NORTH DAKOTA STATE AGENCY
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EIGHTH BIENNIAL REPORT

of the

State Water Conservation Commission

and the

TWENTY-FIFTH BIENNIAL REPORT

of the

STATE ENGINEER

of

North Dakota

July 1, 1950 to June 30, 1952

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State Water Conservation Commission

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TWENTY-FIFTH BIENNIAL REPORT

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STATE ENGINEER

of

North Dakota

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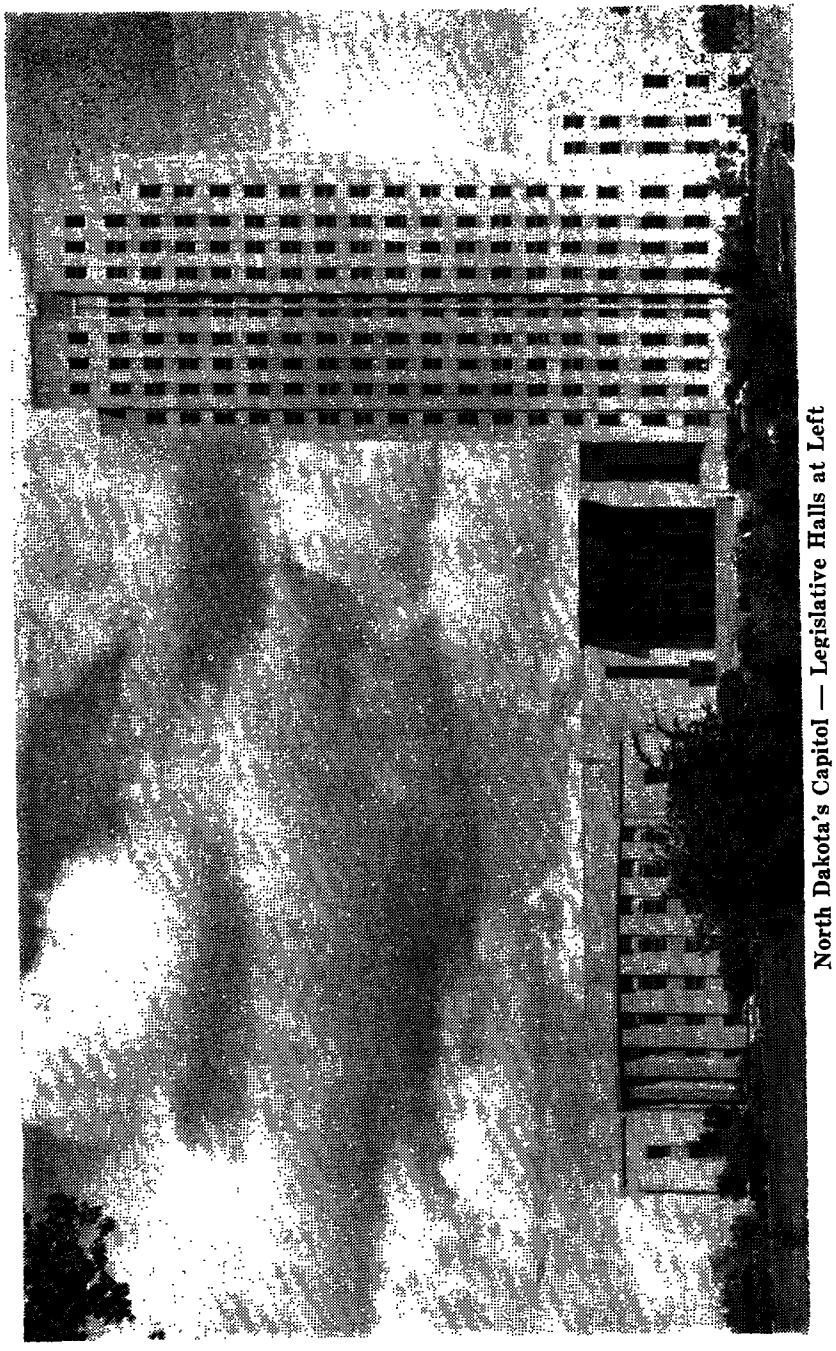

North Dakota's Capitol — Legislative Halls at Left

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Message from PRESIDENT THEODORE ROOSEVELT to First Irrigation Congress held in Bismarck, October 20, 21, 1903.

"I congratulate the irrigation congress of North Dakota. There is no measure with which my administration has been connected that I esteem as of more far-reaching and beneficial importance than the law ensuring the interest and aid of the national government to irrigation movement in the west and there is no cause more worthy of hearty support."

Excerpts from address of Major J. W. Powell to North Dakota Constitutional Convention, August 5, 1889.

"All other wealth falls into insignificance compared with which is to come from these lands from the pouring on them of the running streams of this country. Don't let these streams get out of possession of the people."

NORTH DAKOTA CONSTITUTION DECLARES:

ARTICLE 17. Sec. 210: "All flowing streams and natural water courses shall forever remain the property of the State for mining, irrigating and manufacturing purposes."

LETTER OF TRANSMITTAL

Honorable Norman Brunsdale
Governor of North Dakota

Sir:

In compliance with the provisions of law we transmit herewith for your information and consideration the Eighth Biennial Report of the activities of the North Dakota State Water Conservation Commission and the Twenty-Fifth Biennial Report of the North Dakota State Engineer covering the period of July 1, 1950 to June 30, 1952.

Respectfully submitted,

STATE WATER CONSERVATION COMMISSION
CURTIS OLSON, Vice Chairman
EINAR DAHL
EARLE F. TUCKER
A. M. CHRISTENSEN
MATH DAHL
OSCAR LUNSETH

J. J. Walsh
Secretary and Chief Engineer
State Engineer

Chapter I

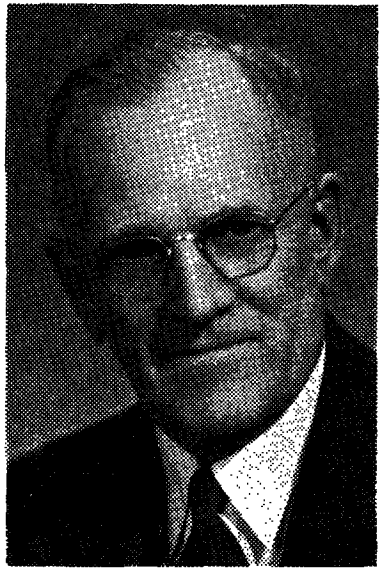
GENERAL DATA

Members of North Dakota State Water Conservation Commission

Einar Dahl

Curtis Olson

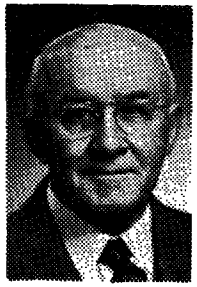
Earle F. Tucker



Governor Norman Brunsdale

Oscar Lunseth

A. M. Christensen



J. J. Walsh

Math Dahl

ORGANIZATION OF THE COMMISSION

The North Dakota State Water Conservation Commission was created in 1937 by the 25th Session of the Legislative Assembly of North Dakota. The Governor was designated as ex-officio chairman of the Commission and was given authority to appoint six other qualified electors of the state to serve as members of the Commission. In 1939 the legislature reduced the number of members of the Commission to five including the Governor and in 1949 the Commission was increased in size to seven members including the Governor and the Commissioner of Agriculture and Labor. The Commission selects one of its members to serve as Vice Chairman.

The State Water Conservation Commission is presently composed of the following members:

Name	Appointed	Present Term Ends
Governor Norman Brunsdale, Ex Officio Chairman	Jan. 2, 1952	
Curtis Olson, Valley City, Vice Chairman	Jan. 1, 1948	July 1, 1957
Einar Dahl, Watford City	April 3,1939	July 1, 1953
Earle F. Tucker	May 1, 1948	July 1, 1955
A. M. Christensen, Minot	May 27, 1949	June 30, 1955
Oscar Lunseth, Grand Forks	May 1, 1951	July 1, 1953
Math Dahl, Comm. of Agriculture & Labor Ex Officio member	May 27,1949	
J. J. Walsh, Secretary and Chief Engineer, State Engineer		

The Commission meets at irregular intervals at the call of the Chairman or, in his absence, of the Vice Chairman, either in the prinicipal office at Bismarck or at such special places as may be designated. During the period July 1, 1950 to June 30, 1952 the State Water Conservation Commission held 17 meetings in Bismarck and 3 meetings in other cities throughout the state.

PERSONNEL EMPLOYED BY THE COMMISSION

Full time personnel employed by the Commission on June 30, 1952 are as follows:

J. J. Walsh	Secretary and Chief Engineer, State Engineer
Vernon S. Cooper	Assistant Secretary
I. A. Acker	Special Assistant Attorney General
Don L. Nichols	Chief Construction Engineer
Edward S. Hagert	Chief Investigation Engineer
Marvin Sheldon	Construction Engineer
Harold E. Dodd	Construction Engineer
Albin S. Anderson	Field Engineer
Clarence A. Gamble	Assistant Field Engineer
Joe Kramer	Construction Foreman
Franz Nordstrom	Equipment Foreman
Wasilij Kudinow	Draftsman
Winifred Peterson	Chief Stenographer
Darlene Spitzer	Stenographer
Joyce Worle	Bookkeeper
Einar Berge	Technical Assistant
Fred J. Fredrickson	Planning Coordinator

In addition to the above personnel the Commission usually employs about twelve temporary employees as instrumentmen and rodmen to assist in survey work during the summer season and several crews of skilled construction operators, truck drivers and laborers for work on the various construction projects undertaken by the Commission.

MEETINGS, CONFERENCES AND HEARINGS

During the period of this report the State Water Conservation Commission has met 20 times to take up routine business of the Commission. Seventeen of these meetings were held in Bismarck and three in other cities in the state. At these meetings the Commission met with various delegations to discuss matters pertaining to the water resources of the state and development of these resources. Meetings were held at places indicated on the following dates:

July 11, 1950 — Bismarck	June 29, 1951 — Bismarck
August 12, 1950 — Bismarck	July 27, 1951 — Bismarck
September 5, 1950 — Fargo	August 17, 1951 — Bismarck
October 5, 1950 — Minot	October 24, 1951 — Bismarck
October 18, 1950 — Bismarck	November 29, 1951 — Bismarck
December 14, 1950 — Bismarck	January 11, 1952 — Bismarck
January 18, 1951 — Bismarck	March 14, 1952 — Bismarck
April 6, 1951 — Bismarck	April 21, 1952 — Bismarck
April 20, 1951 — Bismarck	May 19, 1952 — Bismarck
May 28, 1951 — Bismarck	June 14, 1952 — Bismarck

Conferences and meetings out of the state that have been attended by members or employees of the State Water Conservation Commission include Missouri Basin Interagency Committee and Sub Committee meetings, Yellowstone and Red River Compact meetings, International Joint Commission meetings, State and National Reclamation meetings, Congressional hearings on legislation affecting water development in North Dakota, and other conferences on various aspects of the water program in the state. In all over 40 meetings and conferences of this type have been attended by representatives of the Commission during the period of this report.

POWERS AND DUTIES, STATE WATER COMMISSION

Powers and Duties of the Commission. The commission shall have full and complete power, authority, and general jurisdiction:

1. To investigate, plan, regulate, undertake, construct, establish, maintain, control, and supervise all works, dams, and projects, public and private, which in its judgment may be necessary or advisable:

a. To control the low-water flow of streams in the state;

b. To impound water for the improvement of municipal and rural water supplies;

c. To control and regulate flood flow in the streams of the state to minimize the damage of such flood waters;

d. To conserve and develop the waters within the natural water-shed areas of the state and, subject to vested and riparian rights, to divert the waters within water-shed area to another water-shed area and the waters of any river, lake or stream into another river, lake or stream.

e. To improve the channels of the streams for more efficient transportation of the available water in the streams;

f. To provide sufficient water flow for the abatement of stream pollution;

g. To develop, restore and stabilize the waters of the state for domestic, agricultural and municipal needs, irrigation, flood control, recreation, and wildlife conservation, by the construction and maintenance of dams, reservoirs and diversion canals;

h. To promote the maintenance of existing drainage channels in good agricultural lands and to construct any needed channels;

i. To provide more satisfactory subsurface water supplies for the smaller villages of the state;

j. To finance the construction, establishment, and maintenance of public and private works, dams, and irrigation projects, which in its judgment may be necessary and advisable;

k. To provide for the storage, development, diversion, delivery, and distribution of water for the irrigation of agricultural land;

l. To provide for the drainage of lands injured by or susceptible of injury from excessive rainfall or from the utilization of irrigation water and, subject to the limitations prescribed by law, to aid and cooperate with the United States and any department, agency, or officer thereof, and with any county, township, drainage district or irrigation district of this state, or of other states, in the construction or improvement of such drains;

m. To provide water for stock; and

n. To provide water for the generation of electric power and for mining and manufacturing purposes;

2. To define, declare, and establish rules and regulations:

a. For the sale of waters and water rights to individuals, associations, corporations, and political subdivisions of the state, and for the delivery of water to users;

b. For the full and complete supervision, regulation, and control of the water supplies within the state; and

c. For the complete supervision and control of acts tending to pollute watercourses, for the protection of the health and safety of all the people of the state;

3. To exercise full power and control of the construction, operation, and maintenance of works and the collection of rates, charges, and revenues realized therefrom;

4. To sell, lease, and otherwise distribute all waters which may be developed, impounded, and diverted by the commission under the provisions of this chapter, for the purpose of irrigation, the development of power, and the watering of livestock, and for any other private or public use; and

5. To exercise all express and implied rights, power, and authority, that may be necessary, and to do, perform, and carry out all of the expressed purposes of this chapter and all of the purposes reasonably implied incidentally thereto or lawfully connected therewith.

6. To acquire, own and develop lands for irrigation and water conservation and to acquire, own and develop dam sites and reservoir sites and to acquire easements and rights-of-way for diversion and distributing canals.

7. To cooperate with the United States and any department, agency or officer thereof in the planning, establishment and maintenance of dams, reservoirs, diversion and distributing canals, for the utilization of the waters of the state for domestic and municipal needs, irrigation,

flood control, water conservation, generation of electric power and for mining, agricultural and manufacturing purposes, and in this connection the State Water Conservation Commission is hereby authorized, within the limitations prescribed by law, to acquire, convey, contribute or grant to the United States real and personal property, including land or easements for dams and reservoir sites and rights-of-way and easements for diversion and distribution canals.

THE STATE ENGINEER

The State Water Conservation Commission appoints the State Engineer, who shall be a qualified and experienced hydraulic engineer and also shall be an experienced irrigation engineer. He shall serve as secretary and chief engineer of the commission.

He is required to make a formal printed report to the Governor for the biennium preceding each legislative session. He passes on applications for permits to appropriate water, records the permit when granted, and issues certificate of construction of irrigation works or dams when completed, examines and approves plans and specifications for dams or irrigation works, inspects dam sites and construction works, and collects state fees for same as required by law.

His records are open to public inspection during business hours. He is the custodian of General Land office maps, field notes and records of surveys of land turned over by the government to the state.

He shall make such rules and regulations necessary to carry into effect the duties devolving upon his office, relating to applications for permits to appropriate water, for the inspection of works, for the issuance of licenses, and for the determination of rights to the use of water.

He cooperates with Federal agencies in making hydrographic surveys and investigation of each stream system and source of water supply in the state, and shall obtain and record all available data for the determination, development and adjudication of the water supply of the state, and other duties pertaining thereto.

He cooperates with the U. S. Geological Survey in making topographic maps and surveys.

GEOGRAPHICAL DATA CONCERNING NORTH DAKOTA

I. Boundary Lines (to nearest tenth mile).

A. North—310.0 miles—Follows the 49° parallel.

B. East—213.5 miles—air-line-river boundary approximately 416 miles.

C. South—360.6 miles—7th Standard parallel.

D. West—210.8 miles—27th Standard meridian.

II. Boundary Corners (to nearest second of latitude or longitude).

A. Northeast—49° 00′ 02″ N. Lat.; 97° 13′ 41″ W. Long.

B. Southeast—45° 56′ 07″ N. Lat.; 96° 33′ 41″ W. Long.

C. Southwest—45° 56′ 43″ N. Lat.; 104° 02′ 17″ W. Long.

D. Northwest—49° 00′ 00″ N. Lat.; 104° 02′ 53″ W. Long.

III. Areas

A. Of State ..... 70,665 Square Miles

1. Land area ..... 70,054 Square Miles

2. Water area ..... 611 Square Miles

B. Of Basins (Based on line of Bureau of Reclamation)

1. Red-Souris-Devils Lake to Hudson's Bay 29,500 Square Mi. (Approximately)

2. Missouri to Gulf of Mexico .....41,200 Square Mi. (Approximately)

DRAINAGE BASIN AREAS—NORTH DAKOTA

(Approximate areas in square miles)

I. Hudson Bay Drainage Basin			
a. Devils Lake	3,450 sq. mi.	5%	
b. Lower Red River	7,850 " "	11%	
c. Sheyenne River	7,350 " "	10%	
d. Souris River	8,550 " "	12%	
e. Wild Rice River	2,050 " "	3%	
		41%	29,250 sq. mi.
II. Missouri River Drainage Basin			
a. Cannonball River	4,550 sq. mi.	7%	
b. Grand River	950 " "	1%	
c. Heart River	3,150 " "	4%	
d. James River	7,200 " "	10%	
e. Knife River	2,600 " "	4%	
f. Little Missouri River	4,650 " "	7%	
g. Missouri River (main stem)	17,700 " "	25%	
h. Yellowstone River	600 " "	1%	
		59%	41,400 sq. mi.
TOTAL			70,650 sq. mi.

HISTORY OF IRRIGATION

The practice of irrigation had been established when the writing of history began. Perhaps the earliest irrigation practiced that can be traced by history was in China. As early as 2,000 BC there was irrigation of lands in the Nile Valley in Egypt as well as in adjacent areas of Babylonia, Palestine and India. Some of the canals supposed to have been built for these early systems are still in use. Other areas in which irrigation was practiced in early history are in Syria, Persia, India, Java and parts of Italy. In both Egypt and India, irrigation has been found to be the "very condition of existence both of government and the people."

In America the prehistoric Indians of the Southwest practiced irrigation in New Mexico. Even today traces of ditches that were dug to transport water to their fields can be seen. The early Spanish missionaries who came to the Southwestern part of the United States brought with them knowledge of irrigation as they practiced it in their Mediterranean homes. From nearby streams they watered gardens and fields around their missions.

Modern irrigation as it is known in the United States today dates from July 24, 1847 when the Mormons broke some desert land in the Salt Lake Valley of Utah and diverted waters from what is now City Creek to the land by means of a plow furrow. From this simple beginning, modern irrigation has grown until now there are approximately 22 million acres in the United States under irrigation.

In 1902 the U. S. Reclamation Service was created. The prinicpal purpose of this agency was to aid in the development of the public lands of the west. During its 50 years of operation this agency, now designated as the Bureau of Reclamation, has provided more than 6,000,000 acres with a new or supplemental supply of water. The 100,000 farms on these projects produce a great variety of crops including citrus and decidious fruits, cotton, vegetables, truck crops, and all feed, forage and field crops. In addition the power installations in connection with these projects is well in excess of 3,500,000 kilowatts. In 1950 the total kilowatts produced exceeded 20 billion. The total cost of the many projects built by the Bureau of Reclamation, including the Grand Coulee dam and the huge million acre Columbia Basin project, the Hoover Dam, over 100 other storage dams and 65 diversion dams, over 16,000 miles of canals as well as the many other allied works, is approximately two billion dollars. The gross value of crops produced on these projects since their construction is in excess of seven billion dollars.

In addition to the 22 million acres already under irrigation, there are in the 17 western states a total of 17 million acres that are potentially irrigable. Of these 17 million acres about 6 million acres are in the Missouri River Basin of which over 1,200,000 are in North Dakota. As investigations continue and techniques improve it may prove feasible to irrigate other areas not included in the present plans.

IRRIGATION IN NORTH DAKOTA

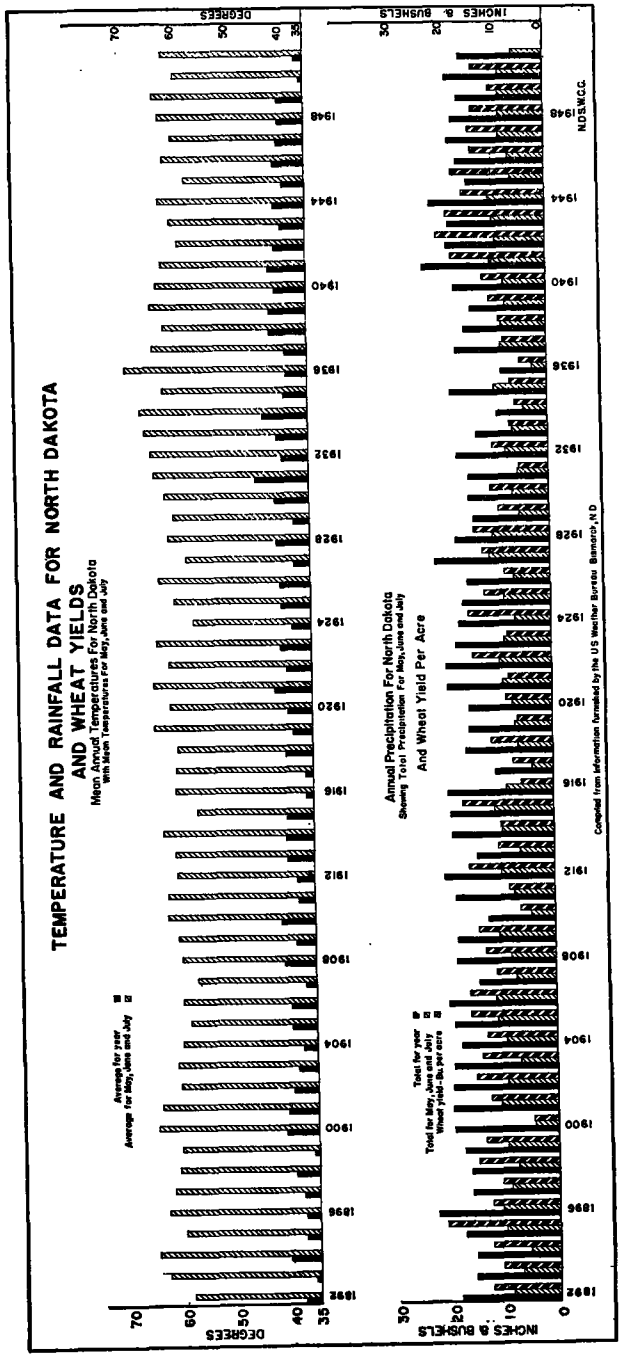
Records show that irrigation in North Dakota dates back to 1889 its first year of statehood when 445 acres were irrigated. In that same year at a convention at Grand Forks, North Dakota the public attention was attracted to the value of irrigation in this state through the adoption of a memorial whereby Congress was urged to take preliminary steps to the construction of a canal from the Missouri River in Montana eastward through Montana and North Dakota to the Red River. In 1891 North Dakota established a department of irrigation and forestry. This department functioned until 1901 when the Legislature abolished it because of the lack of interest shown on the part of the stock growers and ranchers in some areas. With the passage of the Federal Reclamation Act by congress in 1902 considerable enthusiasm in North Dakota resulted.

This new interest in irrigation in the state lead to the holding of the first irrigation congress in Bismarck, North Dakota, in October, 1903. At this meeting the North Dakota Irrigation Association was formed. This association was active in helping to secure for the State the Williston and Buford-Trenton projects.

In the summer of 1904 a number of prominent citizens of the state advanced $5,000 to employ Professor E. F. Chandler of the University of North Dakota to act as State Engineer and to assist in bringing to the attention of the Reclamation Service the irrigable tracts of land in the state. As a result of Professor Chandler's work, the State Legislature in 1905 passed a state irrigation code. This code provided for the creation of the office of State Engineer. A. L. Fellows of Denver, Colorado was appointed to fill the position of State Engineer and served in that position until July 1, 1907. In the following years, through the efforts of the office of the State Engineer, the interest of the United States Reclamation Service was obtained in several reclamation and irrigation projects in North Dakota.

During North Dakota's first years of statehood the number of acres irrigated in the state and the size of the individual tracts were small. In 1899 the Census report shows that there were 4,872 acres in North Dakota under irrigation with an average of 90.2 acres per farm on which irrigation was practiced. The total irrigated acreage in North Dakota has increased gradually since then until at the present there are an estimated 70,000 acres irrigated in the state. Included in this area are individual projects and land in organized irrigation districts.

By far, the greater part of the irrigated area in North Dakota is located in the western part of the state, mainly in Williams and McKenzie counties where organized irrigation districts have been operating since the early 1900's. These districts include the Lower Yellowstone, located in McKenzie county and constructed in 1910 by the federal government, the Lewis and Clark project in McKenzie county constructed in 1939 by the State Water Conservation Commission, the Sioux project in McKenzie county constructed in 1940 constructed by the Commission and the Buford-Trenton project in Williams county constructed by the federal government in 1940. Crop returns from these projects show that the income per acre of irrigated land is more than double of that of non irrigated land in the same area.



A summary of the areas in North Dakota presently irrigated and those potentially irrigable are as follows:

Areas Under Irrigation in North Dakota

Name	Location	Acres	Source of Water
Lower Yellowstone	McKenzie County	20,000	Yellowstone River
Lewis and Clark	McKenzie County	5,000	Missouri River
Buford-Trenton	Williams County	14,000	Missouri River
Sioux	McKenzie County	700	Yellowstone River
Fort Clark (Under construction)	Mercer County	2,100	Missouri River
Eaton Flood Irrigation Project	McHenry County	7,000	Souris River
Individual Projects (Estimated)	All Sections	25,000	Various
Total Irrigated Acres		73,800	

Investigated Potential Irrigable Areas — Missouri Diversion

	Acres
Souris Loop (Velva, Mohall, Bottineau, Towner)	705,000
Esmond to Oberon (North of Sheyenne River)	80,000
Tokio, Warwick, McVille	40,000
New Rockford, Sheyenne	60,000
Harvey, Fessenden, Carrington	70,000
Jamestown	10,000
Oakes, Forman, N. D., Britton, S. D.	125,000
Total — Missouri Diversion	1,090,000 Acres

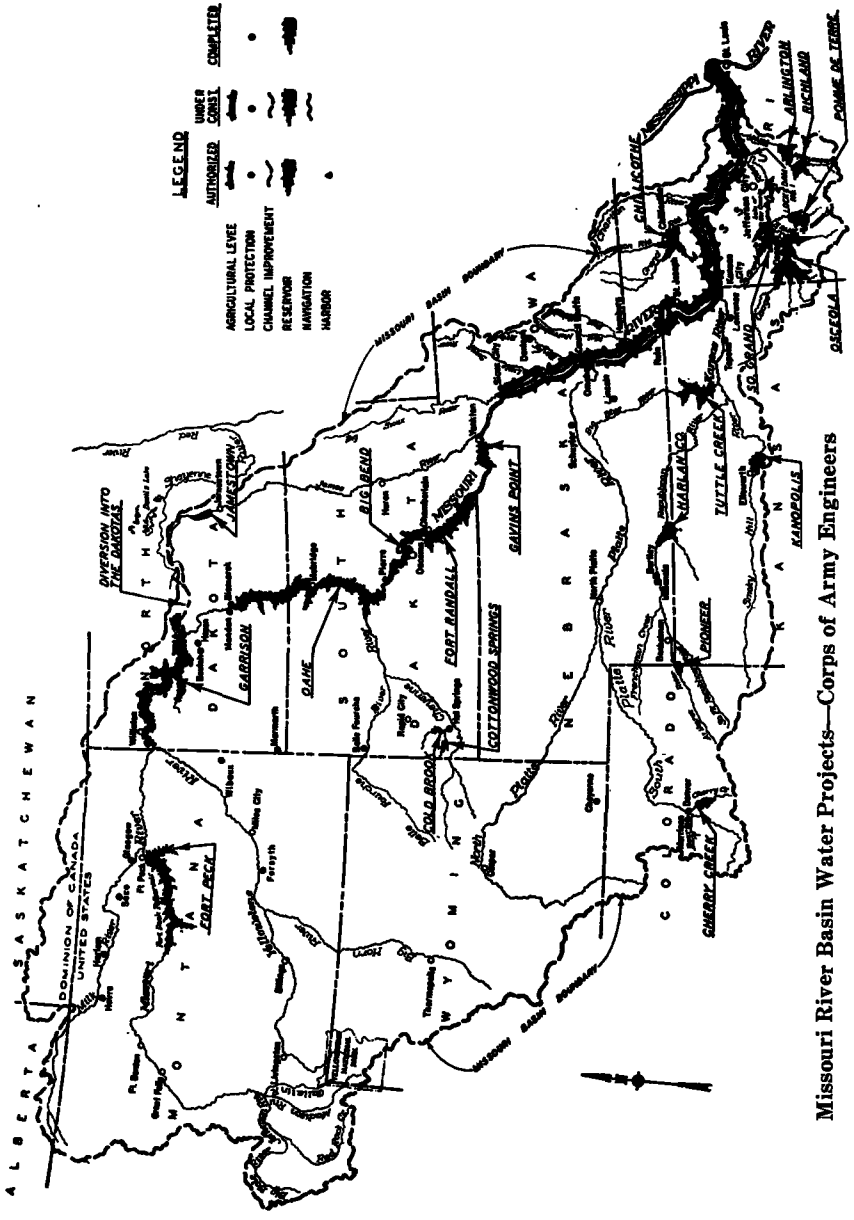
Investigated Potential Irrigable Areas — Pumping Projects

Name	Source of Water Supply	Acres
Williston Unit	Missouri River	9,000
Nesson Unit	Missouri River	7,400
Hancock Flats Unit	Missouri River	5,400
Coleharbor Unit	Missouri River	45,000
Oliver-Sanger	Missouri River	8,300
Painted Woods Unit	Missouri River	2,700
Manley	Missouri River	1,200
Wogansport	Missouri River	1,600
Square Butte Unit	Missouri River	1,900
Burnt Creek Unit	Missouri River	1,300
Bismarck Unit	Missouri River	8,500
Little Heart Unit	Missouri River	2,300
Horsehead Flats	Missouri River	6,500
Winona Unit	Missouri River	4,500
Fort Yates	Missouri River	4,700
Little Missouri Division	Little Missouri River	20,000
Knife Division	Knife River	15,400
Dickinson Unit	Heart River	900
Heart-Butte Unit	Heart River	13,100
Cannonball Unit	Cannonball River	12,400
Thunderhawk Unit	Cedar River	6,100
Bowman-Haley	Grand River	5,000
Total — Pumping Projects		183,200 Acres
Total Potential Irrigated Areas Investigated		1,273,200 Acres

Areas under Investigation:

Walhalla Area, Larimore Area, Sheyenne Delta Area, Steele Area } Estimated to be 1½ million acres in these four areas to be investigated

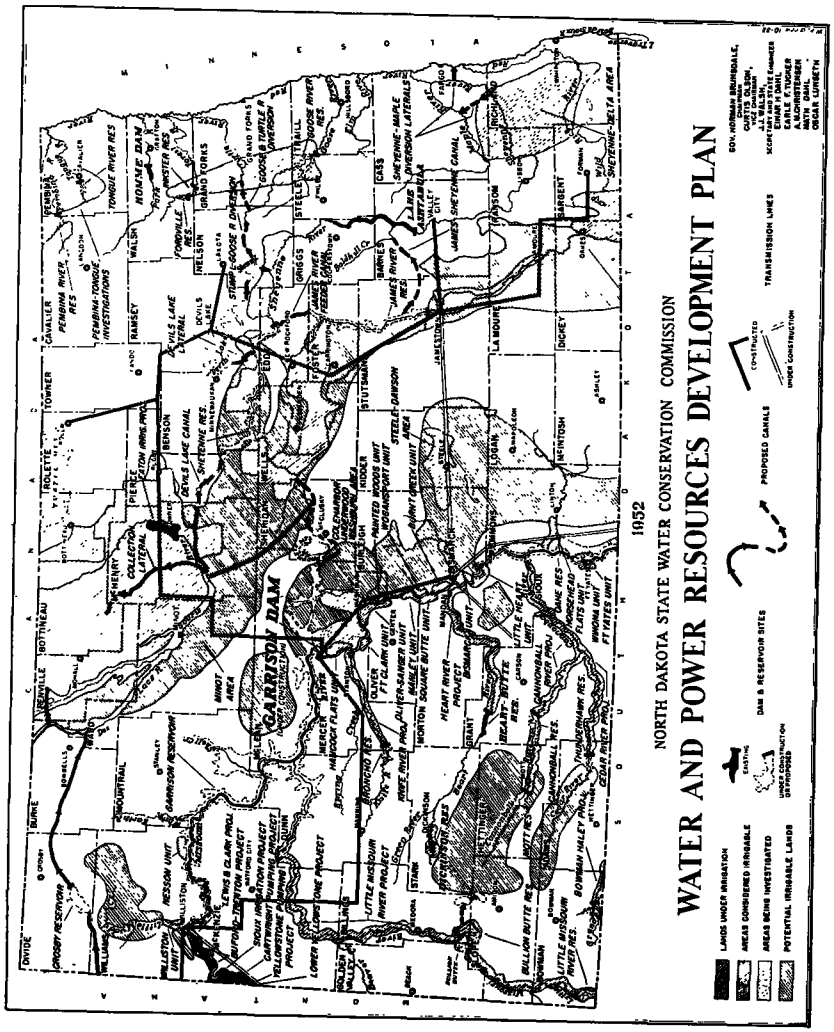
As the development of irrigation in North Dakota progresses, more farmers, who now live in areas of normally abundant rainfall, will become aware of the advantage of having a water supply available for their crops when needed, thereby averting the effects of dry periods they often have to contend with.



Missouri River Basin Water Projects—Corps of Army Engineers

Chapter II

NORTH DAKOTA STATE WATER CONSERVATION COMMISSION ACTIVITIES



SUMMARY OF NORTH DAKOTA STATE WATER CONSERVATION COMMISSION ACTIVITIES

Since its organization in 1937 the State Water Conservation Commission has been active in all phases of the development of the water resources of North Dakota. The Commission's program has included the following:

1. Conducting surveys of areas in the state for use in planning for the development of irrigation and drainage.
2. Designing and constructing irrigation works.
3. Cooperating in and assisting in the coordination of programs of federal agencies for the development of the water and other resources of the Missouri River Basin as pertains to North Dakota.
4. Cooperation with the U. S. Geological Survey in conducting topographic, hydrographic and underground water surveys.
5. Organization of conservation and irrigation districts.
6. Cooperating with local groups and federal agencies in the developing of flood control projects, and many other incidental duties in administering the water laws and furthering the development of the water resources of the state.
7. Processing water right applications received from individual farmers, cities, and industries.
8. Cooperating in conducting soil surveys in areas proposed for irrigation development.
9. Negotiating river compacts with other states.
10. The construction and repair of small dams.
11. Assistance to counties for the construction and repair of legal drains, and to irrigation districts for repairs to irrigation works.

A summary of the accomplishments in each of these phases of the Commission's program is as follows:

In the construction and repair of small dams in the state the Commission has, since the beginning of this program in 1939, assisted in the repair and construction of 91 dams located in all sections of the state. The Commission has received appropriations totaling $329,000 for the period July 1, 1939 to June 30, 1953 of which $211,757.22 has been used to date and a balance of $100,154.18 is available for the remainder of the current biennium. Cooperating agencies during this period have contributed $138,187.59 toward the cost of their repairs. During the period

covered by this report 33 dams were repaired or reconstructed at a cost of $90,520.56 to the Commission and $82,400.59 to other cooperating groups.

The program of assisting counties and irrigation districts in work on legal drains and irrigation facilities has included assistance to drainage districts in 12 counties and 4 irrigation districts in the state since 1945 when the first appropriation for this program was received. Since that time the Commission has paid $537,303.14 to these agencies for the construction or repair of 117 projects. The payments made by the State Water Conservation Commission represents approximately 40% of the construction costs of this work. During the period covered by this report 10 counties and irrigation districts have received $159,707.54 from the Commission for the construction and repair of 42 projects. An additional $111,305.10 was allocated to 12 counties and irrigation districts to pay the states 40% share of the costs of work underway on 20 projects.

Accomplishments of the Commission's cooperative programs with the various branches of the U. S. Geological Survey since their beginnings include the topographic mapping of 11,710 square miles of the state, gathering and compiling stream flow records on the Missouri, Souris and Red Rivers and their tributaries to provide basic data needed in planning the water resource development in the state, and conducting ground water surveys for 32 cities and towns in North Dakota to locate an adequate ground water supply for a municipal water supply for these localities. During the period of this report a total of about 5,000 square miles of the state was topographically mapped, stream flow measurements were gathered from 70 gaging stations located at various points on rivers and streams in the state of which the State Water Conservation Commission cooperated in maintaining 30, and ground water studies were conducted for 6 localities, planned for 2 others and reports for 6 others were completed, three of which have been released.

During the past biennium the Engineering Department of the Commission have surveyed and mapped an estimated 120,000 acres of land in detail for use in planning and developing the water resources of the state for irrigation and other beneficial use. Included in the works the Water Commission surveyors have completed is 72,000 acres in the Jamestown-Oakes area, 42,000 acres in Cannonball-Cedar River areas as well as completing surveys for dam sites and many other miscellaneous projects.

Negotiations for a compact on many of the interstate and international streams flowing through North Dakota have been instituted since the Commission was organized including the Little Missouri, Yellowstone, Red, Souris and others. During the past two years a compact was enacted for the division of the waters of the Yellowstone River between the states of Wyoming, Montana and North Dakota. This compact as approved by the states was ratified by Congress and enacted into law. The Commission has also participated in conferences of the International

Joint Commission concerning problems of division of water of the Souris and Red Rivers between the United States and Canada and has conducted preliminary negotiations for a compact with Minnesota relative to the division of the waters of the Red River of the North.

The extensive activity of the various federal agencies in developing the water resources of North Dakota and of the Missouri River Basin has required an active interest in assisting in the coordination of the programs of the federal and state agencies and cooperating with all groups who are interested in the program. The Governor, as a member of the Missouri Basin Inter-Agency Committee, has been in constant close contact with the Missouri River Basin Resource Development Program. Other groups with whom the Commission has participated conferences are the North Dakota Resources Council, the Missouri River States Committee, the National Reclamation Association, the State Reclamation Association, the National Rivers and Harbors Congress, the National Water Conservation Conference and others.

At the present time over 600 water-right applications have been processed by the State Engineer and the State Water Conservation Commission since the enactment of the law providing for water right permits in 1905. These permits are, for the most part, for individual farmers, cities and industries. To date the applications approved cover the appropriation of water for the irrigation of 93,320 acres of which 45,148 acres are in organized irrigation districts and 48,172 acres for individual farmers. During the period of this report 79 water-right applications have been pocessed for the irrigation of 10,212 acres, and 41 applications for water to irrigate 5,300 acres are pending.

In 1948 the Commission entered into a cooperative agreement with the Department of Agriculture through the North Dakota Agricultural College to conduct soil surveys of areas in the state for which irrigation is possible. To date a total of 170,000 acres have been classified in this program. The Commission has also cooperated with the Bureau of Reclamation during the past year in conducting a resurvey of that portion of the Missouri-Souris unit located west of the Des Lacs River.

There are 8 organized irrigation districts and 5 organized water conservation and flood control districts in North Dakota. The irrigation districts include 48,700 acres and the water conservation and flood control districts include 4 entire counties and a portion of the fifth. During the past biennium 1 new water conservation and flood control district was organized. In addition the Commission assisted in organization and operation problems of several of the irrigation districts.

Since its organization the Commission has designed and constructed the works for two irrigation districts in the state, both of which have operated successfully since their completion. Although no construction program was undertaken during the past biennium, work was carried on investigating areas for possible future small project development.

Assistance from the Commission has been given several localities in the state in providing flood control works for those areas by coordinating the activities of local and federal groups, providing necessary assurances and investigating and planning for the project itself. Some of the proposals in which the Commission has cooperated during the past biennium include the Rush River snagging and drainage project in Cass County, levee protection in the Heart River Basin in Morton County, and the Eaton irrigation project.

In administering the water laws of North Dakota there are a multitude of administrative activities in which the Commission is involved. Activities such as providing information pertaining to data on file with the Commission and the programs for development of the water resources of the state, making engineering investigations to determine the feasability of various proposals as well as to provide a satisfactory basis for solution to various problems of water control and development, and preparing reports for various agencies and groups are but a few of these miscellaneous functions of the Commission.

A detailed discussion of these and other activities of the Commission is contained in this chapter under appropriate headings.

MAINTENANCE OF DAMS

There are in North Dakota over 1,800 small dams most of which were built during the drouth years of the 1930's by various Federal Agencies. The reservoirs created by these dams serve a number of conservation needs. They provide water for small irrigation projects, water for livestock, water for municipal use, for recreation purposes and for the conservation and propagation of fish and wildlife. These reservoirs provide many benefits to the regions of the state that would be devoid of such facilities were it not for the existence of the dams.

When the programs of these Federal Agencies were terminated, no provision was made for the maintenance and repair of these structures with any federal or state department. The counties were delegated to assume the responsibility for this work on those dams in their county that were outside of water conservation districts. At that time there were few such districts organized so this work fell almost entirely on the counties. The counties had difficulty in providing the necessary funds by providing for them in their budget, and they could not make a special levy for this purpose without legislative authority. Another problem that faced the counties was that of providing trained engineering personnel to supervise a program of this nature.

Recognizing these difficulties that confronted the counties, the state legislature in 1939 appropriated funds to the State Water Conservation Commission to assist in repairing these small dams. Since the state's

dam maintenance program was established in 1939, the legislature has appropriated additional funds each biennium to take care of the increased demand for this work.

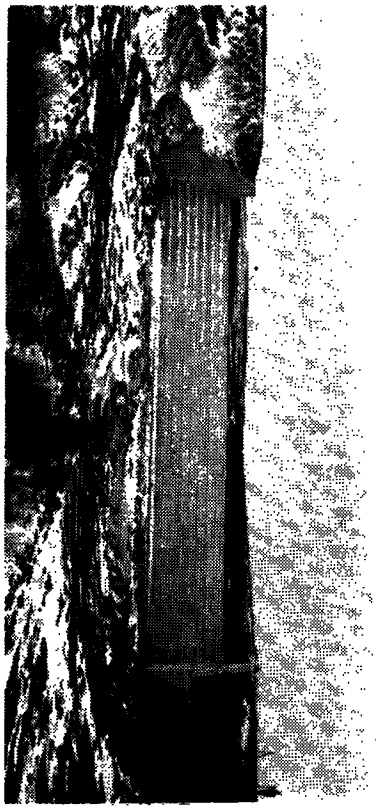
The Commission's program provides for investigation, survey, design and supervision of the actual construction. The actual repair work for nearly all of these projects is done by Commission crews using state equipment. The work is financed on a cooperative basis with the Commission and counties or locally interested groups participating. The State Game and Fish Department shares in the cost of projects in which fishing and wildlife benefits will prevail.

The maintenance work involved in the program ranges from the reconstruction of spillways to small jobs of repairing damaged portions of existing structures. The Commission has followed the practice of repairing existing structures as economically as possible. Concrete construction is used to replace those portions of the structures in need of repair. The work consists mainly of repairs to the damaged spillway structure itself including placement of sheet steel piling or concrete cutoff walls, repair or replacement of overflow sections with either rubble, plain or reinforced concrete materials and, when required, the replacement of riprap and earth fill material.

There are a number of federal constructed dams in the state that have been damaged by floodwaters and frost action during the recent years of extremely heavy precipitation where maintenance work has been neglected and the water is gradually undermining and destroying the structures. Where damages to spillways are small they should be repaired as soon as possible.

The State Water Conservation Commission program of repair and construction of small dams since its inception in 1939 has consisted of the repair to 91 dams located in all sections of North Dakota. For this work the state legislature has appropriated $329,000.00 to the Commission from July 1, 1939 to June 30, 1953. A total of $211,757.22 of this amount has been utilized in the Commission's dam repair program and a balance of $100,154.18 is available for the remainder of the current biennium. Cooperating agencies have contributed $138,187.59 to the cost of the repairs made since this program was started.

During the period covered by this report 33 spillway structures were reconstructed and repaired, of these 21 were major reconstruction jobs and 12 were smaller repair jobs to existing spillways. The total costs of this work that is chargeable to these projects is $172,921.15 with the costs of the individual jobs ranging from $16.00 to $53,752.41. The 33 structures repaired were located in 19 counties throughout the state.



Cedar Dam Spillway

Cedar Dam during 1952 Spring Run-off

Yanktonai Dam and Reservoir

DAMS CONSTRUCTED OR REPAIRED—July 1, 1950 - June 30, 1952

Project No.	Name	County	Water Commission	Game and Fish	U. S. Fish & Wildlife	Local	Total Cost
390	Beaver Lake	Logan	$ 8.00	$	$	$ 8.00	$ 16.00
488	Benzi	McLean	35.96	.....	.....	35.96	71.92
453	Berger	Barnes	4,493.03	2,000.00	.....	2,302.75	8,795.78
264	Braddock	Emmons	168.69	168.68	.....	168.68	506.05
353	Cedar Dam	Slope	14,752.41	9,000.00	30,000.00	.....	53,752.41
510	Crystal Springs	Stutsman	680.39	.....	.....	.....	680.39
346	Epping	Williams	104.78	.....	.....	104.78	209.56
389	Fessenden	Wells	1,170.29	.....	.....	645.83	1,816 12
482	Foogman	Traill	2,804.08	.....	.....	2,804.09	5,608.17
491	Frey	Stutsman	1,909.34	500.00	.....	300.00	2,709.34
257	Green River	Stark	662.98	662.97	.....	.....	1,325.95
484	Hoskins Lake	McIntosh	2,017.79	516.18	.....	1,476.19	4,010.16
253	Jackson	McKenzie	21,162.15	1,700.00	.....	1,742.00	24,604.15
354	Jamestown	Stutsman	8,973.58	.....	.....	2,890.00	11,863.58
242	Jund	McIntosh	314.31	314.31	.....	314.31	942.93
	Lake Ensign	Barnes	327.20	.....	.....	327.20	654.40
330	Lake Metigoshe	Bottineau	1,093.84	500.00	.....	500.00	2,093.84
498	Lake Patricia	Morton	.....	.....	4,033.88	.....	4,033.88
485	LaMoure	LaMoure	272.38	.....	.....	200.00	472.38
316	Lisbon	Ransom	1,024.74	700.00	.....	700 00	2.424 74
512	Nieuwsma	Emmons	716.66	.....	.....	358 33	1,074.99
490	Noonan	Divide	1,391.69	.....	.....	1,250.00	2,641.69
394	Odland	Golden Valley	1,219.84	1,219.84	.....	1,219.84	3,659.52
495	Petersen	Nelson	453.77	326.89	.....	200.00	980.66
499	Ray	Williams	117.97	.....	.....	117.97	235.94
381	Schlenker	McIntosh	177.85	.....	.....	16.00	193.85
483	Skedsvold	McKenzie	4,531.00	1,000.00	.....	1,479.50	7,010.50
431	Strawberry Lake	McLean	269.62	269.61	.....	49.20	588.43
486	Twin Lakes	Williams	2,204.85	.....	.....	2,204.84	4.409.69
440	Watford City	McKenzie	2,078.16	.....	.....	.....	2,078.16
487	Welk	Emmons	1,487.00	.....	.....	1,487 00	2.974.00
380	Williams Creek	Golden Valley	3,286.42	1,644.70	.....	1,785.00	6,716.12
364	Yanktonai	McLean	10,609.79	.....	.....	3,156.06	13,765.85
			$ 90.520.56	$ 20,523.18	$ 34,033.88	$ 27,843.53	$172,921.15

A summary of data concerning the dams that were repaired during the period of this report is as follows:

Berger Dam—Barnes County

Scope of Work: Reconstruction of Spillway Structure.

Sponsors: State Water Conservation Commission, State Game and Fish Department, Barnes County.

Quantities: Reinforced Concrete—75 cubic yards, Rubble Concrete—200 cubic yards, Reinforcing Steel—5,300 pounds, Riprap—60 cubic yards, Earthwork—500 cubic yards.

Cedar Dam—Slope County

Scope of Work: Reconstruction of Spillway Structure, Embankment Raised, Construction of Emergency overflow section.

Sponsors: State Water Conservation Commission, State Game and Fish Department, Federal Aid Division—Game and Fish Department.

Quantities: Reinforced Concrete—280 cubic yards, Rubble Concrete—760 cubic yards, Reinforcing Steel—24,645 pounds, Sheet Steel Piling—915 square feet, Riprap—300 cubic yards, Grouted Riprap—80 cubic yards, Earthwork—6,000 cubic yards.

Fessenden Dam—Wells County

Scope of Work: Placement of Concrete cutoff wall and spillway repairs.

Sponsors: State Water Conservation Commission, City of Fessenden.

Quantities: Plain Concrete—30 cubic yards, Rubble Concrete—40 cubic yards.

Foogman Dam—Traill County

Scope of Work: Reconstruction of abutment section of Spillway structure.

Sponsors: State Water Conservation Commission, City of Hillsboro.

Quantities: Reinforced Concrete—40 cubic yards, Rubble Concrete—75 cubic yards, Reinforcing Steel—2,300 pounds, Sheet Steel Piling—180 square feet, Riprap—40 cubic yards, Earthwork—150 cubic yards.

Frey Dam—Stutsman County

Scope of Work: Placement of cutoff wall and construction of secondary spillway drop.

Sponsors: State Water Conservation Commission, Stutsman County Wildlife Federation.

Quantities: Rubble Concrete—120 cubic yards, Sheet Steel Piling—270 square feet, Riprap—30 cubic yards.

Hoskins Lake Dam—McIntosh County

Scope of Work: Spillway structure widened, training walls, apron and secondary drop constructed, embankment raised and outflow channel excavated.

Sponsors: State Water Conservation Commission, City of Ashley, McIntosh County.

Quantities: Reinforced Concrete—15 cubic yards, Rubble Concrete—185 cubic yards, Reinforcing Steel—700 pounds, Riprap—60 cubic yards, Earthwork—1,000 cubic yards.

Jackson Dam—McKenzie County

Scope of Work: New spillway and levee constructed and sheet steel piling core wall through embankment placed.

Sponsors: State Water Conservation Commission, State Game and Fish Department, McKenzie County.

Quantities: Reinforced Concrete—195 cubic yards, Rubble Concrete—155 cubic yards, Reinforcing Steel—9,800 pounds, Steel Sheet Piling—240 square feet, Riprap—180 cubic yards, Earthwork—14,000 cubic yards.

Jamestown Dam—Stutsman County

Scope of Work: Replacement of abutment section and large portion of weir of spillway and control structure improved.

Sponsors: State Water Conservation Commission, City of Jamestown.

Quantities: Reinforced Concrete—40 cubic yards, Rubble Concrete—220 cubic yards, Reinforcing Steel—1,510 pounds, Steel Sheet Piling—1,150 square feet, Riprap—40 cubic yards, Earthwork—500 cubic yards.

Lake Metigoshe Dam—Bottineau County

Scope of Work: Spillway Replaced, apron reconstructed, Steel piling cutoff wall placed.

Sponsors: State Water Conservation Commission, State Game and Fish Department, Local Citizens.

Quantities: Reinforced Concrete—12 cubic yards, Rubble Concrete—25 cubic yards, Reinforcing Steel—530 pounds, Steel Sheet Piling—150 square feet, Riprap—20 cubic yards.

Lake Patricia Dam—Morton County

Scope of Work: Spillway repaired; cutoff wall placed, Diversion dam and channel repaired and cleaned out.

Sponsors: Federal Aid Division, Game and Fish Department.

Quantities: Rubble Concrete—50 cubic yards, Steel Sheet Piling—920 square feet, Grouted Riprap—20 cubic yards, Earthwork—900 cubic yards.

Lisbon Dam—Ransom County

Scope of Work: Placement of spillway apron and secondary, Rubble Concrete drop, Repair upstream wingwall.

Sponsors: State Water Conservation Commission, State Game and Fish Department, City of Lisbon.

Quantities: Rubble Concrete—70 cubic yards, Riprap—40 cubic yards, Earthwork—250 cubic yards.

Nieuwsma Dam—Emmons County

Scope of Work: Repairs to spillway.

Sponsors: State Water Conservation Commission, State Game and Fish Department, Emmons County.

Quantities: Rubble Concrete—50 cubic yards.

Noonan Dam—Divide County

Scope of Work: Reconstruction of spillway structures.

Sponsors: State Water Conservation Commission, City of Noonan.

Quantities: Reinforced Concrete—8 cubic yards, Rubble Concrete—105 cubic yards, Reinforcing Steel—330 pounds.

Odland Dam—Golden Valley County

Scope of Work: Spillway extensively repaired including main and wingwall sections.

Sponsors: State Water Conservation Commission, State Game and Fish Department, Golden Valley County.

Quantities: Rubble Concrete—210 cubic yards, Earthwork—200 cubic yards.

Skedsvold Dam—McKenzie County

Scope of Work: Reconstruction of spillway structure.

Sponsors: State Water Conservation Commission, State Game and Fish Department, McKenzie County, City of Alexander.

Quantities: Reinforced Concrete—60 Cubic yards, Rubble Concrete—160 cubic yards, Plain Concrete—5 cubic yards, Reinforcing Steel—3,400 pounds, Riprap—40 cubic yards, Earthwork—500 cubic yards.

Twin Lakes Dam—Williams County

Scope of Work: New earthfill and riprap and old embankment raised, new outlet and spillway drops constructed.

Sponsors: State Water Conservation Commission, City of Williston.

Quantities: Reinforced Concrete—10 cubic yards, Rubble Concrete—25 cubic yards, Reinforcing Steel—560 pounds, Steel Sheet Piling—660 square feet, Riprap—700 cubic yards, Earthwork—10,250 cubic yards.

Williams Creek Dam—Golden Valley County

Scope of Work: Construction of new spillway structure.

Sponsors: State Water Conservation Commission, State Game and Fish Department, Golden Valley County.

Quantities: Reinforced Concrete—45 cubic yards, Rubble Concrete—150 cubic yards, Reinforcing Steel—2,660 pounds; Steel Sheet Piling—195 square feet, Riprap—50 cubic yards, Earthwork—2,000 cubic yards.

Watford City Dam—McKenzie County

Scope of Work: Repairs to concrete cutoff wall.

Sponsors: State Water Conservation Commission.

Quantities: Rubble Concrete—10 cubic yards, Earthwork—100 cubic yards.

Welk Dam—Emmons County

Scope of Work: Spillway repaired and additional apron placed.

Sponsors: State Water Conservation Commission, Emmons County.

Quantities: Reinforced Concrete—30 cubic yards, Rubble Concrete—120 cubic yards, Reinforcing Steel—1,700 pounds.

Green River Dam—Stark County

Scope of Work: Abutments reinforced and steel piling cutoff wall placed.

Sponsors: State Water Conservation Commission, State Game and Fish Department.

Quantities: Rubble Concrete—75 cubic yards, Steel Sheet Piling—175 square feet.

Yanktonai Dam—McLean County

Scope of Work: Reconstruction of spillway structure.

Sponsors: State Water Conservation Commission, McLean County.

Quantities: Reinforced Concrete—115 cubic yards, Rubble Concrete—230 cubic yards, Plain Concrete—70 cubic yards, Reinforcing Steel—5,300 pounds, Riprap—60 cubic yards.

Minor repair jobs completed during the period of this report are as follows:

Beaver Lake Dam—Logan County

Sponsors: State Water Conservation Commission, Local interested groups.

Benzi Dam—McLean County

Sponsors: State Water Conservation Commission, McLean County.

Braddock—Emmons County

Sponsors: State Water Conservation Commission, State Game and Fish Department, Emmons County.

Crystal Springs Dam—Stutsman County

Sponsors: State Water Conservation Commission, State Game and Fish Department.

Epping Dam—Williams County

Sponsors: State Water Cnoservation Commission, Williams County.

Jund Dam—McIntosh County

Sponsors: State Water Conservation Commission, State Game and Fish Department, McIntosh County.

Lake Ensign—Barnes County

Sponsors: State Water Conservation Commission, Barnes County.

LaMoure Dam—LaMoure County

Sponsors: State Water Conservation Commission, City of LaMoure.

Peterson Dam—Nelson County

Sponsors: State Water Conservation Commission, State Game and Fish Department, Pekin Wildlife Federation.

Ray Dam—Williams County

Sponsors: State Water Conservation Commission, City of Ray.

Schlenker Dam—McIntosh County

Sponsors: State Water Conservation Commission, McIntosh County.

Strawberry Lake Dam—McLean County

Sponsors: State Water Conservation Commission, State Game and Fish Department.

In addition to those dams that were repaired by the Commission during the last biennium, at the request of the local interests the following 33 dams in 23 counties were inspected and in need of repair due to lack of maintenance, disintegration of material, excessive floods and other causes.

Barnes County: Tomahawk Refuge Dam, Hansen Dam
Bottineau County: Lake Upsilon (Wakopa Creek)
Bowman County: Amor Township Dam
Burleigh County: Lake Moraine Dam, Olson Dam, Reid Dam
Cass County: Mark Andrews Dam
Dickey County: Elm Creek Dam
Grant County: Raleigh Dam
Griggs County: Knutson Dam
Hettinger County: Larson Lake Dam, New England Dam
Kidder County: Dawson Refuge
LaMoure County: LaMoure Dam
Logan County: Beaver Lake Dam
McKenzie County: Sivertson Dam, Arnegard Dam, Storholm Dam
McLean County: LeRoy Dam
Mercer County: Antelope Creek Dam
Morton County: Meissner Dam
Nelson County: Snortland Dam, Tolna Dam
Oliver County: Center Dam
Pierce County: Balta Dam
Stutsman County: McElroy Park Dam
Traill County: Portland Dam
Ward County: Burlington Park Dam
Wells County: Sykeston Dam, Heaton Dam, Fessenden Dam, Rau Dam (Hawksnest)

CONSTRUCTION AND RECONSTRUCTION DRAINS OR IRRIGATION

One of the major problems that has confronted the farmers in various sections of the state over the years is that of draining excess waters from their land before it can be cultivated. This problem is much greater in the Red River Valley area where the terrain is extremely flat and the spring runoff either drains off very slowly or forms large shallow lakes that are dissipated through evaporation.

In many areas of the state the farmers have organized into drainage districts and constructed drainage ditches that carry off the flow of these floodwaters from their lands. Some of the drains constructed are 40 to 50 years old. All of the established drains have paid for themselves many times through making land available for cultivation that would otherwise be useless because of the excessive water.

During the drouth years of the 30's the problem of drainage was of less importance. Because of this the maintenance of many of these drains were neglected and consequently their efficiency was impaired. As the need again arose for the drains during the 40's it was found that extensive clean-out and rebuildnig program was necessary before these drains could be of service. The legislature in 1943 recognized the problem that the counties faced and designated the Commission to assist them in carrying out a program to provide for drainage for lands damaged by excessive water. To carry out this program the Commission was appropriated $50,000.00 for the 1943-45 biennium.

Since 1943, when the State Water Conservation Commission received its first appropriation for the Reconstruction of Drains or Irrigation, $537,303.14 has been paid 16 counties and irrigation districts in the state as a share of the cost of doing the necessary construction work on 117 projects. Funds appropriated to the Commission for this purpose have varied each biennium depending upon the demand and activity in the counties. The drainage programs of the counties, located mainly in the Red River Valley, are dependent to a great extent on the spring runoff and the damage to the agricultural lands in those areas resulting from excessive flooding. The Commission's appropriations, the allocations and payments to counties and irrigation districts since this program was started in 1943 is listed on a schedule in this section.

In carrying out this drainage program the Commission has received the cooperation of the Soil Conservation Service in providing the engineering service necessary to plan, organize, survey, design, and supervise construction work on the various drainage projects. The District Conservationists of the Soil Conservation Service also provides the technical assistances required by the drainage districts at no cost to the Commission or the district.

Funds appropriated to the State Water Conservation Commission for drainage work are allocated to the various counties who require assistance

on the basis of their need. If a county receives such an allocation and it later develops that they cannot proceed with their work as they originally planned, their allocation is transferred to another county where additional funds are required. The State Water Conservation Commission provides this financial assistance to the counties on a 60-40 basis with the county drain district paying 60% of the cost and the state 40%. Generally the state's 40% share is based on construction costs only.

In addition to the program of assisting counties in drainage work the Commission has assisted several of the irrigation districts in the state. Assistance given these districts was for repair and improvement of the irrigation work and for drainage of lands within the districts.

Various rules have been adapted by the Commission for use in administering their drainage activities. These rules have been amended as necessary from time to time and at the present include the following provisions:

Rules and Drainage Regulations Approved By
North Dakota State Water Conservation Commission—June 14, 1952

1. State Water Conservation Commission funds appropriated for construction and reconstruction of drainage or irrigation works will be available only for work done on legally established drainage ditches and in conformity with following rules and regulations.

2. For the purpose of these regulations relating to drainage work, the following definitions are applicable: Clean-outs are defined as the repair and restoration of existing drains to substantially the original depth, gradient and section; reconstruction is defined as practicably a new construction job to meet present requirements, or revision of existing drains on the basis of new designs and specifications; and construction is defined as new legally established and located drains, designed to meet local requirements. The Chief Engineer of the State Water Conservation Commission shall approve the classification for each drain in which the Commission participates.

3. Before any state funds will be available for a drain all engineering plans showing location, profile, cross section, control structures, etc., and specifications shall be approved by, and be on file in the office of the Chief Engineer of the State Water Conservation Commission. If an existing drain requires additional work for which plans are necessary they must be approved and on file with the Commission before any state funds will be available for such work.

4. All standards for design of all drains in which participation by the Commission is requested shall be equal in water carrying capacity to those set forth by John T. Stuart in Bulletin #189 of the Office of Experiment Station of the U. S. Department of Agriculture, entitled "Report on the Drainage of the Eastern parts of Cass, Traill, Grand Forks, Walsh, Pembina and Richland Counties, North Dakota".

5. The Board of County Commissioners, the Board of Drain Commissioners or the Township Board of Supervisors or any other legally constituted board, as the case may be, upon awarding of a contract shall file a copy of such contract with the State Water Conservation Commission before any state funds will be available for such drain.

6. Where the problems of determining capacities of state, county or township culverts and bridges to provide sufficient size to permit maximum quantity of water to flow freely through or under such structures, the Chief Engineer will be available upon request to determine as nearly as practicable the maximum size of structure to install.

7. When a Drainage District is unable to obtain engineering for surveying, design, and supervision of the works, the State Water Conservation Commission may provide such engineering assistance as is required, if available, charging the cost hereof against the drain on which such services are required.

8. State funds shall be available up to 40% of the cost on the following items:

1. Excavation.
2. Drops, regulating and control structures, to prevent erosion in the drain.
3. Cleaning and grubbing.
4. Leveling spoil banks.
5. Culvert inlets from field drains or natural water courses.
6. Field drain inlets.
7. Farmstead driveways or crossings.
8. Moving and reconstructing fence lines.
9. Purchase of right-of-way.

9. State funds shall not be available for:

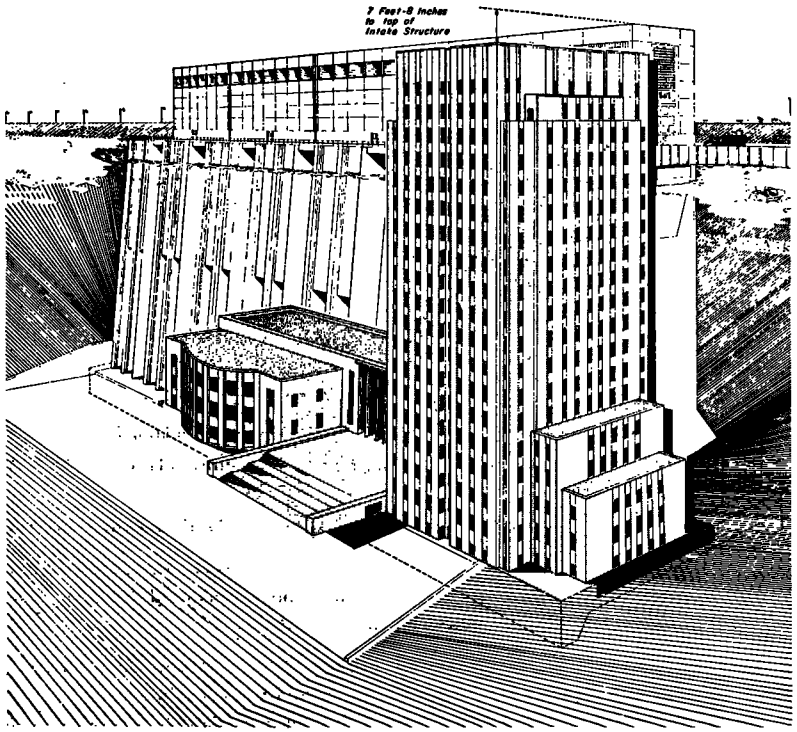
1. Installation of bridges or culverts across section lines.
2. Administrative or legal expenses in connection with any drain.
3. Paying any costs of drainage work involved in court action.

10. State funds shall not be available for assistance for maintenance work on any drain after state assistance has been received for the construction, reconstruction or clean-out of such drain.

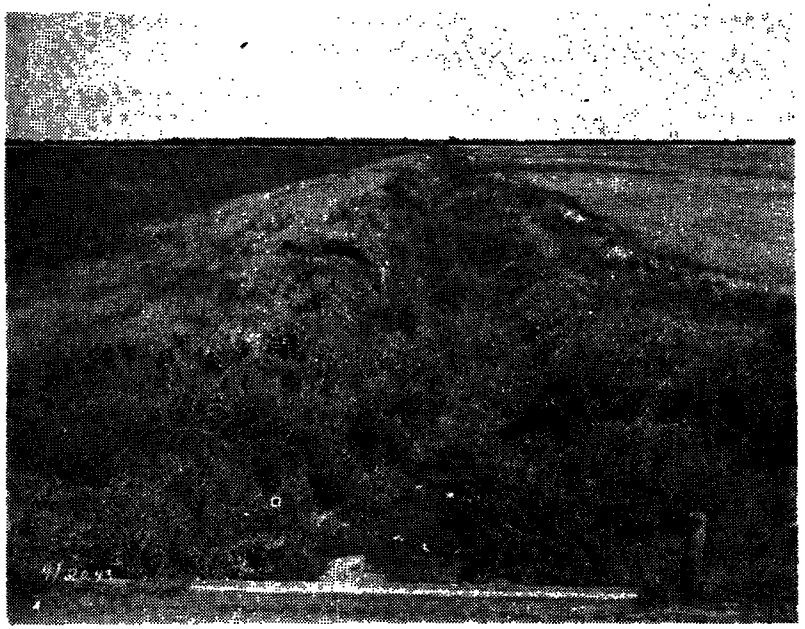
11. Before vouchers are submitted to the State Water Conservation Commission for payment they must be approved by the Chairman of the Board of County Commissioners, or the Chairman of the Board of Drain Commissioners, or Board of Township Supervisors and the District Conservationist of the Soil Conservation Service, or the County Engineer in charge.

12. The Chief Engineer of the State Water Conservation Commission shall approve the job before final payment is made. Payment of the State Water Conservation Commission's share for such work or other expenses shall be made only upon vouchers properly certified, according to law and in compliance with the terms of these rules, and prepared in the form designated by the State Water Conservation Commission.

During the period of this report the State Water Conservation Commission has cooperated with 8 counties in the repair of 39 drains. These drains involved excavation of over 2,150,000 cubic yards of material and, in addition, construction of farmstead crossings, installation of field inlets, spoil bank leveling and other incidental items. The total cost of this work $451,973.25 of which the Commission paid $179,702.13 and the counties $272,663.18. Irrigation and drainage districts who have received assistance from the State Water Conservation Commission during the period of this report are listed on the following schedule.



Capitol Imposed to Contrast Size
Garrison Dam Intake Structure



Pembina County Drain No. 13 before clean-out

Pembina County Drain No. 55

SUMMARY OF DRAINAGE APPROPRIATION, ALLOCATIONS AND EXPENDITURES — 1943 - 1953

County or Irrigation District	1943-1945 $50,000 Appropriation		1945-1947 $240,000 Appropriation		1947-1949 $200,000 Appropriation		1949-1951 $150,000 Appropriation		1951-1953 $90,000 Appropriation		Total 1943-1953 $730,000 Appropriated	
	Allocation	Expenditures	Allocation	Expenditures	Allocation	Expenditures	Allocation	Expenditures	Allocation	Expenditures	Allocated	Expenditures
Bottineau	$	$	$ 2,785.31	$ 2,785.31	$	$	$	$	$10,000.00	$	$ 12,785.31	$ 2,785.31
Cass	8,930.00	8,930.00	72,171.51	72,171.51	40,000.00	27,823.73	17,854.14	12,785.14*	16,800.00		155,755.65	121,710.38
Cavalier							1,595.93	1,595.93	4,800.00		6,395.93	1,595.93
Dickey									3,600.00		3,600.00	
Grand Forks	1,954.12	1,954.12	7,820.92	7,820.92	4,618.74	4,618.74	1,415.25	1,415.25	6,000.00		21,809.03	15,809.03
Morton	2,995.00	2,995.00									2,995.00	2,995.00
Nelson									4,000.00		4,000.00	
Pembina	3,760.00	3,760.00	11,212.19	11,212.19	5,620.00	3,945.08	88,990.88	74,814.78*	4,500.00		114,083.07	93,732.05
Richland	27,001.01	27,001.01	70,782.51	70,782.51	343.12	343.12	16,918.00	11,298.75	20,600.00		135,644.64	109,425.39
Sargent					2,436.55	2,436.55			1,300.00		3,736.55	2,436.55
Traill	2,350.00	2,350.00	30,756.83	30,756.83	58,847.26	58,847.26	12,339.50	12,331.98	6,000.00		110,293.59	104,286.07
Walsh	3,009.87	3,009.87					4,453.07	4,453.07	2,400.00		9,862.94	7,462.94
Walsh- Pembina Lewis & Clark Irrigation District			38,964.93	38,964.93	4,324.85	4,324.85					43,289.78	43,289.78
Burlington Irrigation District					10,000.00	8,456.35					10,000.00	8,456.35
Sioux Irrigation District					5,000.00	2,144.80					5,000.00	2,144.80
Eaton Flood Irrigation District			4,816.64	4,816.64	5,000.00	614.18	5,090.00	*			14,906.64	5,430.82
Miscellaneous and Unallocated			689.16		420.00	420.00					420.00	420.00
					63,389.48	13,979.51	1,343.23	1,343.23	10,000.00		75,421.87	15,322.74
	$50,000.00	$ 50,000.00	$240,000.00	$239,310.84	$200,000.00	$129,954.17	$150,000.00	$120,038.13	$90,000.00		$730,000.00	$537,303.14

NORTH DAKOTA STATE WATER CONSERVATION COMMISSION
DRAINAGE EXPENDITURES
July 1, 1950-June 30, 1952

Payments to Drainage Districts

County & Drain	State Share	District Share	Total Cost
Cass			
14	$ 11,704.84	$ 17,557.26	$ 29,262.10
16	2,180.66	3,271.00	5,451.66
27	1,652.77	2,479.17	4,131.94
31	1,944.17	2,916.26	4,860.43
35	421.20	631.80	1,053.00
40	3,210.43	4,815.65	8,026.08
45	688.74*	2,579.12	3,267.86
Total	$ 21,802.81	$ 34,250.26	$ 56,053.07
Cavalier			
Hunters Lake	$ 1,595.93	$ 2,393.89	$ 3,989.82
Grand Forks			
Michigan Twp.	$ 392.06	$ 588.10	$ 980.16
Pembina			
13	$ 31,150.14	$ 46,725.22	$ 77,875.36
16	9,058.30*	13,587.46	22,645.76
20	10,279.00	15,418.49	25,697.49
22	10,821.27*	16,231.90	27,053.17
23	6,504.24*	9,756.37	16,260.61
28	1,683.84*	2,525.76	4,209.60
47	5,369.83	8,054.94	13,424.77
55	6,514.85	9,772.26	16,287.11
Total	$ 81,381.47	$122,072.40	$203,453.87
Richland			
3	$ 188.80	$ 283.20	$ 472.00
12	5,539.12	8,308.70	13,847.82
15	72.32	108.48	180.80
28	81.60	122.40	204.00
32	168.32	252.48	420.80
37	86.56	129.84	216.40
39	197.68	296.52	494.20
57	36.24	54.36	90.60
58	4,928.11	7,392.17	12,320.28
Total	$ 11,298.75	$ 16,948.15	$ 28,246.90

County & Drain	State Share	District Share	Total Cost
Traill			
8	$ 3,869.44	$ 6,895.32	$ 10,764.76
6	929.26	1,453.88	2,383.14
10	3,196.28	4,794.43	7,990.71
13	302.42	453.62	756.04
15	336.60	485.40	822.00
16	200.00	300.00	500.00
17	402.11	603.16	1,005.27
18	164.95	247.43	412.38
19	1,806.12	2,709.18	4,515.30
26	863.93	1,288.89	2,152.82
27	3,417.15	5,125.71	8,542.86
Total	$ 15,488.26	$ 24,357.02	$ 39,845.28
Walsh			
4	$ 4,453.07	$ 6,679.62	$ 11,132.69
Pembina-Walsh			
50	$ 43,289.78*	$ 64,934.68	$108,224.46
Totals	$179,702.13	$272,224.12	$451,973.25

Payments to Irrigation Districts

Burlington	$ 424.00	$	$ 424.00
Eaton	420.00	630.00	1,050.00
Lewis and Clark	4,897.00	1,223.50	6,121.50
Sioux	203.88	.....	203.88
Total	$ 5,944.88	$ 1,853.50	$ 7,799.38

*19,602.53 of state cost of these projects paid from 1947-49 funds.

Vouchers for which payment is pending for drainage work completed during period of report but for which sufficient state funds not available at present.

County & Drain	State Share	District Share	Total Cost
Cass			
2	$ 6,661.68	$ 9,992.53	$ 16,654.21
37	218.44	327.66	546.10
34	480.00	720.00	1,200.00
Total	$ 7,360.12	$ 11,040.19	$ 18,400.31

County & Drain	State Share	District Share	Total Cost
Sargent			
3	$ 1,334.22	$ 1,991.35	$ 3,335.57
Traill			
8 (Balance)	$ 436.46	$ 654.69	$ 1,091.15

The expenditures by the Commission listed in the above schedule were made from the drainage appropriation for the 1949-1951 biennium except where otherwise noted. In addition the State Water Conservation Commission has made allocations to various counties in the state from its 1951-1953 appropriation for work that is now in progress. A list of these allocations are:

ALLOCATIONS FROM 1951-1953 DRAINAGE APPROPRIATION

County	State Funds Allocated
Bottineau	$10,000.00
Cass	16,800.00
Cavalier	4,800.00
Dickey	3,600.00
Grand Forks	6,000.00
Pembina	4,500.00
Richland	20,600.00
Walsh	2,400.00
Traill	6,000.00
Nelson	4,000.00
Sargent	1,300.00

ENGINEERING SURVEYS AND INVESTIGATIONS

The State Legislature has appropriated to the Water Commission funds for continuing survey investigations and studies of projects in cooperation with the Bureau of Reclamation and surveying small projects. This work is comprised largely of making detailed and small scale topographic maps to be used in layiny out irrigation systems and for soils and other surveys. The area covered extends over part of the lands in the Sheyenne and James River valleys, and the Cannonball and Cedar rivers in the southwestern part of the state. These maps are being made available to the Bureau for planning irrigation development in North Dakota and locating potential lands suitable for irrigation.

A brief summary of the surveys conducted by the Commission is given as follows:

JAMES RIVER

During 1950, river bottom surveys along the James River between Jamestown and LaMoure included detailed topographic mapping of approimately 12,600 acres on a scale of four hundred feet to the inch with a contour interval of two feet.

During the summer of 1951 additional topographic mapping of the James River lower basin was completed, this included an area about 67,900 acres using a scale of 1"=1000' with a contour interval of two feet and 1110 acres of 1" = 400' and a two foot contour interval in the Oakes area. These mapped areas embraced parts of Dickey and Sargent counties. Other surveys in the Oakes area were completed during 1952 including mapping of 1600 acres on a scale of 1"=1000' and 640 acres on a scale of 1"=400'. These surveys included running some level lines for vertical control in 1951 and 1952. All these topographic maps were made available to the Bureau of Reclamation.

A "Public Use Area" located on the east side or the reservoir above the Jamestown Dam has been mapped using a large scale of 1"=200' and 2' contour interval to be used for laying out a 270 acre recreational area.

CANNONBALL RIVER

Topographic surveys on this project during 1950 included mapping approximately 12,000 acres along the low lands of Cedar Creek on a 1" = 400' scale, this additional mapping was done at the request of the Bureau of Reclamation.

Other mapping surveys in 1951 included 30,000 acres on a scale of 1" = 2000' and 5' contour interval and two dam sites detailed on scales of 1" = 100' and 1' contour interval along Cedar River. In order to establish vertical control of this area it was necessary to run approximately 100 miles of 3rd order levels. Concrete bench marks were placed to record elevations.

HEART RIVER

The topography of an area of approimately 80 acres was mapped on a scale of 1" = 200' and a contour interval of 2' in June of 1952, for a cabin site and recreational area bordering the Heart Butte Reservoir.

BUREAU OF RECLAMATION OBSERVATION WELL ELEVATIONS AND RADIO TOWER SITES

Well casing elevations were established on some 87 ground water observation wells placed by the Bureau of Reclamation in Eddy, Foster, and Wells counties. 180 miles of 4th order levels were run establishing elevations on these well casings for showing fluctuations and relative ground water levels based on sea level datum of the U. S. Coast & Geodetic Survey and U. S. Geological Survey. This project includes 101 wells in this area and a record of the recording is being kept by the Bureau.

Two radio tower sites for the Bureau of Reclamation was mapped in June, 1952. One site in Sec. 24 - T. 139 - R. 64, near Jamestown; the other near Bismarck - Sec. 30 - T. 139 - R. 79.

Surveying on Projects James River Valley, Cannonball-Cedar, Heart River, Observation Well Elevations and the radio tower sites by the State Water Commission is for the Missouri River development program and in cooperation with the Federal Government thru the Bureau of Reclamation.

BIG MEADOW (Williams County)

At the request of local landowners living in the vicinity of Big Meadows, surveys were conducted to determine the possibility of draining water from Big Meadow slough. Topography was taken on a scale of 1" = 1000' and 5' contour intervals to determine a drainage route to the White earth river. Two alternate routes were surveyed, further studies and surveys will be required to locate the most feasible and economical drainage ditch.

DEVILS LAKE DRAINAGE

During the recent years of maximum precipitation and runoff into Devils Lake, crop lands of farmers living in the vicinity of Lakes Alice, Irvine, and Sweetwater were subject to considerable flooding, and they requested aid from the State Water Commission to make surveys to determine whether or not it is possible to bypass Maurais Coulee and find a shorter route via Grand Harbor south into Devils Lake. This work consisted of running approximately 60 miles of preliminary survey lines, and the work was done during February and March, 1951. Because the cost of construction of this project would be high, no further action has been taken pending further investigation by Federal agencies.

MISCELLANEOUS SURVEYS

At the request of organized districts, cities, towns, individual water users and others interested water development the Commission has assisted in making investigations and surveys for various irrigation, drainage, and other miscellaneous projects during the period of this report. These projects include a drainage survey on the Lewis and Clark project; irrigation supply ditch for the Burlington and Sioux projects; surveys for repairing a dam on the Eaton Flood Irrigation project; surveys for diversion from Long Creek for a water supply for the City of Crosby; drainage surveys for Underwood, Max, Rice Lake, Nordea Township, Lake Isben, Martin Heidt, Leo Stecker; and Einar Einarson; Flood damage survey on the Bismarck Irrigated Gardens; water right survey in connection with Buford-Trenton Irrigation project; and several individual water right investigations.

INTERNATIONAL AND INTERSTATE RIVER COMPACTS

It is generally recognized throughout the United States that there is an imperative need for conservation and control of the waters in our rivers and streams in order to provide adequate supplies for municipal, domestic and industrial uses; for the prevention of stream pollution for irrigation, and for other uses. In that many of the major rivers and streams in the United States are interstate streams a problem eixsts as to the division of the waters in those rivers and streams. The most satisfactory method of solving problems of this nature is by compact rather than by litigation in the courts or by direct congressional legislation.

When our forefathers drew up the Constitution of the United States they provided in Section 10 of Article I that "No State shall, without the Consent of Congress, . . . enter into any Agreement or Compact with another State. . ." While in the early days of our country, the device provided in this section of the constitution was little used, many modern interstate problems have been satisfactorily solved through compacts. Interstate Compacts are of particular value in solving problems arising in the division of waters of interstate streams because they allow the states, who are directly affected and have a vital interest in the waters flowing through their states, to negotiate an equitable division of such waters with the other states concerned.

The procedure afforded by interstate compacts is of great importance to the State of North Dakota in dealing in problems arising from the use of waters of its interstate and, international rivers and streams. North Dakota's rivers and streams are vital to the welfare and devolopment of the state and it is of much concern to the state that it shall not be deprived of its reasonable and equitable use of such water. Entering into compacts with other states who have interests in these streams is the practical method of assuring the states concerned of the reasonable and equitable use of these waters.

In North Dakota there are seven rivers that are either international or interstate rivers. These rivers are: the Red River of the North, the Souris River, the James River, the Grand River, the Little Missouri River, the Yellowstone River and the Missouri River. The Red River of the North and the Souris River are international streams affecting both Canada and the United States and negotiations concerning these rivers are conducted under the direction of the International Joint Commission. The James River, the Grand River, the Little Missouri River, the Yellowstone River and the Missouri River are interstate streams affecting one or more states other than North Dakota, and negotiations concerning them must be made with the states concerned with the authorization and approval of Congress. A discussion of compacts on these rivers affecting North Dakota is given on the following pages.

INTERSTATE COMPACTS — APPROVED

Yellowstone River Compact

On June 2, 1949 authorization by Congress was approved permitting the States of North Dakota, Wyoming and Montana to enter into compact negotiations for the division of the waters, Yellowstone River and its tributaries. On November 29, 1949 the first meeting of representatives of the three states was held in Billings, Montana at which engineering and compact drafting committees were organized. Several other meetings were held to consider the reports of these two committees and to complete negotiations for the compact.

On December 8, 1950 a compact was approved by the representatives of the various states and was then submitted to the legislature of the three states for approval. The compact as adopted was approved by the legislatures and then approved by the Congress of the United States and signed by the President October 30, 1951. The provisions of the Compact as approved are as follows:

YELLOWSTONE RIVER COMPACT

The State of Montana, the State of North Dakota, and the State of Wyoming, being moved by consideration of interstate comity, and desiring to remove all causes of present and future controversy between said States and between persons in one and persons in another with respect to the waters of the Yellowstone River and its tributatries, other than waters within or waters which contribute to the flow of streams within the Yellowstone National Park, and desiring to provide for an equitable division and apportionment of such waters, and to encourage the beneficial development and use thereof, acknowledging that in future projects or programs for the regulation, control and use of water in the Yellowstone River Basin the great importance of water for irrigation in the signatory States shall be recognized, have resolved to conclude a Compact as authorized under the Act of Congress of the United States of America, approved June 2, 1949 (Public Law 83, 81st Congress, First Session).

ARTICLE I

A. Where the name of a State is used in this Compact, as a party thereto, it shall be construed to include the individuals, corporations, partnerships, associations, districts, administrative departments, bureaus, political subdivisions, agencies, persons, permittees, appropriators, and all others using, claiming, or in any manner asserting any right to the use of the waters of the Yellowstone River System under the authority of said State.

B. Any individual, corporation, partnership, association, district, administrative department, bureau, political subdivision, agency, person, permittee, or appropriator authorized by or under the laws of a signatory State, and all others using, claiming, or in any manner asserting any

right to the use of the waters of the Yellowstone River System under the authority of said State, shall be subject to the terms of this Compact. Where the singular is used in this arcticle, it shall be construed to include the plural.

ARTICLE II

A. The State of Montana, the State of North Dakota, and the State of Wyoming are hereinafter designated as "Montana," "North Dakota," and "Wyoming," respectively.

B. The terms "Commission" and "Yellowstone River Compact Commission" mean the agency created as provided herein for the administration of this Compact.

C. The term "Yellowstone River Basin" means areas in Wyoming, Montana, and North Dakota drained by the Yellowstone River and its tributaries, and includes the area in Montana known as Lake Basin, but excludes those lands lying within Yellowstone National Park.

D. The term "Yellowstone River System" means the Yellowstone River and all of its tributaries, including springs and swamps, from their sources to the mouth of the Yellowstone River near Buford, North Dakota, except those portions thereof which are within or contribute to the flow of streams within the Yellowstone National Park.

E. The term "Tributary" means any stream which in a natural state contributes to the flow of the Yellowstone River, including interstate tributaries and tributaries thereof, but excluding those which are within or contribute to the flow of streams within the Yellowstone National Park.

F. The term "Interstate Tributaries" means the Clarks Fork, Yellowstone River; the Bighorn River (except Little Bighorn River); the Tongue River; and the Powder River, whose confluences with the YellowstoneRiver are respectively at or near the city (or town) of Laurel, Big Horn, Miles City, and Terry, all in the State of Montana.

G. The terms "Divert" and "Diversion" mean the taking or removing of water from the Yellowstone River or any tributary thereof when the water so taken or removed is not returned directly into the channel of the Yellowstone River or of the tributary from which it is taken.

H. The term "Beneficial Use" is herein defined to be that use by which the water supply of a drainage basin is depleted when usefully employed by the activities of man.

I. The term "Domestic Use" shall mean the use of water by an individual, or by a family unit or household for drinking, cooking, laundering, sanitation and other personal comforts and necessities; and for the irrigation of a family garden or orchard not exceeding one-half acre in area.

J. The term "Stock Water Use" shall mean the use of water for livestock and poultry.

ARTICLE III

A. It is considered that no Commission or administrative body is necessary to administer this Compact or divide the waters of the Yellowstone River Basin as between the States of Montana and North Dakota. The provisions of this Compact, as between the States of Wyoming and Montana, shall be administered by a Commission composed of one representative from the State of Wyoming and one representative from the State of Montana, to be selected by the Governors of said States as such States may choose, and one representative selected by the Director of the United States Geological Survey or whatever Federal agency may succeed to the functions and duties of that agency, to be appointed by him at the request of the States to sit with the Commission and who shall, when present, act as Chairman of the Commission without vote, except as herein provided.

B. The salaries and necessary expenses of each State representative shall be paid by the respective State; all other expenses incident to the administration of this Compact not borne by the United States shall be allocated to and borne one-half by the State of Wyoming and one-half by the State of Montana.

C. In addition to other powers and duties herein conferred upon the Commission and the members thereof, the jurisdiction of the Commission shall include the collection, correlation, and presentation of factual data, the maintenance of records having a bearing upon the admintration of this Compact and recommendations to such States upon matters connected with the administration of this Compact, and the Commission may employ such services and make such expenditures as reasonable and necessary within the limit of funds provided for that purpose by the respective States, and shall compile a report for each year ending September 30 and transmit it to the Governors of the signatory States on or before December 31 of each year.

D. The secretary of the Army; the Secretary of the Interior; the Secretary of Agriculture; the Chairman, Federal Power Commission; the Secretary of Commerce, or comparable officers of whatever Federal agencies may succeed to the functions and duties of these agencies, and such other Federal officers and officers of appropriate agencies of the signatory States having services or data useful or necessary to the Compact Commission, shall cooperate, ex-officio, with the Commission in the execution of its duty in the collection, correlation, and publication of records and data necessary for the proper administration of the Compact; and these officers may perform such other services related to the Compact as may be mutually agreed upon with the Commission.

E. The Commission shall have power to formulate rules and regulations and to perform any act which they may find necessary to carry out the provisions of this Compact, and to amend such rules and regulations. All such rules and regulations shall be filed in the office of the State Engineer of each of the signatory States for public inspection.

F. In case of the failure of the representative of Wyoming and Montana to unanimously agree on any matter necessary to the proper administration of this Compact, then the member selected by the Director of the United States Geological Survey shall have the right to vote upon the matters in disagreement and such points of disagreement shall then be decided by a majority vote of the representatives of the States of Wyoming and Montana and said member selected by the Director of the United States Geological Survey, each being entitled to one vote.

G. The Commission herein authorized shall have power to sue and be sued in its official capacity in any Federal Court of the Signatory States, and may adopt and use an official seal which shall be judicially noticed.

ARTICLE IV

The commission shall itself, or in conjunction with other responsible agencies, cause to be established, maintained, and operated such suitable water gaging and evaporation stations as it finds necessary in connection with its duties.

ARTICLE V

A. Appropriative rights to the beneficial uses of the water of the Yellowstone River System existing in each signatory State as of January 1, 1950, shall continue to be enjoyed in accordance with the laws governing the acquisition and use of water under the doctrine of appropriation.

B. Of the unused and unappropriated waters of the interstate tributaries of the Yellowstone River as of January 1, 1950, there is allocated to each signatory state such quantity of that water as shall be necessary to provide supplemental water supplies for the rights described in paragraph A of this Article V, such supplemental rights to be acquired and enjoyed in accordance with the laws governing the acquisition and use of water under the doctrine of appropriation, and the remainder of the unused and unappropriated water is allocated to each State for storage or direct diversions for beneficial use on new lands or for other purposes as follows:

1. **Clarks Fork, Yellowstone River**
   a. To Wyoming 60%
      To Montana 40%
   b. The point of measurement shall be below the last diversion from Clarks Fork above Rock Creek.

2. **Bighorn River (Exclusive of Little Bighorn River)**
   a. To Wyoming 80%
      To Montana 20%
   b. The point of measurement shall be below the last diversion from the Bighorn River above its junction with the Yellowstone River, and the inflow of the Little Bighorn River shall be excluded from the quantity of water subject to allocation.

3. **Tongue River**
   a. To Wyoming 40%
      To Montana 60%
   b. The point of measurement shall be below the last diversion from the Tongue River above its junction with the Yellowstone River.

4. **Powder River (including the Little Powder River)**
   a. To Wyoming 42%
      To Montana 58%
   b. The point of measurement shall be below the last diversion from the Powder River above its junction with the Yellowstone River.

C. The quantity of water subject to the percentage allocations, in paragraph B 1, 2, 3 and 4 of this Article V, shall be determined on an annual water year basis measured from October 1st of any year through September 30th of the succeeding year. The quantity to which the percentage factors shall be applied through a given date in any water year shall be, in acre-feet, equal to the algebraic sum of:

1. The total diversions, in acre-feet, above the point of measurement, for irrigation, municipal, and industrial uses in Wyoming and Montana developed after January 1, 1950, during the period from October 1st to that given date;

2. The net change in storage, in acre-feet, in all reservoirs in Wyoming and Montana above the point of measurement completed subsequent to January 1, 1950, during the period from October 1st to that given date;

3. The net change in storage, in acre-feet, in existing reservoirs in Wyoming and Montana above the point of measurement which is used for irrigation, municipal, and industrial purposes developed after January 1, 1950, during the period October 1st to that given date;

4. The quantity of water, in acre-feet, that passed the point of measurement in the stream during the period from October 1st to that given date.

D. All existing rights to the beneficial use of waters of the Yellowstone River in the States of Montana and North Dakota, below Intake, Montana, valid under the laws of these States as of January 1, 1950, are hereby recognized and shall be and remain unimpaired by this Compact. During the period May 1 to September 30, inclusive, of each year, lands within Montana and North Dakota shall be entitled to the beneficial use of the flow of waters of the Yellowstone River below Intake, Montana, on a proportionate basis of acreage irrigated. Waters of tributary streams, having their origin in either Montana or North Dakota, situated entirely in said respective States and flowing into the Yellowstone River

below Intake, Montana, are allotted to the respective States in which situated.

E. There are hereby excluded from the provisions of this Compact:

1. Existing and future domestic and stock water uses of water: **Provided,** That the capacity of any reservoir for stock water so excluded shall not exceed 20 acre-feet;

2. Devices and facilities for the control and regulation of surface waters.

F. From time to time the Commission shall re-examine the allocations herein made and upon unanimous agreement may recommend modifications therein as are fair, just, and equitable, giving consideration among other factors to:

Priorities of water rights;

Acreage irrigated;

Acreage irrigable under existing works; and

Potentially irrigable lands.

ARTICLE VI

Nothing contained in this Compact shall be so construed or interpreted as to affect adversely any rights to the use of the waters of Yellowstone River and its tributaries owned by or for Indians, Indian tribes, and their reservations.

ARTICLE VII

A. A lower signatory State shall have the right, by compliance with the laws of an upper signatory State, except as to legislative consent, to file application for and receive permits to appropriate and use any waters in the Yellowstone River System not specifically apportioned to or appropriated by such upper State as provided in Article V; and to construct or participate in the construction and use of any dam, storage reservoir, or diversion works in such upper State for the purpose of conserving and regulating water that may be apportioned to or appropriated by the lower State: **Provided,** That such right is subject to the rights of the upper State to control, regulate, and use the water apportioned to and appropriated by it: **And provided further,** That should an upper State elect, it may share in the use of any such facilities constructed by a lower State to the extent of its reasonable needs upon assuming or guaranteeing payment of its proportionate share of the cost of the construction, operation, and maintenance. This provision shall apply with equal force and effect to an upper State in the circumstance of the necessity of the acquisition of rights by an upper State in a lower State.

B. Each claim hereafter initiated for an appropriation of water in one signatory State for use in another signatory State shall be filed in the Office of the State Engineer of the signatory State in which the water is to be diverted, and a duplicate copy of the application or notice shall be filed in the office of the State Engineer of the signatory State in which the water is to be used.

C. Appropriations may hereafter be adjudicated in the State in which the water is diverted, and where a portion or all of the lands irrigated are in another signatory State, such adjudications shall be confirmed in that State by the proper authority. Each adjudication is to conform with the laws of the State where the water is diverted and shall be recorded in the County and State where the water is used.

D. The use of water allocated under Article V of this Compact for projects constructed after the date of this Compact by the United States of Ameirca or any of its agencies or instrumentalities, shall be charged as a use by the State in which the use is made: **Provided,** That such use incident to the diversion, impounding, or conveyance of water in one State for use in another shall be charged to such latter State.

ARTICLE VIII

A lower signatory State shall have the right to acquire in an upper State by purchase, or through exercise of the power of eminent domain, such lands, easements, and rights-of-way for the construction, operation. and maintenance of pumping plants, storage reservoirs, canals, conduits, and appurtment works as may be required for the enjoyment of the privileges granted herein to such lower State. This provision shall apply with equal force and effect to an upper State in the circumstance of the necessity of the acquisition of rights by an upper State in a lower State.

ARTICLE IX

Should any facilities be constructed by a lower signatory State in an upper signatory State under the provisions of Article VII, the construction, operation, repairs, and replacements of such facilities shall be subject to the laws of the upper State. This provision shall apply with equal force and effect to an upper State in the circumstance of the necessity of the acquisition of rights by an upper State in a lower State.

ARTICLE X

No water shall be diverted from the Yellowstone River Basin without the unanimous consent of all the signatory States. In the event water from another river basin shall be imported into the Yellowstone River Basin or transferred from one tributary basin to another by the United States of America, Montana, North Dakota, or Wyoming, or any of them jointly, the State having the right to the use of such water shall be given proper credit therefor in determining its share of the water apportioned in accordance with Article V herein.

ARTICLE XI

The provisions of this Compact shall remain in full force and effect until amended in the same manner as it is required to be ratified to become operative as provided in Article XV.

ARTICLE XII

This Compact may be terminated at any time by unanimous consent of the signatory States, and upon such termination on all rights then established hereunder shall continue unimpaired.

ARTICLE XIII

Nothing in this Compact shall be construed to limit or prevent any State from instituting or maintaining any action or proceeding, legal or equitable, in any Federal Court or the United States Supreme Court, for the protection of any right under this Compact or the enforcement of any of its provisions.

ARTICLE XIV

The physical and other conditions characteristic of the Yellowstone River and peculiar to the territory drained and served thereby and to the development thereof, have actuated the signatory States in the consummation of this Compact, and none of them, nor the United States of America by its consent and approval, concedes thereby the establishment of any general principle or precedent with respect to other interstate streams.

ARTICLE XV

This Compact shall become operative when approved by the Legislature of each of the signatory States and consented to and approved by the Congress of the United States.

ARTICLE XVI

Nothing in this Compact shall be deemed:

(a) To impair or affect the sovereignty or jurisdiction of the United States of America in or over the area of waters affected by such compact, any rights or powers of the United States of America, its agencies, or instrumentalities, in and to the use of the waters of the Yellowstone River Basin nor its capacity to acquire rights in and to the use of said waters;

(b) To subject any property of the United States of America, its agencies or instrumentalities to taxation by any State or subdivision thereof, nor to create an obligation on the part of the United States of America, its agencies, or instrumetntalities, by reason of the acquisite construction, or operation of any property or works of whatsoever kind, to make any payments to any State or political subdivision thereof, State agency, municipality, or entity whatsoever in reimbursement for the loss of taxes;

(c) To subject any property of the United States of America, its agencies, or instrumentalities, to the laws of any State to an extent other than the extent to which these laws would apply without regard to the Compact.

ARTICLE XVII

Should a Court of competent jurisdiction hold any part of this Compact to be contrary to the constitution of any signatory State or of the United States of America, all other severable provisions of this Compact shall continue in full force and effect.

ARTICLE XVIII

No sentence, phrase, or clause in this Compact or in any provision thereof, shall be construed or interpreted to divest any signatory State or any of the agencies or officers of such States of the jurisdiction of the water of each State as apportioned in this Compact.

Approved by Compact Commission December 8, 1952.
Ratified:

Wyoming — January 27, 1951
Montana — February 13, 1951
North Dakota — March 7, 1951
Consent by United States — October 30, 1951

INTERNATIONAL JOINT COMMISSION

On January 11, 1909, the United States and Great Britain entered into a treaty relating to boundary waters and questions arising between these two countries. This treaty provided that an International Joint Commission be created to have jurisdiction over the use of boundary waters by the United States and Canada. This Commission consists of six members, three from each country.

Members of the International Joint Commission representing the United States are: A. O. Stanley, chairman, U. S. Section, Washington, D. C.; R. McWhorter, member, chief engineer of the Federal Power Commission, Washington, D. C., and E. W. Weber, member, Army Corps of Engineers, Washington, D. C. Canadian members are: A. G. L. McNaughton, George Spence and J. Lucien Dansereau.

Matters relating to international waters are referred to the International Joint Commission for study and decision. Such studies were titled "References" and may be instituted by the Commission upon application by an interested government or private party. To date there have been two References that affect North Dakota, which are:

Souris (Mouse) River Reference
Souris—Red Rivers Reference

SOURIS (MOUSE) RIVER REFERENCE

The Souris (Mouse) River, an international stream located in the Hudson Bay drainage area, has its source in southern Saskatchewan, Canada, and flows in a loop for a distance of 300 river miles, through North Dakota, returning to the Province of Manitoba, Canada.

In October 1940, the International Joint Commission issued interim recommendations concerning the apportionment of waters of the Souris River between the State of North Dakota, and the Provinces of Saskatchewan and Manitoba. These recommendations were made to care for the immediate needs of the state and affected provinces pending permanent settlement of the reference. The original interim measure was amended in November 1942 increasing the amount of water to be released from North Dakota to Canada.

These interim measures which are to remain in effect until permanent measures are adopted by the International Joint Commission or unless they are qualified or modified are as follows:

1. The province of Saskatchewan shall be permitted to continue its present use of the waters of the Souris river, and in addition, to construct a reservoir with usable capacity not exceeding 4,000 acre feet, for the purpose of providing an adequate water supply for the town of Weyburn and the Mental Hospital at Weyburn.
2. The State of North Dakota shall be permitted to continue its present use of the waters of the Souris river, and in addition, to construct a small reservoir on Long Creek, with capacity of 200 acre feet, to provide an adequate water supply for the town of Crosby, North Dakota.
3. A regulated flow of not less than 10 cubic feet per second shall be released from the State of North Dakota to the Province of Manitoba during the months of June, July, August, September and October of each year.
4. In the event that the State of North Dakota or the provinces of Saskatchewan or Manitoba should desire to construct any additional storage works, or otherwise make additional use of the waters of the Souris river basin, application shall be made to the International Joint Commission for authority to construct the desired storage works or otherwise to make use of additional waters.
5. The interim measures for which provision is hereinbefore made shall remain in effect unless subsequently qualified or modified by the Commission prior to the adoption of permanent measures in accordance with the requirement of "Questions (1) and (2) of the Reference."

On November 17, 1942, after two years of operation under the terms of original report, the International Joint Commission issued an interim order in the matter of the apportionment of the waters of the Souris (Mouse) river which increased the amount of water released at the Westhope dam in North Dakota from 10 to 20 cubic feet per second. This action was taken in order to augment the original allocation to Manitoba, which was found to be inadequate.

SOURIS-RED RIVERS REFERENCE

In January, 1948, the governments of the Dominion of Canada and of the United States of America initiated a Reference to the International Joint Commission to investigate the use of the waters of the Souris and Red Rivers and make recommendations for the apportionment of waters between Canada and the United States.

An Engineering Committee, composed of Canadian and United States engineers, was appointed to review the problems of this Reference and to determine the water requirements of the two countries for municipal, industrial, irrigation, hydro-electric and stream pollution abatement uses. Separate reports are being prepared to cover the Red and the Souris rivers. The reports are to be submitted to the International Joint Commission so it can determine allocation of waters of these rivers.

The Reference is composed of four paragraphs, as follows:

1. To investigate and report on the water requirements arising out of the existing dams and other works or projects located in the waters which are of common interest along, across, or in the vicinity of the International Boundary from the eastern boundary of the Milk River drainage basin on the west up to and including the drainage basin of the Red river of the North on the east.

2. To report whether in the judgment of the Commission further uses of these waters within their respective boundaries by Canada and the United States would be practicable in the public interest from the points of view of the two governments.

3. Having regard to the report made under paragraphs 1 and 2, and for those streams where in the judgment of the International Joint Commission apportionment of the waters is advisable, to make advisory recommendations concerning the apportionment which should be made between Canada and the United States of such of the waters under reference as cross the International Boundary, and with respect to each such crossing of the International Boundary.

4. To conduct necessary investigations and to prepare a comprehensive plan or plans of mutual advantage to the two countries for the conservation, control, and utilization of the waters under reference in accordance with the recommended apportionment thereof.

In the conduct of its investigations, and otherwise in the performance of its duties under this Reference, the International Joint Commission may utilize the services of engineers and other specially qualified personnel of technical agencies of Canada and the United States, and will, as far as possible, make use of information and technical data which have been acquired by such technical agencies or which may become available during the course of the investigation, thus avoiding duplication of effort and unnecessary expense.

Several investigations and studies by the Engineering Committee concerning the water use and water supply of these two rivers have been conducted and reports are in the process of being prepared. The State Water Conservation Commission has cooperated in supplying available information on these rivers to this Engineering Committee. This information and other that will be gathered will be used in preparing the recommendations to the International Joint Commission for consideration in preparing their recommendations for permanent measures for the apportionment of the waters of these two rivers.

Members of this Engineering Sub-Committee of the International Joint Commission from the United States and Canada are as follows:

Canada:

G. N. Munro, Regina Saskatchewan

D. M. Stephens, Winnipeg, Manitoba

H. L. Johnston, Winnipeg, Manitoba

E. J. Scammell, Regina, Saskatchewan

United States:

K. F. Vernon, Bureau of Reclamation, Billings, Montana

W. V. Taylor, Fish and Wildlife Service, Minneapolis, Minnesota

Lt. Col. L. C. Yoder, Corps of Engineers, St. Paul, Minnesota

INTERSTATE COMPACTS UNDER NEGOTIATION RED RIVER OF THE NORTH

Tri-State Waters Commission

A compact was made by the states of South Dakota, North Dakota and Minnesota in June, 1937, and congress gave its approval on April 2, 1938, providing for the organization of the Tri-State Waters Commission of nine members, three from each of the three states, to supervise the drainage area of the Red river except the Otter Tail river and its tributaries. It has power to maintain and control lake levels, stream flood and boundary waters in cooperation with state, federal and municipal agencies; to make studies and surveys for construction, maintenance and operation of water projects within the scope of its jurisdiction. Meetings of the Commission are called as matters come up in the area it supervises.

In recent years the Tri-State Water Commission has been inactive because of the lack of interest on the part of South Dakota in administering the provisions of the compact. According to these provisions, as they have been approved and enacted into law, a majority of the members from each state shall constitute a quorum for the transaction of business in the exercise of any powers or the performance of any duties, but no action of the Tri-State Commission shall be binding unless at least two of the members from each state shall vote in favor thereof. The difficulty experienced by the Tri-State Commission in holding meetings within the provisions of the compact has prevented the proper consideration of problems concerning the Red River of the North drainage basin.

The allocation of the waters stored in the Baldhill reservoir on the Sheyenne River has presented a problem concerning the division of water of the Red River because the Sheyenne is a tributary of the Red River. The use of the waters of the Red River watershed, which includes parts of North Dakota, Minnesota, and South Dakota is a concern of these states but primarily of North Dakota and Minnesota. For these reasons it is desirable that a compact on the division and allocation of the waters of the Red River, particularly as such divisions affects North Dakota and Minnesota be negotiated.

In May, 1951 a preliminary meeting was held with officials of Minnesota to initiate negotiations for a compact on the Red River of the North. Since that time two other meetings have been held. Studies and assembly of water use datum and requirements are being continued by the two interested states in an effort to prepare a plan that will be acceptable in formulating a compact on the Red River for submission to the 1953 legislatures of North Dakota and Minnesota. Representatives from North Dakota conferring on this matter are:

Curtis Olson, Vice Chairman, State Water Conservation Commission, Valley City, North Dakota

Oscar Lunseth, Member State Water Conservation Commission, Grand Forks, North Dakota

J. J. Walsh, Secretary State Water Conservation Commission, Bismarck, North Dakota

INTERSTATE COMPACTS FOR FUTURE CONSIDERATION

Little Missouri

In 1940, Congress authorized Wyoming, South Dakota, Montana, and North Dakota to enter into compact negotiations for the allocation of the waters of the Little Missouri river. Preliminary surveys were undertaken but no agreement was reached prior to the expiration date of January 1, 1943. The equitable apportionment of the waters of this stream is a highly complicated problem and it is most important that North Dakota be allotted its equitable share of the waters for irrigation and for general agricultural purposes.

James River

Future development of areas in the James river basin will require consideration of a compact between North and South Dakota for the allocation of the waters of the James river. This river originates in central North Dakota and empties into the Missouri river near Yankton, South Dakota.

Recent investigations by the State Water Conservation Commission and the Bureau of Reclamation indicates that there is considerable acreage along the James River south of Jamestown and in the Oakes area that is irrigable. Although plans call for irrigation of this area with water diverted from the Missouri River, the division of the waters of the James River between North and South Dakota, excluding such waters diverted, should be decided by compact to avoid future litigation on the matter.

North Branch of the Grand River

The apportionment of the waters of the North Branch of the Grand River between North and South Dakota is a problem that should be determined in the near future. The Bureau of Reclamation recently completed the Shadehill dam in South Dakota constructed to provide water to irrigation in that state. This dam will store a major portion of the runoff from both forks of the Grand River.

In North Dakota the Bowman-Haley irrigation district was organized in the early 1930's for the irrigation of several thousand acres in Bowman and Adams counties. Development of this project is still pending. Although North Dakota's rights to waters originating in the state are set forth in the Constitution, these rights should be protected by a compact providing for the reasonable and equitable division of the water in this river.

In order to protect the interests of this district, the State Water Conservation Commission in 1951 passed a resolution reserving the waters of the North Fork of the Grand River in North Dakota for the beneficial use of the district for irrigation.

Records show that the Bowman-Haley Project was first considered by the Reclamation Service in 1905 and recommended as feasible. Public lands at that time were withdrawn from entry. A few years ago the Department of the Interior proposed to open these lands for entry, however at the request of the State Water Conservation Commission this proposal was withdrawn and the lands are being reserved for a reservoir area.

COOPERATIVE PROGRAMS WITH U. S. G. S.

In a program for the development of the water and other natural resources of an area such as is underway in North Dakota at the present, one of the most important phases is that of collecting basic data for use in planning for these development programs. This data takes the form of topographic surveys, measurements of stream flows and surveys of ground water resources. From information of this nature the many features of the water and other resource development program can be be planned and designed based on accurate data.

The State Water Conservation Commission has cooperated with the branches of the U.S.G.S. who have as their function the collecting and compilation of this basic data. These cooperative programs are accomplished under the direction of the U.S.G.S. with the state and the U.S.G.S. each contributing 50% of the costs. During the past several bienniums the State Water Conservation Commission has participated in a topographic mapping program, a stream gaging program and an underground water survey program all in cooperation with the U.S.G.S. These programs are discussed individually on the following pages.

TOPOGRAPHIC MAPPING—COOPERATION WITH U.S.G.S.

The Lewis and Clark Expedition of 1804 and 1806 preceded the establishment of the Corps of Topographic Engineers but was not related to this organization. Following the Civil War, interest increased in exploratory surveys and several new organizations were created. Two of these were the Geological Surveys west of the 100th Meridian, directed by Captain George M. Wheeler, under the War Department and the U. S. Geographical and Geological Survey of the Rocky Mountain Region, directed by Major J. W. Powell. All were exploratory. They did, however, produce the first comprehensive maps covering large areas of the western United States. Topographic mapping, was made a part of the general work of the Geological Survey.

It is interesting to note that in the 60 year period from 1888 to 1948, funds directly appropriated to the Survey for topographic mapping amounted to approximately $33,000,000. This amount was increased through transfers and State cooperative mapping programs by about $37,000,000, making a total of $70,000,000 for the entire sixty years.

The topographic quadrangles produced by the Geological Survey are commonly called the "mother map". These related maps include, among many others, geologic, mineral and water resource data maps, road maps, county and state maps, as well as the base map of the United States, its territories and possessions.

In its published form the modern topographic quadrangle provides essential basic data for a wide variety of land and water utilization projects. Because it is a graphic portrayal of a part of the earth's surface, it shows such features as roads, railroads, highways, buildings, section lines, canals, ditches and reservoirs, rivers, streams, lakes, and other bodies of water. These features are shown in their correct size and true position. The topographic quadrangle, however, is unique in that it shows the elevations, slope and configuration of all the ground surfaces. In short, it presents the same information as represented by a true scale model of the terrain.

After a project is authorized studies are made to determine the proper scale which is generally either 1:62,500—approximately one mile to the inch—or 1:24,000—1 inch equals 2,000 feet; and the contour interval may

be 5, 10, 20, 40 or 80 feet, depending on the scale and the type of terrain to be mapped.

The Missouri River Basin development plan presents a striking example of the civilian needs for basic data in the form of good topographic maps. Both irrigation and flood control projects must be planned with a knowledge of the topography of the area involved. Dam sites can be selected and properly located, and the capacity of large and small reservoirs can be estimated on the map. Preliminary location of ditches and canals that conform to the slope of the land can be made in the office. In fact, topographic maps of the Basin might well be called "blue prints for progress". It is axiomatic that topographic maps, to be of maximum value, should be available in the early stages of project planning.

Standard topographic maps of the Federal Government are required to comply with national map accuracy specifications as adopted in 1941, and map sheets are tested to insure compliance with these specifications. The published map carries a note on its lower margin which states, "This map complies with national map accuracy standards." Several worthwhile objectives motivated the adoption of these specifications. Another objective is to make each original topographic map of sufficient accuracy so that it can be revised at any time without the necessity of a basic resurvey.

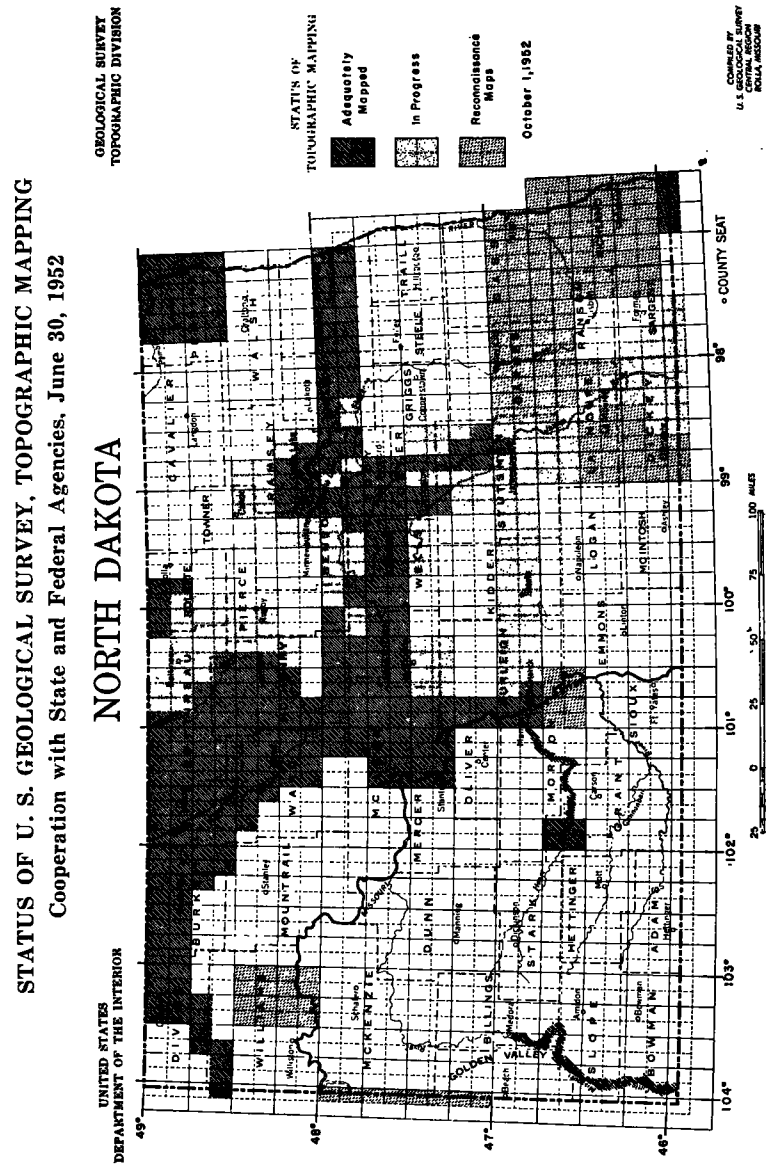
Topographic maps prepared by most photogrammetric methods require that the original manuscript be plotted at large scales generally depending upon the contour interval. These large scale originals usually show many features not included on the published map, such as fence lines, hedges, field boundaries, farm roads, and small outbuildings in rural areas.

Contrary to widespread belief, no new mapping process or instrument was developed during the late war which would greatly modify or expedite standard topographic mapping at medium or large scales.

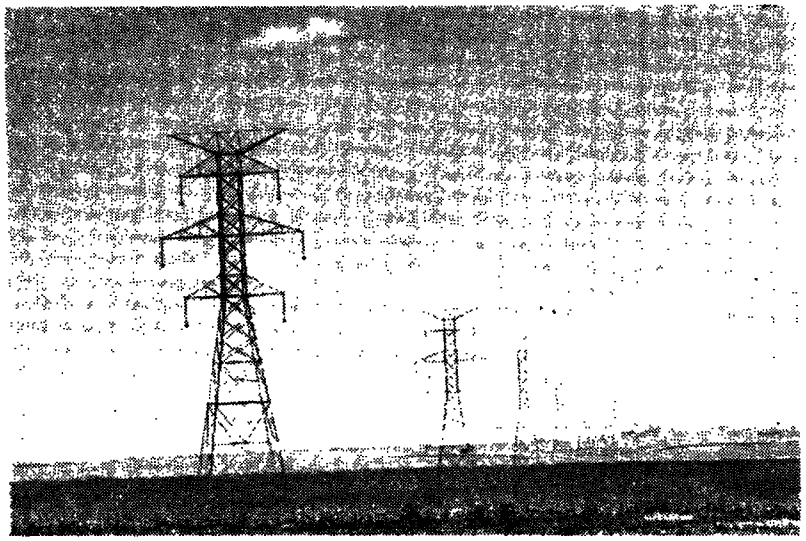
Since the beginning of World War II, the Geological Survey has prepared more than 4½ million square miles of shaded relief mapping. A limited amount of shaded relief work is also being done on selected standard survey quadrangle maps.

In recent years many geologists have begun using aerial photographs, either contact prints or enlargements, as bases on which to plot detailed field geology.

A national mapping program designed to provide the basic data required for the development of our resources is a recognized necessity.



During the period of this report the topographic mapping program conducted by the U.S.G.S. in cooperation with the State Water Conservation Commission has resulted in the completion and publication of 4 - 15' and 1 - 7½ quadrangle sheets of various areas in the state. In addition work was in progress on 2 - 15' and 8 - 7½' sheets on June 30, 1952. Other areas for which the U.S.G.S. completed topographic maps during this period in cooperation with other federal agencies include 61 - 7½' and 6 - 15' quadrangle sheets. Work was in progress on June 30, 1952 under this program on 110 - 7½ sheets and 6 - 15' sheets. Mapping completed during this period totals tbout 5,000 square miles with mapping in progress on about 7,900 additional square miles. On June 30, 1952 the combined cooperative mapping programs had resulted in the completicn of adequate topographic mapping of 11,710 square miles of the state. Appropriated to the State Water Conservation Commission for this cooperative program for the 1949-51 biennium was $30,000.00 and for the 1951-53 biennium $35,000.00. A list of the quadrangle sheets on which work was in progress or completed during the period of this report and the current status of these quadrangles is as follows:



Transmission Lines in North Dakota

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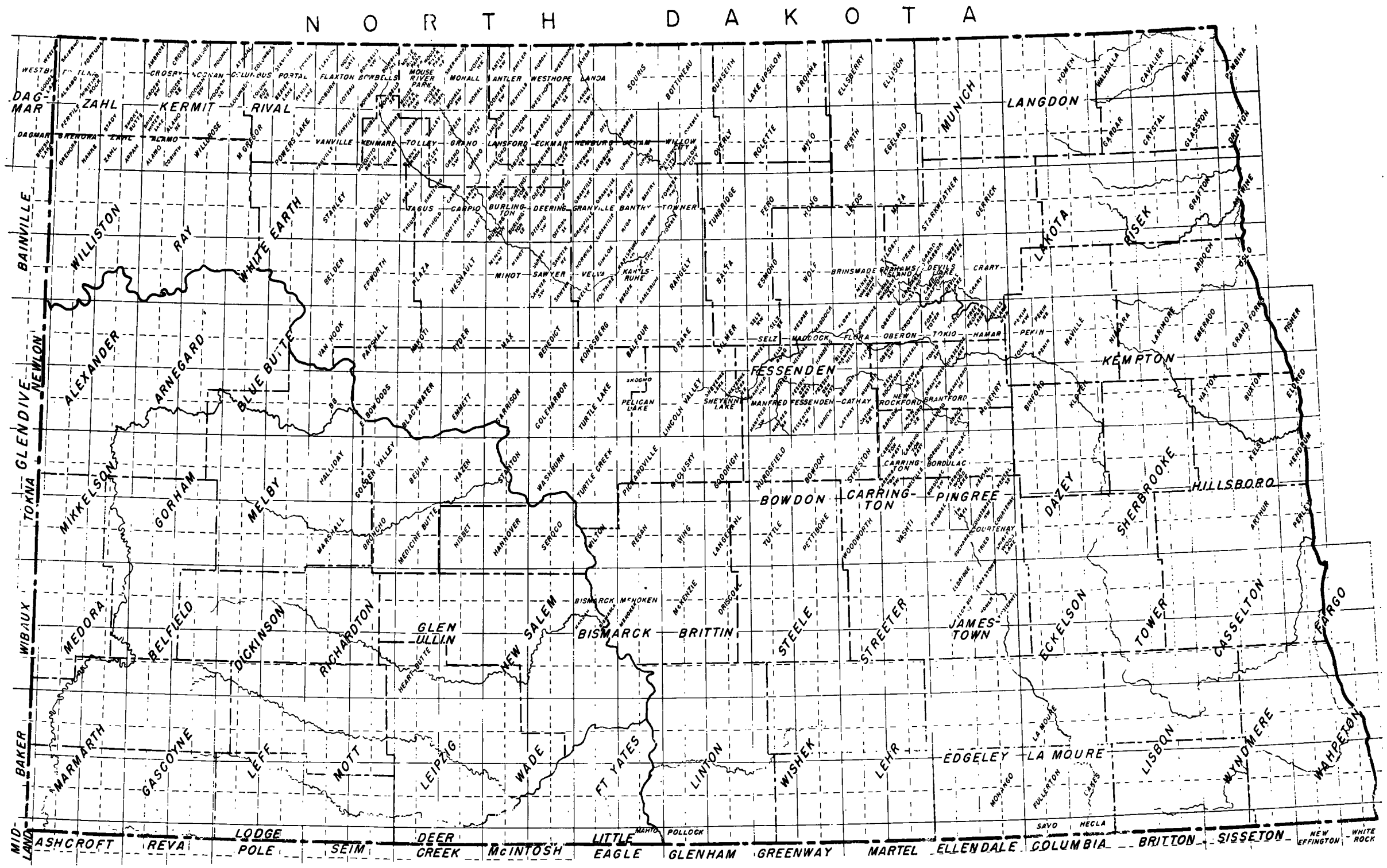
Remarks

Revision



U. S. Geological Survey Topographic Maps—June 30, 1952

INDEX OF QUADRANGLE NAMES

Areas Mapped by U.S.G.S. in Cooperation With State and Federal Agencies

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PROGRESS OF USGS QUADRANGLE MAPS

COOPERATORS AND STATUS OF WORK

Federal—TS Complete—X | State—Coop In Work—/ | Missouri River Basin—MRB Suspended—0

NAME OF QUADRANGLE	Size	Cooperator	Basic Control	Multiplex	Field Contouring	Office Processing	Publication	Remarks
Anamoose	7½	MRB	X	X	X	/		
Antler	7½	MRB	X	X	X	X	X	
Arrowwood Lake	7½	MRB	X	X	X	X	X	
Bantry	7½	MRB	X	X	X	X	X	
Barlow	7½	MRB	X	X	X	X	X	
Bathgate	15	TS		X				Revision
Bismarck 1SW	7½	Coop	X	X	X	X	X	
Bismarck	15	Coop	X	X	X	X	X	
Black Hammer Hill	7½	MRB	X	X	X	/		
Bottineau SE	7½	MRB	X					
Bottineau SW	7½	MRB	X					
Bowbells	15	TS				X	X	
Bowden NE	7½	MRB	X	X	X	/		
Bowden NW	7½	MRB	X	X	X	/		
Bordulac	7½	MRB	X	X	X	/		
Bordulac NE	7½	MRB	X	X	X	X	X	
Bordulac SW	7½	MRB	X	X	X	/		
Brantford NW	7½	MRB	X	X	X	X	X	
Brimsmade	15	MRB	X	0 /				
Britton 1NE	7½	MRB	X	X				
Britton 1NW	7½	MRB	X	X				
Britton 2NE	7½	MRB	X	X				
Britton 2NW	7½	MRB	X	X				
Buchanan	7½	MRB	X	X	X	X	X	
Camp Grafton	7½	MRB	X	X	X	X	X	
Carrington E	7½	MRB	X	X	X	X	X	
Carrington W	7½	MRB	X	X	X	X	X	

PROGRESS OF USGS QUADRANGLE MAPS

COOPERATORS AND STATUS OF WORK

Federal—TS State—Coop Missouri River Basin—MRB
Complete—X In Work—/ Suspended—0

NAME OF QUADRANGLE	Size	Cooperator	Basic Control	Multiplex	Field Contouring	Office Processing	Publication	Remarks
Carrington SW	7½	MRB	X	X	X	X	X	
Cavalier						/		Revision
Columbus	15	TS				X	X	
Courtenay NW	7½	MRB	X	X	X	X	X	
Courtenay	7½	MRB	X	X	X	/		
Crary	15	MRB	X	0 /				
Crary	7½	MRB	X	X	X	X	X	
Deep	7½	MRB	X	X	X	X	X	
Denbigh	7½	MRB	X	X	X	X	X	
Devils Lake	7½	MRB	X	X	X	X	X	
Devils Lake SE	7½	MRB	X	X	X	X	X	
Devils Lake Mountain	7½	MRB	X	X	X	X	X	
Devils Lake—Stump Lake Special		MRB		X	X	X	X	
Drayton								Revision
Driscoll	15	Coop	X	X	X	/		
Dunseith SE	7½	MRB	X					
Dunseith SW	7½	MRB	X					
Eckleson 3SW	7½	MRB	X	X				
Ellendale 1NE	7½	MRB	X	X				
Eldridge	7½	MRB	X	X	/			
Eldridge SE	7½	MRB	X	X	/			
Fero NW	7½	MRB	X					
Fero SW	7½	MRB	X					
Flora	7½	MRB	X	X	X	/		
Flora SE	7½	MRB	X	X	X	X	X	
Flaxton	7½	MRB	X	X	X	X	X	
Free Peoples Lake	7½	MRB	X	X	X	X	X	

PROGRESS OF USGS QUADRANGLE MAPS

COOPERATORS AND STATUS OF WORK

Federal—TS State—Coop Missouri River Basin—MRB
Complete—X In Work—/ Suspended—0

NAME OF QUADRANGLE	Size	Cooperator	Basic Control	Multiplex	Field Contouring	Office Processing	Publication	Remarks
Fried	7½	MRB	X	X	X	X	X	
Fullerton NE	7½	MRB	X	X				
Fullerton SE	7½	MRB	X	X				
Fullerton SW	7½	MRB	X	X				
Glasston	15	TS		X				Revision
Glenfield	7½	MRB	X	X	X	/		
Grace City	7½	MRB	X	X	X	X	X	
Grahams Island	7½	MRB	X	X	X	X	X	
Grand Harbor	7½	MRB	X	X	X	X	X	
Grano	7½	MRB	X	X	X	X	X	
Hamber	7½	MRB	X	X	X	/		
Harvey	7½	MRB	X	X	X	X	X	
Hecla NE	7½	MRB	X	X				
Hecla NW	7½	MRB	X	X				
Heimdal	7½	MRB	X	X	X	/		
Hesper	7½	MRB	X	X	X	/		
Homer	7½	MRB	X	X				
Jamestown	7½	MRB	X	X	X	X	X	
Jamestown 1NE	7½	MRB	X	X	/			
Jamestown 1SE	7½	MRB	X	X	/			
Jamestown 1SW	7½	MRB	X	X				
Jamestown 2NE	7½	MRB	X	X	/			
Jamestown 2SW	7½	MRB	X	X				
Jamestown 3NE	7½	MRB	X	X				
Jamestown 3 NW	7½	MRB	X	X				
Jamestown 4NE	7½	MRB	X	X				
Jamestown 4NW	7½	MRB	X	X				

PROGRESS OF USGS QUADRANGLE MAPS

COOPERATORS AND STATUS OF WORK

Federal—TS State—Coop Missouri River Basin—MRB
Complete—X In Work—/ Suspended—0

NAME OF QUADRANGLE	Size	Cooperator	Basic Control	Multiplex	Field Contouring	Office Processing	Publication	Remarks
Jamestown 4SE	7½	MRB	X	X				
Jamestown 4SW	7½	MRB	X	X				
Jim Lake	7½	MRB	X	X	X	X	X	
Josephine	7½	MRB	X	X	X	/		
Kenmare	7½	MRB	X	X	X	X	X	
Kensal	7½	MRB	X	X	X	/		
Kensal SE	7½	MRB	X	X	X	/		
Kramer	7½	MRB	X	X	X	X	X	
Kuroki	7½	MRB	X	X	X	X	X	
Lake Upsilon	7½	MRB	X					
LaMoure NE	7½	MRB	X	X				
LaMoure NW	7½	MRB	X	X				
LaMoure SW	7½	MRB	X	X				
LaMoure 1SW	7½	MRB	X	X				
Landa NE	7½	MRB	X					
Landa SE	7½	MRB	X					
Lisbon 3NW	7½	MRB	X	X				
Lisbon 3SE	7½	MRB	X	X				
Lisbon 3SW	7½	MRB	X	X				
Maddock	7½	MRB	X	X	X	/		
Mandan	7½	Coop	X	X	X	X	X	
Manfred	7½	MRB	X	X	X	X	X	
Martin	7½	MRB	X	X	X	/		
Maza	15	MRB	X	0 /				
Menoken	15	Coop	X	X	X	X	X	
Melville	7½	MRB	X	X	X	X	X	
Minnewauken East	7½	MRB	X	X	X	X	X	

PROGRESS OF USGS QUADRANGLE MAPS

COOPERATORS AND STATUS OF WORK

Federal—TS State—Coop Missouri River Basin—MRB
Complete—X In Work—/ Suspended—0

NAME OF QUADRANGLE	Size	Cooperator	Basic Control	Multiplex	Field Contouring	Office Processing	Publication	Remarks
Mohall	15	TS				X	X	
Monango SE	7½	MRB	X	X				
Mouse River Park	15	TS				X	X	
McClusky NE	7½	MRB	X					
McClusky NW	7½	MRB	X					
McClusky SE	7½	MRB	X					
McClusky SW	7½	MRB	X					
McKenzie	15	Coop	X	X	X	/		
Newburg	7½	MRB	X	X	X	X	X	
Newburg SE	7½	MRB	X	X	X	X	X	
New Rockford NE	7½	MRB	X	X	X	X	X	
New Rockford SE	7½	MRB	X	X	X	X	X	
Oakes NE	7½	MRB	X	X				
Oakes NW	7½	MRB	X	X				
Oakes SE	7½	MRB	X	X				
Oakes SW	7½	MRB	X	X				
Oberon NE	7½	MRB	X	X	X	X	X	
Oberon NW	7½	MRB	X	X	X	X	X	
Overly NE	7½	MRB	X					
Overly NW	7½	MRB	X					
Overly SE	7½	MRB	X					
Overly SW	7½	MRB	X					
Pekin NE	7½	MRB	X	X	X	X	X	
Pekin NW	7½	MRB	X	X	X	X	X	
Pekin SE	7½	MRB	X	X	X	/		
Pekin SW	7½	MRB	X	X	X	/		
Pembina	15	TS		X				Revision

PROGRESS OF USGS QUADRANGLE MAPS

COOPERATORS AND STATUS OF WORK

Federal—TS Complete—X State—Coop In Work—/ Missouri River Basin—MRB Suspended—0

NAME OF QUADRANGLE	Size	Cooperator	Basic Control	Multiplex	Field Contouring	Office Processing	Publication	Remarks
Penn	7½	MRB	X	X	X	X	X	
Pickardville NE	7½	MRB	X					
Pickardville NW	7½	MRB	X					
Pickardville SE	7½	MRB	X					
Pickardville SW	7½	MRB	X					
Pingree	7½	MRB	X	X	X	/		
Pingree 1NW	7½	MRB	X	X	X	/		
Pingree 3SW	7½	MRB	X	X	X	/		
Portal	15	TS				X	X	
Rangley NE	7½	MRB	X					
Rangley NW	7½	MRB	X					
Rolette NW	7½	MRB	X					
Rolette SW	7½	MRB	X					
Savo NE	7½	MRB	X	X				
Savo NW	7½	MRB	X	X				
Sawyer	7½	MRB	X	X	X	X	X	
Selz NE	7½	MRB	X	X	X	/		
Selz NW	7½	MRB	X	X	X	/		
Sheyenne	7½	MRB	X	X	X	X	X	
Sheyenne Lake NE	7½	MRB	X	X	X	X	X	
Sheyenne Lake	7½	MRB	X	X	X	X	X	
Spiritwood Lake	7½	MRB	X	X	X	X	X	
Starkweather	15	MRB	X	0 /				
Souris NW	7½	MRB	X					
Souris SE	7½	MRB	X					
Souris SW	7½	MRB	X					
Steele 1NE	7½	Coop	X	X	/			

PROGRESS OF USGS QUADRANGLE MAPS

COOPERATORS AND STATUS OF WORK

Federal—TS Complete—X State—Coop In Work—/ Missouri River Basin—MRB Suspended—0

NAME OF QUADRANGLE	Size	Cooperator	Basic Control	Multiplex	Field Contouring	Office Processing	Publication	Remarks
Steele 1 NW	7½	Coop	X	X	/			
Steele 1SE	7½	Coop	X	X	/			
Steele 1 SW	7½	Coop	X	X	/			
Steele 2NE	7½	Coop	X	X				
Steele 2NW	7½	Coop	X	X				
Steele 2SE	7½	Coop	X	X				
Steele 2SW	7½	Coop	X	X				
Sykeston NE	7½	MRB	X	X	X	/		
Sykeston NW	7½	MRB	X	X	X	/		
Sweetwater	7½	MRB	X	X	X	X	X	
Tilden	7½	MRB	X	X	X	X	X	
Tokio NE	7½	MRB	X	X	X	X	X	
Tokio NW (Fort Totten)	7½	MRB	X	X	X	/		
Tokio SE	7½	MRB	X	X	X	/		
Tokio SW	7½	MRB	X	X	X	X	X	
Tolley	15	TS				X	X	
Towner	7½	MRB	X	X	X	X	X	
Towner NE	7½	MRB	X					
Towner SE	7½	MRB	X					
Turnbridge NE	7½	MRB	X					
Turnbridge NW	7½	MRB	X					
Turnbridge SE	7½	MRB	X					
Turnbridge SW	7½	MRB	X					
Upham	7½	MRB	X	X	X	X	X	
Upham SE	7½	MRB	X	X	X	X	X	
Upham SW	7½	MRB	X	X	X	X	X	
Vashita NE	7½	MRB	X					

PROGRESS OF USGS QUADRANGLE MAPS

COOPERATORS AND STATUS OF WORK

Federal—TS State—Coop Missouri River Basin—MRB
Complete—X In Work—/ Suspended—0

NAME OF QUADRANGLE	Size	Cooperator	Basic Control	Multiplex	Field Contouring	Office Processing	Publication	Remarks
Vashita NW	7½	MRB	X					
Vashita SE	7½	MRB	X					
Vashita SW	7½	MRB	X					
Wellsburg	7½	MRB	X	X	X	X	X	
Westhope NE	7½	MRB	X	X	X	X	X	
Westhope SE	7½	MRB	X	X	X	X	X	
Willow City NE	7½	MRB	X					
Willow City NW	7½	MRB	X					
Willow City SW	7½	MRB	X					
Wilton	15	Coop	X	X	X	X	X	
Ypsilanti	7½	MRB	X	X				

HYDROGRAPHIC SURVEYS — COOPERATION WITH U.S.G.S.

Many difficult problems arise in connection with matters involving the waters of our surface streams. Fundamental to the solution of these problems is an adequate knowledge of how much water there is or there will be, and how is it distributed with respect to time. Where the flow varies widely from season to season as it does in North Dakota, an understanding of the variations is extremely important.

The proper administration of water rights and related considerations requires basic information concerning the available supplies at all times. Interstate and international allocations of water between two or more civil jurisdictions must be based upon a knowledge of the available supplies. The erratic characteristics of the flow of our streams frequently requires that water be stored for flood control purposes, for municipal, industrial or irrigation water supplies, for hydroelectric power development and for recreational and wildlife management purposes. Questions arise as to how much water must be stored to affect the required reduction in the flood peaks or to provide the necessary supply during periods when the natural flow is inadequate, and as to the adequacy of the runoff to meet the needs if it is stored and properly used.

A closely related problem is that of spillway capacity requirements. Whenever water is impounded it is essential to know how much spillway capacity will be required to accommodate the flood flows that may be expected. A spillway that is too small endangers lives and property downstream; one that is too large results in a waste of funds. Likewise bridges and culverts should be designed to pass floods that may reasonably be expected to occur during a period of years commensurate with the economical considerations. If a structure is too small a waste occurs due to excessive replacement costs and traffic interruptions as well as possible damage to property upstream; if it is too large, a waste results from an unnecessarily large investment in the structure. The design of artificial channels or changes in natural channels for the passage of flood waters and for drainage purposes must consider the volume of water to be handled. Sewage treatment plant designs and other means of waste disposal must take into account the amount of stream flow available for dilution of the wastes. This feature will become increasingly critical with industrial expansion and increasing urban population. Another consideration of steadily increasing importance in North Dakota is the selection of sites for industrial plants most of which require large and dependable water supplies.

The answer to these and many other problems can be found only through the proper application of records of the flow of our streams. The relation between precipitation and runoff is exceedingly variable so records of rainfall and snowfall will not serve as a measure of available water supply. In most cases it is important that the records cover long periods of years so that the extremes and the duration and frequency of their occurrence is established.

In North Dakota, approximately 70 gaging stations are in operation with continuous records of the stream flow and height being obtained. These stations are maintained and operated by the United States Geological Survey in cooperation with various agencies. Thirty of the stations are maintained wholly or partly through cooperation with the Water Conservation Commission; others are maintained through cooperation with the U. S. Corps of Engineers, Fish and Wildlife Service, State Department and the Interior Department Missouri Basin Program. The monthly and annual summaries of the records collected in this program during the 1950 and 1951 climatic years are given on the following pages. More detailed records are published each year in U. S. Geological Survey Water Supply Papers.

The climatic year ending October 1, 1951 was one of abnormally high runoff in most North Dakota watersheds according to records collected by the Bismarck office of the U. S. Geological Survey acting in cooperation with the North Dakota State Water Conservation Commission and other federal agencies. Although runoff was generally below that which occurred in 1950 with its record breaking floods, it was above that recorded during three-fourths of the years covered by the period of record.

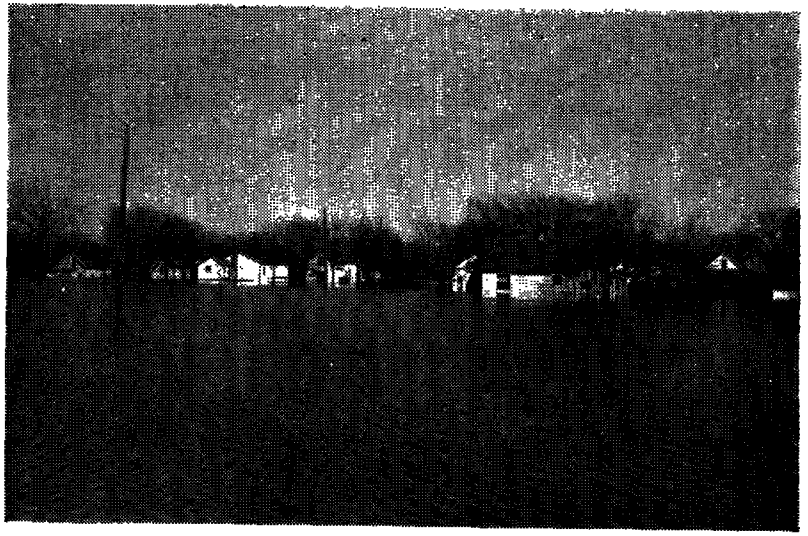
In eastern North Dakota, runoff conditions are represented by flow of the Red River of the North at Grand Forks where the runoff volume totaled 2,660,000 acre-feet, the equivalent of 320% in March to 692% in January.

In the southwestern section, the records for the Cannonball River at Breien show the runoff for the year totaled 201,000 acre-feet which is 190% of normal. The runoff during all months was above normal except for July which was 91%. September was the highest with respect to normal with 10 times the usual September flow.

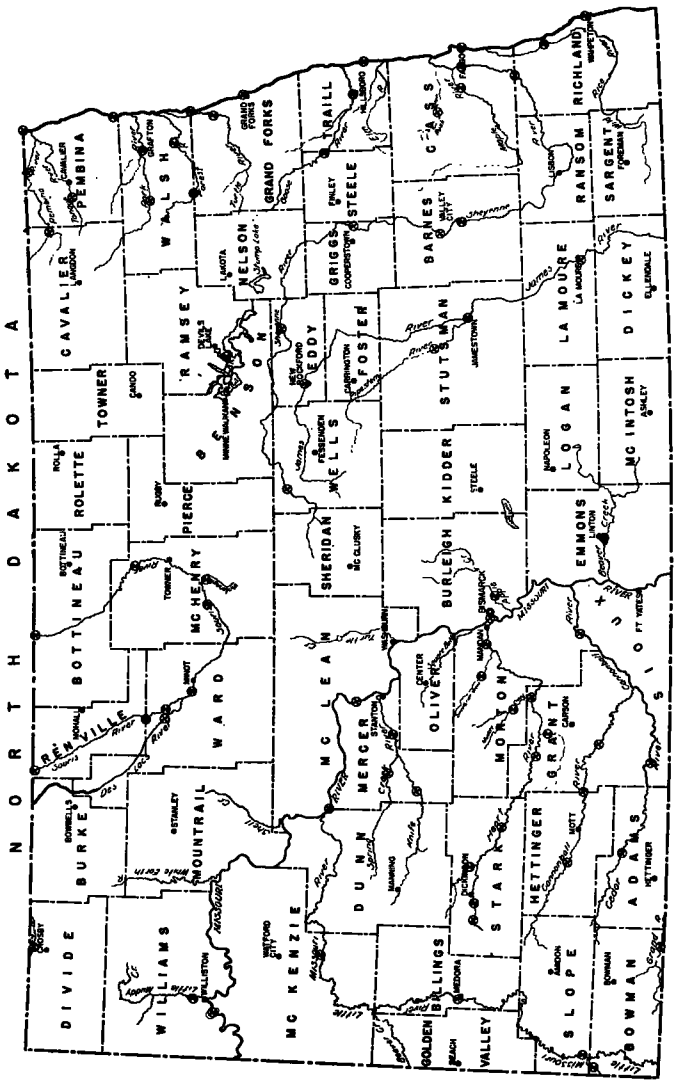
The outstanding hydrologic event of the period covered by this report was unquestionably the widespread flood in the spring of 1950. At least two-thirds of the state was subject to severe flooding and new high water records were established at about half the gaging stations in the state. During that year Devils Lake rose about eight feet to altitude 1415 feet, the highest level reached since 1924. These floods are covered in detail in two U. S. Geological Survey Water Supply Papers; No. 1137-A, Missouri River Basin Floods of April-May, 1950 in North and South Dakota, and No. 1137-B, Floods of 1950 in the Red River of the North and Winnipeg River Basins.

During the latter part of July 1951 a severe cloudburst type of storm occurred over a relatively small area along the state line in Bowman County, North Dakota and Harding County, South Dakota. Evidence was found indicating rainfall amounting to as much as ten inches in a few hours. Although no regular gaging stations were operated in the areas, surveys were made following the flood to determine the peak-flow rates on several small streams where the flooding was most severe. Peak-flow rates of as much as 1,400 cfs per square mile for areas of about five square miles were found.

During the past biennium the State Water Conservation Commission has continued its cooperative program with the U.S.G.S. in gathering stream flow measurement of the various rivers and streams in the state. This program is financed on a 50-50 basis with the Commission and the Geological Survey cooperating. The appropriation for the states 50% share of the costs of this work during the 1949-1951 biennium was $20,000.00 and for the 1951-53 biennium was $25,000.00. The stream flow measurements are taken at several locations on all the major rivers and streams in the state and for many of the minor tributary streams. Stream flow measurements recorded during the period of this report are given on the following pages.



Red River Flood at Fargo, 1952



STREAM GAUGING STATIONS IN NORTH DAKOTA

U.S.G.S. IN COOPERATION WITH N.DAK. STATE WATER COMMISSION

U.S.G.S. IN COOPERATION WITH OTHER AGENCIES

MISSOURI RIVER NEAR WILLISTON, N. Dak.

Location.—Lat. 48°07′, long. 103°44′, in sec 31, T 154 N, R 101 W, on left bank 10 ft downstream from Lewis and Clark Highway bridge, 5 miles southwest of Williston (7 miles by road) and 25 miles downstream from Yellowstone River, at mile 1650.2.

Drainage area.—164,500 square miles.

Records available.—April 1905 to May 1907 (fragmentary), September 1928 to September 1951. Gage-height records collected in this vicinity 1908 to 1911 and since 1913 are contained in reports of United States Weather Bureau.

Gage.—Water-stage recorder. Datum of gage is 1,830.20 ft above mean sea level, datum of 1929. 1905-07, chain and staff gages at site 15 miles downstream, at different datum.

Average discharge.—23 years, 19,790 cfs.

Extremes.—Maximum discharge during year, 110,000 cfs. Apr. 8; maximum gage height, 16.76 ft Apr. 8 (affected by ice); minimum daily discharge, 6,000 cfs Nov. 20, minimum gage height, 3.56 Nov. 20.

1928-51: Maximum discharge, 231,000 cfs Apr. 4, 1930, from rating curve extended above 80,000 cfs; maximum gage height, 19.78 ft Mar. 28, 1943 (ice jam); minimum daily discharge, 1,320 cfs Dec. 28, 1939.

Maximum stage known, about 28 ft in Apr. 1912, according to local residents.

Month	Second Foot Days	Maximum	Minimum	Mean	Run-off in Acre-Feet
October	1,076,100	36,900	32,900	34,710	2,134,000
November	664,300	34,000	16,300	22,140	1,318,000
December	288,000	16,500	4,000	9,290	571,200
Calendar year 1948	10,347,500	77,200	4,000	28,270	20,520,000
January	329,700	11,300	10,200	10,640	654,000
February	324,000	12,100	10,700	11,570	642,600
March	584,800	32,000	10,500	18,860	1,160,000
April	685,400	35,000	16,400	22,850	1,359,000
May	863,800	40,600	22,900	27,860	1,713,000
June	1,157,700	49,700	30,200	38,590	2,296,000
July	833,400	30,600	23,900	26,880	1,653,000
August	795,700	26,600	24,600	25,670	1,578,000
September	785,100	27,900	25,400	26,170	1,557,000
Water year 1948-49	8,388,000	49,700	4,000	22,980	16,640,000

Month	Second Foot Days	Maximum	Minimum	Mean	Run-off in Acre-Feet
October	780,900	27,900	20,800	25,190	1,549,000
November	423,000	19,500	12,700	14,100	839,000
December	255,700	12,800	5,800	8,248	507,200
Calendar year 1949	7,819,200	49,700	5,800	21,420	15,510,000
January	271,500	10,000	7,500	8,758	538,500
February	239,500	9,400	7,700	8,554	475,000
March	424,450	26,000	8,600	13,690	841,900
April	915,800	80,000	16,000	30,530	1,816,000
May	663,300	26,700	16,700	21,400	1,316,000
June	1,283,400	62,000	24,400	42,780	2,546,000
July	1,137,200	49,600	25,300	36,680	2,256,000
August	905,000	33,300	26,800	29,190	1,795,000
September	856,900	32,000	25,600	28,560	1,700,000
Water year 1949-50	8,156,650	80,000	5,800	22,350	16,180,000

Month	Second Foot Days	Maximum	Minimum	Mean	Run-off in Acre-Feet
October	936,900	31,800	28,200	30,220	1,858,000
November	594,300	33,500	6,000	19,810	1,179,000
December	419,800	16,200	10,500	13,540	832,700
Calendar year 1950	8,648,050	80,000	6,000	23,690	17,150,000
January	397,700	15,200	10,600	12,830	788,800
February	372,700	17,900	10,100	13,310	739,200
March	488,700	38,000	8,800	15,760	969,300
April	909,300	68,500	22,400	30,310	1,804,000
May	982,100	43,400	26,200	31,680	1,948,000
June	1,231,800	56,800	27,300	41,060	2,443,000
July	1,034,600	37,000	30,000	33,370	2,052,000
August	1,118,000	39,900	31,600	36,060	2,218,000
September	1,043,800	38,900	31,800	34,790	2,070,000
Water year 1950-51	9,529,700	68,500	6,000	26,110	18,900,000

MISSOURI RIVER MAIN STEM

Missouri River near Elbowoods, N. Dak.

Location.—Lat 47°34′, long 102° 12′ in NE¼NE¼ sec 12, T 147 N, R 91 W, on downstream side of right span of bridge on State Highway 8, 2 miles downstream from Little Missouri River, 2½ miles west of Elbowoods, and at mile 1504.0.

Drainage area.—179,800 square miles.

Records available.—October 1939 to September 1951.

Gage.—Type A wire-weight gage read once daily. Datum of gage is 1,716.15 (revised) ft above mean sea level, datum of 1929. Oct. 1, 1939 to Apr. 18, 1940, the same wire-weight was in use. April 19, 1940 to Nov. 8, 1945, water-stage recorder at same site and datum.

Average discharge.—12 years, 22,860 cfs.

Extremes.—Maximum discharge observed during year, 94,000 cfs Apr. 11; maximum gage height, 16.03 ft Apr. 6 (affected by ice); minimum daily discharge, 4,000 cfs Nov. 22; minimum gage height about 3 ft Nov. 21.

1939-51: Maximum discharge, about 260,000 cfs Mar. 26, 1947 (gage height, 23.2 ft, affected by ice); minimum discharge, about 1,500 cfs Dec. 30, 1939; minimum gage height, 2.00 ft Sept. 18, 1940.

Month	Second Foot Days	Maximum	Minimum	Mean	Run-off in Acre-Feet
October	1,077,100	37,800	33,000	34,750	2,136,000
November	683,600	34,200	16,000	22,790	1,356,000
December	244,500	15,500	3,400	7,887	485,000
Calendar year 1948	10,634,800	76,500	3,400	29,060	21,090,000
January	354,500	12,300	10,600	11,440	703,100
February	328,000	12,800	11,100	11,710	650,600
March	727,000	65,000	12,900	23,450	1,442,000
April	1,073,500	100,000	19,900	35,780	2,129,000
May	857,900	41,300	22,400	27,670	1,702,000
June	1,157,100	51,000	27,600	38,570	2,295,000
July	840,900	30,900	24,000	27,130	1,668,000
August	797,200	27,300	24,500	25,720	1,581,000
September	780,700	28,600	24,200	26,020	1,548,000
Water year 1948-49	8,922,000	100,000	3,400	24,440	17,700,000

Month	Second Foot Days	Maximum	Minimum	Mean	Run-off in Acre-Feet
October	791,100	28,300	20,600	25,520	1,569,000
November	436,400	19,700	12,700	14,550	865,600
December	240,700	13,700	4,000	7,765	477,400
Calendar year 1949	8,385,000	100,000	4,000	22,970	16,630,000
January	264,100	9,900	7,500	8,519	523,800
February	241,500	9,300	8,000	8,625	479,000
March	390,500	18,000	9,000	12,600	774,500
April	1,285,700	100,000	19,000	42,860	2,550,000
May	722,700	30,900	18,400	23,310	1,433,000
June	1,265,400	63,600	22,800	42,180	2,510,000
July	1,156,500	51,300	25,000	37,310	2,294,000
August	910,400	34,800	25,700	29,370	1,806,000
September	869,200	33,700	26,100	28,970	1,724,000
Water year 1949-50	8,574,200	100,000	4,000	23,490	17,010,000

Month	Second Foot Days	Maximum	Minimum	Mean	Run-off in Acre-Feet
October	960,000	32,600	29,000	30,970	1,904,000
November	588,400	33,800	4,000	19,610	1,167,000
December	424,600	16,700	9,200	13,700	842,200
Calendar year 1950	9,079,000	100,000	4,000	24,870	18,010,000
January	411,600	15,900	11,800	13,280	816,400
February	381,000	19,300	10,200	13,610	755,700
March	483,700	40,000	8,900	15,600	959,400
April	1,114,100	69,000	23,400	37,140	2,210,000
May	974,000	43,300	25,000	31,420	1,932,000
June	1,257,300	59,600	27,800	41,910	2,494,000
July	1,046,100	37,300	28,900	33,750	2,075,000
August	1,124,000	42,900	30,800	36,260	2,229,000
September	1,071,100	41,500	31,600	35,700	2,124,000
Water year 1950-51	9,835,900	69,000	4,000	26,950	19,510,000

MISSOURI RIVER MAIN STEM

Missouri River below Garrison Dam, N. Dak.

Location.—Lat 47°30′, long. 101°24′, in sec 5, T 146 N, R 84 W, on upstream side near right end of construction bridge at Garrison damsite, 12 miles north of Stanton, and 14 miles upstream from Knife River.

Drainage area.—181,400 square miles.

Records available.—April 1948 to September 1951.

Gage.—Wire-weight gage read once daily. Datum of gage is at mean sea level, datum of 1929 (levels by Corps of Engineers). Apr. 27, 1948 to July 4, 1949, same gage. July 5, 1949 to Apr. 30, 1951, water-stage recorder 8 miles downstream, at same datum.

Extremes.—Maximum discharge during year, about 120,000 cfs Apr. 9; maximum elevation, 1686.19 Apr. 7; minimum daily discharge, 3,000 cfs Nov. 24.

1948-51: Maximum discharge, 220,000 cfs Apr. 16,1950 (elevation, 1687.64 ft); minimum daily, that of Nov. 24, 1951.

Month	Second Foot Days	Maximum	Minimum	Mean	Run-off in Acre-Feet
October	1,083,900	38,100	33,200	34,960	2,150,000
November	686,000	34,000	15,500	22,870	1,361,000
December	247,200	15,400	3,500	7,970	490,300
January	363,300	12,500	11,000	11,720	720,600
February	339,500	12,700	11,500	12,120	673,400
March	689,200	60,000	12,800	22,230	1,367,000
April	1,183,300	148,000	19,800	39,440	2,347,000
May	868,600	42,600	23,100	28,020	1,723,000
June	1,163,300	52,500	27,700	38,780	2,307,000
July	847,000	31,800	24,300	27,320	1,680,000
August	798,400	27,200	24,500	25,750	1,584,000
September	774,100	28,500	24,700	25,800	1,535,000
Water year 1948-49	9,043,800	148,000	3,500	24,780	17,940,000

Month	Second Foot Days	Maximum	Minimum	Mean	Run-off in Acre-Feet
October	796,000	30,300	21,700	25,680	1,579,000
November	445,000	21,000	13,400	14,830	882,600
December	236,700	14,000	3,800	7,635	469,500
Calendar year 1949	8,504,400	148,000	3,800	23,300	16,870,000
January	267,800	10,200	7,400	8,639	531,200
February	238,900	9,400	7,900	8,532	473,900
March	356,200	16,000	8,800	11,490	706,500
April	1,301,800	120,000	17,000	43,390	2,582,000
May	734,200	30,200	18,700	23,680	1,456,000
June	1,258,000	64,000	23,700	41,930	2,495,000
July	1,166,500	48,900	25,700	37,630	2,314,000
August	902,800	32,800	26,200	29,120	1,791,000
September	877,100	32,800	26,700	29,240	1,740,000
Water year 1949-50	8,581,000	120,000	3,800	23,510	17,020,000

Month	Second Foot Days	Maximum	Minimum	Mean	Run-off in Acre-Feet
October	959,800	32,700	29,400	30,960	1,904,000
November	596,000	34,700	3,000	19,870	1,182,000
December	420,500	16,300	9,200	13,560	834,000
Calendar year 1950	9,079,600	120,000	3,000	24,880	18,010,000
January	417,000	15,500	12,000	13,450	827,100
February	376,600	18,600	10,600	13,450	747,000
March	446,000	35,000	9,300	14,390	884,600
April	1,195,200	70,000	25,300	39,840	2,371,000
May	978,000	44,500	25,100	31,550	1,940,000
June	1,259,700	58,500	28,000	41,990	2,499,000
July	1,048,200	36,900	30,900	33,810	2,079,000
August	1,133,400	42,000	31,100	36,560	2,248,000
September	1,099,600	42,900	32,400	36,650	2,181,000
Water year 1950-51	9,930,000	70,000	3,000	27,210	19,700,000

MISSOURI RIVER MAIN STEM

Missouri River at Bismarck, N. Dak.

Location.—Lat 46°48′50″ long. 100°49′10″, in sec 31, T 139 N, R 80 W, on left bank, 40 ft upstream from Bismarck city water plant, 2,100 ft downstream from Northern Pacific Railway bridge, 1.6 miles northwest of Bismarck Post Office, 3.6 miles upstream from Heart River, and at mile 1377.8.

Drainage area.—186,400 square miles.

Records available.—September 1904 to December 1905, October 1927 to September 1951.

Average discharge.—23 years (1928-51), 21,020 cfs.

Extremes.—Maximum discharge during year, about 130,000 cfs Apr. 5 (gage-height 16.0 ft); maximum gage height, 16.30 ft Apr. 4; minimum daily discharge, 3,000 cfs Nov. 23; minimum gage height, 5.68 ft Nov. 16.

1904-05, 1927-51: Maximum discharge, 282,000 cfs Apr. 3, 1943; maximum gage height, 22.2 ft Apr. 1, 1943 from flood marks; minimum discharge, about 1,800 cfs Jan. 3, 1940; minimum gage height, 1.35 ft, present site and datum, Sept. 4, 1934. Maximum stage known, 31.6 ft, present site and datum, Mar. 31, 1881 (ice jam).

Month	Second Foot Days	Maximum	Minimum	Mean	Run-off in Acre-Feet
October	1,089,500	38,600	33,000	35,150	2,161,000
November	698,900	34,400	15,700	23,300	1,386,000
December	248,300	14,900	2,900	8,010	492,500
Calendar year 1948	10,853,600	75,600	2,900	29,650	21,530,000
January	385,700	13,300	11,600	12,440	765,000
February	346,700	13,100	11,800	12,380	687,700
March	631,500	55,000	13,000	20,370	1,253,000
April	1,377,500	145,000	20,000	45,920	2,732,000
May	874,300	41,700	23,200	28,200	1,734,000
June	1,170,300	53,500	27,300	39,010	2,321,000
July	851,900	33,100	24,400	27,480	1,690,000
August	797,500	27,200	24,300	25,730	1,582,000
September	771,300	28,300	24,500	25,710	1,530,000
Water year 1948-49	9,243,400	145,000	2,900	25,320	18,334,200

Month	Second Foot Days	Maximum	Minimum	Mean	Run-off in Acre-Feet
October	801,500	30,500	23,000	25,850	1,590,000
November	457,400	22,600	13,400	15,250	907,200
December	232,800	13,800	3,400	7,510	461,800
Calendar year 1949	8,698,400	145,000	3,400	23,830	17,250,000
January	265,300	10,200	7,300	8,558	526,200
February	238,100	10,000	7,200	8,504	472,300
March	342,400	15,000	8,500	11,050	679,100
April	1,408,900	143,000	15,000	46,960	2,795,000
May	786,600	35,300	20,200	25,370	1,560,000
June	1,258,700	63,800	24,300	41,960	2,497,000
July	1,174,700	48,400	25,900	37,890	2,330,000
August	902,900	34,300	26,500	29,130	1,791,000
September	883,500	34,900	27,100	29,450	1,752,000
Water year 1949-50	8,752,800	143,000	3,400	23,980	17,360,000

Month	Second Foot Days	Maximum	Minimum	Mean	Run-off in Acre-Feet
October	966,900	33,700	28,700	31,190	1,918,000
November	607,700	35,900	3,000	20,260	1,205,000
December	420,900	17,300	7,800	13,580	834,800
Calendar year 1950	9,256,600	143,000	3,000	25,360	18,360,000
January	436,000	17,500	11,800	14,060	864,800
February	370,100	17,900	10,700	13,220	734,100
March	429,800	35,000	9,000	13,860	852,500
April	1,359,500	94,400	25,700	45,320	2,697,000
May	978,200	44,800	23,900	31,550	1,940,000
June	1,272,500	60,100	27,500	42,420	2,524,000
July	1,056,400	37,500	31,400	34,080	2,095,000
August	1,127,800	42,900	31,100	36,380	2,237,000
September	1,119,500	41,700	33,800	37,320	2,220,000
Water year 1950-51	10,145,300	94,400	3,000	27,800	20,120,000

LITTLE MUDDY CREEK BASIN

Little Muddy Creek near Williston, N. Dak.

Location.—Lat 48°11′40″, long. 103°35′50″, on line between sec 31, T 155 N, R 100 W and sec 6, T 154 N R 100 W, on upstream side of highway bridge, 4 miles northeast of Williston, and 6 miles upstream from mouth.

Drainage area.—1,010 square miles.

Records available.—February 1904 to April 1909 (no winter records), June 1932 to July 1933, April 1946 to September 1951.

Gage.—Wire-weight gage read once daily.

1904-09, chain gage at site 2½ miles upstream above Camp Creek, at different datum. 1932-33, wire-weight gage half a mile upstream at different datum. Apr. 18, 1946 to Oct. 20, 1949, staff gage at present site and datum. Altitude of gage is 1,850 ft. by interpolation between known altitudes along river channel.

Average discharge.—5 years (1946-51), 45.8 cfs.

Extremes.—Maximum discharge during year, 2,330 cfs Apr. 4 (gage height 11.92 ft); no flow Feb. 11 to Mar 26.

1904-09, 1932-33, 1946-50: Maximum discharge, 4,340 cfs (estimated) Apr. 11, 1904 (gage height, 10.3 ft, site and datum then in use); no flow at times.

A stage of approximately 12 ft was reached in years 1911, 1916, 1925, 1929, and 1935, present site and datum.

Remarks.—Records are good during open water periods, fair during period of ice effect, and poor during period of doubtful gage height record. Some small diversions for irrigation. Some regulation by Lake Zahl, Fish and Wildlife Service reservoir.

Month	Second Foot Days	Maximum	Minimum	Mean	Run-off in Acre-Feet
October	258.5	13	5.2	8.34	513
November	252.4	11	6.1	8.41	501
December	137.0	8	1.2	4.42	272
Calendar year 1949	13,221.1	1,200	.5	36.2	26,220
January	44.4	3	.6	1.43	88
February	9.4	.6	0	.34	19
March	1,605	400	0	51.8	3,180
April	11,375	1,100	59	379	22,560
May	1,288	64	23	41.5	2,550
June	733	50	15	24.4	1,450
July	384.7	34	6.9	12.4	763
August	380.5	24	6.9	12.3	755
September	253.7	12	.2	8.5	503
Water year 1949-50	16,721.6	1,100	0	45.8	33,150

Peak discharge (base, 300 sec.-ft.). Apr. 7 (9 p. m.) 1,330 sec.-ft.

Month	Second Foot Days	Maximum	Minimum	Mean	Run-off in Acre-Feet
October	374.2	------	8.1	12.1	742
November	318	--	9	10.6	631
December	288	15	6	9.29	571
Calendar year 1950	17,053.9	1,100	0	46.7	33,810
January	199	------	------	6.42	395
February	15	------	0	.54	30
March	1,690	820	0	54.5	3,350
April	14,838	2,100	51	495	29,430
May	974	62	13	31.4	1,930
June	352.9	15	7.8	11.8	700
July	245.7	10	6.0	7.93	487
August	212.1	9.4	5.8	6.84	421
September	884.8	155	7.8	29.5	1,750
Water year 1950-51	20,391.7	2,100	0	55.9	40,440

LITTLE MISSOURI RIVER BASIN

Little Missouri River at Marmarth, N. Dak.

Location.—Lat. 46°14′,long. 103°54′, in SE¼ sec 30, T 133 N, R 105 W, on upstream side of highway bridge in Marmarth, 1½ miles downstream from Little Beaver Creek.

Drainage area.—4,570 square miles.

Records available.—March 1938 to September 1951.

Gage.—Wire-weight gage. Prior to June 23, 1950, various wire-weight gages on former highway bridge 75 ft downstream, at same datum.

Average discharge.—13 years, 396 cfs.

Extremes.—Maximum discharge observed during year, 4,940 cfs July 29 (gage height, 8.05 ft); no flow Jan. 31 to Feb. 9, Mar. 3-15.

1938-51: Maximum discharge, 45,000 second-feet Mar. 23, 1947 (gage height, 21.7 ft); no flow for part of most winters.

According to local residents the highest known flood occurred in June 1907 (stage unknown). Other major floods occurred in March 1913, May 1929, and March 1920 and reached stages of about 21.5, 20.2 and 19.7 feet, respectively. (These stages are not comparable to stages during the period of record, owing to construction of levees).

Remarks.—Records good except those for periods of ice effect or doubtful gage-height record, which are poor. Gage read once or twice daily. Some small diversions above station for irrigation.

Revisions (Water years).—W896: 1938, 1939, W1086: 1943, 1944.

Month	Second Foot Days	Maximum	Minimum	Mean	Run-off in Acre-Feet
October	1,863	99	30	60.1	3,700
November	428.5	28	5	14.3	850
December	55.8	10	0	1.80	111
Calendar year 1949	158,877.3	11,000	0	435	315,100
January	0	0	0	0	0
February	77	10	0	2.8	153
March	19,600	4,000	100	632	38,880
April	153,527	16,900	459	5,120	304,500
May	39,879	4,930	122	1,290	79,100
June	3,370	215	64	112	6,680
July	2,238	188	30	72.2	4,440
August	3,726	340	29	120	7,390
September	540.4	44	3.9	18.0	1,070
Water year 1949-50	225,304.7	16,900	0	617	446,900

Peak discharge (base 1,500 sec.-ft.).—Mar. 5 (5 a. m.) 4,900 sec.-ft.; Apr. 3 (5 p. m.) 6,000 sec.-ft.; Apr. 7 (8 a. m.), 18,500 sec.-ft.; Apr. 15 (2 p. m.) 13,300 sec.-ft.; May 5 and 10 or 11 (time and discharge unknown);

Month	Second Foot Days	Maximum	Minimum	Mean	Run-off in Acre-Feet
October	825.8	55	2.7	26.6	1,640
November	471	36	5	15.7	934
December	131	6	2	4.2	260
Calendar year 1950	24,653.2	3,800	0	67.5	48,900
January	114	6	0	3.7	226
February	108	10	0	3.9	214
March	7.268	1,200	0	234	14,420
April	3,026	270	42	101	6,000
May	1,640	290	13	52.9	3,250
June	4,555	619	42	152	9,030
July	9,027	3,210	16	291	17,900
August	3,541.8	516	5.0	114	7,030
September	9,079	2,100	57	303	18,010
Water year 1950-51	39,786.6	3,210	0	109	78.910

LITTLE MISSOURI RIVER BASIN

Little Missouri River at Medora, N. Dak.

Location.—Lat. 46°55′10″, long. 103°31′40″, in NE¼ sec 27, T 140 N, R 102 W, on left bank 600 ft below bridge on U. S. Highway 10, 1 mile upstream from Andrews Creek.

Drainage area.—6,190 square miles.

Records available.—May 1903 to October 1908, October 1921 to September 1924, August 1928 to September 1934, October 1945 to September 1951.

Gage.—Water-stage recorder. Altitude of gage is 2,250 ft (from topographic map). Prior to Oct. 9, 1945, staff, chain, or wire-weight gages at several sites within ¼ mile range upstream from present site at various datums. Oct. 9, 1945 to Aug. 22, 1951, wire-weight gage at site 600 ft upstream at same datum.

Average discharge.—9 years (1923-24, 32-34, 45-51) 539 cfs.

Extremes.—Maximum discharge during year, 5,200 cfs Mar. 22 (gage height 8.5 ft, affected by ice); no flow Jan. 25 to Feb. 2, Feb. 5-9.

1903-08: 1921-24; 1928-34; 1945-51; Maximum discharge, 65,000 cfs Mar. 23, 1947 (gage height, 20.5 ft.); no flow at times.

Remarks.—Records good except those for periods of ice effect which are poor. Some small diversions above station for irrigation.

Month	Second Foot Days	Maximum	Minimum	Mean	Run-off in Acre-Feet
October	2,714	151	19	87.5	5,380
November	911	65	11	30.4	1.810
December	126	22	0	4.1	250
Calendar year 1949	219,518.3	14,000	0	601	435,400
January	0	0	0	0	0
February	0	0	0	0	0
March	30,665	7,000	0	989	60,820
April	203,180	23,300	550	6,773	403,000
May	53,892	5,420	220	1,738	106,900
June	5,790	516	109	193	11,480
July	3,180	248	42	103	6,310
August	4,039	336	31	130	8,010
September	1,575	173	28	52.5	3,120
Water year 1949-50	306,072	23,300	0	839	607,100

Peak discharge (base, 3,000 sec.-ft.).—Mar. 6 (6 a. m.) 7,970 sec.-ft.; Apr. 3 (time and discharge unknown); Apr. 8 (4 a. m.) 25,600 sec.-ft.; Apr. 16 (6 p. m.) 20,800 sec.-ft.; May 11 (7 p. m.) 5,610 sec.-ft.

Month	Second Foot Days	Maximum	Minimum	Mean	Run-off in Acre-Feet
October	1,704	123	27	55.0	3,380
November	450	27	2	15.0	893
December	118	12	1	3.8	234
Calendar year 1950	304,593	23,300	0	835	604,100
January	34	4	0	1.1	67
February	3,017	300	0	108	5,980
March	18,735	2,800	2	604	37,160
April	6,341	600	58	211	12,580
May	1,976	103	29	63.7	3,920
June	5,320	750	47	177	10,550
July	6,890	1,810	43	222	13,670
August	4,415	870	31	142	8,760
September	11,010	2,170	85	367	21,840
Water year 1950-51	60,010	2,800	0	164	119,000

LITTLE MISSOURI RIVER BASIN

Little Missouri River near Watford City, North Dakota

Location.—Lat. 47°36′, long. 103°16′, in NW¼ Sec 35, T 148 N, R 99 W, on left bank at downstream side of bridge on U. S. Highway 85, 17½ miles south of Watford City and 18 miles upstream from Cherry Creek.

Drainage area.—8,490 square miles.

Records available.—October 1934 to September 1951.

Average discharge.—17 years, 646 cfs.

Gage.—Water stage recorder and Type A wire-weight gage read once or more daily. Datum of gage is 1,929.03 ft above mean sea level, datum of 1929. Prior to June 9, 1939, recorder at present site. June 9, 1939 to Apr. 15, 1943 recorder at site 700 ft upstream at same datum. The Type A wire-weight gage on downstream side of bridge has been used intermittently since station establishment.

Extreme.—Maximum discharge during year, about 18,000 cfs Mar. 27 (gage height, 13.82 ft, affected by ice); maximum gage height, 13.94 ft Mar. 25, affected by ice; no flow Dec. 5 to Feb. 11, Mar. 7-23.

1934-51: Maximum discharge, 110,000 cfs Mar. 25, 1947 (gage height, 24.0 ft from floodmark); no flow at times.

Remarks.—Records good except those for period of ice effect, which are fair except those for Feb. 12-25, which are poor. Some diversions above station for irrigation.

Revisions (water years).—W926: 1935.

Month	Second Foot Days	Maximum	Minimum	Mean	Run-off in Acre-Feet
October	2,764	122	46	89.2	5,480
November	1,202	74	22	40.1	2,380
December	274	49	0	8.8	543
Calendar year 1949	312,141	24,000	0	855	619,100
January	0	0	0	0	0
February	0	0	0	0	0
March	39,398	8,510	0	1,271	78,140
April	229,620	25,000	600	7,654	455,400
May	64,643	5,820	355	2,085	128,200
June	11,164	772	169	372	22,140
July	4,726	382	85	152	9,370
August	8,355	1,390	64	270	16,570
September	4,537	824	51	151	9,000
Water year 1949-50	366,683	25,000	0	1,005	727,200

Month	Second Foot Days	Maximum	Minimum	Mean	Run-off in Acre-Feet
October	2,348	114	44	75.7	4,660
November	668	43	8	22.3	1,320
December	10	4	0	.3	20
Calendar year 1950	365,469	25,000	0	1,001	724,800
January	0	0	0	0	0
February	7,930	3,500	0	283	15,730
March	60,001	15,000	0	1,936	119,000
April	17,983	1,900	204	599	35,670
May	4,234	338	70	137	8,400
June	4,938	443	81	165	9,790
July	6,130	551	57	198	12,160
August	5,965	755	50	192	11,830
September	15,601	1,740	126	520	30,940
Water year 1950-51	125,808	15,000	0	345	249,500

LITTLE MISSOURI RIVER BASIN

Little Beaver Creek near Marmarth, N. Dak.

Location.—Lat. 46°16′, long. 103°58′, in NE¼ sec 7, T 132 N, R 106 W, on left bank 150 ft upstream from concreted ford, ¾ mile downstream from Corral Creek, 3 miles southwest of Marmarth and 5 miles upstream from mouth.

Drainage area.—615 square miles.

Records available.—April 1938 to September 1951.

Gage.—Water-stage recorder. Prior to Mar. 15, 1941, wire-weight gage at site half a mile upstream at datum 0.57 ft lower. Mar. 15, 1941 to May 20, 1947, staff or wire-weight gages at present site and datum. May 21, 1947 to June 27, 1951 staff and wire-weight gage at site half a mile upstream, at same datum.

Average discharge.—13 years, 50.4 cfs.

Extremes.—Maximum discharge during year, 2,430 cfs Sept. 3 (gage height, 6.21 ft); no flow at times.

1938-51: Maximum discharge, 6,820 cfs during night of June 22, 1944 (gage height, 12.5 ft, observer's estimate at site then in use), but may have been higher during flood of Mar. 23, 1947; no flow at times.

Remarks.—Records fair prior to June 28 and good thereafter except those for period of ice-effect, which are poor. No regulation. Some small diversions for irrigation.

Month	Second Foot Days	Maximum	Minimum	Mean	Run-off in Acre-Feet
October	247.0	36	1.0	7.97	490
November	83.2	3.9	1.3	2.77	165
December	11.1	1.4	.2	.36	22
Calendar year 1949	20,063.4	3,000	0	55.0	39,800
January	1.5	.1	0	.05	3.0
February	29	5	0	1.0	58
March	3,887	1,200	2	125	7,710
April	15,630	3,800	45	521	31,000
May	2,332	279	16	75.2	4,630
June	999.5	368	8.5	33.3	1,980
July	201.7	11	3.9	6.51	400
August	99.9	18	.6	3.22	198
September	44.8	3.0	.1	1.49	89
Water year 1949-50	23,566.7	3,800	0	64.6	46,740

Peak discharge (base 300 sec.-ft.).—Mar. 5 (time unknown) 1,800 sec.-ft.; Mar. 23 (time unknown) 600 sec.-ft.; Apr. 3 (time and discharge unknown); Apr. 7 (5 p. m.) 4,600 sec-ft.; Apr. 14 (2 p. m.) 920 sec.-ft.; May 9 (4 p. m.) 760 sec.-ft.; June 25 (9 a. m.) 685 sec.-ft.

Month	Second Foot Days	Maximum	Minimum	Mean	Run-off in Acre-Feet
October	132.0	11	2.2	4.26	262
November	73.5	3.9	1.4	2.45	146
December	56.6	2.8	1.5	1.83	112
Calendar year 1950	23,487.5	3,800	0	64.3	46,590
January	30.8	2.5	0	0.99	61
February	51.9	8	0	1.85	103
March	1,512.1	400	0.2	48.8	3,000
April	313.9	27	4.5	10.5	623
May	187.4	54	1.9	6.05	372
June	424.7	119	0.6	14.2	842
July	1,178.0	770	0	38.0	2,340
August	287.6	149	0	9.28	570
September	2,960.6	1,110	1.5	98.7	5,870
Water year 1950-51	7,209.1	1,110	0	19.8	14,300

KNIFE RIVER BASIN

Knife River near Golden Valley, North Dakota

Location.—Lat. 47°09′, long. 102°03′, in SE¼ sec 34, T 143 N, R 90 W, on left bank 6 ft downstream from county highway bridge, 2½ miles downstream from Elm Creek and 10 miles south of Golden Valley.

Drainage area.—1,230 square miles.

Records available.—April 1943 to September 1951 at present site. May 1903 to November 1904 at site 3 miles downstream; March 1905 to October 1919. October 1921 to September 1924 at site 1 mile upstream, published as Knife River at or near Broncho, in reports of Geological Survey. May 1903 to November 1904, March 1905 to October 1919, October 1921 to September 1925, March to September 1927, April 1943 to September 1951 in reports of State Engineer of North Dakota.

Gage.—Water-stage recorder. Datum of gage is 1847.13 ft above mean sea level, datum of 1929 (levels by Corps of Engineers). Prior to November 1904, cantilever chain gage at site 3 miles downstream at different datum. March 23, 1905 to Oct. 31, 1919, Oct. 10, 1921 to Sept. 20, 1924, cantilever chain gage at site 1 mile upstream, at datum about 2.8 ft higher than former gage.

Apr. 24, 1943 to Oct. 27, 1943, vertical staff gage at present site and datum. Relation of datum with that of former gages not known.

Oct. 28, 1943 to Nov. 28, 1945, wire-weight gage (similar to Canfield gage) at present site and datum.

Average discharge.—14 years (1909-11, 1921-25, 1943-51) 110 cfs.

Extremes.—Maximum discharge during year, 7,200 cfs Mar. 28 (gage height 25.67 ft, backwater from ice); minimum daily discharge, 5 cfs Feb. 1-18; minimum gage height, 2.17 ft Aug. 23, 24.

1903-19, 1921-24, 1943-51: Maximum discharge, 10,900 cfs Apr. 16, 1950 (gage height, 26.37 ft, from floodmark in well); no flow Sept. 6-8, 1905, Sept. 18, 19, 1908.

Flood of June 26, 1914 reached a stage of 24.0 ft from floodmark, site and datum then in use; (discharge, 7,700 cfs, from rating curve extended above 2,000 cfs).

Flood of Mar. 26, 27, 1943, reached a stage of 26.7 ft, from floodmark; (discharge, 11,500 cfs, from rating curve extended above 7,800 cfs).

The floods of March 1943 and April 1950 are the only major floods since 1903 according to local residents.

Revisions.—W 1146: Location.

Month	Second Foot Days	Maximum	Minimum	Mean	Run-off in Acre-Feet
October	305.4	13	6.6	9.85	606
November	272.1	10	6.3	9.07	540
December	166.3	9.8	3	5.36	330
Calendar year 1949	47,785.6	5,300	2	131	94,800
January	41	3	1	1.32	81
February	28	1	1	1.0	56
March	9,066	1,600	1	292	17,980
April	51,691	10,300	100	1,723	102,500
May	5,655	527	39	182	11,220
June	969	38	25	32.3	1,920
July	600	31	11	19.4	1,190
August	328.6	15	8.8	10.6	652
September	290.5	15	7.6	9.68	576
Water year 1949-50	69,412.9	10,300	1	190	137,700

Peak discharge (base 1,500 sec.-ft.)—Mar. 26 (10 a. m.) 1,700 sec.-ft.; Apr. 8 time and discharge unknown); Apr. 16 (12 p. m.) 10,900 sec.-ft.

Month	Second Foot Days	Maximum	Minimum	Mean	Run-off in Acre-Feet
October	318.1	11	9.5	10.3	631
November	245.4	9.2	7.0	8.18	487
December	263.0	9	8	8.48	522
Calendar year 1950	69,495.6	10,300	1	190	137,800
January	282	10	6	9.1	559
February	150	6	5	5.4	298
March	25,154	6,800	6	811	49,890
April	20,015	2,800	74	667	39,700
May	1,423	139	18	45.9	2,820
June	1,751	504	14	58.4	3,470
July	890.2	71	9.2	28.7	1,770
August	1,017.7	356	6.0	32.8	2,020
September	1,142.6	155	8.4	38.1	2,270
Water year 1950-51	52,652.0	6,800	5	144	104,400

KNIFE RIVER BASIN

Knife River at Hazen, N. Dak.

Location.—Lat. 47°17′, long.101°37′, in SE¼ Sec 18, T 144 N, R 86 W, on right bank at upstream side of county highway bridge, 0.5 mile south of Hazen and 2 miles upstream from Antelope Creek.

Drainage area.—2,350 square miles.

Records available.—October 1928 to August 1933 (fragmentary), August 1937 to September 1951.

Gage.—Water-stage recorder. Datum of gage is 1,712.35 ft above mean sea level, datum of 1929. Prior to Sept. 25, 1947, wire-weight or chain gages at same site and datum.

Average discharge.—14 years (1937-51),213 cfs.

Extremes.—Maximum discharge during year, 9,000 cfs Mar. 30 (gage height, 25.36 ft); minimum discharge, 20 cfs Feb. 13 to Mar. 23; minimum gage height 3.47 ft Aug. 8.

1928-33, 1937-51: Maximum discharge, 26,500 cfs Mar. 26 or 27, 1943 (gage height, 26.3 ft, from floodmarks); no flow (estimated) Jan. 21 to Feb. 5, 1933.

Floods of Mar. 26 or 27, 1943 and Apr. 17, 1950 are the only major floods known since 1884.

Remarks.—Records good except those for periods of ice effect, which are poor. Some diversions above station. Flow regulated by Ilo Lake (capacity, 7,130 acre-feet).

Revisions (water year).—W1146: 1943.

Month	Second Foot Days	Maximum	Minimum	Mean	Run-off in Acre-Feet
October	1,043	41	27	33.6	2,070
November	957	37	25	31.9	1,900
December	603	30	13	19.5	1,200
Calendar year 1950	82,302	7,640	7	225	163,200
January	288	13	7	9.3	571
February	156	7	5	5.6	309
March	12,973	2,500	5	418	25,730
April	100,690	21,800	250	3,356	199,700
May	14,290	1,220	150	461	28,340
June	3,444	140	93	115	6,830
July	2,322	102	58	74.9	4,610
August	1,682	70	49	54.3	3,340
September	1,484	64	42	49.5	2,940
Water year 1949-50	139,932	21,800	5	383	277,500

Month	Second Foot Days	Maximum	Minimum	Mean	Run-off in Acre-Feet
October	1,408	49	43	45.4	2,790
November	1,061	44	30	35.4	2,100
December	930	----	----	30	1,840
Calendar year 1950	140,728	21,800	5	386	279,100
January	930	----	----	30	1,840
February	620	25	20	22.1	1,230
March	21,977	8,900	20	709	43,590
April	52,968	7,400	228	1,766	105,100
May	4,357	291	77	141	8,640
June	3,961	838	72	132	7,860
July	2,359	160	45	76.1	4,680
August	3,635	1,080	34	117	7,210
September	2,406	240	39	80.2	4,770
Water year 1950-51	96,612	8,900	20	265	191,650

KNIFE RIVER BASIN

Spring Creek at Zap, North Dakota

Location.—Lat. 47°16′50″, long. 101°55′10″, in SW¼ sec 14, T 144 N, R 89 W, on right bank 250 ft downstream from Northern Pacific Railroad bridge in Zap and 9 miles upstream from mouth.

Drainage area.—545 square miles.

Records available.—March to September 1924, October 1945 to September 1951 in reports of Geological Survey. January to December 1924, August to December 1925, October 1945 to September 1951 in reports of State Engineer.

Gage.—Water-stage recorder. Datum of gage is 1819.39 ft above mean sea level, datum of 1929 (levels by Corps of Engineers). Prior to Sept. 30, 1924, staff gage 250 ft upstream at a different datum. Oct. 1, 1945 to Sept. 30, 1947, staff gage 250 ft upstream at datum 1.12 ft. higher.

Average discharge.—6 years (1945-51), 53.7 cfs.

Extremes.—Maximum discharge during year, 3,900 cfs Apr. 5 (gage height 18.38 ft, backwater from ice); minimum observed 3.6 cfs Feb. 17, 18, 20 (gage height, 1.95 ft).

1924, 1945-51: Maximum discharge, 4,580 cfs Apr. 17, 1950 (gage height 18.80 ft); no flow at times.

Maximum stage known occurred in about 1902, from ice jam.

Flood of February 1913 reached a stage about 1 foot higher than that of Apr. 17, 1950, according to local residents.

Flood of March 1943 reached a stage about ½ foot higher than that of Apr. 17, 1950.

Remarks.—Record good except those for period of ice effect, which are poor. Flow regulated by Ilo Lake (capacity, 7,130 acre-feet).

Month	Second Foot Days	Maximum	Minimum	Mean	Run-off in Acre-Feet
October	225.3	9.0	5.7	7.27	447
November	217.9	7.7	6.7	7.26	432
December	115	7	2	3.71	228
Calendar year	15,063.3	2,540	0	41.3	29,870
January	19	2	0	.61	38
February	0	0	0	0	0
March	3,326	1,100	0	107	6,600
April	20,173	4,400	50	672	40,010
May	2,767	243	25	89.2	5,490
June	660	28	17	22.0	1,310
July	428	19	11	13.8	849
August	353.5	22	8.2	11.4	701
September	294.9	15	6.4	9.83	585
Water year 1949-50	28,579.6	4,400	0	78.3	56,690

Month	Second Foot Days	Maximum	Minimum	Mean	Run-off in Acre-Feet
October	318.2	12	9.1	10.3	631
November	211.8	8.6	6	7.06	420
December	195	7	6	6.3	387
Calendar year 1950	28,746.4	4,400	0	78.8	57,020
January	238.2	8.2	6.8	7.68	472
February	145.1	8.2	3.6	5.18	288
March	723.7	250	4.5	23.3	1,440
April	18,177	3,600	60	606	36,050
May	1,029	64	20	33.2	2,040
June	1,362	669	14	45.4	2,700
July	378.0	29	7.8	12.2	750
August	615.3	211	5.8	19.8	1,220
September	299.3	28	6.4	9.98	594
Water year 1950-51	23,692.6	3,600	3.6	64.9	46,990

HEART RIVER BASIN

Heart River Near South Heart, N. Dak.

Location.—Lat. 46°51′40″, long. 102°56′50″, in SW¼ sec. 8, T. 139 N., R. 97 W., on left bank half a mile downstream from North Creek and 2 miles east of South Heart.

Drainage area.—315 square miles.

Records available.—May 1947 to September 1951.

Gage.—Water-stage recorder. Datum of gage is 2,429.45 ft. above mean sea level, datum of 1929 (levels by Corps of Engineers).

Extremes.—Maximum discharge during year, 2100 cfs Mar. 26 (gage height, 17.09 ft); minimum, 0.3 cfs Aug. 2-12.

1947-51: Maximum discharge, 4,080 cfs Apr. 16, 1950 (gage-height, 21.67 ft, from floodmark in gage well); minimum daily, 0.1 cfs Jan. 16 to Feb. 5, 1950.

Remarks.—Records good except those for periods of ice effect, which are poor.

Month	Second Foot Days	Maximum	Minimum	Mean	Run-off in Acre-Feet
October	52.3	7.2	0.7	1.69	104
November	20.3	1.0	.6	.68	40
December	7.4	.6	.2	.24	15
Calendar year 1949	18,021.9	2,260	.2	49.4	35,740
January	4.6	.2	.1	.15	9.1
February	5.1	.2	.1	.18	10
March	3,235.8	600	.2	104	6,420
April	13,295	3,740	10	443	26,370
May	1,166.4	251	3.6	37.6	2,310
June	96.1	7.1	1.7	3.20	191
July	36.0	2.5	.4	1.16	71
August	17.2	1.1	.3	.55	34
September	24.3	3.5	.3	.81	48
Water year 1949-50	17,960.5	3,740	.1	49.2	35,620

Peak discharge (base 200 sec.-ft.)—Mar. 7 (10 a. m.) 450 sec.-ft.; Mar. 23 7:30 a. m.) 630 sec.-ft.; Apr. 16 (6:30 p. m.) 4,080 sec.-ft.; May 11 (8 a. m.) 281 sec.-ft.

*—Winter discharge measurement made on this day.

Note.—Stage-discharge relation affected by ice Dec. 10 to Apr. 15 (no gage-height record Jan. 8-24, Jan. 28 to Feb. 6).

Month	Second Foot Days	Maximum	Minimum	Mean	Run-off in Acre-Feet
October	34.8	4.9	.7	1.12	69
November	27.4	1.3	.6	.91	54
December	30.0	1.1	.8	.97	60
Calendar year 1950	17,972.72	3,740	.1	49.2	35,650
January	25.1	1.1	.4	.81	50
February	1,377.8	250	.4	49.2	2,730
March	8,050.5	2,050	.8	260	15,970
April	638.3	104	2.9	21.3	1,270
May	182.4	29	1.0	5.88	362
June	187.8	36	1.0	6.26	372
July	135.1	34	.4	4.36	270
August	73.2	16	.3	2.36	145
September	138.8	34	.6	4.63	275
Water year 1950-51	10,901.2	2,050	.3	29.9	21,630

HEART RIVER BASIN

Dickinson Reservoir Near Dickinson, N. Dak.

Location.—Lat. 46°52′00″, long. 102°49′45″, near west line of sec 8, T 139 N, R 96 W, 2 miles southwest of Dickinson.

Drainage area.—400 square miles.

Records available.—May 1950 to September 1951.

Gage.—Staff gage. Datum of gage is mean sea level. datum of 1929 (levels by Bureau of Reclamation).

Extremes.—Maximum contents during period, 9,050 acre-feet Mar. 27, 1951 (elevation 2,418.82 ft); minimum after Mar. peak, 5,630 acre-feet Sept. 30 (elevation, 2,414.98 ft).

Remarks.—Reservoir is formed by earth-fill dam; storage began May 23, 1950; dam completed Aug. 9, 1950. Total capacity is 25,700 acre-feet at maximum pool, elevation 2,429.3 ft. Dead storage is 1,100 acre-feet below lowest point of outlet, elevation 2,404.7 ft. Conservation storage is 5,900 acre-feet between elevation 2,404.7 ft and crest of spillway, elevation 2,416.5 ft. Figures given herein represent total contents. The reservoir is for flood control, irrigation, and municipal supply.

Cooperation.—Record of gage heights and contents furnished by Bureau of Reclamation.

Monthly Elevations and Contents, April 1950 to September 1951.

Date	Elevation (feet)	Contents (acre - feet)	Change in contents During month (acre-feet)
April 30, 1950	2,385		
Dec. 31	2,396	300	
Calendar year 1950			+300
Feb. 28, 1951	2,410.86	3,150	
Mar. 31	2,416.95	7,230	+4,080
Apr. 30	2,416.34	6,700	—530
May 31	2,416.01	6,420	—280
June 30	2,415.96	6,380	—40
July 31	2,415.68	6,170	—210
Aug. 31	2,415.18	5,780	—390
Sept. 30	2,414.98	5,630	—150

HEART RIVER BASIN

Heart River at Lehigh, N. Dak.

Location.—Lat. 46°52′, long. 102°43′ in NE¼ sec. 7, T. 139 N., R. 95 W., on upstream side of county highway bridge in Lehigh, 150 ft. downstream from Northern Pacific Railway bridge, 6 miles below Dickinson Dam and about 10 miles upstream from Green River.

Drainage area.—443 square miles (revised).

Records available.—March 1943 to September 1951.

Gage.—Wire-weight gage read twice daily during spring highwater and once at other times. Datum of gage is 2,328.39 ft. above mean sea level, datum of 1929 (levels by Corps of Engineers).

Average discharge.—8 years, 51.9 cfs.

Extremes.—Maximum discharge during year, 2,600 cfs Mar. 26; maximum gage height, 15.0 ft. Mar. 26 (from highwater mark, backwater from ice); minimum daily discharge 0.1 cfs July 29, 30 (gage height 3.49 ft. July 29, 30).

1943-51: Maximum discharge, 5,980 cfs Apr. 15, 1950; (gage height, 17.90 ft. from high water mark) no flow Mar. 14-18, 1944.

Maximum discharge known, that of Apr. 15, 1950.

Flood of Mar. 25, 1943, reached a stage of 17.7 ft. from floodmark, (discharge, 5,420 cfs).

Flood of Mar. 13, 1945, reached a stage of 17.7 ft. from floodmark, backwater from ice, (discharge, 4,500 cfs).

Remarks.—Records fair except those for periods of ice effect, which are poor. Regulated at low-flow by 24" gate in Dickinson Dam and at high-flow by storage in the reservoir (capacity, 7,000 acre-feet). Several small diversions above stations for irrigation, and water supply for the city of Dickinson and the Northern Pacific Railway Co.

Month	Second Foot Days	Maximum	Minimum	Mean	Run-off in Acre-Feet
October	90.7	4.9	0.6	2.93	180
November	35.0	1.9	.6	1.17	69
December	54.8	2.1	1.0	1.77	109
Calendar year 1949	24,024.2	3,000	.5	65.8	47,650
January	46.5	1.5	1.5	1.50	92
February	42.0	1.5	1.5	1.50	83
March	4,363.5	620	1.5	141	8,650
April	17,790	4,460	25	593	35,290
May	1,811.7	284	3.8	58.4	3,590
June	96.4	29	1.0	3.21	191
July	25.6	1.3	.4	.83	51
August	31.8	1.9	.3	1.03	63
September	62.1	3.0	1.4	2.07	123
Water year 1949-50	24,450.1	4,460	.3	67.0	48,490

Month	Second Foot Days	Maximum	Minimum	Mean	Run-off in Acre-Feet
October	51.4	2.7	1.0	1.66	102
November	44.9	3.2	.8	1.50	89
December	29.0	1.5	.5	.94	58
Calendar year 1950	24,394.9	4,460	.3	------	48,382
January	38.5	1.5	1.0	1.24	76
February	224.5	50	1.0	8.02	445
March	7,990.0	2,200	1	258	15,850
April	875.2	200	2.0	29.2	1,740
May	69.0	6.0	.4	2.23	137
June	93.4	9.0	.3	3.11	185
July	111.4	13	.1	3.59	221
August	160.0	25	.4	5.16	317
September	128.0	10	1.6	4.27	254
Water year 1950-51	9,815.3	2,200	.1	26.9	19,474

HEART RIVER BASIN

Heart River near Richardton, N. Dak.

Location.—Lat. 46°44′46″, long. 102°18′27″, in NE¼ sec. 29, T. 138 N., R. 92 W., on right bank 10 ft. upstream from bridge on State Highway 8, half a mile downstream from Blacktail Creek and 9½ miles south of Richardton.

Drainage area.—1,240 square miles (revised).

Records available.—May 1903 to September 1922 (few winter records). April 1943 to September 1951.

Gage.—Water-stage recorder. Datum of gage is 2,153.67 ft. above mean sea level, datum of 1929. 1903-22, staff or chain gages at 3 sites in 1 mile reach below present site at different datums, each used intermittently. April 14, 1943 to July 7, 1947, wire-weight gage at present site and datum.

Average discharge.—9 years (1920-21, 1944-51) 147 cfs.

Extremes.—Maximum discharge during year, 7,900 cfs Mar. 27 (gage height, 19.52 ft.); minimum, 1.7 cfs Aug. 7 (gage height, 5.04 ft.), but may have been less during period of ice effect.

1903-1922, 1943-51: Maximum discharge, 23,400 cfs Apr. 16, 1950 (gage height, 28.05 ft. from high-water mark in gage house); no flow at times.

Maximum stage known that of Apr. 16, 1950.

Flood of July 5, 1938, reached a stage of about 26 ft. from information by local resident (discharge 16,000 cfs).

Flood of Mar. 25, 1943, reached a stage of 24.2 ft. from floodmarks (discharge, 11,700 cfs).

Remarks.—Records good except those for period of ice effect, which are poor.

Revisions.—W : 1938 (M).

Month	Second Foot Days	Maximum	Minimum	Mean	Run-off in Acre-Feet
October	316.0	13	4.7	10.2	627
November	249.2	10	3.8	8.31	494
December	91.6	9.7	1	2.95	182
Calendar year 1949	62,829.6	6,050	1	172	124,600
January	5	1	0	.2	9.9
February	0	0	0	0	0
March	11,140	1,600	0	359	22,100
April	64,792	17,000	182	2,160	128,500
May	6,087	808	42	196	12,070
June	969	58	20	32.3	1,920
July	457.4	24	7.0	14.8	907
August	247.7	13	5.0	7.99	491
September	227.9	13	3.4	7.60	452
Water year 1949-50	84,582.8	17,000	0	232	167,800

Peak discharge (base, 1500 sec.-ft.).—Mar. 25, time and discharge unknown; April 16 (11 p. m.) 23,400 sec.-ft.

Month	Second Foot Days	Maximum	Minimum	Mean	Run-off in Acre-Feet
October	277.2	12	6.8	8.94	550
November	208.3	8.5	4.6	6.94	413
December	198.1	7.9	4.6	6.39	393
Calendar year 1950	84,609.6	17,000	0	232	167,800
January	193.5	8.2	2	6.24	384
February	1,552	220	2	55.4	3,080
March	35,057	7,500	10	1,131	69,530
April	5,087	710	51	170	10,090
May	1,013	58	15	32.7	2,010
June	1,145	187	12	38.2	2,270
July	660.7	56	3.1	21.3	1,310
August	509.2	54	2.0	16.4	1,010
September	524.1	41	8.5	17.5	1,040
Water year 1950-51	46,425.1	7,500	2	127	92,080

HEART RIVER BASIN

Heart Butte Reservoir near Glen Ullin, N. Dak.

Location.—Lat. 46°35′48″, long. 101°48′34″, in SE¼NE¼ sec. 13, T. 136 N., R. 89 W., 10 miles upstream from Heart Butte Creek, 14 miles south of Glen Ullin, and 14 miles north of Elgin.

Drainage area.—1,710 square miles (revised).

Records available.—August 1949 to September 1951.

Gage.—Staff gage read once daily. Datum of gage is mean sea level, datum of 1929 (levels by Bureau of Reclamation).

Extremes.—Maximum contents during year, 114,680 acre-feet Mar. 30 (elevation, 2,074.70 ft.); minimum, 57,720 acre-feet Feb. 19 (elevation, 2058.98 it.).

Remarks.—Reservoir is formed by earth-filled dam; storage began Sept. 29, 1949; dam completed Dec. 9, 1949. Total capacity is 428,000 acre-feet at maximum pool, elevation 2,118.2 feet. Dead storage is 6,800 acre-feet below lowest point of outlet, elevation 2,030.0 feet. Active conservation storage is 68,700 acre-feet between elevation 2,030.0 feet and crest of spillway, elevation 2,064.5 feet. Figures given herein represent total contents. Controlled releases are through 4 foot by 5 foot slide gate. The spillway is uncontrolled "glory hole" type and discharge through a conduit 14 feet in diameter. The reservoir is for flood control, irrigation and incidental water supply.

Cooperation.—Record of gage heights and contents furnished by Bureau of Reclamation.

HEART BUTTE RESERVOIR NEAR GLEN ULLIN, N. DAK.

Monthly Elevation and Contents

Date	Elevation* (feet)	Contents (acre - feet)	Change in contents During month (acre-feet)
Aug. 31	------	0	------
Sept. 30	------	20	+20
Water year 1948-49	------	------	+20
Oct. 31	2,015.0	210	+190
Nov. 30	2,018.1	630	+420
Dec. 31	2,017.8	570	—60
Calendar Year 1949	------	------	+570
Jan. 31	2,016.5	350	—220
Feb. 28	2,015.1	200	—150
March 31	2,040.7	18,080	+17,880
Apr. 30	2,068.09	88,000	+69,920
May 31	2,063.53	72,050	—15,950
June 30	2,062.70	69,320	—2,730
July 31	2,061.98	67,000	—2,320
Aug. 31	2,061.13	64,300	—2,700
Sept. 30	2,060.49	62,310	—1,990
Water year 1949-50	------	------	+62,290

*—Elevation at midnight.

HEART BUTTE RESERVOIR NEAR GLEN ULLIN, N. DAK.

Monthly Elevations and Contents, Water Year 1950 to September 1951

Date	Elevation (feet)	Contents (acre - feet)	Change in contents During month (acre-feet)
Sept. 30	2,060.49	62,310	------
Oct. 31	2,059.93	60,580	—1,730
Nov. 30	2,059.64	59,700	—880
Dec. 31	2,059.38	58,920	—780
Calendar Year 1950	------	------	+58,350
Jan. 31	e 2,059.14	58,210	—710
Feb. 28	2,060.49	62,310	+4,100
Mar. 31	2,074.06	111,890	+49,580
Apr. 30	2,065.14	77,480	—34,410
May 31	2,064.31	74,650	—2,830
June 30	2,064.31	74,650	0
July 31	2,062.96	70,170	—4,480
Aug. 31	2,062.17	67,610	—2,560
Sept. 30	2,060.61	62,680	—4,930
Water year 1950-51	------	------	+370

e—Gage height interpolated.

HEART RIVER BASIN

Heart River below Heart Butte Dam near Glen Ullin, N. Dak.

Location.—Lat. 46°35′50″, long. 101°48′05″, in NE¼ sec. 13, T. 136 N., R. 89 W., on right bank 0.5 mile downstream from Heart Butte Dam, 10 miles upstream from Heart Butte Creek, 14 miles south of Glen Ullin, and 14 miles north of Elgin.

Drainage area.—1,710 square miles (revised).

Records available.—April 1943 to September 1951. Prior to October 1948, published as Heart River near Glen Ullin.

Gage.—Water-stage recorder. Datum of gage is 1,998.87 ft. above mean sea level, datum of 1929 (levels by Corps of Engineers). Prior to June 1, 1947, wire-weight gage or recorder at site 4 miles upstream, at different datum.

Average discharge.—8 years, 198 cfs.

Extremes.—Maximum discharge during year, 3,400 cfs Mar. 29 (gage-height, 6.42 ft.); minimum daily discharge 0.1 cfs Aug. 14-16.

1943-51: Maximum discharge, 25,000 cfs Mar. 24, 1947 (gage height, 21.5 ft., former site and datum, from floodmark, backwater from ice); no flow at times.

Flood of Mar. 25, 1943, reached a stage of 18.77 ft., former site and datum (discharge, 20,000 cfs, by slope-area method).

Remarks.—Records good. Flow regulated by Heart Butte Reservoir (see preceding page).

Month	Second Foot Days	Maximum	Minimum	Mean	Run-off in Acre-Feet
October	11.7	1.3	0.1	0.38	23
November	10.6	1.9	0	.35	21
Decemmber	53.3	------	0	1.72	106
Calendar year 1949	86,396.1	6,730	0	237	171,400
January	91.5	3.5	------	2.95	181
February	67.0	3.5	0	2.39	132
March	124	------	------	4.0	246
April	48,092	3,800	0	1,603	95,390
May	17,591	1,470	87	567	34,890
June	2,477	108	55	82.6	4,910
July	1,088	68	29	35.1	2,160
August	899	29	29	29.0	1,780
September	896.4	46	.2	29.9	1,780
Water year 1949-50	71,401.5	3,800	0	196	141,600

Month	Second Foot Days	Maximum	Minimum	Mean	Run-off in Acre-Feet
October	975.5	46	0.3	31.5	1,930
November	538	18	16	17.9	1,070
December	558	18	18	18.0	1,110
Calendar year 1950	73,397.4	3,800	0	201	145,600
January	558	18	18	18.0	1,110
February	490.8	18	8.8	17.5	973
March	17,734	3,430	11	572	35,170
April	23,754	3,310	76	792	47,120
May	2,179	95	43	70.3	4,320
June	1,488.6	108	8.6	49.6	2,950
July	3,148	108	92	102	6,240
August	1,694.6	148	0.1	54.7	3,360
September	2,568.5	261	0.3	85.6	5,090
Water year 1950-51	55,687.0	3,430	0.1	153	110,400

HEART RIVER BASIN

Heart River near Lark, N. Dak.

Location.—Lat. 46°36′00″, long. 101°22′30″, in S½ sec. 9, T. 136 N., R. 85 W., on right bank 20 ft. downstream from bridge on State Highway 31, 1 mile downstream from Muddy Creek, and 10 miles north of Lark.

Drainage area.—2,750 square miles (revised).

Records available.—June 1946 to September 1951.

Gage.—Water-stage recorder. Datum of gage is 1802.83 feet above mean sea level, datum of 1929 (levels by Corps of Engineers). Prior to Nov. 16, 1948, wire-weight gage at same site and datum.

Average discharge.—5 years (1946-51), 326 cfs.

Extremes.—Maximum discharge during year, 9,000 cfs Mar. 26 (gage height, 14.9 ft., from floodmark, affected by ice); minimum, 11 cfs Aug. 27 (gage height, 2.94 ft.).

1946-51: Maximum discharge, 29,200 cfs Apr. 17, 1950 (gage height, 20.70 ft.); no flow Jan. 16 to Mar. 4, 1950.

Remarks.—Records good except those for periods of ice effect or no gage-height record, which are fair. Flow regulated by Heart Butte Reservoir (see page ——).

Month	Second Foot Days	Maximum	Minimum	Mean	Run-off in Acre-Feet
October	232.7	11	4.7	7.51	462
November	169.9	8.8	2.4	5.66	337
December	64.6	9.7	.1	2.08	128
Calendar year 1949	113,116.7	9,000	.1	310	224,400
January	1.5	------	----	.05	3.0
February	------	------	----	----	--
March	491	60	0	15.8	974
April	120,385	23,200	45	4,013	238,800
May	27,339	1,840	156	882	54,230
June	4,883	868	100	163	9,690
July	1,617	99	34	52.2	3,210
August	1,120	46	32	36.1	2,220
September	1,284	69	32	42.8	2,550
Water year 1949-50	157,587.7	23,200	0	432	312,600

Month	Second Foot Days	Maximum	Minimum	Mean	Run-off in Acre-Feet
October	1,279	56	15	41.3	2,540
November	689	34	16	23.0	1,370
December	573	24	13	18.5	1,140
Calendar year 1950	159,661.5	23,200	0	437	316,700
January	610	22	16	19.7	1,210
February	698	90	16	24.9	1,380
March	39,869	7,400	15	1,286	79,080
April	45,352	6,170	218	1,512	89,950
May	3,891	220	75	126	7,720
June	3,035	220	30	101	6,020
July	4,451	301	113	144	8,830
August	2,552	200	12	82.3	5,060
September	3,055	258	17	102	6,060
Water year 1950-51	106.054	7,400	12	291	210,400

HEART RIVER BASIN

Heart River near Mandan, N. Dak.

Location.—Lat. 46°50′, long. 100°59′, in NE¼NW¼ sec. 25 T. 139 N., R. 82 W., on right bank 25 ft. downstream from bridge on U. S. Highway 10, 3 miles west of Mandan, and 4 miles downstream from Sweetbriar Creek.

Drainage area.—3,310 square miles (revised).

Records available.—April to September 1924, March 1928 to June 1933, August 1937 to September 1951. Published as "at Sunny" 1924, 1928-33.

Gage.—Water stage recorder. Datum of gage is 1,638.70 feet above mean sea level datum of 1929) and 1,632.03 feet above Northern Pacific Railway datum.

1924, staff gage on old highway bridge, close to present site, at datum 2.79 ft. lower. March 1928 to Mar. 27, 1943, chain or wire-weight gages on old highway bridge at present datum. Apr. 9, 1943 to Mar. 16, 1948, wire-weight gage on Northern Pacific Railway bridge, 300 ft. upstream, at same datum. Mar. 17, 1948 to Sept. 12, 1948, wire-weight gage on present highway bridge, at same datum.

Average discharge.—16 years (1928-29, 1930-31, 1937-51) 297 cfs, median of yearly mean discharges, 280 cfs.

Extremes.—Maximum discharge during year, 14,000 cfs Apr. 3, when ice jam broke; maximum gage height, 24.35 ft. Mar. 28 (ice jam); minimum discharge, 16 cfs Feb. 21 to Mar. 11; minimum gage height, 2.69 ft. Nov. 8.

1924, 1928-33, 1937-51: Maximum discharge, about 30,500 cfs Apr. 19, 1950 (gage height 23.64 ft.); maximum gage height, 24.7 feet Mar. 27, 1943; no flow on many days.

Remarks.—Records good except those for period of ice effect, which are fair, and those for days without gage-height record, which are poor. Flow regulated by Heart Butte Reservoir (see p.—). Some diversions above station.

Revision (water years).—W 926: 1938.

Month	Second Foot Days	Maximum	Minimum	Mean	Run-off in Acre-Feet
October	462	19	13	14.9	916
November	356.2	18	9.0	11.9	707
December	93.3	14	.1	3.01	185
Calendar year 1949	131,203.4	9,940	0	359	260,200
January	0	0	0	0	0
February	0	0	0	0	0
March	415	60	0	13.4	823
April	176,543	28,400	80	5,885	350,200
May	43,367	2,960	430	1,399	86,020
June	10,156	2,270	148	339	20,140
July	2,800	187	54	90.3	5,550
August	1,812	87	44	58.5	3,590
September	1,672	71	47	55.7	3,320
Water year 1949-50	237,676.5	28,400	0	651	471,500

Peak discharge (base, 2000 sec.-ft.)—Apr. 19 (4 a. m.) 30,500 sec.-ft.; May 11 (8 p. m.) 3,070 sec.-ft.; June 8 (time unknown) about 2,700 sec.-ft.

Month	Second Foot Days	Maximum	Minimum	Mean	Run-off in Acre-Feet
October	1,737	64	44	56.0	3,450
November	1,034	60	25	34.5	2,050
December	630	25	18	20.3	1,250
Calendar year 1950	240,166	28,400	0	658	476,400
January	620	20	20	20.0	1,230
February	500	20	16	17.9	992
March	42,051	10,000	16	1,356	83,410
April	66,218	8,000	310	2,207	131,300
May	5,496	318	119	177	10,900
June	3,898	223	74	130	7,730
July	5,124	313	120	165	10,160
August	4,523	533	38	146	8,970
September	3,670	272	49	122	7,280
Water year 1950-51	135,501	10,000	16	371	268,700

HEART RIVER BASIN

Green River near Gladstone, N. Dak.

Location.—Lat. 46°53′20″, long. 102°38′20″, in SW¼ sec. 36, T. 140 N., R. 95 W., on upstream side of bridge on U. S. Highway 10, 3 miles northwest of Gladstone, 3 miles upstream from mouth, and 8 miles downstream from Spring Creek.

Drainage area.—356 square miles.

Records available.—October 1945 to September 1951.

Gage.—Wire-weight gage read once daily below 3 ft. and twice daily above, with no readings during period of complete ice cover. Prior to July 6, 1949, wire-weight gage ¼ mile east on Highway 10 bridge over former channel at same datum. July 6, 1949 to Aug. 3, 1951, on downstream side of present bridge, at same datum.

Average discharge.—6 years, 49.9 cfs.

Extremes.—Maximum discharge during year, 3,800 cfs Mar. 27 (gage height, 16.7 ft., from floodmark, backwater from ice); minimum daily discharge, 0.4 cfs Aug. 2.

1945-51: Maximum discharge, 5,260 cfs Apr. 15, 1950 (gage height, 18.3 ft., from floodmark).

Maximum stage known, about 20 feet March 1943.

Remarks.—Records fair except those for period of ice effect or no gage-height record, which are poor. A few small diversions for irrigation of hay meadows and gardens and for washing of sand and gravel at two or three pits above station.

Month	Second Foot Days	Maximum	Minimum	Mean	Run-off in Acre-Feet
October	106.2	4.2	1.5	------	211
November	115.5	4.7	3.2	------	229
December	63.4	4.4	1.5	------	126
Calendar year 1949	19,332.1	3,420	.9	------	38,350
January	18.8	1.4	.2	------	37
February	5.6	.2	.2	------	11
March	2,725.6	500	.2	------	5,410
April	16,814	4,640	40	------	33,350
May	1,699	215	12	------	3,370
June	301.8	16	6.4	------	599
July	126.4	9.6	1.5	------	251
August	79.2	4.0	1.4	------	157
September	82.3	5.6	1.2	------	163
Water year 1949-50	22,137.8	4,640	.2	------	43,910

Month	Second Foot Days	Maximum	Minimum	Mean	Run-off in Acre-Feet
October	108.8	4.3	2.6	3.51	216
November	110.6	5.0	2.5	3.69	219
December	104.5	4.0	2.0	3.27	207
Calendar year 1950	22,176.6	4,640	.2	60.8	43,990
January	95.1	4.0	1.0	3.07	189
February	390.5	57	.5	13.9	775
March	12,846.4	3,600	1	414	25,480
April	2,267	400	17	75.6	4,500
May	376.7	28	4.6	12.2	747
June	740.4	210	4.0	24.7	1,470
July	236.8	21	1.2	7.64	470
August	231.2	66	.4	7.46	459
September	177.5	28	1.7	5.92	352
Water year 1950-51	17,685.5	3,600	.4	48.5	35,080

HEART RIVER BASIN

Antelope Creek near Carson, N. Dak.

Location.—Lat. 46°32′, long. 101°39′, in NW¼NE¼ sec. 8, T. 135 N., R. 87 W., near center of span on upstream side of county road bridge, 4 miles upstream from mouth and 8 miles northwest of Carson.

Drainage area.—221 square miles.

Records available.—June 1948 to September 1951.

Gage.—Wire-weight gage read once daily.

Extremes.—Maximum discharge during year, 2,900 cfs Mar. 27 (gage height, 15.5 ft.); no flow Aug. 10, 11, 13.

1948-51: Maximum discharge, 11,100 cfs Apr. 16, 1950 (gage height, 17.95 ft., from floodmark) by slope-area method; no flow at time in each year.

The flood of Mar. 25, 1943 reached a stage of 17.1 feet, the highest known prior to 1950.

Remarks.—Records good above five second-feet during open water and fair at other times.

Month	Second Foot Days	Maximum	Minimum	Mean	Run-off in Acre-Feet
October	18.4	0.8	0.3	.59	36
November	20.2	1.0	.5	.67	40
December	7.5	.6	.1	.24	15
Calendar year 1949	6,983.5	1,200	0	19.1	13,850
January	0	0	0	0	0
February	0	0	0	0	0
March	66	------	------	2.1	131
April	12,670	4,400	------	422	25,130
May	1,810	------	------	58.4	3,590
June	210	------	------	7.0	417
July	61.5	------	------	1.98	122
August	23.8	------	------	.77	47
September	50.0	------	------	1.67	99
Water year 1949-50	14,937.4	4,400	0	40.9	29,630

Month	Second Foot Days	Maximum	Minimum	Mean	Run-off in Acre-Feet
October	43.0	2.0	------	1.39	85
November	45.4	2.1	1.0	1.51	90
December	39.4	1.4	1.0	1.27	78
Calendar year 1950	15,019.1	4,400	0	41.1	29,790
January	33.1	1.2	0.8	1.07	66
February	618.7	100	0.8	22.1	1,230
March	5,670	1,750	1	183	11,250
April	888	90	13	29.6	1,760
May	238.3	17	2.3	7.69	473
June	286.5	21	3.3	9.55	568
July	149.8	19	0.5	4.83	297
August	67.3	20	0	2.17	133
September	48.2	5.5	0.2	1.61	96
Water year 1950-51	8,127.7	1,750	0	22.3	16,130

HEART RIVER BASIN

Muddy Creek near Almont, N. Dak.

Location.—Lat. 46°41′40″, long. 101°27′50″, in SW¼ sec. 7, T. 137 N., R. 85 W., near center of span on downstream side of bridge on county road, 2 miles downstream from Hailstone Creek, 3 miles southeast of Almont, and 12 miles upstream from mouth.

Drainage area.—456 square miles.

Records available.—October 1945 to September 1951.

Gage.—Wire-weight gage read once daily.

Prior to Apr. 11, 1951, various staff gages or wire-weight gage at same site and datum.

Average discharge.—6 years (1945-51) 51.6 cfs.

Extremes.—Maximum discharge during year, 2,050 cfs Apr. 5 (gage height, 19.0 ft.); maximum gage height, 19.5 ft. Mar. 30 (backwater from ice); minimum discharge, 1.4 cfs Sept. 28-29; minimum gage height, 3.65 ft. Sept. 18.

1945-51: Maximum discharge, 20,200 cfs Apr. 17, 1950 (gage height, 30.7 ft. from floodmarks) by slope-area method; no flow at times.

Remarks.—Records fair.

Month	Second Foot Days	Maximum	Minimum	Mean	Run-off in Acre-Feet
October	36.6	1.4	0.7	1.18	73
November	31.8	1.4	.8	1.06	63
December	29.2	1.1	.8	.94	58
Calendar year 1949	14,913.9	1,360	0	40.9	29,580
January	10.6	.6	.1	.34	21
February	1.0	.1	0	.04	2.0
March	232.6	20	0	7.50	461
April	34,811	15,000	22	1,160	69,050
May	4,956.7	707	8.4	160	9,830
June	390.0	170	3.4	13.0	774
July	77.9	3.6	1.9	2.51	155
August	50.8	2.3	1.2	1.64	101
September	128.7	27	1.3	4.29	255
Water year 1949-50	40,756.9	15,000	0	112	80,840

Peak discharge (base, 200 sec.-ft.).—Apr. 7 (time and discharge unknown); Apr. 17 (12 m.) 20,200 sec.-ft.; May 12 (4 am) 780 sec.-ft.

Month	Second Foot Days	Maximum	Minimum	Mean	Run-off in Acre-Feet
October	62.2	2.4	1.7	2.01	123
November	76.5	3.0	1.9	2.55	152
December	74.5	2.5	2.0	2.40	148
Calendar year 1950	40,872.5	15,000	0	112	81,070
January	77.5	2.5	2.5	2.50	154
February	77.0	3.0	2.5	2.75	153
March	6,925.0	1,800	2.0	223	13,740
April	9,785	1,870	23	326	19,410
May	293.0	35	2.9	9.45	581
June	434.8	105	2.4	14.5	862
July	459.3	131	2.5	14.8	911
August	169.9	36	2.1	5.48	337
September	123.4	23	1.4	4.11	245
Water year 1950-51	18,558.1	1,870	1.4	50.8	36,820

HEART RIVER BASIN

Sweetbriar Creek near Judson, N. Dak.

Location.—Lat. 46°51′, long. 101°15′, in SW¼ Sec. 14, T 139 N, R 84 W on upstream side of bridge on U. S. Highway 10, two miles northeast of Judson and 16 miles upstream from mouth.

Drainage.—157 square miles.

Records available.—July to September 1951.

Gage.—Wire-weight gage read once daily.

Extremes.—Maximum discharge observed during period, 28 cfs Sept. 11 (gage height, 2.80 ft.); minimum 0.4 cfs Aug. 4 (gage height, 1.98 ft.).

Maximum stage known 14.9 ft. Apr. 17, 1950, from flood marks (discharge, 5,910 cfs by contracted-opening determination of peak flow).

Remarks.—Records fair. No regulation or diversions.

Month	Second Foot Days	Maximum	Minimum	Mean	Run-off in Acre-Feet
October	------	------	------	------	------
November	------	------	------	------	------
December	------	------	------	------	------
Calendar year	------	------	------	------	------
January	------	------	------	------	------
February	------	------	------	------	------
March	------	------	------	------	------
April	------	------	------	------	------
May	------	------	------	------	------
June	------	------	------	------	------
July 5-31	79.6	15	.9	2.95	158
August	44.5	4.4	.4	1.44	88
September	142.6	28	.9	4.75	283
The period Jul. 5-Sep. 30	266.7	28	.4	3.03	529

APPLE CREEK BASIN

Apple Creek near Menoken, N. Dak.

Location.—Lat. 46°47′35″, long. 100°39′15″, on line between secs. 4 and 9, T. 138 N, R 79 W, on upstream side near middle of single span bridge on former U S Highway 10, 4 miles upstream from Hay Creek 6.3 miles west of Menoken and 6.4 miles east of Bismarck.

Drainage area.—1,680 square miles (revised), of which 500 square miles is probably non-contributing.

Records available.—October 1945 to September 1951.

Gage.—Wire-weight gage read three or four times weekly except above 5 ft. stage when it was read once daily or oftener. Altitude of gage is 1,640 ft (from topographic map).

Average discharge.—6 years, 75.1 cfs.

Extremes.—Maximum discharge during year, 3,200 cfs Apr. 7 (gage height, 16.40 ft); minimum not determined.

1945-51: Maximum discharge, 6,750 cfs Apr. 18, 1950 (gage height, 17.07 ft); no flow Aug. 25 to Sept. 17, 1946.

Remarks.—Records good except those for period of ice effect, which are fair.

Month	Second Foot Days	Maximum	Minimum	Mean	Run-off in Acre-Feet
October	38.5	2.0	.7	1.24	76
November	41.9	1.5	1.2	1.40	83
December	34.0	1.3	1	1.10	67
Calendar year 1949	8,758.6	700	.1	24.0	17,360
January	26.3	------	------	.85	52
February	20.9	------	------	.75	41
March	300.8	40	.9	9.70	597
April	44,942	5,590	41	1,498	89,140
May	32,188	2,390	548	1,038	63,840
June	5,750	487	76	192	11,400
July	2,140	90	53	69.0	4,240
August	1,942	75	50	62.6	3,850
September	1,185	56	22	39.5	2,350
Water year 1949-50	88,609.4	5,590	------	243	175,700

Peak discharge (base, 200 sec.-ft.).—Apr. 7 (12 m.) about 560 sec.-ft.; Apr. 18 (2 p. m.) 6,750 sec.-ft.; May 14 (4 a. m.) 2,720 sec.-ft.

Month	Second Foot Days	Maximum	Minimum	Mean	Run-off in Acre-Feet
October	411	19	8	13.3	815
November	145	8	3	4.8	288
December	107	------	3	3.45	212
Calendar year 1950	89,158.0	5,590	------	244	176,800
January	108.5	------	------	3.5	215
February	76	------	------	2.71	151
March	184	50	------	5.94	365
April	18,113	2,470	70	604	35,930
May	4,116	249	72	133	8,160
June	2,780	122	66	92.7	5,510
July	1,583	73	30	51.1	3,140
August	770	53	19	24.8	1,530
September	2,538	251	49	84.6	5,030
Water year 1950-51	30,931.5	2,470	------	84.7	61,350

CANNONBALL RIVER BASIN

Cannonball River at Regent, N. Dak.

Location.—Lat. 46°26′, long. 102°33′, in NE¼NE¼ sec. 13, T 134 N, R 95 W, on right bank 400 ft upstream from bridge on county highway, 0.3 mile north of Regent.

Drainage area.—590 square miles.

Records available.—September 1950 to September 1951.

Gage.—Water-stage recorder. Datum of gage is 2,422.90 ft. above mean sea level datum of 1929.

Extremes.—Maximum discharge during year, about 1300 cfs Mar. 22 (gage-height, 10.05 ft, affected by ice); no flow Dec. 5-22.

Maximum stage known, 26.1 ft, April 16, 1950, from floodmarks (discharge, 20,300 cfs on basis of slope-area measurement 4 miles downstream).

Remarks.—Records good except those for period of ice effect, which are fair.

Month	Second Foot Days	Maximum	Minimum	Mean	Run-off in Acre-Feet
September	102.8	4.4	2.6	3.43	204

Month	Second Foot Days	Maximum	Minimum	Mean	Run-off in Acre-Feet
October	124.4	4.8	3.6	4.01	247
November	66.4	4.2	1.0	2.21	132
December	16	2	0	0.52	32
Calendar year 1950					
January	51.5	2	1	1.66	102
February	845.6	140	0.7	30.2	1,680
March	6,398	1,200	1	206	12,690
April	1,080	120	13	36.0	2,140
May	343.5	18	5.0	11.1	681
June	363.5	49	6.7	12.1	721
July	122.2	9.5	1.7	3.94	242
August	82.8	10	1.2	2.67	164
September	414.6	173	3.0	13.8	822
Water year 1950-51	9,908.5	1,200	0	27.1	19,650

CANNONBALL RIVER BASIN

Cannonball River at Bentley, N. Dak.

Location.—Lat. 46°21′, long. 102°04′, in W½SW¼ sec 12, T 133 N, R 91 W, on upstream side of bridge on county highway, 1 mile north of Bentley, 1 mile upstream from Thirty Mile Creek.

Records available.—February to September 1951 discontinued).

Gage.—Type A wire-weight gage read once or twice daily.

Extremes.—Maximum discharge observed during period, 3,280 cfs Mar. 25 (gage height, 15.05 ft); minimum, 2.7 cfs Aug. 26, Sept. 30 (gage height 3.09 ft).

Maximum stage known, 27.5 ft Apr. 17, 1950, from high water mark.

Remarks.—Records good except those for period of ice effect which are fair. No regulation. Negligible diversions for small farm irrigation and stock water.

Month	Second Foot Days	Maximum	Minimum	Mean	Run-off in Acre-Feet
February 15-28	1,170	180	5	83.6	2,320
March	10,203	2,700	3	329	20,240
April	1,681	205	21	56.0	3,330
May	573	24	11	18.5	1,140
June	570	50	14	19.0	1,130
July	292.2	17	6.0	9.43	580
August	199.2	20	2.7	6.43	395
September	970.9	160	2.7	32.4	1,930
The period Feb. 15-Sep 30	15,659.3				31,060

CANNONBALL RIVER BASIN

Cannonball River near New Leipzig, N. Dak.

Location.—Lat. 46°20′, long. 101°57′, in SW¼ Sec 11, T 133 N, R 90 W, at downstream end of right downstream wingwall of bridge on State Highway 49, 2½ miles south of New Leipzig and 8 miles downstream from Thirty Mile Creek.

Drainage area.—1180 square miles.

Records available.—April 1943 to September 1951.

Gage.—Water-stage recorder. Datum of gage is 2,222.90 ft above mean sea level, datum of 1929, (levels by Corps of Engineers).

Prior to Nov. 7, 1947, wire-weight gage at same site and datum.

Average discharge.—8 years, 123 cfs.

Extremes.—Maximum discharge during year, 6,320 cfs Mar. 25 (gage height, 18.99 ft.); minimum, 1.0 cfs Nov. 8 (gage height, 4.86 ft).

1943-51: Maximum discharge, 51,800 cfs Apr. 17, 1950 (gage height, 34.0 ft, from floodmark in well) by slope-area and contracted-opening methods; no flow at times.

Maximum known stage, that of Apr. 17, 1950.

Flood of Mar. 25 or 26, 1943 reached a stage of 26.9 ft, from floodmarks (discharge, 15,000 cfs by slope-area method).

Remarks.—Records good, except those for period of ice effect or no gage-height record, which are poor. Some diversions and some storage in small lakes above station.

Month	Second Foot Days	Maximum	Minimum	Mean	Run-off in Acre-Feet
October	262.2	12	3.8	8.46	520
November	247.1	16	6.5	8.24	490
December	117.8	8.0	2	3.80	234
Calendar year 1949	50,524.5	4,910	0	138	100,200
January	23	2	0	.7	46
February	0	0	0	0	0
March	2,476	250	0	79.9	4,910
April	105,438	37,100	80	3,515	209,100
May	7,479	634	62	241	14,830
June	1,548	261	33	51.6	3,070
July	736	33	15	23.7	1,460
August	409	17	10	13.2	811
September	393.3	34	6.4	13.1	780
Water year 1949-50	119,129.4	37,100	0	326	236,300

Peak discharge (base, 500 sec.-ft.).—Apr. 17 (12 p. m.) 51,800 sec.-ft.; May 12 (5 p.m.) 655 sec.-ft.; June 8 (12 m.) 538 sec.-ft.

Month	Second Foot Days	Maximum	Minimum	Mean	Run-off in Acre-Feet
October	418	15	11	13.5	829
November	276.9	14	5.3	9.23	549
December	253	10	7	8.2	502
Calendar year 1950	119,450.2	37,100	0	327	236,900
January	274	10	6	8.8	543
February	2,236	350	5	79.9	4,440
March	17,841	4,410	5	576	35,390
April	2,718	299	20	90.6	5,390
May	756	34	16	24.4	1,500
June	821	51	16	27.4	1,630
July	466.6	29	6.9	15.1	925
August	347.8	55	3.9	11.2	690
September	1,098.1	234	6.4	36.6	2,180
Water year 1950-51	27,506.4	4,410	3.9	75.4	54,570

CANNONBALL RIVER BASIN

Cannonball River near Heil, N. Dak.

Location.—Lat. 46°17′, long. 101°42′, in SW¼ sec 4 T 132 N, R 88 W, on downstream side of bridge 7½ miles south of Heil.

Drainage area.—1,340 square miles.

Records available.—October 1950 to September 1951.

Gage.—Wire-weight gage read once or twice daily. Altitude of gage is 2,060 ft (by interpolation between points of known elevation).

Extremes.—Maximum discharge during year, 6,500 cfs Mar. 25 (gage height, 12.1 ft); minimum 5 cfs Feb. 1-9, 12-14.

Maximum stage known, about 23.5 ft Apr. 17-18, 1950 from floodmarks.

Remarks.—Records good except those for periods of ice effort or no gage-height record, which are fair.

Month	Second Foot Days	Maximum	Minimum	Mean	Run-off in Acre-Feet
October	465			15.0	922
November	332	15	8	11.1	659
December	226	8	7	7.3	448
Calendar year 1950					
January	242	8	6	7.8	480
February	2,220	430	5	79.3	4,400
March	19,506	5,700	7	629	38,690
April	3,487	400	42	116	6,920
May	919	40	18	29.6	1,820
June	1,244	118	20	41.5	2,470
July	614	43	10	19.8	1,220
August	589.6	152	5.3	19.0	1,170
September	1,158.8	204	9.8	38.6	2,300
Water year 1950-51	31,003.4	5,700	5	84.9	61,500

CANNONBALL RIVER BASIN

Cannonball River at Brein, N. Dak.

Location.—Lat. 46°23′, long. 100°56′, in sec 36, T 134 N, R 82 W, on right bank 600 ft upstream from bridge on State Highway 6, 950 ft downstream from Louise Creek and 0.5 miles south of Brein.

Drainage area.—4,100 square miles (revised).

Records available.—August 1934 to September 1951.

Gage.—Water-stage recorder. Datum of gage is 1,676.54 ft above mean sea level, datum of 1929.

Average discharge.—17 years, 278 cfs.

Extremes.—Maximum discharge during year, 17,200 cfs Mar. 27 (gage height, 14.80 ft, from floodmark); minimum not determined.

1934-51: Maximum discharge, 94,800 cfs Apr. 19, 1950 (gage height 22.50 ft); no flow at times in some years.

Remarks.—Records good except those for periods of ice effect or no gage-height record, which are fair. Some diversions above station. Some storage in several small lakes above station.

Revisions (water year).—W786: 1934, W1145: 1943.

Month	Second Foot Days	Maximum	Minimum	Mean	Run-off in Acre-Feet
October	651	66	14	21.0	1,290
November	441	19	12	14.7	875
December	143	16	1	4.6	284
Calendar year 1949	140,049.1	8,200	0	384	277,800
January	9.9	1	.1	.32	20
February	8.2	.5	.2	.29	16
March	2,614.2	700	.3	84.3	5,190
April	302,180	63,100	160	10,070	599,400
May	35,872	2,460	342	1,157	71,150
June	9,487	712	158	316	18,820
July	3,590	185	75	116	7,120
August	5,979	1,760	66	193	11,860
September	1,855	109	49	61.8	3,680
Water year 1949-50	362,830.3	63,100	.1	994	719,700

Peak discharge (base 1,000 sec.-ft.)—Mar. 25 (2:45 p. m.) about 1,200 sec.-ft.; Apr. 7 (7 a. m.) 9,400 sec.-ft.; Apr. 19 (2 a. m.) 94,800 sec.-ft.; May 9 (8 a. m.) 2,860 sec.-ft.; Aug 14. (6 a. m.) 3,800 sec.-ft.

Month	Second Foot Days	Maximum	Minimum	Mean	Run-off in Acre-Feet
October	1,681	79	47	54.2	3,330
November	1,241	47	34	41.4	2,460
December	913	32	25	29.5	1,810
Calendar year 1950	365,430.3	63,100	0.1	1,001	724,900
January	820			26.5	1,630
February	2,090	400		74.6	4,150
March	54,561	15,000	20	1,760	108,200
April	15,535	1,900	156	518	30,810
May	3,565	192	62	115	7,070
June	11,568	2,170	119	386	22,940
July	3,158	258	44	102	6,260
August	6,114	2,480	23	197	12,130
September	4,669	703	38	156	9,260
Water year 1950-51	105,915	15,000		290	210,000

CANNONBALL RIVER BASIN

Cedar Creek near Haynes, N. Dak.

Location.—Lat. 46°49′, long. 102°28′, in W½ sec. 20, T 131 N, R 94 W, on left bank 400 ft downstream from bridge on State Highway 8, 12½ miles north of Haynes.

Drainage area.—553 square miles.

Records available.—October 1950 to September 1951.

Gage.—Water-stage recorder. Altitude of gage is 2,470 ft. Prior to May 20, 1951, wire-weight gage on bridge, 400 ft upstream at same datum.

Extremes.—Maximum discharge during year, 1,000 cfs Mar. 27 (gage height, 14.2 ft, affected by ice); minimum, 0.3 cfs July 30; minimum gage height, 2.38 ft Aug. 8.

Flood of Apr. 17, 1950 reached stage of more than 22 ft (discharge 26,900 cfs, by slope area determination 9 miles upstream).

Remarks.—Records good except those for periods of no gage-height, which are poor.

Month	Second Foot Days	Maximum	Minimum	Mean	Run-off in Acre-Feet
October	80.1	------	------	2.58	159
November	75.3	------	------	2.51	149
December	71.7	------	------	2.31	142
Calendar year 1950	------	------	------	------	------
January	64.0	------	------	2.06	127
February	440	90	------	15.7	873
March	4,147	850	3	134	8,230
April	483.1	70	7.2	16.1	958
May	181.4	13	1.6	5.85	360
June	166.3	16	2.6	5.54	330
July	79.5	9.0	.3	2.56	158
August	60.1	21	.4	1.94	119
September	137.3	29	1.1	4.58	272
Water year 1950-51	5,985.8	850	0.3	16.4	11,880

CANNONBALL RIVER BASIN

Cedar Creek near Pretty Rock, N. Dak.

Location.—Lat. 46°02′, long. 101°49′, in S½ sec 33, T 130 N, R 89 W, at county highway bridge 7 miles north of Keldron, S. Dak., 10½ miles south of abandoned town site of Pretty Rock, and 15 miles downstream from Timber Creek.

Drainage area.—1,340 square miles (revised).

Records available.—April 1943 to September 1951.

Gage.—Water-stage recorder. Datum of gage is 2,155.17 ft above mean sea level (levels by Corps of Engineers). Prior to Oct. 17, 1947 wire-weight gage at same site and datum.

Average discharge.—8 years, 107 cfs.

Extremes.—Maximum discharge during year, about 3,000 cfs Mar. 26 (gage height, 20.89 ft, affected by ice); minimum, 1.3 cfs Aug. 8 (gage height, 2.82 ft).

1943-51: Maximum discharge, 48,000 cfs, Apr. 17, 1950 (gage height, 26.5 ft, from flood mark in gage house) by slope-area method; no flow at times.

Maximum stage known, that of Apr. 17, 1950. Second highest stage known, 21.8 ft from flood marks, Mar. 24, 1943 (discharge, 14,300 cfs).

Remarks.—Records good except those for periods of wire-weight or no gage-height record, which are fair and those for period of ice effect, which are poor.

Revisions (water years).—W1146: 1944, 1947.

Month	Second Foot Days	Maximum	Minimum	Mean	Run-off in Acre-Feet
October	44.3	3.4	0	1.43	88
November	74.8	3.4	1.4	2.49	148
December	52.3	2.7	1.1	1.69	104
Calendar year 1949	37,434.9	3,500	0	103	74,250
January	5.7	1.1	0	.18	11
February	0	0	0	0	0
March	464	80	0	15.0	920
April	106,923	34,000	10	3,564	212,100
May	6,391	428	57	206	12,680
June	1,981	296	31	66.0	3,930
July	661	35	13	21.3	1,310
August	923.4	152	9.4	29.8	1,830
September	277.0	13	4.7	9.23	549
Water year 1949-50	117,797.5	34,000	0	323	233,700

Peak discharge (base, 500 sec.-ft.).—Apr. 17 (9 p. m.) 48,000 sec.-ft.; June 8 (11 p. m.) 657 sec.-ft.

Month	Second Foot Days	Maximum	Minimum	Mean	Run-off in Acre-Feet
October	296.2	13	8.0	9.55	588
November	251.1	13	3.8	8.37	498
December	292.1	12	5.7	9.42	579
Calendar year 1950	118,465.5	34,000	0	325	235,000
January	192.7	8.7	2.7	6.22	382
February	423.8	84	1.9	15.1	841
March	14,103	2,800	6	455	27,970
April	2,888	700	24	96.3	5,730
May	627	29	12	20.2	1,240
June	2,587	920	12	86.2	5,130
July	495.5	62	2.4	16.0	983
August	90.5	10	1.3	2.92	180
September	689.7	60	4.3	23.0	1,370
Water year 1950-51	22,936.6	2,800	1.3	62.8	45,490

MISSOURI RIVER BASIN

Beaver Creek at Linton, N. Dak.

Location.—Lat. 46°15′40″, long. 100°14′00″, on line between sections 17 and 18, T 132 N, R 76 W, near center of span on downstream side of bridge on U. S. Highway 83, 0.7 mile south of railway station in Linton and one mile upstream from Spring Creek.

Drainage area.—717 square miles (revised), of which 100 square miles is probably noncontributing.

Records available.—August 1949 to September 1951.

Gage.—Wire-weight gage read once daily, with additional readings during high water periods.

Extremes.—Maximum discharge during year, 2,550 cfs Apr. 1 (gage height, 15.17 ft); maximum gage height, 15.6 ft Mar. 30 (affected by ice); minimum discharge observed, 4.4 cfs Feb. 13 (discharge measurement); minimum gage height, 2.95 ft Sept. 19, 22, 26, 30.

1949-51: Maximum discharge, 3,680 cfs Apr. 7, 1950; maximum gage height, 16.50 ft Apr. 7, 1950; no flow Jan. 10-31, 1950.

Remarks.—Records good except those for period of ice effect, which are fair, and those for period of doubtful gage-height record, which are poor. Small diversions above station for irrigation.

Month	Second Foot Days	Maximum	Minimum	Mean	Run-off in Acre-Feet
October	153.3	8.1	1.3	4.95	304
November	157.6	6.6	3.9	5.25	313
December	57.0	4.4	.4	1.84	113
Calendar year 1949					
January	1.8	.3	0	.06	3.6
February	2.8			.10	5.6
March	2,081.8	400	.1	67.2	4,130
April	37,401	3,280	126	1,247	74,180
May	9,943	918	70	321	19,720
June	2,995	761	22	99.8	5,940
July	947	71	16	30.5	1,880
August	340.0	15	7.8	11.0	674
September	261.6	12	6.8	8.72	519
Water year 1949-50	54,341.9	3,280	0	149	108,800

Month	Second Foot Days	Maximum	Minimum	Mean	Run-off in Acre-Feet
October	248.4	9.2	7.2	8.01	493
November	188.5	7.2	5.8	6.28	374
December	172.9	6.1	5.5	5.58	343
Calendar year 1950	54,583.8	3,280	0	150	108,300
January	167.0	5.5	5.0	5.39	331
February	129.5	5.0	4.5	4.62	257
March	8,001.0	2,200	5.0	258	15,870
April	12,914	2,000	59	430	25,610
May	1,141	62	23	36.8	2,260
June	1,083	80	23	36.1	2,150
July	1,666	195	21	53.7	3,300
August	1,171	69	25	37.8	2,320
September	1,036	156	20	34.5	2,050
Water year 1950-51	27,918.3	2,200	4.5	76.5	55,360

GRAND RIVER BASIN

North Fork Grand River at Haley, N. Dak.

Location.—Lat. 45°57′, long. 103°07′, in NE¼ sec. 36, T 129 N, R 100 W, on left bank 10 ft downstream from county highway bridge, about 300 ft south of post office at Haley and half a mile north of the South Dakota State line.

Drainage area.—509 square miles.

Records available.—May 1908 to September 1917 (no winter records), October 1945 to September 1951.

Gage.—Water-stage recorder. Prior to 1911, staff gage at site 100 ft upstream at different datum. 1911 to September 1917, reference mark on highway bridge at different datum.

Oct. 23, 1945 to June 18, 1951, wire-weight gage on downstream side of bridge near left abutment at same datum. Gage read once daily or oftener during 1951.

Average discharge.—6 years (1945-1951), 47.2 cfs.

Extremes.—Maximum discharge during year, 2,680 cfs July 30 (gage height, 12.81 ft); no flow Jan. 30 to Feb. 10.

1908-17, 1945-51: Maximum discharge 11,300 cfs Apr. 15, 1950 (gage height, 17.10 ft), by slope-area method; no flow at times.

Maximum discharge known, that of Apr. 15, 1950.

Flood of 1913: Maximum discharge observed, 5,810 cfs Mar. 31, 1913, discharge measurement (gage height, 9.85 ft, datum then in use).

Remarks.—Records good except those for period of ice effects, which are poor.

Month	Second Foot Days	Maximum	Minimum	Mean	Run-off in Acre-Feet
October	67.0	3.5	1.0	2.16	133
November	48.0	2.2	1.0	1.60	95
December	32.5	1.6	.6	1.05	64
Calendar year 1949	15,987.2	1,600	0	43.8	31,705
January	6.0	0.5	0	0.19	12
February	0	0	0	0	0
March	3,299	1,600	0	106	6,540
April	36,549	9,300	2	1,218	72,490
May	3,706	643	14	120	7,350
June	308.0	15	6.6	10.3	611
July	138.7	6.9	2.1	4.47	275
August	110.1	10	1.3	3.55	218
September	41.2	24	.6	1.37	82
Water year 1949-50	44,305.5	9,300	0	121	87,870

Month	Second Foot Days	Maximum	Minimum	Mean	Run-off in Acre-Feet
October	67.4	2.9	1.5	2.17	134
November	55.6	2.9	1	1.85	110
December	38.0	1.5	1	1.23	75
Calendar year 1950	44,319.0	9,300	0	121	87,900
January	39.0	1.5	0	1.26	77
February	15.4	2	0	0.55	31
March	2,481.6	700	0.2	80.1	4,920
April	533.7	97	5.8	17.8	1,060
May	169.5	14	1.3	5.47	336
June	246.8	37	1.3	8.23	490
July	3,437.6	1,840	0.7	111	6,820
August	671.3	186	4.7	21.7	1,330
September	809.5	270	4.7	27.0	1,610
Water year 1950-51		1,840	0	23.5	17,000

JAMES RIVER BASIN

James River at New Rockford, N. Dak.

Location.—Lat. 47°41′05″, long. 99°07′30″, on line between sec. 32 and 33, T. 149 N., R. 66 W., on right bank 90 ft. downstream from U. S. Highway 281 bridge at New Rockford, 7 miles upstream from small tributary.

Drainage area.—596 square miles, of which 100 square miles is probably noncontributing.

Records available.—August 1950 to September 1951.

Gage.—Water-stage recorder. Datum of gage is 1500.00 ft. above mean sea level, datum of 1929.

Prior to Aug. 8, 1951, wire-weight gage at same site and datum.

Extremes.—Maximum discharge during period August 1950 to September 1951, 840 cfs Apr. 12 (gage height, 9.20 ft); no flow at times.

Maximum stage known since at least 1925, about 13 ft. in April 1948, from information by local resident. Flood of April 1950 reached a stage of 11.3 ft., from floodmarks.

Remarks.—Records good above 5 cfs and fair below, except period of ice effect, which is fair throughout.

Month	Second Foot Days	Maximum	Minimum	Mean	Run-off in Acre-Feet
October	0.8	0.1	0	.03	1.6
November	0	0	0	0	0
December	0	0	0	0	0
Calendar year 1950	0	0	0	0	0
January	0	0	0	0	0
February	0	0	0	0	0
March	0	0	0	0	0
April	4,734	483	0	158	9,390
May	599.2	37	4.0	19.3	1,190
June	385.0	20	4.0	12.8	764
July	124.1	10	.2	4.00	246
August	5.1	.2	0	.16	10
September	6.0	.2	.2	.20	12
Water year 1950-51	5,854.2	483	0	16.0	11,610

JAMES RIVER BASIN

James River at Jamestown, N. Dak.

Location.—Lat. 46°54′, long. 98°41′, in SW¼ sec. 31, T 140 N, R 63 W, on right bank 80 ft downstream from Asylum bridge at southeast corner of Jamestown, 2.5 miles downstream from Pipestem Creek.

Drainage area.—2,840 square miles (revised), of which 500 square miles is probably noncontributing.

Records available.—June 1928 to August 1933, August 1937 to September 1938, March 1943 to September 1951.

Gage.—Water-stage recorder. Datum of gage is 1,375.27 ft above mean sea level, datum of 1929.

Prior to Oct. 1, 1949, staffs, tape, or wire-weight gages at bridge 80 ft upstream; 1928-33 at datum 5.00 ft higher, and 1937-49 at present datum.

Average discharge.—14 years (1928-33, 1937-38, 1943-51), 73.2 cfs; median of yearly mean discharge, 27 cfs.

Extremes.—Maximum discharge during year, 1,180 cfs Apr. 5 (gage height, 9.48 ft); maximum gage height, 9.63 ft Mar. 29; minimum daily discharge, 2 cfs Feb. 9-20; minimum gage height, 1.60 ft Aug. 18.

1928-33, 1937-38, 1943-51: Maximum discharge, 6,390 cfs May 13, 1950 (gage height, 15.82 ft); no flow June 28, 29, July 4, 5, 1933.

Remarks.—Records good except those for periods of backwater from debris which are poor. Flow regulated by Arrowood and Jim Lakes (capacity, 16,000 acre-feet).

Month	Second Foot Days	Maximum	Minimum	Mean	Run-off in Acre-Feet
October	68.1	6.4	1.4	2.20	135
November	62.2	2.4	1.9	2.07	123
December	60.5	2.1	1.9	1.95	120
Calendar year 1949	31,292.8	1,230	1.4	85.7	62,080
January	55.7	1.8	1.7	1.80	110
February	47.7	1.8	1.7	1.70	95
March	853.7	148	2.0	27.5	1,690
April	73,010	5,840	250	2,434	144.800
May	79,319	6,170	979	2,559	157,300
June	11,084	906	134	369	21,980
July	2,686	151	26	86.6	5,330
August	412.2	32	3.3	13.3	818
September	136.0	6.4	3.4	4.53	270
Water year 1949-50	167,795.1	6,170	1.4	460	332.800

Peak discharge (base 200 sec.-ft.).—Apr. 7 (11:30 p. m.) 1,680 sec. ft.; Apr. 17 (11:30 p. m.) 6,020 sec.-ft.; May 13 (4 a. m.) 6,390 sec.-ft.; June 12 (9:30 p. m.) 589 sec.-ft.; June 26 (8 p. m.) 328 sec.-ft.

Month	Second Foot Days	Maximum	Minimum	Mean	Run-off in Acre-Feet
October	173.9	12	4.2	5.61	345
November	158.1	10	4.0	5.27	314
December	144.1	5.1	4.2	4.65	286
Calendar year 1950	168,080.4	6,170	1.7	460	333,300
January	105.8	4.2	2.5	3.41	210
February	87.0	6.2	2.0	3.11	173
March	2,695.7	860	4.2	87.0	5,350
April	16,198	1,100	276	540	32,130
May	4,331	250	63	140	8,590
June	1,092	62	17	36.4	2,170
July	259.6	27	2.8	8.37	515
August	104.7	10	2.1	3.38	208
September	76.5	4.0	2.2	2.55	152
Water year 1950-51	25,426.4	1,100	2.0	69.7	50,440

JAMES RIVER BASIN

James River at LaMoure, N. Dak.

Location.—Lat. 46°21'20,", long. 98°18'15", at northeast corner of Sec. 11, T. 133 N., R. 61 W. on left bank 80 ft. downstream from State Highway 13, a half mile west of LaMoure, and 12 miles upstream from Cottonwood Creek.

Drainage area.—5,740 square miles (revised), of which 2,000 square miles is probably noncontributing.

Records available.—April to July 1903 (gage height record only). April 1950 to Sept. 1951. Gage-height records 1902-11 are contained in reports of U. S. Weather Bureau.

Gage.—Water-stage recorder and rubble masonry control. Datum of gage is 1,290.00 ft. above mean sea level, datum of 1929. Prior to Sept. 2, 1951, wire-weight gage on bridge 80 ft. upstream, at same datum. 1902-11, staff gage at datum 4.8 ft. higher.

Extremes.—Maximum discharge during year, 2,000 cfs Apr. 8; maximum gage height, 11.45 ft. Apr. 3, affected by ice; minimum discharge, 4 cfs Sept. 28 (gage height, 7.05 ft.) result of upstream wind.

1950-51: Maximum discharge, 5,730 cfs May 16, 1950 (gage height, 15.34 ft.); minimum, that of Sept. 28, 1951.

A long time local resident says above stage was the highest since 1882, with stage in either 1942 or 1943 being almost as high due to large ice jam.

Remarks.—Records good except those for periods of ice effect, which are fair.

Revisions.—W : 1950

Month	Second Foot Days	Maximum	Minimum	Mean	Run-off in Acre-Feet
April 19-30	48,820	4,840	3,230	4,068	96,830
May	96,540	5,660	1,680	3,114	191,500
June	17,350	1,530	200	578	34,410
July	4,190	300	65	135	8,310
August	1,454	65	20	46.9	2,880
September	1,021	41	30	34.0	2,030
Period Apr 19 '50-Sept 30 '51	169,375	------	------	------	336,000

Peak discharge (base, 500 sec.-ft.).—Apr. 25 (12 m.) 4,880 sec.ft.; May 16 (2-8 p. m.) 5,730 sec.-ft.

Month	Second Foot Days	Maximum	Minimum	Mean	Run-off in Acre-Feet
October	1,117	47	24	36.0	2,220
November	854	47	13	28.5	1,690
December	639	28	16	20.6	1,270
Calendar year 1950	------	------	------	------	------
January	568	23	16	18.3	1,130
February	682	42	15	24.4	1,350
March	1,706	250	32	55.0	3,380
April	23,990	1,900	300	800	47,580
May	6,776	362	116	219	13,440
June	2,545	215	40	84.8	5,050
July	1,022	62	18	33.0	2,030
August	547	29	11	17.6	1,080
September	514	28	6	17.1	1,020
Water year 1950-51	40,960	1,900	6	112	81,200

JAMES RIVER BASIN

Pipestem Creek near Buchanan, N. Dak.

Location.—Lat. 47°04', long. 98°55', in SE¼ sec. 33, T. 142 N., R. 65 W., on left bank 30 ft. downstream from bridge on county road 4½ miles west of Buchanan.

Drainage area.—925 square miles, of which 300 square miles is probably noncontributing.

Records available.—March 1950 to September 1951.

Gage.—Water-stage recorder. Datum of gage is 1467.01 ft. above mean sea level, datum of 1929.

Prior to July 11, 1950, wire-weight gage at same site and datum.

Extremes.—Maximum discharge during year, 826 cfs Apr. 6 (gage height, 7.84 ft); maximum gage height, 8.38 ft. Apr. 4 (affected by ice); no flow on many days 1950-1951; Maximum discharge 4,480 cfs Apr. 17, 1950 (gage height 10.77 ft.): Maximum gage height, 11.89 ft. Apr. 9, 1950; no flow at times.

Remarks.—Records good except those for periods of ice effect or no gage-height record, which are fair.

Month	Second Foot Days	Maximum	Minimum	Mean	Run-off in Acre-Feet
October	------	------	------	------	------
November	------	------	------	------	------
December	------	------	------	------	------
Calendar year	------	------	------	------	------
January	------	------	------	------	------
February	0	------	------	------	------
March	0	0	0	0	0
April	26,151	3,960	0	872	51,870
May	22,566	3,360	80	728	44,760
June	709	69	12	23.6	1,410
July	281.9	13	4.8	9.09	559
August	62.2	4.4	.8	2.01	123
September	48.1	4.6	.4	1.60	95
The period Apr. 1, 1950-Sept. 30, 1950	------	------	------	------	98,820

*—Winter discharge measurement made on this day.

Month	Second Foot Days	Maximum	Minimum	Mean	Run-off in Acre-Feet
October	43.6	2.1	1.0	1.41	86
November	66.2	5.6	1.5	2.21	131
December	28.0	------	------	.90	56
Calendar year 1950	------	------	------	------	------
January	15.5	------	------	.50	31
February	0	0	0	0	0
March	710	180	0	22.9	1,410
April	5,186	720	37	173	10,290
May	579.0	39	6.6	18.7	1,150
June	180.6	8.1	2.4	6.02	358
July	45.7	3.6	.1	1.47	91
August	9.8	2.0	0	.32	19
September	97.7	9.1	.8	3.26	194
Water year 1950-51	6,962.1	720	0	19.1	13,800

RED RIVER OF THE NORTH BASIN

Red River of the North at Wahpeton, N. Dak.

Location.—Lat. 46°15′55″, long. 96°35′40″, in NE¼ sec 8, T. 132 N., R. 47 W., on left bank in Wahpeton, 800 feet downstream from confluence of Bois de Sioux and Otter Tail rivers, at mile 548.6 from mouth.

Drainage area.—4,010 square miles.

Records available.—April 1942 to September 1951.

Gage.—Water-stage recorder. Datum of gage is 942.97 ft. above mean sea level, datum of 1929. Prior to Oct. 28, 1950, chain gage at same site and datum.

Average discharge.—8 years (1943-51) 550 cfs.

Extremes.—Maximum discharge during year, 6,090 cfs. Apr. 7 (gage height, 14.01 ft.); minimum recorded, 59 cfs. Nov. 9 or 10 (gage height, 2.60 ft.).

1942-51: Maximum discharge, that of Apr. 7, 1951; maximum gage height, 14.75 ft. Apr. 2, 1943, from floodmark (backwater from ice); minimum daily discharge, 40 cfs. Dec. 31, 1948, Jan. 1, 1949.

Maximum stage known, 15.6 ft in spring of 1897.

Remarks.—Records good except those for periods of ice effect or shifting control, which are fair. Flow partly regulated by several power plants and by numerous controlled lakes and ponds, of which Lake Traverse is the largest.

Month	Second Foot Days	Maximum	Minimum	Mean	Run-off in Acre-Feet
October	3,033	121	58	97.8	6,020
November	2,980	122	78	99.3	5,910
December	2,945	120	70	95.0	5,840
Calendar year 1949	78,183	2,240	40	214	155,100
January	2,725	110	75	87.9	5,400
February	3,707	160	85	132	7,350
March	13,840	3,030	110	446	27,450
April	40,214	4,120	350	1,340	79,760
May	48,721	4,050	356	1,572	96,640
June	43,740	1,690	985	1,458	86,760
July	47,320	1,880	1,250	1,526	93,860
August	20,940	1,320	219	675	41,530
September	6,348	286	88	212	12,590
Water year 1949-50	236,513	4,120	58	648	469,100

Month	Second Foot Days	Maximum	Minimum	Mean	Run-off in Acre-Feet
October	4,531	238	70	146	8,990
November	3,730	176	73	124	7,400
December	3,910	150	110	126	7,760
Calendar year 1950	239,726	4,120	70	657	475,500
January	4,810	170	140	155	9,540
February	4,140	230	110	148	8,210
March	7,490	700	130	242	14,860
April	66,247	5,960	780	2,208	131,400
May	50,070	1,800	910	1,615	99,310
June	31,878	1,400	821	1,063	63,230
July	18,378	836	397	593	36,450
August	11,497	454	292	371	22,800
September	9,949	375	285	332	19,730
Water year 1950-51	216,630	5,960	70	594	429,700

RED RIVER OF THE NORTH BASIN

Red River of the North at Fargo, N. Dak.

Location.—Lat. 46°52′10″, long. 96°47′00″, in NE¼, sec. 7, T. 139 N., R. 48 W., on left bank just upstream from Island Park Dam in Fargo, 10 miles upstream from Sheyenne River, and at mile 452.1.

Drainage area.—6,800 square miles.

Records available.—May 1901 to September 1951.

Gage.—Staff gage, read twice daily. Datum of gage is 870.00 ft above mean sea level, adjustment of 1912. Prior to Sept. 1, 1914, staff gage at site half a mile downstream, at datum 6.65 ft. lower. Sept. 1, 1914 to July 31, 1928, staff gage at present site at datum 3.70 ft. higher.

Average discharge.—49 years (1902-1951), 474 cfs (unadjusted); median of yearly mean discharges, 370 cfs.

Extremes.—Maximum discharge during year, 8,010 cfs Apr. 11; maximum gage-height, 20.73 ft. Apr. 11; minimum discharge, 59 cfs Nov. 12 (gage height, 7.59 ft.).

1901-51: Maximum discharge, 17,000 cfs Apr. 7, 1943 (gage height, 28.40 ft.); no flow for many days in each year for period 1932-41.

Maximum stage known, 40.1 ft. Apr. 7, 1897, site and datum in use prior to 1914.

Remarks.—Records good. Flow partly regulated by several power plants and numerous controlled lakes and ponds, of which Lake Traverse is the largest. Some small diversions for municipal supply. Figures of daily discharge do not include diversion by city of Fargo.

Revisions (water years).—W 1115: 1943.

MONTH	Second-foot-days	Observed discharge in second-feet			Runoff in Acre-feet	Diversion in Acre-feet	Adjusted for Diversion in Acre-feet	Mean
		Max.	Min.	Mean				
October	2,439	104	51	78.7	4,840	432	5,270	85.7
November	2,414	98	51	80.5	4,790	400	5,190	87.2
December	2,964	123	70	95.6	5,880	393	6,270	102
Calendar year 1949	90,729	2,600	42	249	179,950	4,946	184,960	256
January	2,736	101	78	88.3	4,430	405	5,840	94.9
February	3,742	169	88	134	7,420	381	7,800	141
March	16,344	3,330	88	527	32,420	411	32,830	534
April	110,064	7,680	750	3669	218,300	386	218,700	3675
May	102,909	6,520	832	3320	204,100	398	204,500	3326
June	53,030	2,120	1,340	1768	105,200	503	105,700	1776
July	47,140	1,800	1,330	1521	93,500	546	94,050	1530
August	23,821	1,320	232	768	47,250	610	47,860	778
September	6,411	283	106	214	12,720	473	13,190	222
Water year 1949-50	374,014	7,680	51	1025	741,800	5,338	747,200	1031

Peak discharge (base 2,500 sec.-ft.).—Apr. 7 (4 a. m.) 7,800 sec.-ft.; Apr. 16 (12 p. m). 4,080 sec.-ft.; May 12 (12 p. m.) 6,540 sec.-ft.

Month	Second Foot Days	Maximum	Minimum	Mean	Run-off in Acre-Feet
October	4,497	204	82	145	8,920
November	2,900	151	63	96.7	5,750
December	3,621	131	93	117	7,180
Calendar year 1950	377,215	7,680	63	1,033	748,200
January	4,755	185	125	153	9,430
February	4,291	218	120	153	8,510
March	7,922	561	188	256	15,710
April	96,998	7,990	726	3,233	192,400
May	53,080	1,820	1,570	1,712	105,300
June	33,431	1,480	809	1,114	66,310
July	19,614	879	396	633	38,900
August	12,031	447	339	388	23,860
September	10,237	433	300	341	20,300
Water year 1950-51	253,377	7,990	63	694	502,600

Does not include diversion by city of Fargo.

RED RIVER OF THE NORTH BASIN

Red River of the North at Halstad, Minn.

Location.—Lat. 47°21′, long. 96°51′, on line between sec. 24 and 25, T. 145 N., R. 49 W., on downstream side of highway bridge half a mile west of Halstad, 2½ miles downstream from Wild Rice River and at mile 375.2.

Drainage area.—21,800 square miles (includes 3,940 square miles in closed Devils Lake Basin).

Records available.—March 1936 to June 1937 (no winter records), April 1942 to June 1951 (spring and early summer months only).

Gage.—Wire-weight gage read once daily. Datum of gage is 826.65 ft. above mean sea level, datum of 1929.

Extremes.—Maximum discharge during period, 12,900 cfs Apr. 10 (gage height, 22.43 ft.); Minimum not determined.

1936-37, 1942-51: Maximum discharge, 24,500 cfs Apr. 16, 1947; maximum gage height, 34.00 ft. Apr. 17, 1947; minimum discharge observed, 5.4 cfs Oct. 8, 9, 12-14, 1936.

Remarks.—Records good except for period of ice effect and for May 25 to June 30 when they are fair. Some regulation by many controlled lakes and reservoirs on tributaries.

Month	Second Foot Days	Maximum	Minimum	Mean	Run-off in Acre-Feet
January	------	------	------	------	------
February	------	------	------	------	------
March	------	------	------	------	------
April	416,580	22,000	5,000	13,890	826,300
May	357,300	18,500	5,010	11,530	708,700
June	136,650	5,650	2,760	4,555	271,000
July	76,240	4,530	1,740	2,459	151,200
August	------	------	------	------	------
September	------	------	------	------	------
The period	------	------	------	------	2,057,000

Peak discharge (base, 2000 sec.-ft.).—Apr. 12 (time and discharge unknown); May 11 (6 p. m.) to May 12 (4 a. m.) 12,700 sec.ft.; June 27 (4 p. m.) 4,950 sec.-ft.

Month	Second Foot Days	Maximum	Minimum	Mean	Run-off in Acre-Feet
October	------	------	------	------	------
November	------	------	------	------	------
December	------	------	------	------	------
Calendar year 1950	------	------	------	------	------
January	------	------	------	------	------
February	------	------	------	------	------
March	------	------	------	------	------
April	191,600	12,900	700	6,387	380,000
May	81,660	3,160	2,000	2,634	162,000
June	49,900	2,200	1,100	1,663	98,980
July	------	------	------	------	------
August	------	------	------	------	------
September	------	------	------	------	------
Water year 1950-51	------	------	------	------	641,000

RED RIVER OF THE NORTH BASIN

Red River of the North at Grand Forks, N. Dak.

Location.—Lat. 47°56′26″, long. 97°02′47″, in SE¼NE¼ sec. 33, T. 152 N., R. 50 W., on left bank 500 ft. below dam at Riverside Park, in Grand Forks, 2 miles downstream from Red Lake River and at mile 296.0.

Drainage area.—30,100 square miles (includes 3,940 square miles in closed Devils Lake Basin).

Records available.—May 1901 to September 1951 in reports of the Geological Survey. April 1882 to November 1912 in report of Minnesota State Drainage Commission.

Gage.—Water-stage recorder. Datum of gage is 778.42 ft. above mean sea level, datum of 1929. 1882-1892, gage or gages in general vicinity of site of Northern Pacific Railway bridge, 1½ miles upstream (history not available, datum apparently the same as following gage). 1892 to Oct. 15, 1926, staff and chain gages on Northern Pacific Railway bridge, datum 779.9 feet above sea level by Corps of Engineers levels run from St. Paul in 1881. Oct. 16, 1926 to Nov. 2, 1933 staff age in several sections distributed in vicinity of present gage, at same datum.

Average discharge.—69 years, 2,315 cfs.

Extremes.—Maximum discharge during year, 23,600 cfs Apr. 12 (gage height, 33.52 ft); minimum, 936 cfs Aug. 24 (gage height, 4.49 ft.).

1882-1951: Maximum discharge, about 80,000 cfs Apr. 10, 1897 (gage height, 50.2 ft., site and datum then in use), from rating curve extended above 54,000 cfs; minimum discharge, 2.4 cfs Feb. 3-5, 12, 14, 16-19, 1937 (caused by unusual regulation during repair of dam at Grand Forks).

Remarks.—Records excellent except those for period of ice effect, which are fair. Flow partly regulated by many lakes and reservoirs on tributaries.

Revisions. (water year).—W855:1936 (M), W 1115: 1942, W : 1897 (M).

Month	Second Foot Days	Maximum	Minimum	Mean	Run-off in Acre-Feet
October	33,241	1,350	811	1,072	65,930
November	35,174	1,400	704	1,172	69,770
December	32,170	1,240	860	1,038	63,810
Calendar year 1949	823,926	15,100	380	2,257	1,634,000
January	24,210	960	620	781	48,020
February	20,480	820	640	731	40,620
March	32,760	3,390	680	1,057	64,980
April	723,110	43,000	4,640	24,100	1,434,000
May	1,131,900	53,900	19,200	36,510	2,245,000
June	332,340	17,900	6,970	11,080	659,200
July	240,590	13,500	4,610	7,761	477,200
August	93,900	4,290	2,010	3,029	186,200
September	66,790	2,520	1,860	2,226	132,500
Water year 1949-50	2,766,665	53,900	620	7,580	5,487,000

Peak discharge (base, 10,000 sec.-ft.).—Apr. 24 (12 p. m.) to Apr. 25 (3 a. m.) 43,800 sec.-ft.; May 12 (7 a.m.) 54,000 sec.-ft.; July 1 (9 p. m.) 13,500 sec.-ft.

Month	Second Foot Days	Maximum	Minimum	Mean	Run-off in Acre-Feet
October	84,390	2,920	2,440	2,722	167,400
November	59,620	2,440	1,300	1,987	118,300
December	63,150	2,100	1,900	2,037	125,300
Calendar year 1950	2,875,060	53,900	600	7,877	5,702,000
January	59,800	1,950	1,900	1,929	118,600
February	51,000	1,900	1,750	1,821	101,200
March	70,350	3,700	1,850	2,269	139,500
April	431,400	23,500	4,000	14,380	855,700
May	253,970	10,900	5,650	8,193	503,700
June	122,620	5,420	2,850	4,087	243,200
July	69,720	2,820	1,570	2,249	138,300
August	34,512	1,470	950	1,113	68,450
September	42,800	1,680	1,260	1,427	84,890
Water year 1950-51	1,343,332	23,500	950	3,680	2,665,000

RED RIVER OF THE NORTH BASIN

Red River of the North at Oslo, Minn.

Location.—Lat. 48°11′35″, long. 97°08′25″, in sec. 31, T. 155 N., R. 50 W., on upstream side of main span of highway bridge in Oslo, at mile 271.1 above mouth.

Drainage area.—27,300 square miles (excludes 3,940 square miles in closed Devils Lake Basin).

Records available.—April 1936 to June 1937, April 1941 to June 1951 (high-water periods only). Records prior to 1945 do not include flow in bypass channel.

Gage.—Wire-weight gage read twice daily. Datum of gage is 777.65 ft. above mean sea level, datum of 1929. Prior to Apr. 2, 1948, staff gage on railroad bridge, 800 ft. upstream, at same datum.

Extremes.—Maximum discharge during season, 24,800 cfs. Apr. 12; maximum gage height 25.59 ft. Apr. 14; minimum discharge not determined.

1936-37, 1941-51: Maximum discharge, 63,000 cfs. May 10, 1950 (gage height, 31.83 ft.) minimums not determined.

Maximum stage known, about 32.5 ft. in 1897.

Remarks.—Records excellent except those for period of ice effect, which are fair. For stages above 13 feet, discharge includes flow in bypass channel 1½ miles west of Oslo. Recording gage at Grand Forks used as auxiliary gage for computation of slope. Some regulation by lakes and reservoirs on tributaries.

Month	Second Foot Days	Maximum	Minimum	Mean	Run-off in Acre-Feet
October					
November					
December					
Calendar year					
January					
February					
March					
April	811,400	48.400	3,400	27,050	1,609,000
May	1,269,200	62.700	22.400	40.940	2,517,000
June	352.630	20.600	6,930	11,750	699,400
July	246,030	13,400	4,900	7,936	488,000
August					
September					
Water year 1949-50	2,679,260				5,314,000

Month	Second Foot Days	Maximum	Minimum	Mean	Run-off in Acre-Feet
October					
November					
December					
Calendar year 1950					
January					
February					
March					
April	460,100	24,600	4,200	15,340	912,600
May	261,750	11,300	5,860	8,444	519,200
June	129,300	5,660	3,070	4,310	256,500
July					
August					
September					
Water year 1950-51					1,688,000

RED RIVER OF THE NORTH BASIN

Red River of the North at Drayton, N. Dak.

Location.—Lat. 48°33′40″, long. 97°10′30″ in NW¼SE¼ sec. 26, T. 159 N., R. 51 W. on downstream side of left span of interstate highway bridge at Drayton, at mile 208.2.

Drainage Area.—34,800 square miles (includes 3,940 square miles in closed Devils Lake Basin).

Records available.—April 1936 to June 1937, April 1941 to September 1951 (fragmentary prior to April 1949).

Gage.—Wire-weight gage read twice daily Oct. 1 to Dec. 9 and Apr. 2 to July 15, and once daily at other times. Datum of gage is 756.59 feet above mean sea level, datum of 1929.

Extremes.—Maximum discharge during year, 24,600 cfs. Apr. 15; maximum gage height, 30.25 ft. Apr. 17; minimum discharge, 1,010 cfs. Aug. 26 (gage height, 3.52 ft.).

1936-37, 1941-51: Maximum discharge, 86,500 cfs. May 12, 1950 (gage height, 41.58 ft.); minimum observed, 7.7 cfs. Oct. 16, 1936 (gage height, 1.75 ft.).

Maximum discharge known since 1860, that of May 12, 1950. Flood of April 1897 reached a stage of about 41 ft.

Remarks.—Records good except those for period of ice effect, which are fair. Some regulation by reservoirs on tributaries.

Month	Second Foot Days	Maximum	Minimum	Mean	Run-off in Acre-Feet
October	34,872	1,340	840	1,125	69,170
November	38,480	1,470	900	1,283	76,320
December	33,150	1,300	900	1,069	65,750
Calendar year 1949					
January	24,740	1,000	650	798	49,070
February	20,430	820	650	730	40,520
March	30,340	1,900	800	979	60,180
April	933,600	71,500	2,200	31,120	1,852,000
May	1,825,700	86,100	32,200	58,890	3,621,000
June	460,700	30,000	7,560	15,360	913,800
July	262,340	13,300	5,210	8,463	520,300
August	103,060	5,090	2,080	3,325	204,400
September	69,000	2,600	1,900	2,300	136,900
Water year 1949-50	3,836,412	86,100	650	10,510	7,609,410

Peak discharge (base, 10,000 sec.-ft.).—Apr. 26 (7 p. m.) 72,000 sec.-ft.; May 12 (3 p. m.) 86,500 sec.-ft.; July 4 (9 a. m.) 13,400 sec.-ft.

Month	Second Foot Days	Maximum	Minimum	Mean	Run-off in Acre-Feet
October	91,560	3,500	2,620	2,954	181,600
November	59,600	2,590	1,550	1,987	118,200
December	62,400	2,050	1,700	2,013	123,800
Calendar year 1950	3,953,670	86,100	720	10,830	7,842,000
January	61,200	2,000	1,900	1,974	121,400
February	51,250	1,900	1,750	1,830	101,700
March	70,700	3,600	1,950	2,281	140,200
April	515,200	24,600	4,300	17,170	1,022,000
May	279,680	12,200	6,260	9,022	554,700
June	133,970	6,040	3,060	4,466	265,700
July	75,670	3,040	1,850	2,441	150,100
August	38,600	1,800	1,010	1,245	76,560
September	51,320	2,570	1,230	1,711	101,800
Water year 1950-51	1,491,150	24,600	1,010	4,085	2,958,000

RED RIVER OF THE NORTH BASIN

Red River of the North at Emerson, Manitoba
(International gaging station)

Location.—Lat. 49°00′30″, long. 97°13′00″, on Canadian National Railway bridge in Emerson, half a mile downstream from International Boundary, 3 miles downstream from Pembina River, and at mile 154.5.

Drainage area.—40,200 square miles (includes 3,940 square miles in closed Devils Lake Basin).

Records available.—March to November 1902 and October 1929 to September 1951 in reports of Geological Survey; May 1912 to September 1951 in reports of the Water Resources Division, Department of Resources and Development, Canada.

Gage.—Chain gage read once daily. Datum of gage is at mean sea level, datum of 1929, by Geodetic Survey of Canada. Prior to Oct. 1, 1948, at datum 0.21 ft. higher.

Average discharge.—38 years (1913-51) 2,706 cfs; median of yearly mean discharges, 2,260 cfs.

Extremes.—Maximum daily discharge during year,26,600 cfs Apr. 15-18; maximum elevation, 774.55 ft. Apr. 18-19; minimum daily discharge 1,200 cfs Aug. 29 (elevation, 747.36 ft).

1912-51: Maximum discharge, 95,500 cfs May 13, 1950 (elevation, 790.89 ft.) minimum observed, 0.9 second-feet Feb. 6-8, 1937.

Remarks.—Records good except those for periods of ice effect, which are fair.

Cooperation.—This station is one of the international gaging stations maintained by Canada under agreement with the United States.

Revisions.—(Water year)—W925: 1940.

Month	Second Foot Days	Maximum	Minimum	Mean	Run-off in Acre-Feet
October	35,519	1,520	856	1,150	70,450
November	41,620	1,560	1,060	1,390	82,550
December	33,032	1,340	878	1,070	65 520
Calendar year 1949	1,181,614	29,200	409	3,240	2,344,000
January	25,645	1,080	673	827	50,870
February	20,942	844	661	748	41,540
March	28,732	1,360	798	927	56,990
April	796,270	73,200	1,560	26,500	1,579,000
May	2,257,500	94,400	45,000	72,800	4,478,000
June	668,870	42,900	9,880	22,300	1,327,000
July	313,450	15,400	6,050	10,100	621,700
August	117,960	5,970	2,240	3,810	234,000
September	78,520	3,070	2,000	2,620	155,700
Water year 1949-50	4,418,060	94,400	661	12,100	8,763,000

Peak discharge (base, 10,000 sec.-ft.).—Apr. 30 (5 p. m.) 73,300 sec.-ft.; May 13 (5 p. m.) 95,500 sec.-ft.; July 4 (all day) 15,400 sec.-ft.

Month	Second Foot Days	Maximum	Minimum	Mean	Run-off in Acre-Feet
October	103,230	3,800	2,860	3,330	204,800
November	62,190	2,830	1,510	2,070	123,400
December	66,960	2,290	1,560	2,160	132,800
Calendar year 1950	4,540,269	94,400	661	12,440	9,006,000
January	63,650	2,210	1,930	2,050	126,200
February	50,390	1,920	1,700	1,800	99,950
March	70,910	3,820	1,810	2,290	140,600
April	589,540	26,600	4,360	19,700	1,169,000
May	336,750	15,300	7,280	10,900	667,900
June	148,240	7,020	3,350	4,940	294,000
July	84,990	3,330	2,090	2,740	168,600
August	45,290	2,100	1,200	1,460	89,830
September	58,650	2,850	1,340	1,960	116,300
Water year 1950-51	1,680,790	26,600	1,200	4,600	3,333,000

RED RIVER OF THE NORTH BASIN

Wild Rice River near Mantador, N. Dak.

Location.—Lat. 46°10′20″, long. 97°00′35″, on downstream side of county highway bridge on south ½ of east line of section 12, T. 131 N., R. 51 W., 1½ miles west of Mantador.

Drainage area.—1,340 square miles.

Records available.—March 1944 to September 1951 (discontinued).

Gage.—Wire-weight gage read once daily below 4 ft. and twice daily above. Datum of gage is 997.78 ft. above mean sea level, datum of 1929 (Corps of Engineers bench mark). Prior to Nov. 3, 1949, staff gage at same site and datum.

Average discharge.—7 years, 30.9 cfs.

Extremes.—Maximum discharge during year, 275 cfs. Apr. 4; maximum gage height, 7.15 ft. Apr. 4, affected by ice; no flow during several months.

1944-51: Maximum discharge, 938 cfs. Mar. 20, 1945, (gage height, 9.57 ft); no flow at times in each year.

Flood in spring of 1943 reached a stage of about 12.8 ft., from floodmarks.

Remarks.—Records good except those for periods of ice effect, which are fair. Some regulation by Fish and Wildlife Service wild fowl refuges, of which Lake Tewauken is the largest. Some small diversions for irrigation.

Month	Second Foot Days	Maximum	Minimum	Mean	Run-off in Acre-Feet
October	0	0	0	0	0
November	71.6	5.3	0	2.39	142
December	36.1	3.0	0	1.16	72
Calendar year 1949	3,581.8	100	0	9.81	7,110
January	0	0	0	0	0
February	0	0	0	0	0
March	1,120	180	0	36.1	2,220
April	7,316	430	135	244	14,510
May	7,804	372	112	252	15,480
June	753.8	96	2.3	25.1	1,500
July	125.7	10	0.9	4.05	249
August	15.8	3.3	0	.51	31
September	0	0	0	0	0
Water year 1949-50	17,243.0	430	0	47.2	34,200

Month	Second Foot Days	Maximum	Minimum	Mean	Run-off in Acre-Feet
October	0	0	0	0	0
November	0	0	0	0	0
December	0	0	0	0	0
Calendar year 1950	17,135.3	430	0	46.9	33,990
January	0	0	0	0	0
February	0	0	0	0	0
March	66	30	0	2.13	131
April	3,000	250	25	100	5,950
May	790.3	60	4.7	25.5	1,570
June	648.4	40	9.4	21.6	1,290
July	299.5	30	.1	9.66	594
August	0	0	0	0	0
September	0	0	0	0	0
Water year 1950-51	4,804.2	250	0	13.2	9,540

RED RIVER OF THE NORTH BASIN

Wild Rice River Near Abercrombie, N. Dak.

Location.—Lat. 46°28′35″, long. 96°47′15″, in NE¼SW¼ sec. 25, T. 135 N., R. 49 W., on left bank 160 feet upstream from rubble masonry dam which serves as control, 3½ miles northwest of Abercrombie, and 8 miles downstream from Antelope Creek.

Drainage area.—2,170 square miles.

Records available.—April 1932 to September 1951.

Average discharge.—15 years (1932-33, 1936-37, 1938-51), 73.1 cfs.; median of yearly mean discharges, 46 cfs.

Gage.—Staff gage read once daily below 2.5 ft. and once daily above. Datum of gage is 907.94 ft. above mean sea level, datum of 1929. Prior to Dec. 7, 1939, chain gage at site ¾ mile upstream at datum 5.00 ft. lower.

Extremes.—Maximum discharge during year, 1,890 cfs. Apr. 6 (gage height, 11.95 ft., affected by ice); no flow Oct. 1 to Mar. 14.

1932-51: Maximum discharge, 5,500 cfs. Apr. 2, 1943 (gage height, 21.02 ft., from floodmark) from rating table extended above 2,100 cfs.; no flow for some periods each year.

Flood in spring of 1897 reached a stage between 8 and 10 ft. higher than that of 1943, from information by local residents.

Remarks.—Records good except those for period of ice effect, which are fair. Some regulation by Fish and Wildlife Service wild fowl refuges, of which Lake Tewauken is largest. Some small diversions for irrigation.

Month	Second Foot Days	Maximum	Minimum	Mean	Run-off in Acre-Feet
October	0	0	0	0	0
November	0	0	0	0	0
December	0	0	0	0	0
Calendar year 1949	9,866.3	600	0	0	19,570
January	0	0	0	0	0
February	0	0	0	0	0
March	5,476	1,130	0	177	10,860
April	24,388	2,190	180	813	48,370
May	18,407	1,810	176	594	36,510
June	1,726.5	212	7.7	57.6	3,420
July	237.2	38	1.8	7.65	470
August	53.5	4.6	0	1.73	106
September	0	0	0	0	0
Water year 1949-50	50,288.2	2,190	0	138	99,740

Month	Second Foot Days	Maximum	Minimum	Mean	Run-off in Acre-Feet
October	0	0	0	0	0
November	0	0	0	0	0
December	0	0	0	0	0
Calendar year 1950	50,288.2	2,190	0	138	99,740
January	0	0	0	0	0
February	0	0	0	0	0
March	451.6	230	0	14.6	896
April	17,506	1,850	97	584	34,720
May	1,272	86	11	41.0	2,520
June	812	50	12	27.1	1,610
July	613.9	38	1.1	19.8	1,220
August	14.2	1.4	0	.46	28
September	28.7	3.4	.1	.96	57
Water year 1950-51	20,698.4	1,850	0	56.7	41,050

RED RIVER OF THE NORTH BASIN

Sheyenne River Near Harvey, N. Dak.

Location.—Lat. 47°47′25″, long. 99°53′25″, in SE¼SW¼ sec. 21, T. 150 N., R. 72 W., on left bank 300 ft. north of Harvey Water Works, 0.4 mile upstream from small tributary and 2¼ miles northeast of Harvey.

Drainage area.—562 square miles.

Records available.—October 1945 to September 1951.

Gage.—Staff gage read once daily. Altitude of gage is 1,530 ft. (from topographic map). Prior to June 11, 1946, staff gage at site 3 miles upstream at different datum.

Average discharge.—6 years, 17.8 cfs.

Extremes.—Maximum discharge during year, 340 cfs. Apr. 7 (gage height, 5.85 ft., affected by ice); maximum gage height observed, 5.95 ft. Apr. 6, affected by ice; minimum discharge, 0.1 cfs. Aug. 30, 31; minimum gage height observed, 1.69 ft. Aug. 30.

1945-51: Maximum discharge observed, 1,430 cfs. Apr. 18, 1950; maximum gage height observed, 6.95 ft. Apr. 17, 1950, affected by ice; no flow during several months in each year, 1945-50.

Flood in midsummer of 1917, 1918 or 1919 reached a stage about 1 ft. higher than that of 1950, from information by a local resident.

Remarks.—Records fair except those for periods of ice effect or no gage-height record, which are poor.

Month	Second Foot Days	Maximum	Minimum	Mean	Run-off in Acre-Feet
October	0	0	0	0	0
November	0	0	0	0	0
December	0	0	0	0	0
Calendar year 1949	5,429.4	547	0	14.9	10,770
January	0	0	0	0	0
February	0	0	0	0	0
March	106	30	0	3.42	210
April	9,725	1,360	10	324	19,290
May	6,223	617	65	201	12,340
June	919.7	77	8.7	30.7	1,820
July	153.2	12	1.4	4.94	304
August	8.4	1.2	0	.27	17
September	3.5	.4	0	.12	6.9
Water year 1949-50	17,138.8	1,360	0	47.0	33,990

Peak discharge (base, 100 sec.-ft.).—Apr. 8 (9 a. m.) 450 sec.-ft.; Apr. 18 (9 a. m.) 1,430 sec.-ft. May 14 (6 a. m.) 667 sec.-ft.; June 12 (12 m.) 119 sec.-ft.

Month	Second Foot Days	Maximum	Minimum	Mean	Run-off in Acre-Feet
October	25.2	1.1	.4	.81	50
November	44.8	1.7	1.1	1.49	89
December	45.4	1.6	1.3	1.46	90
Calendar year 1950	17,254.2	1,360	0	47.3	34,220
January	55.0	2.7	1.1	1.77	109
February	22.5	1.1	.6	.80	45
March	67.0	12	.6	2.16	133
April	3,741	320	10	125	7,420
May	696.3	56	4.1	22.5	1,380
June	1,187.6	100	4.1	39.6	2,360
July	139.5	14	.6	4.50	277
August	31.6	2.1	.1	1.02	63
September	84.8	11	.2	2.83	168
Water year 1950-51	6,140.7	320	.1	16.8	12,180

RED RIVER OF THE NORTH BASIN

Sheyenne River at Sheyenne, N. Dak.

Location.—Lat. 47°50′20″, long. 99°07′30″, in NE¼ sec. 5, T. 150 N., R. 66 W., at recreation-pond dam, 1 mile north of Sheyenne.

Drainage area.—1,830 square miles.

Records available.—April 1929 to June 1933, October 1939 to September 1951 (discontinued).

Gage.—Staff gage read once daily. Datum of gage is 1,408.65 ft. above mean sea level, datum of 1929. Prior to May 11, 1949, wire-weight and various staff gages at points within 300 ft. of present site, at same datum.

Average discharge.—13 years (1929-30, 1939-51), 47.3 cfs.

Extremes.—Maximum discharge during year, 1,420 cfs. Apr. 18 (gage height, 6.25 ft. affected by ice); no flow at times.

1929-33, 1939-51: Maximum discharge, 3,940 cfs. Apr. 18, 1950, maximum gage height 8.51 feet Apr. 18, 19, 1948; no flow during parts of most years.

Flood in 1919 reached a stage about 3 ft. higher than that of April 1948.

Remarks.—Records poor except those from April 5 to May 5, which are fair. Stage-discharge relation substantially affected by the wind at times.

Revisions.—W : drainage area.

Month	Second Foot Days	Maximum	Minimum	Mean	Run-off in Acre-Feet
October	6.4	2.0	0	0.21	13
November	7.4	1.6	0	.25	15
December	19.7	1.3	.2	.64	39
Calendar year 1949	22,388.9	2,030	0	61.3	44,010
January	1.1	.2	0	.04	2.2
February	0	0	0	0	0
March	350.8	80	0	11.3	696
April	38,250	3,290	43	1,275	75,870
May	18,884	1,460	144	609	37,460
June	1,826	124	18	60.9	3,620
July	498.2	40	5.6	16.1	988
August	79.9	8.2	0	2.58	158
September	18.0	1.3	0	.60	36
Water year 1949-50	59,941.5	3,290	0	164	118,900

Peak discharge (base, 100 sec.-ft.)—Apr. 18 (3:30 p. m.) 3,940 sec.-ft.; May 12 (12 m.) 1,280 sec.-ft.; May 19 (12 p. m.) 1,600 sec.-ft.

Month	Second Foot Days	Maximum	Minimum	Mean	Run-off in Acre-Feet
October	11.8	1.6	0	.38	23
November	48.6	5	0	1.62	96
December	43	------	------	1.4	85
Calendar year 1950	60,011.4	3,290	0	164	119,000
January	41.5	------	.9	1.34	82
February	20.0	1.5	.3	.71	40
March	321.8	80	1.2	10.4	638
April	12,794	1,400	40	426	25,380
May	2,189	149	28	70.6	4,340
June	1,589	102	28	53.0	3,150
July	243.9	33	2.0	7.87	484
August	27.0	2.0	0	.87	54
September	106.8	10	0	3.56	212
Water year 1950-51	17,436.4	1,400	0	47.8	34,580

RED RIVER OF THE NORTH BASIN

Sheyenne River Near Warwick, N. Dak.

Location.—Lat. 47°48′20″, long. 98°42′57″, on south quarter of line between sec. 15 and 16, T. 150 N., R. 63 W., on left bank on downstream side of bridge on county road 3.3 miles south of Warwick. Records include flow of spring which enters below gage and just above control.

Drainage area.—2,100 square miles.

Records available.—November 1949 to September 1951.

Gage.—Water-stage recorder and rubble masonry control. Altitude of gage is 1,380 ft. (from topographic map).

Extremes.—Maximum discharge during year, 1,240 cfs. Apr. 11 (gage height, 5.01 ft.) minimum, 1 cfs. Aug. 9, 23-28; minimum gage height, 2.03 ft. Aug. 26.

1949-51: Maximum discharge, 3,800 cfs. Apr. 17, 1950 (gage height, 7.45 ft.) minimum discharge, that of Aug. 8, 9, 23-29, 1951; minimum gage height, that of Aug. 26, 1951.

Remarks.—Records good above 20 cfs. and poor below. Measurements of spring inflow made during the year are listed below.

Date.	Discharge, in second ft.	Date.	Discharge, in second ft.
Oct. 13	1.5	Apr. 2	2.6
Nov. 18	1.7	May 1	1.6
Dec. 9	1.4	May 16	1.5
Jan. 6	1.4	July 20	1.1
Feb. 12	1.4	Aug. 13	1.1
		Sept. 21	1.2

Month	Second Foot Days	Maximum	Minimum	Mean	Run-off in Acre-Feet
October	------	------	------	------	------
November 9-30	184	11	4	8.4	365
December	125.5	11	1.5	4.05	249
Calendar year	------	------	------	------	------
January	46.5	1.5	1.5	1.50	92
February	42.0	1.5	1.5	1.50	83
March	382.5	103	1.5	12.3	759
April	42,624	3,450	80	1,421	84,540
May	26,473	1,640	217	854	52,510
June	2,964	300	50	98.8	5,880
July	931	48	12	30.0	1,850
August	255	18	2	8.2	506
September	182.5	16	1.5	6.08	362
The period	------	------	------	------	147,200

Peak discharge (base 200 sec.-ft.)—Apr. 17 (9 p. m.) 3,800 sec.-ft.; May 14 (6-10 a. m.) 1,650 sec.-ft.; May 22 (8 a. m.) 1,630 sec.-ft.

Month	Second Foot Days	Maximum	Minimum	Mean	Run-off in Acre-Feet
October	371	19	8	12.0	736
November	333	24	5	11.1	660
December	255	9	8	8.23	506
Calendar year 1950	74,859.5	3,450	1.5	205	148,500
January	329	12	8	10.6	653
February	187	8	5	6.68	371
March	672	146	7	21.7	1,330
April	13,210	1,200	131	440	26,200
May	2,805	174	30	90.5	5,560
June	2,104	109	33	70.1	4,170
July	667	56	4	21.5	1,320
August	83	18	1	2.68	165
September	347	26	3	11.6	688
Water year 1950-51	21,363	1,200	1	58.5	42,360

RED RIVER OF THE NORTH BASIN

Sheyenne River Near Cooperstown, N. Dak.

Location.—Lat. 47°26′, long. 98°02′, in NE¼SE¼ sec. 27, T. 146 N., R. 58 W., on right bank 150 feet downstream from county bridge 5 miles east of Cooperstown.

Drainage area.—6,780 square miles (includes 3,940 square miles in closed Devils Lake Basin).

Records available.—March 1945 to September 1951.

Gage.—Water-stage recorder. Datum of gage is 1,274.57 ft. above mean sea level (Corps of Engineers bench mark). Prior to Aug. 3, 1950, wire-weight gage 150 ft. upstream, at same datum.

Average discharge.—6 years, 163 cfs.

Extremes.—Maximum discharge during year, 989 cfs. Apr. 9 (gage height, 11.05 ft.); maximum gage height, 11.46 ft. Apr. 6, affected by ice; minimum discharge, 1.2 cfs. Nov. 9 (gage height, 3.65 ft.), result of freeze-up.

1945-51: Maximum discharge, 7,830 cfs. Apr. 17, 1950, (gage height, 18.69 ft); minimum daily discharge, 1 cfs. Mar. 1-9, 1947; minimum gage height observed, 3.52 ft. Sept. 6, 1945 and Sept. 27, 1948.

Remarks.—Records good except those for period of ice effect, which are fair.

Month	Second Foot Days	Maximum	Minimum	Mean	Run-off in Acre-Feet
October	739	44	2.6	23.8	1,470
November	710	30	11	23.7	1,410
December	5[illegible]0	28	9	16.8	1,030
Calendar year 1949	46,380.2	2,280	2.0	127	92,000
January	399	16	8	12.9	791
February	241	10	8	8.6	478
March	1,666	240	4	53.7	3,300
April	68,780	7,410	110	2,293	136,400
May	60,530	3,390	1,040	1,953	120,100
June	8,179	817	143	273	16,220
July	2,492	146	46	80.4	4,940
August	763	47	15	24.6	1,510
September	761.7	46	7.3	25.4	1,510
Water year 1949-50	145,780.7	7,410	2.6	399	289,200

Peak discharge, (base, 200 sec.-ft.).—Apr. 17 (about 4 a. m.) 7,830 sec.-ft.; May 9 (12 p. m.) to May 10 (7 a. m.) 3,460 sec.-ft.; June 16 (7:25 p. m.) 352 sec.-ft.; June 25 (7:45 p. m.) 430 sec.-ft.

Month	Second Foot Days	Maximum	Minimum	Mean	Run-off in Acre-Feet
October	898	39	20	29.0	1,780
November	718	29	15	23.9	1,420
December	719	25	20	23.2	1,430
Calendar year 1950	146,146.7	7,410	4	400	289,900
January	644	24	16	20.8	1,280
February	502	20	16	17.9	996
March	2,593	500	12	83.6	5,140
April	19,512	980	312	650	38,700
May	5,376	304	69	173	10,660
June	2,742	131	65	91.4	5,440
July	1,086	70	11	35.0	2,150
August	346	22	6.4	11.2	686
September	954	80	12	31.8	1,890
Water year 1950-51	36,090	980	6.4	98.9	71,570

RED RIVER OF THE NORTH BASIN

Lake Ashtabula at Baldhill Dam, N. Dak.

Location.—Lat. 47°02′00″, long. 98°05′00″, in NW¼ sec. 18, T. 141 N., R. 58 W. at Baldhill Dam on Sheyenne River 8 miles northwest of Valley City.

Drainage area.—7,900 square miles (includes 3,940 square miles in closed Devils Lake Basin).

Records available.—July 1949 to September 1951.

Gage.—Water-stage recorder. Datum of gage is mean sea level, datum of 1929.

Extremes.—Maximum contents during year, 33,620 acre-feet Apr. 18 (elevation, 1,257.82 ft.); minimum, 7,900 acre-feet Oct. 1 (elevation, 1,246.20 ft.).

1949-51: Maximum contents, 91,600 acre-feet May 14, 1950 (elevation, 1,269.46 ft.); minimum since reservoir first reached spillway level, 7,900 acre-feet Sept. 30 and Oct. 1, 1950.

Remarks.—Reservoir is formed by an earth-fill dam 1,650 feet long; storage began on July 30, 1949; dam completed September 1949. Usable capacity, 69,500 acre-feet between invert of outlet conduit, elevation, 1,238.0 feet, and normal pool level, elevation 1,266.0 feet. Dead storage below elevation 1,238.0 feet, 1,200 acre-feet. Maximum pool elevation, 1,273.2 feet, capacity, 116,500 acre-feet. Low flows are controlled by 2 sluice gates 3 feet in diameter. The spillway crest is 120 feet long at elevation 1,252.0 feet, surmounted by 3 Tainter gates, each 15 feet high and 40 feet long. The reservoir is operated for flood control and improvement of low-water flow.

Cooperation.—Records furnished by Corps of Engineers.

Date	Elevation (feet)	Contents (acre - feet)	Change in contents During month (acre-feet)
July 31	1,229.92	0	------
August 31	1,237.95	1,200	+1,200
September 30	1,237.69	1,150	—50
Water year 1948-49			+1,150
October 31	1,239.75	2,200	+1,050
November 30	1,239.84	2,300	+100
December 31	1,239.43	2,000	—300
Calendar year			+2,000
January 31	1,239.22	1,900	—100
February 28	1,239.20	1,900	0
March 31	1,243.90	5,300	+3,400
April 30	1,266.98	76,400	+71,100
May 31	1,264.40	61,900	—14,500
June 30	1,251.75	17,500	—44,400
July 31	1,246.95	8,900	—8,600
August 31	1,245.37	6,900	—2,000
September 30	1,246.20	7,900	+1,000
Water year 1949-50			+6,750

Date	Elevation (feet)	Contents (acre - feet)	Change in contents During month (acre-feet)
Sept. 30	1,246.20	7,900	
Oct. 31	1,246.90	8,870	+970
Nov. 30	1,247.10	9,150	+280
Dec. 31	1,247.07	9,100	—50
Calendar Year 1950			+7,100
Jan. 31	1,246.77	8,700	—400
Feb. 28	1,246.58	8,450	—250
Mar. 31	1,250.82	15,840	+7,390
Apr. 30	1,255.75	27,240	+11,400
May 31	1,252.50	19,200	—8,040
June 30	1,252.45	19,100	—100
July 31	1,252.00	18,200	—900
Aug. 31	1,251.72	17,640	—560
Sept. 30	1,251.64	17,480	—160
Water Year 1950-51			+9,580

RED RIVER OF THE NORTH BASIN
Sheyenne River Below Baldhill Dam, N. Dak.

Location.—Lat. 47°01'50", long. 98°05'00", in NW¼ sec. 18, T. 141 N., R. 58 W., on right bank 600 feet downstream from Baldhill Dam, 8 miles northwest of Valley City, and at mile 270.5.

Drainage area.—7,900 square miles (includes 3,940 square miles in closed Devils Lake Basin).

Records available.—November 1949 to September 1951.

Gage.—Water-stage recorder or staff gage read once daily. Datum of gages is 1,200.00 feet above mean sea level, datum 1929.

Extremes.—Maximum discharge during year, 1,270 cfs. Apr. 19 (gage height, 28.00 ft); minimum, 7.1 cfs. Oct. 14; minimum gage height, 24.01 ft. on several days in December.

1949-51: Maximum discharge, 3,150 cfs. May 23, 1950 (gage height 32.62 ft.); no flow Sept. 8, 9, 1950.

Maximum discharge known about 4,600 cfs. Apr. 27 or 28, 1948.

Remarks.—Records are fair.

Cooperation.—Gage-height record furnished by Corps of Engineers.

Month	Second Foot Days	Maximum	Minimum	Mean	Run-off in Acre-Feet
October	------	------	------	------	------
November 29-30	56	28	28	28	111
December	566	28	14	18.3	1,120
Calendar year 1949	------	------	------	------	------
January	328	13	10	10.6	651
February	285	12	10	10.2	565
March	1,550	250	11	50.0	3,070
April	51,910	2,920	160	1,730	103,000
May	90,090	3,100	2,520	2,906	178,700
June	34,626	3,070	264	1,154	68,680
July	7,611	286	59	246	15,100
August	2,115.5	238	7.1	68.2	4,200
September	103.8	16	0	3.5	206
The period	189,241.3	3,100	0	618	375,400

Month	Second Foot Days	Maximum	Minimum	Mean	Run-off in Acre-Feet
October	407.0	73	8.3	13.1	807
November	795.6	30	8.7	26.5	1,580
December	846	28	26	27.3	1,680
Calendar year 1950	190,667.9	3,100	0	522	378,200
January	798	26	24	25.7	1,580
February	662	26	22	23.6	1,310
March	1,228	268	15	39.6	2,440
April	16,414	1,150	242	547	32,560
May	9,914	945	78	320	19,660
June	2,694	155	65	89.8	5,340
July	1,454	139	15	46.9	2,880
August	734	26	22	23.7	1,460
September	868	34	26	28.9	1,720
Water year 1950-51	36,814.6	1,150	8.3	101	73,020

RED RIVER OF THE NORTH BASIN
Sheyenne River at Valley City, N. Dak.

Location.—Lat. 46°54'50", long. 98°00'30", in SE¼NW¼ sec. 28, T. 140 N., R. 58 W., on left bank 100 feet downstream from College Dam in Valley City, 13 miles downstream from Baldhill Dam, and at mile 253.0.

Drainage area.—8,200 square miles (includes 3,940 square miles in closed Devils Lake Basin).

Records available.—March to August 1919, March 1938 to September 1951.

Gage.—Water-stage recorder and concrete control. Datum of gage is 1,199.91 ft. above mean sea level, datum of 1929 (levels by Corps of Engineers). March to August 1919, staff gage at site half a mile upstream at different datum. March to Oct. 13, 1938, staff gage at present site and datum.

Average discharge.—13 years (1938-51), 142 cfs.; median of yearly mean discharge, 104 cfs.

Extremes.—Maximum discharge during year, 1,270 cfs. Apr. 17 (gage height, 8.08 ft.). minimum, 1.0 cfs. Nov. 4, 5 (gage height, 2.53 ft.).

1919, 1938-51: Maximum discharge, 4,580 cfs. Apr. 28, 1948 (gage height 17.51 ft.); no flow during several periods in 1938-41.

Remarks.—Records good. Flow regulated by Lake Ashtabula (see page——).

Revisions.—W : drainage area.

Month	Second Foot Days	Maximum	Minimum	Mean	Run-off in Acre-Feet
October	93.7	22	0.1	3.02	186
November	826	31	25	27.5	1,638
December	680	30	14	21.9	1,349
Calendar year 1949	54,286.6	2,110	.1	149	107,700
January	341.4	14	9.2	11.0	677
February	256.6	10	8.0	9.16	509
March	2,388.8	460	8.0	77.1	4,738
April	52,380	2,980	320	1,746	103,900
May	92,240	3,030	2,870	2,975	183,000
June	36,935	2,970	296	1,231	73,260
July	7,864	311	52	254	15,600
August	2,058.8	219	7.0	66.4	4,080
September	68.8	18	.1	2.29	136
Water year 1949-50	196,133.1	3,030	.1	537	389,100

Month	Second Foot Days	Maximum	Minimum	Mean	Run-off in Acre-Feet
October	408.5	63	5.3	13.2	810
November	919.8	60	1.1	30.7	1,820
December	824	28	24	26.6	1,630
Calendar year 1950	196,685.7	3,030	0.1	539	390,200
January	804	28	24	25.9	1,590
February	671	31	22	24.0	1,330
March	2,270	320	12	73.2	4,500
April	16,678	1,240	290	556	33,080
May	10,090	962	95	325	20,010
June	2,859	132	68	95.3	5,670
July	1,464	116	13	47.2	2,900
August	692	33	16	22.3	1,370
September	825	35	19	27.5	1,640
Water year 1950-51	38,505.3	1,240	1.1	105	76,350

RED RIVER OF THE NORTH BASIN

Sheyenne River Near Kindred, N. Dak.

Location.—Lat. 46°37′35″, long. 97°00′05″, in NE¼NW¼ sec. 5, T. 136 N., R. 50 W., near center of span on downstream side of Great Northern Railway bridge, 1½ miles southeast of Kindred and at mile 68.1.

Drainage area.—9,170 square miles (includes 3,940 square miles in closed Devils Lake Basin).

Records available.—July 1949 to September 1951.

Gage.—Wire-weight gage read once daily. Datum of gage is 929.16 ft. above mean sea level (Great Northern Railway bench mark).

Extremes.—Maximum discharge during year, 1,010 cfs. May 5 (gage height, 7.70 ft.); maximum gage height, 10.15 ft. Apr. 3 (affected by ice); minimum daily discharge, 35 cfs. Nov. 10 (gage height, 3.27 ft.), result of freezeup.

1949-51: Maximum discharge, 3,210 cfs. May 13, 14, 1950 (gage height, 20.50 ft.); minimum daily, 20 cfs Jan. 26-30, 1950; minimum gage height, 3.07 ft. Sept. 29, 30, 1949.

Flood of March and April 1947 reached a stage of 22.1 ft., from floodmarks (discharge, about 3,600 cfs,.

Remarks.—Records good except those for period of ice effect, which are fair. Flow regulated to a large degree by Lake Ashtabula (see page——) and several smaller reservoirs.

Month	Second Foot Days	Maximum	Minimum	Mean	Run-off in Acre-Feet
October	1,080	46	23	34.8	2,140
November	1,191	56	26	39.7	2,360
December	1,369	53	30	44.2	2,720
Calendar year					
January	920	35	20	29.7	1,820
February	810	30	25	28.9	1,610
March	6,220	1,000	30	201	12,340
April	47,250	2,420	820	1,575	93,720
May	94,630	3,210	2,470	3,053	187,700
June	58,132	3,080	542	1,938	115,300
July	12,443	674	246	401	24,680
August	5,405	294	80	174	10,720
September	1,722	78	43	57.4	3,420
Water year 1949-50	231,172	3,210	20	633	458,530

Month	Second Foot Days	Maximum	Minimum	Mean	Run-off in Acre-Feet
October	1,580	64	45	51.0	3,130
November	1,922	100	35	64.1	3,810
December	1,475	55	40	47.6	2,930
Calendar year 1950	232,509	3,210	20	637	461,200
January	1,550	50	50	50.0	3,070
February	1,400	50	50	50.0	2,780
March	2,705	450	45	87.3	5,370
April	20,481	930	413	683	40,620
May	16,444	1,000	204	530	32,620
June	5,531	260	153	184	10,970
July	3,936	258	66	127	7,810
August	1,829	106	51	59.0	3,630
September	2,137	143	55	71.2	4,240
Water year 1950-51	60,990	1,000	35	167	121,000

RED RIVER OF THE NORTH BASIN

Sheyenne River at West Fargo, N. Dak.

Location.—Lat. 46°53′20″, long. 96°54′55″, in sec. 31, T. 140 N., R. 49 W., on left bank 80 ft. downstream from county highway bridge, one mile north of West Fargo, 3 miles upstream from Maple River and at mile 24.5.

Drainage area.—9,270 square miles (includes 3,940 square miles in closed Devils Lake Basin).

Records available.—March 1902 to June 1907, March to August 1919, September 1929 to September 1951. Published as "at Haggart" 1902-07, 1919.

Gage.—Water-stage recorder. Datum of gage is 877.19 ft. above mean sea level, datum of 1929.

March 1902 to June 1907 and March to August 1919, staff gage at private bridge one fourth mile upstream at different datum. September 1929 to July 22, 1930, wire-weight gage at present site and datum.

July 22, 1930 to June 27, 1933, chain gage at present site and datum.

Average discharge.—22 years, 151 cfs.; median of yearly mean discharges, 130 cfs.

Extremes.—Maximum discharge during year, 1,020 cfs. Apr. 5 (gage height, 13.25 ft., affected by ice); minimum, 28 cfs. Aug. 8 (gage height, 2.92 ft.).

1902-07, 1919, 1929-51: Maximum discharge, 2,810 cfs. May 22, 1950; maximum gage height, 20.61 ft. May 11, 1950 (backwater from Maple River); minimum discharge, 2.0 cfs. Dec. 14, 1936 (gage height, 1.90 ft.).

Remarks.—Records good except those for period of ice effect, which are fair. Flow regulated to a large degree by Lake Ashtabula (see page——) beginning in August 1949, and several smaller reservoirs.

Revisions.—WSP drainage area.

Month	Second Foot Days	Maximum	Minimum	Mean	Run-off in Acre-Feet
October	1,031	44	19	33.3	2,040
November	1,269	61	26	42.3	2,520
December	1,397	58	40	45.1	2,770
Calendar year 1949	73,264	1,970	19	201	145,300
January	910	40	20	29.4	1,800
February	770	35	20	27.5	1,530
March	4,052	570	28	131	8,040
April	46,250	2,420	770	1,542	91,740
May	82,270	2,800	2,420	2,654	163,200
June	53,553	2,600	574	1,785	106,200
July	13,764	870	314	444	27,300
August	5,858	287	85	189	11,620
September	1,858	83	46	61.9	3,690
Water year 1949-50	212,982	2,800	19	584	422,400

Peak discharge (base, 500 sec.-ft.).—Apr. 8 (time and discharge unknown); May 22 (5 p. m.) 2,810 sec.-ft.; July 1 (1 p. m.) 883 sec.-ft.

Month	Second Foot Days	Maximum	Minimum	Mean	Run-off in Acre-Feet
October	1,632	64	44	52.6	3,240
November	1,952	100	40	65.1	3,870
December	1,685	70	45	54.4	3,340
Calendar year 1950	214,554	2,800	20	588	425,600
January	1,550	50	50	50.0	3,070
February	1,400	50	50	50.0	2,780
March	2,100	260	50	67.7	4,170
April	21,266	1,000	400	709	42,180
May	17,157	962	225	553	34,030
June	5,753	265	158	192	11,410
July	4,109	237	74	133	8,150
August	1,915	72	52	61.8	3,800
September	2,064	113	55	68.8	4,090
Water year 1950-51	62,583	1,000	40	171	124,100

RED RIVER OF THE NORTH BASIN

Maple River at Mapleton, N. Dak

Location.—Lat. 46°53′20″, long. 97°03′20″, in NE¼NE¼ Sec. 1, T. 139 N., R. 51 W., near center of downstream side of county highway bridge, in Mapleton, 10.5 miles upstream from mouth.

Drainage area.—1,480 square miles.

Records available.—April 1944 to September 1951.

Gage.—Wire-weight gage read once daily and loose rock dam. Datum of gage is 886.67 ft. above mean sea level, datum of 1929.

Average discharge.—7 years, 58.6 cfs.

Extremes.—Maximum discharge during year, 750 cfs. Apr. 7; maximum gage height, 14.15 ft., affected by ice; minimum not determined.

1944-51: Maximum discharge, 3,880 cfs. Apr. 14, 1947 (gage height, 18.04 ft.); no flow at times in most years.

Remarks.—Records fair. No regulation or diversion.

Month	Second Foot Days	Maximum	Minimum	Mean	Run-off in Acre-Feet
October	14.7	4.8	0	0.47	29
November	81.9	4.4	2	2.73	162
December	31.0	4	.1	1.00	6.1
Calendar year 1949	7,630.5	800	0	20.9	15,080
January	1.3	.1	0	.04	2.6
February	0	0	0	0	0
March	2,668	1,550	0	86.1	5,290
April	27,801	1,950	290	927	55,140
May	19,208	1,730	105	620	38,100
June	2,301	270	33	76.7	4,560
July	2,022	230	14	65.2	4,010
August	200.2	14	3.0	6.46	397
September	73.9	5.1	.4	2.46	147
Water year 1949-50	54,403.0	1,950	0	149	107,800

Month	Second Foot Days	Maximum	Minimum	Mean	Run-off in Acre-Feet
October	133.1	6.0	1.9	4.29	264
November	106.6	6.0	2	3.55	211
December	42.3	2	1	1.36	84
Calendar year 1950	54,557.4	1,950	0	149	108,200
January	22.0	1	.4	0.71	44
February	5.6	.....	.....	0.2	11
March	228.5	200	.....	7.37	453
April	7,024	740	32	234	13,930
May	500.0	36	6.0	16.1	992
June	347.1	23	4.5	11.6	688
July	352.5	17	4.5	11.4	699
August	186.6	19	4.3	6.02	370
September	324.3	20	3.2	10.8	643
Water year 1950-51	9,272.6	740	.....	25.4	18,390

RED RIVER OF THE NORTH BASIN

Rush River at Amenia, N. Dak.

Location.—Lat. 47°00′40″, long. 97°13′10″, on line between sec. 23 and 24, T. 141 N., R. 52 W., near center of span on upstream side of bridge on State Highway 18, 0.4 mile north of Amenia.

Drainage area.—107 square miles.

Records available.—July 1946 to September 1951.

Gage.—Wire-weight gage read once daily below 2.5 ft. gage height and twice daily above. Datum of gage is about 943 ft. above mean sea level, datum of 1929 (from railroad profile). Prior to Oct. 7, 1947, staff gage at site 150 ft. downstream at same datum.

Average discharge.—5 years, 14.2 cfs.

Extremes.—Maximum discharge during year, 368 cfs. Mar. 28 (gage height, 8.60 ft.); maximum gage height, 9.0 ft. Mar. 27, from floodmarks (affected by ice); no flow during several months.

1946-51: Maximum discharge, 1,230 cfs. Apr. 14, 1947; maximum gage height observed, 10.96 ft. Mar. 27, 1950 (affected by ice); no flow for some periods in each year.

Remarks.—Records fair.

Month	Second Foot Days	Maximum	Minimum	Mean	Run-off in Acre-Feet
October	0	0	0	0	0
November	1.1	.3	0	.04	2.2
December	0	0	0	0	0
Calendar year 1949	1,868.6	320	0	5.12	3,710
January	0	0	0	0	0
February	0	0	0	0	0
March	766	350	0	24.7	1,520
April	6,111	580	13	204	12,120
May	2,520.9	314	5.2	81.3	5,000
June	513.7	192	1.7	17.1	1,020
July	80.7	11	.3	2.60	160
August	.8	.3	0	.03	1.6
September	0	0	0	0	0
Water year 1949-50	9,994.2	580	0	27.4	19,820

Month	Second Foot Days	Maximum	Minimum	Mean	Run-off in Acre-Feet
October	4.6	0.3	0	0.15	9.1
November	4.5	0.3	0	0.15	8.9
December	0	0	0	0	0
Calendar year 1950	10,002.2	580	0	27.4	19,840
January	0	0	0	0	0
February	0	0	0	0	0
March	925	300	0	29.8	1,830
April	845.8	150	4.8	28.2	1,680
May	68.2	4.6	.6	2.20	135
June	91.7	11	.6	3.06	182
July	19.5	2.2	0	0.63	39
August	0	0	0	0	0
September	7.9	1.0	0	0.26	16
Water year 1950-51	1,967.2	300	0	5.39	3,900

RED RIVER OF THE NORTH BASIN

Goose River Near Portland, N. Dak.

Location.—Lat. 47°33′, long. 97°28′, on line between sec. 12 and 13, T. 147 N., R. 54 W., on upstream side of highway bridge, 1½ miles downstream from Beaver Creek and 6½ miles northwest of Portland.

Drainage area.—544 square miles.

Records available.—October 1939 to September 1951.

Gage.—Wire-weight gage read once daily. Datum of gage is 978.76 ft. above mean sea level, datum of 1929. Prior to July 14, 1951, chain gage at same site and datum.

Average discharge.—12 years, 35.5 cfs.; median of yearly mean discharges, 15 cfs.

Extremes.—Maximum discharge during year, 650 cfs. Mar. 30 (gage height, 12.5 ft); no flow July 13 to Sept. 30.

1939-51: Maximum discharge, 8,090 cfs. May 9, 1950; maximum gage height, 22.98 ft. Apr. 18, May 9, 1950; no flow for several months in each year.

Remarks.—Records fair.

Month	Second Foot Days	Maximum	Minimum	Mean	Run-off in Acre-Feet
October	1.9	0.1	0	0.06	3.8
November	4.0	.3	0	.13	7.9
December	3.7	.3	0	.12	7.3
Calendar year 1949	9,975.6	1,100	0	27.3	19,780
January	0	0	0	0	0
February	0	0	0	0	0
March	377	65	0	12.2	748
April	32,420	6,820	60	1,081	64,300
May	43,083	6,800	139	1,390	85,450
June	1,741	123	35	58.0	3,450
July	550.6	41	4.2	17.8	1,090
August	40.9	4.2	.4	1.32	81
September	16.3	1.6	.2	.54	32
Water year 1949-50	78,238.4	6,820	0	214	155,200

Peak discharge (base, 200 sec.-ft.).—Apr. 18 (4 p. m.) 7,620 sec.-ft.; May 9 (4 a. m.) 8,090 sec.-ft.

Month	Second Foot Days	Maximum	Minimum	Mean	Run-off in Acre-Feet
October	4.3	.2	.1	.14	8.5
November	18.4	.9	.2	.61	36
December	24.2	.8	.7	.78	48
Calendar year 1950	78,275.7	6,820	0	214	155,200
January	17.7	.7	.4	.57	35
February	11.2	.4	.4	.40	22
March	1,685.3	530	.3	54.4	3,340
April	2,820	400	14	94.0	5,590
May	188.8	14	1.1	6.09	374
June	56.9	11	.3	1.90	113
July	4.2	.6	0	.14	8.3
August	0	0	0	0	0
September	0	0	0	0	0
Water year 1950-51	4,831.0	530	0	13.2	9,570

RED RIVER OF THE NORTH BASIN

Goose River at Hillsboro, N. Dak.

Location.—Lat. 47°24′, long. 97°03′, in NW¼ sec. 5, T 145 N., R. 50 W., on left bank 50 feet upstream from Foogman Dam in Hillsboro, and 22 miles upstream from mouth.

Drainage area.—1,220 square miles (revised).

Records available.—March 1931 to September 1951 (no winter records prior to 1938).

Gage.—Water-stage recorder and concrete control. Prior to Apr. 3, 1940, chain gages at datum 11.45 ft. lower, Mar. 17, 1931 to Mar. 20, 1935 at site 1,000 ft. downstream and Mar. 21, 1935 to Apr. 3, 1940 at site 600 downstream. Mar. 29, 1940 to Sept. 25, 1941, staff gage at present site and datum.

Average discharge.—13 years (1938-51), 71.0 cfs., median of yearly mean discharges, 36 cfs.

Extremes.—Maximum discharge observed during year, 1,130 cfs. Mar. 31 (gage height, 3.48 ft.); no flow Sept. 26-30.

1931-51: Maximum discharge, 9,420 cfs. Apr. 19, 1950; maximum gage height, 14.94 ft. Apr. 19, 1950; no flow at times.

Remarks.—Records good Oct. 1 to Jan. 2, Apr. 5-22, May 3 to July 1, Sept. 25-30 and poor at other times.

Revisions (water year).—W925: 1935, 1936, 1939.

Month	Second Foot Days	Maximum	Minimum	Mean	Run-off in Acre-Feet
October	100.1	7.8	0.8	3.23	199
November	198.2	9.4	4.1	6.61	393
December	153.8	7.2	2.7	4.96	305
Calendar year 1949	22,934.2	1,550	.2	62.8	45,500
January	83.3	3.4	2.4	2.69	165
February	66.3	2.4	2.1	2.37	132
March	1,398.2	400	2.5	45.1	2,770
April	65,046	8,340	220	2,168	129,000
May	70,514	7,590	289	2,275	139,900
June	4,049	251	97	135	8,030
July	1,796	151	28	57.9	3,560
August	371.0	24	7.2	12.0	736
September	215.4	15	2.9	7.18	427
Water year 1949-50	143,991.3	8,340	.8	394	285,600

Peak discharge, (base, 200 sec.-ft.).—Mar. 28 (4 p. m.) about 440 sec.-ft.; Apr. 10 (7 a. m.) 2,100 sec.-ft.; Apr. 19 (noon) 9,420 sec.-ft.; May 10 (noon) 8,520 sec.-ft.

Month	Second Foot Days	Maximum	Minimum	Mean	Run-off in Acre-Feet
October	188.6	8.6	4.4	6.08	374
November	236.5	11	5.9	7.88	469
December	227.9	8.6	6.5	7.35	452
Calendar year 1950	144,192.2	8,340	--	395	286,000
January	194.3	7.2	------	6.27	385
February	162.8	------	------	5.81	323
March	2,856	1,000	------	92.1	5,660
April	8,679	1,100	45	289	17,210
May	850	55	11	27.4	1,690
June	431.4	22	8	14.4	856
July	111.9	7.1	------	3.61	222
August	49.0	9.1	------	1.58	97
September	128.7	13	0	4.29	255
Water year 1950-51	14,116.1	1,100	0	38.7	27,990

RED RIVER OF THE NORTH BASIN

Turtle River at Manvel, N. Dak.

Location.—Lat. 48°05′, long. 97°11′, in SE¼ sec. 10, T. 153 N., R. 51 W., on downstream side of bridge on State Highway 33, 0.3 mile west of Manvel and 10 miles upstream from mouth.

Drainage area.—602 square miles.

Records available.—October 1945 to September 1951.

Gage.—Chain gage read once daily below 14 ft. gage height and twice daily above. Datum of gage is 799.28 ft. above mean sea level, datum of 1929.

Average discharge.—6 years, 85.6 cfs.

Extremes.—Maximum discharge during year, 940 cfs. Apr. 6; maximum gage height, 14.80 ft. Apr. 2 (backwater from ice); minimum discharge, 1.7 cfs. July 29, but may have been less during period of ice effect.

1945-51: Maximum discharge, 28,000 cfs. Apr. 19, 1950 (gage height 21.5 ft., from floodmarks) on basis of contracted-opening determination of peak flow; no flow Jan. 16 to Apr. 10, 1950.

Remarks.—Records good except those for period of ice effect, which are fair.

Month	Second Foot Days	Maximum	Minimum	Mean	Run-off in Acre-Feet
October	206.5	12	.2	6.66	410
November	201.8	10	4	6.73	400
December	213	13	1	6.9	422
Calendar year 1949	14,445.2	1,600	.1	39.6	28,650
January	3.1	.8	0	.10	6.1
February	0	0	0	0	0
March	0	0	0	0	0
April	59,620	20,700	0	1,987	118,300
May	45,130	7,390	94	1,456	89,510
June	1,468	86	27	48.9	2,910
July	1,311	166	15	42.3	2,600
August	276.6	14	4.8	8.92	549
September	587.7	84	3.2	19.6	1,170
Water year 1949-50	109,017.7	20,700	0	299	216,200

Peak discharge (base, 200 sec.-ft.).—Apr. 19 (6 p. m.) 28,000 sec.-ft.; May 9 (7:30 p. m.) 7,930 sec.-ft.

Month	Second Foot Days	Maximum	Minimum	Mean	Run-off in Acre-Feet
October	518	25	11	16.7	1,030
November	412	20	9	13.7	817
December	140	----	----	4.5	278
Calendar year	109,466.4	20,700	0	300	217,130
January	158	----	----	5.1	313
February	56	----	----	2.0	111
March	1,277	400	----	41.2	2,530
April	6,330	800	39	211	12,560
May	747	39	12	24.1	1,480
June	424.3	21	8.0	14.1	842
July	122.5	7.4	1.7	3.95	243
August	371.8	64	4.0	12.0	737
September	1,243.8	195	5.4	41.5	2,470
Water year	11,800.4	800	----	32.3	23,410

RED RIVER OF THE NORTH BASIN

Forest River Near Fordville, N. Dak.

Location.—Lat. 48°12′, long. 97°44′ on line between sec. 32 and 33, T. 155 N., R. 55 W., on right bank 50 ft. upstream from highway bridge, half a mile downstream from South Branch, and 3 miles southeast of Fordville, N. Dak.

Drainage area.—500 square miles (revised).

Records available.—April 1940 to Sept. 1951.

Gage.—Water-stage recorder. Prior to July 21, 1951, chain gage at same site and datum.

Average discharge.—11 years, 47.4 cfs.; median of yearly mean discharges, 27 cfs.

Extremes.—Maximum discharge during year, about 500 cfs. Mar. 29; maximum gage height, 5.5 ft. Mar. 28 (affected by ice), minimum discharge, 4 cfs. July 11-20.

1940-51: Maximum discharge, 16,400 cfs. Apr. 18, 1950 (gage height, 14.48 ft. from floodmark) by contracted-opening and slope area method; no flow Apr. 1-13, Sept. 3, 1940.

Remarks.—Records fair except those for Mar. 26-29, which are poor.

Revisions (water years).—W1175: 1948.

Month	Second Foot Days	Maximum	Minimum	Mean	Run-off in Acre-Feet
October	262.9	29	4.3	8.48	521
November	221.8	8.7	5.9	7.39	440
December	201.9	8.2	5	6.51	400
Calendar year 1949	12,419.8	1,180	----	34.0	24,640
January	143	5	4	4.6	284
February	158	6	5	5.6	313
March	361	50	6	11.6	716
April	35,466	10,900	20	1,182	70,350
May	32,150	6,550	50	1,037	63,770
June	697	46	14	23.2	1,380
July	349.3	18	7.0	11.3	693
August	211.8	7	6	6.83	420
September	263.5	20	6	8.78	523
Water year 1949-50	70,486.2	10,900	4	193	139,800

Peak discharge (base, 200 sec.-ft.).—Apr. 18 (about 5 a. m.)16,400 sec.-ft.; May 8 (5:30 a.m.) 8,760 sec.-ft.; May 11 (6 a. m.) 4,880 sec.-ft.

Month	Second Foot Days	Maximum	Minimum	Mean	Run-off in Acre-Feet
October	257	9	8	8.3	510
November	260	9	8	8.7	516
December	259	9	8	8.4	514
Calendar year 1950	70,575.6	10,900	4	193	140,000
January	241	9	7	7.8	478
February	204	8	7	7.3	405
March	**1,766**	**450**	**8**	**57.0**	**3,500**
April	3,119	421	20	104	6,190
May	429	23	9	13.8	851
June	314	15	7	10.5	623
July	162	10	4	5.2	321
August	209	10	5	6.7	415
September	174	8	5	5.8	345
Water year 1950-51	7,394	450	4	20.3	14,670

RED RIVER OF THE NORTH BASIN

Forest River at Minto, N. Dak.

Location.—Lat. 48°16′10″, long. 97°22′10″, in SE¼ sec. 31, T. 156 N., R. 52 W., on downstream side of left approach span of street bridge one block east of Highway 81 and 450 ft. above dam, in Minto.

Drainage area.—740 square miles (revised).

Records available.—April 1944 to September 1951.

Gage.—Wire-weight gage read once daily. Altitude of gage is 807 ft. (from Great Northern Railway profile).

Average discharge.—7 years, 76.9 cfs.

Extremes.—Maximum discharge during year, 900 cfs. Apr. 5 (gage height, 3.6 ft.); Maximum gage height, 5.1 ft. Apr. 1 (affected by ice); minimum daily discharge, 3 cfs. Dec. 29 to Jan. 11.

1944-51: Maximum discharge, 17,000 cfs. Apr. 18, 1950 (gage height, 11.80 ft., from floodmarks), by contracted-opening method; no flow at times each year 1945-47.

Remarks.—Records fair except those for Mar. 28 to Apr. 2, which are poor.

Month	Second Foot Days	Maximum	Minimum	Mean	Run-off in Acre-Feet
October	174.0	14	0.3	5.61	345
November	209.0	8.9	6.3	6.97	415
December	155.0	8.9	1	5.00	307
Calendar year 1949	18,273.5	2,000	.3	50.1	36,240
January	21.7	.7	.7	.70	43
February	19.6	.7	.7	.70	39
March	24.7	1.3	.7	.80	49
April	49,930.8	12,200	1.7	1,664	99,040
May	49,740	7,660	102	1,605	98,660
June	1,624	97	36	54.1	3,220
July	878	46	14	28.3	1,740
August	249.5	12	6.3	8.05	495
September	267.8	19	4.8	8.93	531
Water year 1949-50	103,294.1	12,200	.3	283	204,900

Peak discharge (base 200 sec.-ft.).—Apr. 18 (about 8 p. m.) 17,000 sec.-ft.; May 8 (7:30 p. m.) 10,300 sec.-ft.

Month	Second Foot Days	Maximum	Minimum	Mean	Run-off in Acre-Feet
October	260.6	16	4.8	8.41	517
November	277.3	11	8	9.24	550
December	142	7	3	4.6	282
Calendar year 1950	103,436.0	12,200	0.7	283	205,200
January	113	4	3	3.6	224
February	126	5	4	4.5	250
March	968	400	4	31.2	1,920
April	5,960	850	42	199	11,820
May	849	42	18	27.4	1,680
June	465.6	20	9.8	15.5	924
July	200.9	8.9	4.1	6.48	398
August	288.9	14	6.3	9.32	573
September	252.7	17	4.8	8.42	501
Water year 1950-51	9,904.0	850	3	27.1	19,640

RED RIVER OF THE NORTH BASIN

South Branch Park River Near Park River, N. Dak.

Location.—Chain gage, lat. 48°24′, long. 97°50′, on line between sec. 15 and 16, T. 157 N., R. 56 W., at bridge on State Highway 32, half a mile upstream from small tributary and 4½ miles northwest of the town of Park River.

Drainage area.—214 square miles (revised).

Records available.—March 1940 to September 1950 (discontinued).

Extremes.—Maximum discharge observed during year, 5,970 sec.-ft. Apr. 19 (gage height, 10.1 feet); minimum, 0.1 sec.-ft. on many days.

1940-50: Maximum discharge, 11,000 sec.-ft. Apr. 18, 1948 (gage height, 11.80 feet), from rating curve extended above 6,600 sec.-ft.; no flow during part of some years.

Remarks.—Records good except those for periods of ice effect, doubtful gage-height record, or indefinite stage-discharge relation, which are poor. Gage read once daily.

Month	Second Foot Days	Maximum	Minimum	Mean	Run-off in Acre-Feet
October	39.6	2.7	.2	1.28	79
November	5.7	.4	.1	.19	11
December	3.5	.2	.1	.11	6.9
Calendar year 1949	8,077.3	1,110	0	22.1	16,020
January	3.1	.1	.1	.10	6.1
February	2.8	.1	.1	.10	5.6
March	32.1	4.0	.1	1.04	64
April	19,254.7	4,700	2.5	642	38,190
May	19,815	3,630	40	639	39,300
June	480.6	36	6.8	16.0	953
July	106.7	7.1	1.4	3.44	212
August	38.5	9.9	.6	1.24	76
September	11.9	.9	.1	.40	24
Water year 1949-50	39,794.2	4,700	.1	109	78,930

Peak discharge (base, 200 sec.-ft.).—Apr. 19 (about 2 a.m.) 5,970 sec.-ft.; Apr. 21 (11 p. m.) 2,680 sec.-ft.); May 1 (2 p. m.) 552 sec.-ft.; May 7 (10-12 p. m.) 4,460 sec.-ft.; May 19 (6 p. m.) 332 sec.-ft.

RED RIVER OF THE NORTH BASIN

Homme Reservoir Near Park River, N. Dak.

Location.—Lat. 48°24′20″, long. 97°47′10″, in SE¼NW¼ sec. 19, T. 157 N, R. 55 W., at Homme Dam on South Branch Park River 2 miles west of town of Park River.

Drainage area.—229 square miles.

Records available.—September 1949 to October 1951.

Gage.—Water-stage recorder. Datum of gage is mean sea level, datum of 1929.

Extremes.—Maximum contents during year, 3,736 acre-feet Apr. 30 (elevation, 1,080.40 ft.); minimum, 101 acre-feet October 28.

1949-51: Maximum contents, that of April 30, 1951; reservoir empty during part of 1950.

Remarks.—Reservoir is formed by an earth-fill dam 865 feet long; storage began September 1949; dam completed October 1950. Usable capacity between invert of outlet, elevation 1,048.0 feet, and crest of spillway, elevation 1,080.0 feet, is 3,500 acre-feet). Low flows are controlled by two sluice gates 3 feet by 5 feet. The spillway, which is 150 feet long, is uncontrolled. The records herein represent total contents. The reservoir is operated for the control of floods, for water supply, and pollution abatement during low-flow periods.

Cooperation.—Records furnished by Corps of Engineers.

Date	Elevation (feet)	Contents (acre - feet)	Change in contents During month (acre-feet)
Sept. 30	1,040.50	0	--
Oct. 31	1,046.39	70	+70
Nov. 30	1,048.00	100	+30
Dec. 31	1,048.25	110	+10
Calendar Year 1949			+110
Jan. 31	1,048.25	110	0
Feb. 28	1,048.25	110	0
Mar. 31	1,048.70	120	+10
Apr. 30	1,039.65	0	—120
May 31	1,036.03	0	0
June 30	1,035.75	0	0
July 31	1,036.37	0	0
Aug. 31	1,046.19	60	+60
Sept. 30	1,048.35	110	+50
Water Year 1949-50			+110

Date	Elevation (feet)	Contents (acre - feet)	Change in contents During month (acre-feet)
Sept. 30	1,048.35	110	
Oct. 31	1,048.05	102	—8
Nov. 30	1,049.36	141	+39
Dec. 31	1,049.36	141	0
Calendar Year 1950			+31
Jan. 31	1,049.36	141	0
Feb. 28	1,049.36	141	0
Mar. 31	1,064.20	1,100	+959
Apr. 30	1,080.40	3,736	+2,636
May 31	1,080.00	3,660	—76
June 30	1,079.80	3,622	—38
July 31	1,079.65	3,593	—29
Aug. 31	1,079.96	3,652	+59
Sept. 30	1,066.30	1,325	—2,327
Water Year 1950-51			+1,215

RED RIVER OF THE NORTH BASIN

South Branch Park River Below Homme Dam, N. Dak.

Location.—Lat. 48°24′, long. 97°47′ in SE¼ sec. 19, T 157 N, R. 55 W., half a mile downstream from Homme Dam, 2 miles west of town of Park River.

Drainage area.—229 square miles.

Records available.—December 1949 to September 1951.

Gage.—Water-stage recorder. Datum of gage is 1,000.00 ft. above mean sea level, datum of 1929.

Extremes.—Maximum discharge during year, about 900 cfs. Apr. 4 (gage height 28.42 ft., affected by ice); minimum discharge, 0.4 cfs. Aug. 9-13.

1949-51: Maximum discharge, about 13,000 cfs. Apr. 24, 1950, result of failure of emergency embankment at site of Homme Dam (gage height, 37.52 ft.), from rating curve extended above 5,500 cfs., no flow Dec. 1-3, 1949

Remarks.—Records good above 10 cfs. and fair below.

Month	Second Foot Days	Maximum	Minimum	Mean	Run-off in Acre-Feet
October					
November					
December	13.8	.7	0	.45	27
Calendar Year					
January	15.5			.5	31
February	16.5	.7	.5	.59	33
March	68.6	9	.7	2.21	136
April	22,479.5	4,330	4	749	44,590
May	21,881	3,940	46	706	43,400
June	639	42	10	21.3	1,270
July	210.9	14	.4	6.80	418
August	83.9	35	.2	2.71	166
September	23.8	5.0	.1	.79	47
The period					90,120

Peak discharge, (base 200 sec.-ft.).—Apr. 18 (9 p. m.) 5,200 sec.-ft.; Apr. 24 (11 a. m.) 13,000 sec.-ft.; May 1 (9 p. m.) 546 sec.-ft.; May 8 (3 a. m.) 5,030 sec.-ft.; May 20 (3 a. m.) 352 sec.-ft.

Month	Second Foot Days	Maximum	Minimum	Mean	Run-off in Acre-Feet
October	42.4	3.2	.8	1.37	84
November	85.9	10	.6	2.86	170
December	57.8			1.86	115
Calendar year 1950					
January	49.6			1.6	98
February	44.8			1.6	89
March	252.0	150		8.13	500
April	2,812.4	700	4	93.7	5,580
May	302.5	33	1.2	9.76	600
June	102.5	8.7	1.1	3.42	203
July	29.8	1.9	.5	0.96	59
August	31.0	4.1	.4	1.00	61
September	1,086.5	105	1.7	36.2	2,160
Water year 1950-51	4,897.2	700	0.4	13.4	9,720

RED RIVER OF THE NORTH BASIN

Park River at Grafton, N. Dak.

Location.—Lat. 48°25′, long. 97°24′ in NE¼ sec. 13, T. 157 N., R. 53 W., on upstream side of Wakeman Ave. bridge in Grafton, 3.5 miles downstream from South Branch.

Drainage area.—742 square miles.

Records available.—April 1931 to September 1951 (incomplete prior to 1937).

Gage.—Wire-weight gage read once daily, with additional readings at high stages. Temporary staff gage half a mile downstream used Oct. 29 to Mar. 30. Rubble masonry control dam 2 miles downstream. Datum of gage is 807.39 ft. above mean sea level, datum of 1929.

Prior to Sept. 30, 1940, chain gage at present site and datum. Oct. 1, 1940 to Sept. 17, 1946, staff gage at site 2 miles downstream above control dam, at same datum. Sept. 18, 1946 to May 24, 1949, on downstream side of Wakeman Ave. bridge, at same datum.

Average discharge.—15 years (1936-51), 66.0 cfs.; median of yearly mean discharges, 36 cfs.

Extremes.—Maximum discharge during year, 1,640 cfs. Apr. 6 (gage height, 13.34 ft.); no flow July 16-29, Aug. 3-5, 24.

1931-51: Maximum discharge, 12,600 cfs. Apr. 19, 1950, from rating curve extended above 9,000 cfs. (gage height, 20.13 ft.); no flow at times in most years.

Remarks.—Records fair above 10 cfs. and poor below. Partly regulated by Homme Reservoir beginning September 1949 (see page——) and several small reservoirs.

Revisions (water year).—W955: 1941; W. 1, 175 Drainage area.

Month	Second Foot Days	Maximum	Minimum	Mean	Run-off in Acre-Feet
October	12.0	1.8	0	.39	24
November	5.6	.2	.1	.19	11
December	3.1	.1	.1	.10	6.1
Calendar year 1949	25,152.9	2,500	0	689	49,890
January	3.1	.1	.1	.10	6.1
February	2.8	.1	.1	.10	5.6
March	5.3	.5	.1	.17	11
April	61,530.3	11,700	.5	2,051	122,000
May	64,196	8,370	160	2,071	127,300
June	1,949	141	33	650	3,870
July	657.3	45	6.1	21.2	1,300
August	401.0	101	.1	12.9	795
September	37.7	4.1	.3	1.26	75
Water year 1949-50	128,803.2	11,700	.1	353	255,400

Peak discharge (base 200 sec.-ft.)—Apr. 19 (6-11 a. m.) 12,600 sec.-ft.; May 9 (3 p. m.) 8,730 sec.-ft.

Month	Second Foot Days	Maximum	Minimum	Mean	Run-off in Acre-Feet
October	67.7	2.9	1.7	2.18	134
November	48.3	2.7	1.5	1.61	96
December	65.5	2.2	1.5	2.11	130
Calendar year 1950	128,964.0	11,700	0.1	353	255,700
January	34.2	1.8	.8	1.10	68
February	15.9	.8	.4	0.57	32
March	375.3	200	.4	12.1	744
April	9,934	1,520	63	331	19,700
May	1,048.7	103	6.0	33.8	2,080
June	193.0	14	.9	6.43	383
July	21.9	8.3	0	0.71	43
August	92.4	19	0	2.98	183
September	1,239.3	131	1.0	41.3	2,460
Water year 1950-51	13,136.2	1,520	0	36.0	26,050

RED RIVER OF THE NORTH BASIN

Pembina River Near Manitou, Manitoba

Location.—Lat. 49°08′50″, long. 98°33′30″, on bridge near the Lea's farm, 9 miles south of Manitou.

Drainage area.—2,090 square miles.

Records available.—October 1929 to September 1951 (no winter records) in reports of Geological Survey. April 1921 to September 1951 in reports of Water Resources Division, Department of Resources and Development, Canada.

Gage.—Chain gage, read once daily.

Extremes.—Maximum daily discharge during year, 642 cfs Apr. 5 (gage height, 95.95 ft.); minimum discharge not determined.

1921-51: Maximum daily discharge, 5,030 cfs. Apr. 17, 1949 (gage height, 101.68 ft.); no flow on many days in 1934, 1937, 1939-41.

Remarks.—Records good except those for period of ice effect, which are poor. Gage read once daily.

Revisions.—W : drainage area.

Cooperation.—Records furnished by Water Resources Division, Department of resources and Development, Canada.

MONTHLY DISCHARGE OF PEMBINA RIVER AT MANITOU, MANITOBA

Month	Second-foot-days	Discharge in second-feet				Run-off	
		Max.	Min.	Mean	Per sq. mile	Inches	Acre-ft.
October	943.4	44.0	23.0	30.4	0.01	0.01	1,870
November 1-18	395.4	29.6	17.0	22.0	0.01	0.01	784
April	20,174	2,660	10	672	0.32	0.36	40,000
May	40,920	1,950	1,010	1,320	0.63	0.73	81,200
June	26,265	1,200	639	876	0.42	0.47	52,100
July	13,506	613	318	436	0.21	0.24	26,800
August	9,235	399	207	298	0.14	0.16	18,300
September	5,132	206	138	171	0.08	0.09	10,200
Water year 1949-50							

Note.—Stage-discharge relation affected by ice Nov. 16-18, Apr. 1-17.

Month	Second Foot Days	Maximum	Minimum	Mean	Run-off in Acre-Feet
October	3,313	142	81	107	6,570
November 1-10	700	77	67	70	1,390
December					
Calendar year					
January					
February					
March 28-31	410	200	20	102	813
April	14,246	642	250	475	28,260
May	12,368	508	282	399	24,530
June	5,829	269	143	194	11,560
July	2,450.6	137	48.2	79	4,860
August	1,128.1	54	26.0	36.4	2,240
September	568.0	26.0	14.0	18.9	1,130
Water year 1950-1951					

RED RIVER OF THE NORTH BASIN

Pembina River Near Walhalla, N. Dak.

Location.—Lat. 48°53′32″, long. 97°59′09″, in SE¼SW¼ sec. 35, T. 163 N., R. 57 W., on left bank 1½ miles downstream from Little Pembina River and 3½ miles southwest of Walhalla.

Drainage area.—3,109 square miles.

Records available.—October 1939 to September 1951.

Gage.—Water-stage recorder. Altitude of gage is 960 ft. (from Corps of Engineers dam site plat). Prior to Oct. 24, 1941, staff gage at same site and datum. Oct. 24, 1941 to Nov. 10, 1943, chain gage at same site and datum.

Average discharge.—12 years, 242 cfs.; median of yearly mean discharges, 200 cfs.

Extremes.—Maximum discharge during year, 2,310 cfs. Apr. 5 (gage height, 8.22 ft.).; minimum discharge, 20 cfs. Feb. 11-24, Mar. 5-23; minimum gage height, 2.46 ft. Sept. 22-23.

1939-51: Maximum discharge, 20,400 cfs. Apr. 18, 1950 (gage height, 19.2 ft.); no flow during parts of 1940, 1941, 1947.

Remarks.—Records good except those for period of ice effect, which are fair.

Revisions.—W : drainage area.

Month	Second Foot Days	Maximum	Minimum	Mean	Run-off in Acre-Feet
October	1,393	67	35	44.9	2,760
November	1,002	42	24	33.4	1,990
December	595	30	13	19.2	1,180
Calendar year 1949	159,363	5,740	4	437	316,100
January	392	14	12	12.6	778
February	302	12	8	10.8	599
March	531	50	8	17.1	1,050
April	64,031	13,800	50	2,134	127,000
May	95,490	7,590	1,570	3,080	189,400
June	33,039	1,530	797	1,101	65,530
July	17,968	884	396	580	35,640
August	11,617	586	251	375	23,040
September	6,125	294	146	204	12,150
Water year 1949-50	232,485	13,800	8	637	461,100

Peak discharge (base, 800 sec.-ft.).—Apr. 18 (6 a. m.) 20,400 sec.-ft.; May 9 (9:30 p. m.) 12,000 sec.-ft.; July 15 (1:30 a. m.) 1,660 sec.-ft.

Month	Second Foot Days	Maximum	Minimum	Mean	Run-off in Acre-Feet
October	4,001	157	99	129	7,940
November	2,244	99	36	74.8	4,450
December	810	33	25	26.1	1,610
Calendar year 1950	236,550	13,800	8	648	469,200
January	765	26	22	24.7	1,520
February	606	30	20	21.6	1,200
March	2,522	600	20	81.4	5,000
April	24,496	1,730	557	817	48,590
May	14,577	649	334	470	28,910
June	7,679	334	179	256	15,230
July	3,228	179	56	104	6,400
August	1,659	91	40	53.5	3,290
September	943	47	24	31.4	1,870
Water year 1950-51	63,530	1,730	20	174	126,000

RED RIVER OF THE NORTH BASIN

Pembina River at Neche, N. Dak.

Location.—Lat. 48°59′20″, long. 97°33′05″, in SE¼NW¼ sec. 31, T. 164 N., R. 53 W., on right bank, 2 blocks east of State Highway 18 at north edge of Neche.

Drainage area.—3,189 square miles.

Records available.—May 1903 to September 1915, April 1919 to September 1951.

Gage.—Water-stage recorder and concrete control. Altitude of gage is 805 ft. from topographic map). Prior to May 24, 1932 staff gage at Great Northern Railway bridge 1 mile upstream, at same datum. May 25, 1932 to Apr. 17, 1939, chain gage on State Highway 18 bridge 500 ft. downstream from railway bridge, at same datum.

Average discharge.—34 years (1907-08, 1914-15, 1919-51), 153 cfs.; median of yearly mean discharges, 119 cfs.

Extremes.—Maximum discharge during year, 2000 cfs. Apr. 7 (gage height, 14.95 ft., affected by ice; minimum, 23 cfs. Feb. 16-23 (gage height, 5.91 ft.).

1903-15, 1919-51: Maximum discharge, 10,700 cfs. Apr. 20, 1950 (gage height, 21.58 ft., affected by ice, from rating curve extended above 5,300 second-feet); no flow at times during each year 1932-41.

Remarks.—Records excellent except those for period of solid ice cover, which are good, and those for period of ice break-up (Mar. 30 to Apr. 10) which are fair.

Cooperation.—This station is one of the international gaging stations maintained by the United States under agreement with Canada.

Revisions.—W : drainage area.

Month	Second Foot Days	Maximum	Minimum	Mean	Run-off in Acre-Feet
October	1,756	71	46	56.6	3,480
November	1,250	51	23	41.7	2,480
December	552	36	9	17.8	1,090
Calendar year 1949	160,776	4,910	9	440	318,900
January	273	10	7	8.8	541
February	197	8	7	7.0	391
March	297	14	7	9.6	589
April	54,115	7,700	7	1,804	107,300
May	89,510	5,170	1,750	2,886	177,500
June	36,335	1,690	854	1,211	72,070
July	18,549	828	424	598	36,790
August	12,656	612	277	408	25,100
September	6,675	270	179	222	13,240
Water year 1949-50	222,165	7,700	7	609	440,600

Peak discharge (base, 900 sec.-ft.).—Apr. 20 (9:30 a. m.) 10,700 sec.-ft.; May 12 (5 a. m.) 5,320 sec.-ft.

Month	Second Foot Days	Maximum	Minimum	Mean	Run-off in Acre-Feet
October	4,707	172	133	152	9,340
November	2,634	128	51	87.8	5,220
December	1,158	45	34	37.4	2,300
Calendar year 1950	227,106	7,700	7	622	450,400
January	976	36	29	31.5	1,940
February	700	29	23	25.0	1,390
March	1,190	400	25	38.4	2,360
April	25,336	1,950	400	845	50,250
May	15,893	681	360	513	31,520
June	7,967	346	182	266	15,800
July	3,725	179	73	120	7,390
August	2,087	89	55	67.3	4,140
September	1,458	67	36	48.6	2,890
Water year 1950-51	67,831	1,950	23	186	134,500

RED RIVER OF THE NORTH BASIN

Tongue River at Cavalier, N. Dak.

Location.—Lat. 48°47′55″, long. 97°37′35″, in SE¼NE¼ sec. 4, T. 161 N., R. 54 W., on left abutment of dam half a mile upstream from (3 blocks west of) State Highway 5 in Cavalier.

Drainage area.—153 square miles.

Records available.—October 1938 to October 1951 (discontinued).

Gage.—Staff gage, read once daily, and concrete control. Datum of gage is 880.98 feet above mean sea level, datum of 1929, Emerson Crookston Supplementary Adjustment of 1941.

Prior to Sept. 30, 1946, wire-weight or chain gage at site .5 mile downstream at datum 11.74 ft. lower.

Average discharge.—13 years, 21.3 cfs.; median of yearly mean discharges, 19.5 cfs.

Extremes.—Maximum discharge observed during year, 420 cfs. Apr. 5 (gage height, 2.6 ft.); minimum, 0.4 cfs. July 24, 25, Sept. 21-25.

1938-51—Maximum discharge, 1,340 cfs. May 8, 1950 (gage height, 4.58 ft.); no flow for several months in some years.

Remarks.—Records good above 10 cfs. and fair below, except periods of ice effect or no gage-height record, which are poor.

Revisions.—W : drainage area.

Month	Second Foot Days	Maximum	Minimum	Mean	Run-off in Acre-Feet
October	159.0	12	.4	5.13	315
November	114.7	7.9	2.5	3.82	228
December	40.4	4.5	.5	1.30	80
Calendar year 1949	6,776.0	676	.....	18.6	13,430
January	10.8	.....	.....	.35	21
February	7.1	.....	.....	.25	14
March	16.3	.....	.....	.53	32
April	5,344	899	1	178	10,600
May	12,582	1,240	91	406	24,960
June	1,366	102	21	45.5	2,710
July	441.6	27	4.5	14.2	876
August	90.3	6.0	1.5	2.91	179
September	112.6	7.9	.7	3.75	223
Water year 1949-50	20,284.8	1,240	.....	55.6	40,240

Peak discharge (base, 200 sec.-ft.).—Apr. 18 (noon) 828 sec.-ft.; Apr. 22 (5 p. m.) 1,100 sec.-ft.; May 2 (4 p. m.) 240 sec.-ft.; May 8 (12:30 p. m.) 1,340 sec.-ft.; May 20 (2 p. m.) 523 sec.-ft.

Month	Second Foot Days	Maximum	Minimum	Mean	Run-off in Acre-Feet
October	163.8	7.9	3.1	5.28	325
November	117.7	6.0	.	3.92	233
December	70.7	3.0	.....	2.28	140
Calendar year 1950	20,322.9	1,240	.....	55.7	40,310
January	49.7	.....	.....	1.60	99
February	28.0	.....	.....	1.00	56
March	837.0	300	. .	27.0	1,660
April	3,180	393	38	106	6,310
May	605.2	77	1.1	19.5	1,200
June	229.6	14	4.0	7.65	455
July	61.2	4.0	.4	1.97	121
August	122.9	8.9	1.1	3.96	244
September	76.1	6.9	.4	2.54	151
Water year 1950-51	5,541.9	393	0.4	15.2	10,990

RED RIVER OF THE NORTH BASIN

Souris River Near Sherwood, N. Dak.
(International Gaging Station)

Location.—Lat. 48°59′, long. 101°58′, in NE¼ Sec. 33, T. 164 N., R. 87 W., on right bank three-quarters of a mile south of international boundary and 16 miles northwest of Sherwood.

Drainage area.—9,570 square miles.

Records available.—March 1930 to September 1951.

Gage.—Water-stage recorder and concrete control. Datum of gage is 1,604.00 ft. above mean sea level, datum of 1929. Prior to Apr. 8, 1935, staff gage at same site and datum.

Average discharge.—17 years (1934-51), 106 cfs. median of yearly mean discharges, 78 cfs.

Extremes.—Maximum discharge during year, 2,680 cfs. May 10 (gage height, 19.23 ft.); minimum, 4 cfs. Nov. 24, 25, 30, Dec. 1; minimum gage height, 1.59 ft. Oct. 6, Nov. 16.

1930-51: Maximum discharge, 7,400 cfs. Apr. 28, 1948 (gage height, 23.80 ft.); no flow for periods in each year 1930-42, 1946.

Maximum stage known, that of Apr. 28, 1948. Flood in 1927 reached a stage of about 22 ft., from information by local residents.

Remarks.—Records excellent except those for period of ice effect, which are fair. Slight regulation by small reservoirs in Canada. Some small diversions for irrigation.

Cooperation.—This is one of the international gaging stations maintained by the United States under agreement with Canada.

Month	Second Foot Days	Maximum	Minimum	Mean	Run-off in Acre-Feet
October	196.9	14	3.0	6.35	391
November	298.3	31	5.7	9.94	592
December	131.9	5.5	3	4.25	262
Calendar year 1949	30,626.4	2,700	1	83.9	60,740
January	93	3	3	3.0	184
February	76	3	2	2.7	151
March	1,721	280	2	55.5	3,410
April	26,692	1,600	300	890	52,940
May	9,904	588	169	319	19,640
June	4,025	257	88	134	7,980
July	1,895	108	36	61.1	3,760
August	1,216	95	21	39.2	2,410
September	395.8	29	4.0	13.2	785
Water year 1949-50	46,644.9	1,600	2	128	92,500

Month	Second Foot Days	Maximum	Minimum	Mean	Run-off in Acre-Feet
October	279.9	25	5.2	9.03	555
November	263.5	15	4	8.78	523
December	171	6	4	5.5	339
Calendar year 1950	46,732.2	1,600	2	128	92,680
January	189	11	5	6.1	375
February	147	6	5	5.2	292
March	200	7	5	6.5	397
April	35,902	2,250	7	1,197	71,210
May	45,031	2,680	288	1,453	89,320
June	4,588	263	73	153	9,100
July	1,203	71	17	38.8	2,390
August	653	49	13	21.1	1,300
September	428.7	22	6.7	14.3	850
Water year 1950-51	89,056.1	2,680	4	244	176,700

RED RIVER OF THE NORTH BASIN

Lake Darling Near Foxholm, N. Dak.

Location.—Lat. 48°27′, long. 101°35′ in NE¼NE¼ sec. 1, T. 157 N., R. 85 W., on control structure of Lake Darling Dam, reservoir of Fish and Wildlife Service, on Souris River, about 6 miles north of Foxholm, and at mile 82.9 downstream from Canadian border (U.S.G.S. river plan and profile).

Drainage area.—10,100 square miles.

Records available.—April 1937 to September 1951.

Gage.—Staff gage, read about once a week, oftener during April and May. Datum of gage is 1,577.00 feet above mean sea level (Fish and Wildlife Service bench mark).

Extremes.—Maximum gage height observed during year, 21.50 ft. May 16; minimum observed 14.70 ft. Apr. 3

1937-51: Maximum gage height observed, 22.83 ft. Apr. 23, 24, 1943; minimum observed, 1.53 ft. Mar. 1, 1938.

Remarks.—Reservoir is formed by concrete dam; storage began in April 1936; dam complete in July 1936. Capacity, 128,500 acre-feet between gage heights 0.0 ft. (sill of control gates) and 23.0 ft. (top of 2-foot flashboards). Dead storage 3,500 acre-feet. Water is used during periods of low flow at wildlife refuges downstream.

Cooperation.—Gage-height record furnished by Fish and Wildlife Service.

Date	Elevation (feet)	Contents (acre - feet)	Change in contents During month or year (acre-feet)
Sept. 30	16.7	73,000	
Oct. 31	16.1	67,800	—5,200
Nov. 30	15.4	62,200	—5,600
Dec. 31	15.3	61,400	—800
Calendar year 1949			—12,400
Jan. 31	15.0	59,000	—2,400
Feb. 28	15.0	59,000	0
Mar. 31	14.8	57,600	—1,400
Apr. 30	19.7	99,300	+41,700
May 31	18.8	91,200	—8,100
June 30	18.7	90,300	—900
July 31	18.5	88,500	—1,800
Aug. 31	18.4	87,600	—900
Sept. 30	18.1	84,900	—2,700
Water-year 1949-50			+11,900

Note: Listed gage heights are interpolations between weekly readings.

LAKE DARLING NEAR FOXHOLM, N. DAK.

Monthly gage heights and contents, water year October 1950 to September 1951

Date	Elevation (feet)	Contents (acre - feet)	Change in contents During month (acre-feet)
Sept. 30	18.10	84,900	
Oct. 31	18.10	84,900	0
Nov. 30	17.60	80,600	—4,300
Dec. 31	16.96	75,200	—5,400
Calendar year 1950			+13,800
Jan. 31	15.78	65,200	—10,000
Feb. 28	15.60	63,800	—1,400
Mar. 31	15.11	59,900	—3,900
Apr. 30	19.10	93,900	+34,000
May 31	18.46	88,100	—5,800
June 30	18.36	87,200	—900
July 31	17.95	83,600	—3,600
Aug. 31	17.90	83,200	—400
Sept. 30	17.75	81,900	—1,300
Water year 1950-51			—3,000

Note.—Listed gage heights are interpolations between weekly readings.

RED RIVER OF THE NORTH BASIN

Souris River Near Foxholm, N. Dak.

Location.—Lat. 48°22′, long. 101°30′, in SW¼SE¼ sec. 34 T. 157 N, R. 84 W., on left bank 30 ft. upstream from county highway bridge, 3 miles east of Foxholm, and at mile 98.3 downstream from Canadian border (U.S.G.S. river plan and profile).

Drainage area.—10,100 square miles.

Records available.—June 1904 to November 1905, April 1937 to September 1951.

Gage.—Water-stage recorder and concrete control. Datum of gage is 1,560.73 feet above mean sea level, datum of 1929. Prior to Mar. 25, 1938, staff gage at site 600 ft. downstream, at datum about half foot higher. June 23, 1904 to Nov. 28, 1905, staff gage at site 4 miles upstream at different datum.

Average discharge.—14 years (1937-51), 107 cfs. (unadjusted); median of yearly mean discharges, 52 cfs.

Extremes.—Maximum discharge during year, 2,120 cfs. May 14 (gage height, 13.98 ft.); minimum, 1.0 cfs. Aug. 26-28 (gage height, 5.15 ft).

1904-5, 1937-51: Maximum discharge, 3,040 cfs. May 16, 1948 (gage height, 14.79 ft.); maximum reverse flow, 25 cfs. Apr. 4, 1949; no flow at times in many years.

Remarks.—Records good except those for period of ice effect, which are fair. Flow completely regulated since 1936 by Lake Darling (see preceding page) and several smaller reservoirs (combined capacity, 133,000 ac.-ft.). Some small diversions in Canada.

Month	Second Foot Days	Maximum	Minimum	Mean	Run-off in Acre-Feet
October	1,173.6	59	3.2	37.9	2,330
November	4,071	222	48	136	8,070
December	1,269	82	5	40.9	2,520
Calendar year 1949	38,866.9	681	—5	106	77,100
January	589	24	14	19.0	1,170
February	387	18	10	13.8	768
March	213	10	5	6.9	422
April	13,178	1,280	2	439	26,140
May	17,397	1,150	262	558	34,330
June	3,362.4	272	2.0	112	6,670
July	2,644.9	169	4.4	85.3	5,250
August	183.2	21	1.0	5.91	363
September	177.4	19	.8	5.91	352
Water year 1949-50	44,555.5	1,280	.8	122	88,380

Month	Second Foot Days	Maximum	Minimum	Mean	Run-off in Acre-Feet
October	285.2	91	2.7	9.20	566
November	3,654	138	89	122	7,250
December	4,167	138	130	134	8,270
Calendar year 1950	46,148.1	1,280	.8	126	91,600
January	4,065	141	124	131	8,060
February	928.6	120	2.3	33.2	1,840
March	2,818	400	14	90.9	5,590
April	18,879	1,030	14	629	37,450
May	51,198	2,100	558	1,652	101,500
June	5,048	1,110	27	168	10,010
July	740.0	136	6.5	23.9	1,470
August	677.0	130	1.0	21.8	1,340
September	196.4	68	1.2	6.55	390
Water year 1950-51	92,656.2	2,100	1.0	254	183,700

RED RIVER NEAR THE NORTH BASIN

Souris River Above Minot, N. Dak

Location.—Lat. 48°14′45″, long. 101°22′15″, near center of Sec. 17, T. 155 N., R. 83 W., on right bank 180 ft. downstream from county highway bridge, 3½ miles west of Minot, 7 miles downstream from Des Lacs River, and at mile 124.1 downstream from Canadian border (U.S.G.S. river plan and profile.)

Drainage area.—11,300 square miles.

Records available.—May 1903 to March 1924, April 1927 to September 1928, and October 1929 to September 1951, in reports of Geological Survey. May 1903 to September 1951 in reports of State Engineer.

Gage.—Water-stage recorder and concrete control. Datum of gage is 1,545.75 ft. above mean sea level, datum of 1929. Prior to Oct. 1, 1934, staff or chain gage at mile 135.0 in Minot, at datum 12.5 ft. lower. Records equivalent except those for periods of extreme low flow, as some industrial and sanitary waste enters river between the two sites.

Average Discharges.—38 years (1913-51), 128 cfs (unadjusted); median of yearly mean discharges, 85 cfs.

Extremes.—Maximum discharge during year, 2,280 cfs. May 16, maximum gage height, 14.81 ft. Apr. 8 (affected by ice); minimum discharge, 10 cfs. Feb. 22-24; minimum gage height, 4.31 ft. Oct. 20.

1903-51: Maximum discharge, 12,000 cfs. Apr. 20, 1904 (gage height, 21.9 ft. at site at Minot), from rating curve extended above 8,100 cfs; no flow at times in some years.

Maximum stage known at present site, about 23 feet in April 1904.

Remarks.—Records good except those for period of ice effect, which are fair. Flow almost completely regulated by Lake Darling and several smaller reservoirs (combined capacity, 143,000 ac.-ft.). Some small diversions in Canada.

Month	Second Foot Days	Maximum	Minimum	Mean	Run-off in Acre-Feet
October	1,135.0	57	6.0	36.6	2,250
November	4,212	215	73	140	8,350
December	1,376	81	8	44.4	2,730
Calendar year 1949	57,027.4	2,200	1	156	113,100
January	580	20	12	18.7	1,150
February	459	20	14	16.4	910
March	649	120	10	20.9	1,290
April	21,462	1,340	45	715	42,570
May	24,337	1,280	320	785	48,270
June	5,310	323	79	177	10,530
July	3,770	198	32	122	7,480
August	905.7	66	9.7	29.2	1,800
September	709.1	66	8.7	23.6	1,410
Water year 1949-50	64,904.8	1,340	6.0	178	128,700

Note.—Stage-discharge relation affected by ice Dec. 8 to Apr. 17. No gage-height record Nov. 18-30, Dec. 8-20, Dec. 24 to Jan. 16, Jan. 21 to Feb. 13, Feb. 15 to Mar. 13, Mar. 16-26, Apr. 8-12; discharge computed on basis of 8 discharge measurements, contiguous gage heights, weather records and records for Des Lacs River at Foxholm and station near Foxholm.

Month	Second Foot Days	Maximum	Minimum	Mean	Run-off in Acre-Feet
October	883	47	15	28.5	1,750
November	3,760	140	93	125	7,460
December	4,330	150	130	140	8,590
Calendar year 1950	67,154.8	1,340	8.7	184	133,200
January	4,240	140	130	137	8,410
February	1,295	130	10	46.2	2,570
March	2,319	360	15	74.8	4,600
April	35,186	2,150	319	1,173	69,790
May	56,290	2,280	660	1,816	111,600
June	8,551	1,410	113	285	16,960
July	2,020	213	28	65.2	4,010
August	1,386	131	24	44.7	2,750
September	937	75	21	31.2	1,860
Water year 1950-51	121,197	2,280	10	332	240,400

RED RIVER OF THE NORTH BASIN

Souris River Near Verendrye, N. Dak

Location.—Lat. 48°09′, long. 100°44′, in NW¼SW¼ sec. 17, T. 154 N., R. 78 W., on left bank 2.7 miles north of Verendrye and 7½ miles southwest of (19 miles upstream from) mouth of Wintering River, at mile 210.5 downstream from Canadian border (U.S.G.S. river plan and profile).

Drainage area.—12,200 square miles.

Records available.—February to June 1933 (gage heights only), April 1937 to September 1951 (winter records incomplete prior to 1945).

Gage.—Water-stage recorder. Datum of gage is 1,464.87 ft. above mean sea level, datum of 1929. Prior to Mar. 4, 1938, staff gage at same site, at datum 1.97 ft. higher. February to June 1933, at site 4 miles upstream, at datum 1.65 ft. higher.

Average discharge.—7 years (1944-51), 219 cfs.

Extremes.—Maximum discharge during year, 2,710 cfs. Apr. 12 (gage height, 15.55 ft.); minimum, 18 cfs. Oct. 3, 4 (gage height, 3.60 ft).

1937-51: Maximum discharge, about 4,200 cfs. Apr. 6, 1949 (gage height, 17.7 ft., high water mark, backwater from ice); minimum discharge recorded, 0.3 cfs. Aug. 11-19, 1937, Oct. 10-21, 1939.

Flood of April 1904 did not exceed that of 1949, according to local residents.

Remarks.—Records good except those of period of ice effect, which are fair. Flow regulated by Fish and Wildlife Service dams on Souris and Des Lacs Rivers.

Month	Second Foot Days	Maximum	Minimum	Mean	Run-off in Acre-Feet
October	1,289	101	16	41.6	2,560
November	4,398	258	53	147	8,720
December	1,652	99	15	53.3	3,280
Calendar year 1949	78,995	4,000		216	156,700
January	665		15	21.5	1,320
February	610			21.8	1,210
March	1,095	120		35.3	2,170
April	22,170	1,400	50	739	43,970
May	37,648	2,120	440	1,214	74,670
June	8,369	422	123	279	16,600
July	5,150	241	57	166	10,210
August	1,949	97	24	62.9	3,870
September	916	80	20	30.5	1,820
Water year 1949-50	85,911	2,120	15	235	170,400

Month	Second Foot Days	Maximum	Minimum	Mean	Run-off in Acre-Feet
October	1,216	67	18	39.2	2,410
November	3,525	150	36	118	6,990
December	4,570	160	140	147	9,060
Calendar year 1950	87,883	2,120	15	241	174,300
January	4,310	140	130	139	8,550
February	2,074	130	26	74.1	4,110
March	2,045	500	25	66.0	4,060
April	43,825	2,650	600	1,461	86,930
May	49,291	2,000	616	1,590	97,770
June	21,780	1,800	266	726	43,200
July	3,900	272	51	126	7,740
August	2,097	144	46	67.6	4,160
September	1,318	63	34	43.9	2,610
Water year 1950-51	139,951	2,650	18	383	277,600

RED RIVER OF THE NORTH BASIN

Souris River near Bantry, N. Dak.

Location.—Lat. 48°30′, long. 100°25′, in SE¼ sec. 14, T. 158 N., R. 76 W. on left bank 200 ft. upstream from Nelson bridge 8 miles east of Bantry, 18 miles upstream from Willow Creek, at mile 284.8 below Canadian border (U.S.G.S. river plan and profile).

Drainage area.—13,400 square miles.

Records available.—March 1937 to September 1951 (no winter records prior to 1945).

Gage.—Water-stage recorder. Datum of gage is 1,427.56 ft. above mean sea level, datum of 1929, Emerson Crookston Supplementary Adjustment of 1941. Prior to Mar. 16, 1938, staff gage at same site, at datum 0.17 ft. lower.

Average discharge.—7 years (1944-51), 249 cfs.

Extremes.—Maximum discharge during year, 2,220 cfs. Apr. 23 (gage height, 12.55 ft); minimum, 30 cfs. Mar. 9-12; minimum gage height, 1.73 ft. Oct. 9, 10.

1937-51: Maximum discharge, 4,760 cfs. Apr. 10, 1949 (gage height, 13.76 ft., high water mark); no flow at times in each year 1937-40.

Maximum stage known, that of Apr. 10, 1949.

Remarks.—Records good except those for period of ice effect, which are fair. Some water diverted for irrigation in Canada and at Eaton Dam about 42 miles above station. Flow regulated by Fish and Wildlife Service dams on Souris, Des Lacs and Wintering rivers (total capacity, 145,000 ac.-ft.).

Month	Second Foot Days	Maximum	Minimum	Mean	Run-off in Acre-Feet
October	1,386	102	18	44.7	2,750
November	4,843	270	67	161	9,610
December	2,125	120	30	68.5	4,210
Calendar year 1949	103,538	4,560	.....	284	205,400
January	670	30	15	21.6	1,330
February	1,065	40	35	38.0	2,110
March	1,240	45	30	40.0	2,460
April	16,175	1,240	50	539	32,080
May	48,800	1,890	1,010	1,574	96,790
June	15,976	948	235	533	31,690
July	7,014	369	132	226	13,910
August	2.602	118	65	83.9	5,160
September	1,313	80	34	43.8	2,600
Water year 1949-50	103,209	1,890	15	283	204,700

Month	Second Foot Days	Maximum	Minimum	Mean	Run-off in Acre-Feet
October	1,727	80	42	55.7	3,430
November	3,368	150	50	112	6,680
December	4,440	150	140	143	8,810
Calendar year 1950	104,390	1,890	15	286	207,000
January	4,410	150	130	142	8,750
February	2,475	130	45	88.4	4,910
March	1,415	70	30	45.6	2,810
April	37,135	2,180	75	1,238	73,660
May	44,770	1,880	1,210	1,444	88,800
June	38,316	2,110	453	1,277	76,000
July	6,189	426	81	200	12,280
August	2,754	145	71	88.8	5,460
September	2,144	101	50	71.5	4,250
Water year 1950-51	149,143	2,180	30	409	295,800

RED RIVER OF THE NORTH BASIN

Souris River Near Westhope, N. Dak.
(International Gaging Station)

Location.—Lat. 48°59′47″, long. 100°57′29″, in SW¼SE¼ sec. 30, T. 164 N., R. 79 W., on left bank 1,200 feet upstream from second crossing of international boundary, 1 mile downstream from Fish and Wildlife Service dam 357, 7 miles northeast of Westhope, 11 miles downstream from Boundary Creek, and at mile 358.2 downstream from international boundary (U.S.G.S. river plan and profile).

Drainage area.—17,600 square miles.

Records available.—July 1929 to September 1951 (no winter records prior to 1936).

Gage.—Water-stage recorder and concrete control. Datum of gage is 1,401.74 ft. above mean sea level, datum of 1929. Prior to Mar. 28, 1938, chain gage at site 6.3 miles upstream, at datum 3.29 ft. higher.

Average discharge.—16 years (1935-51), 187 cfs.; median of yearly mean discharges, 103 cfs.

Extremes.—Maximum discharge during year, 3,100 cfs. Apr. 29 to May 1; maximum gage height, 13.98 ft. May 8; minimum discharge, 1.8 cfs. Nov. 9 (gage height, 4.93 ft.).

1929-51: Maximum discharge, 6,400 cfs. Apr. 18, 1949; maximum gage height, 16.9 ft. (floodmark) Apr. 20, 1949; no flow at times in most years.

Remarks.—Records fair. Flow regulated by Fish and Wildlife Service dams on Souris, Des Lacs Rivers, and Wintering Rivers (combined capacity, 190,000 acre-feet).

Cooperation.—This station is one of the international gaging stations maintained by the United States under agreement with Canada.

Month	Second Foot Days	Maximum	Minimum	Mean	Run-off in Acre-Feet
October	367.0	19	1.5	11.8	728
November	30	1	1	1.0	60
December	40.0	2	1	1.3	79
Calendar year 1949	165,676.5	6,300	1	454	328,600
January	78	.....	.....	2.5	155
February	84	.....	.....	3.0	167
March	190	.....	.....	6.1	377
April	21,978	1,820	15	733	43,590
May	64,090	2,630	1,210	2,067	127,100
June	39,159	2,100	31	1,305	77,670
July	11,525	749	57	372	22,860
August	4,634	203	97	149	9,190
September	1,864	91	27	62.1	3,700
Water year 1949-50	144,039	2,630	1	395	285,700

Month	Second Foot Days	Maximum	Minimum	Mean	Run-off in Acre-Feet
October	865	65	13	27.9	1,720
November	399	27	2.2	13.3	791
December	1,468	56	30	47.4	2,910
Calender year 1950	146,334	2,630	.....	401	290,200
January	3,756	183	56	121	7,450
February	4,836	180	160	173	9 590
March	3,019	160	3	97.4	5,990
April	55,320	3,100	110	1,844	109,700
May	77,300	3,100	2,000	2,494	153,300
June	45,608	1,950	524	1,520	90,460
July	7,461	608	16	241	14,800
August	826	39	14	26.6	1,640
September	4,363	174	41	145	8,650
Water year 1950-51	205,221	3,100	2.2	562	407,000

RED RIVER OF THE NORTH BASIN

Long Creek Near Crosby, N. Dak

Location.—Lat. 48°58′30″, long. 103°15′40″, in NW¼ sec. 3, T. 163 N., R. 97 W., on downstream side of county highway bridge, 1 mile downstream from small tributary, and 5 miles northeast of Crosby.

Drainage area.—About 1,800 square miles.

Records available.—March to April 1943, April 1944 to September 1951.

Gage.—Wire-weight gage read once daily. Altitude of gage is 1,870 ft. (from topographic map).

Average discharge.—7 years (1944-51), 38.3 cfs.

Extremes.—Maximum discharge during year, 1,250 cfs. Apr. 18 (gage height 12.4 ft., affected by ice, from graph based on gage readings): no flow during several months.

1943-51: Maximum discharge, 6,240 cfs. Apr. 23, 1948, (gage height, 16.10 ft.); maximum gage height, 16.10 ft. also Apr. 22, 1948 (affected by ice); no flow during part of each year.

Maximum stage known, that of Apr. 22, 23, 1948. Flood in 1904 reached about the same stage from information by local residents.

Remarks.—Records good during May and June and fair at other times.

Month	Second Foot Days	Maximum	Minimum	Mean	Run-off in Acre-Feet
October	0	0	0	0	0
November	0	0	0	0	0
December	0	0	0	0	0
Calendar year 1949	4,401.8	480	0	12.1	8,730
January	0	0	0	0	0
February	0	0	0	0	0
March	22	5	0	.7	44
April	9,217	1,030	10	307	18,280
May	883.6	57	7.7	28.5	1,750
June	1,112.4	270	1.3	37.1	2,210
July	187.5	19	1.1	6.05	372
August	25.9	3.2	0	.84	51
September	0	0	0	0	0
Water year 1949-50	11,448.4	1,030	0	31.4	22,710

Month	Second Foot Days	Maximum	Minimum	Mean	Run-off in Acre-Feet
October	0	0	0	0	0
November	0	0	0	0	0
December	0	0	0	0	0
Calendar year 1950	11,448.4	1,030	0	31.4	22,710
January	0	0	0	0	0
February	0	0	0	0	0
March	0	0	0	0	0
April	15,636	1,150	0	521	31,010
May	5,423	980	12	175	10,760
June	231.2	22	1.6	7.71	459
July	11.4	1.5	0	.37	23
August	0	0	0	0	0
September	67.5	34	0	2.25	134
Water year 1950-51	21,369.1	1,150	0	58.5	42,390

RED RIVER OF THE NORTH BASIN

Des Lacs River at Foxholm, N. Dak.

Location.—Lat. 48°22′, long. 101°34′, in NW¼ sec. 2, T. 156 N., R. 85 W., on right bank 10 ft. downstream from county highway bridge in Foxholm.

Drainage area.—973 square miles.

Records available.—June 1904 to July 1906, October 1945 to September 1951.

Gage.—Water-stage recorder. Datum of gage is 1,632.98 ft. above mean sea level, datum of 1929.

Prior to Aug. 31, 1948, staff gage at same site and datum.

1904 to 1906, staff gage at about the same site and datum.

Average discharge.—6 years (1945-51), 32.9 cfs.

Extremes.—Maximum discharge during, 1,800 cfs. Apr. 6 (gage height, 18.05 ft.); no flow Mar. 8-26.

1904-6, 1945-51: Maximum discharge, 2,000 cfs. Apr. 4, 1949 (gage height, 18.04 ft., backwater from ice); no flow at times in some years.

Maximum stage known since 1886, about 18.8 ft. in spring of 1939, from information by local residents.

Remarks.—Records good except those for Oct. 26 to Mar. 6, which are fair and those for Aug. 4-10, which are poor. Some regulation at low flow by a series of wild fowl refuge ponds, combined capacity about 9,000 acre-feet.

Month	Second Foot Days	Maximum	Minimum	Mean	Run-off in Acre-Feet
October	67.6	3.8	0.2	2.18	134
November	66.1	3.8	.7	2.20	131
December	25.9	2.4	.4	.84	51
Calendar year 1949	14,303.3	1,800	.....	39.2	28,380
January	4.6	.3	.....	.15	9.1
February	2.8	.....	.....	.10	5.6
March	470.5	150	.....	15.2	933
April	8,540	976	35	285	16,940
May	4,174	494	48	135	8,280
June	1,505	59	41	50.2	2,990
July	1,017	44	26	32.8	2,020
August	609.4	51	6.4	19.7	1,210
September	514.7	49	5.8	17.2	1,020
Water year 1949-50	16,997.6	976	.....	46.6	33,720

Month	Second Foot Days	Maximum	Minimum	Mean	Run-off in Acre-Feet
October	593.9	29	6.5	19.2	1,180
November	288	19	7	9.6	571
December	282	10	8	9.1	559
Calendar year 1950	18,001.9	976	0.1	49.3	35,720
January	251	9	5	8.1	498
February	122	.....	.....	4.4	242
March	75	18	0	2.4	149
April	12,359	1,600	20	412	24,510
May	4,886	386	69	158	9,690
June	1,671	71	34	55.7	3,310
July	1,037	48	26	33.5	2,060
August	652	29	4	21.0	1,290
September	697	29	21	23.2	1,380
Water year 1950-51	22,913.9	1,600	0	62.8	45,440

RED RIVER OF THE NORTH BASIN

Wintering River Near Karlsruhe, N. Dak.

Location.—Lat. 48°10′ long. 100°32′, on line between sec. 10 and 11, T. 154 N., R. 77 W., on left bank 30 ft. upstream from highway bridge, 4 miles upstream from mouth, and 7 miles northeast of Karlsruhe.

Drainage area.—675 square miles.

Records available.—March 1937 to September 1951.

Gage.—Water-stage recorder. Altitude of gage is 1,480 ft. from river-profile map.

Average discharge.—9 years (1939-41, 1944-51), 15.0 cfs.

Extremes.—Maximum discharge during year, about 450 cfs. Apr. 9 (gage height, 7.70 ft. affected by ice); maximum gage height, 8.03 ft. Apr. 5 (affected by ice) no flow Feb. 26 to Apr. 3.

1937-51: Maximum discharge, 3,000 cfs. Apr. 7, 1949, by velocity-area determination; maximum gage height, 12.0 ft. Apr. 7, 1949 (channel choked by packed snow); no flow at times in many years.

Maximum stage known, that of Apr. 7, 1949.

Remarks.—Records good except those for periods of ice effect or no gage-height record, which are fair.

Month	Second Foot Days	Maximum	Minimum	Mean	Run-off in Acre-Feet
October	140.7	6	3.3	4.54	279
November	152.7	7.3	4.3	5.09	303
December	65.3	5.4	.6	2.11	130
Calendar year 1949	13,561.2	2,500	0	37.2	26,900
January	5.0	------	0	.16	9.9
February	0	0	0	0	0
March	6.0	------	------	.19	12
April	2,482	180	1	82.7	4,920
May	5,213	421	59	168	10,340
June	773	49	17	25.8	1,530
July	363.0	18	7.8	11.7	720
August	198.2	8.9	4.9	6.39	393
September	170.7	7.2	4.4	5.69	339
Water year 1949-50	9,569.6	421	0	26.2	18,980

Peak discharge (base, 100 sec.-ft.).—Apr. 17 (11 a. m.) 164 sec.-ft.; Apr. 22 (7 a. m.) 196 sec.-ft.; May 16 (6 p. m.) 474 sec.-ft.

Month	Second Foot Days	Maximum	Minimum	Mean	Run-off in Acre-Feet
October	177.4	6.6	5.1	5.72	352
November	115.4	5.9	2	3.85	229
December	84	3	2	2.7	167
Calendar year	9,587.7	421	0	26.3	19,010
January	80	3	1	2.6	159
February	17.5	1	0	0.62	35
March	0	0	0	0	0
April	3,307	400	0	110	6,560
May	1,138	68	16	36.7	2,260
June	804	53	16	26.8	1,590
July	348.2	23	4.0	11.2	691
August	139.2	9.1	4.0	4.49	276
September	157.5	9.6	3.7	5.25	312
Water year	6,368.2	400	0	17.4	12,630

RED RIVER OF THE NORTH BASIN

Devils Lake Near Devils Lake, N. Dak.

Location.—Lat. 48°04′00″, long. 98°56′07″, in SW¼ sec. 18, T. 153 N., R. 64 W., at Lakewood, on east bank of Creel Bay and 4½ miles southwest of city of Devils Lake. Creel Bay, which is half a mile wide, is an arm of Devils Lake and extends 2 miles to the north of the Lake.

Drainage area.—3,940 square miles (including Lake surface).

Records available.—1867, 1879, 1883, 1887, 1890, 1896 (one gage height for each year and 1901-1951 (fragmentary).

Gage.—Staff gage read about twice a week except during winter. Datum of gage is 1,400.00 ft. above mean sea level, datum of 1929; gage readings have been reduced to elevations above mean sea level.

1867 to September 1938, various staffs and reference points at datum 0.56 ft. lower. October 1938 to June 22, 1950, various staffs at present datum.

Extremes.—Maximum elevation during year, 1415.47 ft. May 3; minimum, 1414.40 ft. Sept. 29.

1867-1951: Maximum elevation observed, 1438.40 in 1867, present datum; minimum observed, 1400.87 ft. Oct. 24, 1940.

Remarks.—Elevation at gage frequently affected by wind. Elevations listed below are for calmer days:

Elevation in feet, 1949-50

Oct. 1	1406.42	June 1	1412.52	July 24	1414.58
Oct. 12	1406.42	June 4	1412.97	July 30	1414.65
Oct. 22	1406.52	June 11	1413.17	Aug. 8	1414.70
Nov. 2	1406.53	June 16	1413.46	Aug. 24	1414.80
Nov. 11	1406.54	June 22	1413.72	Aug. 30	1414.85
Nov. 18	1406.50	June 26	1414.00	Sept. 12	1414.86
Dec. 1	1406.50	June 30	1414.18	Sept. 17	1414.93
Apr. 11	1406.62	July 9	1414.35	Sept. 24	1414.95
May 24	1411.21	July 19	1414.45	Sept. 29	1414.93
May 26	1411.67				

Elevation, in feet, 1950-51

Oct. 6	1414.90	Apr. 22	1415.35	July 10	1415.08
Oct. 13	1414.90	Apr. 30	1415.44	July 19	1414.92
Oct. 16	1414.90	May 3	1415.47	July 27	1414.84
Oct. 26	1414.84	May 16	1415.37	Aug. 3	1414.80
Nov. 7	1414.80	May 26	1415.40	Aug. 13	1414.73
Nov. 17	1414.83	June 11	1415.33	Sept. 3	1414.64
Dec. 9	1414.88	June 22	1415.35	Sept. 11	1414.65
Mar. 19	1414.99	June 26	1415.35	Sept. 23	1414.50
Apr. 10	1415.14	June 30	1415.20	Sept. 29	1414.40
Apr. 18	1415.29				

UNDERGROUND WATER SURVEYS—Cooperation with U. S. G. S.

During the past seven years ground-water investigations by the Ground Water Branch of the United States Geological Survey have been in progress in various parts of the State. These investigations are being made in financial cooperation with the North Dakota State Water Conservation Commission, under the general supervision of the State Geologist who acts as technical advisor for the State Water Conservation Commission in their program.

The ultimate aim of the program is to obtain an overall knowledge of the ground-water resources in the entire State which would be adequate for effectively directing the optimum development of this resource for domestic, municipal, industrial and irrigation purposes and for effectively programming conservation and administrative measures which may be necessary or desirable in connection with its development and use.

However, there has been and currently is a great need for adequate and perennial ground-water supplies for numerous communities throughout the State which are attempting to construct public water-supply and sewage facilities for the first time or which have experienced shortages under present facilities. Therefore, the bulk of the investigational work has been directed toward securing data on the ground-water resources that would be within reach of these communities.

Through contacts with the State Geologist and the State Water Conservation Commission, about 80 communities have in the past expressed interest in receiving assistance under this program. However, in many cases facilities were not available for starting new investigations immediately and many of the communties that requested assistance have temporarily solved many of their problems on their own initiative or with nominal assistance from the State Geologist and the State Water Conservation Commission. Many of these communities no longer appear to be actively interested in obtaining the benefits of any real investigation at the present time. On the other hand, many of the communities are still much interested in obtaining assistance but are waiting until facilities for conducting the work are more readily available.

At the present time, investigations have been completed or are under way in 32 areas in the State. Reports have been released on 18 areas. Three other reports have been completed but not officially released as yet. It is expected that the field work will be completed on all of these projects that are now under way during the forthcoming field season but it probably will be two years or longer before all the reports can be completed and released. In all, the reports will present information for more than 5,000 square miles of area.

Up to July 1, 1952, more than 750 test holes had been drilled with the State-owned drilling rig in connection with investigational work. These holes represent approximately 90,000 feet or equivalent to over 17 miles of test drilling.

During the past two years investigations have been conducted in the vicinities of the towns of Fairmont, Streeter, Devils Lake, St. John, Rolla, and Bowbells, and investigations are being planned in the vicinities of Stanley and Upham. Three reports have been duplicated and released to the public during the two year period and three other reports are essentially complete and will be duplicated in the near future.

The reports on the investigations may be had free of charge unless the supply for distribution has been exhausted, in which case copies may be examined in any of the State College libraries, The North Dakota Research Foundation library in Bismarck, offices of the State Water Conservation Commission in Bismarck, North Dakota Geological Survey and the United States Geological Survey both at the Universtiy of North Dakota in Grand Forks. Requests for reports should be made to one of the following agencies:

North Dakota State Water Conservation Commission
Bismarck, North Dakota

North Dakota Geological Survey
University Station
Grand Forks, North Dakota

United States Geological Survey
University Station
Grand Forks, North Dakota

The following list shows the reports that have been completed and whether or not they are currently available. A brief abstract giving the essential information has been prepared for the State Water Commission by the State Geologist and is available at the office of the State Water Commission on request.

No. 1 Ground Water in the Fessenden Area, Wells County, North Dakota, by Leonard Filaseta, 1946. (Edition exhausted)

No. 2 Ground Water in Beach Deposits of Glacial Lake Agassiz near Mountain, Pembina County, North Dakota, by P. D. Akin, 1946. (Edition exhausted).

No. 3 Ground Water at Dickinson, North Dakota, by T. G. McLaughlin, 1946. (Edition exhausted)

No. 4 Ground water in the Deposits of Ancient Lake Dakota, Dickey County, North Dakota by William C. Rasmussen, 1947.

No. 5 Ground Water near Buxton, Traill County, North Dakota, by P. E. Dennis, 1947. (Edition exhausted)

No. 6. Geology and Ground Water Conditions at Minot, North Dakota, by P. D. Akin, 1947. (Edition exhausted)

No. 7 Ground water in the Aneta Area, Nelson County, North Dakota, by P. E. Dennis, 1947. (Edition exhausted)

No. 8. Ground Water in the Sharon Area, Steele County, North Dakota by P. E. Dennis,, 1947.

No. 9. Ground Water in the Hope Area, Steele County, North Dakota, by P. E. Dennis, 1947.

No. 10 Ground water in the Wimbledon Area, Barnes and Stutsman Counties, North Dakota, by P. E. Dennis, 1948.

No. 11 Geology and Ground Water Resources of Parts of Cass and Clay Counties, North Dakota and Minnesota, by P. E. Dennis, P. D. Akin and G. F. Worts, 1949.

No. 12. Ground Water in the Zeeland Area, North Dakota, by Wilson M. Laird, 1948.

No. 13 Ground Water in the Wyndmere Area, Richland County, North Dakota, by P. E. Dennis, P. D. Akin, and Suzanne L. Jones, 1950.

No. 14. Ground Water in the Kindred Area, Cass and Richland Counties, North Dakota, by P. E. Dennis, P. D. Akin and Suzanne L. Jones, 1950.

No. 15. Ground Water in the Portland Area, Traill County, North Dakota, by P. E. Dennis and P. D. Akin, 1950.

No. 16 Ground Water in the Neche Area, Pembina County, North Dakota, by Quentin F. Paulson, 1951.

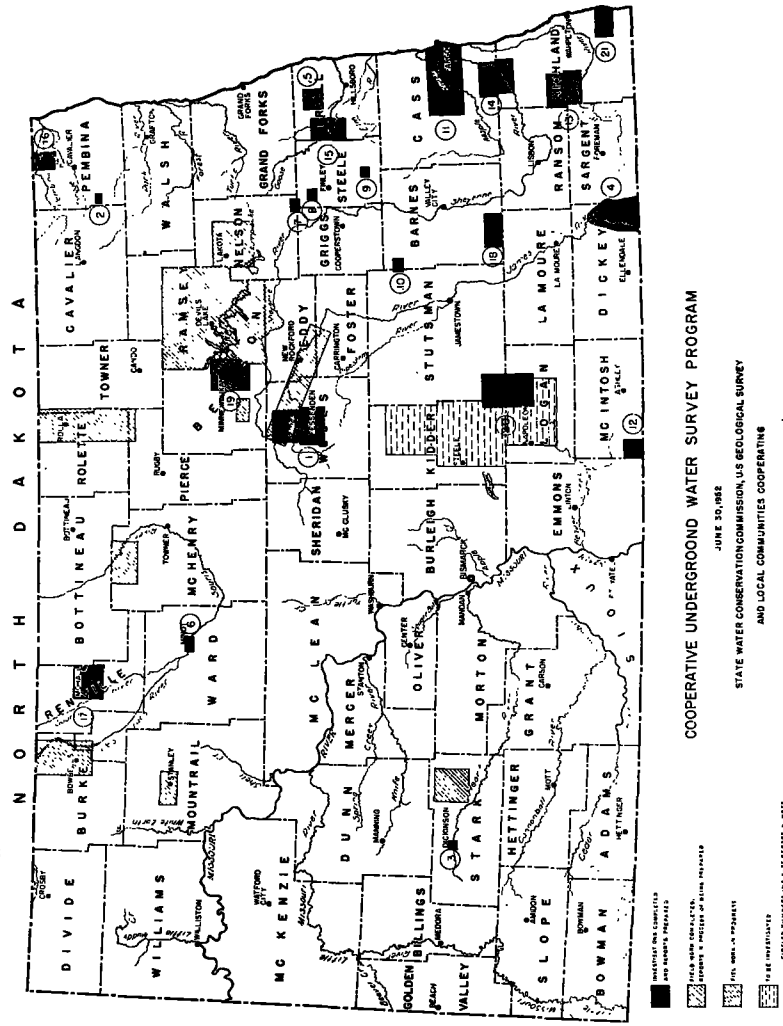
No. 17 Ground Water in the Mohall Area, Bottineau and Renville Counties, North Dakota, by P. D. Akin.

No. 18. Ground Water in the Litchville Area, Barnes County, North Dakota, by P. D. Akin, 1952.

No. 19. Geology and Ground Water Resources in the Minnewaukan Area, Benson County, North Dakota, by Saul Aronow, P. E. Dennis and P. D. Akin, (This report has not yet received final review prior to release to the public).

No. 20. Geology and Occurrence of Ground Water in the Streeter Area, Stutsman, Logan, and Kidder Counties, North Dakota, by Quentin F. Paulson.

No. 21. Ground Water in the Fairmount area, Richland County, North Dakota, and adjacent areas in Minnesota, by Quentin F. Paulson. (This report has not yet received final review prior to release to the public).



SOIL SURVEY PROGRAM

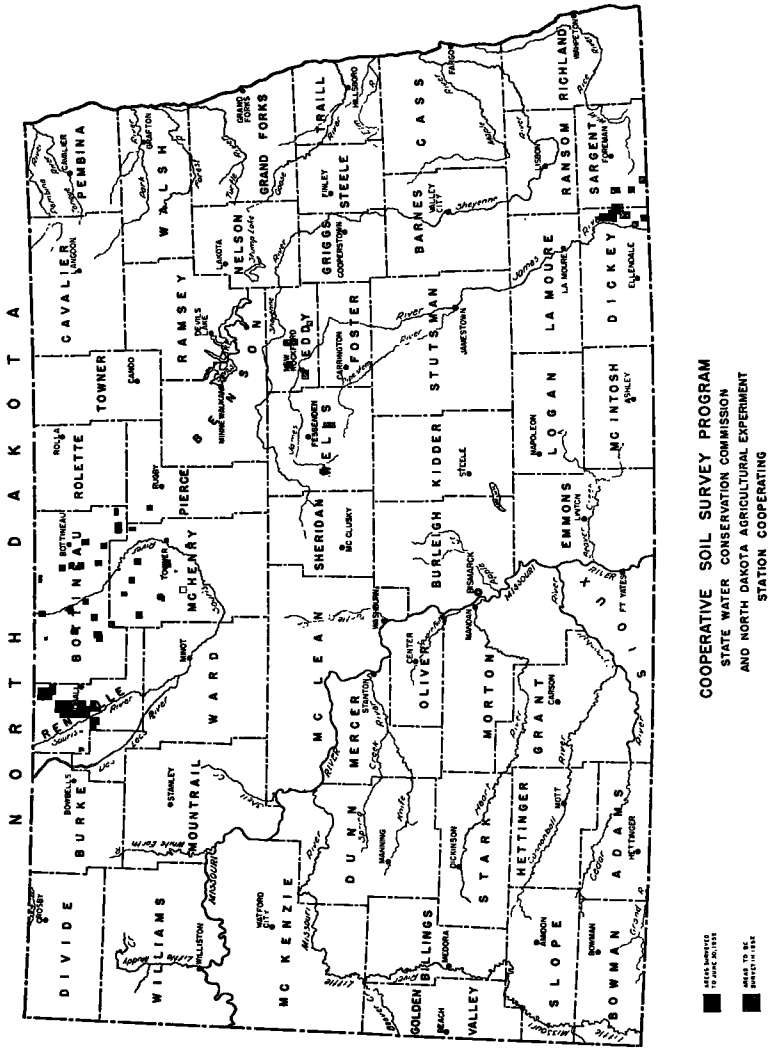
In 1948 the North Dakota State Water Conservation Commission entered into an agreement with the North Dakota Agricultural Experiment Station to conduct soil surveys in various areas in the state proposed for irrigation development. The original agreement provided the actual surveying would be under the direction of the North Dakota Agricultural Experiment Station. The Commission allocated $30,000 from their Cooperation with the U. S. Departments appropriation as their initial 50% share of the cost of these surveys. Since that time an additional $10,000 has been allocated for this purpose. Initial surveys were to be conducted in the areas of the proposed Missouri-Souris Project, particularly in areas east of the Des Lacs River. Other areas in which there have been surveys since these initial surveys were undertaken are in Bottineau, McHenry and the Oakes over in Dickey and Sargent Counties.

Recent reports show that 170,000 acres have been covered by the Soil Survey program to date in Renville and Bottineau Counties and the Oakes area, with a cost to the State of .18 per acre. Of this total, 123 sq. mi. have been surveyed in Renville County, 72 sq. mi. in Old Glacial Lake Souris Basin, Bottineau County, 55 sq. mi in the Oakes area, and 22 sq. mi. in the New Rockford area.

The purpose of the surveys was to study the physical and chemical properties of the soils to determine their irrigability. Certain of the soil properties can be easily recognized by the soil surveyor through observation and simple field tests. Others cannot be classified or evaluated readily in the field and must be studied in the laboratory. From these studies the adaptability of the various types of soils of irrigation can be determined.

Field and laboratory studies of the soils in the Missouri-Souris area have begun in 1948 in this cooperative program. Work was done chiefly in Burke, Divide, Renville counties and the gooseneck of Ward County.

In these studies emphasis was placed on soil characteristics that influenced potential irrigability. The soils were analyzed chemically to determine their salinity, alkalinity, p-H values, and the amount of gypsum and carbonates present. Their physical properties and other features studied were texture, structure, consistance, permeability, slope, erosion, stoniness and kind of apparent material. The accompanying map shows the areas for which these soil surveys have been conducted. These areas were selected as containing representatives soils of the proposed irrigation areas in those localities. Complete information on the results of the survey and conclusions reached is available at the office of the State Water Conservation Commission.



RESURVEY OF THE BOWBELLS BLOCK OF THE MISSOURI-SOURIS UNIT

On November 29, 1951 the North Dakota State Water Conservation Commission and the United States Bureau of Reclamation entered into an agreement to conduct a resurvey of the Bowbells Block of the Missouri-Souris project to review and analyze the findings of the Bureau of Reclamation relating to the irrigability and drainability of land in this area. Over a year before this agreement was made, the Bureau of Reclamation announced that they were excluding the Crosby-Mohall unit from the Missouri-Souris project, because their findings as to the irrigability and drainability indicated the project infeasible. W. G. Sloan, consulting engineer, formerly a Bureau of Reclamation engineer, conducted a study of the data the Bureau of Reclamation had gathered and his conclusions in this study were contrary to those of the Bureau.

In order that the question of irrigability and drainability of these lands could be determined impartially, the State Water Conservation Commission and the Bureau of Reclamation entered into a cooperative agreement to employ a board of experts in the irrigation field to review and analyze all available data pertaining to this area and collect any new data they deemed necessary. Appointed to this board were J. L. Burkholder, San Diego, California; S. T. Harding, Berkeley, California, and H. E. Selby, Washington, D. C.

The review board commenced their study in February, of 1952 and made two field trips to the area in question, one in April and one in May and June. During their field trips to the Bowbells Block of the Crosby-Mohall area they spent considerable time going over the Bureau of Reclamation reports and other data available. The State Water Commission and the Bureau of Reclamation offered whatever assistance they could to the board.

On July 1, 1952 the board issued their report on the suitability for sustained irrigation of lands in North Dakota, west of the Des Lacs River. A copy of their findings and conclusions are as follows:

REPORT ON SUITABILITY FOR SUSTAINED IRRIGATION OF LANDS IN NORTH DAKOTA WEST OF THE DES LACS RIVER

— by —

J. L. BURKHOLDER — S. T. HARDING — H. E. SELBY

July 1, 1952

INTRODUCTION

As a result of differences in opinion among the various interested parties regarding the suitability for sustained irrigation of lands in North Dakota west of the Des Lacs River, the State Water Conservation Commission of North Dakota and the U. S. Bureau of Reclamation agreed to the appointment of a consulting board to formulate specific conclusions

on this subject. The Board appointed under this agreement, consisting of the authors of this report, submits herewith the results of its work.

The duties of the Board are defined in a letter dated November 1, 1951 signed jointly by Governor Brunsdale for the State Water Conservation Commission and Regional Director Vernon for the Bureau of Reclamation. The scope of the assignment to be covered by the Board is also the subject of a letter from the Commissioner of Reclamation to Governor Brunsdale dated October 15, 1951. Copies of the pertinent portions of these letters are attached to this report, as Appendix "A".

Following the appointment of the Board, these instructions were discussed and amplified at a meeting with Governor Brunsdale and Regional Director Vernon in Salt Lake City on February 6, 1952. It is the understanding of this Board that its assignment is that stated in the title of this report and that, in carrying out this assignment, the Board has been free to consider and to comment on any matters relative to this title which the Board may consider to be pertinent. This report has been prepared on the basis of this understanding.

A list of the records and reports supplied by governmental agencies and reveiwed by the Board is attached hereto, as Appendix "B". Items in this list have been numbered so that reports referred to in the text can be readily identified. The Special Report, Bowbells Block (1) and the Review of that report by Mr. W. G. Sloan (2) are principal items in this reference material. The Special Report on the Bowbells Block (1) is largely a digest and summary of earlier and more detailed reports on this subject.

The Board had its first meeting in Salt Lake City on February 6 and 7, 1952. The periods April 21 to 30 and May 26 to June 4, 1952 were spent in the project area and in office studies in Minot and Bismarck. Additional time has been spent by the members of the board in office study of the material submitted for its review. In all of its work the Board has received full cooperation from all local, state and federal parties. This assistance has been very helpful. Without attempting to list the many individuals who have assisted us, we gratefully acknowledge our obligation to them and express our appreciation of their cooperation.

Extensive investigations of the lands involved in this review have been made by the Bureau of Reclamation. The members of the Board have made sufficient field investigations to acquaint themselves with the conditions in the area and to evaluate the extent and usefulness of the work of the federal and state agencies. The Board has not attempted to make detailed field investigations and classification of its own. It has investigated and checked in the field the methods used and work done by others.

The extent and character of the information secured by the governmental agencies has been adequate to meet the needs of this study. A greater amount and variety of factual material has been secured than is

usually available. Without such material, conclusions regarding these lands could not have been reached within the period of time used in the preparation of this report.

CONCLUSIONS

It is the interpretation of this Board that the term "sustained irrigation" means **permanent irrigation successfully maintained over an indefinitely long period.** Under such sustained irrigation, damage from high ground water and alkali accumulations should be confined to a minor portion of the area served.

The lands west of the Des Lacs River are now used in general successful dry farming agriculture subject to the menace of occasional periods of successive years of drought. If irrigation should be provided for this area and result in injury to the lands as a result of inability to provide adequate drainage, the resulting alkali accumulations would either prevent, or delay for long periods, the return of the affected lands to successful dry farming.

Based on a review of the information and data supplied by governmental agencies and private individuals and on field examinations made by it, the Board has reached the following conclusions relative to the suitability for sustained irrigation of the area west of the Des Lacs River:

1. That, while the character of the topography and the high alkalinity of the subsoil of these lands reduces their desireability for irrigation, drainage is the factor which will determine the final success or failure of the area if it should be changed to an irrigated agriculture.

2. That surface drains would alleviate the problem to some extent but would not provide protection against a high ground water table incident to irrigation of the lands.

3. That deep drains ultimately would be required, the success or failure of which would be determined by the permeability of the dense texture of the glacial till through which water must percolate into drains if they are to function efficiently.

4. The fluctuations of the ground water in this area indicate that some movement of ground water takes place in the till soils; however the rate of movement is slow and the volume moved is small. The small volume of ground water reaching the till under existing conditions is sufficient to maintain relatively steep ground water slopes even in areas having accessible natural outlets. Irrigation would increase by several fold the amount of ground water required to be removed from the area and its removal could not be successfully accomplished under the prevailing conditions without incurring prohibitive costs.

5. That should irrigation be undertaken, the change from dry farming to an irrigated agriculture would take place relatively slowly and extensive damage from deficient drainage might not develop until a substantial part of the area had been irrigated for a decade or more. There is no positive basis on which the details of the drainage problem can be forecast or the time specified at which relief might be needed. The need for drainage would occur relatively early within the period of time represented by "sustained irrigation".

6. That, because of conditions relating particularly to drainage but including also consideration of such factors, as soils, topography, alkalinity and cost of works, the lands are believed to be unsuitable for sustained irrigation.

7. That an attempt to change present dry farming to an irrigated agriculture would culminate in eventual losses to the landowners resulting from inability successfully to maintain an irrigated agriculture, from losses of expenditures made by the farmers to convert present dry lands to irrigation and from losses due to a reduction in the value of a large part of the lands as a consequence of alkali accumulations in the surface soils.

ADDITIONAL COMMENTS

The extent of the available reports and records considered in the preparation of this report makes it impractical to review in detail all of the support for the preceding conclusions. The following comments are made on some of the principal items that were considered.

Land Classification

The Boards conclusions regarding the drainability of the lands west of the Des Lacs River were reached on the basis of data on soils previously collected by the Bureau and on information the Board gathered on field trips and are not dependent on the particular standards of land classification used by the Bureau. However, the Bureau's inventory of the physical condition of the lands was extensively used in our studies and assisted in reaching conclusions.

The field inventory of the various factors affecting the adaptability of these lands for sustained irrigation is unusually complete. Without this inventory the Board would not have been able to reach conclusions regarding these lands within the time period used in the studies.

In view of the confusion that appears to exist regarding the objectives of the Bureau in the use of its field inventory of land factors to determine the various land classifications, it may be helpful to state our understanding of the Bureau's land classification standards.

The land classification standards used by the Bureau were correlated with the payment capacity of the lands classified. The divisions between Classes 1, 2, 3 and 6 for the several land factors used were adjusted so that the different classes for each factor would have similar payment capacities. This is shown by the Bureau's report on the Bowbells Block (1). (Also 6 and 7.)

In the Bureau's report on the Bowbell's Block (1) there are two sections in which land classification is discussed. One, beginning on page 66, describes the land classification as it was carried out in the field and in the soil laboratory. This consists mainly of a definition of the items to be inventoried in the field, the basis for the division between different land classes for each factor, how to combine the effect of the several factors into the final single class index, and the symbols or abbreviations to be used in the mapping and assembling of the results. This system is detailed and its explanation enables the results of the land classification based on its application to the field data to be understood. Such understanding, however, is separate from any questions regarding agreement or disagreement with the definition of the standards themselves.

The second section in the report (1) relating to land classification starts on page 122 under the heading "Economic Analyses of Land Classification Standards". The first paragraph, under this general heading, is a statement of the "Problem" and is, in part, as follows:

> "The standards of land classification are designed to measure various degrees of suitability for irrigation. . . . . It was agreed that an analysis should be made to evaluate the effects of various kinds of soil and topographic deficiencies on payment capacity and to recommend changes where necessary, in order to make the various deficiency factors more nearly equal in terms of payment capacity."

From the above quotation it is evident that the segregation of these lands by the Bureau into Classes 1, 2, 3 and 6 is an economic classification in which the physical conditions are reflected in the segregation to such classes on the basis of their effect on the payment capacity of these lands.

The above statement is illustrated by the change in the standards used for the uneveness of topography and the requirements for land leveling (U Factor). The earlier standards used for the limits of leveling for Classes U1, U2, and U3 resulted in payment capacities for lands placed in the U3 class of $5.33 per acre per year while the payment capacities for soil Class S3 (marginal for irrigation), for size of field Class J3 (field of over 2 acres, runs of over 300 feet), and slope Class G3 (slopes of 5 to 8 per cent) varied from $1.12 to $2.88 per acre (page 129 (1). To bring the land leveling Class U3 into a similar payment capacity to the other Class 3 factors, the limits of the soil to be moved in land leveling for Class U3 were increased from the previous standard of 175 to 350 cubic yards per acre to 350 to 650 cubic yards per acre.

This economic land classification by the Bureau also results in placing in the general Class 6 lands having two factors in Class 3 or one factor in Class 3 with 2 other factors in Class 2. This effect follows from the decrease in payment capacity of each deficiency in the land as it is reflected in the average crop yield or the cost of crop production.

Based on these standards and their estimated farm budgets, the Bureau's report on the Bowbells Block derives repayment capacities for lands having 2 factors in Class 2 which vary from $3.11 to $4.49 per acre per year (1, p. 130). Lands having 3 Class 2 factors, lands having one Class 3 and one Class 2, lands having one Class 3 and two Class 2, and lands having two Class 3 factors were found to have repayment capacities varying from $1 47 to minus $5.12. These abilities to pay are based on **average crop prices for the period 1939-44.** For the same period the Bureau has used a cost of operation and maintenance of $2.50 per acre per year for a project serving the full area (1, p. 128 and 6, p. 17). On this basis the lands falling in Class 6 would not be able to meet the costs of operation and maintenance even if the full area should be irrigated. Changes in crop prices and costs of operation and maintenance since 1944 would not materially change the nature of this conclusion.

Modifying the economic land classification in ways that would result in some of the lands now placed in Class 6 qualifying in Class 3 would, of course, increase the acreage of land in Class 3 and thus increase the acreage classified as arable. This, however, would decrease the average payment capacity of the resulting Class 3 lands and of the total arable lands as a result of adding lands of lower payment capacity.

This Board has not attempted to review the many details of farm production costs and returns that provide the basis for the payment capacity estimate in the Bowbells Block Report. It is our opinion, however, (a) that the resulting estimate of payment capacities are reasonably consistent with known payment capacities in existing irrigated areas having farming conditions similar to the type that would be expected to develop in the Bowbells Block, and, (b) that no lowering of the economic land classification standards in relation to their effect on payment capacity would be warranted.

In addition to the land classification based on economic conditions and used to derive payment capacity, land classifications also can be made which represent an inventory of the physical factors alone without regard to the cost of water or the economic returns from use of the land. The soil surveys of the type made by federal and state agencies are such inventories of the soil textures of the lands covered in such surveys. The land classification of the Bureau separately grades lands according to the different sizes of fields which can be laid out for irrigation. Such information has been useful to this Board even though we may not agree with the particular segregations to classes used by the Bureau. Similar conditions apply to the other factors separately recognized in the land classification of the Bureau.

Many land classifications have been made in which from three to six separate classes have been recognized based on smiliar factors to those used by the Bureau without relating the classes directly to the payment capacity of the lands. Such classifications represent physical inventories which can be used to segregate the lands covered into any economic classes

that may be desired. These inventories are usable for economic analyses of either irrigation or dry farming areas. Different consideration would be given to the various items mentioned for each different use, but the inventory would not be changed. For classifications of this type, the limits used in the Bureau's inventory of the lands in the Bowbells Block are more restrictive on lands placed in Classes 1, 2, and 3, than those that have been used in some classifications made by other agencies.

Crosby-Mohall Unit

The Crosby-Mohall Unit of the Missouri-Souris Project has a gross area of about 1,000,000 acres (1). It includes lands west of the Des Lacs River, lands between the Des Lacs and Souris Rivers and lands within the Souris Loop. Of this gross area only the portion located west of the Des Lacs River was assigned to this Board for investigation and report on its suitability for sustained irrigation. Within the Souris loop the soil conditions improve to the east, particularly within the area of the former Souris Lake. The Board examined lands in these more favorable areas for the purpose of comparing the results of applying the land classification standards of the Bureau on these areas with the results found on the less favorable lands west of the Des Lacs River.

Area West of Des Lacs River

The area west of the Des Lacs River contains 477,260 acres (34). The complete land classification of the Bureau of Reclamation places 0.1% of this area in Class 1, 1.35% in Class 2, 2.4% in Class 3 and 96.15% in Class 6 (34). This is the portion of the Crosby-Mohall Unit of the Missouri-Souris Project assigned to this Board for investigation and report on its suitability for sustained irrigation. It is the portion of the Crosby-Mohall Unit in which the topography and subsoil conditions are the most unfavorable.

The land classification results of the Bureau for this area illustrate the effect of combining deficiencies in the separate factors on the final result (34). On the basis of soils alone, assuming subsurface drainage could be provided, 56% of the area was classified as arable land (Classes 1, 2, and 3). On topography alone 66% was classified as arable. Combining soil and topography reduced the arable area to 18%. Adding the drainage factor further reduced the arable area from 88,083 acres to 18,418 acres, a reduction of 79%. A similar proportion of the area placed in Class 6 for deficiencies in other factors would also be deficient in drainage.

These results are in general agreement with the conclusions of the State Agricultural College (17). Its classification of the soils in this area is 5% of good irrigability, 25% of highly questionable irrigability and 70% of definitely poor irrigability.

Bowbells Block

The Bowbells Block contains 45,120 acres (1, p. 5). It was selected by the Bureau as an area which would be representative of lands in the Crosby-Mohall Unit which are located west of the Des Lacs River. The

final land classification of this area places no land in Class 1, 0.7% in Class 2, 4.9% in Class 3 and 94.4% in Class 6 (1, Table 34). This division to land classes in similar to that found for the entire area of 477,260 acres located west of the Des Lacs River.

On the basis of soils only, assuming subsurface drainage could be provided, 68% of the area was classified as arable land (Classes 1, 2, and 3) (1, Table 33). On topography alone 79% was classified as arable. Combining soil and topography reduced the arable area to 25%. Adding the drainage factor further reduced the arable area from 11,263 acres to 1,539 acres, a reduction of 86%. A similar porportion of the area placed in Class 6 for deficiencies in other factors would also be deficient in drainage.

The Bowbells Block was selected by the Bureau for the purpose of making a detailed investigation of the soils and subsoils in order to avoid the cost of similar detailed work on the entire area. It is our opinion that the Bowbells Block is generally representative of the entire area west of the Des Lacs River and that conclusions based on the results of the more detailed investigation of this Block are generally applicable to the entire area west of the Des Lacs River.

Bowbells Development Farm

The Bowbells Development Farm of 165 acres was established in 1948 to determine the results of irrigation on the till subsoils in the project area west of the Des Lacs River (3). While much detail and experimental work has been done on the farm, its principal purpose was to serve as a trial of irrigation under the conditions which would confront the landowners having similar soils if the Missouri-Souris Project should be constructed.

The records of this farm have been carefully studied as it represents the only example now available of irrigation on the glacial till soils and uneven topography of this area. It also furnishes a comparison of yields with and without irrigation from field areas having similar sizes to those used in farm operation.

Records of operation for the four years 1948 to 1951 are available (3). An average of 127 acres per year has been irrigated. A total of 345 acre-feet of irrigation water was delivered to this area during these four years. This represents an average depth of irrigation per season of 8.1 inches with a maximum depth in 1949 of 14.5 inches. The rainfall for the first three of these years was about equal to the 33 year mean at Bowbells; for 1951 it was about 80% of this mean.

The amounts of absorption secured under irrigation depend on soil conditions and the results secured on the Farm should be representative of what can be expected under general practice in this area. However, irrigation on the Farm has been more carefully supervised than can be expected under general farm practice and the amounts of surface waste

that have occurred on the Farm are probably less than those that would occur under general project conditions. For project conditions rates of delivery of water to the farms would be expected to be larger, consumptive uses would be similar, and return flows through surface drains would be larger than have occurred on the Farm.

The Bowbells Development Farm is well located for natural drainage with Des Lacs Lake to the east and a draw on the southwest into which the constructed drain on the west side of the Farm discharges. Even with the steep slopes under which ground water can move potentially from under the Farm, the ground water remains relatively close to the ground surface.

The amounts of water absorbed during each irrigation have been relatively small. A direct rise of the ground water under the areas irrigated has occurred from some irrigations but not from others (31). Generally such rises have occurred where surface water from irrigation was ponded at the lower ends of water runs.

It is considered that the Bowbells Development Farm is representative of this general area in soil and topography. It has better than average natural drainage conditions but still retains ground water at fairly shallow depths. The extent of irrigation use to date has been insufficient to represent a comparative test of what can be expected if a substantial area should be irrigated under the conditions usual to general farm practice.

Soils

The general texture of the soils above the glacial till subsoil, while somewhat heavier than might be preferred, is within the range of soils found to be suitable for irrigation. Rates of absorption of the surface soils meet the requirements for successful irrigation.

The glacial till subsoil is extremely compact, has a very small difference in moisture content between its field capacity and saturation and has very low permeability. It is estimated that the difference between saturation and field capacity is only about 3 per cent by weight of the till (1, p. 60). Ground water movement occurs only at very slow rates under steep gradients.

The difference in texture between the surface soil and the till subsoil usually found at depths of about three feet is a factor in the irrigation of these lands where heavy leveling may be required. Exposed subsoil will have reduced productivity until it is improved by the use of fertilizer and continued cultivation.

Alkalinity

The areas showing surface indications of alkali are relatively small; however excessive alkalinity occurs in the subsoil of parts of the area. For the area in the Bowbells Block 5% was placed in Class A3 and 14% in Class A6 (1, Table 33). Analyses of the ground waters in the Bowbells Block show wide variations in individual wells, with a general average of over 7,000 parts per million of total solubles (1, p. 51). Wells in the remainder of the area west of the Des Lacs River show similar results.

With such alkali contents in the present ground waters and with salt deposits in the subsoil, the higher ground waters resulting from irrigation will gradually cause surface accumulations of alkali. Under these conditions, and with knowledge of the high costs involved in bringing water to these lands, the feasibility of providing adequate subsoil drainage when the need for it arises should be determined in advance of the initial project construction if the danger of a major project failure is to be avoided. The situation would be aggravated by the salt content of the water applied to the land. It is estimated that water from the Missouri River, after evaporation losses in transit to the project area, would contain about a ton of total dissolved salts per acre-foot.

Permeability of Glacial Till

As the permeability of the till was recognized by the Bureau as the controlling factor in the drainage of this area, much effort has been expended in attempts to measure the rate at which moisture moves in these soils (1, p. 53 and 9). In order to secure control of the movement of moisture, much of the work has been done in the laboratory. Both disturbed and undisturbed soil samples have been used. Interpretation of such laboratory tests involves the uncertainty of their application to field conditions. However, small ring tests in the field and laboratory tests yield useful information in relative terms for different soils.

Attempts have also been made to measure permeability by draw down tests made by pumping from wells (1, p. 60). The duration of such tests and the small amount of draft secured were, in our opinion, insufficient to supply results from which conclusions regarding the drainability of these lands can be drawn.

The Bureau has classified as Class 1 for permeability any soil which can absorb water at a rate exceeding one-fifth inch per hour (1, p. 71). Rates of absorption of less than 0.06 inches per hour are placed in Class 6. For subsoil drainage, a layer at least one foot in thickness in the subsoil must have a permeability rate of one inch per hour to be rated in Class 1. A rate less than three-tenths of an inch per hour is placed in Class 6 for drainage (1, p. 53).

The glacial till below 36 inches depth was found to have an average permeability of 0.02 inches per hour (1, p. 59). This represents very nearly an imperviousness soil. The total pore space of the till is about 30% (1, p. 60). The imperviousness of the till results from the smallness of the individual pores rather than the absence of pores. The average apparent density is 1.85 giving a soil weight of about 116 pounds per cubic foot (1, p. 60). Its average depth below ground surface is fifty feet and there are maximum depths of over 100 feet. The field and labora-

tory tests show a generally high percentage of exchangeable sodium with resulting low permeability (1, p. 41). The Project Board of Review in its report of February 6, 1950 states that the extremely low permeability of the till is the result of the combination of its density and the high percentage of exchangeable sodium contained in the ground water. (1, p. 63 and 15, p. 3.)

Topography

The principal unfavorable factor in the topography of this area is the irregular surface. The general slope of the area as a whole is well adapted to irrigation although the undulating surface with its many minor depressions interferes with regular layouts for irrigated fields. Heavy leveling would result in high land costs and reduced yields on areas where fertile top soils have been removed.

The cost of even moderate leveling for farm layouts adapted to the topography will result in farm costs to be incurred by the landowners which, on much of these lands, will approach or even exceed the present value of lands for dry farming. Such leveling would result in a doubling of the landowners' present investment per acre if this area should change from dry farming to irrigation. Such land leveling costs would be separate from the charges for the construction of the irrigation project system and its annual operation costs.

The topography of this area, considered by itself, in our opinion would not prevent the successful irrigation of these lands. The irregular land surface is an additional detrimental factor in the feasibility of irrigating this area rather than a controlling one.

Pot Holes

The pot holes in the area west of the Des Lacs River are such a prominent feature of the factors affecting irrigation that separate comments are warranted. Like many glaciated areas, closed topographic depressions were left when the glacier retreated. These vary from temporary ponds of less than an acre to permanent lakes.

The pot holes are important in relation to the drainability of these lands. Any system of surface drains would be based on providing outlets for the pot holes and any deep drains would follow the same general alignment.

The pot holes also furnish an indication of ground water movement. Percolation from them appears to occur at relatively slow rates. At the request of the Board, borings were made by the Bureau adjacent to four pot holes and the depths of ground water were observed weekly during May 1952 (29). These observations showed that the ground water was receiving some increment although the rate of percolation appeared to be very slow.

Present Ground Water Conditions

The present water table is high, generally 5 to 15 feet below much of the land surface (1, p. 47). The ground water contains large amounts of soluble salts, varying widely in individual areas but averaging about 7,000 parts per million (1, p. 51). As the only apparent source of water now contributing to the maintenance of the water table is the small accretion from rainfall and melting snow, the present high ground water conditions indicate that natural drainage is restricted and slow.

Sprinkling Irrigation

In an effort to avoid excessive land leveling on the Bowbells Development Farm, part of the Farm has been irrigated by portable sprinklers. While this method was successful in avoiding land leveling, difficulties arose because of lack of capacity of the sprinkler plant and frequent uneven distributions of water due to wind action. This resulted in the replacement by gravity irrigation of a part of the area formerly sprinkled.

The Bureau made an estimate of the cost of a distribution system to supply water for sprinkler irrigation on a 30,000 acre tract within the project area (1, p. 102). Such a system would involve high costs of installation and large amounts of power for its operation.

In theory irrigation with sprinklers permits light applications of water to be distributed uniformly and thus reduce run-off and percolation losses. These results if obtainable would reduce the amount of water requiring removal through a deep drainage system and thus might delay the time at which such a system would be required in this area.

In our opinion, sprinkler irrigation is not an answer to the problem of sustained irrigation on the lands west of the Des Lacs River. Its costs for equipment and for operation would have to be met by the landowners. These costs would be in excess of permissible costs for types of crops which can be raised and the yields obtainable in this area.

Experience in Other Areas of Glacial Till

The Bureau has made reports (1, 15, and 24) on the irrigation experience in other areas of glacial till. In addition to a study of these reports the Board has discussed conditions with persons who have direct knowledge of these areas and are in a position to compare them with the glacial tills west of the Des Lacs River. The Board did not visit any of these other areas in connection with the preparation of this report. To enable dependable soil comparisons with other areas to be made would have required amounts of time on the part of the Board comparable to the time used in investigating the area west of the Des Lacs.

The areas of glacial till on which irrigation has been practiced include projects in Canada, near Lethbridge, and in Montana near Valier. The information available on these areas indicates that the character of the glacial tills differs to an etxent from those in the area west of the Des

Lacs River, so that an attempt to draw conclusions from the experience in these other areas becomes a matter of judgment rather than of proof. Probably no area having comparable topography, alkalinity and glacial till subsoil has been placed under irrigation under conditions and to an extent that it can supply an example of what will happen in the area west of the Des Lacs if it should be placed under irrigation.

Drainability.

The most important factor affecting the suitabiliy of these lands for sustained irrigation is their slow drainability. Under irrigation, artificial drainage would be required and the feasibility of accomplishing adequate results would determine the success or failure of irrigation.

The general surface slopes of the area are adequate for construction of drainage works and outlets usually exist within reasonable distances into which drainage waters could be discharged. Much of the area contains disconnected pot holes and other surface depressions which serve to impound run-off and contribute accretions to the ground water. This condition could be corrected by the construction of surface drains at reasonable costs.

Surface drainage would be needed immediately to remove waste waters escaping from the irrigated fields. Subsurface drainage would be needed ultimately to control the elevation of the ground water, now dangerously close to the surface in many places. Surface drains would reduce the amount of percolation to the ground water and thus postpone the time when deep drains would be required, but surface drains alone would not meet the full needs or avoid the necessity for some type of deep drainage. A system of deep open drains could be adapted for use in removing surface waste but the shallow drains needed to remove surface waste would not be generally adaptable for deep drainage.

Available records show that some ground water movement occurs in the till. The ground water rises in the spring melt period and lowers slowly during the remainder of the year. While the spring rise may be due to the return to the ground water of upward capillary movement which occurred during the freezing period (30), the continued lowering in the late summer months indicates a slow general ground water outflow. Water in the pot holes appears to lower at rates somewhat in excess of the expected rates of evaporation and transpiration, thus indicating an accretion to the ground water from this source (29).

In the easterly portion of the area the lands border on the Des Lacs River, the channel of which is over 100 feet below the surface of the lands to the west. A study of the run-off records of this stream (28) indicates that there are no significant inflows of ground water from its drainage area.

That the rate of ground water movement in the till is very slow is indicated further by the experience with borings below the water table

made for use in measurements of the ground water elvation. In usual practice such holes are bored and the water in the holes reaches equilibrium with the adjacent ground water within a period of a few hours. For three-inch borings into the till subsoils in this area the time required to reach similar equilibrium has been found frequently to be a matter of days, extending over a week in many cases (1, p. 48).

Irrigation of these lands would place additional ground water into the present supply. Existing natural drainage through the tight till soils cannot be expected to remove the additional ground water burden and waterlogging and salinization of the soils of material portions of the area would follow. Therefore, sustained irrigation would require the installation of a deep drainage system but the success of such works would depend upon the rate of movement of ground water to the drains through the glacial till subsoils. The depth of the more permeable surface soil is insufficient to enable the surplus ground water to be removed by drainage from the top of the glacial till and the till is too deep to permit its penetration by a drainage ditch. The principal factor which would prevent the success of a deep drainage system would be the low permeability of the underlying till.

While the amount of water which would need to be removed from the area by deep drainage would be relatively small, nevertheless its removal would be necessary if waterlogging and salinization is to be prevented. During a long period of time the need for progressive installations of very extensive and costly works would develop. Because of the unique soil characteristics and the high amounts of salts in the subsoils and ground waters these works might not in the end be fully effective.

CONCLUDING STATEMENT

This Board is keenly aware that a successful irrigation project in the area west of the Des Lacs River would be highly beneficial to the people in the area and to North Dakota as a whole. Also it is aware that the people in this area have been given reason to expect that such an irrigation project was feasible and that they have expended much effort and money based on that expectation.

However, it is the unanimous and considered belief of the members of this Board that the feasibility of the project is highly speculative and that under the conditions that prevail widespread and sustained irrigation would eventually result in loss rather than benefit for most of the people in the area.

The cost of this review was paid for on a 50-50 basis by the State Water Conservation Commission and the Bureau of Reclamation. Each agency allocated 10 thousand dollars for the study. The total cost of this study was $11,063.02 of which the State Water Conservation Commission paid 50% and the Bureau of Reclamation paid 50%.

ORGANIZED IRRIGATION DISTRICTS

There are in North Dakota 9 organized irrigation districts. Of the districts organized 5 are operating, 1 is under construction and 3 are organized but construction of irrigation facilities has not been undertaken. The operations of these organized irrigation districts will offer a guide for other districts that will be organized in the future as irrigation development in the state progresses.

Of the organized districts that are operating, the oldest is the Lower Yellowstone Project located in McKenzie County first irrigated in 1909 and comprising some 20,000 acres in North Dakota. Of the other operating projects 3 are located in McKenzie and Williams counties on the Yellowstone and Missouri Rivers. These were organized and constructed during the 30's and early 40's.

A brief discussion of these projects is as follows:

LOWER YELLOWSTONE IRRIGATION DISTRICT

The oldest irrigation district in operation in the state is the Lower Yellowstone Irrigation District located along the Yellowstone River in McKenzie County. The district as a whole includes about 58,000 acres of land in Montana and North Dakota, of which 20,000 acres are in North Dakota. The project was one of the first constructed under the Federal Reclamation law of 1902 by the U. S. Reclamation Service. The irrigation facilities were constructed during the period 1907-1909 and the first irrigation water was available in 1909.

The construction costs chargeable to this project amounted to $66 per acre, which amortized over a period of 40 years amounted to a repayment of $1.60 per acre per year. In addition the operation and maintenance charge for the 1951 season was $1.90 per acre.

The principal crops produced on this project are alfalfa, sugar beets potatoes, wheat, barley, corn, oats, beans and flax. The average return per cultivated acre on the North Dakota portion of the project was $56.20 for the 1951 season, and for the 1950 season $59.30 per acre. The crop report of the district shows further that there are 215 operators on the farms in the 20,000 acres of the project in North Dakota and that these operators had farmed on the project for an average of 9 years. An important operation on the project is feeding and fattening cattle and sheep for market.

A summary of the crop production report for District Number 2 which is the portion of the project in North Dakota is given below. A summary of the combined report for both districts of the project is given in this section.

LOWER YELLOWSTONE IRRIGATION DISTRICT
CROP PRODUCTION REPORT — 1951 SEASON
NORTH DAKOTA — DISTRICT 2

Total Irrigated and Cultivated acres	16,413	
Gross Crop Value		$771,734
Additional Revenue (Sugar Program)		150,618
Total Gross Revenue		$922,352
Average value per acre		$56.20

Crop	Acres	Yield Per Acre	Total	Value of Crops Per Acre	Total
CEREALS					
Barley	653	29.70	19,395	$25.25	$16,486
Corn	12	10.00	120	16 00	192
Oats	760	45.17	34,331	28.91	21,792
Wheat	5,633	28.30	159,414	52.35	294,916
	7,058		213,260	$47.26	$333,566
FORAGE					
Alfalfa Hay	3,146	2.24	7,037	$38.03	$119,629
Other Hay	110	1.40	154	11 20	1,232
Irrigated Pasture	1,395			12.20	16.740
Beet Tops			10,994		7,146
Green Manure Crops	59				
Corn Fodder	67	4.58	307	45.82	3,070
Corn Silage	509	6.83	3,477	34 16	17,385
	5,286			$31.25	$165,202
MISC. FIELD CROPS					
Sugar Beets	2,226	9.88	21,988	$93.84	$208,886
Dry & Edible Beans	338	14.14	4,781	81.33	27,491
	2,564			$92.19	$236,377
SEED CROPS					
Alfalfa	68	.32	22	$13.59	$ 924
Flax	115	2.72	313	14.70	1,690
	183		335	$14.28	$ 2,614
VEGETABLES					
Potatoes	172	220.93	38,000	$165.70	$ 28,500
FAMILY GARDEN	73			$75.00	$ 5,475
Total All Crops	15,336				
Less Multiple Crops	127				
	15,209			$50.74	$771.734
Land in Fallow and Soil Building and Additional Revenue	1,204				150,618
	16,413	acres		$56 20	$992,352

Livestock Inventory

All Cattles and Calves	789
Milk Cows	326
Other Cattle (Beef)	337
All Hogs and Pigs	513
All Sheep and Lambs	1,945
Ewes, 1 year and older	1,691
All Hens	2,329

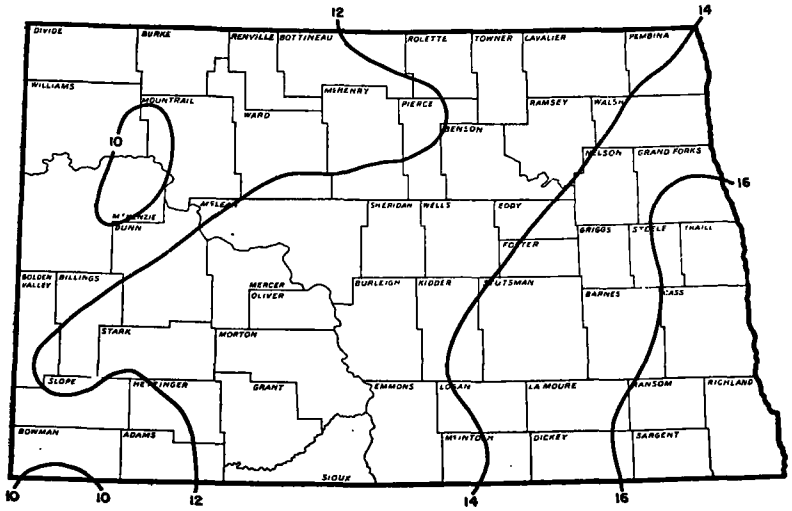
Fattened for Market During Year

Cattle and Calves Fed for Market	946
Lambs and Sheep Fed for Market	21,427

Livestock and Poultry Raised or to be Raised During Year

Calves	396
Pigs	130
Lambs	647
Chickens	165

NORTH DAKOTA
AVERAGE WARM-SEASON PRECIPITATION (INCHES)
(APRIL TO SEPTEMBER INCLUSIVE)



LOWER YELLOWSTONE IRRIGATION DISTRICT
North Dakota and Montana — 49,164 Acres
CROP RETURNS

CROP	1947 Av. Yield	1947 Acre Value	1947 Total	1949 Av. Yield	1949 Acre Value	1949 Total	1950 Av. Yield	1950 Acre Value	1950 Total	1951 Av. Yield	1951 Acre Value	Total
CEREAL:												
Barley	39.51	55.31		31.0	27.90		36.62	27.47		37.23	31.64	
Corn	35.17	52.76		34.36	29.21		29.09	24.73		24.91	39.85	
Oats	55.88	44.71		42.96	25.77		52.59	28.92		47.90	30.65	
Wheat	30.71	74.63		24.61	44.30		26.85	47.25		28.67	53.04	
Speltz	42.04	42.04		28.41	25.57		60.00	48.03		40.54	36.49	
Subtotal			$1,080,936.51			$ 686,950.40			$ 691,766.00			$ 890,331.00
SEED:												
Alfalfa	1.52	25.59		1.23	30.76		3.02	75.68		.64	27.07	
Clover	4.00	24.00		2.19	15.79					1.33	11.78	
Flax	10.21	61.27		10.12	33.92		15.99	46.03		3.58	19.32	
Millet	17.42**	47.78**										
Subtotal			74,733.60			18,561.35			12,928.00			9,381.00
FORAGE:												
Alfalfa	1.92	28.87		2.35	24.17		2.20	30.89		2.13	36.50	
Other Hay	1.00	5.98		1.18	3.54		1.07	3.22		1.65	13.22	
Corn Fodder	1.57	7.83		1.45	5.82		2.68	13.38		4.20	42.04	
Corn Silage	6.72	20.15		5.10	12.75		7.27	18.18		7.23	36.14	
Sugar Beet Tops		5.62			4.20			6.72				
Irrigated Pasture		12.50			12.50			12.50			12.00	
Subtotal			225,873.50			319,820.50			411,557.00			566,645.00
VEGETABLES:												
Beans, Commerce	9.5	45.04		9.06	51.21		14.21	48.17		13.15	75.63	
Potatoes, White	65.55	59.00		210.0	110.75		300.65	232.24		220.23	165.17	
Gardens, Truck		83.27			70.35			78.34			75.00	
Subtotal			74,610.00			125,384.95			198,782.00			99,730.00
Sugar Beets	11.25	126.34	1,929,583.52	10.3	91.84	983,272.50	10.34	95.67	1,036,518.00	9.90	94.08	713,023.00
Gross Crop Value			$3,386,738.03			$2,133,089.70			$2,351,551.00			$2,279,110.00
Additional Revenue			498,037.25			532,206.03			424,497.00			498,762.00
Total Gross Value			$3,883,775.28			$2,666,195.73			$2,776,048.00			$2,777,872.00
Value Per Acre			80.19			54.33			56.52			56.43

SIOUX IRRIGATION DISTRICT

Construction of the Sioux Irrigation project was completed in 1938 under the supervision of the State Water Conservation Commission and financed by the Rural Rehabilitation Corporation. The project is located on the right bank of the Yellowstone River in McKenzie County near the town of Cartwright. About 800 acres of the project are irrigable. Water was first made available for this project in 1940 when 508 acres were irrigated.

A few difficulties have been encountered in the pumping plant and replacement of the pump motor was necessary. During the period 1946-1948 the State Water Conservation Commission assisted the district in reconstructing the main canal below the intake and assisted in ditch cleanout work. The Commission paid $2,026.28 toward the cost of these repairs. During the past biennium the Commission paid $1,479.78 toward the costs of installing a new natural gas engine for the district.

LEWIS AND CLARK IRRIGATION DISTRICT

The Lewis and Clark project was constructed in 1937 by the State Water Conservation Commission in cooperation with the Rural Rehabilitation Corporation who supplied the finances to purchase the land and pay the construction costs. The project comprises about 7,700 acres of land along the Missouri River six miles southwest of Williston in McKenzie County and is divided into 53 units varying in size from 100-160 acres of irrigable land. Approximately 5,000 acres of the lands in the project are irrigable.

After development of the project was completed the farms were sold to the operators as a complete irrigation unit, the purchase price of the farm included the construction costs. The Rural Rehabilitation Corporation was the agency under whom such sales were made. Under this procedure there has been no assessment made by the district to cover the construction costs of the irrigation works. The District does make an annual operation on maintenance assessment, which in 1952 was $3.00 per acre.

Crop returns from the Experimental Farm located in the project indicate the yields listed below.

YIELDS

CROP	1950	1951	1952	'50-'52 avg.	'46-'52 avg.
Alfalfa	5 ton/ac	6 ton/ac	6 ton/ac	5⅔ ton/ac	.....
Corn (silage)	.....	10 ton/ac	14 ton/ac	12 ton/ac	.....
Oats	110 bu/ac	60 bu/ac	56 bu/ac	75 bu/ac	85 bu/ac
Barley	82 bu/ac	58 bu/ac	26 bu/ac	55 bu/ac	59 bu/ac
Flax	27 bu/ac	17 bu/ac	25 bu/ac	23 bu/ac	23 bu/ac
Potatoes	385 bu/ac	300 bu/ac	350 bu/ac	345 bu/ac	.....

Estimated Average yields for the years 1950, 51, and 52 of project operators are:

CROP	YIELD
Alfalfa	3½-5 tons/acre
Corn (silage)	7-12 tons/acre
Oats	40-70 bushel/acre
Barley	35-50 bushel/acre
Wheat	20-35 bushel/acre
Flax	15-22 bushel/acre
Potatoes	200-300 bushel/acre

BUFORD-TRENTON IRRIGATION PROJECT

The Buford-Trenton project was constructed in 1940-1941 by the Bureau of Reclamation in cooperation with the Department of Agriculture under the Case-Wheeler Act. This project includes about 14,000 acres along the Missouri River in Williams County. The development of the project included clearing and preparing the lands in the district for irrigation, construction of canals, a pumping station and other irrigation facilities as well as homes and farm buildings for the operators. The complete units were made available to the farmers in 1943. After construction was completed, the project was turned over to the Farm Security Administration for operation.

Since 1943 the actual operation of the project has been accomplished through the Buford-Trenton Mutual Aid Corporation. In 1950 the farmers on the project voted to organize an irrigation district that would function in the operation of the project. The Board of Reclamation is negotiating with the water users on the project on a repayment contract for the land and irrigation facilities.

HEART RIVER IRRIGATION DISTRICT

The Heart River Irrigation District was organized in 1946 by order of the state engineer upon petition and approval of the landowners of the area included in the district. About 13,000 acres of lands located in the Heart River Valley below the Heart Butte Dam are included in the district. The construction of the project is under the direction of the Bureau of Reclamation.

The Bureau of Reclamation began construction of the Heart Butte Dam, located about 20 miles south of Glen Ullin, in 1947 and construction was completed in 1949. This dam was built mainly for flood control and irrigation and multiple uses. The lands to be irrigated were those situated in the Heart River Irrigation district. After the dam was completed, plans of the Bureau of Reclamation to construct the remainder of the irrigation works for the district went forward. Negotiations for a repayment contract between the Bureau of Reclamation and the District were started but were delayed because some of the landowners in the district objected to the inclusion of their lands in the district and filed petitions demanding that such lands be excluded. The matter of exclusion of their lands from the district was eventually appealed to the district court and to the Supreme Court of North Dakota. The context of the appeal to the Supreme Court and the decision of the court is given below.

The main issue involved in this case as it was appealed to the Supreme Court is:

"Must each tract of land within an irrigation district as a unit of assessment for general and special taxes contain only acreage upon which irrigation water can actually be applied or may such unit of assessment

consist of irrigable and nonirrigable areas provided each unit or tract of land as a whole is benefited by irrigation?"

The decision of the Supreme Court concerning this issue as stated in the syllabus of the opinion handed down by the court is as follows:

"Whether certain lands are nonirrigable from some natural cause is a question of fact to be determined in the first instance by the board of directors of an irrigation district under the provisions of Secs. 61-1016-7 NDRC 1943. Such a determination is a judicial determination and is subject to review by the courts.

"When a tract of land in an irrigation district is nonirrigable from some natural cause and it has been so determined by the board of directors of the district, or the court on appeal, it is the purpose of Sec. 61-1016 NDRC 1943 to require its exclusion from the district upon proper petition therefor being made to the board of directors of the district.

"In proceedings for excluding lands from an irrigation district the description thereof need not be more definite nor specific than the description provided by law to be used by the assessor in listing such lands for taxation, and where, as in the instant case, the board of directors of the irrigation district described the lands to be retained in the district by legal subdivisions of ten acres, such descriptions were permissable although certain ten acre tracts retained in the district contained portions of nonirrigable lands.

"In a proceeding to exclude lands from an irrigation district under the provisions of Chapter 61-10 NDRC 1943, where it appears that the board of directors of an irrigation district has divided the legal subdivisions into rectangular ten acre tracts, the refusal of the board to exclude those tracts containing a substantial portion of irrigable land was not erroneous, it not being imperative that irrigable areas retained within a district be described by metes and bounds."

The decision of the Supreme Court was referred back to the district court where further action is now pending.

The program of starting construction of the irrigation facilities for the unit has not materialized because of the failure to reach an agreement on the repayment contract between the Bureau of Reclamation and the irrigation district. Negotiations for a repayment contract for the Heart River irrigation district are continuing.

On October 20, 1951 the Assistant Secretary of the Interior, William E. Warne, conducted a public meeting to give the members of the Heart River Irrigation District an opportunity to express their views and suggestions as to how they would like to have irrigation in the Heart River Valley develop. It was the purpose of this meeting to gather information that might be used by the Department of Interior in formulating a satisfactory solution to the problems that arose in the development of the

project. Mr. Warne's report and recommendations on this meeting have not been released to the date of this report.

It is the contention of the State Water Conservation Commission that all possible information concerning the development of the Heart River project be made available and therefore, the Commission adopted a resolution requesting the secretary of the Interior to release Mr. Warne's report. There has been no action on the part of the Department of the Interior concerning this request.

Although irrigation for the district as a whole has been delayed several of the farmers and landowners in the district have made arrangements with the Bureau of Reclamation to purchase water stored in the Heart Butte Reservoir for use in irrigating small tracts of their farms. The Bureau has sold this water to the farmers for $1.50 per acre per season. A much greater demand for water under this type of an agreement is anticipated for the 1953 season.

FORT CLARK IRRIGATION DISTRICT

The Fort Clark Irrigation District, which is located in Mercer county on the right bank of the Missouri River between Stanton and Fort Clark, North Dakota, embraces about 6,000 acres of land of which 2,100 acres will be ultimately developed for irrigation. The district was organized in 1948 and in October, 1950 voted to accept a repayment contract offered by the Bureau of Reclamation. The proceedings leading to the organization of the district and the acceptance of the repayment contract by the district were reviewed by the Supreme Court and validated in July, 1951.

Construction of the irrigation facilities is underway at the present time and is expected to be completed in 1953. First irrigation water will be available in 1953 or 1954. The total cost of the project is estimated at about $600,000.00.

The repayment contract signed by the district calls for the repayment by the landowners at a rate of 4.15 per acre for a period of 40 years for each irrigable acre. In addition there will be a manual operation and maintenance charge that will depend upon the cost of operation of the district.

The Fort Clark unit will be the first of fifteen North Dakota pumping irrigation units to be developed under the Missouri River Basin project. It is expected that this district will serve as a guidance for future similar units that will be constructed under the supervision of the Bureau of Reclamation as irrigation in North Dakota develops.

YELLOWSTONE PUMPING IRRIGATION DISTRICT

The Yellowstone Pumping Irrigation District is located in McKenzie county on the Yellowstone River and was organized in 1938. This project is an extension of the Sidney project in Montana and includes about 2,000 acres in North Dakota. Irrigation waters would be provided through en-

larging the pumping facilities of the Sidney project so as to provide sufficient water to serve the area of the Yellowstone Pumping Irrigation project in North Dakota.

As a result of surveys made by the State Water Conservation Commission in 1941 the plan for furnishing water for this project as outlined above was evolved. The State Water Conservation Commission advanced $3,500 to this district to cover the construction costs of enlarging the Sidney project structures so as to serve the North Dakota unit. The district issued its registered warrant to the commission to cover this advance.

Before construction of the irrigation canals and other facilities were undertaken World War II had started and the district decided to delay the work due to material shortages and increase costs. To date this construction work has not been undertaken. Development of the project has now been included in the Bureau of Reclamation's program in connection with the development of the Sidney unit in Montana.

The State Water Conservation Commission still holds the registered warrant of the Yellowstone pumping irrigation district for $3,500. Payments received from the district were the satisfaction of the interest and principle of this warrant totaled $1,711.40.

BOWMAN-HALEY IRRIGATION DISTRICT

The Bowman-Haley irrigation district includes about 5,000 acres of valley land suitable for irrigation in Bowman County along the North Fork of the Grand River. This district was organized in 1933. Construction was delayed, owing to the districts inability to finance the work.

The plan for development of the project includes the construction of a 50 foot high dam on the Grand River that will store 45,000 acre-feet of water and other irrigation facilities. The stored water would be available for irrigation as well as for augmenting municipal water supplies. This project has been investigated by both the Bureau of Reclamation, Corps of Army engineers and State Engineers department over a period of nearly 50 years. It was first found feasible, but recently reported infeasible by the Bureau, however no report has been released to the Public.

Local interests in the project indicates that it is strongly desired. In order to protect the project and to assure an adequate water supply when development of the unit is undertaken the State Water Conservation Commission in 1950 preserved the unappropriated waters of the North Fork of the Grand River in North Dakota for the district.

WATER RIGHT FILINGS

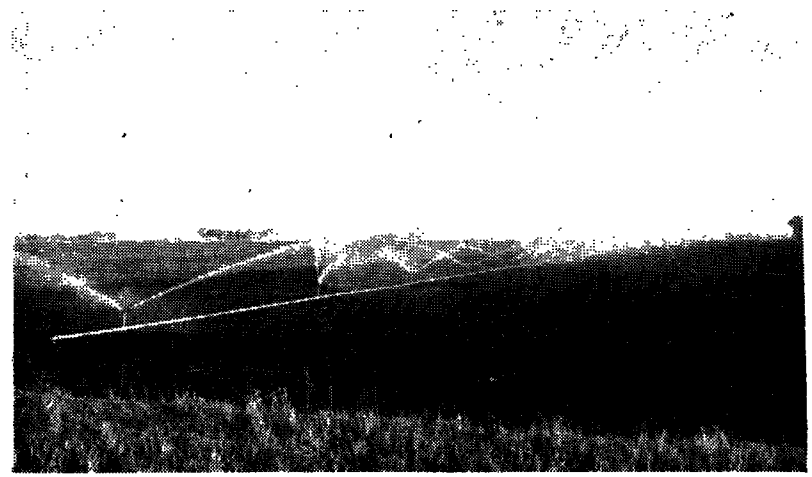
Section 61-0402 of the North Dakota revised code provides that "Any person, association, or corporation intending to acquire the right to the beneficial use of any waters, before commencing any construction for such purpose, or before taking the same from any constructed works, shall make application to the state engineer for a permit to appropriate."

Since the provision for water right filings was made in 1905 the State Engineer and the State Water Conservation Commission has processed over 600 water right applications for purpose of irrigation, municipal and industrial uses. Water rights established prior to the enactment of North Dakota's water right laws are recognized as valid and vested.

The water right applications on file in the office of the State Engineer establish the date of priority of use by the applicants. The right to use water for irrigation becomes appurtenant to the land to be irrigated and the transfer of title to the land carries with it the right to the beneficial use of water.

Forms for applying for water rights and instructions for completing same by applicants are furnished by the State Engineer upon request.

During the period July 1, 1950 to June 30, 1952, 79 applications for water to irrigate 10,212 acres of land have been received from irrigation districts, individuals and have been approved by the State Engineer and the State Water Conservation Commission. In addition 41 applications have been received for the irrigation of 5,300 acres that are pending on June 30, 1952. Of these 9 applications that were filed prior to July 1, 1950 are being held pending action of the International Joint Commission and other agencies from whom approval is required.



Sprinkler Irrigation System

WATER RIGHT APPLICATIONS PENDING JUNE 30, 1952
Applied for before June 30, 1950

No.	Name of Applicant	Lands to be Irrigated	County	Source	Sec. Ft.	Acres	Date of Claim
	Chester Olson, Towner	NW¼, W½NE¼, SW , W½SE¼ Sec. 6-157-75	McHenry	Mouse River		445	3-25-40
296	Wendel Sand, Gladstone	SE¼SW¼, SW¼SE¼ Sec. 26-142-94	Dunn	Deep Creek, trib. of Knife River	.75	60	5- 8-47
297	W. T. Krebsbach, Reeder	NW¼SW¼ 34-133-98	Slope	Cedar Creek, trib. of Cannonball R.	.5	40	5-31-47
298	Edward Hammer, Velva (Pending International Joint Comm. Action)	W½SE Sec. 7-153-79	McHenry	Souris River	.5	24.3	8-13-47
312	J. E. Harding, Medora	S½NW¼, NE¼, W½SW¼ Sec. 21; NE¼NE¼, SE NE¼, W½SE¼ Sec. 29-139-102	Billings	Little Missouri R.	3.0	246	7-30-49
313	D. L. McLeod, Medora	NE¼NW¼, SE¼NW¼, NW¼NE¼, S½NE¼, N½SE¼, SE SE¼ Sec. 23; SW¼NW¼, N½SW¼, SW¼SW¼ Sec. 24-142-102	Billings	Little Missouri R.	2.0	164	8- 3-49
316	Georgia Olson, Medora	S½SW¼ Sec. 1; SE¼SE Sec. 2; NW¼, N½SW¼ Sec. 11; NE¼NW¼, SE¼NW¼, S½NE¼ Sec. 14-142-102	Billings	Little Missouri R.	3.7	292	8-12-49
318	Ray Schnell	NE¼NW , NE¼, NE¼SW¼, SE¼SW¼, SE Sec. 11; NW¼, S½NE¼, SW¼, SE¼ Sec. 12-139-96	Stark	Heart River	7.54	603.7	8-29-49
345	Olaf Falkvord, Skaar	Stock Dam: NW¼ Sec. 6-145-104, (Montana) **Lands:** Secs. 31-32-33-34, 146-104 Secs.: 4-5-6-7-8-9-10-15-16-17-18, 145, 104 Secs.: 35-36, 146-105 Secs.: 1-2-3-11-12-13, 145, 105	McKenzie	Poison Spring Creek & Tributaries	4.0	200	5- 8-50

WATER RIGHT APPLICATIONS PENDING JUNE 30, 1952
Applied for July 1, 1950 to June 30, 1952

No.	Name of Applicant	Lands to be Irrigated	County	Source	Sec. Ft.	Acres	Date of Claim
354	Herbert, George C. & Oscar Indergard, Sidney, Montana	W½SW¼ Sec. 8; NE¼SW¼, SE¼SW¼, SE¼ Sec. 7-147-103	McKenzie	Baye Creek, trib. of Bennie Pierre Creek	2.75	217.8	8-12-50
356	Paul Motzko, Buford	SW¼NW¼, W½SW¼ Sec. 31-153-102; NW¼ Sec. 3-152-103	Williams	Eight Mile Creek, trib. of Missouri R.	3.0	256.3	9- 9-50
363	Henry Iszley, Cartwright	NW¼ Sec. 1-150-104	McKenzie	Two Dry Runs of Yellowstone R.	1.5	131.0	9-23-50
384	City of Bismarck	Municipal Water Supply	Burleigh	Missouri River	23.2		2- 5-51
386	R. C. Lewis, Fargo	NW¼, SW¼, W½SE¼ Sec. 21-141-49	Cass	Sheyenne River	4.15	332	3- 8-51
387	Leo L. Anderson, Fargo	NW¼, SW¼NE¼, N½SW , NW¼SE¼ Sec. 1-141-49	Cass	Red River	2.35	188	3-14-51
388	William Fowler, W. Fargo	SE¼NW¼, NE¼ Sec. 18-140-49	Cass	Sheyenne River	.89	72	3-19-51
389	A. L. Nordhougen, Fargo	SW SW¼ Sec. 19-139-48	Cass	Red River	.125	10	3-27-51
397	Donald C. Holand, etc., Lisbon	SW¼SW¼ Sec. 1-134-56	Ransom	Sheyenne	Less than 1 gal. per sec.	1.0	5- 7-51
399	Donald Novak, Alexander	NE¼NE¼, SE¼NE¼, NE SW¼, N½SE¼ Sec. 10-153-101	McKenzie	Lewis & Clark drain ditch, Missouri River	.75	66.6	6- 1-51
402	Chester Davis, Sidney, Montana	SW¼NW¼, N½SW Sec. 27; NW¼, NE¼, NW¼SW¼, W½SE¼ Sec. 28-146-103	McKenzie	Unnamed Creek, trib., Bennie Pierre Creek	2.5	200.6	7-12-51
403	Harry Kruger, Sidney, Montana	NE¼NW , S½NW¼, W½NE¼, SW¼, SW¼SE¼ Sec. 21-146-103	McKenzie	Unnamed Creek, trib., Bennie Pierre Creek	2.5	198.4	7-13-51

WATER RIGHT APPLICATIONS PENDING JUNE 30, 1952—(Continued)

Applied for July 1, 1950 to June 30, 1952

No.	Name of Applicant	Lands to be Irrigated	County	Source	Sec. Ft.	Acres	Date of Claim
408	Henry Knudsen, Cartwright	NE¼SW¼ Sec. 27, NW¼SE¼ Sec. 28-151-103	McKenzie	Charbonneau Creek, trib. Yellowstone R.	1.0	80.0	9- 4-51
409	Andrew Nelson, Foxholm	S½NE¼, N½SE¼ Sec. 26-157-85 (Pending International Joint Commission action)	Ward	Des Lacs River, trib. Mouse River	.26	31.1	9- 6-51
422	Joe Feist, Velva	NE SE¼ Sec. 23; NW¼SW¼ Sec. 24-153-80 (Pending International Joint Commission action)	McHenry	Spring Creek, trib. Souris River	3.0	67.5	1- 3-52
425	Eugene Johnson & George Gilbert, Lisbon	NE¼SE¼, SE¼SE¼ Sec. 23; W½SW¼ Sec. 24-134-56	Ransom	Sheyenne River	1.5	132.3	3- 7-52
427	T. Clem Casey, Bismarck	NW¼, W½NE¼, S½SW¼ Sec. 22, Twp. 139, Rge. 78	Burleigh	Apple Creek, trib. of Missouri River	1.0	163.2	3-19-52
432	Alvin Schreiber, Fairmount	NE¼ Sec. 33; NW¼, SW¼NE¼ Sec. 34-131-47	Richland	Bois des Sioux R., trib. of Red R.	2.0	290.2	3-31-52
437a	Nels Buckman, Gascoyne	W½SW¼ Sec. 4-130-99	Bowman	Buffalo Creek, trib. of Grand R.	½	42.5	4-28-52
437b	Nels Buckman, Gascoyne	SE NW¼, NE¼SW¼ Sec. 10-130-99	Bowman	Buffalo Creek, trib. of Grand R.	⅜	28	4-28-52
438	Floyd Monteith, Leonard	S½NW¼, N½SW¼ Sec. 8-135 N., Rge. 52 W.	Richland	Sheyenne River	.5	35.0	4-29-52
439	Elmer Flor, Marmarth	S½SW¼ Sec. 26-133-106; NE¼ Sec. 34-133-106	Slope	Beaver Creek, trib. Little Missouri R.	1.0	79.8	5-12-52
440a	Richard Palczewski, Haley	SW¼ Sec. 14-129-99	Bowman	Lightning Creek trib. of Grand R.	⅝	53.5	5-24-52
440b	Richard Palczewski, Haley (Temporary permit)	SW¼NE Sec. 34-129-99	Bowman	Grand River	¼	9.0	5-24-52
441	Flora Weinhandl & R. H. Weinhandl, Mandan	Lot AF and Lot Q of NE¼ Sec. 26-139-81	Morton	Missouri River	⅕	13.56	6- 2-52
442	Lloyd Dennis, Belfield	SW¼NE¼, NE¼SW¼, SE¼SW¼, W½SE¼, Sec. 29-142-98	Billings	Spring Creek, trib. of Green River	1.0	69.1	6- 5-52
443	M. M. Lunde, Cooperstown	W½SW¼ Sec. 3; NE¼SE¼, SE¼SE¼ Sec. 4; W½SW¼, SE¼SW¼ Sec. 10-145-58	Griggs	Permanent Lagoons & Sheyenne River	1.0	98.8	6- 6-52
444	Thomas Tarnavsky, Watford City	SE¼NE, SE¼ of Sec. 34; SW¼NW¼, NW¼SW¼ Sec. 35-148-99	McKenzie	Little Missouri R.	2.0	92.0	6-12-52
445	Albert Schmidt, Dickinson	N½SE¼ Sec. 12-138-96	Stark	Antelope Creek, trib. of Heart R.	0.63	50.7	6-12-52
446	John Schmidt, Jr., Dickinson	S½SW¼ Sec. 3; SW¼SE¼ Sec. 4-138-95	Stark	Antelope Creek, trib. of Heart R.	0.15	12.3	6-12-52
447	John Blees, Bowman	NE¼ Sec. 18-130-101	Bowman	Spring Creek trib. of Grand R.	1⅛	90.5	6-18-52
448	Northwest Nursery Co., Valley City	S½NW¼, SW¼ Sec. 15; SE¼NW¼, NE¼NW¼ Sec. 22-140-58	Barnes	Sheyenne River	1.3	103	6-20-52
449	Sunset Memorial Gardens, Inc., Fargo		Cass	Red River			6-28-52

No.	Name of Applicant	Municipal Water Supply	County	Source of Supply Baldhill Reservoir	Amount of Water Claimed in Sec. Feet	Date of Claim
	American Crystal Sugar Co.	NE¼NW¼ 5-139-48	Cass	Sheyenne River	7.75 c.f.s.	June 4, 1948
	City of Fargo	NW¼NW¼ 5-138-49	Cass	Sheyenne River	0 to 25	June 5, 1948
	Grand Forks	NE¼SE¼ 10-151-50	Grand Forks	Sheyenne River	7.2	June 8, 1948
	Great Northern Railway	NE¼NW¼ 5-136-50	Richland	Sheyenne River	g.p.d. 50,000	June 9, 1948
	Northern Pacific Railway			Sheyenne River	10	
	Soo Line Railway	SW¼NE¼ 16-140-58	Barnes	Sheyenne River	0.0297	June 14, 1948
	Northern States Power Co., Fargo, N. Dak.	In city of Fargo 4th St. S. and 4th Ave. S. Projected to Red River	Cass	Sheyenne River	1.33	June 14, 1948
	Union Stock Yards West Fargo, N D.	NE¼ 6-139-49	Cass	Sheyenne River	g.p.d. 1,500,000	June 28, 1948
	Valley City		Barnes	Sheyenne River	56	Mar. 22, 1949
	Lisbon (Contrib. to Baldhill Dam)		Ransom	Sheyenne River		Pending
	Southwest Fargo		Cass	Sheyenne River	0 to 5	July 23, 1948

WATER RIGHT FILINGS
LISTED AS PENDING IN SUPPLEMENT "A" OF THE SEVENTH BIENNIAL REPORT
Approved Since June 30, 1950

No.	Name of Applicant	Lands to be Irrigated	County	Source	Sec. Ft.	Acres	Date of Claim
322	Herman Leutz, Taylor	SW¼NW¼ Sec. 1; NE¼NW¼, N½NE¼ Sec. 2, Twp. 137 N, Rge. 92 W.	Stark	Heart River	0.6	47.0	10-31-49
324	Chester Abrahamson, Bowman	NE¼SE¼ Sec. 20; N½SW¼, SW¼SW¼ Sec. 21, Twp. 129 N., Rge. 102 W.	Bowman	North Fork, Grand R.	1.0	82.5	11-16-49
326	William Lassey, Cartwright	SE¼NE¼, NE¼SE¼, S½SE¼ Sec. 10; S½NW¼, W½SW¼ Sec. 11, Twp. 150 N., Rge. 104 W.	McKenzie	Yellowstone River	1.6	128.1	12- 3-49
329	Jake and Norbert Fries, Mott	N½NE¼, SE¼NE¼ Sec. 27, Twp. 134 N., Rge. 91 W.	Hettinger	Thirty Mile Creek, trib. Cannonball R.	1.0	67.5	12-21-49
331	Leonard Lowe, Rhame	S½SW¼ Sec. 15; N½NW¼, SE¼NW¼, SW¼SW¼ Sec. 22; NE¼NE¼, S½SE¼ Sec. 21; NE¼NE¼ Sec. 28, Twp. 129 N., Rge. 106 W.	Bowman	Little Missouri R.	2.0	160.0	2- 3-50
339	Mark Andrews, Mapleton	SW¼, SE¼ Sec. 20; SW¼, SE¼ Sec. 21, Twp. 140 N., Rge. 50 W.	Cass	Maple River, trib. of Sheyenne River	1.0	608.6	3- 3-50
344	John Brunsman, LaMoure	W½NW¼, NW¼SW¼, Sec. 1; SE¼NE¼, NE¼SE¼ Sec. 2, Twp. 133 N., Rge. 61 W.	LaMoure	James River	1.0	80.5	4-18-50
347	Ewald Feiler	NE¼NE¼ Sec. 12-139-95 NW¼NW¼ Sec. 7-139-94	Stark	Green River, trib. of Heart River	.5	6	6- 6-50
348	Anders Madson, Alexander	NW¼NW¼, S½NW¼, SW¼NE¼, SW¼, NW¼SE¼, S½SE¼ Sec. 9, Twp. 152 N., Rge. 100 W.	McKenzie	Missouri River	3.0	257.0	6- 8-50
349	Anders Madson, Alexander	SW¼ of Sec. 7, Twp. 152 N., Rge. 100 W.	McKenzie	Timber Creek, trib. of Missouri R.	1.0	80.0	6- 8-50
350	Frank Palczewski, Scranton	SE¼ Sec. 28; NE¼NE¼ Sec. 33; N½NW¼, SE¼NW¼, W½NE¼ Sec. 34, Twp. 129 N., Rge. 100 W.	Bowman	North Fork, Grand River	1.0	215.5	6-10-50

WATER RIGHT FILINGS
Filed and Approved — July 1, 1950 to June 30, 1952

No.	Name of Applicant	Lands to be Irrigated	County	Source	Sec. Ft.	Acres	Date of Claim
340	Ed Whitney, Ypsilanti	NE¼, SE¼ Sec. 12; NE¼, SE¼ Sec. 13, Twp. 138, Rge. 63 W.	Stutsman	James River	1.0	200	3- 7-50
351	R. I. Miller, Rhame	A—NE¼SW¼, SE¼ Sec. 34-129-106 B—NE¼SW¼, N½SE¼ Sec. 28; NE¼SW¼, SE¼SW¼, N½SE¼ Sec. 29-129-106	Bowman Bowman	Little Missouri Box Elder Creek, and Little Mo.	1.0	80	7-24-50
352	Calvin Miller, Rhame	A—NE¼SE¼, SE¼SE¼ Sec. 34; SW¼ Sec. 35-129-106	Bowman	Reservoir on Intermittent Stream, tributary Little Missouri River	1.0	80	7-24-50
		B—S½SW¼, SW¼SE¼ Sec. 29; NE¼NW¼, SE¼NW¼, W½NE¼ Sec. 32-129-106	Bowman	Box Elder Creek, trib. Little Missouri River	1.0	80	7-24-50
353	C. L. Stenhjem, Kindred	SE¼NW¼, SW¼ Sec. 11-137-50	Cass	Sheyenne River	1.0	80	7-31-50
355	W. L. Gardner, New England	W½SE¼ Sec. 4-135-97	Hettinger	Cannonball River	.5	24.5	8-14-50
357	Oscar Austin, New England	NE¼SE¼, S½SE¼ Sec. 21; N½NE¼ Sec. 28-135-96	Hettinger	Cannonball River	1.0	58.8	9-14-50
358	Robert Martin, Mott	NW¼ Sec. 3-133-93	Hettinger	Cannonball River	1.0	80.0	9-14-50
359	Fred Martin, Mott	NE¼ Sec. 4-133-93	Hettinger	Cannonball River	1.0	80.0	9-14-50
360	A. C. DeLaPointe, Mott	S½SW¼ Sec. 34-134-93	Hettinger	Cannonball River	⅛	11.4	9-18-50
361	Frank Gruber, Haley (Temporary permit)	NE¼NE¼, SE¼NE¼ Sec. 34-129-100	Bowman	Grand River	1.0	40.6	9-18-50
362	John Neurohr, Gladstone	S½NE¼, N½SE¼ Sec. 17; NW¼SW¼ Sec. 16-139-94	Stark	Heart River	.535	42.8	9-21-50
363	Henry Iszley, Cartwright (Temporary permit)	NW¼ Sec. 1-150-104	McKenzie	Two dry runs, trib. of Yellowstone River	1.5	131	9-23-50
364	John B. and Neil Davison, Lemmon, S. Dak.	NE¼NW¼, SE¼NW¼ Sec. 15; N½NW¼, N½NE¼, SW¼NE¼, SE¼SE¼ of Sec. 23-130-93	Adams	South Fork of Cannonball	1.0	61.6	9-29-50

WATER RIGHT FILINGS
Filed and Approved—July 1, 1950 to June 30, 1952 (Continued)

No.	Name of Applicant	Lands to be Irrigated	County	Source	Sec. Ft.	Acres	Date of Claim
365	R. Spangenberger, Heil	NE¼SW¼, S½SW¼, N½SE¼, SW¼SE¼ Sec. 6; NW¼NE¼ Sec. 7-134-87	Grant	Antelope Creek, trib. of Heart R.	.97	77.5	10- 3-50
366	Joe Hackenberg, Williston	S½SW¼ Sec. 26-153-102	McKenzie	Missouri River Slough	1.0	78	10-10-50
367	Joe Wingenback, Brisbane	NW¼SW¼, S½SW¼ Sec. 26-132-87	Grant	Cannonball River	.335	26.8	10-11-50
368	William Wruck, Bentley	N½NW¼, SE¼NW¼, N½NE¼, SE¼NE¼, NE¼SE¼, S¼SE¼ Sec. 1-133-91	Hettinger	Thirty Mile Creek & Cannonball R.	1.0	80	10-27-50
369	Alvin Abrahamson, Bowman	SE¼NW¼, SW¼NE¼, NE¼SW¼, NW¼SE¼ Sec. 31; S½SE¼ Sec. 32-129-101	Bowman	North Fork of Grand River	1.0	47.9	11-14-50
370	George Bergmeyer, Elgin	NE¼SW¼, SE¼SW¼, S½SE¼ Sec. 2-133-89	Grant	Cannonball River	.518	41.5	11-22-50
371	Richard Engwicht, Richardton	NE¼NW¼, SE¼NW¼, NW¼NE¼ Sec. 4-141-91	Dunn	Little Knife River	.565	45.2	11-24-50
372	Clemens Urlacher, Lemmon, S. Dak.	NW¼NE¼, S½NE¼, N½SE¼ Sec. 25-130-92; SW¼NW¼, W½SW¼ Sec. 30-130-91	Adams	South Fork of Cannonball	1.0	78.9	12-23-50
373	John Nordahl, Halliday	N½NW¼, SE¼NW¼, NE¼SW¼, Sec. 30-145-91	Dunn	Spring Creek, trib. of Knife R.	1.0	79.9	12-29-50
374	Albert M. Schmit, Oakes	NE¼NW¼, SE¼NW¼, SW¼ Sec. 7-130-59	Dickey	James River	2.0	157.2	1- 6-51
375	Albert M. Schmit, Oakes	NE¼, NW¼ Sec. 17-131-59	Dickey	Bear Creek, trib. of James River	2.0	250.8	1- 6-51
376	Albert M. Schmit, Oakes	SW¼ Sec. 20; NE¼SE¼, SE¼SE¼ Sec. 19-131-59	Dickey	James River	2.0	157.4	1- 6-51
377	Albert M. Schmit, Oakes	S½NE¼, SE¼ Sec. 7-131-59	Dickey	James River	2.0	171.1	1- 6-51
378	Albert M. Schmit, Oakes	NE¼ Sec. 20-131-59	Dickey	Well-Static water level 19′, depth 81′	1.6	149.2	1- 6-51
379	Albert M. Schmit, Oakes	SE¼ Sec. 17-131-59	Dickey	Well-Static water level 28′, depth 81′	1.8	144	1- 6-51
380	George Phillips, Williston	S½SW¼, SW¼SE¼ Sec. 6; N½NW¼ Sec. 7-154-100	Williams	Little Muddy, trib. of Missouri River	1.5	106.4	1-11-51
381	Herbert Sprecher, New Leipzig	NW¼ Sec. 36-134-91	Hettinger	Turkey Creek & Thirty Mile Creek, trib. N. Fork of Cannonball River		27.9	1-22-51
382	Adolph Kalina, Bowman	S½SE¼ Sec. 19; N½NE¼ Sec. 30; NW¼NW¼ Sec. 29; SE¼ Sec. 28-131-102	Bowman	Dry Run & Spring Creek, trib. Spring Creek & Grand River	1.0	80.0	1-26-51
383	Ben Huether, Regent	14.4 in Lot 2; 6-132-96	Adams	Chanta Peta Creek, trib. S. Fork of Cannonball	.18	14.4	2- 1-51
385	Fred F. Hall, Chaseley	Sec. 16-147-72	Wells	Lake located in Sec. 16-147-72, trib. James River	1.0	640	2- 5-51
390	Ernest Jensen, Grenora	NE¼ Sec. 34-160-103	Divide	Natural Lake	2.0	149.4	4- 5-51
391	A. C. DeLaPointe, Mott	SW¼ Sec. 32-134-93	Hettinger	North Fork of Cannonball River	.82	65.4	4- 6-51
392	James River Soil Cons. Dist., Oakes	NE¼NE¼, S½NE¼ Sec. 32; SW¼NW¼, NW¼SW¼ Sec. 33-131-59	Dickey	Underground water from wells	1.49	121.2	4- 9-51
393	J. H. Winslow, LaMoure	NW¼ Sec. 2-133-61	LaMoure	James River	1.0	79.0	4-13-51
394	Warren W. Erickson, Cartwright	NE¼SE¼, SE¼SE¼ Sec. 21; NW¼, NE¼, N½SW¼, NW¼SE¼ Sec. 22; W½NW¼ Sec. 23-152-103	McKenzie	Missouri River	6.0	457.1	4-18-51
395	Christ Christenson, Pekin	N½NW¼ Sec. 30; S½SW¼ Sec. 19-150-60	Nelson	Sheyenne River	1.0	72.4	4-19-51
396	Albert H. Fordahl, Hettinger	SE¼SW¼, SW¼SE¼ Sec. 10; NE¼NW¼, SE¼NW¼ Sec. 15-131-95	Adams	South Fork of the Cannonball River	1.0	79.3	5- 7-51
398	John Tibor, Glen Ullin (Draeb & Krauth)	NW¼, NE¼ Sec. 29, Twp. 137, Rge. 90	Grant	Heart River	1.39	111.4	5-11-51

WATER RIGHT FILINGS
Filed and Approved—July 1, 1950 to June 30, 1952 (Continued)

No.	Name of Applicant	Lands to be Irrigated	County	Source	Sec. Ft.	Acres	Date of Claim
400	Valley City Fish Cultural Station	Fish hatchery	Barnes	Sheyenne River and tributaries	Descr. in app.	Pool A 31.28	6-20-49
401	Emil Gustafson, Dodge	N½NW¼, SE¼NW¼, N½NE¼, SW¼NE¼ Sec. 5-144-91	Dunn	Spring Creek, trib. of Knife R.	.91	72.8	7- 2-51
404	Alvin Andre, Grenora	NW¼ Sec. 24-158-103	Williams	Unnamed Creek, trib. Willow Creek	2.0	160.0	7-14-51
405	Nick Andre, Grenora	NW¼ Sec. 25-158-103	Williams	Willow Creek, trib. Cottonwood Creek	2.0	151.0	7-16-51
406	George W. Hammer, Reeder	W½NE¼, SE¼ Sec. 32-130-98	Adams	Buffalo Creek, trib. North Grand River	1.0	80	8-14-51
407	Earl Rundle, New England	NE¼NE¼, S½NE¼, W½SE¼ Sec. 32-136-99	Slope	North Fork of Cannonball River	.63	50.2	9- 1-51
410	John Boehm, New England	NE¼SE¼, SE¼SE¼ Sec. 9; W½SW¼ Sec. 10-135-96	Hettinger	Dead Horse Creek, trib. North Fork Cannonball River	1.0	80	9-16-51
411	Vernon Miller, Rhame	S½NW¼, N½SW¼, SW¼SW¼ Sec. 32-129-106	Bowman	Box Elder Creek, trib. Little Missouri River	.87	69.7	9-18-51
412	Leo Gardner, New England	NE¼NW¼, NE¼ Sec. 14-135-97	Hettinger	Cannonball River	1.0	80	9-21-51
413	Chas. H. Schumacher, New England	SW¼NE¼ Sec. 4-135-97	Hettinger	North Fork Cannonball River	.25	15.5	10- 1-51
414	Allan K. Rustan, DeSart	NW¼ Sec. 5-133-97	Hettinger	Chanta Peta Creek, trib. South Fork of Cannonball	.98	78.4	10- 2-51
415	Eddie R. Rustan, DeSart	N½NW¼, SE¼NW¼, NW¼NE¼, S½NE¼ Sec. 9-133-97	Hettinger	Chanta Peta Creek. trib. South Fork of Cannonball	.51	40.9	10- 2-51
416	Valley City Fish Cultural Station, Baldhill Unit	Fish hatchery	Barnes	Sheyenne River and tributaries		Pool A 23.0	6- 1-50
417	Fort Clark Pumping Unit (U. S. Bur. of Recl.)	Lands lying within Irriga. Dist. described in "Order"	Mercer and Oliver	Missouri River	40.0	2,039	10- 1-51
418	Kenneth Underland, Bucyrus	NW¼NW¼ Sec. 34, Twp. 132 N., Rge. 96 W.	Adams	South Fork of the Cannonball R.	.266	30	12- 6-51
419	Nels Underland, Bucyrus	W½NW¼; W½SW¼; Sec. 28-132-96	Adams	South Fork of the Cannonball R.	.85	68.0	12- 6-51
420	Earl Krinke, Haley (Temporary permit)	NE¼ Sec. 36-129-100	Bowman	North Fork of the Grand River	.76	60.6	12-10-51
421	W. O. Rabe, Dickinson	NE¼ Sec. 30; SE¼NE¼, NE¼SE¼ Sec. 19, 135-102	Slope	Deep Creek, trib. Little Missouri R.	.825	33.0	12-15-51
423	James Towberman, Dickinson	NW¼SW¼ Sec. 7-138-95	Stark	Antelope Creek. trib. Heart River	.356	28.5	1-31-52
424	Gustaf L. Carlson, Mandan	NW¼, W½NE¼ of Sec. 5-138-82	Morton	Sweet Briar Creek, trib. Heart River	1.0	48.7	3- 6-52
426	Ervin E. Mohl, Beulah	NW¼, S½NE¼, N½SE¼ Sec. 28-144-88	Mercer	Spring Creek, trib. Knife River	1.0	93.8	3-10-52
428	Charles Peterson, LaMoure	S½NW¼, NE¼SW¼ Sec. 33-133-60	LaMoure	James River	.9	73.2	3-26-52
429	Donald Martin, Marmarth	SE¼SW¼, W½SE¼ Sec. 10; NW¼NE¼ Sec. 15-132-106	Bowman	Little Missouri R.	1.0	79.9	3-27-52
430	Larry Martin, Marmarth	NW¼NE¼, S½NE¼; SE¼ Sec. 15-132-106	Bowman	Little Missouri R.	1.0	80.0	3-27-52
431	Donald Lowe, Rhame	SW¼ Sec. 22; N½NW¼ Sec. 27-129-106	Bowman	Little Missouri R.	1.0	80.0	3-29-52

WATER RIGHT FILINGS
Filed and Approved—July 1, 1950 to June 30, 1952 (Continued)

No.	Name of Applicant	Lands to be Irrigated	County	Source	Sec. Ft.	Acres	Date of Claim
433	Arthur Nordby, Scranton	SE¼NW¼, NE¼SW¼, SE¼SW¼ Sec. 8, Twp. 132, Rge. 99	Bowman	Cedar Creek, trib. of Missouri River	½	38.1	4- 2-52
434	Bureau of Reclamation, U. S. Dept of Interior, Billings, Montana	Dam and Reservoir	Stutsman	James River			4-16-52
435	Bureau of Reclamation, U. S. Dept of Interior, Billings, Montana	City of Jamestown, Municipal Water Supply	Stutsman	James River	15		4-16-52
436	Lynn Peterson, LaMoure	SW¼NE¼, W½SE¼ Sec. 28-133-60	LaMoure	James River, trib. Missouri River	1.0	79.7	4-24-52

WATER CONSERVATION AND FLOOD CONTROL DISTRICTS

The original act authorizing the establishment of water conservation districts was enacted by the legislature in 1935 and embodied in the session laws of that year under Chapter 228. It designated the State Engineer as State Water Conservation Commission and provided that whenever presented with a petition signed by any county, city, village, township or by any cooperative grazing association, or by fifty per cent or more of the freeholders within the limits of a proposed water conservation district, the commissioner was required forthwith to make an investigation of the proposal. If he should find that the establishment of a water conservation district would be impracticable or undesirable he was directed to make an order disallowing the petition, giving his reasons for such action. Upon the adoption of the 1943 Revised Code the Office of State Water Commissioner was abolished and the State Water Conservation Commission was vested with his functions. The Act of 1935 was embodied in the 1943 Revised Code under Chapter 61-16.

In 1949 the legislature enacted a new law authorizing the creation of "Water Conservation and Flood Control districts".

This act, now in effect, reenacted the various sections of Chapter 61-16 of the 1943 Revised Code and further provided that water conservation and flood control districts may be established for the purpose of water conservation or flood control, or both water conservation and flood control.

When presented with a sufficient petition requesting the establishment of a water conservation and flood control district the State Water Conservation Commissioner may direct its Chairman and Secretary to execute on its behalf an order establishing such district. And "in determining the area to be included within the district the Commission shall disregard township and county boundaries and shall consider only the drainage area to be affected by the water development proposed and the probable future development thereof". Th order of the Commission must specify the name or number by which each conservation and flood control district shall be known and must be filed with the County Auditor of each county within which any portion of the district shall lie.

At the first regular meeting or special meeting of the board of county commissioners after an order establishing a district has been filed with the county auditor, the board of county commissioners must appoint a board of water conservation and flood control commissioners for such district. When any such district is confined to the limits of one county, such board shall consist of three members. When any such district shall include land in two counties, the board of commissioners shall consist of five members of which three must be appointed by the board of county commissioners of the county containing the greater "acreage" within the district, and two must be selected by the board of county commissioners containing the lesser acreage. And when any such district shall

include land in more than two counties, two members must be appointed by the county board of each county except that only one member may be appointed from the county containing the least acreage within the district, thus insuring such district an odd instead of an even number of commissioners.

The county auditor is required to serve as secretary and the county treasurer is required to serve as treasurer of the water conservation and flood control district. If such district includes land in more than one county, the county auditor and county treasurer of the county having the greatest acreage are required to serve as secretary and treasurer respectively.

All dams, water conservation and flood control devices constructed in any water conservation and flood control district are under the jurisdiction of the board of commissioners of such district unless specifically exempted therefrom. Dams constructed by or with the assistance of a federal agency and having no one responsible for its operation and maintenance, and outside of a water conservation and flood control district, are under the jurisdiction of the board of county commissioners of the county in which such dams or devices are located.

The powers and duties of the board of a water conservation and flood control district in ten numbered paragraphs under Section 61-1614 of the 1949 Supplement to the 1943 Revised Code. The powers and duties of such board are very comprehensive. Among these are (1) the power to sue and be sued, (2) to exercise the right of eminent domain, (3) to accept funds and financial assistance from federal, state and any other public or private sources for the construction or maintenance of water conservation and flood control projects and (4) "to do all things necessary and proper to preserve the benefits to be derived from the construction, control and regulation of the water resources of this state."

A tax of not to exceed one-half mill may be levied upon all the taxable property within a water conservation and flood control district to meet the expenses of the district. Special assessments may be levied against lands benefited by a water conservation or flood control project. Before special assessments may be levied substantially the same procedure must be followed as in the case of drainage districts.

Five water conservation and flood control districts have been organized in the state. They are: Bowman County, Adams County, Nelson County, Pembina County and Rush River located in Cass County.

The 1949 North Dakota legislature, in order to facilitate the construction of the Missouri-Souris irrigation and water diversion project created a conservancy and reclamation district known as the "Missouri-Souris Conservancy and Reclamation District":

1. To provide for the future economic welfare and prosperity of the people of this state, and particularly of the people residing in the area embraced within the boundaries of such conservancy and reclamation district.
2. To provide for the irrigation of lands within the sections of such district periodically afflicted with drought, and to stabilize the production of crops on such lands.
3. To replenish and restore the depleted waters of lakes, rivers and streams in said district, and to stabilize the flow of said streams.
4. To replenish the waters of, and to restore the level of Devils Lake.
5. To make available within the district, waters diverted from the Missouri river for irrigation, domestic, municipal and industrial needs, and for hydroelectric power and other beneficial and public uses.

The district embraces the following fifteen counties: Divide, Burke, Williams, Renville, Ward, Bottineau, McHenry, Pierce, Benson, Ramsey, Eddy, Foster, Stutsman, LaMoure and Dickey. Other counties adjoining may become part of the district.

FINANCES

When the State Water Conservation Commission was created by the legislature in 1937, the legislature appropriated $112,500.00 to the "Administration Fund" of the Commission to cover its general operating expenses. In addition the legislature in Section 61-0246 of the North Dakota Revised Code provided:

"The Commission may provide by resolution, at one time or from time to time, for the issuance of state water conservation commission revenue bonds not exceeding a total of three million dollars, for the purpose of paying the cost of any one or more of the works authorized by this chapter and for the purpose of acquiring lands and preparing and developing the same for irrigation. The principal and interest of such bonds shall be payable from the special fund provided for in this chapter for such payment."

Appropriations have been made each biennium by the legislature to the Commission's "Administration Fund" and, at the present, the Commission has one bond issue outstanding. Information concerning the finances of the Commission is contained in the following paragraphs.

Funds appropriated to the Commission to carry on its activities for the 1951-53 biennium totaled $581,000.00. During the 1949-51 biennium the Commission had available in appropriations from the legislature $606,400.00. An explanation of the items for which appropriations were made for the 1951-53 biennium is as follows:

Commissioners Per Diem and Expenses — $6,000.00

Appropriations for this item are used to pay the per diem allowance and travel and maintenance expenses of the members of the Commission while attending meetings and conferences and conducting other official business for the Commission in the state.

Administration — $35,000.00

This item is used to cover the general operating administrative expense of the Commission. Included are salaries and travel expenses of administrative personnel, office supplies, equipment, and all other expenses connected with the administration work of the Commission.

Maintenance of Dams — $120,000.00

The Commission's share of the cost of repairing small dams throughout the state is paid from this item. This dam repair program is financed on a cooperative basis with local groups or agencies and the State Game and Fish Department sharing in the costs. These funds are used to cover the purchase of materials and supplies, labor and salaries, equipment rental and all other expenses of the various repair jobs. The actual work is done by repair crews of the Commission using state equipment.

International and Interstate Commissioners & Conference Expenses — $14,000.00

Expenses incurred by the members and employees of the Commission while attending out-of-state meetings and conferences of an international or interstate nature such as river compact meetings, congressional hearings, Missouri River Basin meetings and similar activities are paid from this item.

Topographic Surveys-Cooperation with U. S. Geological Survey — $35,000.00

Appropriations for this item are used to pay the state's 50% share of the costs of conducting topographic mapping of the state in cooperation with the U. S. Geological Survey.

Hydrographic Surveys—Cooperation with U. S. Geological Survey — $25,000.00

The state's 50% share of the costs of maintaining stream gaging stations and gathering and compiling stream flow data is paid from this appropriation. The U. S. Geological Survey is in charge of this program.

Salary—State Engineer — $6,000.00

The Secretary and Chief Engineer of the State Water Conservation Commission is also designated State Engineer. He is the supervisor of the use of all the waters of the state. The item of the appropriation is used to pay his salary as State Engineer for the biennium.

Construction and Reconstruction Drains or Irrigation — $90,000.00

Funds appropriated to this item are used to pay the state's 40% share of the cost of construction work on legal drains in the state and to pay a share of the costs of repair work on various irrigation districts in the state.

Engineering and Geological Surveys and Demonstrations — $35,000.00

This item is used to pay the state's share of the costs of conducting underground water surveys for communities in the state in cooperation with the U. S. Geological Survey and the local communities. The U. S. Geological Survey pays 50% of the costs of this work and state and local funds constitute the other 50%. The State Water Conservation Commission has designated the State Geologist as its representative in matters dealing with underground water surveys.

Cooperation with U. S. Departments and for Organizing Conservation & Irrigation Districts — $135,000.00

This appropriation is used to finance cooperative programs for development of water resources in the state with various federal agencies such as the Bureau of Reclamation, Corps of Engineers, Soil Conservation Service, Department of Agriculture and others. These programs include soil surveys, surveys of areas for irrigation development and other investigations. This appropriation is also used to assist in organizing irrigation and conservation districts.

Small Projects, Other Investigations, Demonstrations, etc. — $150,000.00

This appropriation is used by the Commission in making surveys, investigations and plans for development of areas in the state not covered under other programs of federal or state agencies. Information compiled in these investigations is available to other agencies for use in their programs.

NORTH DAKOTA STATE WATER CONSERVATION COMMISSION
Financial Statement
June 30, 1952
1949-1951 Appropriations

APPROPRIATION	Available	Expended June 30, 1950	Expended July 1, 1950 to June 30, 1952	Balance July 1, 1952
Commissioners—Per Diem & Expenses	$ 4,000.00	$ 2,079.03	$ 1,916.86	$ 4.11
Administration	30,000.00	18,317.87	17,500.29	11.54
Collections and Refunds	5,829.70			
Maintenance of Dams	100,000.00	58,020.76	95,372.76	176.10
Collections and Refunds	53,569.62			
International & Interstate—Commissions' & Conference Expense	12,000.00	5,578.77	4,322.28	2,098.95
Topographic & Conservation, Cooperation with U. S. Geological Survey	30,000.00	7,392.16	22,607.84	.....
Hydrographic Surveys, Cooperation with U. S. Geological Survey	20,000.00	9,383.34	10,616.66	.....
Salary—State Engineer	5,400.00	2,700.00	2,700.00	.....
Construction & Reconstruction Drains or Irrigation	150,000.00	21,423.23	105,181.56	23,395.21
Engineering & Geological Surveys & Demonstrations	30,000.00	18,220.04	14,786.08	.....
Plus Transfer	3,006.12			
Cooperation with U. S. Depts. & for Organizing Conservation & Irrigation Districts	135,000.00	2,940.73	60,054.37	59,004.90
Minus Transfer	—13,000.00			
Other Investigations & etc.	90,000.00	52,710.79	37,203.82	85.39
	$655,805.44	$198,766.72	$372,262.52	$84,776.20

NORTH DAKOTA STATE WATER CONSERVATION COMMISSION
Financial Statement
June 30, 1952
1951-53 Appropriations

APPROPRIATIONS	Available	Expended to June 30, 1952	Balance July 1, 1952
Commissioners—Per Diem & Expenses	$ 6,000.00	$ 1,888.62	$ 4,111.38
Administration	35,000.00	16,136.56	21,231.81
Collections and Refunds	2,368.37		
Maintenance of Dams	120,000.00	69,717.07	100,154.18
Collections and Refunds	49,871.25		
International & Interstate—Commissions' & Conference Expense	14,000.00	3,302.92	10,697.08
Topographic & Conservation, Cooperation with U. S. Geological Survey	35,000.00	10,363.85	24,636.15
Hydrographic Surveys, Cooperation with U. S. Geological Survey	25,000.00	9,242.43	15,757.57
Salary—State Engineer	6,000.00	3,000.00	3,000.00
Construction & Reconstruction Drains & Irrigation	90,000.00	.....	90,000.00
Engineering & Geological Surveys & Demonstrations	35,000.00	16,800.48	18,199.52
Cooperation with U. S. Depts. & for Organizing Conservation and Irrigation District	65,000.00	38,911.05	26,088.95
Small Projects, Other Invest., Surveys & Etc.	150,000.00	22,976.29	127,023.71
	$633,239.62	$192,339.27	$440,900.35

BONDS OUTSTANDING

When the State Water Conservation Commission undertook the organization and construction of several irrigation projects during the 1930's and early 1940's several bond issues were sold to obtain funds to finance the work. These bond issues were secured by the districts for whom the projects were developed. In 1945 the Commission consolidated these outstanding bond issues into one Series J issue of $63,000.00. These bonds are 2%, due December 10, 1957.

This bond issue is secured by a Sinking Fund composed of U. S. Government Bonds, Sioux Irrigation District Bonds and cash not invested in securities and is on deposit with the Bank of North Dakota as Sinking Fund Trustee. The status of this issue is as follows:

Bonds Outstanding:

Series J Bonds — 2%	$63,000.00

Secured by Sinking Fund on Deposit with Bank of North Dakota as Sinking Fund Trustee, composed of:

Cash	$ 1,163.28
Series G — U. S. Government Bonds 2½%	70,000.00
U. S. Treasury Bonds 2½%	3,000.00
Sioux Irrigation Bonds 3%	21,500.00
	$95,663.28

SIOUX IRRIGATION DISTRICT BONDS

Construction of the Sioux Irrigation project was financed with funds in the amount of $25,000.00 borrowed by the Commission from the Rural Rehabilitation Corporation. The district in turn issued its bonds to the Commission for 25,000.00 bearing 3% interest. The Commission's obligation to the Rural Rehabilitation Corporation was settled in the transaction of the Series J Refunding issue discussed above.

The bonds of the Sioux Irrigation District are to mature as follows: $5,000 July 1, 1949 and $1,000.00 annually thereafter. To date $3,500 of these bonds have been redeemed. Negotiations are underway to refund this bond issue in order that the district will better be able to levy assessments to take care of this obligation.

CONSTRUCTION BOND GUARANTY FUND

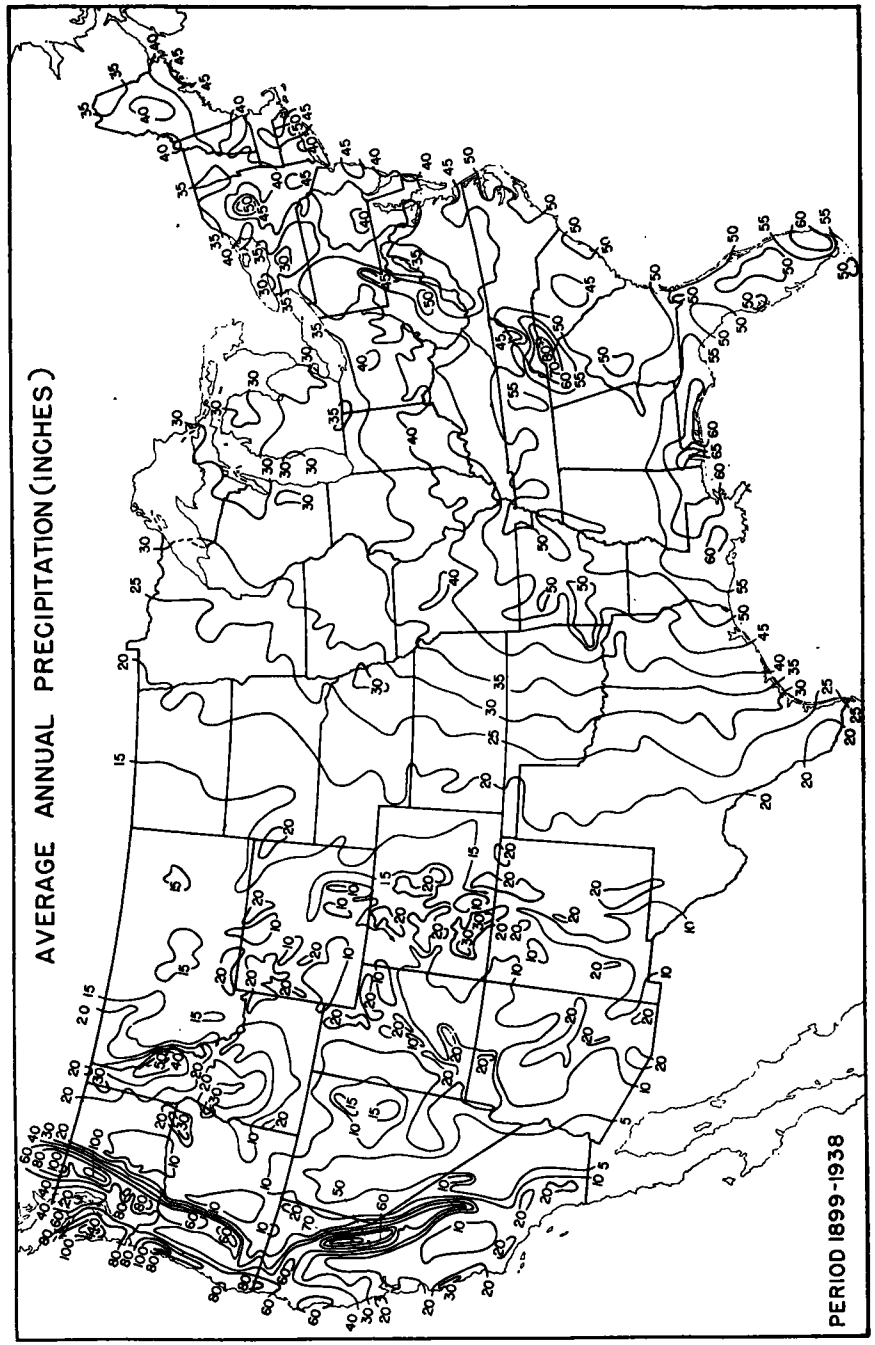
The legislature in 1939 appropriated $50,000.00 to the State Water Conservation Commission as a Construction Bond Guaranty fund to be used by the Commission to provide security, up to 20% of bond issues of irrigation districts. The purpose was to provide additional security for these bond issues so the irrigation districts would be able to secure a more favorable interest rate. This appropriation is a continuing and does not

revert to the General Fund. The 1941 legislature appropriated an additional $40,000.00 for this purpose making the total appropriated to this fund $90,000.00.

Of this appropriation $19,459.00 has been deposited with the Bank of North Dakota as collateral for various bond issues and is included in the Sinking Fund.

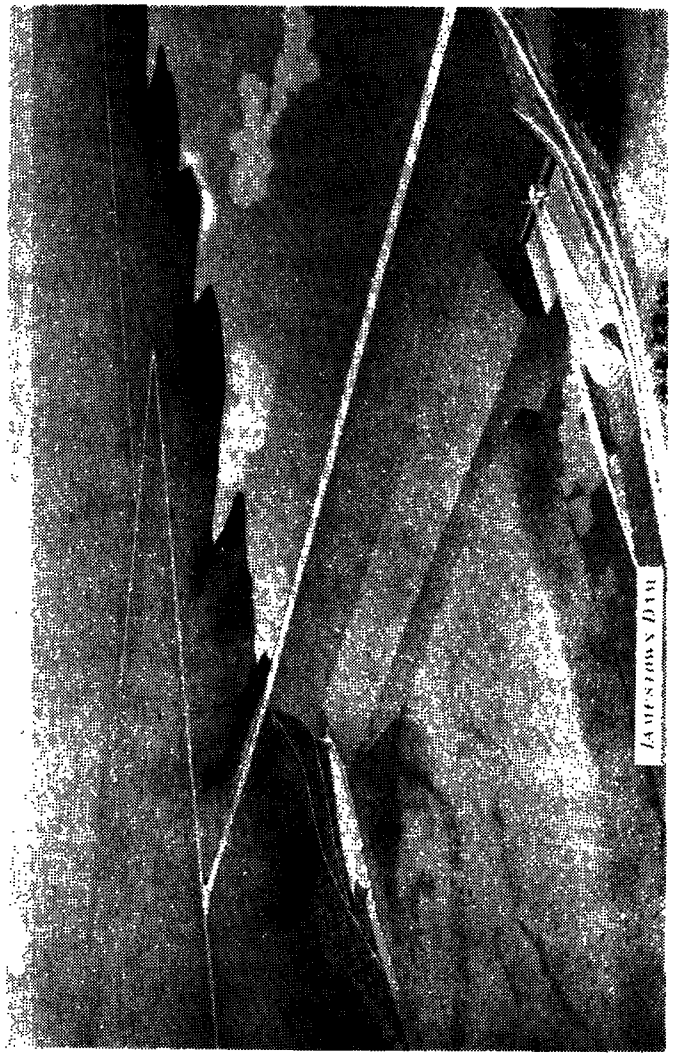
YELLOWSTONE PUMPING IRRIGATION DISTRICT WARRANT

In 1939 the State Water Conservation Commission loaned $3,500.00 to the Yellowstone Pumping Irrigation District to finance the enlargement of the intake structure of the Sidney project in Montana so that it would be sufficient to serve the Yellowstone Pumping Irrigation District in North Dakota. The district issued a construction warrant to the Commission covering this advance. Assessments were to be levied on lands in the district to pay this construction warrant. Tax collections applied to interest and principal of this warrant to June 30, 1952 are $1,711.40.



Chapter III

U. S. BUREAU OF RECLAMATION ACTIVITIES



Artist's Sketch of Jamestown Dam

BUREAU OF RECLAMATION ACTIVITIES

The Bureau of Reclamation, originally called the Reclamation Service, was created in 1902 by order of the Secretary of the Interior to administer the Reclamation Act adopted in that year. The primary objective of the Bureau of Reclamation is the transformation of arid and semi-arid land into productive farms through irrigation. Utilization of waters stored for irrigation to provide for flood control, hydroelectric power, municipal water supplies, recreation, stream pollution abatement and propogation of fish and wildlife are other of the multiple-purpose objectives of the Bureau of Reclamation's program.

The Bureau of Reclamation's activities in North Dakota are under the direction of Kenneth Vernon, Regional Director of Region VI. Bruce Johnson is District Manager of the Missouri-Souris District which includes the greater part of North Dakota in which the Bureau of Reclamation is carrying on its work. The projects of the Missouri-Souris District are discussed below in connection with the division of which they are a part.

MISSOURI-SOURIS DIVISION

The Missouri-Souris Division is in northeastern Montana and North Dakota extending from Fort Peck Dam in Montana eastward to the vicinity of Devils Lake, North Dakota and southward along the James River to near Britton, South Dakota. It is planned in this division to utilize the water stored in the Fort Peck Reservoir for irrigation and other uses in North Dakota.

As originally planned a dam downstream from the Fort Peck dam would divert water into the Missouri Canal from which it would be taken to serve irrigable land in Montana. This canal would also be used to fill the Medicine Lake Reservoir in northeastern Montana from which it would be lifted by a pumping plant at Grenora into the Souris Canal. The water would then be transported by the Souris Canal to provide for the irrigation of hundreds of thousands acres in the Crosby-Mohall, Devils Lake, New Rockford, Jamestown and Oakes units in North Dakota. In addition return flows from irrigation could be reused to restore levels of Devils and Stump Lakes and to provide for municipal and sanitary uses in downstream areas. Flows in the Red River could be supplemented through division into the Sheyenne and Devils Lake basins.

Topographic, geologic and land classification surveys of this unit are nearing completion. Engineering and Soil Surveys are in progress and special detailed studies are being made. These surveys have revealed the following:

In Montana irrigable areas totaling about 155,000 acres have been found.

In North Dakota a large portion of the western most lands located in the Crosby-Mohall area first proposed for irrigation have been classified as nonirrigable because of dense subsoils and restricted drainage. The

report of the Bureau of Reclamation disclosing these findings was reviewed by a Board of Review composed of irrigation experts who substantiated the Bureau's findings. The report issued by this Board of Review was financed cooperatively by the State Water Conservation Commission and the Bureau and can be found on page 164. Lands east of the Crosby-Mohall area were found to be more adaptable to irrigation and a large acreage in Bottineau County, east of that included in the original project, has been determined to be irrigable.

Investigations of lands located in this division indicate that there are excellent possibilities of developing irrigation in the Sheyenne River Basin in the Devils Lake, Harvey, New Rockford, area in central North Dakota. It is estimated that almost 250,000 acres of irrigable land is available in this area.

The Jamestown Unit includes about 10,000 irrigable acres along the James River between Jamestown and Oakes. One of the main features of this unit is the Jamestown Dam, presently under construction, which will store return flows from future upstream irrigation for irrigation and municipal use, as well as to provide partial flood protection for the city of Jamestown. There are also about 100,000 irrigable acres in the Oakes area that will be served by these return flows in the James River as regulated by the Jamestown Dam.

With the exclusion of the land of the Crosby-Mohall area the possibility of diverting water from the Garrison Reservoir to serve these irrigable areas rather than diverting from the Fort Peck Reservoir has been considered as being more practical. Under this plan water would be diverted from the Garrison Reservoir from the Snake Creek portion of the Reservoir to a canal in which it would flow to a point near Velva and then northward to serve the Souris Loop and Bottineau county areas. The canal included in this plan would be about 80 miles long compared with the 250 mile canal required if the water were diverted from Fort Peck Reservoir.

Data on dams and reservoirs in this unit are:

Jamestown Dam and Reservoir

(Under Construction)

Earthfilled, excavation — 1,400,000 C.Y. Embankment — 940,000 C.Y.
Concrete 5,500 C.Y.
Height — 80 feet. Length — 1,400 feet.
Spillway — Gloryhole type, Capacity 3,100 c.f.s.
Reservoir capacity—230,000 acre feet
Drainage area — 1,291 square miles.

Sheyenne Dam and Reservoir

Earthfill type
Height — 92 feet. Length — 2,300 feet.
Reservoir Capacity — 535,000 acre feet
Drainage area — 935 square miles

NORTH DAKOTA PUMPING DIVISION

The North Dakota Pumping Division consists of 15 separate pumping units along the course of the Missouri River in North Dakota. These units will be irrigated by pumping from the Missouri River or from the back waters of the Garrison and Oahe Reservoirs. The total area purposed for irrigation in the 15 units is approximately 67,500 acres. These units and their irrigable acreages are as follows:

Williston	9,000 acres
Nessen	7,400 acres
Hancock Flats	5,400 acres
Fort Clark	2,100 acres
Oliver-Sanger	8,300 acres
Painted Woods	2,700 acres
Manley	1,200 acres
Wogansport	1,600 acres
Square Butte	1,900 acres
Burnt Creek	1,300 acres
Bismarck	8,500 acres
Little Heart	2,300 acres
Horsehead Flats	6,500 acres
Winona	4,500 acres
Fort Yates	4,700 acres

Of these units construction of the Fort Clark Unit got underway during 1952 and preconstruction investigations were in progress on the Painted Woods, Hancock Flats, and Square Butte Units. The Bureau of Reclamation's program for the other units consisted of gathering preliminary data needed to establish an orderly program for development of these units. A discussion of those units in the construction and preconstruction phase is as follows:

FORT CLARK UNIT

The Fort Clark Unit is on the west bank of the Missouri River in Mercer and Oliver Counties a few miles south of Stanton, North Dakota. The unit is in an area of flood plains and terrace lands of which 2,100 acres have been classified as irrigable. To serve this irrigable land water will be pumped from the Missouri River at the upstream end of the unit area.

A contract was awarded for the construction of the project in March of 1952 and work began in April. The contract was awarded to the Korshoj Construction Company of Blair, Nebraska. The contract bid for constructing the project was $329,435.50, and the contract earnings as of June 30, 1952 amounted to $65,229.00. The Bureau of Construction of the project includes the construction and installation of the pumping plant facilities and the main canals of the project. The estimated total cost of the unit is $602,741.00.

Completion of construction of the project is scheduled for 1953 with water being available for the 1954 crop season.

PAINTED WOODS UNIT

The Painted Woods Unit is on the east bank of the Missouri River in Burleigh County about 7 miles southeast of Washburn, North Dakota. The unit is planned to serve approximately 2,700 acres of land by pumping from the Missouri River with one main pump and four relets. Studies are complete on a plan to provide irrigation water by pumping ground water. A proposed plan of development will be presented in 1952, and construction can begin when landowners are ready to organize a district and negotiate a repayment contract.

HANCOCK FLATS UNIT

The Hancock Flats Unit is on the east bank of the Missouri River in McLean County approximately 4 miles south of Riverdale. The unit, occupying a flood plain and a low terrace, consists of approximately 5,400 acres of irrigable lands. Preliminary investigations and land classifications have been completed for this unit and detailed surveys and plans for the pumping plant, canals and laterals will be prepared when landowner and local interest is made sufficient to warrant advancement of the work.

SQUARE BUTTE UNIT

The Square Butte Unit is on the west, or right bank of the Missouri River in Morton County about 8 miles north of Mandan. This unit contains about 1,900 acres of land classed as irrigable. Water to serve these irrigable lands will be pumped from the Missouri. No irrigation district has been formed as yet and continued detail studies will depend on the attitude of the landowners.

LITTLE MISSOURI DIVISION

The Little Missouri Division begins at the head waters of the Little Missouri River in northeastern Wyoming and extends downstream along the course of the river through southeastern Montana, northwestern South Dakota and western North Dakota to the confluence of the Little Missouri and Missouri Rivers near Elbowoods, North Dakota.

At the present time a plan is being studied whereby water will be stored in the proposed Bullion Butte Reservoir located northwest of Amidon and northeast of Marmarth, North Dakota, water would be used to irrigate about 20,000 acres of the Little Missouri River bottoms in North Dakota. A plan for diversion of waters to the head waters of the Heart, Cannonball, and Grand Rivers from the Little Missouri is also being investigated.

The multiple benefits that will accrue as a result of the development of the water resources of the Little Missouri Basin in addition to the irrigation benefits include the control of floods, retention of silt, expansion of recreational possibilities, and fish and wildlife conservation.

GARRISON DIVISION

The Garrison Division extends from Riverdale, North Dakota, eastward across central North Dakota to the vicinity of New Rockford. The Division includes pumping plants on the Snake Creek and Turtle Lake Reservoirs and a canal system that may eventually irrigate several hundred thousand acres of land. Present plans include the diversion of water stored in Garrison Reservoir by pumping into Snake Creek and Turtle Lake Reservoirs. A pumping plant on Turtle Lake Reservoir near Prophets Mountain would lift water over the divide between the Missouri River Valley and the James and Sheyenne Rivers. Once across the divide, water would be available for irrigation through a system of canals, power plants, reservoirs, and natural stream channels and would reach land proposed for irrigation in the east central and Souris river areas of North Dakota. Some areas included in this division could also be served by diversion from Fort Peck, however, if both diversion from Garrison and Fort Peck Reservoirs is undertaken they can be interconnected.

Areas that would be served by diversion from Garrison include the Coleharbor, Underwood, Washburn Unit which is located close to Garrison Dam and includes 45,000 acres of land that can be developed alone or in connection with the rest of the diversion. Water can be provided for this area by one main pumping plant and several small relift pumping plants and a system of canals and laterals. Up to June 30, 1952 12,900 acres of this unit have been classified in semi-detail. Other areas of this division that are scheduled for semi-detailed land classifications include the 450,000 Carrington and Fessenden area of which about 375,000 acres were classified in semi-detail up to June 30, 1952, and the Bismarck-Steele area of approximately 250,000 acres for which semi-detailed classifications were begun the latter part of the current biennium.

Other investigations undertaken include preliminary foundation investigations and topographic mapping of the Lone Tree Dam Site and Reservoir on the upper reaches of the Sheyenne River. Preliminary surveys were also completed for the canal routes from McClusky to Garman Coulee and from Lone Tree Reservoir to Velva.

Major benefits that would accrue through the development of the water resources by diversion from Garrison include irrigation, municipal water supplies, hydroelectric power, expanded recreation possibilities, and fish and wildlife propagation.

KNIFE DIVISION

The Knife River Project includes the Broncho Dam located on the Knife river about 10 miles south of Golden Valley, Mercer County, North Dakota that will store water to irrigate about 15,400 acres of land along the lower 37 miles of the Knife River. According to present plans 60,000

acre feet of water would be stored in the Broncho Reservoir of which 50,000 acre feet would be available for irrigation.

A preliminary survey has been completed for the area and detailed land classification are underway and additional dam and reservoir surveys and studies will be required to determine the power potential, flood control requirements, sedimentation and quality of irrigation water.

The multiple purposes of this unit include irrigation, flood control, silt detention, expansion of recreational facilities and fish and wildlife propagation.

Preliminary data concerning the Broncho Dam and Reservoir are as follows:

Earthfill, Embankment — 1,200,000 C. Y.
Height — 52 feet above stream bed
Crest Height — 2,800 feet
Spillway Capacity — 22,000 c.f.s.
Reservoir Capacity — 23,000 acre feet
Drainage area — 1,113 square miles

HEART DIVISION

The Heart River Project includes the Heart-Butte and Dickinson dams and reservoirs both of which are constructed, and about 14,000 acres of irrigable land along the Heart River. These units are discussed separately:

DICKINSON UNIT

The Dickinson Unit includes the Dickinson Dam and Reservoir located on the Heart River about 1½ miles west of Dickinson and some 900 acres of irrigable land in the vicinity of the reservoir and other areas along the river, which can be served by seven small pumping plants.

Construction of the Dickinson Dam was completed in 1950 at a cost of $1,385,000 which costs includes construction of the dam, engineering and supervision and purchase of a greater portion of the reservoir right of way. Primary use of the dam and reservoir is to provide the city of Dickinson with a much needed municipal water supply. Other benefits that will accrue include irrigation, recreation possibilities, silt detention and fish and wildlife propagation. A repayment contract was negotiated with the City of Dickinson for the municipal water supply service whereby the city agreed to repay the Federal Government $950,000.00 over a period of 40 years. Temporary arrangements were also completed in 1951 to make possible the use of the excess waters in the reservoir for irrigation. Four landowners in the area entered into contracts to purchase of excess water for 1951 at $1.50 per acre and entered into similar contracts for the 1952 season.

Data concerning dam and reservoir are as follows:
Earthfill, Excavation — 617,000 C.Y. Embankment — 317,000
Concrete — 7,310 C.Y.
Height — 49 feet. Length —2,276 feet
Spillway Capacity — 33,500 c.f.s.
Reservoir Capacity — 16,500 acre feet
Drainage area — 405 square miles

HEART-BUTTE UNIT

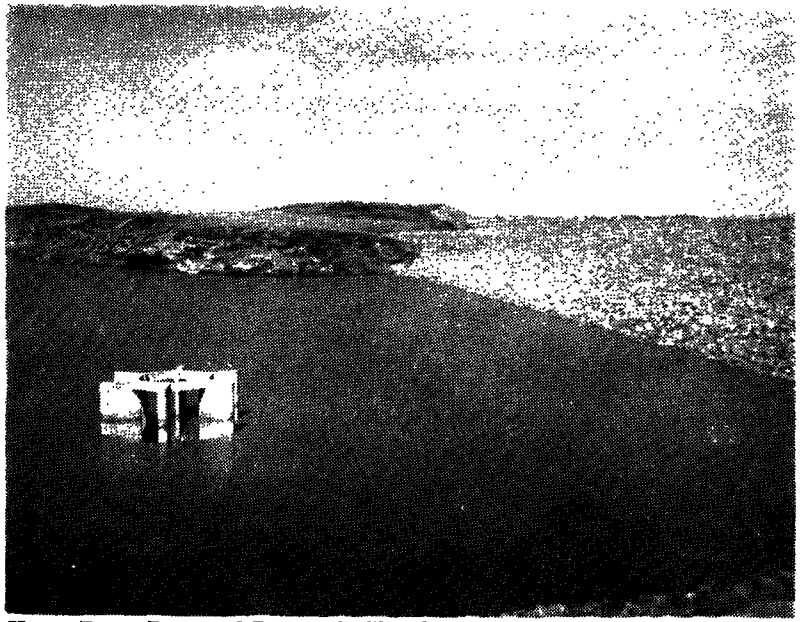
This unit includes the Heart-Butte Dam and Reservoir about 15 miles south of Glen Ullin on the Heart River and 13,100 acres of irrigable land along the course of the Heart River between the dam and the mouth of the river at Mandan. Construction of the dam began in 1948 and was completed late in 1949. The estimated total of the dam and irrigation facilities is over $5,000,000.00.

Constructed primarily to provide irrigation water for the Heart River Irrigation District, the dam has proved to be of great value in providing flood protection for the city of Mandan. In 1950 the spring snow melt came suddenly and set new runoff records for the Heart River. Heart-Butte Dam in conjunction with the Corps of Engineers levee system around Mandan during the 1950, 1951, and 1952 spring runoffs prevented a major flood disaster that would have caused damages estimated at $6,800,000. During these years operation of the dam lowered flood crests at Mandan materially.

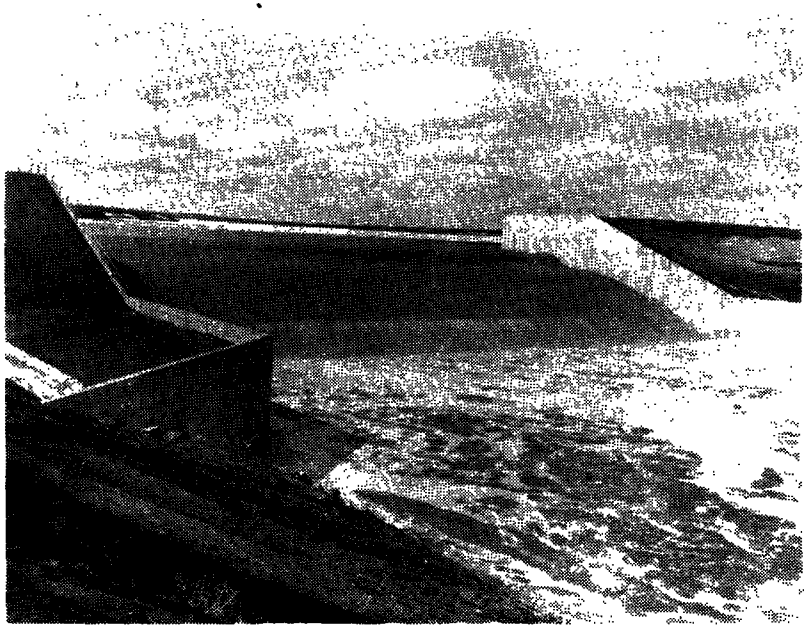
The irrigation works for this unit will consist of 49 pumping plants along the river with appurtenant canals and laterals. Although the Heart River Irrigation District has been organized negotiations for a repayment contract with the Bureau of Reclamation have been delayed pending settlement of legal issues raised by some of the landowners. Temporary water contracts have enabled landowners to use irrigation water on a rental basis. These contracts provide the landowners will pay the Bureau $1.50 per acre per season.

Arrangements have been completed with the North Dakota State Game and Fish Department for stocking the reservoir with game fish and for fencing portions of the reservoir and planting trees and shrubs for wildlife propagation. To date over 5 million of all species of game fish have been planted in the reservoir and about 75,000 trees and shrubs have been planted. Negotiations are currently underway for management of the Heart-Butte reservoir area and for developing cabin sites.

Data concerning the dam and reservoir are as follows:
Earthfill, Excavation — 1,863,000 C.Y. Embankment — 1,129,000 C.Y.
Concrete — 9,785 C. Y.
Height — 124 feet. Length — 1,850 feet
Spillway, Gloryhole type. Capacity 5,650 c.f.s.
Reservoir Capacity — 225,500 acre feet
Drainage area — 1,810 square miles



Heart-Butte Dam and Reservoir Showing Intake of Glory-hole Spillway



Dickinson Dam Spillway

CANNONBALL DIVISION

The Cannonball Division is located in the Cannonball River Basin in southwestern North Dakota and includes the Cannonball and Thunderhawk units. The latter unit is located on Cedar Creek a tributary of the Cannonball.

THUNDERHAWK UNIT

The Thunderhawk Unit includes plans for the construction of the Thunderhawk dam about 25 miles south of Elgin, North Dakota, on the Cedar Creek and about 6,100 acres of irrigable land along this river.

Surveys and investigations are underway for this unit and preliminary design data has been completed. A tentative irrigation map has been prepared showing pumping sites, water requirements, pumping lifts and irrigable areas.

Preliminary dam and reservoir data are as follows:

Earthfill, 351,700 C.Y. Embankment

Height — 62 feet (structural)

Crest Length — 2,400 feet

Reservoir Capacity — 30,000 acre feet

Drainage area — 1,150 square miles

CANNONBALL UNIT

This unit includes the Cannonball Dam and Reservoir on the Cannonball River near Elgin and some 12,400 acres of irrigable land on the river bottoms and benches along the Cannonball to its confluence with the Missouri. Investigations are also underway to determine the feasability of constructing a dam above Mott so as to provide flood protection for that city. To June 30, 1952 semi-detailed land classifications were completed for 25,000 acres in this unit with about 15,000 to be covered. Work was also underway on the preliminary layout and irrigation pattern layout have begun. The Definite Plan report for development of this unit is scheduled for April 1954.

TRANSMISSION DIVISION

Under the flood control act of 1944, the responsibility for disposing of excess power, generated by Missouri River Basin project plans, was assigned to the Secretary of the Interior. The Bureau of Reclamation has been designated as the agency responsible for the prosecution of the power marketing program. The major source of power from projects of this nature will be Garrison Dam.

Present plans call for the initial operation of the Garrison Dam in 1955, two units totaling 160,000 kilowatts of installed capacity being placed in operation at that time. Two additional units of 80,000 kilowatt capacity each are scheduled for installation in 1956. The installation for

the fifth unit is scheduled for 1957, at which time the ultimate generating capacity of 400,000 kilowatts will have been installed.

A new network of high tension transmission lines, in addition to existing lines in the area, is required to transmit power to major load centers. The principle new lines needed, particularly those to be operated at 115,000 and 230,000 volts will be constructed by the Bureau of Reclamation. Contracts have been negotiated with existing utility companies, whereby excess capacities in their facilities may be used to transmit power to Bureau customers.

The Bureau has prepared a plan for an extensive transmission system. This system includes proposed lines at 230,000 volts for transmission of large blocks of power to primary delivery place. Lines at 115,000 volts would be fed from substations or power plants, and would carry the power to or near points of delivery to the customers. For customers cannot be served from the 115,000 volt lines, 69,000 volt lines are planned for further secondary transmission as is practicable and necessary. Construction of about 1,000 miles of this transmission system is now underway.

During the past two years the following accomplishments can be reported: The completion of the 115 kilovolt line from Williston to Garrison Dam: sub stations at Beulah, Williston, and Watford City; The completion of the 115 kilovolt lines in the central North Dakota system; The continuing work on the 230 kilovolt lines; The initiation of construction of the Bismarck DeVaul 69 kilovolt transmission lines; Custer Trail and DeVaul sub stations and the Bismarck-Mobridge, South Dakota 230 kilovolt lines.

DEVELOPMENT FARMS

Two development farms are now in operation in the Missouri-Souris District to study the effects of the application of irrigation water on the soils to the areas proposed for irrigation and to determine the types of crops and farming operations best suited for the areas in which irrigation development is planned. The farms are located near Mandan and Bowbells, North Dakota.

A program is being formulated for the establishment of additional development farms within the district to study the adaptability of sandy textured alluvial soils to irrigation farming. It is expected that development farms will be in operation in 1953 in the Oakes Unit area along the James River in the extreme southern North Dakota and in the area proposed for irrigation east of the Souris River in the northern part of the state. Another development farm is planned for later development in the vicinity of New Rockford, North Dakota.

MANDAN DEVELOPMENT FARM

The Mandan Development farm is located at the western city limits of Mandan, North Dakota along U. S. Highway No. 10. The farm, covering 80 acres, is representative of the climate, soil and topography found in the Heart River Valley and in other areas proposed for irrigation development in southwestern North Dakota.

Some of the yields at this farm are: alfalfa planted in 1948 has yielded an anuual average of 5.4 tons an acre for the three years. Potatoes have averaged 367 bushels of U. S. No. 1's an acre; Corn has averaged 54.4 bushels of grain or 6.7 tons of silage. In 1950, 20 yearling steers gained 447.7 pounds on each acre of a 7.6 acre pasture. The pasture carried the steers for 110 days. In 1951, the 7.6 acre pasture carried 18 producing Holstein cows for 99 days; the cows prdouced 61,290 pounds of milk during that period.

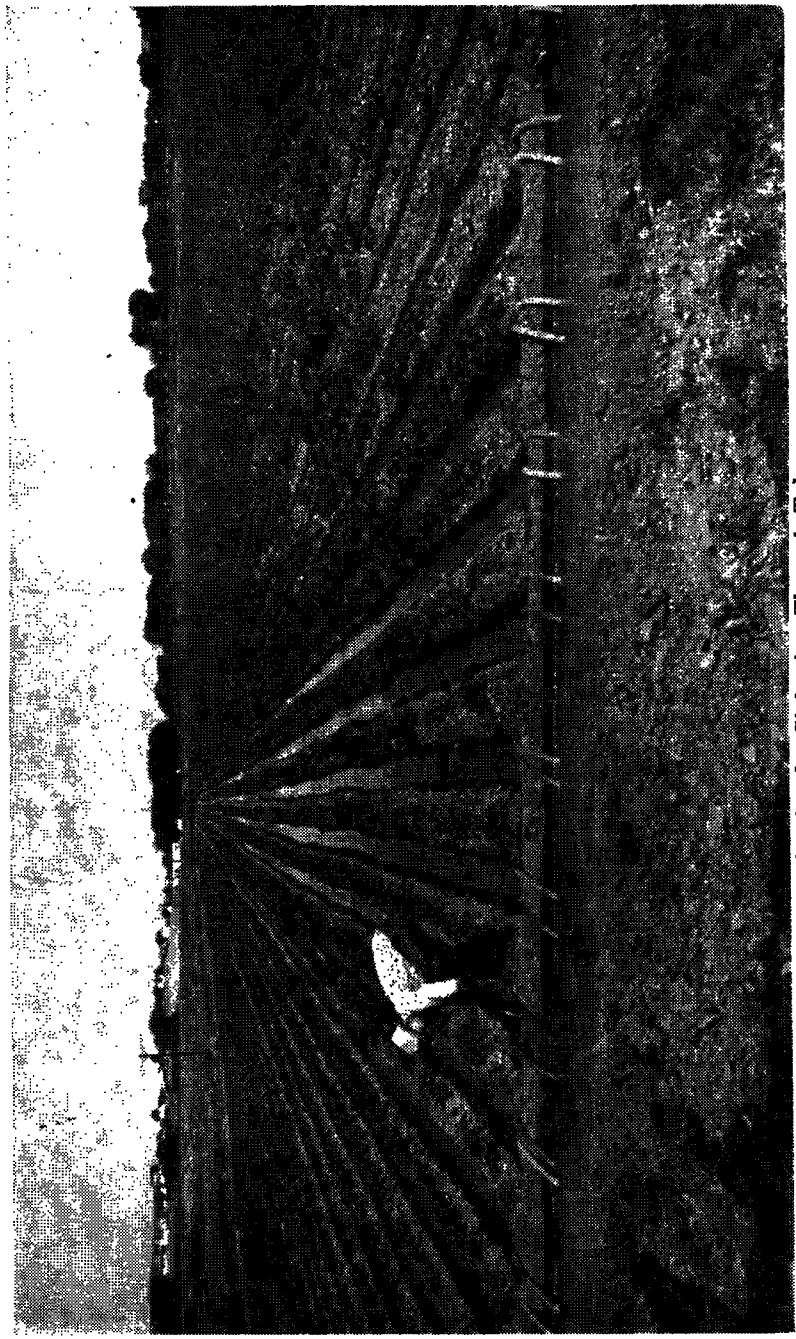
BOWBELLS DEVELOPMENT FARM

The Bowbells development farm is located 4½ miles east of Bowbells, North Dakota on State Highway No. 52. It is situated on glacial soils within the western portion of the Crosby-Mohall unit. The farm covers 166 acres, 72 acres of which are irrigated by gravity and 88 acres by sprinkler. Irrigation water is pumped from the upper Des Lacs Lake. The farm was in full operation in 1949 and in 1950.

The cropping plan on the Bowbells farm is the same as that used on the Mandan farm, except flax has grown instead of corn. Crop yields have been generally favorable. The alfalfa yields are generally less than expected, however, because of the dense sub soil and unfavorable drainage conditions. Operation of the Bowbells farm is planned to be discontinued at the end of the 1952 farming season.

EASTERN NORTH DAKOTA

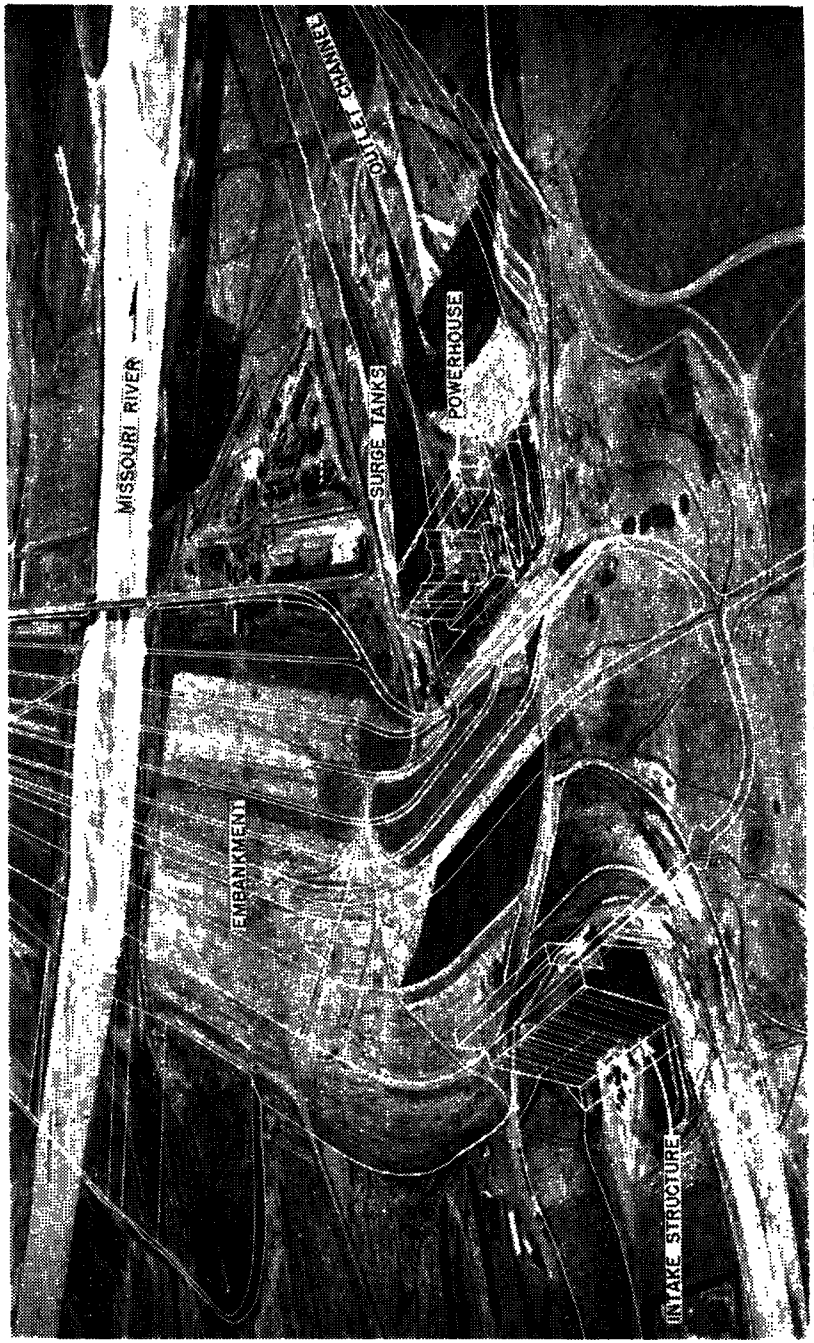
Recent investigations by the Bureau of Reclamation have revealed that their are more than a million acres in three areas in eastern North Dakota that are potentially irrigable. These areas are: The Walhalla area in the northeastern part of the state, the Larimore area in the east central part of the state and the Sheyenne-Delta area in the southeastern part of the state. Reconnaissance surveys and preliminary investigations, that are nearly complete, indicate that there are large blocks in these areas that can be irrigated. Water to serve these areas would have to be furnished by diversion from the Missouri River. By June 30, 1952 195,000 acres of the 370,000 acres in the Sheyenne-Delta area have been classified by reconnaissance. A preliminary survey of 900,000 acres of the 1,000,000 in the Walhalla and Larimore areas have been completed at this date.



Irrigating by Siphoning Through Tubes

Chapter IV

ACTIVITIES OF CORPS OF ENGINEERS U. S. ARMY



Garrison Dam—Outlined as it Will Appear

CORPS OF ENGINEERS — GARRISON DISTRICT

GARRISON DAM

The Garrison Dam, located very close to the central part of the state and about 75 miles north of Bismarck on the Missouri River, is one of the key units of the Pick-Sloan plan for the development of the Missouri River Basin. This Corps of Engineers project was authorized by the flood control act of 1944 and construction began in the summer of 1946. This project is designed to provide flood control for the downstream areas of the Missouri River Basin, water for irrigation in central North Dakota and possibly areas in the Souris River Basin, hydroelectric power, water for downstream navigation, recreational facilities, municipal water and stream pollution abatement and other multiple benefits.

More than one-third of the drainage area of the Missouri River is above the dam site and the dam will actually control nearly one-third of the total volume of flow of the Missouri River at its confluence with the Mississippi River. Maximum and mean discharges at the dam site were approximately 275,000 and 40,000 cubic feet per second.

Initial construction of the project included building an access highway, railroad, and temporary headquarters at Riverdale in 1946 and a construction bridge in 1947. In 1947 the first earth moving contract was awarded for excavation of part of the power house area and placing some 14,000,000 yards of material in the west embankment. Also included in this $6,349,830 contract was a construction of a 240 foot long test tunnel that was used to aid in the design of the 8 flood control and power tunnels of the project. The contract for this first stage of the construction of the project was completed in 1949.

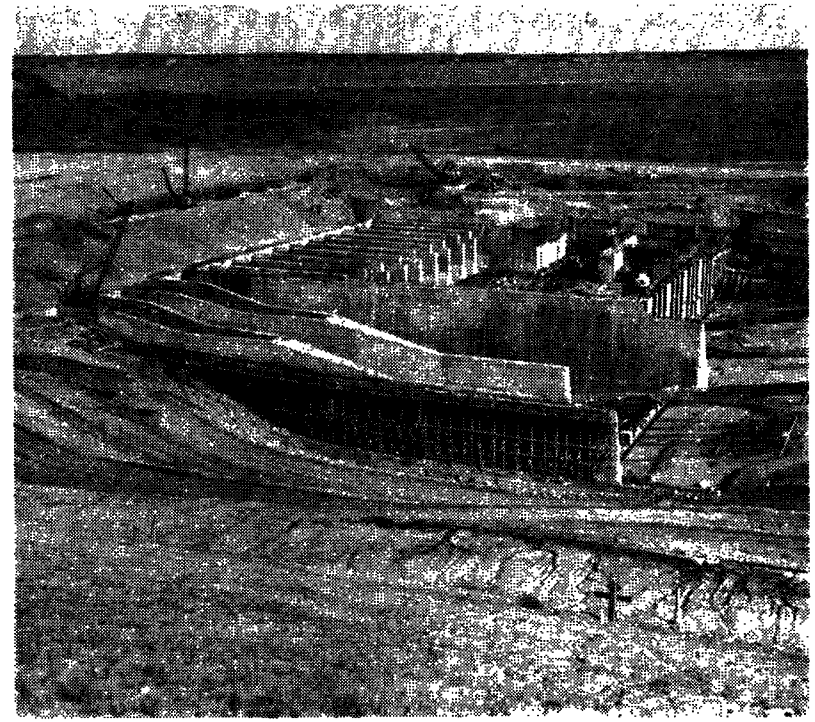
In the fall of 1948 the contract for stage three of the excavation and main embankment was awarded. This contract, which included excavation of 19,350,000 yards of material from the spillway area and placing 16,-630,000 yards of it in the embankment, was completed in the spring of 1951. Early in 1949 the contract for construction of the three regulating tunnels and five power tunnels were awarded. These tunnels were completed in July, 1951. The contract for the power house and stilling basin was awarded in 1950 and work is scheduled for completion late in 1952.

Late in 1949 the contract for the intake structure was awarded and construction of this portion of the works was initiated that year with completion scheduled for 1954. This contract amounted to $15,449,830. The fall of 1950 marked the awarding of the contract for stage three of the embankment for $6,190,000 which provided for the completion of the embankment on the west side of the river. The stage four embankment contract was awarded in 1951 in the amount of $16,940,210. Work on this segment of the embankment which includes diversion of the river in May of 1953 and closure of the embankment began in the fall of 1951 and is scheduled for completion by April, 1954. The materials for this stage of the embankment will be taken from the spillway section.

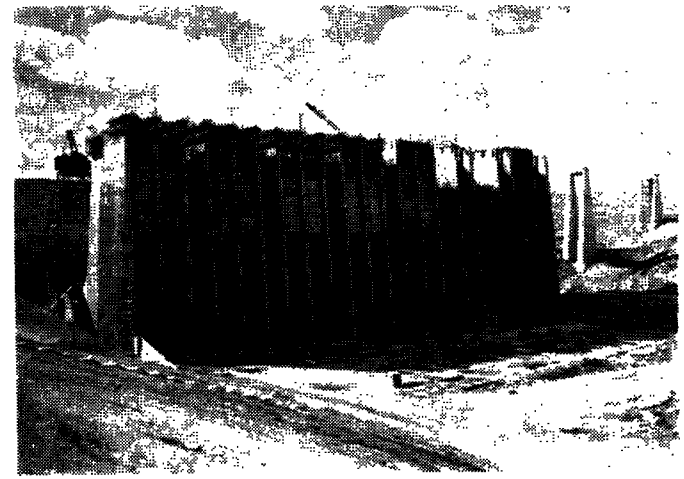
The contract award for the spillway section was made in 1952 with work starting in July, 1952 and scheduled for completion in September, 1955. The amount of this contract was $18,780,000. This contract includes the placing of some 720,000 cubic yards of concrete and the construction of the spillway bridge and the gates needed to control the flow of water through the spillway.

In addition to the work at the dam site proper, relocation of the Sanish bridge and the towns of Sanish and Van Hook is progressing as well as the relocation of other facilities affected by the reservoir. These include relocation and construction of over 42 miles of state and 55 miles of county highways and roads. It will also be necessary to relocate and reconstruct 25 miles of railroad. Relocation and construction of roads is being done by the state and counties, costs being borne by the Federal Government. It will be necessary to replace the two existing Sanish and Elbowoods bridges by a new structure. The new bridge is located about one mile below the Sanish bridge and will be 4,400 feet long, consisting of three main spans crossing over the reservoir. The present Elbowoods bridge will be moved upstream and used as part of the approaches to the main bridge. Another one of the largest of these relocation jobs is the construction of the Snake Creek embankment over which the Sioux line railroad and U. S. Highway No. 83 will cross the reservoir. It will also serve as a sub impoundment dam that can be used for diversion of waters through central and eastern North Dakota as is authorized in the flood control act of 1944. Work on the contract for this job was started in 1951 and is scheduled for completion in 1953. The relocation of the towns of Sanish and Van Hook is being undertaken by the towns themselves, but the Corps of Engineers assisting in an advisory capacity.

Other contracts have been let for various intake structure equipment so that this equipment will be installed prior to the closure operations in 1953. The hydro-turbans, auto transformers, turban generators, generators and such equipment as is needed for the power plant are being manufactured under schedules that will permit the first power to be generated in 1955 and the initial three generators to be installed by 1956. Flood control benefits will be realized after 1954 when the river has been closed.



Garrison Dam—Power House and Stilling Basin Section



Garrison Dam—Intake Structure

A summary of pertinent data concerning this project is as follows:

The Dam:

Type	Rolled earth fill
Length	12,000 feet
Height	210 feet
Volume of earth fill	70,000,000 cubic yards
Volume of excavation	86,000,000 cubic yards
Concrete	1,500,000 cubic yards
Riprap	650,000 cubic yards

Spillway:

Length	1444 feet

Control Tower:

Height	210 feet

Tunnels:

3 — Flood control	1 — 26′ and 2 — 22′ diameter
5 — Power	5 — 29′ diameter

Generating Capacity:

5 Units — 80,000 KW each	400,000 KW

Reservoir:

Drainage area above dam	180,940 square miles
Capacity-Maximum pool	23,000,000 acre feet
Area-Maximum normal pool	390,000 acres
Length	200 miles

FLOOD CONTROL ACTIVITIES

Some other flood control work is being carried on by the Garrison district in North Dakota. The Mandan protective works constructed in 1949 and 1950 has already aided in preventing flood damages many times in excess of the construction costs. Operating in conjunction with the Heart-Butte Reservoir, the estimated damages prevented by the two projects has been set at $6,800,000 for the years from 1950 and 1952. Some damages to the levee were caused by the 1952 flood and the repairs are being made to restore the levee before the 1953 flood season.

At Marmarth, North Dakota emergency repair work on the local levee has been completed this year. Bank erosion protection along the Missouri has also been provided near the REA sub station at the Buford-Trenton irrigation project in Williams County, North Dakota.

Studies are also being conducted on the James River Basin and the Cannonball River Basin in North Dakota by the Garrison District of the Corps of Engineers.

CORPS OF ENGINEERS — ST. PAUL DISTRICT

The St. Paul District of the Corps of Engineers have been given the responsibility for the flood control improvement of the Hudson Bay Drainage area in North Dakota. This area includes all lands in the state drained by the Red River of the North and the Souris River. Projects that are completed include the Baldhill and Homme Dams, Lake Traverse and the Bois de Sioux Project and several other river channel improvement projects. These projects are discussed below under headings designating their stage of progress. Projects completed.

BALDHILL DAM AND LAKE ASHTABULA

This project is located on the Sheyenne River 16 miles upstream from Valley City, North Dakota and about 271 river miles above the mouth of the river. The dam creates a reservoir that will be used to provide a substantial degree of flood control to the cities, villages, and urban areas along the Sheyenne River and to provide water supply and pollution abatement for the section of the Sheyenne River, below the dam and a section of the Red River of the North. The plan also provides for the construction of a low diversion dam in the Sheyenne River 35 miles above the mouth, and a short ditch leading thence to the existing Stanley ditch, the latter could be cleared and deepened to the Red River of the North which it enters about 9 miles from Fargo.

This project was constructed subject to the following conditions:

1. That local interests contribute $208,000.00 toward the first cost of the reservoir.

2. That local units hold and save the United States free from damages due to construction works.

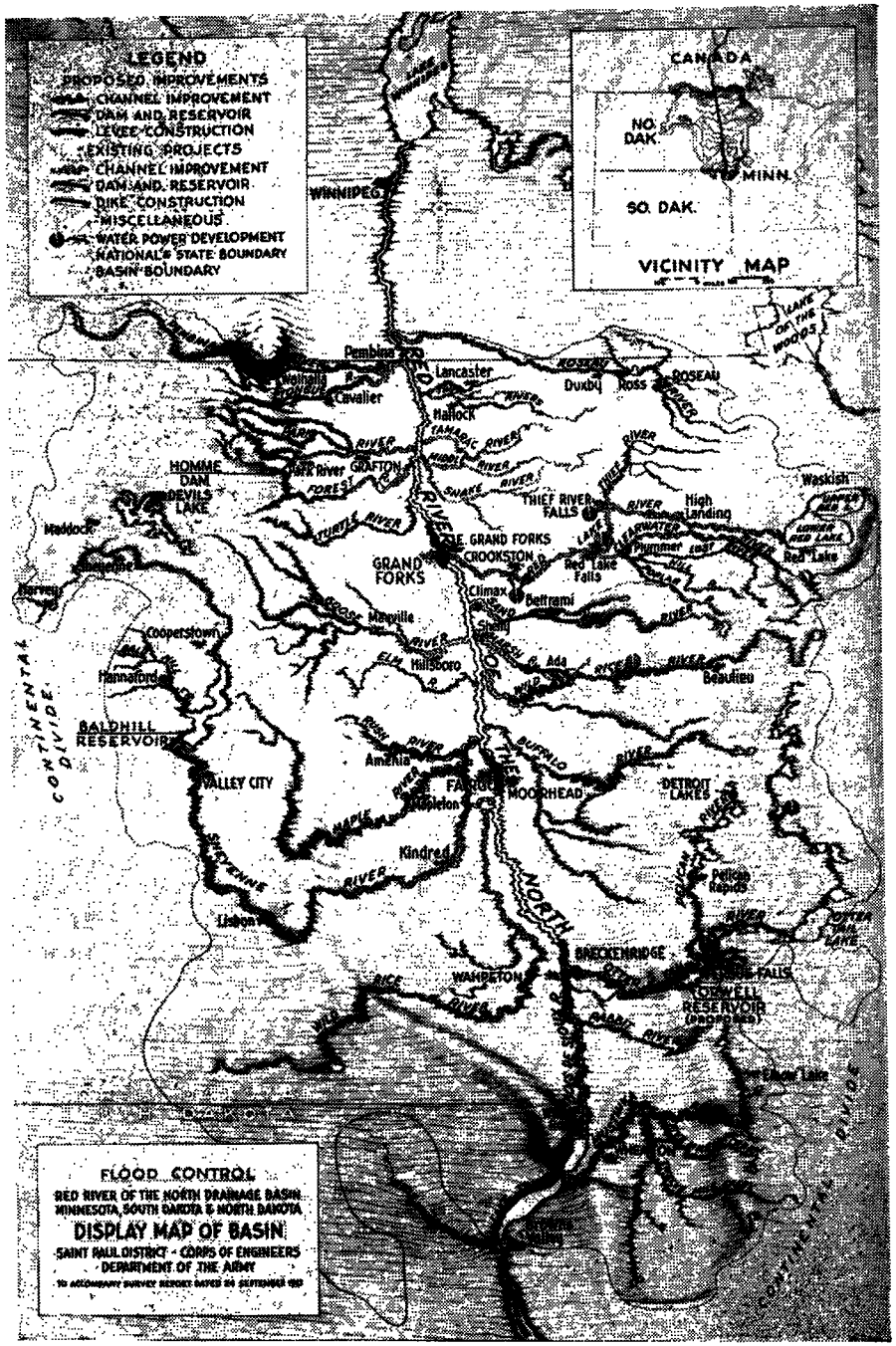
3. That they bear the expense of all necessary alterations of utilities, roads, highways, and bridges or that they construct, operate, and maintain the Fargo division dam and the diversion ditch improvements in accordance with plans and regulations to be approved by the Secretary of War.

4. That they maintain the channels below the reservoir and satisfactory conditions for the flow of water released from storage.

5. That they establish and enforce suitable regulations to prevent pollution of the waters of the Sheyenne River.

Local interests have complied with these conditions except for the construction of the Fargo diversion dam and ditch.

The major portion of construction has been completed and the reservoir was placed in full operation in the fall of 1950. During the record breaking high water during the spring of 1950 the reservoir was operated in an emergency status with large benefits to the downstream interests, particularly at Valley City. The cost of initial capital



outlay to the United States is estimated to be about $2,653,200. There are no directly repayable features of the project except the provisions of local cooperation outlined above. The Corps of Engineers operates and maintains the control structures. Construction of features for public use remaining to be initiated have been deferred until after the present defense emergency.

A summary of data on the dam and reservoir is as follows:

Type	Earth fill
Length	1,650 feet
Height	61 feet
Earth fill	283,600 cubic yards
Excavation	439,000 cubic yards
Concrete	13,915 cubic yards
Riprap	11,100 cubic yards
Control length	120 feet
Reservoir drainage area	Devils Lake Basin
Capacity	Max. pool, 70,700 acre feet
Reservoir area	5,430 acres
Length	27 miles
Federal Cost of Construction	$2,653,200
Local cost	$270,000

HOMME RESERVOIR AND DAM

This project is located on the South Branch of the Park River, about 4 miles upstream from Park River, North Dakota. The 3,650 acre foot reservoir created by the dam will afford partial flood control protection to areas below the dam and will be used to provide a flow of about five second feet in the river to meet the water supply and pollution abatement needs from the dam to Grafton, North Dakota. In addition a sixteen inch cast iron pipe water suply outlet through the dam has been provided at the request of local interests.

The improvement is subject to the following conditions;

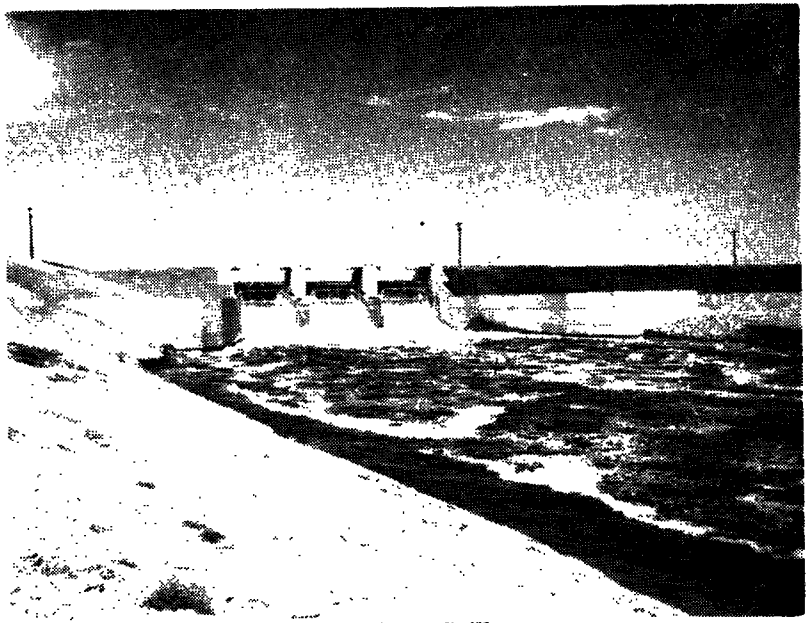
1. That local interests make a cash contribution of $40,000 toward the construction costs.

2. That they provide without cost to the United States all lands, easements, and rights of way necessary for the construction of the project.

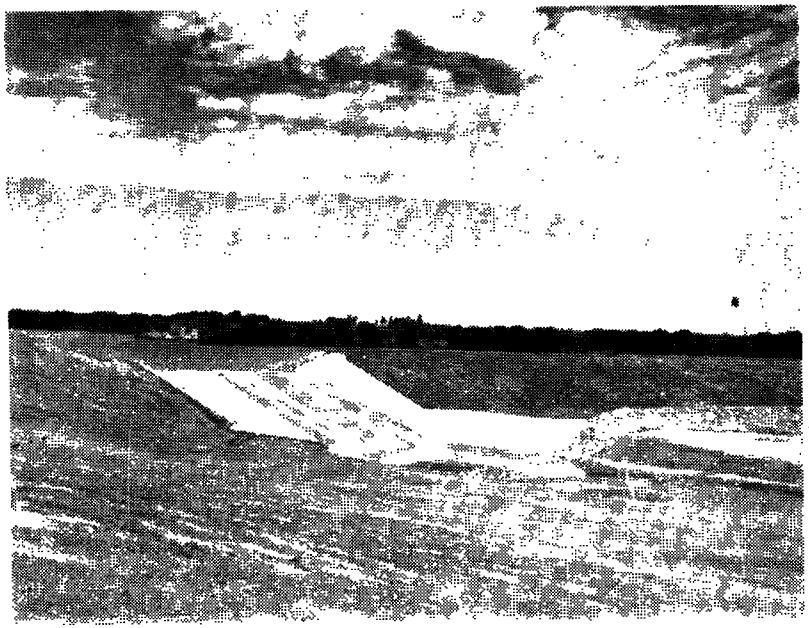
3. That they make necessary changes in roads, bridges, and utilities.

4. That they maintain the channel below the reservoir.

5. That they hold and save the United States free from damages due to construction works.



Baldhill Dam Spillway



Homme Dam Spillway

6. That they limit future construction of dams below the reservoir.

7. That they prevent the discharge of raw sewage into the river by municipalities.

An additional cash contribution of $16,220.00 was required for the sixteen inch water supply outlet that was requested by them. The local interests that provided $56,220 cash contribution in all the necessary lands.

The major portion of construction work has been completed and the reservoir was placed in full operation on August 4, 1950. The total cost to the United States is estimated to be about $1,326,700. There are no directly repayable features of the project except the requirements of the local cooperation outlined above. The Corps of Engineers is maintaining and operating the control structures. Already completed are construction of two bathing beaches for public use, however, construction of additional public use facilities have been curtailed until after the present defense emergency.

Data concerning the dam is as follows:

Type	Earth fill
Length	865 feet
Height	67 feet
Earth fill	334,100 cubic yards
Excavation	419,000 cubic yards
Concrete	6,750 cubic yards
Riprap	9,050 cubic yards
Control length	150 feet
Reservoir drainage area	265 square miles
Capacity	Max. pool, 3,650 acre feet
Reservoir area	194 acres
Length	2¼ miles
Federal cost of construction	$1,231,600
Local cost	$56,220

SNAGGING AND CLEARING OPERATIONS

During the period of this report snagging and clearing operations were performed on the Tongue and Sheyenne Rivers. Work on the Sheyenne River extended from the mouth of Rush River to Kindred, North Dakota. A distance of 56.3 miles, and was completed in the period from October 26, 1950 to January 13, 1951. Snagging and clearing on the Tongue River was accomplished in the reach from the mouth to 64 miles up the river above Akra, North Dakota, during the period October 7, 1950 to July 14, 1951. This work consists of the removal of snags, debris, brush, and timber within the channel banks to eliminate obstructions to an otherwise free flow of water thus allowing proper discharge of water to reduce flood stages in the effected portion of the streams. Approxi-

mately $50,000 was expended on the Sheyenne River and $40,000 on the Tongue River in accomplishing this work.

PROJECTS UNDER CONSTRUCTION

Snagging and clearing operations are underway on the Park and Forest Rivers in North Dakota. The work being done on the Park River is estimated to cost $45,700.00 and covers a reach on the Park River between Grafton and a point 10 miles above the mouth and on the middle branch of Park River between 30 miles from the mouth to the mouth of the river in the vicinity of Hoople, North Dakota. At a estimated total cost of $28,800 work will be done on the Forest River from a point about 3 miles below Minot, North Dakota upstream to the Grand Forks county line. Both these contracts are scheduled to be completed in November, 1952.

PROJECTS UNDER INVESTIGATION

A study is being made in order to determine the feasibility of improvements to relieve the flood problems due to Swan Creek at Casselton. The report of the District Engineer will be submitted for review in October, 1952. If found favorable funds will need to be allotted by the Chief of Engineers at a later date for the construction of this project.

RED RIVER OF THE NORTH DRAINAGE BASIN STUDIES

A study has been undertaken by the St. Paul District of the Corps of Engineers of the Red River of the North Drainage Basin. This report will include consideration of flood problems on the main stem of the Red River to the Canadian boundary and of tributaries including several of those in North Dakota. Funds for this report have been greatly curtailed due to the present economic situation. Included in this report will be a separate intern survey report covering the situation at Grafton, North Dakota.

SOURIS RIVER STUDY

A preliminary examination on the Souris River which will be used to determine the feasability of improvements on this river principably at Minot, North Dakota, is being undertaken at the present by the St. Paul District of the Corps of Engineers. Work on this report is about 75% complete.

PEMBINA AND TONGUE RIVERS SURVEYS

A survey of the Pembina and Tongue Rivers has been undertaken. Public hearings have been held at three locations on this matter and work on the report is 70% complete at the present.

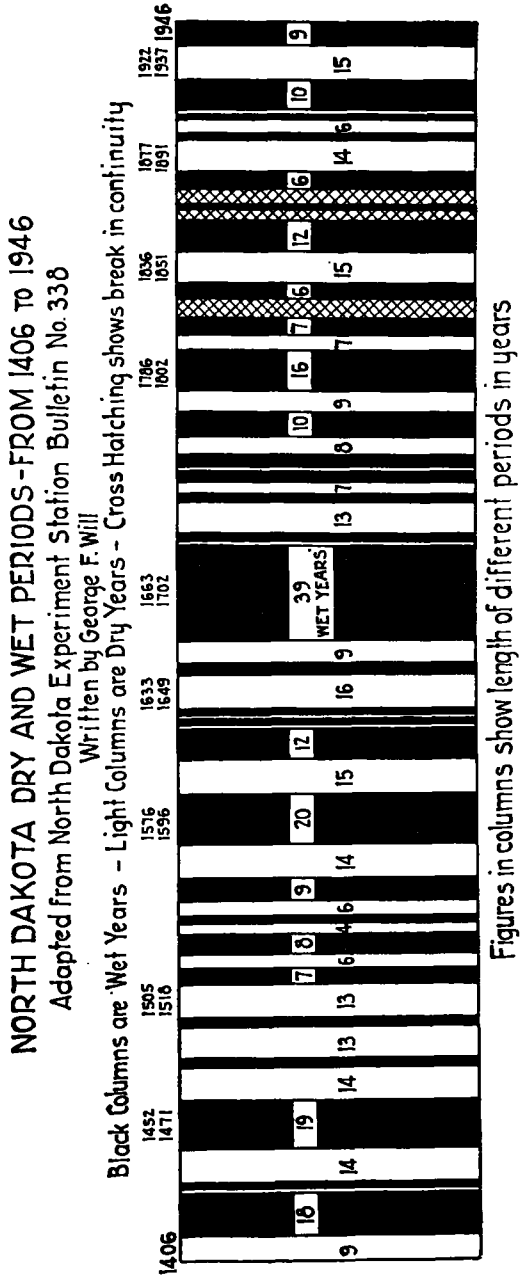
LAKE TRAVERSE AND BOIS DE SIOUX PROJECT

Lake Traverse is located on the boundary between the States of Minnesota and South Dakota, the north end of an extension to the lake reaching within one mile of the North Dakota border. The Bois de Sioux River is the outlet stream for Lake Traverse. It flows from the lower end of Lake Traverse between the state of Minnesota and the states of South Dakota and North Dakota to Wahpeton, North Dakota and Breckenridge, Minnesota where it joins the Ottertail River to form the Red River of the North.

The main features of this project are: (1) the Bois de Sioux channel improvement, (2) the White Rock Dam, (3) the Reservation Highway Dam, (4) the Brown's Valley Dike. The main purpose of the project is to provide flood protection for some 50,000 acres of agricultural land located in this area. Other benefits to be achieved is the creation of a lake that will be ideal for boating, swimming, fishing and wildlife conservation. A third important benefit is the increased low water flow to communities north of the White Rock Dam. Construction of this project was completed in 1941.

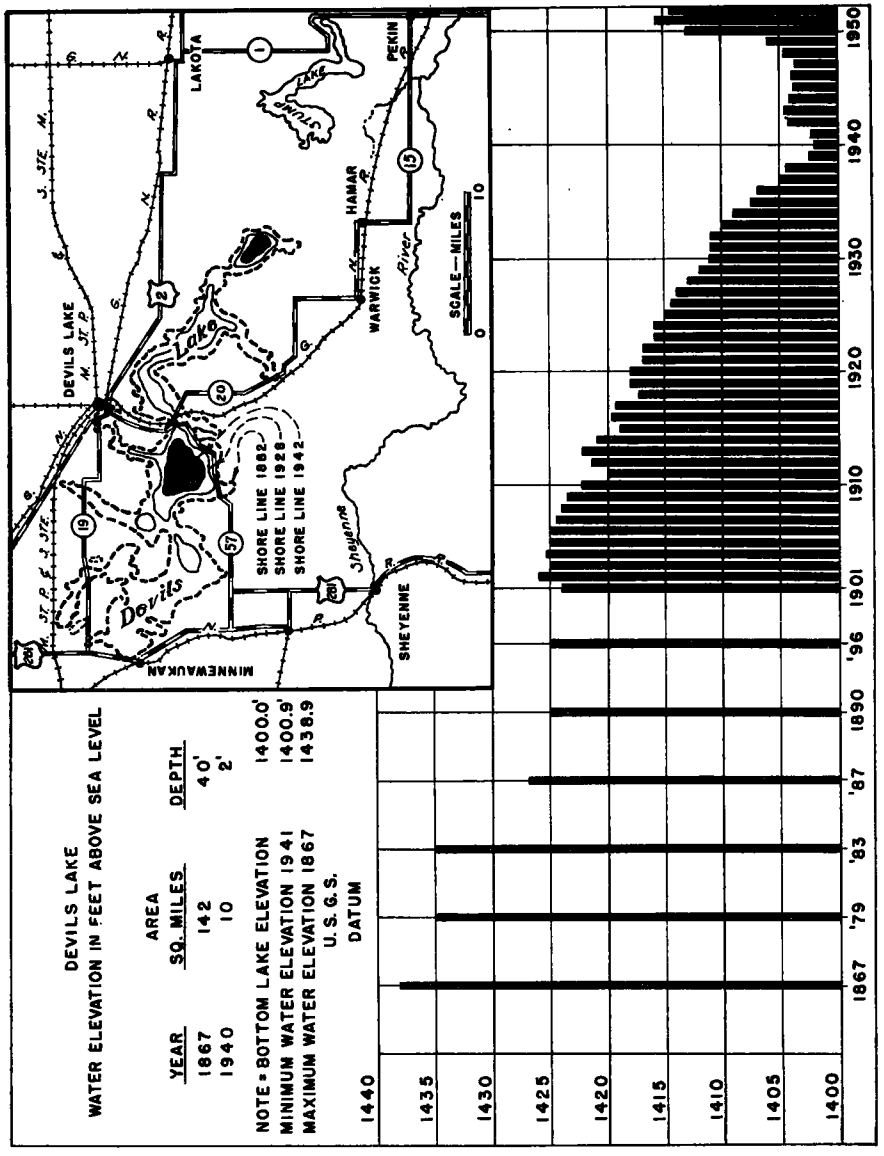
Data pertaining to the White Rock Dam and the Reservation Highway Dam is given below:

	Reservation Control Structure	White Rock Dam
Type	Earth fill	Earth fill
Length	9,100 feet	14,400 feet
Height	14.5 feet	16 feet
Earth fill	3,880 cubic yards	329,244 cubic yards
Excavation	3,350 cubic yards	636,042 cubic yards
Concrete	13 cubic yards	1,245 cubic yards
Riprap	290 cubic yards	18,842 cubic yards
Control lengths	100 feet	39 feet
Reservoir drainage A	.....	1,160 square miles
Capacity, max. pool	.....	249,500 acre feet
Reservoir area	.....	22,900 acres
Length	.....	25 miles
Federal Cost of Construction	.....	$1,332,200
Local Cost	.....	.....



Chapter V

OTHER ACTIVITIES



OTHER ACTIVITIES OF STATE WATER COMMISSION

The State Water Conservation Commission has cooperated closely with several other agencies and groups in planning for and developing the water resources of the state. The work of the Water Commission is closely allied with that of their other agencies and it is through the cooperative effort of all concerned with the various phases of the water program that the development of our water resources can go forward to the best advantage to the state. A brief discussion of the work of these groups is as follows:

NORTH DAKOTA STATE HEALTH DEPARTMENT

The State Department of Health, through the Division of Sanitary Engineering, cooperates closely with the Water Commission and the State Engineer on problems of mutual concern. One hundred fifty-three sets of plans and specifications covering the installation and improvements to municipal water and sewage systems, industrial waste disposal facilities, interstate watering points, and public swimming pools have been reviewed for approval. The majority of these plans and specifications have been for extensions and improvements to the water and sewage systems in our major cities, however within this group there were plans for 19 new water and/or sewage systems. These plans require the joint approval of the Water Conservation Commission and the State Health Department before construction can be initiated.

During the past biennium, two reports, one on the Missouri-Souris-Red River Development Area Water Pollution Investigation, and the other the James River Drainage Basin Water Pollution Investigation, have been completed. These two reports outline a comprehensive program for the pollution abatement measures that are needed in our state. The projects needed by municipalities and industries are outlined, minimum flow needs to maintain the streams where diversion is possible are listed, present sources of pollution are evaluated, and recommendations for control measures needed are given. These two reports will be a guide for future pollution abatement measures for many years in the future of North Dakota.

Since, by State law, pollution control is a joint responsibility of the Health Department and the State Water Conservation Commission, the Health Department has worked closely with Water Commission personnel. An active cooperative program has been developed during this biennium by the two departments. The Health Department program has been implemented by a grant of $9,400 per year under Public Law 845 to assist in a comprehensive study of pollution needs in North Dakota, and by assignment of two engineers from the U. S. Public Health Service to this Department for one and one-half years.

This Division has consulted with members of the oil industry concerning treatment of proposed refinery wastes. Also, investigations have been made of the disposal of oil well brines and the ponding of water at oil well drilling sites. At present, the amount of water separated from the

oil at producing wells is small and does not constitute a pollution problem. However, as oil fields develop with more wells, the water content of the oil may rise and present a real pollution problem to municipalities using water containing oil or oil brines. A refinery must provide adequate waste treatment to avoid a serious pollution problem. No doubt the oil and related industries will grow by leaps and bounds in North Dakota during the next biennium; therefore, adequate finances and facilities must be made available to this Division to meet various problems as they arise so that our streams may be properly protected.

The construction of sewage and industrial waste treatment plants is the answer to the water pollution problem. With such plants, the State can go on with population, industrial, agricultural, and oil expansion. During the past two years there has been considerable progress made in both construction and planning of municipal treatment works.

BUREAU OF LAND MANAGEMENT

The United States Bureau of Land Management, formerly General Land Office, has been resurveying many areas in the state to bring the original General Land Office Plats and Field Notes of North Dakota up to date. These surveys are used to re-establish section corners and boundaries of areas in the state. The surveys as they are completed are filed with the State Engineer and are available for inspection to all interested parties. Areas for which these resurveys have been completed are as follows:

BUREAU OF LAND MANAGEMENT RESURVEYS

Township 129 N, R 106 W.
Township 130 N, R 106 W.
Township 131 N, R 106 W.
Township 132 N, R 106 W
Township 133 N, R 105 W.
Township 134 N, R 105 W.
Township 135 N, R 104, 105 W.
Township 136 N, R 102, 103, 104 W.
Township 137 N, R 101, 102 W; Sec. 19, R. 79 W; Sec. 23 and 24, R. 80 W.
Township 138 N, R 102 W.
Township 139 N, R 102 W.
Township 140 N, R 102 W.
Township 141 N, R 101 W.
Township 142 N, R 102 W.
Township 143 N, R 102 W.
Township 144 N, R 102 W.
Township 145 N, R 84, 102 W.

Township 146 N, R 84 W.
Township 147 N, R 84, 99, 100 W.
Township 148 N, R 97 W.
Township 153 N, R 79, 80, 81 W.
Township 154 N, R 78, 79, 80, 81, 82 W.
Township 155 N, R 78, 79, 80, 81, 82, 83, 84 W.
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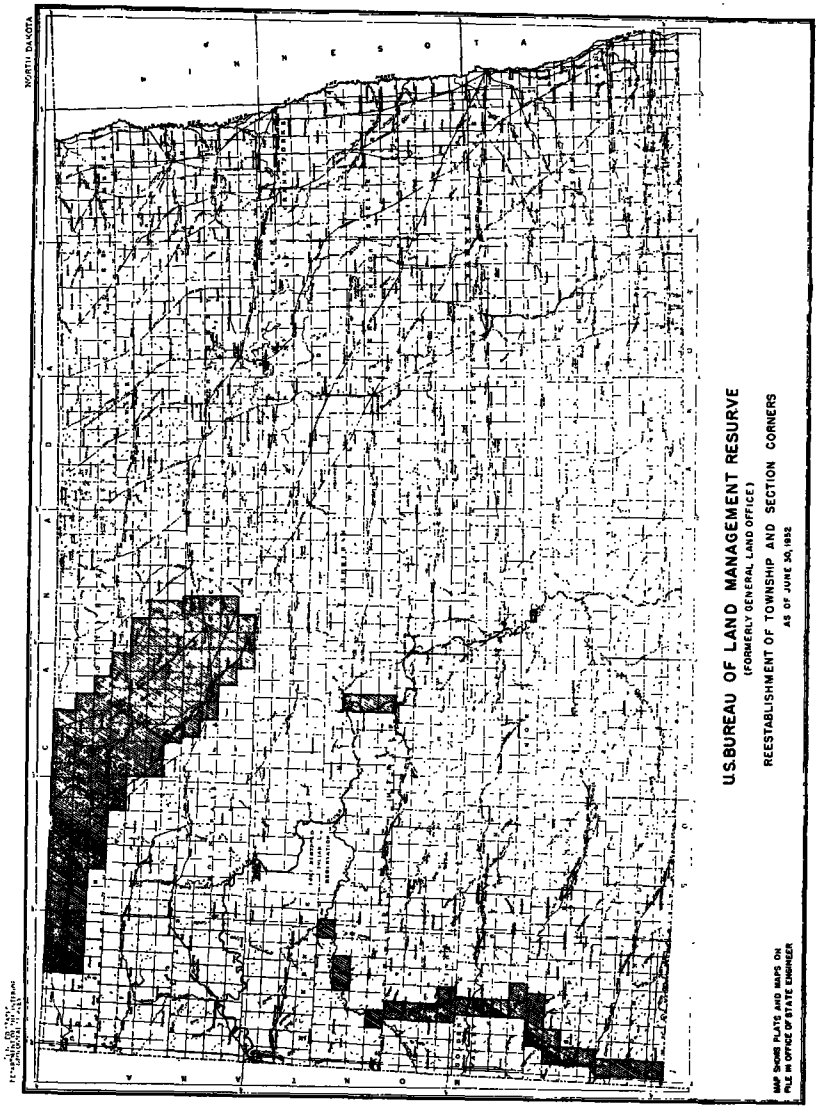
Township 164 N, R 84, 85, 86, 87, 88, 89, 91, 92, 93, 94, 95, 96, 97, 98 W.



SOIL CONSERVATION SERVICE

In addition to the cooperation received by the State Water Conservation Commission from the Soil Conservation Service in the drainage program establishing constructing, and repairing legal drains in the state, cooperation in many other matters has been received by the Commission from this agency. Of major importance to the development of irrigation in the state is the assistance given the individual farmers in surveying their farms for irrigation facilities and laying out irrigation tracts. Many of the surveys that accompany water right applications of farmers in the state have been made by Soil Conservation Service technicians.

District Conservationists of the Soil Conservation Service have assisted the Commission materially in providing information concerning drainage programs of the various counties of the state that is valuable to the Commission in planning and organizing the states' drainage activities. The Commission has also cooperated with the Soil Conservation Service in other irrigation and water conservation irrigation enterprises in the state.

NORTH DAKOTA RECLAMATION ASSOCIATION

The primary purpose of the North Dakota Reclamation Association and the National Reclamation Association is to foster and promote a program for irrigation, reclamation and development of the arid and semi-arid West. It is through the efforts of the state and National Reclamation Associations and other groups and agencies that the water development program has developed to its present stage.

The State Reclamation Association is composed of over 1,000 members from all sections of the state. The activities of the State Association are administered by directors from the four districts into which the state is divided. The president of the Association is Russ Dushinski of Devils Lake and the Secretary is John I. Rovig of Mandan. Harry E. Polk of Williston is the past president of the National Reclamation Association and is at the present the State Director of the National Reclamation Association for North Dakota.

Both of these organizations have been active in informing the people of the state of the values and need for the development of the water resources for beneficial use to the state and the nation. Representatives of these groups have appeared at congressional hearings in the support of various reclamation projects.

In June, 1952 the North Dakota State Reclamation Association sponsored a joint meeting at Roosevelt National Park with the Montana Reclamation Association commemorating the 50th anniversary of the Reclamation Act. Over 2,500 people attended this meeting.

Both the National and State Association have supported a well-balanced program for the development of the water resources of the west. This support includes encouragement of a plan for development of small

irrigation projects, continued investigations to assure orderly development of the states authorized water projects and support of other phases of the land and water resource development programs.

GREATER NORTH DAKOTA ASSOCIATION

The Greater North Dakota Association has been active in furthering the water development program in the state through its education program of motion pictures, exhibits, circular literature concerning the progress of the various water development projects. The Greater North Dakota Association has prepared a motion picture history of the water program since the major development started in 1946 and has shown this picture throughout the state at various meetings and gatherings.

INFORMATION PROGRAM

Since authorization of the plan for the development of the Land and Water Resources of the Missouri River Basin there has been a continual demand for information concerning the various projects of the programs and how they will effect the state. Informational maps, circulars, pictures, copies of speeches have been distributed by the Commission in answer to over 800 requests received during the period of this report. In addition to the Commission's exhibit depicting the water development program in the state has been shown at many fairs, conventions, and other meetings. From July 1, 1950 to June 30, 1952 this exhibit has been displayed at the following shows:

1950—1951

Red River Valley Fair — Fargo
State Fair — Minot
State Conservation Show — Bismarck
Boys State — Fargo
State Dairy Show — Jamestown
Wells County Fair — Fessenden
County Agriculture Meeting — Lakota
Winter Show — Valley City
North Dakota State Reclamation Meeting — Sidney, Montana
National Reclamation Meeting — Spokane, Washington

1951—1952

Red River Valley Fair — Fargo
Winter Show — Valley City
State Dairy Show — Jamestown
North Dakota State Reclamation Meeting — Jamestown
Stutsman County Fair — Jamestown
Farmers Day — Larimore
Slope County Fair — Amidon
National Reclamation Meeting — Amarillo, Texas
Rural Life Conference — Minot

U. S. WEATHER BUREAU

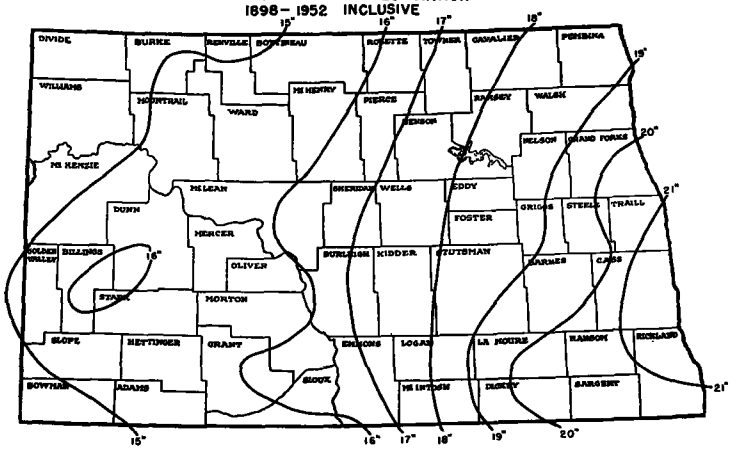
Climate is a natural resource that cannot be exhausted by exploitation as in the case with most natural resources such as soils, forests, and mineral deposits. As civilization becomes more complex, our dependence upon an intimate knowledge of climate and weather increases. Today this knowledge is so indispensable that every civilized country has an extensive weather service. While it is impossible for man to change the climate materially, it is possible for him to plan his activities in such a manner that he will realize the maximum benefit from the forces of nature.

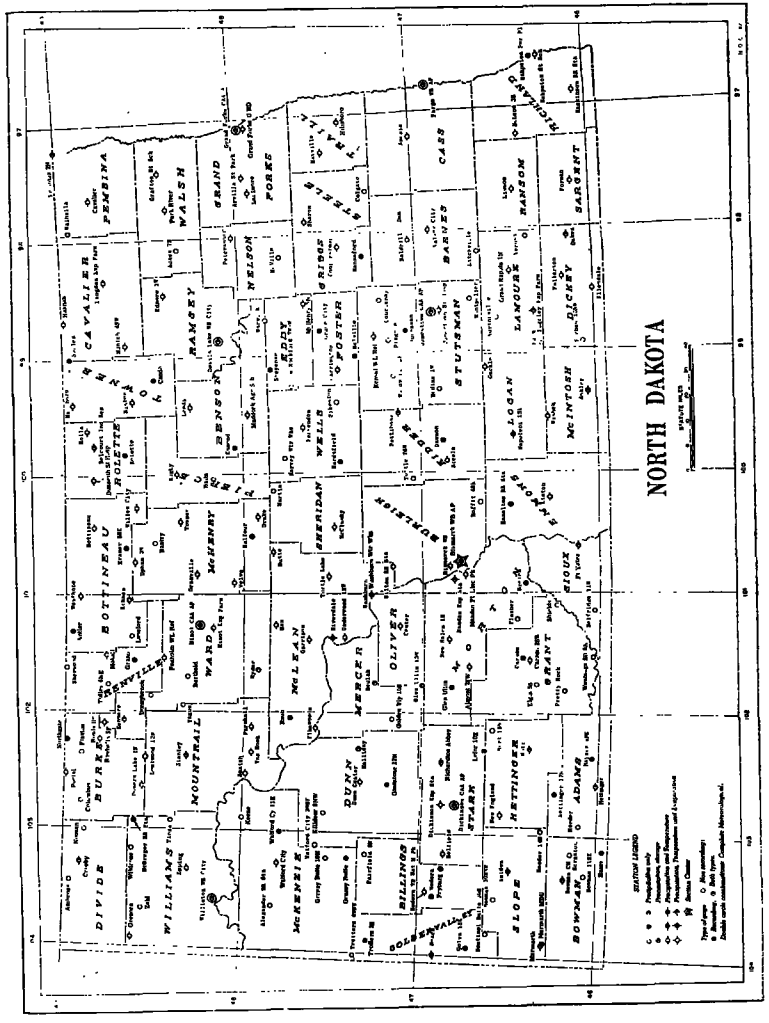
As of 1952 there are 4 first-order Weather Bureau stations in North Dakota and 5 Airway stations, all rendering 24-hour service. There are also 200 cooperative weather observers in the state supervised by the Bismarck office. These cooperative observers take daily readings, recording the high and low temperature, 24-hour precipitation, sky condition and wind. About 35 of the stations have recording rain gages showing hourly precipitation.

The first weather records available for North Dakota were made by Lewis and Clark in 1804 and 1805 at Mandan. Regular daily observations were begun at a few stations by the Army in 1860, but a good distribution of stations was not secured until 1892, when there were 42 stations in the state.

"Climate and Weather in North Dakota", prepared by Meteorologist Frank J. Bavendick and published by the State Water Conservation Commission in 1952 contains a digest of weather records for 80 years. It notes unusual and unfavorable weather conditions to prepare residents for possible recurrence in future years. This book contains a wealth of information of the vagaries of North Dakota weather including floods, blizzards, drought, dust storms, hail, precipitation, snowfall, sunshine, etc. The book is for sale at the office of the State Water Commission at $1.00 a copy.

NORTH DAKOTA
AVERAGE ANNUAL PRECIPITATION
1898–1952 INCLUSIVE





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