations twice daily through the open season and twice weekly through the winter, and on the measurements in the list below and a hundred and nineteen measurements made during the sixteen preceding years, are fairly accurate through the entire year.

MEASUREMENTS OF DISCHARGE.

Date	Hydrographer	Gage-height	Discharge
10-12-1918	Chandler and Strand	3.51	419
1-25-1919	H. A. Noble	4.31*	364
2-15-1919	H. A. Noble	4.13*	324
4-19-1919	Noble and Cady	11.81	4,520
8-15-1919	E. F. Chandler	11.31	4,390
12-23-1919	Chandler and Noble	6.27*	736
3- 1-1920	Noble and Stockwell	7.42*	860
4-24-1920	Stockwell and Knudson	13.51	4,950
8- 3-1920	Chandler and Foster	6.68	1,820

*Frozen: mean thickness of ice from 0.9 feet to 1.7 feet at different times of measurement.

MONTHLY DISCHARGE OF RED RIVER AT GRAND FORKS, N. D.

Year	Month	Maximum	Minimum	Mean	Accuracy
1918	September	950	440	568	B
	October	527	320	407	A
	November	833	558	653	A
	December	760	622	673	B
1919	January	622	341	399	C
	February	440	263	344	C
	March	5,200	[illegible]	1,10[illegible]	[illegible]
	April	7,980	3,700	5,280	B
	May	4,000	1,800	3,220	A
	June	2,140	1,390	1,750	A
	July	13,400	2,380	6,660	A
	August	4,780	1,970	3,150	B
	September	1,910	1,250	1,420	B
	October	1,300	1,070	1,170	B
	November	1,340	871	1,110	C
	December	871	689	779	C
1920	January	804	622	692	C
	February	689	590	661	C
	March	30,300	590	7,000	C
	April	29,800	4,840	11,400	A
	May	4,720	3,280	4,680	A
	June	7,030	3,460	4,630	A
	July	4,600	2,200	3,310	A
	August	2,200	1,070	1,430	A

Maximum gage-heights: 17.3 feet April 4, 1919; 23.2 feet July 8, 1919; 41.0 feet March 29, 1920; 15.4 feet June 17, 1920.
Maximum ever recorded: 50.2 feet April 10, 1897.
Minimum gage-heights: 3.0 feet October 9, 1918; 5.3 feet October 17, 1919; 5.3 feet August 31, 1920.
Minimum ever recorded: 2.6 feet February 10, 1912.

RED RIVER AT FARGO, N. D.

The gaging station on the Red River of the North at Fargo, N. D., was established May 27, 1901. The drainage area above this point is 6,020 square miles, of which 1,750 square miles is in North Dakota, 500 square miles in South Dakota, and 3,770 square miles in Minnesota.

In September, 1914, the gage location for the Geological Survey was changed from the Front Street bridge (where there is a gage still used by the Weather Bureau) to a point immediately above the Island Park dam. The zero of the gage at Island Park is about one foot below the crest of the dam, and is so related to the zero of the Front Street gage

that at flood stages, when the dam is drowned out and causes no irregularity in the surface slope of the river, readings on the Front Street gage are numerically about 10.2 feet greater than on the Island Park gage now used; at low stage, a reading of 7.0 feet at Front Street indicates nearly the same quantity of flow as a reading of 2.0 feet on the Island Park gage.

The tables of discharge, based on the measurements in the list below and on eighty-seven measurements made during the eighteen preceding years, are unusually accurate except during parts of the frozen season when the observations of gage-height were not made daily but at long intervals.

MEASUREMENTS OF DISCHARGE.

Date	Hydrographer	Gage–height	Discharge
9-25-1918	E. F. Chandler	1.25	61
9-25-1918	E. F. Chandler	1.26	75
4- 4-1919	E. F. Chandler	2.52	555
5-16-1919	H. A. Noble	2.54	546
7- 5-1919	E. F. Chandler	2.06	388
8-22-1919	E. F. Chandler	1.69	191
12-26-1919	Noble and Stockwell	1.70	160
4-17-1920	W. L. Stockwell, Jr.	3.00	778
4-18-1920	W. L. Stockwell, Jr.	2.90	738
5-29-1920	W. L. Stockwell, Jr.	3.40	884
6-16-1920	E. F. Chandler	4.28	1,800
8-23-1920	E. F. Chandler	2.28	372

MONTHLY DISCHARGE OF RED RIVER AT FARGO, N. D.

Year	Month	Maximum	Minimum	Mean	Accuracy
1918	September	143	78	116	B
	October	140	71	96	B
	November	198	83	124	B
	December	143	69	103	C
1919	January	.....	.....	78	C
	February	.....	.....	78	C
	March	630	42	276	C
	April	630	312	463	C
	May	630	245	468	B
	June	605	316	398	B
	July	440	178	294	B
	August	420	186	282	B
	September	249	172	209	B
	October	245	90	189	B
	November	320	192	252	B
	December	210	55	153	C
1920	January	175	142	157	C
	February	.....	.....	150	D
	March	6,120	280	1,680	C
	April	2,270	440	888	B
	May	1,190	655	930	B
	June	1,690	945	1,220	B
	July	1,400	555	960	A
	August	605	440	502	B

Maximum gage-heights: 2.7 feet March 22, April 5 and May 12, 1919; 13.3 feet March 28, 1920.

Maximum ever recorded: 19.9 feet (30.1 feet on Front St. gage) April 6, 1916.

Minimum gage-heights: 1.2 feet October 4, 1918, and February 12, 1919; 1.3 feet October 27, 1919.

Minimum ever recorded: 1.0 feet February 11, 1918; 5.7 feet on Front St. gage November 1, 1910.

RED LAKE RIVER AT CROOKSTON, MINN.

The Red Lake River is the principal tributary of the Red River, and its average flow is very nearly equal to that of the Red River itself above the confluence; hence it is an important factor in any problem concerning the lower Red River. The gaging station on the Red Lake River at Crookston, Minn., was established May 19, 1901. The drainage area above Crookston is 5,320 square miles, and there are no considerable tributaries between this point and the mouth of the river, so that almost the entire discharge is shown here.

The tables of discharge are based on the measurements in the list below and a hundred and twenty-two measurements in the eighteen preceding years. Except during some interruptions, they have excellent accuracy through the open season, although by the operation of the power plants above the station there are sometimes caused abrupt variations of flow which appear surprising but are really unimportant.

MEASUREMENTS OF DISCHARGE.

Date	Hydrographer	Gage-height	Discharge
9-26-1918	E. F. Chandler	3.33	283
5- 3-1919	J. T. Greenberg	4.33	755
7- 7-1919	E. F. Chandler	18.10	10,700
9-10-1919	E. F. Chandler	4.36	752
9-10-1919	E. F. Chandler	4.44	812
1- 5-1920	H. A. Noble	5.32*	416
3-26-1920	Chandler and Noble	21.07	8,500
5- 8-1920	W. L. Stockwell, Jr.	6.90	1,320
5-14-1920	W. L. Stockwell, Jr.	6.07	1,620
6-25-1920	E. F. Chandler	5.64	1,380
8-17-1920	E. F. Chandler	3.95	581

*Frozen; mean ice thickness 1.1 foot.

MONTHLY DISCHARGE OF RED LAKE RIVER AT CROOKSTON, MINN.

Year	Month	Maximum	Minimum	Mean	Accuracy
1918	September	.....	50	197	C
	October	.....	88	191	C
1919	March 25-31	2,690	.....	1,900	D
	April	2,760	805	1,470	A
	May	1,260	595	915	A
	June	.....	.....	913	C
	July	14,400	1,500	5,800	A
	August	3,430	1,040	2,040	A
	September	1,040	240	506	C
1920	March 25-31	10,100	.....	7,610	D
	April	5,740	2,410	3,990	B

Maximum gage-heights: 8.4 feet March 30, 1919; 21.1 feet July 5, 1919; 23.3 feet March 25, 1920.
Maximum ever recorded: 25.2 feet April 11, 1897.

THIEF RIVER NEAR THIEF RIVER FALLS, MINN.

The gaging station on the Thief River is located about six miles above the confluence with the Red Lake River at Thief River Falls with Thief River in Section 3, Township 154, Range 43. This river is typical of the sources of occasional spring floods; the drainage area above the station is 1,010 square miles. The station was established July 1, 1909, but was temporarily discontinued because of lack of funds during the years 1918 and 1919.

The tables of discharge are based on the measurements in the list below and forty-one measurements made in previous years, and are excellent in accuracy except during the spring break-up when the effect of ice in raising the gage-height is not readily determinable for every day.

MEASUREMENTS OF DISCHARGE.

Date	Hydrographer	Gage-height	Discharge
4-27-1920	H. A. Noble	6.06	399
5-28-1920	G. L. Smith	5.59	266
6- 4-1920	G. L. Smith	5.85	336
6-10-1920	G. L. Smith	8.93	1,392
6-15-1920	G. L. Smith	7.13	639
8-19-1920	Chandler and Smith	3.86	2.6

MONTHLY DISCHARGE OF THIEF RIVER NEAR THIEF RIVER FALLS, MINN.

Year	Month	Maximum	Minimum	Mean	Accuracy
1920	April	1,780	260	945	C
	May	275	54	147	A
	June	1,230	61	366	A
	July	77	17	36	A
	August	15	0.8	5.1	B

Maximum gage-heights: 14.0 feet April 2, 1920; 8.6 feet June 11, 1920.
Maximum ever recorded: 14.5 feet April 23, 1916; on July 12, 1919, or one or two days earlier or later, a gage-height about 16.6 feet was reached.

BOIS DES SIOUX RIVER NEAR FAIRMOUNT, N. D.

The gaging station on the Bois des Sioux River was established April 5, 1919, at the highway bridge southeast of Fairmount; April 1, 1920, it was moved to the Soo Railway bridge. The elevation of the zero of the gage at the highway bridge is 962.13 feet above sea-level; at the railway bridge the gage-zero is 961.98 feet above sea-level. The drainage area above the station is 1,460 square miles.

The tables of discharge are based on the measurements in the list below and are fairly accurate through the open season; unfortunately gage observations were not made as often as daily during 1919; and channel conditions are such that the growth of weeds obstructs the flow and changes the relation between gage-height and discharge progressively through each season.

MEASUREMENTS OF DISCHARGE.

Date	Hydrographer	Gage-height	Discharge
4- 5-1919	E. F. Chandler	1.56	7
5-17-1919	H. A. Noble	2.21	10
7- 2-1919	D. S. Helmick	2.40	23
7- 4-1919	E. F. Chandler	2.79	23
7-16-1919	Simons and Helmick	3.38	45
7-18-1919	E. F. Chandler	3.38	42
8-16-1919	B. S. Clayton	3.60	45
5- 9-1920	E. F. Chandler	4.08	133
5-21-1920	W. L. Stockwell, Jr.	4.64	169
6-17-1920	E. F. Chandler	4.81	143
8-24-1920	E. F. Chandler	3.85	56

MONTHLY DISCHARGE OF BOIS DES SIOUX RIVER NEAR FAIRMOUNT, N. D.

Year	Month	Maximum	Minimum	Mean	Accuracy
1919	April	9	6	7	C
	May	19	6	12	B
	June	39	8	13	C
	July	51	17	40	B
	August	77	33	53	B
1920	April	214	140	169	A
	May	194	132	159	A
	June	184	82	136	B
	July	82	58	67	B
	August	58	43	50	B

Maximum gage-heights: 4.1 feet August 5, 1919; 5.0 feet April 3, 1920; 5.2 feet June 11, 1920; during the highest flood of 1916 the highest stage reached was about 9.0 feet.

MUSTINKA RIVER ABOVE WHEATON, MINN.

A station was established on the Mustinka River, June 7, 1916, about 3 miles below (southwest from) Wheaton, Minn., but it was found that the stage at this point was likely to be affected by backwater from Lake Traverse. Accordingly the station was transferred March 1, 1917, to its present location, one mile above (northwest from) Wheaton. Because of lack of funds, the station was temporarily discontinued from Oct. 1, 1917, to June 24, 1919. The drainage area above this station is 776 square miles.

The tables of discharge, based on the measurements in the list below and eight previous measurements, are fairly accurate.

MEASUREMENTS OF DISCHARGE.

Date	Hydrographer	Gage-height	Discharge
6-25-1919	P. T. Simons	7.38	460
6-27-1919	D. S. Helmick	5.35	234
3-25-1920	P. T. Simons	7.68	622
5- 9-1920	E. F. Chandler	1.78	11
5-20-1920	W. L. Stockwell, Jr.	2.34	35
6-17-1920	E. F. Chandler	3.39	85
8-24-1920	E. F. Chandler	1.49	3.3

MONTHLY DISCHARGE OF MUSTINKA RIVER NEAR WHEATON, MINN.

Year	Month	Maximum	Minimum	Mean	Accuracy
1919	June 25-30	559	.....	266	B
	July	59	7	27	B
	August	10	1.6	5.3	B
	September	1.7	0.3	0.9	B
	October	4	0.2	1.9	B
1920	March 20-31	.....	.....	261	D
	April	91	10	30	A
	May	970	9	81	B
	June	215	19	103	A
	July	215	15	87	A
	August	14	1.9	6.3	B

Maximum gage-heights: 11.0 feet March 24, 1920; 9.50 feet May 11, 1920.
Maximum recorded at station, 14.7 feet April 1, 1917.
Minimum gage-heights: 1.1 feet October 9, 1919; 1.4 feet August 28, 1920.

PEMBINA RIVER AT NECHE, N. D.

The gaging station on the Pembina River was established April 29, 1903, but was temporarily discontinued during the years 1916, 1917 and 1918 because of lack of funds. It is located at Neche, sixteen miles above the mouth of the river, at the Great Northern Railway bridge. The drainage area above this point is 2,940 square miles, of which 920 square miles are in North Dakota and 2,020 square miles in Manitoba.

The tables of discharge, based on the measurements in the list below and fifty-three measurements in previous years, are fairly accurate through the open season, but are merely estimates for winter.

MEASUREMENTS OF DISCHARGE.

Date	Hydrographer	Gage-height	Discharge
3-31-1919	H. A. Noble	4.30	4*
5- 2-1919	H. A. Noble	5.95	447
5-30-1919	J. T. Greenberg	5.36	283
5-31-1919	J. T. Greenberg	5.39	287
8-14-1919	E. F. Chandler	3.99	25
5- 6-1920	W. L. Stockwell, Jr.	5.22	346
6-28-1920	E. F. Chandler	4.41	111
9- 8-1920	E. F. Chandler	3.48	9.5
9- 9-1920	E. F. Chandler	3.49	9

*Frozen.

MONTHLY DISCHARGE OF PEMBINA RIVER AT NECHE, N. D.

Year	Month	Maximum	Minimum	Mean	Accuracy
1919	April	2,520	4	879	B
	May	516	292	401	B
	June	292	86	145	B
	July	86	34	67	B
	August	34	26	28	B
	September	56	20	30	B
	October	.....	.....	68	C
	November	.....	.....	40	E
	December	.....	.....	20	E
1920	January	.....	.....	15	E
	February	.....	.....	10	E
	March	290	.....	28	E
	April	415	44	194	D
	May	315	216	250	B
	June	192	86	150	B
	July	86	34	69	B
	August	34	10	17	B

Maximum gage-height: 18.3 feet April 8, 1919; 15.1 feet April 15, 1919; 6.9 feet March 31, 1920; 7.1 feet April 19, 1920.

Maximum ever recorded: 20.9 feet May 2, 1904; height said to be 21.5 feet April 19, 1916.

MOUSE RIVER AT MINOT, N. D.

The gaging station on the Mouse River at Minot, N. D., was established May 5, 1903. The drainage area above this point is 8,400 square miles, of which three-fourths is in Canada and one-fourth in North Dakota. The gage is located directly north of the Great Northern roundhouse, so that the gage-heights refer to the water level in the river at that point, which is the same as at the Great Northern Railway bridge.

The tables of discharge, based on the measurements in the list below and on sixty-four measurements made during the previous sixteen years, are fairly accurate for all seasons.

MEASUREMENTS OF DISCHARGE.

Date	Hydrographer	Gage-height	Discharge
4-12-1919	H. A. Noble	11.98	1,340
5-30-1919	H. A. Noble	5.09	50
7- 2-1919	E. F. Chandler	4.57	9
8-30-1919	E. F. Chandler	3.96	0.7
5- 3-1920	E. F. Chandler	16.66	2,120
6-21-1920	E. F. Chandler	5.33	56
8-27-1920	E. F. Chandler	4.49	9

MONTHLY DISCHARGE OF MOUSE RIVER AT MINOT, N. D.

Year	Month	Maximum	Minimum	Mean	Accuracy
1918	September	16	7	13	C
	October	23	10	18	C
	November	.....	.....	18	C
	December	.....	.....	18	C
1919	January	.....	.....	11	C
	February	.....	.....	6	C
	March	118	2	20	C
	April	1,860	155	1,200	B
	May	469	56	199	B
	June	50	17	31	B
	July	25	5	11	B
	August	4	0.7	2.1	B
	September	0.9	0.7	0.8	C
	October	0.7	0.5	0.6	B
	November	1.1	0.8	0.9	B
	December	.....	.....	0.6	C
1920	January	.....	.....	0.5	C
	February	.....	.....	0.5	C
	March	335	0.4	14	C
	April	1,960	25	875	B
	May	2,560	204	1,220	B
	June	194	70	129	B
	July	85	17	34	B
	August	17	2.4	7.1	B

Maximum gage-heights: 12.9 feet April 6, 1919; 15.0 feet April 19, 1919; 17.1 feet May 6, 1920.

Maximum ever recorded: 21.9 feet April 20, 1904.

Minimum gage-heights: 4.4 feet September 1, 1918; 4.3 feet March 1, 1919; 3.9 feet October 25, 1919; 3.7 feet February 29, 1920.

GRAND RIVER (NORTH BRANCH) AT HALEY, N. D.

The gaging station on the North Branch of the Grand River at Haley, N. D., was established May 11, 1908. The drainage area above this point is 500 square miles. The tables of discharge are based on sixty-seven

measurements made previous to 1918, and on gage observations made usually twice a week, and are only approximate during most of the season because of the lack of recent discharge measurements to ascertain minor changes in channel conditions, and because of the infrequency of gage observations.

MONTHLY DISCHARGE OF GRAND RIVER (NORTH BRANCH) AT HALEY, N. D.

Year	Month	Maximum	Minimum	Mean	Accuracy
1918	September	.....	.....	0.6	D
	October	.....	.....	0.6	D
	November	.....	.....	0.6	D
	December	.....	.....	0.6	D
1919	January	.....	.....	1	E
	February	.....	.....	0.6	E
	March	16	.....	2.7	E
	April	16	3	12	D
	May	.....	.....	1	D
	June	.....	.....	0.7	D
	July	.....	.....	0.3	D
	August	.....	.....	0.1	D
	September	.....	.....	0.1	D
	October	.....	.....	0.2	D
	November	.....	.....	0.6	D
	December	.....	.....	0.3	E
1920	January	.....	.....	0.2	E
	February	.....	.....	0.2	E
	March	488	0	155	E
	April	180	0	40	C
	May	3,860	0	243	D
	June	11	2	6	D
	July	658	5	157	C
	August	49	0.1	3.4	D

Maximum gage-heights: 2.8 feet March 28, 1919; 9.0 feet March 15, and March 23, 1920; 10.2 feet May 11, 1920; 5.6 feet July 14, 1920.
Minimum gage-heights: 0.9 feet October 1, 1918; 0.8 feet September 9, 1919; 0.6 feet April 27, 1920.

HEART RIVER NEAR RICHARDTON, N. D.

The gaging station on the Heart River was established May 18, 1903 and was located at the steel highway bridge ten miles south of Richardton N. D. On September 4, 1911, it was transferred one mile downstream, and the gage-datum was changed so as to add approximately 20 feet to all gage-readings; thus a reading of 25 feet on the present gage indicates approximately the same flow as 5 feet on the original gage. The drainage area above this point is 1,250 square miles.

The tables of discharge, based on the measurements in the list below and on fifty-three measurements in the sixteen previous years, are only approximate through most of the season, for the reason that slight changes in the relation between gage-height and discharge were frequently caused by the construction of small beaver dams in the river near the station, and the measurements of discharge have recently been too few to determine precisely all the corrections arising from these causes.

MEASUREMENTS OF DISCHARGE.

Date	Hydrographer	Gage-height	Discharge
8-24-1919	E. F. Chandler	24.04	0.2
8-26-1920	E. F. Chandler	24.54	0.8

MONTHLY DISCHARGE OF HEART RIVER NEAR RICHARDTON, N. D.

Year	Month	Maximum	Minimum	Mean	Accuracy
1918	September	17	1	6	D
	October	17	6	10	C
	November	32	11	15	C
1920	January	11	6	9	D
	October	.....	.....	10	D
	December	.....	.....	18	D
	September	565	.....	47	D
	February	966	0.2	159	C
	March	109	7	42	C
	November	14	1.6	6.5	C
	December	1.4	0	0.4	B
1919	January	11	0	0.3	B
	February	0.2	0	0.1	B
	March	2.3	0.1	0.8	C
	April	.....	.....	1.2	D
	May	.....	.....	0.6	D
	June	.....	.....	1.7	D
	July	.....	.....	3.6	D
	August	1,500	.....	392	D
	April	1,130	52	255	B
	May	57	6	23	B
	June	690	6	96	B
	July	553	8	140	B
	August	6	0.6	1.7	C

Maximum gage-heights: 29.6 feet April 1, 1919; 32.1 feet March 25, 1920.
Maximum ever recorded: 45.9 feet June 10, 1906.

KNIFE RIVER NEAR BRONCHO, N. D.

The gaging station on the Knife River is about twenty miles north of Hebron, N. D., in Section 4, Township 142, Range 90, at the ranch of C. D. Smith, the former location of Broncho postoffice. The drainage

area above the station is 1,260 square miles. A station was first established on this river near this point May 29, 1903.

The tables of discharge, based on the measurements in the list below and forty-six measurements made in the sixteen previous years, are only fair in accuracy because the number of discharge measurements in recent years has been too few to determine accurately the effect for the natural changes in channel and station conditions.

MEASUREMENTS OF DISCHARGE.

Date	Hydrographer	Gage-height	Discharge
8-24-1919	E. F. Chandler	3.51	1.8

MONTHLY DISCHARGE OF KNIFE RIVER NEAR BRONCHO, N. D.

Year	Month	Maximum	Minimum	Mean	Accuracy
1918	September	67	19	32	C
	October	25	19	23	C
1919	March 28 to 31.....	1,000	.....	696	D
	April	3,160	25	516	C
	May	112	12	44	C
	June	201	4	22	C
	July	4	2	2	C
	August	348	2	16	C
	September	4	2	2	C
	October	.....	.....	10	C

Maximum gage-height: 13.9 feet April 2, 1919.
Maximum ever recorded: 24.0 feet June 26, 1914.
Minimum gage-heights: 3.9 feet October 1, 1918; 3.5 feet many times in July, August and September, 1919.
Minimum ever recorded: 3.1 feet September 18, 1908.

STATE HIGHWAY COMMISSION

Brief Historical Review of State Highway Legislation in North Dakota.

Good Roads Experiment Station (1909). State highway legislation in North Dakota may be said to have begun with the passage of the law providing for the establishment of a "good road experiment station" at Bismarck. (Chapter 22 of the Compiled Laws of 1913.) The object of the station was to ascertain "the most practical and economical construction and maintenance of public roads and highways in this state." The Board of Trustees of Public Property had supervision of all roads and highways constructed under the act, the State Engineer was to make the surveys and plans, perform the engineering and have general supervision of both the construction and maintenance, and the Warden of the state penitentiary was to furnish the convict labor "if not otherwise employed" for such construction and maintenance. The only highways to be laid out, constructed and maintained under the act were those from the capitol building to the federal military reservation about 4 miles south (Fort Lincoln) and from the penitentiary to the Missouri River, another distance of 4 miles. No right of way could be purchased but the Board of Trustees might "accept and use" any donations made by the United States or private individual for the improvement of the above mentioned roads.

No examination of the records have been made to ascertain the extent of accomplishment in road improvement but, from the nature of things, the activities of the Board and the State Engineer were very much limited.

State Registration of Motor Vehicles (1911). In 1911 there was enacted a law providing for the registration of motor vehicles. (Chapter 38, Article 56 of the Compiled Laws of 1913.) This act provided for the registration and "tagging" of motor vehicles by the Secretary of State. The fee was fixed at $3 per vehicle for registration or annual re-registration. The Secretary of State deducted sufficient from the gross receipts to purchase tags and books of registration. The remainder was turned by him to the several county treasuries, thus providing county "special road maintenance funds" which, in the absence of any more convenient medium existing for the expenditure thereof, were prescribed to be expended under the direction of the several county Boards of Commissioners (or

the County Superintendent of Highways where such official existed) in "repairs and maintenance on the main traveled roads" of the counties.

It may be here seen that thus early there was observed the principle of using the proceeds of motor vehicle licensing or registration for MAINTENANCE and the recognition of STATE HIGHWAYS ("main roads" of the counties).

Distribution of Road Bulletins by the State Engineer (1911). The next law passed provided that the State Engineer shall furnish available information or bulletins on road construction and maintenance to any County Superintendent of Highway making request and specifies that he shall attend road institutes in the counties whenever the "time and duties of his office permit." (Chapter 145, Article 11, Session Laws of 1911.)

Plans for and Reports on Bridges and Culverts by the State Engineer (1913). The following legislature provided that, when requested by any county or township board of the state, the State Engineer (co-operating with the County Surveyor or County Superintendent of Highways) was to prepare plans for any bridge or culvert or to examine and report on any bridge or culvert indicated. For such work, he was to receive $10 per day and actual traveling expenses to be paid by the board and later to be transmitted to the State Treasurer. (Chapter 30, Article 6 of the Compiled Laws of 1913.)

Creation of the First State Highway Commission (1913). A STATE HIGHWAY COMMISSION was created in 1913 consisting of the Governor (chairman), the State Engineer (secretary) and a member appointed by the Governor—all to serve without extra compensation. (Chapter 5, Article 25 of the Compiled Laws of 1913.) Whenever requested by a county board, the Commission was to direct the State Engineer to prepare plans and specifications for the improvement of any road in the county and, in general, supervise road construction in that county. A county road map was to be prepared showing the roads and the location of all bridges and culverts.

The Attorney General was ex-officio the State Highway Commission's attorney.

The Commission was also to issue bulletins containing advice and suggestions and the law concerning highway construction. The county, city and township officers were required to furnish the State Highway Commission with any road data or information requested.

The State Highway Commission, restricted in its powers, which were largely advisory and dependent upon requests by counties and townships, had no funds placed at its disposal for administration, much less actual road construction, maintenance and improvement. Consequently, as far as accomplishment is concerned, the state's first highway commission existed more on paper than on fact.

Establishment of Present State Highway Commission (1917). In 1916 the now well known Federal Aid Road Act was passed by Congress and signed by the President. One of the obvious or admitted though indirect objects of the enactment of this law was to lead or compel the states

which had weak state highway departments or possessed none at all to strengthen or create them. In this regard, the federal aid road act fulfilled its complete purpose and the establishment of a state highway department in every state in the Union was accelerated by many years. In North Dakota, federal aid for road improvement proved to be good "bait," for the legislature of 1917 promptly provided an actual and stronger State Highway Commission and placed it on a working basis. House Bill No. 168 so-called was approved by Governor Frazier on March 5, 1917. (Chapter 131 of Session Laws of 1917.)

The principal provisions of the law are as follows:

A. Creation of a State Highway Commission composed of the Governor, who is chairman, the State Engineer, who is to be the Chief Engineer and Secretary, and who is to receive $1,000 annually in addition to his salary as State Engineer, the Commissioner of Labor and Agriculture and two members appointed by the Governor, who are to receive $10 per day when serving and necessary traveling expenses.

B. Empowering the State Highway Commission.
   1. To meet whenever and wherever necessary to carry out provisions of the act.
   2. To determine the character and have general control and supervision of the construction, improvement, repair and maintenance of roads and bridges improved under the act.
   3. To reserve sufficient from the state highway fund to pay its expenses and the state's share of maintenance.

C. Prescribing duties of the Chief Engineer and Secretary.
   1. To act as secretary and keep records and files.
   2. To make a map showing the state highway system (in conjunction with the several county boards).
   3. To collect information, data, etc., on roads and bridges.
   4. To investigate and test road building materials and determine best methods of road building and maintenance for the state.
   5. To determine the type of improvement of given projects and supervise construction and maintenance.

D. Provision for Aid in Highway Improvement.
   1. Creating state aid fund (90% to be credited to and spent in counties and 10% to be spent at discretion of the Commission).
   2. Prescribing procedure in applying aid in the improvement of highways.
      a. Application by county.
      b. Approval by commission.
      c. Surveys, plans, etc. to be made by the state.
      d. Advertising, submittal and opening of bids, awarding of contracts, etc. (the latter with approval of the county board).
   3. Making bridges eligible for aid.
   4. Providing that aid shall not exceed 50%.

E. Maintenance prescribed for work constructed.
   1. To be under the direction and supervision of the State Highway Commission and the Chief Engineer.

2. To be paid for one-half by the state and one-half by the county from the special road maintenance fund.

F. Assent to the Federal Aid Road Act, empowering the State Highway Commission to do all things necessary to co-operate with the federal government.

G. Appropriation of $8,000 for immediate organization.

H. Prescribing Disposition of Motor Vehicle License Fees.
   1. Collected by Secretary of State, who deducts necessary amount for purchase of tags, clerk hire, postage, etc.
   2. One-third of the remainder to be turned back to county treasuries to be known as the special road maintenance fund and to be apportioned according to the gross receipts from the counties.
   3. Remaining two-thirds to be the State Highway Fund.

I. Outlining Procedure in Payment of Claims.
   1. Special road maintenance fund—when approved by County Superintendent of Highways or County Board.
   2. State Highway fund—when approved by the Secretary of the State Highway Commission.

J. Money Returned to Counties.
   1. To be spent only for repairs of highways and dragging.
   2. To be used also in aiding townships in dragging.

K. Repeal and Emergency.

The essential features of the foregoing legislation are that the state availed itself of the federal aid road act and provided STATE AID for the construction of state highways.

Revision of Motor Vehicle Registration Law (1919). In 1919 the registration of motor vehicles operating in the state was changed from the Secretary of State to the State Highway Commission, the license fees increased, etc. (Chapter 182 of the Session Laws of 1919).

This law in outline provided as follows:

A. Definition of "motor vehicles" and other terms.

B. Filing with the State Highway Commission a blank of information as to the motor vehicle by every dealer or owner.
   1. Prescribing nature of the blank.
   2. Registration of vehicle.
   3. Transfer of vehicles and registration.
   4. Issuance of tags.
   5. Replacement of lost tags.
   6. Annual registration.

C. Basis of Fee Determination.
   1. Selling price—rate to be 5 mills.
   2. Horsepower—rate to be 10 cents per horsepower.
   3. Weight—rate to be 20 cents per cwt. or fraction.
   4. Reductions—
      a. 10 per cent for second year.
      b. 25 per cent for third year.
      c. 40 per cent for fourth year.
      d. Minimum fee to be $5.00.

5. Truck factors—(additional fee).
   a. $3.00 per ton up to and including 3 tons.
   b. $5.00 per ton from 3 to 4 tons.
   c. $10.00 per ton over 4 tons.
6. Bus—(additional fee—25 cents per passenger carrying capacity).

D. Presence of Correct Tags Required.
E. Prescription as to Size, Numbering, etc. of Tags.
F. Non-resident Vehicles not Required to be Registered if otherwise properly tagged.
G. Reports by Registration Clerk.
H. Creation of State Highway Fund.
   1. Consists of entire gross receipts.
   2. Not to exceed $150,000 annually for expenses of the State High-Commission (including registration, etc.)
   3. Fifty per cent of balance turned back to county treasuries as special road maintenance fund to pay for entire maintenance of the state highways supervised by the State Highway Commission.
   4. Fifty per cent remaining to be used as State Aid in the improvement, maintenance and construction of state highways.
      a. 90% to be credited and spent in the several counties according to the gross receipts from the same.
      b. 10% to be spent at the discretion of the State Highway Commission.
I. Claims Paid upon Approval of the Secretary, etc.
J. Fee in Lieu of All other Taxes.
K. State Highway Commission empowered to enforce provisions of the act.
L. Motor Vehicle Registration Clerk.
   1. Nomination by Secretary and appointment by the Commission.
   2. Bond required in sum of $5,000.
   3. Salary not to exceed $2,000.
   4. Office to be at the state capitol, etc.
   5. Power to appoint deputies, experts, etc.
M. Penalties for Violation of Provisions of Act.
   1. Extent.
   2. County officers, sheriffs, etc., obligated to assist in enforcement.
N. Dealers to Cooperate.
O. Repeal and Emergency.

Note: At this point it may be noted that though the foregoing apparently provides a sum of $150,000 annually for the State Highway Commission for the registration of motor vehicles and administration of the department's business in connection with securing federal aid in highway improvement, two specific appropriation measures, namely for Motor Vehicle Registration (Chapter 50 of the Session Laws of 1919) carrying $44,342.30 per annum and for the State Highway Commission (Chapter 42 of the Session Laws of 1919) with $90,500 per annum, gave the highway department but $134,842.30 yearly for operating expenses. This amount was quite inadequate

to properly carry on the work. The federal aid available to the state at that time for the 5-year period ending June 30, 1921, was about $1,142,000. With the subsequent special session of 1919, it was hoped that more nearly adequate funds would be placed at the disposal of the Highway Commission, an amendment to the federal aid road act having been made increasing the federal aid for the state nearly four times or to be exact $4,226,000. Nevertheless time saw the special session pass with a further reduction of the already inadequate operating fund by $4,250 per annum (Chapter 11 of the Special Session Laws of 1919).

The result has been that the department has not been able to administer its affairs and to conduct its business efficiently and expeditiously. The state was in grave danger of losing part of its federal aid allotments and that danger, unless the next legislature makes more adequate provision for the department, will positively result in loss of federal aid in the immediate future. The inadequate budgets have given occasion for severe criticism of the State Highway Commission by county officers, contractors and others and, in some instances, where it has been financially impossible to provide sufficient or proper engineering or the necessary supervision of construction, the best interests of the counties, the state, the federal government and the people have not been at all served.

Amendment and Re-enactment of the State Highway Law (1919). The existing law establishing the State Highway Commission was amended and somewhat amplified (Chapter 141 of the Session Laws of 1919) as follows:

A. Term of appointed commissioners fixed at two years.
B. Commission to direct and supervise maintenance of entire state highway system.
C. State Aid (90% fund credited to counties) made available for expenditures by the Commission if county fails to apply same.
D. Ten per cent fund and relinquished state aid (see immediately above) to be spent by Commission with or without federal aid or county funds or for machinery, tools, supplies, labor, etc.
E. Empowering State Highway Commission to secure necessary right of way for location of highways or for securing of road building materials.
F. Providing for cooperation of state educational institution laboratories, etc., for testing of materials, etc.
G. Prescribing Drawing of Warrants by County Auditor upon estimates furnished by the State without individual Board action.
H. Providing that Retent on Estimates to Contractors be 10 instead of 30 per cent.
I. Repeal and Emergency.

State Aid in Construction of Bridges (1919). While state aid in general, as may be seen from the foregoing, was available for bridges as state aid or federal aid projects or as parts thereof, a specific act was passed providing that the state shall pay one-third the cost of interstate bridges or bridges across navigable streams, on state highways. (Chap-

ter 73 of the Session Laws of 1919.) No specific appropriation was provided to accompany the act and it was hence practically inoperative. However, the measure paved the way for the construction of the Missouri River Bridge between Bismarck and Mandan, an important structure estimated to cost with approaching roadways into both cities over $1,000,000, the only wagon bridge across the Missouri in the state of North Dakota, the building of which will develop the Slope country or that portion of the state west and south of the river and will give impetus and satisfaction to interstate or transcontinental traffic.

Specific State Aid Appropriations for Bridges (1919). In order to make the foregoing law operative, the special session in late 1919 passed Senate Bill No. 33 which provided $225,000 and $35,000 (taken from the ensuing biennium's collections of the motor vehicle registration fees) to pay the state's one-third of the cost of construction respectively of the Missouri River bridge above-mentioned and an interstate bridge over the Red River between Pembina, North Dakota and St. Vincent, Minnesota.

FEDERAL HIGHWAY LEGISLATION.

Federal Aid Road Act (1916). Under an act of Congress approved by President Wilson on July 11, 1916, federal aid was made available to the states in the improvement of STATE HIGHWAYS.

The federal aid road act, one of the most remarkable of laws because of its brevity compared with the principle involved and the magnitude of work to be done under it, marks a notable step ahead in the development of the highways of the nation.

Among its many features, there were a few provisions which were subsequently amended. The original bill provided for the use of federal aid on "rural post roads" and the interpretation placed on this term by the Solicitor of the U. S. Department of Agriculture, which administers the act through its Bureau of Public Roads, namely that no less than 70 per cent of the mileage of each federal aid road project must be post road (or mail route) was inconsistent with the purposes and intent of the law, made the same more or less inoperative or would ultimately make it so and worked a hardship on the states particularly in the west to secure federal aid. The law also provided that federal aid could not be secured in excess of $10,000 per mile, excluding bridges of 20-foot span and over. The original appropriation provided $75,000,000. for federal aid to states for the 5-year period ending June 30, 1921 in annual amounts of $5,000,000, $10,000,000, $15,000,000, $20,000,000 and $25,000,000. There was also a $10,000,000 appropriation for the improvement of roads in the national forest by the Bureau itself, in $1,000,000 annual increments during the 10-year period ending June 30, 1926.

Amendments to the Federal Aid Road Act (1919). On February 28, 1919, the President approved the Post Office appropriation bill for 1920 which provided:

First, a change in the definition of "rural post roads" so that the

previously mentioned difficulty was practically entirely eliminated and federal aid is now available on any highway jointly agreed upon by the state and federal governments;

Second, an increase in the amount of federal aid available per mile of improved highway so that at present federal aid to the extent of $20,000 per mile is securable (excluding bridges of 20-foot span and over), and

Third, $200,000,000 more federal aid available, making a total of $275,000,000 distributed over the five-year period ending June 30, 1921, in annual allotments of $5,000,000, $10,000,000, $65,000,000, $95,000,000 and $100,000,000 (compare with yearly allotments under the original act).

Distribution of Excess War Materials to State Highway Departments (1919). Following the cessation of hostilities in the war, there was a congressional enactment which provided that excess war material and supplies, such as trucks, tractors, machinery, instruments, tools, explosives, etc., etc., were to be turned over by the War Department to the Department of Agriculture and that the latter distribute the material to the state highway departments for use in constructing and improving roads. Details of the act, enumeration of material received by the State and the present and future use to which the same has or will have been put by the State Highway Commission will be given subsequently in this report.

The outstanding feature of this proposition is that there has come and will come to the state (and owned outright by it) motor trucks, tractors, machinery, equipment, etc., for use in road improvement valued at hundreds of thousands of dollars and that some financial provisions must be made to secure the same, place it in working condition, use it and house or take care of it. Otherwise the state will be criticized as is the War Department for allowing the material, machines, etc., to be idle, exposed to the elements and of no present value. Moreover, such a condition may result in recalling such idle trucks, etc., and will interfere with the state's securing more in the future.

Further Federal Aid Proposed. The original federal aid road act of 1916 provided $75,000,000 federal aid which by the amendment in 1919 was increased to $275,000,000. The success of the measure has been so great that steps have already been taken primarily by the western states for still further increases in federal aid by the amount of $100,000,000 per year for each of the years 1922, 1923, 1924 and 1925, making a total of $675,000,000 to be distributed among the states in the nine-year period ending June 30, 1925.

North Dakota's allotment of the original $75,000,000 was roughly $1,142,000, of the $275,000,000 is about $4,226,000 and of the $675,000,000 would be over $10,000,000.

Townsend Highway Bill. This bill has been before Congress, has a large number of supporters and has been given a great deal of favorable publicity. It provides in the main for the establishment of a Federal (or National) Highway Commission and for no less than two roads north and south and two roads east and west across each state to be constructed and maintained by the Federal Highway Commission with federal funds.

This measure has not, however, received the sanction of the U. S.

Department of Agriculture or approval by the American Association of State Highway Officials. Mr. A. R. Hirst, State Highway Engineer of the Wisconsin State Highway Commission, has made an exhaustive study of the bill and pronounces it impracticable and entirely inadequate as it now stands.

However, the principle of having a national highway commission to build and maintain national roads with national funds on the same basis that state highway commissions build and maintain state roads with state funds must at some time or another be enacted into law and it is highly probable that this will be realized in early future years.

The Federal Aid Road Act in Brief. Before any state could receive allotments of federal aid, three requirements had to be satisfied;

First, the state would have to assent to the provisions of the federal act either by its legislature (Chapter 131, Article 8 of the Session Laws of 1917) or the Governor until the legislature should convene (the legislature being then not in session);

Second, the state would have to have a STATE HIGHWAY DEPARTMENT empowered with direct supervision of the construction and maintenance of federal aid roads, and

Third, federal aid would have to be matched by at least an equal amount of state funds or funds entrusted to or appropriated through the state highway department.

The U. S. Secretary of Agriculture administers the act but, in so doing, deals only with state highway departments. The immediate office in charge of federal aid work is the U. S. Bureau of Public Roads. A sum not to exceed three per cent of each annual appropriation can be used for federal administrative purposes.

The Secretary and the state highway departments agree on the roads to be improved with federal aid which, in effect, means the state highways of the states except that federal aid is not available on roads or streets in places having populations of 2,500 or more (according to the latest census) unless the houses thereon average less than 200 feet apart. The Secretary also prescribes the rules and regulations for the application of federal aid.

The Secretary and the state highway department also agree on the character and method of construction. The federal aid law specified (and the state law as well—see Article 5 Chapter 131 of the Session Laws of 1917) that the improvement shall be "substantial in character." The Bureau of Public Roads has placed a rather liberal interpretation on the term "substantial in character," it being considered in its sense relative to the state, the traffic, the topographic conditions, etc. Federal aid is made available on earth roads and sand-clay or gravel just as well as the higher or more permanent types such as brick, bituminous macadam, asphalt, concrete and the like. A very large percentage of the federal aid projects of this state are of the first type, there being only about ten per cent gravel roads and but two one mile sections of concrete highway (Projects No. 51 and 52 in Grand Forks County). The limit of $20,00f federal aid per mile (exclusive of bridges of 20-foot span and over) hat already been mentioned.

The Secretary also promulgates the standards governing the form and arrangement of plans, specifications and estimates which must be prepared and submitted by the state highway department for approval by him before federal aid is definitely set aside for individual projects. A state highway department has, therefore, little choice in the matter of the kind of surveys, plans and estimates to be made, their form, arrangement, etc., since the approval of the same is a necessary prerequisite to securing federal aid.

In apportioning federal aid to the states, the law prescribes that each fiscal allotment shall be based on three factors:

First, one-third according to the area of the state;

Second, one-third according to the population as shown by the latest available census, and

Third, one-third according to the mileage of rural delivery and star routes, determined annually. It is to be remarked that the above method of apportionment among states has met with universal satisfaction. North Dakota's percentage for the allotments for 1917, 1918, 1919 and 1920 based on the 1910 census was about 1.57. Minnesota's, South Dakota's and Montana's percentages respectively were 2.94, 1.67 and 2.02. Texas is high with 6.02 largely on account of its area, and New York follows with 5.17 because of its population, while the lowest percentage is 0.17 that of Delaware.

TABLE I.
ALLOTMENTS OF FEDERAL AID TO NORTH DAKOTA BY YEARS.

Fiscal Year Ending June 30	1917	1918	1919
Under Act of 1916	$76,143.06	$152,286.12	$229,585.91
Under Act of 1919			768,368.28
Total	$76,143.06	$152,286.12	$997,954.19

Fiscal Year Ending June 30	1920	1921	5-Year Period
Under Act of 1916	$307,344.11	$384,056.95	$1,149,416.15
Under Act of 1919	$1,152,540.42	$1,152,170.85	$3,073,079.55
Total	$1,459,884.52	$1,536,227.80	$4,222,495.70

It is to be noted that an equal amount of "local" funds must be raised to secure federal aid. Consequently, there is in prospect no less than about $8,500,000 worth of federal aid road work in the state.

The law further stipulates that each allotment for a given fiscal year must be covered by project agreement—that is, the survey must have been made, the plans, specifications and estimate prepared by the state

and these approved by the Secretary—before the expiration of the next fiscal year. It is gratifying to note that the North Dakota State Highway Commission, in spite of its inadequate budget which will be given more detailed discussion later, the cheap or low type of federal aid project common in the state thus requiring a much larger mileage in order to use up a given amount of federal aid and the necessity of relying mainly on appropriations of county money to match federal aid, has not yet lost any of its allotments though to be sure advantage was taken of the year of grace. The state's allotment for the first three years (1917, 1918 and 1919 with the year's leeway ending June 30, 1920) was $1,226,375.37. Project agreements had been executed up to that date to the extent of 1,405.99 miles of federal aid road and bridge projects. The 1920 allotment (for the fiscal year) is $1,459,884.53, meaning nearly $3,000,000 worth of additional work which must have surveys, plans, specifications and estimates prepared for, submitted to and approved by the Secretary before June 30, 1921. A corresponding situation exists for the next year and, if further federal aid is provided by Congress in the near future, the situation will have become still more aggravated. In other words, at least as much will have to be taken care of in each of the next two years as the State Highway Commission has been able to handle from March 5, 1917, to June 30, 1920, a period of 3 1/3 years.

Any parts of allotments to states not covered by project agreement within the time specified revert to the federal treasury and are re-allotted to the states as in the case of the regular annual amounts.

The actual road improvement done under the act—that is the construction—must be in accordance with the state laws and under the supervision of the STATE HIGHWAY DEPARTMENT and at the same time be subject to the inspection and approval of the U. S. Secretary of Agriculture. When he finds that the work has been done according to the approved plans and specifications governing, federal aid is paid in the amount set aside for the project but not to exceed one-half the actual cost of the project.

In assenting to the federal aid road act, the state is bound to and insures the proper MAINTENANCE of completed federal aid projects. In case the state fails to maintain or have such projects maintained in a manner satisfactory to the Secretary, then he shall refuse to approve any further projects in the state unless the project or projects in question have been placed in proper condition of maintenance within four months' notice. The federal government does not share in the operation or cost of maintenance of any projects.

No discussion is here given of the building of national forest roads under the federal aid road act, since there are no national forests in North Dakota.

Nor is any extended attention given to the organization of the U. S. Bureau of Public Roads other than to state that the United States has been divided into thirteen districts, varying in size—one comprising the state of California alone and another covering eight states with the others in between. North Dakota with Minnesota, Wisconsin and South Dakota constitute District No. 4 with Mr. E. O. Hathaway, District Engineer in

charge, the headquarters being located in the Post Office Building of Minneapolis, Minnesota.

Progress of a Federal Aid Road Project.

State Aid in Connection with Federal Aid. In the beginning, the state aid provided by the law was a relatively insignificant amount—see report on Motor Vehicle Registration—and it was placed to the credit of the several counties to be utilized in either state aid or federal aid projects or both by application from the county and appropriation of at least an equal amount. At that time the federal aid available was also relatively small and with the post route requirement then to be contended with on federal aid, the State Highway Commission adopted the policy and advocated the counties' meeting federal aid dollar for dollar and allowing the state aid to accumulate to appreciable sums when it could be used for state aid projects where the counties had already taken advantage of all the federal aid apportioned to them by the state or where they wished to match state aid as well as federal aid, each independently dollar for dollar.

However, with the increase in the amounts of federal aid, there is no occasion for the above procedure though, in spite of the later increase in fees, the state aid continues to be small in amount and remains credited to the counties awaiting their application and appropriation of funds. The present practice is to use each county's state aid to supplement an at least equal amount in county appropriations, thus providing a joint state-county fund which can be used to meet federal aid. Shortage in office and clerical force has prevented the actual payment of all the state aid as reimbursement to counties having federal aid projects but it is anticipated that this matter can be given attention during the coming fiscal year.

State aid has also been utilized to provide engineering, particularly in connection with the direction and supervision of construction—the budget of the department making such course absolutely necessary. State aid is not, however, independently available to meet federal aid without supplementary county appropriations.

Consequently, it may be said that the major work of the State Highway Commission has been and probably will be in connection with federal projects. Therefore it may not be amiss to outline briefly the course of a federal aid project.

The initiative rests with the county which, if it desires to receive aid in road improvement, makes formal application to the State Highway Commission, designating the highway contemplated for construction. If the Commission finds that the project is part of the state highway system, previously agreed upon with the county as such, that the proposed improvement is "substantial in character" and that the county is financially able to bear its share of the cost, the Project Engineer or his representative is sent to make an investigation of the proposed work.

He prepares the project statement which is submitted to the (U. S.) District Engineer and by him ultimately to the Secretary for approval if it complies with the law, rules and regulations. The project statement

is merely a statement that the state proposes to construct a certain piece of road of a certain type and length in a certain location. It also contains an approximate estimate of cost and makes a showing as to availability of funds.

When the project statement has been approved by the government, the survey is made normally by the state. The improvement is designed, quantities determined and plans and estimate prepared. These together with the specifications are submitted to the government through the usual channels. When these have been approved and a request having been made for the execution of a project agreement based on the approved documents, the project agreement is executed, a certificate of approval of plans, specifications and estimate is issued and the U. S. Secretary of Treasury sets aside the federal aid specified in the agreement for expenditure on the project. Federal warrants for actual work done and participated in by the government are drawn against this fund. The project agreement is simply a contract between the State and United States specifying that, if the given project is built according to the approved plans and specifications, the federal aid indicated will be paid by the government.

Where practicable and for obvious office reasons, the project agreement is based on the actual contract prices.

With the approval of the plans, etc., the state is authorized by the government to commence construction. The work is then advertised by the State Highway Commission which furnishes the County Auditor with the advertisement to be published, the proposal blanks to be distributed to prospective bidders, the plans and specifications to be filed in his office.

At the letting, the State Engineer, ex-officio Chief Engineer and Secretary of the Commission, opens and reads the proposals. Contracts are awarded by him subject to the approval of the County Board. If no awards are made, the work is readvertised or some arrangement is made such as force account to have the work done. A federal engineer is usually in attendance at the lettings in an advisory capacity.

Copies of the statement of bids received, of the advertisement, of the proposed proposal forms, of the accepted proposals, of the contract aggreements entered into and of the contract bonds are submitted in due time to the federal government.

Copies of the plans, specifications, accepted proposals, contract agreements and accepted bonds are also furnished to the County Auditor, the contractors and the Division and Resident engineers.

Actual construction, etc., is naturally carried on in accordance with the contract and specifications. An engineer is provided to stake out the work, select samples of materials to be tested, inspect construction, determine the amount of work done and prepare the estimates showing the money due the contractor. The work is inspected by the Division Engineer, by the Road Engineer (both from the State Highway Commission) and by the federal engineer from time to time and is finally accepted by the state and federal government in conjunction with the county board which usually accompanies the former in the final inspection.

Monthly estimates are prepared by the state and submitted to the

County Auditor who draws warrants as prescribed by law paying the contractor from the county appropriations for the project. Federal vouchers are also submitted monthly by the state to the government and normally federal aid is paid monthly to reimburse the county through the state. When the amount of work done by the contractor is at least four times the amount of state aid granted or available for that project, this money is also paid to the county. The contractor receives all his money from the county.

After final acceptance, the project is turned over to the Maintenance Department by the Construction Department and maintenance is provided and carried on subject to the inspection of the federal engineers as previously described. The expense of maintenance is paid from the county "special road maintenance" fund as prescribed by law, the actual maintenance being directed and supervised by the state.

FEDERAL AID PROJECTS.

Project statements for federal aid projects have been submitted and approved by the federal government or are in preparation as indicated in Table II following. Without further comment, it is sufficient to say that no difficulty has been or will be encountered in the approval of project statements to more than equal the federal aid now known to be available. The principal strain on the department under existing conditions (inadequate budget, etc.) will be to make surveys, plans and estimates for projects early enough and in number sufficient to prevent some of the state's allotment of federal aid reverting to the federal treasury.

Project agreements have been executed (that is, federal aid set aside to pay the government's share of the cost of a project) or submitted to the Secretary for execution to June 30, 1920, as follows:

Page ٦٦ is a blank page in the original report.

TABLE II.
NORTH DAKOTA FEDERAL AID PROJECT AGREEMENTS.
(Showing also data on Project Statements.)

Proj. No.	County	Location	Miles	Type of Road	Agreements Executed	Modifications Pending	Other Agreements to be Requested
					Federal Aid Set Aside	Federal Aid Requested	Approx. Federal Aid Involved
1	Cass	Fargo—South	16.3	Earth	$7,527.56		
2	Foster	Carrington—N & W	15.0	Earth	(a) 17,971.20		
3	Williams	Williston—NW	30.5	Earth	(a) 55,620.49		
4	Richland	Wahpeton—South	20.0	Earth	9,599.32		
5	Traill	Cummings—N, E, S & W	24.9	Earth	16,039.42		
6	Eddy	Benson Co. Line—South	5.5	Gravel	(a) 10,156.01		$6,000.00
7	Stutsman	Woodworth and Wells Co. Line	9.2	Earth	(a) 12,187.46		
8	Eddy	New Rockford—W & S	9.3	Gravel	(a) 14,576.03		18,000.00
9	Grand Forks	Reynolds—North	3.6	Gravel	5,701.61		5,000.00
10	Pierce	Balta—South	5.0	Earth	(a) 7,603.04		7,000.00
11	Cavalier	Clyde—E & W	7.6	Earth	(a) 5,186.14		
12	Barnes	Valley City—S, E & W	29.5	Earth and Gravel	24,061.33	$30,970.30	
13	Stutsman	Pingree—West	7.9	Earth	7,357.01		
14	Stark	Dickinson—N & S	18.9	Earth	(a) 16,642.86		13,685.33
15	Sargent	Forman—N & W	31.4	Earth	(a) 53,064.83	64,942.29	
16	Grand Forks	Emerado—E & W	6.7	Gravel	(a) 31,776.31		
17	Griggs	Cooperstown—E & W	17.6	Gravel	10,134.24	18,343.33	
18	Ramsey	Churchs Ferry—East	4.5	Gravel	(a) 20,253.73		
19	Ramsey	Devils Lake—SE & NW	19.9	Gravel	(a) 36,727.21		
20	Wells	Harvey—N & S	16.8	Gravel	(a) 17,558.15		25,000.00
21	Bowman	Bowman—N & S	17.7	Earth	(a) 15,111.20	1,831.08	25,000.00
22	Towner	Arndt—North	17.5	Earth	37,910.23		10,000.00
23	LaMoure	Edgeley—E & W	10.0	Earth	4,820.83		
24	Stutsman	Cleveland—N & S	25.9	Earth	46,168.25		
25	Ward	Minot—West	5.6	Earth	(a) 19,180.38	1,800.54	
26	Benson	Eddy Co. Line—North	6.0	Earth			15,000.00
27	Benson	Minnewauken to Churchs Ferry	24.0	Gravel	43,561.88		30,000.00
28	Ransom	Lisbon—N & S	17.9	Earth	29,273.69	29,118.50	
29	Steele	Traill Co. Line—West	8.5	Gravel			50,000.00
30	Divide	Burke Co. Line—West	10.5	Earth	15,869.61		

Proj. No.	County	Location	Miles	Type of Road	Agreements Executed	Modifications Pending	Other Agreements to be Requested
					Federal Aid Set Aside	Federal Aid Requested	Approx. Federal Aid Involved
31	LaMoure	LaMoure—E & W	4.8	Gravel	(a) 18,702.84		
32	Cass	Fargo—South		Bridge	20,625.38		
33	McIntosh	Hazleton—South	18.1	Earth		(b) 39,029.90	
34	Emmons	Ashley—East	11.7	Earth	22,383.93	1,993.40	
35	Logan	Napoleon—E & W	22.1	Earth	37,675.70		
36	Barnes	Valley City—NW & SE	50.5	Earth	30,854.27		90,000.00
37	Hettinger	Mott—E & W	19.0	Earth			47,500.00
38	Hettinger	New England—NE	8.9	Earth	14,687.49	5,983.28	
39	Grant	Carson—E & W	16.5	Earth	16,281.31		30,000.00
40	Bottineau	Mohall—East	8.0	Gravel	12,384.55		10,000.00
41	Grand Forks	Thompson—Northwood	21.0	Earth			42,000.00
42	Pembina	Cavalier—Akra	6.0	Earth			12,000.00
43	Bottineau	Bottineau—E & W	10.1	Gravel	21,480.38		20,000.00
44	Bottineau	West of Botteau at Thor	4.5	Gravel	(a) 16,128.84	2,795.19	9,000.00
45	Foster	Glenfield—West	11.1	Earth	20,144.61	9,239.72	
46	Traill	Cummings and Buxton	4.0	Gravel	5,923.71	11,494.11	
47	Oliver	Center—South	10.2	Earth			
48	Pierce	Wells Co. Line—North	21.6	Earth and Gravel			65,000.00
49	Golden Valley	Beach—N, E, S & W	19.3	Earth		(b) 9,534.30	31,000.00
50	Griggs	West of Cooperstown	4.0	Earth			8,000.00
51	Grand Forks	City to Packing Plant	1.1	Concrete		(b) 20,098.00	
52	Grand Forks	City to University	0.9	Concrete			18,560.00
53	Stark	Hettinger Co. Line—North	5.5	Earth			11,000.00
54	Kidder	Stutsman Co. Line—West	3.7	Earth			8,657.75
55	Stutsman	Barnes Co. Line—West	6.0	Earth			12,000.00
56	Stutsman	Jamestown—N, W & S	40.5	Earth			81,000.00
57	McLean	Garrison—West	10.0	Earth			20,000.00
58	Sargent	Forman—East	19.5	Earth			43,000.00
59	Richland	Fairmount-Hankinson	14.5	Earth			29,000.00
60	Richland	Wahpeton—North	34.0	Earth			74,250.00
61	Traill	Hillsboro—South	12.5	Earth			25,000.00
62	McLean	Turtle Lake and Underwood	10.0	Earth			20,000.00
63	McLean	Wilton and Washburn	10.0	Earth			20,000.00

Proj. No.	County	Location	Miles	Type of Road	Agreements Executed	Modifications Pending	Other Agreements to be Requested
					Federal Aid Set Aside	Federal Aid Requested	Approx. Federal Aid Involved
64	Logan	Burnstad	0.1	Bridge	1,929.25		
65	Stark	South Heart	0.1	Bridge		(b) 4,400.00	
66	Sargent	Perry—North	6.0	Earth			12,000.00
67	Traill	Buxton—N & E	7.0	Gravel			28,000.00
68	Grant	Lark—S & E	6.0	Earth			13,200.00
69	Richland	Mooreton—West	18.0	Earth			36,000.00
70	Nelson	Michigan-Petersburg	5.5	Earth			11,000.00
71	Richland	Wahpeton—West	13.0	Earth			26,000.00
72	Richland	Hankinson—West	18.0	Earth			36,000.00
73	Williams	Tioga—West	18.5	Earth			37,000.00
74	Mountrail	Stanley—East	8.0	Earth			16,000.00
75	Mountrail	Palermo—East	15.0	Earth			30,000.00
76	Burke	Bowbells—North and then West	20.0	Earth			40,000.00
77	Burke	Divide Co. Line—East	18.0	Earth		(b) 11,307.76	25,000.00
78	Divide	Burke Co. Line—West	10.0	Earth			20,000.00
79	Divide	Fortuna-Alkabo	10.0	Earth			20,020.00
80	Williams	Williston—West	19.0	Earth			38,000.00
81	Ward	Minot—East	13.0	Gravel			52,000.00
82	Ward	Minot—North	15.0	Gravel			60,000.00
83	Ward	West of Minot	10.0	Gravel			40,000.00
84	Ward	NW of Minot	25.0	Gravel			100,000.00
85	Ward	Minot—South	14.0	Gravel			56,000.00
86	Ward	McLean Co. Line—North	12.0	Gravel			48,000.00
87	Bottineau	West of Bottineau	15.0	Earth			30,000.00
88	Wells	Hurdsfield—North	11.0	Earth			22,000.00
89	Sargent	Foreman—South	11.5	Earth			23,000.00
90	Wells	Hurdsfield—South	10.0	Earth			20,000.00
91	Emmons	Hazelton—North	10.5	Earth			21,000.00
92	Foster	Guptill—North	4.0	Earth			8,000.00
93	LaMoure	Verona—S & W	8.0	Earth			16,000.00
94	LaMoure	Edgeley and LaMoure	15.0	Earth			30,000.00
95	Ramsey	Devils Lake and Churchs Ferry	12.5	Gravel			50,000.00
96	Ramsey	Nelson Co. Line—West	9.0	Earth			$18,000.00
97	McIntosh	Ashley-Danzig	12.0	Earth			20,010.00

Proj. No.	County	Location	Miles	Type of Road	Agreements Executed	Modifications Pending	Other Agreements to be Requested
					Federal Aid Set Aside	Federal Aid Requested	Approx. Federal Aid Involved
98	Benson	Minnewaukan—SE.	15.0	Earth			30,000.00
99	Griggs	East from Foster Co. Line	2.5	Earth			5,000.00
100	Burleigh and Morton	Bismarck and Mandan	0.5	Bridge	$438,000.00		200,000.00
101	Foster	Carrington—West	6.0	Earth			12,000.00
102	Foster	Glenfield—East	3.5	Earth			7,000.00
103	Eddy	Foster Co. Line—North	4.0	Earth			16,000.00
104	Hettinger	New England	0.1	Bridge			15,000.00
105	Hettinger	Mott	0.1	Bridge			15,000.00
106	Pierce	Rugby-East	7.4	Earth			15,125.00
107	Grand Forks	Manvel—NW.	6.0	Gravel		(b) 19,270.76	
108	Griggs	Barnes Co. Line—North	17.0	Earth			42,185.00
109	Griggs	Nelson Co. Line—South	16.0	Earth			36,355.00
110	Grand Forks	Levant—NW.	3.5	Gravel			(c) 12,000.00
111	Bottineau	Willow City	0.1	Bridge			(c) 5,000.00
112	Dickey	Ellendale—East	20.0	Earth			43,725.00
113	La Moure	Verona—North	8.0	Earth			(c) 32,000.00
114	Pembina	Hamilton-Joliette	11.0	Earth			(c) 25,000.00
115	Adams	State Line	3.0	Earth			(c) 6,000.00
116	Walsh	Park River-Grafton	14.5	Earth			(c) 33,220.06
117	Grand Forks	Larimore—North	21.0	Earth			(c) 50,000.00
118	Mountrail	Stanley—West	28.0	Earth			(c) 70,000.00
119	Emmons	Linton—North	5.5	Earth			(c) 15,000.00
		Total	1,475.7		$1,268,842.28	$282,152.46	$2,619,593.08

NOTE: First column—Federal Aid is by "Original Agreement" except where marked (a), in which cases Federal Aid is by "Modified Agreement."

Second column—Federal Aid is being requested by "Modified Agreement" except where marked by (b), in which cases additional Federal Aid is being requested by "Original Agreement."

Third column—Federal Aid in this column is for projects for which Project Statements have been submitted to the Bureau of Public Roads except where marked (c), in which cases Project Statements are being prepared.

TABLE III.

NORTH DAKOTA FEDERAL AID PROJECTS CONSTRUCTED OR UNDER CONTRACT OR CONSTRUCTION

(June 30, 1920.) (For other details of projects see Table II.)

	Road Grading		Furnishing Culverts		Reinforced Concrete Culverts and Bridges	
Proj. No.	Contractor	Amount	Contractor	Amount	Contractor	Amount
1	Treadwell Twichell	$ 12,216.68	None	$	J. A. Jardine	$ 1,484.30
2	Stanley Bros.	24,109.63	N. D. Metal Culvert Co.	1,733.20	Chas. F. Culp	6,831.98
3	Schultz Bros.	68,473.36	None		Independent Bridge Co.	32,654.80
4	M. D. Larkin	9,748.00	None		Great Northern Bridge Co.	7,705.26
5	W. H. Noel	26,684.50	None		W. H. Noel	8,104.25
6	Al. Campbell	16,625.09	N. D. Metal Culvert Co.	1,042.84	Force Account	1,136.40
7	Stanley Bros.	19,129.28	None		Chas. Jackson	3,624.87
8	O. H. Fletcher	23,638.82	Chas. F. Culp	1,987.60	W. G. Placek	875.47
9	Force Account	11,135.44	None		None	
10	Steig & Olson	11,993.85	None		W. B. Paterson	1,009.12
11	Force Account	8,437.65	None		None	
12	Hugh Fortune	36,831.97	None		E. M. Nielson, J. A. Jardine	7,202.53
13	Stanley Bros.	10,883.39	None		J. A. Jardine	7,506.40
14	Pat Kelly	23,429.44	Noggle Concrete & Tile Co.	2,783.55	Smith & Anderson	4,025.76
15	Larkin Construction Co.	79,681.93	N. W. Sheet & Iron Works	8,702.36	Larkin Construction Co.	8,097.23
16	Force Account	57,775.11	None		None	
17	Hans Skramstad	17,639.50	None		Hans Skramstad	786.40
18	James Yeaman	35,110.38	None		J. A. Jardine	1,714.59
19	Thos. Young & Son	59,241.83	None		J. A. Jardine	7,534.92
20	Druhl & Kemper	26,528.12	None		Druhl & Kemper	5,395.80
21	Sweeney & Winmill	21,758.35	None		Skjonhaug & Van Pelt	5,716.57
22	Dunbar & McCoy, J. E. Foughty, John Coghlan	53,962.24	N. W. Sheet & Iron Works	3,127.52	F. M. Haas Co.	11,603.18
23	A. J. Jackson	8,147.63	None		F. Rasmusson	3,599.05
24	Stevens Bros.	83,942.27	None		None	
25	Minot Construction Co.	38,147.13	None		None	

Proj. No.	Road Grading		Furnishing Culverts		Reinforced Concrete Culverts and Bridges	
	Contractor	Amount	Contractor	Amount	Contractor	Amount
26	F. O. & A. J. Peterson....	$ 13,685.35	N. D. Metal Culvert Co....	$ 831.00	None	$ .....
27	C. M. Padgett	61,177.48	None	.....	Fargo Bridge & Iron Co..	12,007.69
28	J. W. Van Ornum.....	43,076.95	None	.....	J. W. Van Ornum.....	10,147.95
30	F. E. Knowlton & Son...	22,048.15	None	.....	*Independent* Bridge Co...	6,805.70
31	A. J. Jackson	26,851.33	None	.....	None	.....
32	Treadwell Twichell	2,823.21	None	.....	J. A. Jardine	25,261.24
33	Jacob Herr, Jr.	57,351.88	N. W. Sheet & Iron Works	3,911.48	F. M. Haas Co.....	9,700.10
34	Stanley Bros.	38,718.27	N. D. Metal Culvert Co....	2,256.00	Linton Bridge Construction Co.	3,348.15
35	Chas. Dunahey	33,092.21	None	.....	F. M. Haas Co.....	10,419.18
36A	Stanley Bros.	41,649.25	N. W. Sheet & Iron Works	1,173.64	Hutchinson Hardware Co.	13,275.80
38	R. F. Odenthal.....	24,248.21	Gilbert Mfg. Co.	486.00	R. F. Odenthal	5,765.75
40	Wm. Jensen	10,818.83	None	.....	E. A. Moline	9,686.55
43	E. M. Nelson	15,012.79	None	.....	E. A. Moline	14,730.32
44	E. M. Nelson	16,950.16	None	.....	E. A. Moline	17,457.17
45	Stanley Bros.	13,572.34	Foster County	1,261.44	Fargo Bridge & Iron Co.	29,426.14
46	W. H. Noel	10,449.63	None	.....	None	.....
48A	Druhl & Kemper	18,803.87	N. D. Metal Culvert Co...	1,118.10	F. M. Haas Co.....	3,171.12
58	Treadwell Twichell	66,317.89	J. A. Jardine	6,534.30	Chas. C. Jackson.....	21,329.95
59	Treadwell Twichell	44,102.43	N. W. Sheet & Iron Works	607.20	W. H. Noel	15,578.13
64	None	.....			Iowa Bridge Co.....	3,507.73
65	None	.....			R. F. Odenthal	7,871.26
81	Minot Construction Co....	50,553.81	N. D. Metal Culvert Co...	2,416.80	F. M. Haas Co.....	13,452.23
94A	Wm. Geddes	15,327.38	N. D. Metal Culvert Co...	1,372.24	F. W. Rasmusson.....	8,671.46
100	Foundation Co., American Bridge Co.	1,074,263.00	None	.....	None	.....

TABLE III—Continued.

NORTH DAKOTA FEDERAL AID PROJECTS CONSTRUCTED OR UNDER CONTRACT OR CONSTRUCTION.

(June 30, 1920.) (For other details of projects see Table II.)

Project No.	Total Contract Price	Length	Contract Cost Per Mile
1	$ 13,700.98	16.33	$ 839.00
2	32,674.81	15.00	2,178.00
3	101,128.16	30.50	3,315.00
4	17,453.32	20.00	873.00
5	34,788.75	24.87	1,398.00
6	18,804.33	5.50	3,418.00
7	22,754.15	9.16	2,483.00
8	26,501.89	9.50	2,790.00
9	11,135.44	3.58	3,110.00
10	13,002.97	5.00	2,600.00
11	8,437.65	7.64	1,104.00
12	44,034.50	29.50	1,492.00
13	18,389.79	7.92	2,321.00
14	30,238.75	18.90	1,599.00
15	96,481.52	34.40	2,804.00
16	57,775.11	6.60	8,753.00
17	18,425.90	17.60	1,046.00
18	36,824.97	4.50	8,183.00
19	66,776.75	17.10	3,905.00
20	31,923.92	16.80	1,900.00
21	27,474.92	17.70	1,552.00
22	68,692.94	17.50	3,925.00
23	11,746.68	10.0	1,274.00
24	83,942.27	25.9	3,241.00
25	38,147.13	5.60	6,811.00
26	14,516.35	5.02	2,892.00
27	73,185.17	24.04	3,044.00
28	53,224.90	14.41	3,694.00
30	28,853.85	10.46	2,758.00
31	26,851.33	4.79	5,605.00
32	28,084.45	Bridges	.....
33	70,963.46	18.079	3,927.00
34	44,322.42	11.69	3,791.00
35	43,511.39	22.04	1,974.00
36A	56,098.69	14.25	3,937.00
38	30,499.96	8.88	3,435.00
40	20,505.38	8.01	2,560.00
43	29,743.11	10.31	2,885.00
44	34,407.33	4.51	7,629.00
45	44,259.92	11.1	3,987.00
46	10,449.63	4.00	2,612.00
48A	23,093.09	5.65	4,087.00
58	94,182.14	18.95	4,970.00
59	60,287.76	14.43	4,178.00
64	3,507.73	Bridge	.....
65	7,871.26	Bridge	.....
81	66,422.84	12.80	5,189.00
94A	25,371.08	5.0	4,975.00
100	1,074,263.00	Bridge	.....
Grand Total..	$1,782,007.40	605.61	Av. = $2,942.50

No federal aid projects were contracted for or placed under construction until 1918, although a seven mile state aid project lying east of Mayville in Traill County was partly completed during the fall of 1917. In 1919 contracts were let for about 201 miles of federal aid work, of which about 148 miles may be said to have been completed. The first federal aid project to have been fully completed was LaMoure County Federal Aid Project No. 23 which consisted of 10 miles of earth road east and west through Edgeley.

By the end of 1919 a total of 459 miles had been placed under contract by the state, of which about 300 miles was completed.

Up to the date of this report (June 30, 1920) there had been contracts awarded since the creation of the State Highway Commission for 606 miles of federal aid projects. At this time about 425 miles may be said to have been completed.

In financing federal aid projects, the following table gives the amount of county funds, state aid and federal aid for each project:

TABLE IV.

NORTH DAKOTA FEDERAL AID PROJECT FUNDS.

Project No.	County	Estimate of Cost	County Appropriation	State Aid Granted	Federal Aid Set Aside
1	Cass	$ 15,055.13	$ 11,400.00	$ 3,760.00	$ 7,527.56
2	Foster	35,942.40	5,000.00	4,700.00	17,971.20
3	Williams	111,240.98	41,000.00	16,400.00	55,620.49
4	Richland	19,198.65	5,750.00	5,350.00	9,599.32
5	Traill	32,078.85	18,400.00	4,400.00	16,039.42
6	Eddy	31,342.32	10,025.00	2,700.00	15,671.16
7	Stutsman	24,374.92	12,500.00	.....	12,187.46
8	Eddy	29,152.07	10,025.00	2,000.00	14,576.03
9	Grand Forks	11,403.21	12,500.00	.....	5,701.61
10	Pierce	38,847.18	5,200.00	2,500.00	19,423.59
11	Cavalier	10,372.28	2,750.00	2,500.00	5,186.14
12	Barnes	110,063.27	68,200.00	10,000.00	55,031.63
13	Stutsman	14,714.02	7,500.00	.....	7,357.01
14	Stark	33,285.72	10,000.00	7,300.00	16,642.86
15	Sargent	236,014.24	127,000.00	.....	118,007.12
16	Grand Forks	63,552.62	27,600.00	.....	31,776.31
17	Griggs	64,804.44	26,100.00	2,600.00	32,402.21
18	Ramsey	40,507.46	19,300.00	1,000.00	20,253.73
19	Ramsey	73,454.42	23,400.00	8,300.00	36,727.21
20	Wells	115,509.83	14,100.00	6,500.00	57,754.91
21	Bowman	$ 30,222.41	$ 10,500.00	$ 5,000.00	$ 15,111.20
22	Towner	102,795.93	49,400.00	9,000.00	51,397.96
23	LaMoure	9,641.67	5,000.00	2,326.00	4,820.83
24	Stutsman	92,336.51	40,500.00	7,000.00	46,168.25
25	Ward	41,961.84	10,100.00	10,100.00	20,980.92
26	Benson	21,000.00	10,564.00	.....	10,500.00*
27	Benson	87,123.76	37,300.00	7,500.00	43,561.88
28	Ransom	116,784.39	55,300.00	3,200.00	58,392.19
29	Steele	59,413.51	38,000.00	3,000.00	29,706.75
30	Divide	31,739.22	4,500.00	6,400.00	15,869.61
31	LaMoure	37,405.69	18,003 00	300.00	18,702.84
32	Cass	30,892.90	21,000.00	7,720.00	15,446.45
33	McIntosh	78,059.80	49,000.00	.....	39,029 90
34	Emmons	48,754.66	24,500.00	7,000.00	24,377.33
35	Logan	75,351.40	18,000.00	.....	37,675.70
36	Barnes	72,767.62	47,400.00	2,500.00	36,383.81
37	Hettinger	20,700.00	10,350.00	.....	10,350.00*
38	Hettinger	41.341.54	17,650.00	7,200.00	20,670.77
39	Grant	38,228.26	34,500.00	6,500.00	19,114.13
40	Bottineau	24,769.11	9,100.00	4,100.00	12,384.55
41	Grand Forks	30,000.00	15,000.00	.....	15,000.00*
42	Pembina	23,100.00	6,000.00	6,000.00	11,550.00*
43	Bottineau	51,950.83	11,500.00	10,000.00	25,975.41
44	Bottineau	37,848.06	19,000.00	1,000.00	18,924.03
45	Foster	58,768.68	29,400.00	.....	29,384.33
46	Traill	35,934.74	13,100.00	1,600.00	17,967.37
47	Oliver	16,000.00	4,000.00	4,000.00	8,000.00*
48	Pierce	51,700.00	32,500.00	.....	25,850.00*
49	Golden Valley	19,068.61	12,000.00	1,500.00	9,534.30
50	Griggs	8,030.00	2,800.00	2,800.00	4,015.00*
51	Grand Forks	61,198.00	41,100.00	.....	20,098.00
52	Grand Forks	65,905.17	42,667.00	.....	30,000.00*
53	Stark	11,990.00	3,000.00	3,000.00	5,995.00*
54	Kidder	17,315.51	5,000.00	4,000.00	8,657.75
55	Stutsman	19,800.00	9,900.00*	.....	9,900.00*
56	Stutsman	143,000.00	71,500.00*	.....	71,500.00*
57	McLean	33,000.00	16,500.00*	.....	16,500.00*
58	Sargent	86,000.00	43,000.00	.....	43,000.00*
59	Richland	52,200.00	26,100.00*	.....	26,100.00*
60	Richland	115,000.00	57,500.00*	.....	57,500.00*

Project No.	County	Estimate of Cost	County Appropriation	State Aid Granted	Federal Aid Set Aside
61	Traill	38,500.00	19,250.00*	.....	19,250.00*
62	McLean	31,460.00	15,730.00*	.....	15,730.00*
63	McLean	31,900.00	15,950.00*	.....	15,950.00*
64	Logan	3,858.50	2,000.00	.....	1,929.10
65	Stark	8,658.38	4,400.00	.....	4,329.10
66	Sargent	23,760.00	11,880.00*	.....	11,880.00*
67	Traill	23,100.00	11,550.00*	.....	11,550.00*
68	Grant	26,400.00	15,000.00	.....	13,200.00*
69	Richland	54,000.00	27,000.00*	.....	27,000.00
70	Nelson	20,570.00	10,285.00*	.....	10,285.00*
71	Richland	36,300.00	18,150.00*	.....	18,150.00*
72	Richland	54,540.00	27,270.00*	.....	27,270.00*
73	Williams	56,960.00	28,480.00*	.....	28,480.00*
74	Mountrail	22,880.00	11,440.00*	.....	11,440.00*
75	Mountrail	57,750.00	28,875.00*	.....	28,875.00*
76	Burke	$ 52,800.00	$ 26,400.00*	.....	$ 26,400.00*
77	Burke	49,500.00	11,400.00	.....	11,307.76
78	Divide	27,500.00	13,750.00*	.....	13,750.00*
79	Divide	40,040.00	20,020.00*	.....	20,020.00*
80	Williams	60,610.00	30,305.00*	.....	30,305.00*
81	Ward	63,206.00	31,603.00*	.....	31,603.00*
82	Ward	70,950.00	35,475.00*	.....	35,475.00*
83	Ward	47,300.00	24,000.00	.....	23,650.00*
84	Ward	130,000.00	65,000.00*	.....	65,000.00*
85	Ward	78,540.00	39,270.00*	.....	39,270.00*
86	Ward	67,320.00	33,660.00*	.....	33,660.00*
87	Bottineau	52,800.00	26,400.00*	.....	26,400.00*
88	Wells	39,600.00	19,800.00*	.....	19,800.00*
89	Sargent	43,700.00	21,850.00*	.....	21,850.00*
90	Wells	33,000.00	16,500.00*	.....	16,500.00*
91	Emmons	33,495.00	16,747.50*	.....	16,747.50*
92	Foster	13,288.00	16,644.00*	.....	16,644.00*
93	LaMoure	25,696.00	12,848.00*	.....	12,848.00*
94	LaMoure	47,080.00	23,540.00*	.....	23,540.00*
95	Ramsey	56,650.00	28,325.00*	.....	28,325.00*
96	Ramsey	25,300.00	12,650.00*	.....	12,650.00*
97	McIntosh	40,020.00	20,010.00*	.....	20,010.00*
98	Benson	48,950.00	24,475.00*	.....	24,475.00*
99	Griggs	7,480.00	2,500.00	2,750.00	3,740.00*
100	Burleigh and Morton	876,000.00	90,000.00 90,000.00	18,000.00 15,000.00 225,000.00*	438,000.00
101	Foster	16,632.00	8,316.00*	.....	8,316.00*
102	Foster	9,702.00	4,851.00*	.....	4,851.00*
103	Eddy	22,880.00	11,440.00*	1,500.00	11,440.00*
104	Hettinger	15,400.00	7,700.00*	.....	7,700.00*
105	Hettinger	19,800.00	9,900.00*	.....	9,900.00*
106	Pierce	30,250.00	12,125.00*	3,000.00	15,125.00*
107	Grand Forks	38,541.52	19,300.00	.....	19,270.76
108	Griggs	84,370.00	42,185.00*	.....	42,185.00*
109	Griggs	72,710.00	36,355.00*	.....	36,355.00*
110	Grand Forks	24,000.00	12,000.00*	.....	12,000.00*
111	Bottineau	25,000.00	12,500.00	.....	12,500.00*
112	Dickey	87,450.00	25,000.00*	.....	43,725.00*
113	LaMoure	64,000.00	32,000.00*	.....	32,000.00*
114	Pembina	50,000.00	25,000.00*	.....	25,000.00*
115	Adams	12,000.00	3,500.00	3,500.00	6,000.00*
116	Walsh	66,440.00	33,220.00*	.....	33,220.00*
117	Grand Forks	100,000.00	50,000.00*	.....	50,000.00*
	Mountrail	140,000.00	70,000.00*	.....	70,000.00*
	Emmons	30,000.00	15,000.00*	.....	15,000.00*
	Total	$ 6,540,651.23	$2,860,808.50	$ 471,506.00	$3,253,429.54

*Approximate only.

STATE AID PROJECTS.

In the case of state aid projects, no federal aid being involved, the government is not concerned therewith. However, it may be said that the same general procedure and practice is followed in both classes of work except that, for the above reason, no project statements, project agreements, etc., are required, the State Highway Commission being the ultimate authority or factor.

The state aid projects, as previously stated, are few in number as shown by the following table:

TABLE V.

NORTH DAKOTA STATE AID PROJECTS.

Project No.	County	General Location	Miles	Type	Estimate of Cost	County Appro-priation	State Aid	Status June 30, 1920
1672	Foster	East of Carrington.....	4.9	Earth	$15,500.00	$15,500.00	Engrg.	Completed
1872	Grand Forks ..	South of Thompson	3.0	Gravel	9,200.00	5,000.00	$4,200.00	Completed
1874	Grand Forks ..	Manvel North	10.7	Earth	19,200.00	15,000.00	4,200.00	Completed
2282	Kidder	South of Dawson.....	11.0	Earth	8,000.00	6,000.00	2,000.00	Completed
3972	Richland	South of Wahpeton.....	3.0	Earth	3,250.00	1,650.00	1,600.00	Completed
4972	Traill	East of Mayville	7.0	Earth	9,383.86	6,082.00	3,301.86	Completed
	Total		39.6		$64,533.86	$49,232.00	$15,301.86	

There are no new state aid projects in immediate prospect.

OPERATIONS OF THE STATE HIGHWAY COMMISSION.

First Business.

The law creating the present Highway Commission was approved by Governor Frazier on March 5, 1917. The first meeting of the commission took place on April 2nd, the non-appointive members only being present, namely the Governor, the Commissioner of Agriculture and Labor, Mr. John N. Hagan, and the State Engineer, Mr. Jay W. Bliss. The first business transacted was in connection with the laying out of a state highway system on which the work of the department was to be confined and the disposition of the federal aid allotted the state.

Personnel of the Commission.

The next meeting was called for April 20, 1917. In the meantime, the Governor had appointed, as the fourth and fifth members of the State Highway Commission, Mr. Edmund White of Mohall, civil engineer and farmer, and Mr. Theo Andrew of Mayville, also a successful farmer. These commissioners rendered productive and efficient service until the middle of 1919 when both resigned for personal and business reasons.

As their successors, Mr. J. J. Marquart of Napoleon, farmer, and Mr. Frayne Baker of Bismarck, returned service man and auto dealer, were appointed and their connection with the State Highway Commission has continued to this date.

On October 15th, 1918, Mr. Jay W. Bliss, for many years State Engineer and since the creation of the State Highway Commission its Chief Engineer and Secretary, resigned to enter the Officers' Training School in the service of his country.

Mr. W. H. Robinson was appointed by the Governor for the remainder of the term and in the early part of 1919 Mr. Robinson was reappointed as State Engineer with the regular term of appointment of four years.

Determination of State Highways.

Naturally the first duty of the commission was to lay out a system of roads on which state aid and federal aid might be expended. A map showing proposed primary and secondary state highways was prepared and submitted to the counties for action. But about the time when the state highway system was to be approved as such and after nearly three months of organization and development work in getting the department started and laying the foundation for its work, the startling news was received from the federal authorities that, by an opinion of the Solicitor of the U. S. Department of Agriculture, federal aid could be expended only upon roads actually used for the carrying of mails. Heretofore the commission had proceeded with the layout of a state highway system and with a tentative program of work by counties without special regard to the location of post roads or their coincidence with the contemplated state highways. Consequently, with the new federal ruling, much of the previous work of the department was lost or was of little value and the post route requirement became an increasing obstacle and source of annoy-

ance until that portion of the federal law was more liberally amended in 1919.

DISTRIBUTION OF FEDERAL AID AMONG COUNTIES.

Early in the deliberations of the State Highway Commission, the important question of the proper application of federal aid to the highways of the state was given much consideration. The first decision made was that the distribution was to be on the basis of the 5-year period of federal aid appropriations rather than on the basis of annual allotments. Also inasmuch as the state highway system lay in all counties, it was decided that the federal aid be apportioned among all counties but that no county receive in the beginning or at one time more than its share for the first three years. A table of apportionments by counties determined in the same manner as federal aid is allotted to the states, that is one-third according to area, one-third according to population and one-third according to mileage of post routes and a schedule for actual construction was early submitted to the counties for adoption. The following shows the table and schedule:

TABLE VI.

November, 1918, Schedule of Federal Aid Allotments for 5-Year Period Among Counties of North Dakota

($75,000,000 Total Federal Aid)

County	Calculated Apportionment	Apportionment Designated Nov., 1918	1917–1918	1918–1919	1919–1920	1920–1921	Excess
Adams	$ 13,561.57	$	$	$	$	$	$
Barnes	30,208.02	40,000.00	24,000.00	16,000.00			9,791.98
Benson	24,568.78	24,568.78		18,000.00		6,568.78	0
Billings	10,405.12	10,405.12				10,405.12	0
Bottineau	30,987.90	30,987.90		19,987.90		11,000.00	0
Bowman	14,385.94	14,385.94	12,000.00	2,385.94			0
Burke	20,277.27	20,277.27				20,277.27	0
Burleigh	23,664.03	23,664.03		13,664.03	10,000.00		0
Cass	53,365.06	35,300.00	7,800.00	27,500.00			
Cavalier	26,110.94	26,110.94	5,000.00	11,110.94	10,000.00		0
Dickey	20,194.04						
Divide	16,808.21	16,808.21		16,808.21			0
Dunn	19,439.78						
Eddy	10,826.31	18,826.31	18,826.31				8,000.00
Emmons	19,098.02	19,098.02		10,000.00		9,098.02	0
Foster	10,893.03	10,893.03	8,200.00	2,693.03			0
Golden Valley	12,644.79	12,644.79		12,644.79			0
Grand Forks	36,659.79	36,659.79	18,000.00	18,659.79			0
Grant	18,151.58	18,151.58		18,151.58			0
Griggs	13,127.90	13,127.90	13,127.90				0
Hettinger	16,381.38	16,381.38		16,381.38			0
Kidder	13,583.43	13,583.43			13,583.43		0
LaMoure	20,215.22	20,215.22	10,000.00		10,215.22		0
Logan	12,671.16	15,000.00		15,000.00			2,328.84
McHenry	34,018.47	34,018.47			34,018.47		0
McIntosh	12,095.51	12,095.51		12,095.51			0
McKenzie	30,479.03						
McLean	33,899.34	33,899.34		17,000.00	16,899.34		0
Mercer	12,292.05	15,000.00		15,000.00			2,707.95
Morton	25,101.35	25,101.35			25,101.35		0
Mountrail	26,251.88	26,251.88				26,251.88	0
Nelson	20,122.90	20,122.90		8,000.00	12,122.90		0

County	Calculated Apportionment	Apportionment Designated Nov., 1918	1917–1918	1918–1919	1919–1920	1920–1921	Excess
Oliver	$ 7,704.43	$	$	$	$	$	$ .....
Pembina	24,819.40	24,819.40	.....	12,000.00	12,819.40	.....	0
Pierce	18,983.15	20,000.00	6,000.00	.....	14,000.00	.....	1,016.85
Ramsey	25,780.59	25,780.59	13,780.59	12,000.00	.....	.....	0
Ransom	19,206.05	21,206.05	.....	21,206.05	.....	.....	2,000.00
Renville	17,838.06	17,838.06	.....	17,838.06	.....	.....	0
Richland	34,382.60	34,382.60	10,000.00	.....	24,382.60	.....	0
Rolette	16,304.59	.....	.....	.....	.....	.....	.....
Sargent	17,766.39	27,192.04	27,192.04	.....	.....	.....	9,425.65
Sheridan	14,670.21	.....	.....	.....	.....	.....	.....
Sioux	11,040.96	.....	.....	.....	.....	.....	.....
Slope	7,879.84	7,879.84	.....	.....	.....	7,879.84	0
Stark	17,916.28	17,916.28	15,000.00	.....	2,916.28	.....	0
Steele	13,725.09	13,725.09	.....	13,725.09	.....	.....	0
Stutsman	35,640.07	53,640.07	53,640.07	.....	.....	.....	18,000.00
Towner	16,466.89	16,466.89	16,466.89	.....	.....	.....	0
Traill	22,272.25	22,272.25	16,000.00	6,272.25	.....	.....	0
Walsh	31,893.33	.....	.....	.....	.....	.....	.....
Ward	42,937.02	42,937.02	.....	10,000.00	12,937.02	20,000.00	0
Wells	22,975.96	22,975.96	11,256.37	.....	11,719.59	.....	0
Williams	36,552.01	41,872.87	41,872.87	.....	.....	.....	5,320.86
Total	$ 1,142,244.95	$ 1,014,484.10	$ 328,163.04	$ 364,124.55	$ 210,715.60	$ 111,480.91	$ 58,592.13

When in 1919 federal aid to the state in the five-year period ending June 30, 1921, was increased from $1,142,000 to $4,222,000, a new apportionment and schedule was made and submitted to the counties as follows:

TABLE VII.

PROPOSED SCHEDULE OF FEDERAL AID ALLOTMENTS
FOR FIVE-YEAR PERIOD AMONG COUNTIES OF NORTH DAKOTA
($275,000,000—total Federal Aid)

County	Per Cent	1917, 1918, 1919	1920	1921	Total
Adams	1.187	$ 14,557.07	$ 17,328.83	$ 18,276.49	$ 50,126.78
Barnes	2.645	32,437.64	38,613.94	40,725.60	111,697.83
Benson	2.151	26,379.35	31,402.11	33,119.39	90,836.31
Billings	0.911	11,172.28	13,299.55	14,026.86	38,471.36
Bottineau	2.713	33,271.57	39,606.66	41,772.61	114,569.46
Bowman	1.259	15,440.06	18,379.95	19,385.08	53,167.33
Burke	1.775	21,768.16	25,912.95	27,330.04	74,957.91
Burleigh	2.072	25,410.51	30,248.81	31,903.00	87,500.16
Cass	4.672	57,296.28	68,205.78	71,935.74	197,297.64
Cavalier	2.286	28,034.95	33,372.96	35,198.01	96,537.33
Dickey	1.768	21,682.31	25,810.76	27,222.26	74,662.30
Divide	1.472	18,052.24	21,489.50	22,664.69	62,162.28
Dunn	1.702	20,872.90	24,847.24	26,206.04	71,875.13
Eddy	0.948	11,626.04	13,839.71	14,596.56	40,033.86
Emmons	1.672	20,504.99	24,409.27	25,744.13	70,608.23
Foster	0.954	11,699.62	13,927.30	14,688.94	40,287.23
Golden Valley	1.107	13,575.97	16,160.93	17,044.71	46,748.40
Grand Forks	3.209	39,354.41	46,847.68	49,409.63	135,515.44
Grant	1.589	19,487.10	23,197.57	24,466.16	67,103.15
Griggs	1.149	14,091.05	16,774.08	17,691.39	48,522.05
Hettinger	1.434	17,586.22	20,934.75	22,079.59	60,557.54
Kidder	1.189	14,581.60	17,358.03	18,307.28	50,211.24
LaMoure	1.770	21,706.84	25,839.96	27,253.05	74,746.75
Logan	1.109	13,600.50	16,190.12	17,075.50	46,832.86
McHenry	2.978	36,521.47	43,475.36	45,852.87	125,760.35
McIntosh	1.059	12,987.31	15,460.18	16,305.64	44,721.37
McKenzie	2.668	32,719.71	38,949.72	41,079.74	112,669.12
McLean	2.968	36,398.82	43,329.37	45,698.90	125,338.05
Mercer	1.076	13,195.80	15,708.36	16,567.40	45,439.27
Morton	2.197	26,943.48	32,073.67	33,827.66	92,778.87
Mountrail	2.298	28,182.12	33,548.15	35,382.78	97,044.09
Nelson	1.762	21,608.73	25,723.17	27,129.88	74,408.92
Oliver	0.675	8,278.03	9,854.23	10,393.12	28,505.12
Pembina	2.173	26,649.15	31,723.29	33,458.13	91,765.37
Pierce	1.662	20,382.35	24,263.28	25,590.16	70,185.94
Ramsey	2.257	27,679.30	32,949.59	34,751.49	95,312.66
Ransom	1.681	20,615.36	24,540.65	25,882.70	70,988.29
Renville	1.562	19,155.98	22,803.40	24,050.44	65,962.96
Richland	3.010	36,913.92	43,942.50	46,345.59	127,111.71
Rolette	1.427	17,500.37	20,832.55	21,971.81	60,261.93
Sargent	1.555	$ 19,070.00	$ 22,701.21	$ 23,942.66	$ 65,667.34
Sheridan	1.284	15,746.66	18,744.92	19,770.01	54,223.06
Sioux	1.229	15,072.15	17,941.98	18,923.17	51,900.43
Slope	0.690	8,461.99	10,072.21	10,624.08	29,138.56
Stark	1.569	19,241.82	22,905.59	24,158.22	66,258.57
Steele	1.202	14,741.03	17,547.82	18,507.45	50,760.22
Stutsman	3.120	38,262.94	45,548.40	48,039.27	131,757.00
Towner	1.442	17,684 33	21,051.54	22,202.78	60,895.37
Traill	1.950	23,914.31	28,467.75	30,024.55	82,348.11
Walsh	2.792	34,240.41	40,759.97	42,988.99	117,905.62
Ward	3.759	46,099.46	54,877.05	57,878.09	158,741.84
Wells	2.012	24,674.68	29,372.88	30,979.18	84,966.37
Williams	3.200	39,244.03	46,716.30	49,271.05	135,135.38
Total	100.000	$ 1,226,375.37	$ 1,459,884.53	$ 1,536,720.56	$ 4,222,980.46

The need of matching all the federal aid with "local" funds (county appropriations to meet federal aid) then became of more importance

than the equitable distribution among counties, lest the state lose some of its federal aid by default. The matter was again presented to the counties with the result that with the appropriations already made and the "blanket appropriations" laid on the books to meet the unexpected increase in federal aid, about one-half counties more than matched all the federal aid available as may be seen from the following:

TABLE VIII

LOCAL FUNDS, STATE AID AND COUNTY APPROPRIATIONS, MADE AVAILABLE TO MEET FEDERAL AID

County	County Specific Appropriation	County Blanket Appropriation	State Aid Appropriation	Total
Adams	$ 3,500.00	$	$ 3,500.00	$ 7,000.00
Barnes	70,000.00	325,000.00	12,500.00	407,500.00
Benson	14,000.00	144,000.00	7,500.00	165,500.00
Bottineau	16,600.00	95,000.00	15,100.00	126,700.00
Bowman	10,500.00	.....	5,000.00	15,500.00
Burke	.....	99,000.00	.....	99,000.00
Burleigh	90,000.00	.....	18,000.00	108,000.00
Cass	32,800.00	500,000.00	14,450.00	557,250.00
Cavalier	2,750.00	.....	2,500.00	5,250.00
Dickey	25,000.00	.....	20,000.00	45,000.00
Divide	4,500.00	90,000.00	6,500.00	101,000.00
Eddy	20,050.00	.....	6,200.00	26,250.00
Emmons	10,000.00	90,000.00	7,000.00	107,000.00
Foster	25,000.00	55,000.00	4,700.00	84,700.00
Golden Valley	12,000.00	72,000.00	1,500.00	85,500.00
Grand Forks	168,766.66	205,000.00	8,400.00	382,166.66
Grant	49,500.00	.....	6,500.00	56,000.00
Griggs	18,400.00	13,000.00	8,150.00	39,550.00
Hettinger	20,000.00	72,000.00	7,200.00	99,200.00
Kidder	11,000.00	.....	6,000.00	17,000.00
LaMoure	23,003.00	150,000.00	2,626.40	175,629.40
Logan	18,000.00	78,000.00	.....	96,000.00
McIntosh	9,000.00	90,000.00	.....	99,000.00
McLean	.....	150,000.00	.....	150,000.00
Morton	90,000.00	.....	15,000.00	105,000.00
Mountrail	.....	136,000.00	.....	136,000.00
Nelson	.....	113,000.00	.....	113,000.00
Oliver	.....	.....	.....	.....
Pembina	6,000.00	40,000.00	6,000.00	52,000.00
Pierce	$ 37,700.00	$ 80,000.00	$ 5,500.00	$ 123,200.00
Ramsey	14,800.00	180,000.00	9,300.00	204,100.00
Ransom	18,000.00	90,000.00	3,200.00	111,200.00
Richland	7,000.00	150,000.00	6,950.00	163,950.00
Sargent	62,000.00	117,000.00	.....	179,000.00
Stark	17,400.00	.....	10,300.00	27,700.00
Steele	8,000.00	99,000.00	3,000.00	110,000.00
Stutsman	60,500.00	200,000.00	11,000.00	271,500.00
Towner	15,000.00	75,000.00	9,000.00	99,000.00
Traill	20,000.00	164,000.00	9,500.00	193,500.00
Walsh	.....	.....	.....	.....
Ward	10,100.00	270,000.00	10,100.00	290,200.00
Wells	10,000.00	45,000.00	6,500.00	61,500.00
Williams	32,000.00	100,000.00	16,400.00	148,400.00
State Bridge Appropriations—				
To Missouri River Bridge at Bismarck			225,000.00	225,000.00
To Red River Bridge at Pembina			35,000.00	35,000.00
			Total	$ 5,704,946.06

Since the adoption of the above table various changes have been made in the contemplated work of counties—some having dropped out,

some having come in and others having increased their requests and desires for federal aid and state supervision. It may be seen from TABLE VIII how the counties have responded to take advantage of the federal aid act.

A list of counties and their projects follows:

TABLE IX

STATE HIGHWAY PROJECTS BY COUNTIES

County	Federal or State Aid	Project No.	State Job No.	General Location	Length and Type
Adams	Federal Aid	115	0101	On State Line—SE of Haynes	3.0 Earth
Barnes	Federal Aid	12	0271	Valley City—S, E and W	29.5 Earth and Gravel
Barnes	Federal Aid	36	0273	Valley City—NW and SE	50.5 Earth
Benson	Federal Aid	26	0373	Eddy County Line—North	6.0 Earth
Benson	Federal Aid	27	0371	Minnewaukan to Churchs Ferry	24.0 Gravel
Benson	Federal Aid	98	0395	Minnewaukan—SE	15.0 Earth
Bottineau	Federal Aid	40	0581	Mohall—East	8.0 Gravel
Bottineau	Federal Aid	43	0583	Bottineau—E and W	10.1 Gravel
Bottineau	Federal Aid	44	0585	West of Bottineau at Thor	4.5 Gravel
Bottineau	Federal Aid	87	0597	West of Bottineau	15.0 Earth
Bottineau	Federal Aid	111	0501	Willow City	0.1 Bridge
Bowman	Federal Aid	21	0671	Bowman—N and S	17.7 Earth
Burke	Federal Aid	76	0793	Bowbells—North and then West	20.0 Earth
Burke	Federal Aid	77	0791	Divide County Line—East	18.0 Earth
Burleigh	Federal Aid	100	3091	Bismarck and Mandan	0.5 Bridge
Cass	Federal Aid	1	0971	Fargo—South	16.3 Earth
Cass	Federal Aid	32	0983	Fargo—South	... Bridge
Cavalier	Federal Aid	11	1071	Clyde—E and W	7.6 Earth
Dickey	Federal Aid	112	1901	Ellendale—East	20.0 Earth
Divide	Federal Aid	30	1281	Burke County Line—West	10.5 Earth
Divide	Federal Aid	78	1292	Burke County Line—West	10.0 Earth
Divide	Federal Aid	79	1295	Fortuna-Alkabo	10 0 Earth
Eddy	Federal Aid	6	1473	Benson County Line—South	5.5 Gravel
Eddy	Federal Aid	8	1471	New Rockford—W and S	9.3 Gravel
Eddy	Federal Aid	103	1495	Foster County Line—North	4.0 Earth
Emmons	Federal Aid	34	1581	Ashley—East	11.7 Earth
Emmons	Federal Aid	91	1593	Hazelton—North	10.5 Earth
Emmons	Federal Aid	119	1501	Linton—North	5.5 Earth
Foster	Federal Aid	2	1671	Carrington—N and W	15.0 Earth
Foster	Federal Aid	45	1673	Glenfield—West	11.1 Earth
Foster	Federal Aid	92	1699	Gu1till—North	4.0 Earth
Foster	Federal Aid	101	1695	Carrington—West	6.0 Earth
Foster	Federal Aid	102	1697	Glenfield—East	3.5 Earth
Foster	State Aid	...	1672	East of Carrington	4.9 Earth
Golden Valley	Federal Aid	49	1781	Beach—N, E, S and W	19.3 Earth
Grand Forks	Federal Aid	9	1871	Reynolds—North	3.6 Gravel
Grand Forks	Federal Aid	16	1873	Emerado—E and W	6.7 Gravel
Grand Forks	Federal Aid	41	1885	Thompson-Northwood	21.0 Earth
Grand Forks	Federal Aid	51	1895	City to Packing Plant	1.1 Concrete

County	Federal or State Aid	Project No.	State Job No.	General Location	Length and Type
Grand Forks	Federal Aid	52	1897	City to University	0.9 Concrete
Grand Forks	Federal Aid	107	1801	Manvel—NW	6.0 Gravel
Grand Forks	Federal Aid	110	1803	Levant—NW	3.5 Gravel
Grand Forks	Federal Aid	117	1805	Larimore—North	21.0 Earth
Grand Forks	State Aid	...	1872	South of Thompson	3.0 Gravel
Grand Forks	State Aid	...	1874	Manvel—North	10.7 Earth
Grant	Federal Aid	39	1981	Carson—E and W	16.5 Earth
Grant	Federal Aid	68	1993	Lark—E	6.0 Earth
Griggs	Federal Aid	17	2071	Cooperstown—E and W	17.6 Gravel
Griggs	Federal Aid	50	2073	West of Cooperstown	4.0 Earth
Griggs	Federal Aid	99	2075	East from Foster County Line	2.5 Earth
Griggs	Federal Aid	108	2001	Barnes County Line—North	17.0 Earth
Griggs	Federal Aid	109	2003	Nelson County Line—South	16.0 Earth
Hettinger	Federal Aid	37	2181	Mott—E and W	19.0 Earth
Hettinger	Federal Aid	38	2183	New England—NE	8.9 Earth
Hettinger	Federal Aid	104	2195	New England	0.1 Bridge
Hettinger	Federal Aid	105	2197	Mott	0.1 Bridge
Kidder	Federal Aid	54	2291	Stutsman County Line—West	3.7 Earth
Kidder	State Aid	...	2282	South of Dawson	11.0 Earth
LaMoure	Federal Aid	23	2371	Edgeley—E and W	10.0 Earth
LaMoure	Federal Aid	31	2385	LaMoure—E and W	4.8 Gravel
LaMoure	Federal Aid	93	2397	Verona—S and W	8.0 Earth
LaMoure	Federal Aid	94	2399	Edgeley and LaMoure	15.0 Earth
LaMoure	Federal Aid	113	2301	Verona—North	8.0 Earth
Logan	Federal Aid	35	2481	Napoleon—E and W	22.1 Earth
Logan	Federal Aid	64	2493	Burnstad	0.1 Bridge
McIntosh	Federal Aid	33	2681	Hazelton—South	18.1 Earth
McIntosh	Federal Aid	97	2693	Ashley-Danzig	12.0 Earth
McLean	Federal Aid	57	2895	Garrison—West	10.0 Earth
McLean	Federal Aid	62	2893	Turtle Lake and Underwood	10.0 Earth
McLean	Federal Aid	63	2891	Wilton and Washburn	10.0 Earth
Morton	Federal Aid	100	3091	Bismarck and Mandan	0.5 Bridge
Mountrail	Federal Aid	74	3193	Stanley—East	8.0 Earth
Mountrail	Federal Aid	75	3191	Palermo—East	15.0 Earth
Mountrail	Federal Aid	118	3101	Stanley—West	28.0 Earth
Nelson	Federal Aid	70	3291	Michigan-Petersburg	5.5 Earth
Oliver	Federal Aid	47	3371	Center—South	10.2 Earth
Pembina	Federal Aid	42	3481	Cavalier-Akra	6.0 Earth
Pembina	Federal Aid	114	3401	Hamilton-Joliette	11.0 Earth
Pierce	Federal Aid	10	3571	Balta—South	5.0 Earth
Pierce	Federal Aid	48	3583	Wells County Line—North	21.6 Earth and Gravel

County	Federal or State Aid	Project No.	State Job No.	General Location	Length and Type
Pierce	Federal Aid	106	3501	Rugby—East	7.4 Earth
Ramsey	Federal Aid	18	3673	Churchs Ferry—East	4.5 Gravel
Ramsey	Federal Aid	19	3671	Devils Lake—SE and NW	19.9 Gravel
Ramsey	Federal Aid	95	3695	Devils Lake and Churchs Ferry	12.5 Gravel
Ramsey	Federal Aid	96	3697	Nelson County Line—West	9.0 Earth
Ramsey	Federal Aid	28	3781	Lisbon—N and S	17.9 Earth
Ransom	Federal Aid	4	3971	Wahpeton—South	20.0 Earth
Richland	Federal Aid	59	3993	Fairmount—Hankinson	14.5 Earth
Richland	Federal Aid	60	3995	Wahpeton—North	34.0 Earth
Richland	Federal Aid	69	3997	Mooreton—West	18.0 Earth
Richland	Federal Aid	71	3999	Wahpeton—West	13.0 Earth
Richland	Federal Aid	72	3991	Hankinson—West	18.0 Earth
Richland	State Aid	...	3372	South of Wahpeton	3.0 Earth
Sargent	Federal Aid	15	4171	Forman—N and W	31.4 Earth
Sargent	Federal Aid	58	4193	Forman—East	19.5 Earth
Sargent	Federal Aid	66	4195	Perry—North	6.0 Earth
Sargent	Federal Aid	89	4197	Forman—South	11.5 Earth
Sargent	Federal Aid	14	4571	Dickinson—N and S	18.9 Earth
Stark	Federal Aid	53	4593	Hettinger County Line—North	5.5 Earth
Stark	Federal Aid	65	4595	South Heart	0.1 Bridge
Stark	Federal Aid	29	4681	Traill County Line—West	8.5 Gravel
Steele	Federal Aid	7	4773	Woodworth and Wells County Line	9.2 Earth
Stutsman	Federal Aid	13	4775	Pingree—West	7.9 Earth
Stutsman	Federal Aid	24	4771	Cleveland—N and S	25.9 Earth
Stutsman	Federal Aid	55	4797	Barnes County Line—West	6.0 Earth
Stutsman	Federal Aid	56	4799	Jamestown—N, W and S	40.5 Earth
Stutsman	Federal Aid	22	4871	Arndt—North	17.5 Earth
Towner	Federal Aid	5	4971	Cummings—N, E, S and W	24.9 Earth
Traill	Federal Aid	46	4983	Cummings and Buxton	4.0 Gravel
Traill	Federal Aid	61	4993	Hillsboro—South	12.5 Earth
Traill	Federal Aid	67	4995	Buxton—N and E	7.0 Gravel
Traill	State Aid	...	4972	East of Mayville	7.0 Earth
Walsh	Federal Aid	116	5001	Park River—Grafton	14.5 Earth
Ward	Federal Aid	25	5181	Minot—West	5.6 Gravel
Ward	Federal Aid	81	5193	Minot—East	13.0 Gravel
Ward	Federal Aid	82	5195	Minot—North	15.0 Gravel
Ward	Federal Aid	83	5197	West of Minot	10.0 Gravel
Ward	Federal Aid	84	51913	NW of Minot	25.0 Gravel
Ward	Federal Aid	85	5199	Minot—South	14.0 Gravel
Ward	Federal Aid	86	51911	McLean County Line—North	12.0 Gravel
Wells	Federal Aid	20	5271	Harvey—N and S	16.8 Gravel
Wells	Federal Aid	88	5293	Hurdsfield—North	11.0 Earth

County	Federal or State Aid	Project No.	State Job No.	General Location	Length and Type
Wells	Federal Aid	90	5295	Hurdsfield—South	10.0 Earth
Williams	Federal Aid	3	5371	Williston—NE	30.5 Earth
Williams	Federal Aid	73	5393	Tioga—West	18.5 Earth
Williams	Federal Aid	80	5395	Williston—West	19.0 Earth
				Total	1,515.3

At present the sentiment about the state and especially in county circles is such that there is no reason to believe that federal aid will be lost to the state due to failure to raise "local" funds to meet it. The ever present danger has been and is that the State Highway Commission with its limited budget may not be able to make sufficient surveys, prepare plans, etc., or prepare them soon enough to prevent the lapse of part of the state's federal aid allotments.

Unfortunately, also, the county road and bridge funds set aside for federal aid projects might better be used for regular county work and state funds provided to meet federal aid. Moreover, the diversion of county funds to finance federal aid projects makes serious inroads on such funds, nearly one-half being required annually to match federal aid. In addition, the County Commissioners are not always supported by their constituents in the use of the county money to build state highways. The money expended by the counties (and townships) for road and bridge purposes is of great magnitude as may be seen from the following table:

TABLE X.

ROAD AND BRIDGE TAXES LEVIED IN 1919.
BY COUNTIES, TOWNSHIPS AND CITIES OF NORTH DAKOTA.

County	County Road	County Bridge	Township Road and Bridge	City Road Taxes
Adams	$ 20,302.68	$ 8,212.17	$ 25,236.21	.....
Barnes	95,928.25	15,407.95	76,807.62	$ 3,244.56
Benson	48,336.56	7,552.59	56,656.27	2,875.89
Billings	14,456.58	5,074.12	7,534.61	.....
Bottineau	46,979.00	46,979.00	2,035.00	70,402.02
Bowman	33,382.34	10,000.00	25,339.18	.....
Burke	52,531.35	7,926.27	42,056.25	514.50
Burleigh	47,378.57	40,168.78	47,654.25	.....
Cass	46,729.81	61,193.81	101,698.36	3,644.05
Cavalier	30,107.16	35,013.67	62,099.75	.....
Dickey	10,003.30	10,003.30	62,908.17	612.00
Divide	25,494.21	24,385.76	37,004.50	.....
Dunn	38,833.73	21,318.91	4,875.13	366.00
Eddy	22,560.10	9,034.17	24,841.96	.....
Emmons	48,073.08	28,658.78	15,589.56	.....
Fos er	30,495.04	19,790.61	25,870.23	.....
Golden Valley	6,001.26	.....	24,446.53	.....
Grand Forks	75,316.02	51,158.34	68,933.35	.....
Grant	49,906.48	26,067.22	15,733.00	.....
Griggs	24,769.74	5,797.18	38,587.64	.....
Hettinger	26,136.22	20,002.39	28,047.65	1,200.00
Kidder	26,000.00	.....	.....	.....
LaMoure	40,375.46	20,166.39	46,906.65	5,771.57
Logan	28,830.28	15,571.68	11,150.00	.....
McHenry	32,258.62	25,000.43	64,788.13	.....
McIntosh	46,048.76	5,132.25	.....	.....
McKenzie	25,211.42	20,285.05	20,331.50	.....
McLean	60,081.25	32,992.82	29,368.28	612.00
Mercer	41,783.24	20,163.37	.....	356.50
Morton	94,809.00	46,610.00	.....	.....
Mountrail	74,809.92	9,947.02	56,689.34	174.00
Nelson	53,382.35	10,135.89	55,776.84	.....
Oliver	24,777.62	9,108.48	.....	.....
Pembina	30,026.76	32,083.38	40,692.77	5,996.97
Pierce	29,940.08	5,022.49	16,364.80	355.73
Ramsey	48,869.82	10,181.21	55,970.68	.....
Ransom	38,272.25	28,124.23	51,361.58	.....
Renville	20,006.20	10,003.10	28,207.76	.....
Richland	65,080.61	25,031.01	81,636.83	1,714.79
Rolette	68,215.98	19,858.63	4,551.45	282.00
Sargent	40,135.40	30,235.24	55,443.55	3,210.87

County	County Road	County Bridge	Township Road and Bridge	City Road Taxes
Sheridan	18,005.23	6,884.35	15,541.93	.....
Slope	22,792.03	13,195.39	40,211.57	.....
Sioux	7,536.86	5,452.81	.....	499.36
Stark	40,295.10	15,424.42	11,305.98	.....
Steele	35,019.47	14,994.42	30,454.66	.....
Stutsman	83,115.91	25,139.14	108,055.22	.....
Towner	32,510.24	20,318.90	36,947.45	.....
Traill	50,230.22	35,008.90	50,286.13	.....
Walsh	10,070.52	35,115.01	53,719.89	1,478.45
Ward	99,529.72	19,959.17	85,894.93	.....
Wells	34,864.63	24,857.19	54,166.42	.....
Williams	80,307.88	40,248.38	68,487.63	2,542.24
Totals	$2,196,914.31	$1,085,995.77	$1,968,267.19	$105,853.50

Total Road and Bridge Taxes levied in 1919—$5,357,030.77.

With the State Highway Commission acting primarily as the go-between for the counties on one hand and the federal government on the other, the difference of opinion of these two units each providing one-half the funds places the department often in the embarrassing and difficult position of being able to wholly satisfy neither. On the other hand, if state funds were independently available for the meeting of federal aid without county funds being necessarily involved, the results would be that matters of difficulty could be more readily disposed of, a better class and type of work done and the state highways more systematically improved than at present.

In regard to the latter point, the present federal aid will provide for the improvement of about 1,600 miles of the state highway system or about one-third, which mileage will probably be scattered in patches in over 40 of the 53 counties. Stretches of continuous improved state highways of extended mileage or between controlling termini will be relatively few.

State Highway System.

There are about 70,000 miles of public highways in North Dakota. The state highway system, as determined by the county boards and the State Highway Commission, comprises about 5,000 miles or about 7% of the total, the state highways being naturally the main roads of the state.

The system passes into 100 per cent of the counties and through 100 per cent of the county seats. Investigation shows that about 49 per cent of the total population of the state lives within three miles of the roads of the system, 68 per cent within six miles and 85 per cent within twelve miles. At the same time, the state highways pass through 61 per cent of the incorporated cities and villages which contain 88 per cent of the total urban population. Hence it is apparent that both the rural and the urban population are taken care of by the system as laid out.

Chart I shows the state highway system.

ORGANIZATION OF DEPARTMENT.

A state highway department was unknown to North Dakota prior to the spring of 1917. The State Highway Commission was confronted not only by the necessity of organizing an entirely new department, inaugurating a scheme of state aid in highway improvement and securing federal aid for the same purpose, but also doing so while a war was on and in competition with surrounding established state highway departments. Perforce, it passed through that stage of criticism by county officers especially, and others generally through which period every state highway department has had to pass. It is to be remarked that no state highway department yet established has failed to survive the early criticism, emerging therefrom more substantial than ever.

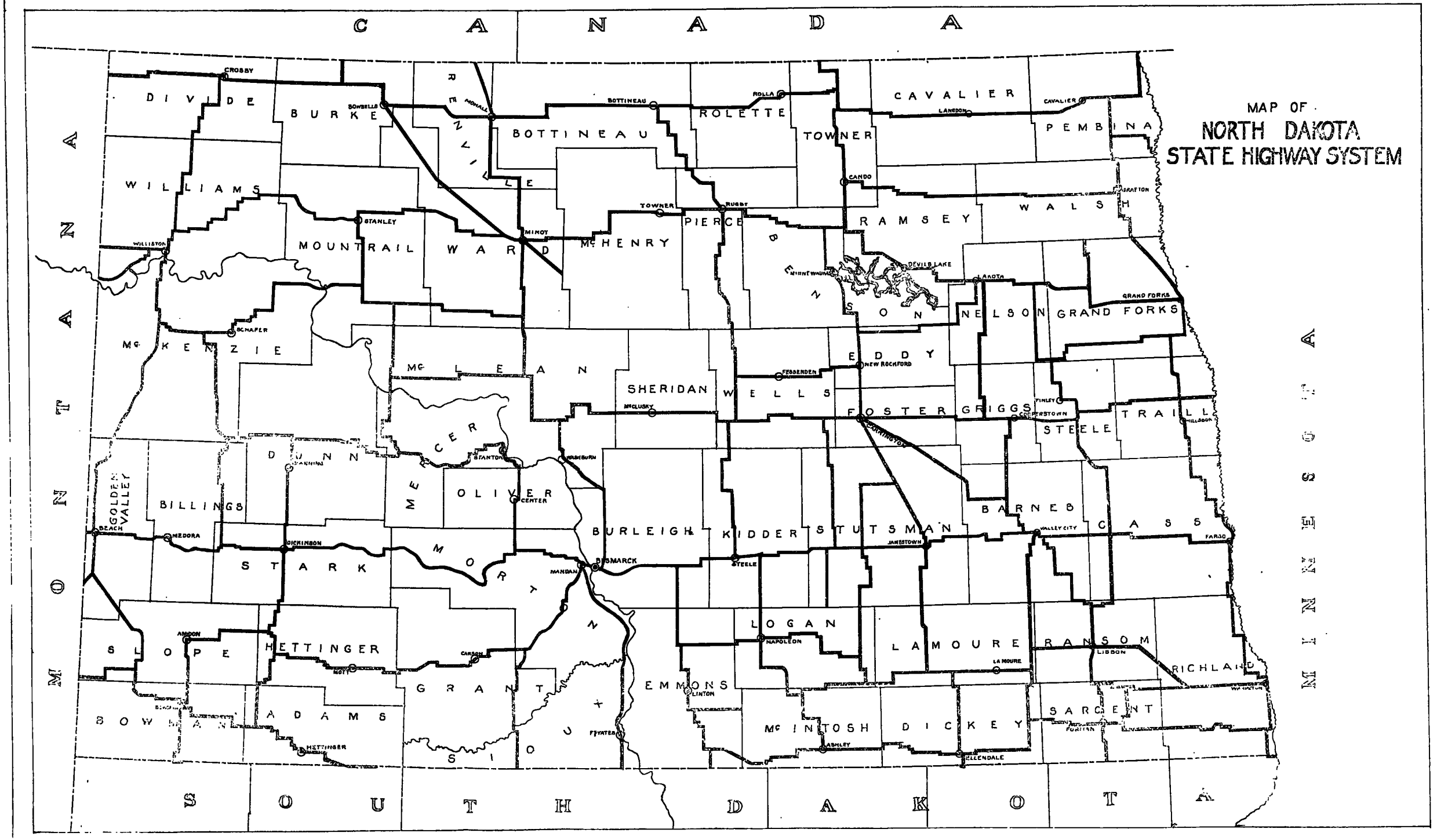
During the war many of the department's employees were called into or entered the service. Always the department has suffered in competition with other state highway departments, all of whom had and have as much work to be done as North Dakota and many of whom were able to offer the employees better positions and salary. The result has been that the department has had an almost complete turnover of force annually. The disadvantage and cost of constantly changing the force seriously effects the production and quality of work of any organization.

Honor Roll.

Those who have served the Nation with honor are:

Name	Title or Position
Jay W. Bliss	Chief Engineer
P. W. Thomas	Assistant State Engineer and Bridge Engineer
T. J. Lough	Project Engineer
C. Handschu	Assistant Engineer
R. N. Carroll	Assistant Engineer
V. H. Sprague	Assistant Engineer
L. B. Dale	Assistant Engineer
L. V. Duffy	Assistant Engineer
A. Overbee	Assistant Engineer
A. C. Armstrong	Assistant Engineer
J. A. Ingram	Assistant Engineer
J. L. Breske	Assistant Engineer
W. Cooper	Rodman
F. Brasie	Rodman
L. Monnahan	Rodman
G. Brown	Rodman
H. A. Saari	Rodman
C. L. Hoffman	Rodman
L. C. Hinkle	Rodman
R. Barr	Rodman
C. A. Gray	Rodman
C. A. Walter	Rodman
D. J. Printup	Rodman
N. Scott	Rodman
P. L. Grambs	Rodman

MAP OF NORTH DAKOTA STATE HIGHWAY SYSTEM



D. Ross .....Rodman
C. S. Anfinson .....Rodman

Mr. Frayne Baker, at present one of the appointed members of the Commission, is a service man.

In the matter of reemployment of service men, it may be said that in no instance has a request by a former employee for reinstatement been refused. In addition, the department has given discharged service men making applications for positions and work preference in the matter of employment.

LIST OF EMPLOYEES, ETC.

STATE HIGHWAY COMMISSION.

Governor Lynn J. Frazier, Chairman.

John N. Hagan, Commissioner of Agriculture and Labor.
Frayne Baker of Bismarck, N. D.
J. J. Marquart of Napoleon, N. D.
W. H. Robinson, State Engineer (ex-officio Chief Engineer and Secretary of the Commission)

ENGINEERING AND ADMINISTRATIVE STAFFS.

J. E. Kaulfuss .....Assistant Chief Engineer
H. K. Craig .....Project and Maintenance Engineer
W. W. Moyer .....Road Engineer
L. O. Marden .....Chief Draftsman and Bridge Engineer
R. E. Schumann .....Chief Clerk
Carl F. Convert .....Assistant Bridge Engineer
E. W. Robinson .....Assistant Maintenance Engineer
J. M. Hansen .....Superintendent of Equipment
T. J. Lough .....Division Engineer
C. A. Myhre .....Division Engineer
J. A. Wallace .....Division Engineer
D. R. Williams .....Division Engineer
C. A. R. Distelhorst .....Division Engineer
G. F. Ludvigsen .....Acting Division Engineer
Mark Sullivan .....Foreman on Construction
R. N. Carroll .....Assistant Engineer
Arthur Overbee .....Assistant Engineer
L. T. Powers .....Assistant Engineer
A. P. Coons .....Assistant Engineer
A. S. Miller .....Assistant Engineer
H. W. Miller .....Assistant Engineer
John O'Neil .....Assistant Engineer
D. A. Payne .....Assistant Engineer
F. H. Peters .....Assistant Engineer
Ralph McKeown .....Assistant Engineer
Arvid Backlund .....Assistant Engineer
M. P. Wynkoop .....Assistant Engineer

C. W. Kniffen	Assistant Engineer
H. E. Fowler	Assistant Engineer
Ed. White	Resident Engineer
J. A. Ingram	Resident Engineer
H. C. Frahm	Resident Engineer
Lloyd Salisbury	Resident Engineer
Paul Hegdal	Resident Engineer
Geo. E. Hanson	Office Engineer
Wm. Barneck	Office Engineer
A. B. Nelson	Office Engineer
Wm. Schroeder	Office Engineer
I. C. Frendburg	Office Engineer
Frank Brasie	Instrument man
H. Pike	Instrument man
Clifford Anfinson	Instrument man
D. R. Mackenroth	Instrument man
Harry C. Knutson	Instrument man
Giles Personius	Instrument man
A. L. Personius	Instrument man
Paul Grambs	Computer
Oliver Knutson	Computer
Paul Yeater	Computer
L. W. Whitlow	Rodman
J. E. Mead	Rodman
H. C. McCready	Rodman
K. S. Salveson	Rodman
C. J. Garland	Rodman
George Merchant	Rodman
John Callahan	Rodman
Alvin Nelson	Rodman
Myron Personius	Rodman
Robt. Callahan	Rodman
S. V. Russell	Rodman
Bernard Roberts	Rodman
Chas. Eberhardt	Rodman
Edw. Senger	Rodman
Albin Gronlund	Rodman
Fielden Shupe	Rodman
John Condie	Rodman
Everett O'Neil	Rodman
A. E. Coulter	Rodman
Chas. McGarvey	Rodman
Clinton A. Hoskin	Rodman
Earl Gann	Rodman
John F. Gates	Rodman
Ed. Rapp	Rodman
A. O. Kasser	Rodman
Harold Stenseth	Rodman
Howard Elliott	Rodman

Chas. Timboe	Rodman
Douglas Galloway	Rodman
R. C. Clarke	Rodman
Walter Puderbaugh	Rodman
Thos. A. White	Rodman
Archie White	Rodman
Ardell Harvey	Rodman
Rudolph Ellison	Rodman
James Sorenson	Rodman
N. Swanson	Rodman
Henry Kraft	Rodman

CLERICAL AND BOOKKEEPING STAFFS.

Minnie E. Hennessy	Bookkeeper
Beulah R. Dow	Assistant Bookkeeper
Rose Sell	Filing Clerk
Hildore Simonsen	Mailing Clerk
Clara Christensen	Stenographer
Mayme Sundquist	Stenographer
Esther Hoover	Stenographer
Edna Knecht	Stenographer
Ruby Amundson	Stenographer
Mildred Crawford	Stenographer

MOTOR VEHICLE REGISTRATION DEPARTMENT.

E. P. Crain	Registrar
E. Olson	Cashier
O. Agre	Rate Clerk
G. Pearce	Bookkeeper
L. Ankemann	Bookkeeper
R. Coil	Clerk
G. Bogle	Stenographer
S. Sloan	Clerk
G. Candee	Clerk
K. Lyons	Clerk
E. Krueger	Clerk
K. Cook	Clerk
R. Fisher	Clerk
H. Conway	Clerk
O. C. Gronvold	Clerk
W. Meyer	Special Agent
C. Carl	Special Agent
C. R. Smith	Special Agent

The chief executive is the Chief Engineer. In immediate charge of all of the work of the department is the Assistant Chief Engineer.

The preparation of project statements and the execution of project agreements are in the hands of the Project Engineer.

The making of surveys and drawing of plans are in charge of the Chief Draftsman.

The Bridge Engineer is responsible for the design, plans and construction of bridges.

The Road Engineer is in charge of the construction work, of preparation of estimates, and of the payment of state aid and federal aid.

The maintenance of completed state aid and federal aid projects and the state highways in general is directed by the Maintenance Engineer.

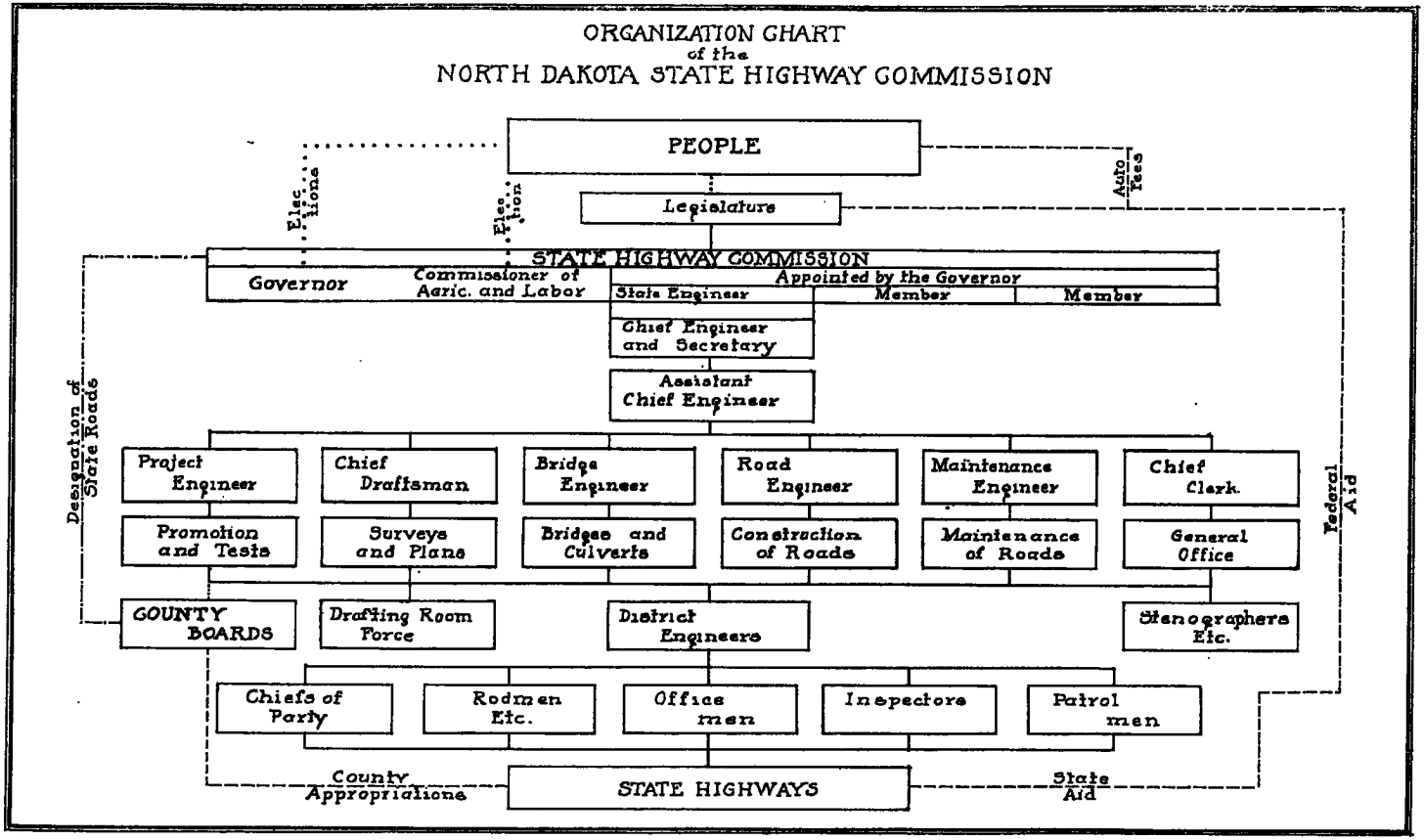
The Assistant State Engineer is in immediate charge of excess war department equipment, materials, etc., except when the same is turned over to other departments.

The Chief Clerk has charge of the clerical, stenographic and bookkeeping forces.

Divisions.

The state is divided into eight divisions as follows:

Division No.	Counties	Headquarters	Division Engineer
1	Grand Forks Nelson Pembina Walsh	Grand Forks	None Appointed
2	Cavalier Ramsey Pierce Towner Benson Eddy	Devils Lake	J. A. Wallace
3	Renville Rolette Bottineau Ward McHenry	Minot	None Appointed
4	Williams McKenzie Burke Mountrail Dunn Divide	Williston	G. F. Ludvigsen (Acting)
5	Golden Valley Slope Bowman Hettinger Billings Stark Adams Grant Sioux	Mott	D. R. Williams


ORGANIZATION CHART
of the
NORTH DAKOTA STATE HIGHWAY COMMISSION
PEOPLE
Elec. tions
Elec. tion
Auto Fees
Legislature
STATE HIGHWAY COMMISSION
Governor
Commissioner of Agric. and Labor
Appointed by the Governor
State Engineer
Member
Member
Chief Engineer and Secretary
Assistant Chief Engineer
Designation of State Roads
Federal Aid
Project Engineer
Chief Draftsman
Bridge Engineer
Road Engineer
Maintenance Engineer
Chief Clerk.
Promotion and Tests
Surveys and Plans
Bridges and Culverts
Construction of Roads
Maintenance of Roads
General Office
COUNTY BOARDS
Drafting Room Force
District Engineers
Stenographers Etc.
Chiefs of Party
Rodmen Etc.
Office men
Inspectors
Patrol men
County Appropriations
STATE HIGHWAYS
State Aid

6	McLean Wells Oliver Kidder Emmons Sheridan Mercer Burleigh Morton Logan McIntosh	Bismarck	T. J. Lough
7	Foster Stutsman LaMoure Griggs Barnes Dickey	Valley City	C. A. Myhre
8	Traill Steele Richland Cass Ransom Sargent	Fargo	C. A. R. Distelhorst

The Division Engineers are provided with the necessary engineering and other assistants to stake out the work of construction, supervise the same, etc., all under the direction and instruction of the Road Engineer. They are also in more immediate charge of maintenance under the control of the Maintenance Engineer. They make surveys of new projects unless these are made by surveying parties sent out directly by the home office. In winter, the division forces are primarily assigned the design of new projects in their respective territories.

To show the organization graphically there is presented the accompanying chart:

Work of the Department.

Specifications for the construction of highways and bridges have been prepared. Standards and standard plans for the same have been made. Systems of records, files, and bookkeeping for the various operations of the department have been devised and put into use.

In the matter of road and bridge work, there have been previously given in the report information, statements and tables showing the accomplishments of the department since its creation.

TOTAL MILEAGE OF PUBLIC AND OF STATE HIGHWAYS IN NORTH DAKOTA BY COUNTIES.

County	Public Highways (1904)	State Highways
Adams	1,000	54
Barnes	2,506.5	146
Benson	1,247	105
Billings	500	47
Bottineau	1,620	95
Bowman	1,160	76
Burke	1,131	51
Burleigh	1,162	150
Cass	3,200	140
Cavalier	1,934.5	64
Dickey	1,072	96
Divide	1,800	90
Dunn	1,000	82
Eddy	315	54
Emmons	1,020	86
Foster	1,305	60
Golden Valley	340	90
Grand Forks	2,890	132
Grant, included in Morton County	....	65
Griggs	550	57
Hettinger	1,435	83
Kidder	785	95
La Moure	1,605	100
Logan	1,150	102
McHenry	2,050	80
McIntosh	336	75
McKenzie	500	200
McLean	2,810	155
Mercer	400	80
Morton	2,935	95
Mountrail	2,000	108
Nelson	1,130	135
Oliver	500	20
Pembina	1,504	88
Pierce	1,310	88
Ramsey	1,340	120
Ransom	1,220	48
Renville	804	57
Richland	2,100	120
Rolette	2,200	35
Sargent	1,700	85
Sheridan	1,000	75
Sioux	200	70
Slope	600	90
Stark	953	96
Steele	1,015	70
Stutsman	2,150	230
Towner	770	82
Traill	1,716	66
Walsh	1,900	73
Ward	902	140
Wells	1,500	118
Williams	729	115
Total	69,002	4,933

Note: Approximately 64,000 miles of county and township roads exclusive of state highways.

COST OF SURVEYS, PLANS, INSPECTION AND SUPERVISION.

Considerable criticism has been directed against the State Highway Commission relative to the cost of the necessary engineering required on state highway projects and more especially federal aid work.

In regard to the latter it need only be said that the federal government cannot by law participate in highway or bridge construction except when work is done according to approved plans and specifications and in due conformity to the law and the rules and regulations promulgated thereunder. The federal rules, regulations and standards determine the nature and extent of the engineering work to be done by the state highway departments and these, if they desire to avail themselves of federal aid, must comply with the government's requisitions.

Apart from this, however, a careful survey and a complete and comprehensive set of plans or drawings are required on work of any magnitude in order to insure truly competitive bidding, to define the kind and amount of work to be done and its manner of being performed (likewise with material to be furnished) and to generally safeguard the interests of the contractor, the county, the state and the federal government. Enlightened opinion finds no objection to the expense of adequate preliminary engineering on all construction work. Proper supervision and careful inspection insures proper fulfillment of the contract by the contractor.

In 1917, during the first year of the department's existence, the cost of surveys was $26.40 per mile and the cost of plans was $29.72, making the total cost of preliminary engineering (up to the time of awarding contracts) $56.12.

Since then, due to the general increase in cost of this work as in the case of all other work, supplies, etc., due to a higher scale of salaries being paid and due to some additional refinements and requirements of the work, the cost per mile of survey during 1920 has advanced to about $45.00 per mile, and the cost of plans to about $65.00, making a total of about $110.00 per mile for preliminary engineering.

Investigations have been made by the State Highway Commission and by others interested in its work and development and it has been found that the cost of engineering for the state of North Dakota is below the average of the surrounding states at least. And some of these are departments of several years' existence, whereas North Dakota's highway department is one of the youngest in the country. It is also to be borne in mind that the amount of engineering and supervision, particularly in the matter of surveys and plans, is practically the same for a road which costs $40,000 per mile as for one which costs $2,500. Hence, the department has been laboring under an unusual handicap in that it is only recently that the average cost of construction has advanced to about $4,000 per mile, the highest figure of work under contract being about $8,000 per mile.

In the matter of the supervision and inspection of construction, if criticism is to be directed against the department, it is to be on the grounds that inadequate inspection, both as to quality and number of inspectors, engineers, etc., has been provided rather than that it has

cost too much. Up to January 1, 1920, the cost of engineering during construction was about $104 per mile. The corresponding cost of surveys and plans was about $72.00 per mile, making a total of about $175.00 per mile. Sufficient projects have not been completed to present conclusive data as to cost of engineering on state work. However, it may be stated that at present the cost does not exced $200 a mile. Since projects have increased in cost, due to advancement of contract prices and also to raising the standard of improvement, to appoximately $5,000 per mile, it may be seen that the per cent of engineering remains conservatively and acceptably within the figures generally conceded to construction work.

Comparison with the cost of engineering work in other states places North Dakota in a very favorable light. It may be said that no small part of this relatively satisfactory showing is due to the effort, sacrifice, industry and diligence of the personnel of the department.

Cost of Construction Engineering.

A contract having been awarded to do certain work or furnish certain materials, it is essential that adequate inspection, direction and supervision is furnished to provide that the terms of the contract are not violated and that the governing specifications are not disregarded. The failing of the department in this regard has been that due to the salaries prescribed by the budget, to its failure to provide inspectors, etc., in sufficient number and to the department's attempt to keep the cost of engineering down to a minimum and thus ward off criticism on that score, the construction work has not always been properly supervised and the material has not always been inspected, much to the disadvantage of the contractors. Also because of this lack of proper field force, the work turned out has not always been first class and, in addition the state has been slow in paying contractor's estimates and in securing federal aid to reimburse the counties' expenditures. Experienced and ample engineering for and during construction is imperative in order to safeguard especially the interests of the counties, state and federal government.

The cost of the engineering thus far provided has been somewhat greater than the cost of the preliminary work prior to the awards of contracts.

Cost of Administration.

The cost of administering the work and affairs of a department are always slightly out of proportion to the work done when that department is new and growing. In this case, not only was the department to be newly equipped with furniture, apparatus, supplies, etc., but much planning, organization and development work had to be done, for the department began from nothing—it being an entirely new creation. In addition, with the effects of the country's being at war, with an ever-changing clerical and engineering force due to the war and to allurements to employes to accept greater remunerations elsewhere, with the increasing

prices of all commodities, supplies, labor, etc., and with the necessity of carrying on actual work during the period of organization, the cost of administration has been greater than it would have been in normal times and in normal conditions.

However, the total cost of engineering and administration up to and including 1919 has been but from 12 to 14 per cent of the cost of construction. In comparison with the application of federal aid in other states, particularly those neighboring, the performance of this state has been creditable. These indicate the cost of engineering and administration to be also from 12 to 15 per cent. It is also to be remarked that about 3 per cent of the above mentioned 12 to 14 per cent will be repaid to the state by the federal government as its share (normally one-half) of the cost of engineering during construction.

The total operating expense of the department for the four fiscal years 1917, 1918, 1919 and 1920 is as follows:

Year	State Highway Commission Proper	Motor Vehicle Registration Department	State Aid Used for Engineering (*)
1917	$32,346.26	$33,781.04	.....
1918	65,359.10	38,633.29	.....
1919	65,025.96	43,651.37	$54,801.20
1920 (June 30)	40,453.03	.....	29,371.66
Total	$203,184.35	$116,065.70	$84,172.86

(*Part to be refunded by Federal Government.)

Without further comment regarding the value of the State Highway Commission, from a material point of view alone, it is to be noted that federal aid paid for actual state highway construction to the amount of $252,226.59** has already been paid to the counties (and has therefore come into the state). Also excess war materials, etc., to the amount of a million dollars or more have become the outright property of the State Highway Commission.

Neither the federal aid nor the excess war materials, etc., would have come to the state without the existence of the State Highway Commission. It is perfectly obvious that the state highway department is virtually a more than "self-supporting" department. In fact, in securing federal aid alone, there has been and will be secured to North Dakota from six to eight dollars (federal aid) for each one dollar of operating expenses of the state highway department.

**Note:—Claims for $207,587.23 more federal aid were submitted during the first twenty days of July.

Construction.

The essential facts and figures regarding this feature of the work of the department has been previously given in the report, especially as concerns work under regular contracts.

***Force Account* by the State.** In one instance, namely Eddy County

Federal Aid Project No. 8, the contractor defaulted his contract, the County and State deciding to undertake finishing the work themselves. In a few other instances where work could not be let at reasonable figures, the work was also performed by the department. Also in a number of cases entire projects were taken over to be done by the counties under the supervision of the state. The gravel surfacing of LaMoure County Federal Aid Project No. 31 was performed by the state, a gravel loader having been purchased and war department trucks being used for hauling.

In practically all of these cases, however, the work has been done with only partial success. This has been due to two primary causes, namely, that the proper and sufficient machinery, tools, etc., could not be supplied, that an efficient working organization could not be developed on account of the nature or isolation of the work and that, because of the inadequate budget previously and frequently referred to, the necessary close supervision and direction of the actual work was lacking.

There are three elements to successful construction on the part of a governmental unit. One of these is that the plant equipment and organization should call for the proper and the necessary machienry, tools, power, etc. Another is that the man-organization must embrace a competent superintendent, efficient foreman and productive and sufficient labor. The third element to insure successful issue is that there shall be enough work to be done by the plant and the force to keep the same busy for an extended period of time (the entire working season if possible) so that the proper men can be retained on regular work and so that the "overhead" on the plant and force is kept down to the comparative minimum.

As stated before, the nature of the state work at present and in the near future at least is such that out of state contractors are not especially attracted to this state. Moreover there is probably even more work available for them in their own states. There have not been enough contractors in the state to take all the past state aid and federal aid work planned by the department and an unusual volume of work will be thrown upon them in the next few years—far more than the present contracting forces can handle even if taken from township, county and city work. In addition, to use all the state's contractors on state highway work alone, even if possible, would be inadvisable as the township, county and city work must also be done.

In the three construction seasons (1918, 1919 and 1920), the state has placed contracts not exceeding the amount of federal aid work which is possible and desired by the counties for each of the next two years. It is therefore apparent that, with the unfinished contracts on the hands of the contractors in 1921, only a relatively small amount of state work will be necessary to tie up the entire contracting field for the year, leaving a considerable amount with no prospect of its being placed under construction except in the doubtful future.

Hence, it is imperative that either funds be made available or provision made, or both, whereby the state may go into the contracting business at once. The projects to be constructed, the desire of the coun-

ties to take advantage of federal aid and the road situation generally in the state demand that this provision be made.

The object of this, the actual construction of work by the state, is advocated not to retard or supplant the contracting business but to supplement it. The development of the contracting field depends upon itself. Contractors cannot be created over night or upon desire. The state can only encourage its growth where occasion presents.

The advantage of state construction, that is force account work or entering into the contract field are as follows:

It will insure the federal aid work on the program being carried out, hasten the building of an extensive mileage of improved roads at this moment required in the state and prevent the loss of federal aid by reversion to the federal treasury.

It will serve as a check or balance on regular contract work and on bids for road and bridge work generally in the state and will, by actual performance, enable the state to determine the fairness of current bid prices.

It will provide a means for the employment of an incalculable amount of farm labor, teams and power during the slack periods on the farms, a procedure whereby the farmers individually and the state generally will profit. The importance and value of this advantage of the state's going into the construction business cannot be overestimated.

The important fact remains, however, that the present contractors cannot handle the state work as fast as it is presented to them. If no greater rate of progress is achieved in the future than has been obtained since 1917, considering the fact that more attention in the future will be given to the surfacing of state highway previously graded, fifty years or a half century will have passed before the state highway system of 5,000 miles (there are 65,000 miles of other highways in the state) will be completed, even as to grading, bridges and drainage generally.

The development of the agricultural and other resources and the prosperity of the state demand immediate and comprehensive improvement of the highways of the state and most especially the state highways which are the channels of domestic and foreign transportation.

Grade Crossing Eliminations. One of the special features of state highway construction is that a studied effort is made to eliminate as many grade crossings as possible on the state highway system. In many cases grade crossings can be avoided by selection of the route. The most notable case of this nature is that of Stutsman County Federal Aid Project No. 56. On the 32½ miles north from Jamestown a number of grade crossings were avoided by securing over six miles of new right of way, the project remaining for the entire length parallel to and on the east side of the railroad. In other instances, as in the case of Barnes County Federal Aid Project No. 12 and McLean County Federal Aid Project No. 63, grade separations will have been made the former by an under-pass and the latter by an overhead crossing.

The co-operation of the railroad companies of the state in this regard is very commendable.

It may also be remarked that a large number of counties have been

entirely agreeable to the purchase of new right of way on projects, necessitated by departing from section lines in order to secure better location, easier grades, cheaper construction, etc.

Hard Surfacing. Less than one-tenth of the mileage of federal aid projects is gravel-surfaced, the remaining nine-tenths being common earth roads. In Grand Forks County two federal aid projects, one of one mile and the other of a mile and a half, are of concrete and are expected to be built in 1921. There has been some talk of concrete highways in Cass and Barnes Counties.

Missouri River Bridge. One of the important achievements of the State Highway Commission has been the making a reality of the Missouri River Bridge between Bismarck and Mandan and already mentioned. The cost of the structure (not including the approaches into the two cities) is estimated to be over $1,000,000. Contracts have been entered into for the work with the Foundation Company and the American Bridge Company, the former to build the piers and concrete approaches and the latter to furnish and erect the steel superstructure. Work by the Foundation Company is already in progress and the structure is expected to be completed before 1922, but certainly before 1923. Ultimately, it is anticipated, the "Twin Cities" of North Dakota will be connected by paved highways meeting at the bridge. It is located about four-fifths of a mile south of the present Northern Pacific Railroad bridge.

The completion of this structure will mean a great deal to the cities of Bismarck and Mandan, and to the two counties, and will open up the undeveloped Slope Country west of the river. The bridge will also be of great value to the state at large and the nation in general, especially as regards interstate or transcontinental traffic.

Maintenance.

According to the federal aid act, maintenance of constructed federal aid projects is absolutely compulsory. Failure to properly and continuously maintain any highway or bridge toward the construction of which the federal government has given federal aid results in all federal aid being shut off to the state until the project (road or bridge) is put and kept in the proper state of maintenance. Hence the adequate maintenance of completed federal aid projects is imperative.

In the first state highway law it was stipulated that the state should direct and supervise the maintenance of all roads and bridges improved under the Act. The cost was to be borne one-half by the county from its special road maintenance fund (provided from the motor vehicle registration fees) and one-half by the state from the State Highway Commission's reservation for that purpose (also from the motor vehicle registration fees).

No work was completed during 1917 and during 1918, due to the war, the shortage of labor and materials, etc. Only 17 miles were constructed and taken over for maintenance. This was done by the patrol system, engaging a man with team to regularly drag the road, etc., after each rain.

In 1919 the legislature practically doubled the amounts returned to the counties for maintenance and provided that the entire cost of main-

taining constructed state highway projects (both state aid and federal aid) should be paid from the county special road maintenance fund. The amendments to the former law also provided that the entire mileage of the state highway system (about 5,000 miles) was to be maintained under the direction and supervision of the State Highway Commission. The cost of maintaining the unimproved state highways was also to be borne by the county special road maintenance fund.

Unfortunately, in order to make such maintenance of the state highway system possible of success, proper provision should have been provided by the legislature for an adequate force or organization in the highway department to properly direct and supervise work of this magnitude. No such provision was made and it was impossible for the one man (the Maintenance Engineer prescribed by the budget) to devise and successfully operate at long distance an effective system of maintenance of so great a mileage of roads, most of which were unimproved and badly in need of extensive repairs before any maintenance at all could be practiced.

The result was that during 1919 the maintenance provided by the State Highway Commission was anything but a success, the failure being due quite entirely to there being no provision made for properly providing and operating the necessary supervising organization.

During 1920 the department concluded to direct its energies as to maintenance to completed state highway projects. No attempt was made to maintain the entire state highway system because of the impossibility of doing so. The counties were early advised that the state would not attempt to look after or maintain the state highways other than those constructed as state aid or federal aid projects. However, counties which requested that the state supervise and direct the maintenance of the state highway mileage therein have been accommodated at least after a fashion.

While the maintenance work during 1920 was more satisfactory than what it was the year before, the work is not yet all that it should be. The acquisition of motor trucks from the War Department has been of some help but the highway department still remains handicapped with an entirely inadequate supervising and directing force, to make no mention of the lack of funds to place and keep the trucks in working condition, to investigate the best type of maintenance equipment to be used with trucks, to secure such equipment, etc.

A plan was evolved whereby a fleet of four to six or eight trucks could be assigned to a county, the first duty of which was to immediately drag the state highways, the trucks being used the remaining time to surface with gravel all federal aid projects, state aid and federal aid roads previously graded and made ready for gravel. The federal aid received in graveling, it was anticipated, would provide for the operation of the fleet and the supervision of such operation. The scheme is somewhat complicated, although entirely feasible and possible of success. Time has been too short to present any definite and conclusive results but again it must be remarked that, without a proper maintenance organization in the department, the plan will not be an entire success.

The matter of the acquisition, use, etc., of motor trucks, other equipment, materials and the like secured by the State Highway Commission from the War Department for highway work will have been presented in greater detail elsewhere in the report.

Proper maintenance is absolutely pre-requisite to the credit and prestige of the state highway department. Under the federal aid act, proper maintenance of projects must be provided by the state. One of the first requirements of satisfactory maintenance is constant, close and competent supervision of the work by the directing maintenance department. Truck drivers, teamsters, etc., must be educated as to what constitutes proper maintenance. They must be taken "by the hand," so to speak, and accompanied over the roads under their care to point out the good work they have done, the things that have been neglected, the faulty things that have been done, etc.

It is a foregone conclusion, at this time at least, that a patrol system or any part time scheme is doomed to unsatisfactory results generally. Farmers cannot be relied upon to drag at the proper time, especially when their farm work appears (and probably actually is) of more importance.

The climatic conditions in the state are such, the rains come in such a way, the soil conditions are generally such, that unless a road is dragged at just the right time following each rain it will be in poor shape for the rest of the year, even though the road is afterwards repeatedly and repeatedly dragged. One faulty or missed dragging may injure the road for the entire season.

Full time organization appears, therefore, to be the only insurance against improper maintenance. Full time maintenance will naturally be expensive but a scheme must be evolved at least on the state highways, where maintenance will be positive and sure and where the demands of farming and harvesting operations will not make inroads on the maintenance forces.

A table showing the mileage of state aid and federal aid projects and other state highways under maintenance by the state follows:

TABLE XI.

FEDERAL AND STATE AID PROJECTS UNDER MAINTENANCE JUNE 30, 1920.

County	Federal Aid Number	State Job Number	Type	Miles
Foster	2	1671	Earth Road	15.0
Williams	3	5371	Earth Road	30.5
Richland	4	3791	Earth Road	20.0
Traill	5, Secs. 1, 2, 4	4971	Earth Road	20.9
Stutsman	7	4773	Earth Road	9.2
Grand Forks	9	1871	Gravel Road	3.6
Stutsman	13	4775	Earth Road	7.9
Stark	14	4571	Earth Road	18.9
Sargent	15	4171	Earth Road	31.4
Griggs	17A	2071	Earth Road	13.7
Wells	20	5271	Earth Road	16.8
Bowman	21	0671	Earth Road	17.7
La Moure	23	2371	Earth Road	10.0
Stutsman	24	4771	Earth Road	25.9
Emmons	34, Sec. B	1581	Earth Road	5.1
Foster	45	1673	Earth Road	11.1
Traill	46	4983	Earth Road	4.0
Grand Forks	..	1872	Gravel Road	3.0
Grand Forks	..	1874	Earth Road	10.7
Foster	..	1672	Earth Road	4.9
Total				280.3

ADDITIONAL MILEAGE UNDER MOTOR TRUCK MAINTENANCE BY SPECIAL AGREEMENT WITH COUNTIES.

County	Additional Mileage (Approximate)
Barnes	90
Bowman	40
Burke	48
Grant	65
Griggs	43
Hettinger	73
Ramsey	95
Sargent	34
Stark	77
Traill	36
Total	601

MOTOR VEHICLE REGISTRATION.

Since 1919, the registration of motor vehicles in the state has been in the hands of a Registrar responsible to the State Highway Commission.

A review of the legislation relative to licensing and license fees has already been given.

To show the growth of the number of motor vehicles in the state and the license fees therefrom, there is given the following table:

Year	Registrations			Expense of Collection, Etc.	Returned to Counties	State Highway Fund
	Gross Receipts	Number of Motor Vehicles	Cycles			
1916	$125,455.49	40,446	1,315	$12,998.52	$112,337.09	.....
1917	211,536.12	62,993	1,834	33,781.04	72,164.14	$105,707.82
1918	472,830.97	71,687	1,658	38,633.29	143,679.93	290,293.14
1919	636,842.40	82,885	903	43,651.37	243,421.20	243,421.20
1920 (June 30)	610,224.45	81,545	728	.....	.....	.....

The number of motor vehicles has increased from 7,220 in 1911 to about 85,000 (estimated) in 1920, or nearly twelve-fold. The use of motor trucks in the state has developed enormously and with the coming of better and more serviceable roads for a greater number of years, the use of trucks in the state, especially for the marketing, etc., will be greatly increased.

According to facts and figures issued by the National Automobile Chamber of Commerce, North Dakota ranked eleventh in the number of persons per automobile in 1919.

1.	California 6.07		6.	Montana 8.42	
2.	Iowa 6.12		7.	Minnesota 9.15	
3.	Nebraska 6.54		8.	Wyoming 9.16	
4.	South Dakota 7.20		9.	Arizona 9.66	
5.	Kansas 8.32		10.	Michigan 9.73	

11. North Dakota..... 9.86

However, semi-official census figures give the state a population of 620,000 for 1920, instead of 817,554 used in the above determination, which would give 7.48 persons per car for North Dakota.

The era of the motor vehicle is here and it shall soon become necessary for the state to have its highways keep pace with the development of the auto industry and the use of motor vehicles generally.

SURPLUS WAR EQUIPMENT.

Section 7 of the Post Office Appropriation Bill passed by Congress, for the fiscal year ending June 30, 1920, authorizes the Secretary of War to transfer to the Secretary of Agriculture all surplus war materials, equipment and supplies suitable for use in the improvement of highways and that the same be distributed among the various highway departments of the states to be used on roads constructed in whole or in part by federal aid.

On March 15, 1920, additional legislation passed by Congress was approved, which allows state highway departments to rent equipment so distributed to any civil unit of the state for highway purposes, the rent to be sufficient to cover upkeep and operating expenses. This last act also provided that the surplus equipment allotted after March 15, 1920, should be paid for by the states receiving it, at the rate of 20

per cent of its estimated value, but from this 20 per cent it is allowable to deduct freight and loading charges.

Under these acts, North Dakota has received 296 trucks with about 30 tons of spare parts. Four tractors, eight Ford ambulances and four light Ford trucks have been received. Besides these, a miscellaneous assortment of other materials have been received. The total estimated value of all surplus war equipment received by the state up to the present time is $1,050,159.38.

It has been necessary for the state to pay freight and loading charges on all of this equipment. The only fund available has been the "10 per cent" fund. Since this is comparatively small, the financing of the proposition has been very difficult and it has been necessary to reject considerable valuable material that has been offered to the state by the Secretary of Agriculture. Among this rejected material were the last 25 of the state's allotment of 319 trucks.

Counties to which these trucks have been allotted by the State Highway Commission have been requested to remit the freight and loading charges, based on the average cost on all of the trucks received in the state.

Most of the trucks received were practically new, but there are some that appear to be in a condition that will hardly warrant the attempt to put them in running order. There are a great number of others that will require considerable overhauling before they can be used. Proper facilities for doing this work are entirely lacking. No storage facilities have been provided and, in consequence, equipment that cannot be repaired on account of lack of shop facilities is standing out on the open prairie, suffering further deterioration.

The allotment of automobiles that has been received from the Department of Agriculture is practically all in very poor condition and it has been found that the cost of repairs on some of them averages seven cents per mile to keep them in service. Considerable extra parts are being received from the Government and arrangements should be made to provide a shop for overhauling all of these automobiles during the winter months, when they are not in service, so that the unnecessary outlay for upkeep and the delay in connection will be avoided in the future.

The trucks received by the state have been re-allotted to the counties on the basis of approximately one truck for each twenty miles of state road in the county at the beginning of 1920. On this basis about 160 trucks will be distributed among the counties, leaving a balance of about 46 to be retained by the state for special work. To date not all counties have availed themselves of the opportunity, but practically all the trucks that are in running order have gone out.

At present the Highway Commission has a fleet of ten trucks graveling a ten mile Federal Aid Project in Eddy County. This outfit began surfacing a five mile project in LaMoure County late in the fall of 1919, but the early snowfall necessitated shutting down before much was accomplished. During the spring months excessive rainfall interfered with the operation of the trucks to a considerable extent by softening the road bed until it was almost impassable for loaded trucks.

If the greater portion of these trucks could be put to work placing gravel and scoria surfacing on our state roads it would be a great step forward, for it cannot be hoped that the state will be able to construct hard surfaced roads on any very extensive scale for many years to come. In the meantime, gravel and scoria surfacing would be a great improvement over our present roads.

Trucks are also being used successfully in several counties on maintenance work, and where surfacing and maintenance can be combined, thus allowing the employment of full time drivers, it is hoped to secure more extensive and successful maintenance than otherwise can be secured.

Following is a list of the surplus war material received by the state to date:

TRUCKS RECEIVED UNDER THE FEDERAL AID ACT.

No.	Make	Capacity	Value
7	G. M. C.	1-ton	$18,354.00
1	G. M. C.	5-ton	1,000.00
51	F. W. D.	3-ton	183,600.00
83	Nash Quad	2-ton	257,300.00
9	I. H. C.	2-ton	16,200.00
29	Pierce Arrow	2-ton	111,157.00
16	Pierce Arrow	5-ton	78,848.00
4	Packard	3-ton	15,864.00
16	Kelley-Springfield	3-ton	54,384.00
27	Vellie	3-ton	95,175.00
1	White	5-ton	1,000.00
1	Hurlburt	5-ton	4,500.00
24	Garford	3-ton	60,000.00
10	Standard	2-ton	15,000.00
12	Republic	3-ton	37,200.00
1	Ford	1-ton	600.00
4	Ford Light Delivery		2,000.00
296	Total		$952,182.00

AUTOMOBILES RECEIVED UNDER THE FEDERAL AID ACT.

No.	Make	Value
4	Hudson Touring	$4,000.00
15	Ford Touring	6,000.00
2	Ford Roadster	800.00
8	Ford Ambulance	5,600.00
29	Total	$16,400.00

MISCELLANEOUS EQUIPMENT AND MATERIAL RECEIVED UNDER THE FEDERAL AID ACT.

No.	Item	Value
4	Cleveland Motorcycles	$800.00
1	15-ton Holt Tractor	6,000.00
1	I. H. C. Tractor	2,000.00
1	Cleveland Tractor	800.00
1	Gray Tractor	1,800.00
30 tons	Nash Quad Parts	30,000.00
1 crate	Nash Quad Curtains and Tops	100.00
	Hudson Spare Parts	300.00
	Ford Spare Parts	1,000.00
	Kelley-Springfield Spare Parts	260.00
250	Pyramidal Tents	5,000.00
2	Eureka Concrete Mixers	300.00
1	Water Wagon	944.88
2	Sprinkling Wagons	4,800.00
8	Drinking Water Carts	$1,400.00
15	Steel Tanks	600.00
2	480-gal. Steel Tanks	140.00
1	Barnes Plunger Pump	350.00
29	Hand Pumps	232.00
5	Hatchets	67.50
24	Shovels	36.00
10	Portable Forges	195.00
48	Lanterns	43.00
96	Lanterns	86.40
1	Chain Hoist	75.00
1	1 yd. Clam Shell Bucket	500.00
2	Folding Tables	5.00
2	Field Desks	20.00
1	Surveyor's Transit and Tripod	275.00
5	Levels and Tripods	550.00
2	Planimeters	150.00
29	Stanley Skid Chains	870.00
5	Army Field Ranges	237.00
25	Slip Scrapers	175.00
1,200	Angle Steel Posts	720.00
5	Trench Shelters	850.00
1,208	Corrugated Metal Sheets	3,865.60
600	Electric Blasting Caps	30.00
25 Sets	Harness	2,500.00
2	Squadron's Repair Units	1,500.00
	Ford Spare Parts	1,000.00
	Heavy Aviation Spare Parts	11,000.00
	Total	$81,577.38

RECOMMENDATIONS.

Among the important recommendations to be made in connection with the State Highway Commission the foremost is the provision for a more adequate budget. The frequent reference to the inadequacy of the budget in the preceding portions of this report illustrates the importance of this recommendation.

Due to the lack of sufficient and proper clerical and field (engineering) forces, the department has not been able to place projects under way as rapidly as the counties and people at large have wished. Administrative matters have not always been expeditiously handled. Contractors have been delayed, hampered and, in some cases, have been incurred with unnecessary expense due to insufficient or low calibre engineering and supervision. Then estimates have sometimes been delayed and federal aid reimbursement and state aid payment to the counties has sometimes been slow. As a result the state has been, to some extent,

justly criticized for delays, non-fulfillment of promises, uncertainty of policy or action, and inefficiency. All such criticisms could have been precluded, had larger funds been available to the department not only for salaries but also for supplies, equipment, traveling expenses and the like.

An adequate budget should make ample provision for a large enough engineering and clerical force. The state highway department is one of the largest of the state departments and will become more so. Due to the existence of the department the state has already secured federal aid and excess war materials several times in excess of the expense of the department, which aid and material of value could not have been secured without a state highway department.

The existing law relative to the maintenance of the entire state highway system by and under the State Highway Commission should be made more workable, which can most readily be done by adequate budget provision.

Other appropriations or provisions should be made to secure, store and use or keep in operation the excess war materials, equipment, trucks, etc., the value of which already received exceeds $1,000,000.00.

A fund should be provided, or provision made, to enable the state to enter into actual construction work on a large scale for reasons previously outlined.

The existing budget before being twice reduced was based on the needs of the department when about $2,225,000 of federal aid work was in prospect. Since a year ago this has been increased to $8,500,000. None can prophecy, but prospects are good that further federal aid appropriations will be made within the next two years or so, so that the department will be confronted with the task of handling about $20,000,000 worth of federal aid work.

The budget would therefore preferably be elastic, its amount being dependent upon the amount of work undertaken by the department. It may be suggested that the amount placed at the disposal of the department for operating expenses (not including, however, purchase of machinery, tools, equipment, etc., for construction by the state) be not to exceed 12 per cent of the estimated or actual cost of construction, and not to exceed, under present conditions, 50 per cent of the gross receipts or motor vehicle license fees.

Equally important is the matter of constructing and maintaining the entire state highway system by means of state funds alone without the necessity of using county monies at all. This may most easily be provided by means of a state bond issue which could be financed without additional levies on the tax payer by increasing (doubling) the present fees. The burden would therefore fall upon the automobile owners, who would not and will not object, judging from state bond issues provided in many other states.

In any event, the constitution should be amended to permit bonding for state highway purposes, and also by counties for road and bridge work.

The existing laws should be changed empowering and directing the State Highway Commission to investigate and study the present state

highway system and to lay out a more intelligent and comprehensive system which will better serve the state, counties, towns and cities, and insure that no highway will be improved under the state highway law which is not inherently a proper part of the system.

It should be prescribed that the entire state highway system be suitably marked and provided with mile-posts, guide-posts or signs, by and under the direction of the State Highway Commission. It should be provided that the marking or blazing of trails on any part of the state highway system be first approved by the state and, in order to prevent confusion, that the marking of all highways meeting or intersecting any part of the state highway system be regulated by the state highway department.

It is further recommended that there be placed on the statute books a provision as to the rule of the road; namely that, of two vehicles crossing at an intersection the one which is on the right shall have the right of way.

It would be desirable and of value in the interests of the state, counties and towns, to provide a bridge law whereby more extended state supervision would be required for drainage structures of and above a given size.

The motor vehicle registration law should be modified to provide for the regulation of traffic on the state highways by the State Highway Commission in the interests of safety and against damages, injury and loss of life. Consideration might be paid to the matter of requiring operators of automobiles to secure licenses. It shall also insure that no person of sixteen years of age or under be eligible to run a motor vehicle on the streets or public highways.

The appointment of a County Superintendent of Highways (permitting one for two counties instead of one for each where conditions warrant) should be made compulsory.

It would be desirable, in order to properly co-ordinate the work of road improvement by the counties, to provide that each county shall submit to the State Highway Commission for its approval a map showing a county highway system feeding into and interlacing the state highways, and to provide further that at least a specified per cent of the county's annual road and bridge fund be expended on such county highway system.

The working out of poll taxes should be abolished and the contract system made compulsory.

The Board of Highway Improvements law should be amended so as to provide for setting the date of annual meeting at the discretion of each board.

Convict labor at the State Penitentiary is by present law available for road work but the law should be amended so as to make such labor available to the State Highway Commission,—as for example, on the maintenance of the Missouri River bridge, manufacturing concrete pipe culverts, making sign-boards, etc.

In addition, other prison labor in county and town or city jails might

be made available for road work by appropriate changes in the code, with mutual profit and benefit to the prisoners and society.

Other general recommendations requiring no legislative action include:

The organization and operation of an active, virile state-wide good roads associations;

The establishment of a closer scheme of co-operation, both as to education on highway engineering and testing of materials used in state highway construction, between the state highway department and the state educational institutions;

The purchase of cement, steel, timber and other materials by the state and the furnishing of the same for use or construction by the contractors.

Other matters which probably need not be given immediate, but should receive future consideration are:

The establishment of civil service for government service or employment;

The separation of the State Engineer's and the State Highway Commission's offices or departments.

In review, the recommendations made are as follows:

A. Affecting the State Highway Commission.
   1. Adequate budget.
      a. To insure efficient administration and prevent criticism.
      b. To insure against loss of federal aid to the state.
      c. To provide sufficient clerical and engineering staffs.
      d. To engage and retain able engineers in competition with other state highway departments, etc., at salaries in keeping with the value and service of the engineering profession.
      e. To provide properly equipped division offices.
      f. To provide necessary equipment, such as surveying instruments, etc.
      g. To provide sufficient traveling expense for the efficient conduct of business.
      h. To issue a regular bulletin, other pamphlets and publicity relative to roads and bridges of interest to the people at large.
      i. To compile and publish the road laws of the state.
      j. To provide for adequate supervision of maintenance of state highways.
      k. To continue the principle of state aid, provide a larger amount of state aid, so that counties need pay less than 50% but not less than 25% of the cost of state highway or bridge construction.
   2. Appropriation to secure, store, use and keep in operation the excess war materials, trucks, etc.
   3. Appropriation and provision for the state's engaging in construction work on a large scale.
   4. Construction and maintenance of state highways with state funds, independent of county appropriations but with or without federal aid. (Bond issue.)

5. Amendment of constitution to permit state and county bonding for road and bridge work.
6. Marking of state highway system; registration of routes and supervision of "blazing" or marking intersecting roads.
7. Establishing rule of road at road intersections.
8. State bridge law.
9. Regulation of traffic and enforcement of law on state highways.

B. Affecting Counties, Townships, Etc.
1. Compulsory appointment of County Superintendent of Highways.
2. Establishing county systems of highways.
3. Abolition of working out poll taxes.
4. Optional date of annual meeting of Board of Highway Improvements.
5. Use of convict and of prison labor for road work.

C. General.
1. Establishing a state good roads association.
2. Establishing co-operative educational and testing arrangement between the state highway department and the state educational institutions.
3. State supplying contractors with materials for use on and in state highway work.
4. Establishment of civil serivce for all government positions.
5. Separation of State Engineer's Office and State Highway Department.

In the clerical force, salaries should be increased comparable to those paid in other state departments and in commercial circles generally. In the case of the engineering service, North Dakota ranks about fortieth among the states of the Union as to salaries paid and, with South Dakota, shares the doubtful honor of paying the lowest salaries in the northwest and west. Naturally there have been a large number of changes in the list of employees, which does not make for efficient and business-like work. The country at large will soon give, and many states already have given, more proper recognition to engineers for the valuable service rendered by them as a profession, and it will be necessary for North Dakota in self defense, so to speak, to be able to compete with other states in the employment of competent highway engineers.

The budget should provide for the proper equipment of the several division offices, some of which now are but mere makeshifts.

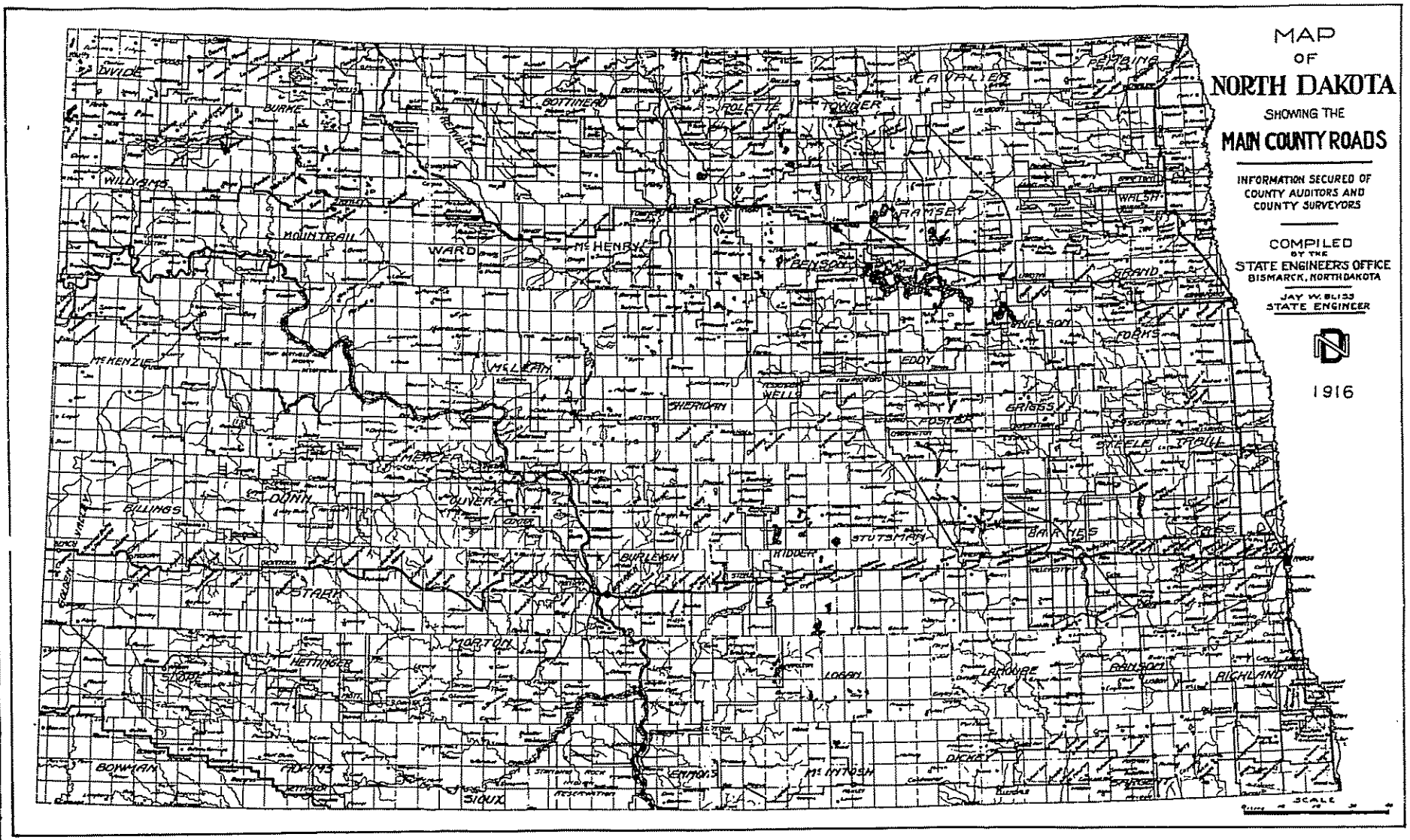
The budget should include provision for necessary equipment, furnishings, etc. The department has even experienced a shortage in transits and levels, the necessary tools of an engineer.

The budget should provide an ample sum for traveling expense in that the proper association might be had with county boards, proper inspections and investigations made, etc.

Provision should be made to enable the State Highway Commission to issue a regular bulletin, other pamphlets and publicity relative to roads and bridges of interest to the public.

Funds should be provided for the compilation and publication of the road and bridge laws of the state.

It would be desirable to expand the principle of state aid and, by providing a larger state aid fund, enable counties to secure state and federal aid on state highway projects up to 75% of the cost of construction. Such a plan would accelerate development in the newer and poorer counties of the state.


MAP
OF
NORTH DAKOTA
SHOWING THE
MAIN COUNTY ROADS
INFORMATION SECURED OF
COUNTY AUDITORS AND
COUNTY SURVEYORS
COMPILED
BY THE
STATE ENGINEERS OFFICE
BISMARCK, NORTH DAKOTA
JAY W. BLISS
STATE ENGINEER
1916
DIVIDE
BURKE
WILLIAMS
MOUNTRAIL
WARD
MCHENRY
RENVILLE
BOTTINEAU
ROLETTE
TOWNER
CAVALIER
PEMBINA
RAMSEY
WALSH
BENSON
GRAND
FORKS
NELSON
EDDY
MCKENZIE
MCLEAN
SHERIDAN
WELLS
FOSTER
GRIGGS
STEELE
TRAILL
MERCER
OLIVER
BURLEIGH
KIDDER
STUTSMAN
BARNES
BILLINGS
GOLDEN VALLEY
DUNN
STARK
MORTON
HETTINGER
GRANT
LOGAN
LAMOURE
RANSOM
RICHLAND
SARGENT
DICKEY
MCINTOSH
EMMONS
SIOUX
ADAMS
BOWMAN
RESERVATION
SCALE