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FIFTH BIENNIAL REPORT

of the

State Water Conservation Commission

and the

TWENTY-SECOND BIENNIAL REPORT

of the

STATE ENGINEER

of

North Dakota

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From November 1, 1944 to October 1, 1946

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FIFTH BIENNIAL REPORT

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State Water Conservation Commission

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TWENTY-SECOND BIENNIAL REPORT

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STATE ENGINEER

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North Dakota

From November 1, 1944 to October 1, 1946

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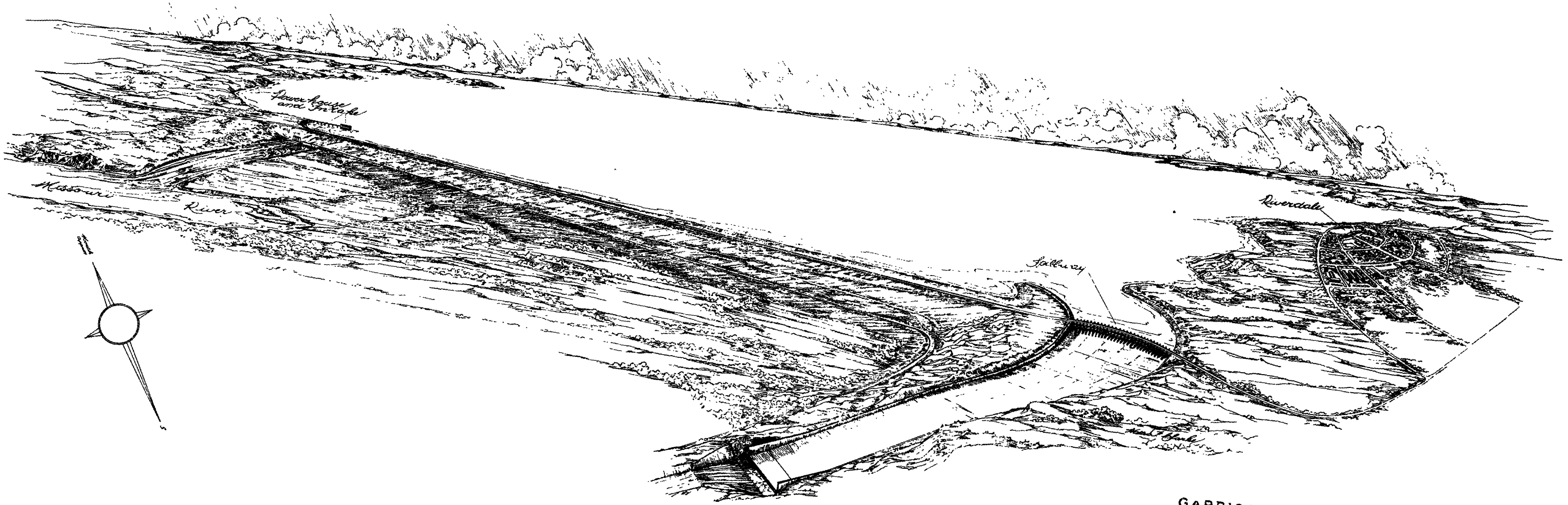
MAPS, GRAPHS, PICTURES

	Page
Garrison Dam, reservoir perspective	3
Governor Aandahl and Brigadier-General Pick	6
Map—Water and Power Development Plan	9
Air View—Missouri river big bend and Garrison dam	11
Graph shows irrigated and non-irrigated lands in U. S.	12
Picture showing method of irrigation	14
Picture of Buford-Trenton Irr. Dist. pumping plant	16
Graph showing progress of irrigation in North Dakota	18
Picture showing site of Heart Butte dam	19
Map showing average rainfall areas in North Dakota	22
Graph showing temperature and rainfall and wheat yields	24
Picture showing site of Sheyenne river dam and reservoir	25
Map and graph showing Devils Lake water level recession	26
Picture of main canal on Lower Yellowstone Irr. Dist.	28
Picture of irrigated grains on Yellowstone Irr. Dist.	30
Picture showing cattle fed for market on beet pulp, etc.	32
Map of Garrison and Turtle Lake reservoirs	35
Map showing Missouri-Souris million acre irr. project	36
Picture showing Nels Bach farm home on irr. project	38
Picture showing Axel Danielson farm home on irr. project	40
Map showing proposed Missouri river reservoirs, etc.	42
Pictures showing big dirt-moving and new railroad spur	44
Map of Lewis & Clark Dist. irrigated farms	47
Picture showing feeder lambs on Yellowstone Irr. Dist.	50
Map showing stream gaging stations in North Dakota	52
Picture showing irrigated sugar beets on Yellowstone	70
Map showing topographic surveys completed in N. D.	72
Graphs showing spring and fall killing frosts in N. D.	75
Graphs showing Jan. and July temperature in N. D.	76
Graphs showing precipitation av. and summers in N. D.	77
Graphs showing days without frost, and county precipitation	78
Map showing annual and seasonal precipitation in N. D.	79
Map showing average annual precipitation in United States	80
Graphs showing precipitation at N. D. cities and towns	81-6
Map showing Rural Electrification Adm. in North Dakota	88
Map of Federal Hydro-Electric Power Line system proposed	91
Map showing drainage and flooded areas in North Dakota	92
Graph showing water levels in Lake Darling reservoir	94
Cross-section of Cass County underground water survey	97
Map showing areas requesting underground water surveys	98
Picture showing irrigated alfalfa on Lower Yellowstone	100
Picture of Missouri river and Highway bridge at Bismarck	102
Picture showing Heart river farmers investigating irrigation	104
Map of Heart River reservoirs and irrigation projects	106
Picture of site of dam and reservoir near Dickinson, N. D.	108
Map of Knife River reservoir and irrigation project	109
Picture of feeding lambs for market on Lower Yellowstone	110
Map of Grand River Bowman-Haley proposed irrigation	112
Picture of proposed Missouri River pumping irrigation unit	114
Picture of irrigation on the Buford-Trenton irr. project	118
Picture of Hebron dam washout and after repaired	119



GARRISON DAM AND RESERVOIR

GARRISON, NORTH DAKOTA

OFFICE OF THE DIVISION ENGINEER MISSOURI RIVER DIVISION.

OMAHA, NEBRASKA. MAY. 1946

TABLE OF CONTENTS

	Page
Letter of Transmittal	4
Dependence on Rain Will Bring Disaster	5
Organization and Personnel	7
Objectives and Program	10
History of Irrigation	13
Economic Charts Showing Need for Irrigation	22
Irrigation Development and Results in North Dakota	17
Progress on Proposed Irrigation Units	23
Central North Dakota Areas to be Served	23
Irrigation Results on the Lower Yellowstone	33
Proposed Reservoirs Serving Central and Eastern N. D.	34
Bureau of Reclamation, Investigations and Plans	37
The Army Engineers Plan—Garrison Dam	43
Other Cooperating Agencies	45
Red River Drainage Progress	49
Stream Flow Measurements, Geological Survey	53
Topographic Surveys, Geologic Survey	71
U. S. Weather Bureau report and graphs	73
State Game and Fish Department cooperation	87
Rural Electrification progress in North Dakota	89
Underground Water Surveys, State Geologist	93
Compacts with adjoining states	103
Heart River and other Proposed Irrigation Projects	105
Appropriations Explained	113
Maintenance of Dams	119
Report on Finances, Appropriations	123
Bonds Outstanding	124

LETTER OF TRANSMITTAL

November 1, 1946

Honorable Fred G. Aandahl
Governor of North Dakota

Sir:

In compliance with provisions of law, we transmit herewith for your information and consideration the Fifth Biennial Report of the activities of the State Water Conservation Commission and the Twenty-second Biennial Report of the State Engineer from November 1, 1944 to October 1, 1946.

Respectfully submitted,

STATE WATER CONSERVATION COMMISSION

KENNETH W. SIMONS, Vice Chairman
SIVERT W. THOMPSON
EINAR H. DAHL
LEWIS T. ORLADY

J. J. Walsh
Secretary and Chief Engineer, State Engineer

DEPENDENCE ON RAIN WILL BRING DISASTER

"Years will come of abundance and years will come of disaster, and between the two the people will be prosperous and unprosperous, and the thing to do is to look the question squarely in the face and provide for this and for all years."

"In the western portion all dependence on rain will ultimately bring disaster to the people. They are unwilling yet, a good many of them, to admit it, but * * * they will have to depend forever on artificial irrigation for all agriculture."

"The State of North Dakota has a curious position geographically in relation to agriculture. The eastern portion of the state has sufficient rainfall for agricultural purposes; the western part has insufficient rainfall, and the western portion is practically wholly dependent on irrigation."

(From talk before the North Dakota Constitutional Convention on Aug. 5, 1889, by Major Power, Director of the U. S. Geological Survey.)

Governor Fred G. Aandahl of North Dakota and Brigadier-General Lewis A. Pick. Site of Garrison dam in background.

ORGANIZATION AND PERSONNEL

The State Water Conservation Commission was created by the 1937 Legislature. The Governor was made ex-officio Chairman, and authorized to appoint the other members. Amendments to the law were made by the 1939 legislature and later sessions.

Membership

	Term Began	Term Ends
Governor Fred G. Aandahl, Ex-officio Chairman	Jan. 2, 1945	
Kenneth W. Simons, Vice-Chairman	Apr. 3, 1939	July 1, 1949
Sivert W. Thompson	Apr. 3, 1941	July 1, 1947
Einar H. Dahl	Apr. 3, 1941	July 1, 1947
Lewis T. Orlady	Mch. 30, 1943	July 1, 1948

J. J. Walsh, Secretary and Chief Engineer, State Engineer.

John T. Tucker, former Secretary and State Engineer, secured leave of absence and volunteered in the U. S. Navy Seabees on June 4, 1943. J. J. Walsh was appointed Acting Secretary. Mr. Tucker was awarded the rank of Lt. Commander for services on the west coast and overseas. On his return to the U. S. he was appointed Supt. of the Naval Proving Station at Port Hueneme, Calif., and J. J. Walsh was made Secretary and State Engineer on June 19, 1946.

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;

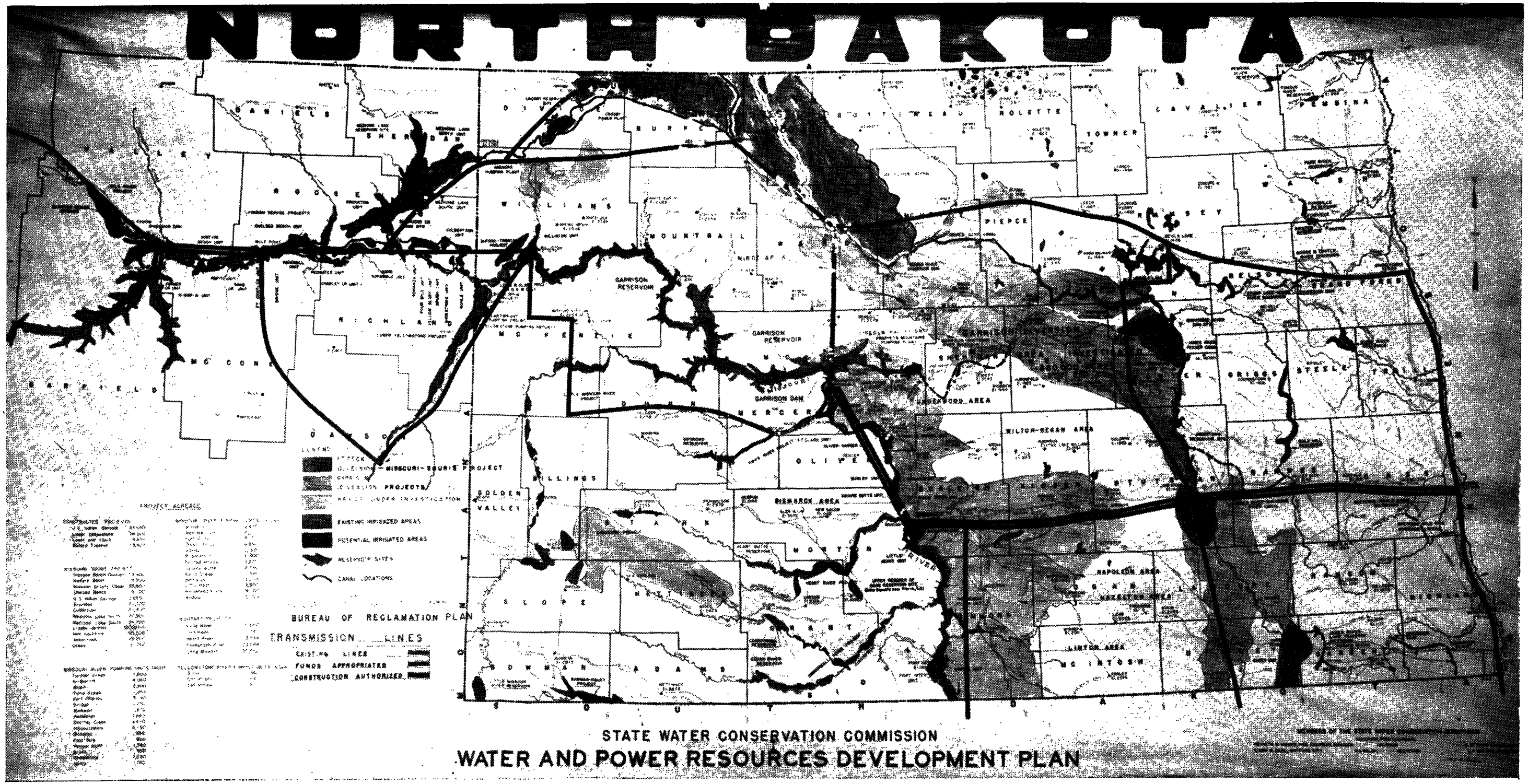
b. For the full and complete supervision, regulation, and control of the water supplies within the state; and

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.



STATE WATER CONSERVATION COMMISSION

WATER AND POWER RESOURCES DEVELOPMENT PLAN

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 must be a qualified and experienced hydraulic engineer as well as 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, examine 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 cooperates with County Commissioners in the engineering work required to construct drains to divert floodwaters.

On request he makes certified copies of maps, field notes and records of surveys of lands turned over by the government to the state, of which he is the custodian.

He makes 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.

OBJECTIVES AND PROGRAM

Plans for the ultimate development of North Dakota's water resources have been greatly advanced with the approval of Congress authorizing the construction of projects, submitted in the reports of the U. S. Bureau of Reclamation, as shown in Senate Document No. 191, "Missouri River Basin, Conservation Control, and use of Water Resources, April 1944," and in the report submitted by the U. S. Corps of Army Engineers, as shown in House Document No. 475, "Missouri River Basin, Flood Control Plan," primarily toward the development of irrigation, hydroelectric power production and other beneficial uses of water.

The general comprehensive plans set forth in House Document 475 and Senate Document 191, Seventy-eighth Congress, Second Session, as revised and coordinated by Senate Document 247 were approved by Public Law 534.

Construction funds were appropriated to the Corps of Army Engineers for the Garrison Dam, to be expended in building an access highway, railway spur, highway construction bridge, and the building of the new town of Riverdale for housing the construction crew and headquarters for Corps of Army Engineers in charge.

Funds have been allocated to the Bureau of Reclamation Engineers for continuing investigations, surveys, reports, and design of diversion works from Fort Peck Reservoir to the Missouri Souris Project, including studies of the proposed Sheyenne River Dam, restoration of Devils Lake, and supplmenting flows in the Sheyenne and Red Rivers for the treatment of water for municipal use and disposal of sewage waste, during seasonal periods of low flows.

Two government agencies have been cooperating with the State Water Conservation Commission in surveying possibilities for irrigation in North Dakota. Each evolved a plan which Congress approved in a consolidated form. This plan provides for a series of dams and reservoirs on the Missouri River for the control of flood waters. The largest dam will be built near Garrison, North Dakota. The water from this reservoir can be pumped over the divide near McClusky and into the head waters of the Sheyenne and James Rivers, from which it can be diverted into Devils Lake and used for irrigation in central North Dakota.

The Bureau of Reclamation plan will divert waters from below Fort Peck dam in Montana to the northwestern part of North Dakota. Approximately 1,000,000 acres of land will be irrigated in the Crosby-Mohall-Minot area. A canal will carry surplus waters to the head waters of the Sheyenne River, to Devils Lake, and into the James River, irrigating 55,000 acres near New Rockford, 22,000 below Jamestown, and 33,000 acres below Oakes, North Dakota. Areas below the Garrison dam will be irrigated by pumping from the Missouri River, as follows: Hancock Flats, 5,030 acres; Fort Clark, 2,750 acres; Oliver-Sanger, 6,880 acres; Painted

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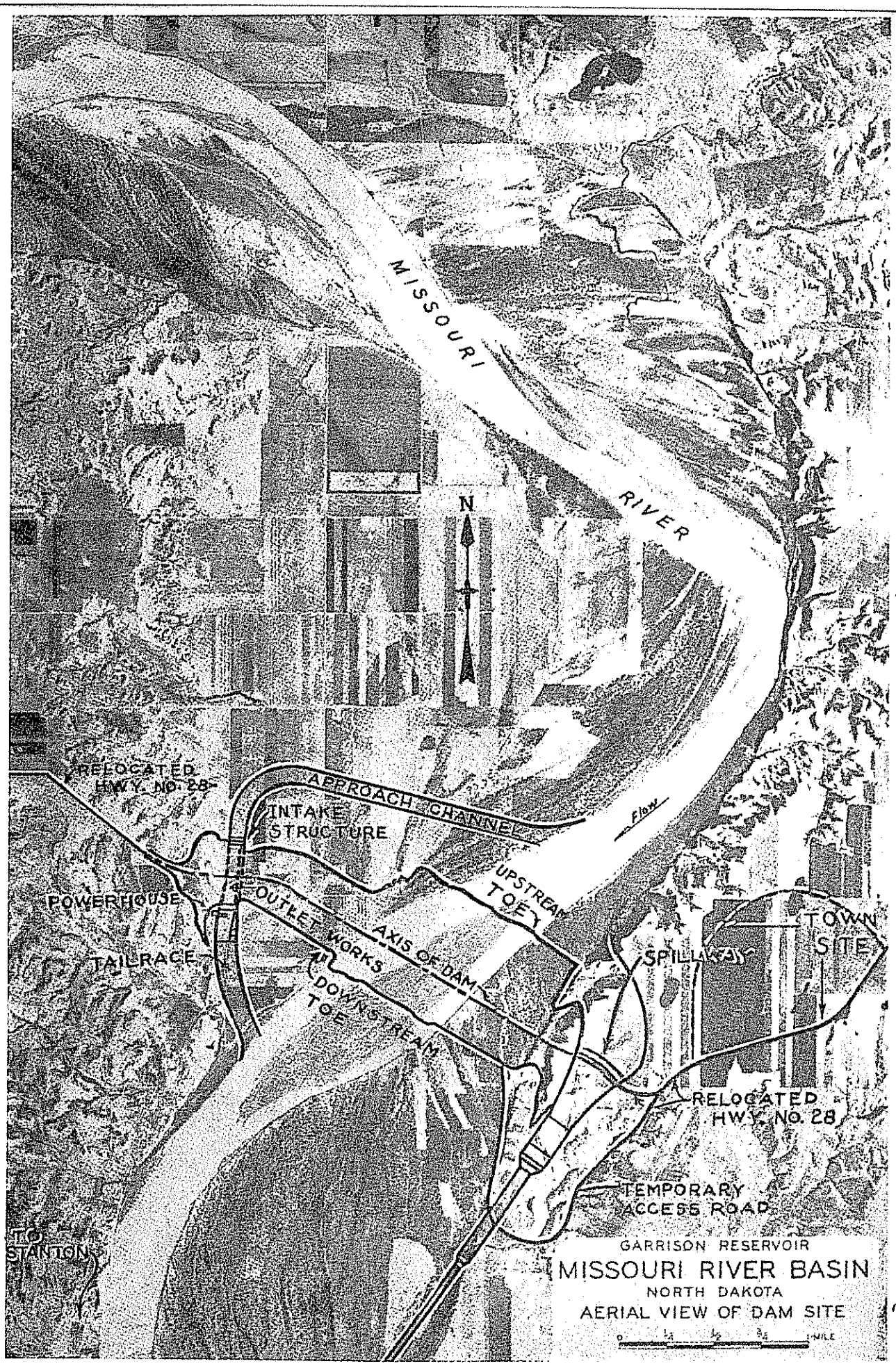


Woods, 2,300 acres; Manley, 2,160 acres; Wogansport, 2,400 acres; Square Butte, 2,750 acres; Burnt Creek, 1,940 acres; Little Heart, 1,940 acres; Horsehead Flats, 9,000 acres; Winona, 5,100 acres; and Bismarck, approximately 10,000 acres, all in North Dakota. The plan would also irrigate 51,800 acres along the western tributaries of the Missouri River, including the Knife, Heart and Cannonball Rivers. This original plan would irrigate about 1,250,000 acres in North Dakota. Later surveys indicate the possibility of adding 750,000 acres to the irrigated areas in central North Dakota.

HYDROELECTRIC POWER

The water power from the Garrison reservoir will generate enough electricity to serve territory within a radius of 150 miles or more from the dam, at a very low rate, less than half the present cost. Practically every farm within this area will ultimately have the benefit of this power in the homes, the barns and shops, enabling farmers to produce much more with much less effort.

On the basis of the experience at other large hydroelectric plants, Engineers of the Federal Power Commission made an estimate from which it is predicted that the low cost hydroelectric power produced at the Garrison dam should bring to the state industrial plants requiring an investment of $200,000,000, and which will employ 35,000 workers, meaning with their families about 175,000 increase in population. The population on irrigated farms in some areas in Nebraska increased ten times in twenty years from the number before the land was irrigated.

USE OF MANPOWER

The construction of these projects will utilize the labor of thousands of men for several years. It will enable many to establish permanent homes either on farms or in towns serving the needs of the farmer.

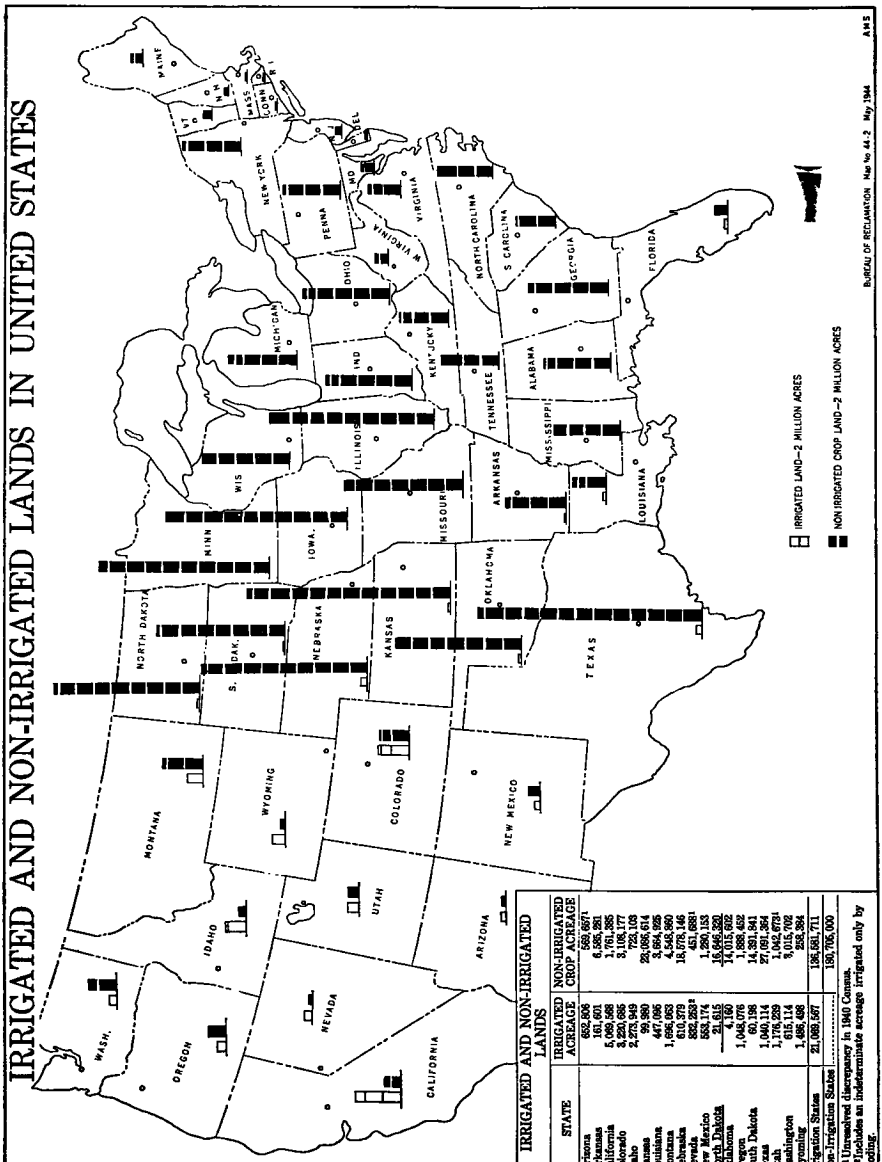
The utilization of surplus manpower is most economical in the development of irrigation. It will after completion pay its own annual cost of operation and pay back to the government the original investment over a period of years. The doubling of the income of the lands irrigated permits this. Irrigation projects in operation in North Dakota reported in later pages demonstrate this.

SOIL PRODUCTIVITY

The experience of recent years in North Dakota, with more than normal rainfall, has proved conclusively the wonderful productivity of the soil of this area, and that all that it needs is ample water.

DRAINAGE

In the Red River basin during years of above normal rainfall, drainage has become a very pressing need. The survey by the U. S. statistician



IRRIGATED AND NON-IRRIGATED LANDS

STATE	IRRIGATED ACREAGE	NON-IRRIGATED CROP ACREAGE
Arizona	652,806	569,6671
Arkansas	161,601	6,535,281
California	5,066,988	3,761,365
Colorado	3,225,365	31,128,177
Idaho	2,272,949	722,119
Kansas	99,980	22,056,614
Louisiana	447,096	3,664,925
Montana	1,696,053	4,549,560
Nebraska	610,379	13,678,146
Nevada	852,2234	451,0681
New Mexico	655,174	1,396,133
North Dakota	21,615	15,646,320
Oklahoma	4,160	14,015,692
Oregon	1,045,076	1,898,452
South Dakota	60,198	14,391,941
Texas	1,040,114	27,091,264
Utah	1,176,229	1,042,6724
Washington	1,015,714	9,015,702
Wyoming	1,498,498	258,394
Irrigation States	21,065,567	136,581,711
Non-Irrigation States	.....	180,705,000

1 Unresolved discrepancy in 1940 Census.
2 Includes an indeterminate acreage irrigated only by flooding.

showed an estimated loss from crop flooding in 1943 and 1944 amounting to more than $23,000,000. With the help of appropriations made by the legislature, a good start has been made in cleaning out, reconstruction and construction of new drains, which have already proved their value. Continuous maintenance of drains will be necessary.

HISTORY OF IRRIGATION

Irrigation has been in use for countless centuries. Egypt, Assyria, Babalonia, China and India were practicing irrigation when the writing of history began. Today, Egypt and India have the greatest irrigation systems in the world. Russia has built immense irrigation systems in the Caspain region. In China, irrigated areas have supported more than 2,000 people to the square mile for more than 2500 years.

The Reclamation Act became a law in 1902. It states, "The right to the use of the water shall be perpetually appertinent to the land irrigated, and beneficial use shall be made the basis, the measure and the limit of the right."

With the formation of the State Water Conservation Commission in 1937, a campaign of education began. Recent developments indicate that irrigation construction in North Dakota will far exceed the fondest expectations of the early promoters.

Actual experience in North Dakota has proved that irrigation can be made highly profitable in the semi-arid areas where the rainfall is insufficient in many seasons to produce a paying crop. This has been the experience in North Dakota, where some drouth years and series of seasons have resulted in harrowing experiences for a majority of its citizens. Millions of dollars of federal money was expended in order to provide subsistence and prevent famine. Between June 1933 and December, 1935, federal emergency relief expenditures in North Dakota amounted to more than $24,000,000. In addition, large sums were expended for relief by the state, subdivisions, municipalities, and Red Cross chapters.

During this period, the bright spot in the state was the irrigated areas on the Lower Yellowstone District, covering about 45,000 acres, of which about one-third is in McKenzie County, North Dakota. On the worst drouth year, 1935, crops on this irrigated land averaged a return of more than $35.00 per acre, while a survey showed that crops under dry land farming methods on adjacent lands averaged returns of only 70 cents per acre.

Even in years of ample rainfall, the returns per acre from the Lower Yellowstone Irrigation District are outstanding. Reports show that in 1942 this area averaged $50.89 per acre, in 1943, $59.65 per acre, in 1944, $62.69 per acre, and in 1945, $57.13 per acre. The light hail storm on the last year mentioned reduced the returns somewhat. This proved con-

Irrigation will Play Vital Role in the Nation's Future Economy

clusively that irrigation farming is more profitable every year than dry land farming, and warrants the expenditure of money for the construction.

An accompanying map shows irrigated and non-irrigated land in the United States. California leads with the largest irrigated acreage. Montana has nearly 1,700,000 acres under irrigation. North Dakota is next to the bottom of the list, but with expected development should rise to be one of the largest irrigated areas. The total land irrigated in the United States is over 21,000,000 acres, involving an investment of $1,052,-049,201, averaging $34.36 per acre.

Lewis & Clark Irrigation District

In 1939-40 the State Water Conservation Commission and the Rural Rehabilitation Corporation cooperated on the construction of the Lewis & Clark Irrigation district of about 5,000 acres, located in McKenzie County North Dakota, about six miles southwest of Williston in the Missouri river valley.

Fifty-two farmers who were formerly dry land operators have purchased irrigated farms averaging 115 acres each. Some are slower than others in adapting their operations to irrigation, but not one is willing to return to dry land farming. Every irrigable acre is occupied.

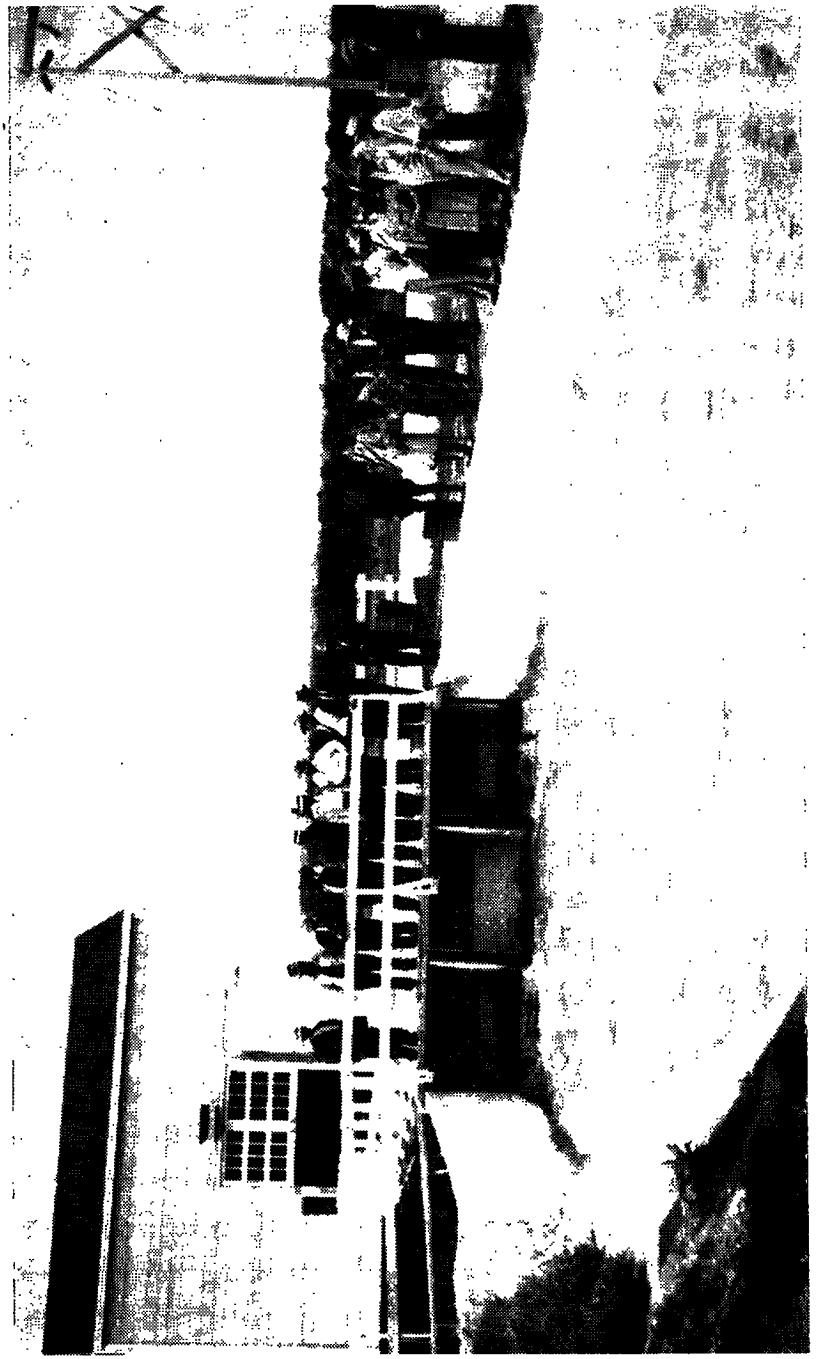
Before irrigation, the average gross income from the tract was $7,900. The 1945 income was $158,085 as per figures as shown in the project report. There was 934 acres of alfalfa, 966 acres of potatoes, 1,100 acres of wheat, and balance in flax, corn and millet. The returns for the tract are twenty times in 1945 what it was in 1939, before irrigation.

Buford-Trenton Irrigation District

14,800 acres of bottom-land on the north of the Missouri river in Williams County, North Dakota is in the process of irrigation construction, 5,000 acres being farmed in 1945 and about 9,000 acres in 1946. The plans include the devolpment of 118 farms on the tract which before irrigation contained only 26 farm families. There is more demand for irrigated farms than can be supplied, by dry-land farmers of that immediate area.

The average gross production of this area was approximately $47,800. In 1945, 5,200 irrigated acres with 3,370 acres still under dry farming produced a gross income of $220,157, according to the project Supervisor. Crops produced were barley, oats, wheat, potatoes, alfalfa hay, beans, millet and corn. In 1946 a beginning was made on raising sugar beets, a high-income crop, on 400 acres.

The Bureau of Reclamation constructed this irrigation system in cooperation with the Department of Agriculture. Farm buildings have been erected on forty farms, and more will be built as fast as possible.



Pumping Station on Buford-Trenton Irrigation District, west of Williston, N. D.

IRRIGATION DEVELOPMENT

The accompanying graph on a separate page pictures the gradual increase in acreage brought under irrigation since 1890. The progress has been steady except for a few years of heavy rainfall. There has been a steady growth in acreage brought under irrigation during the past nine years, since the North Dakota State Water Conservation Commission was created. During this period irrigation increased from about 17,000 acres to 35,000 acres. In view of the increased precipitation during the past five years, this is a real accomplishment in the development of irrigation in North Dakota.

HEART RIVER UNIT—NORTH DAKOTA

The Heart River Unit will provide for irrigation of 12,893 acres of land, and for flood control, silt retention, and municipal uses. Principal features will consist of two multiple-use reservoirs and a system of pumping plants and canals.

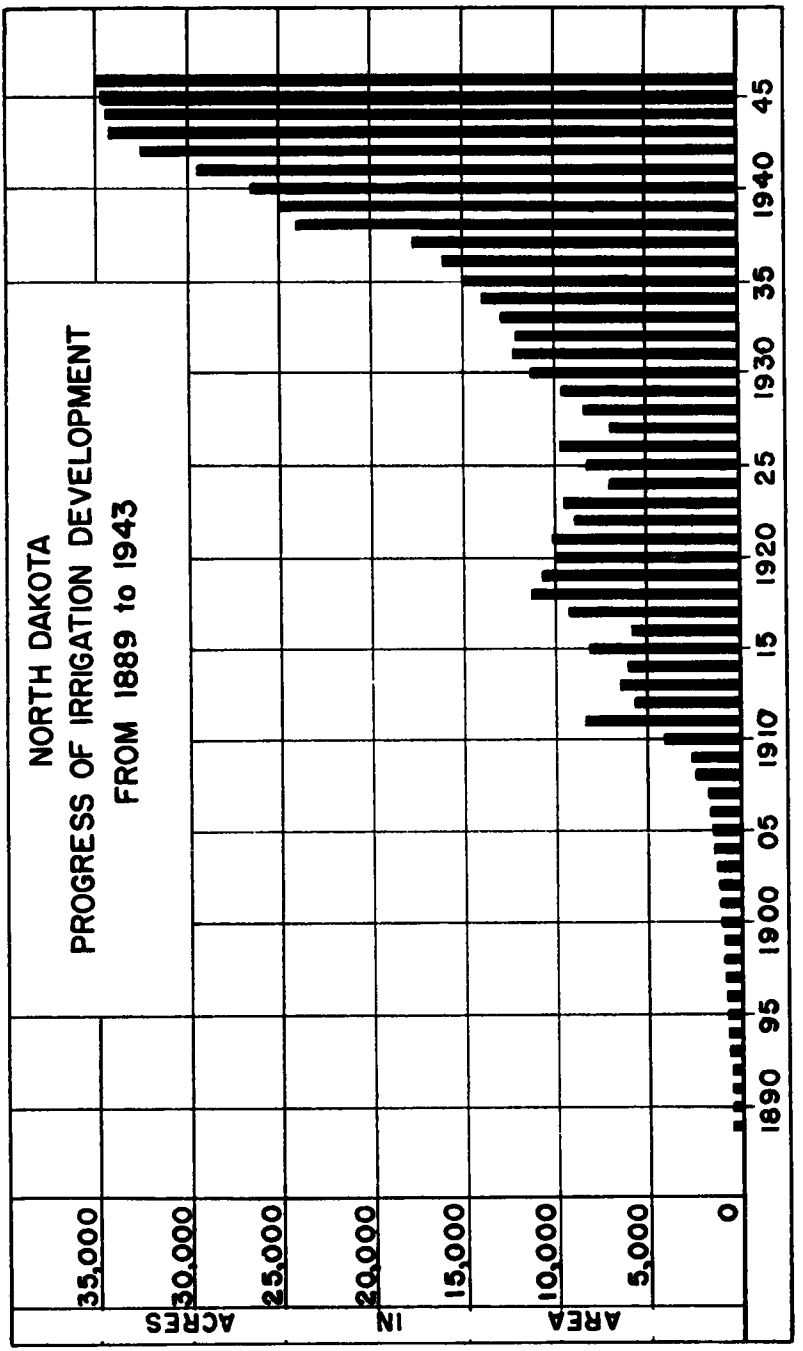
The Dickinson Reservoir, on the Heart River, will be constructed to provide water for municipal use and for the irrigation of 780 acres of land. It will have a storage capacity of 16,500 acre-feet, including 9,500 acre-feet of super-storage for flood control and 3,000 acre-feet for silt retention. The dam, about 1.5 miles above Dickinson, North Dakota, will be an earth-fill structure with a height of 45 feet above the stream bed. The land to be irrigated consists of small parcels which will be served by six pumping plants.

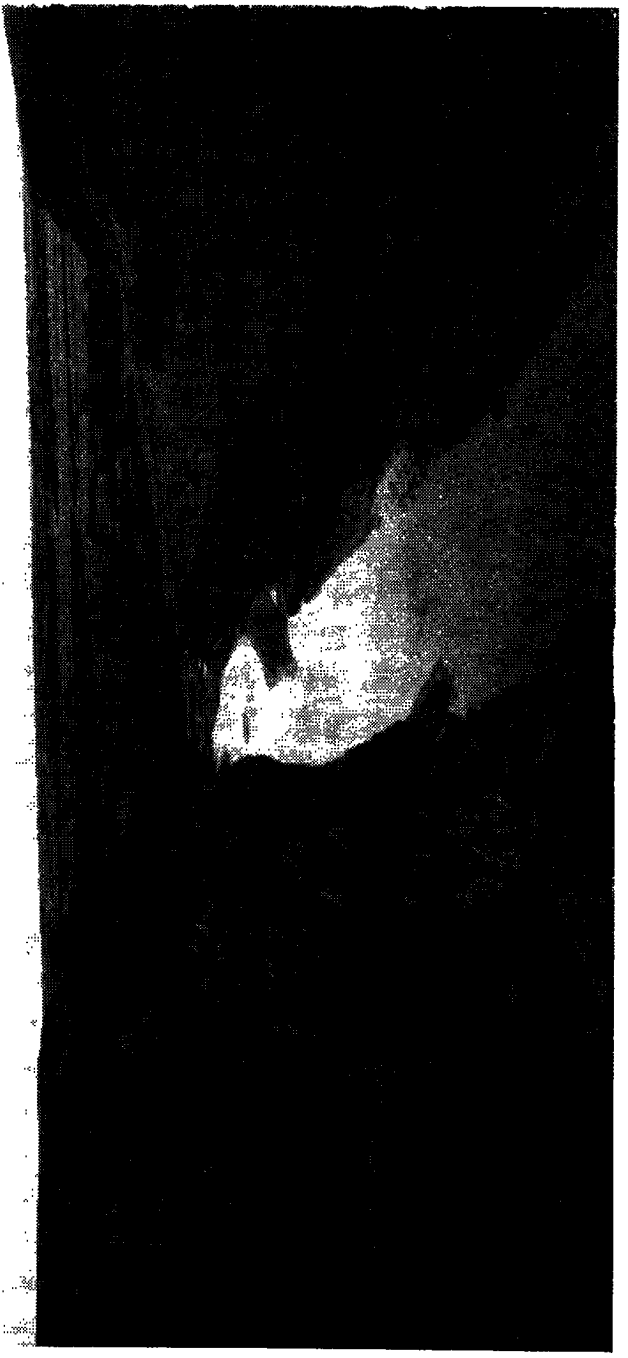
The Heart Butte Reservoir, about 60 miles above the mouth of the Heart River, will store water for the irrigation of 12,893 acres of land. The dam will be an earth-fill structure with a height of about 123 feet above the stream bed. It will provide a storage capacity of 300,000 acre-feet at full pool level, of which 25,000 acre-feet will be used for silt retention, 50,000 for irrigation storage, and 225,000 for flood control. Water will be delivered by gravity to 3,600 acres, and the remaining 8,513 acres will require 37 individual pumping plants.

Completion of water studies and land classification disclosed that more water would be available than is needed by Heart River lands. From reconnaissance surveys, the most practical area for additional irrigation appeared to be in the neighboring Curley Valley. Field studies on a pumping diversion from the proposed Big Bend Canal over a low divide to the Curley Valley is well advanced.

Petitions were circulated for the formation of the Heart River Irrigation District, and on July 26, 1946, the landowners voted 144 to 46 in favor, and the District has been organized.

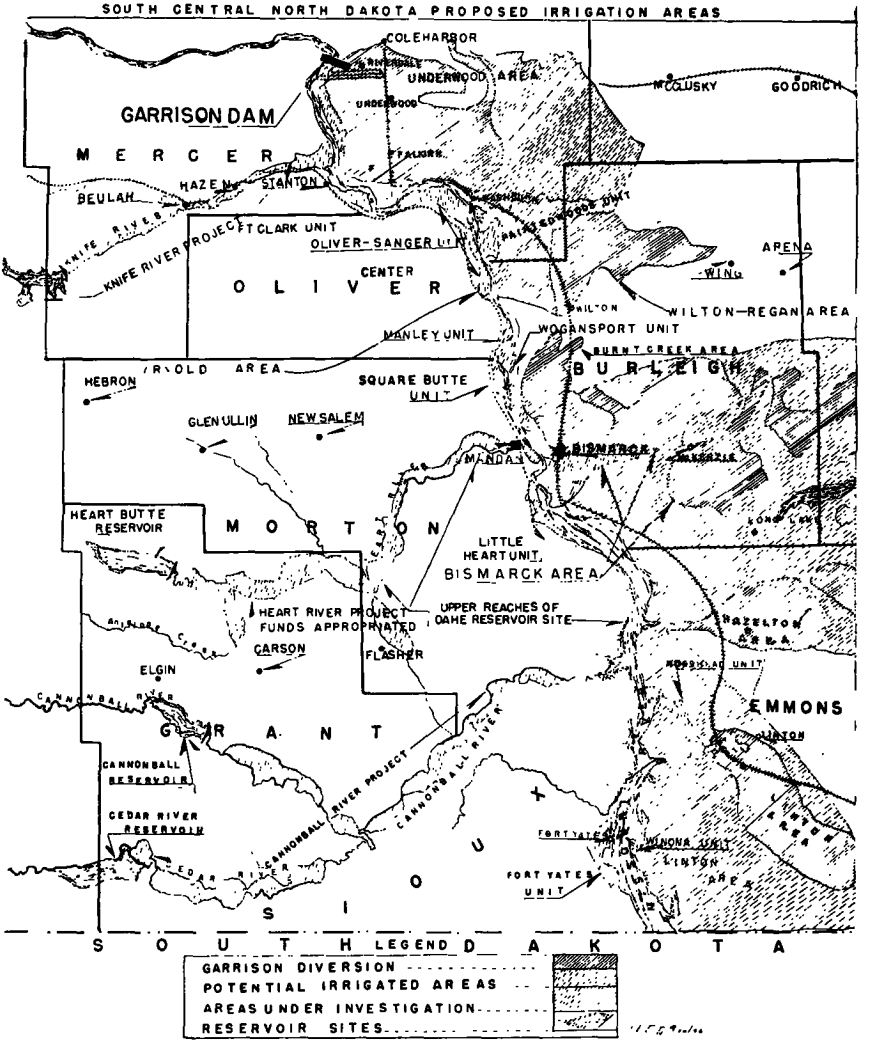
It was planned to immediately call for bids for construction, but an order of the President of the United States required as a matter of public policy that public works projects on which contracts had not been let be temporarily delayed.


NORTH DAKOTA
PROGRESS OF IRRIGATION DEVELOPMENT
FROM 1889 to 1943
AREA IN ACRES
35,000
30,000
25,000
20,000
15,000
10,000
5,000
0
1890
95
1900
05
1910
15
1920
25
1930
35
1940
45



Site of Heart River and reservoir site, about 15 miles south of Glen Ullin, North Dakota

Missouri River Pumping, and Knife, Heart and Cannonball River Projects, located below Garrison Reservoir in



PROGRESS ON OTHER IRRIGATION WORKS

Missouri-Souris Units

Work being done includes preparation of specifications, negotiations with various cooperating agencies, preparation of studies for the Sheyenne River. General Land Office crews began tracing section lines and reestablishing corners. The Geological Survey crews established control for aerial mapping. Topographic surveys of the Medicine Lake area are being made by the Geological Survey. An office was established at Wolf Point, Montana, by the Reclamation Bureau for crews working on the Montana Division. Topographic surveys at the Missouri River diversion site have been completed, also preliminary location surveys for the main canal which will extend from that point to the proposed Medicine Lake Reservoir were under way.

The Reclamation Bureau also opened offices at Crosby, Minot and New Rockford, North Dakota, for preconstruction work on the North Dakota Division. Topographic surveys of the Crosby reservoir site and north and south dam sites were practically complete, and were also started at the Crosby power site and the Des Lacs dam site. Crews located at New Rockford were completing detailed surveys and explorations at the Sheyenne River dam and reservoir site at the end of June.

Proposed Missouri River Pumping Units

Between the Garrison dam and the South Dakota border are thirteen proposed river pumping irrigation units. It is planned to install pumps at each of these cites capable of lifting water to irrigate arable land bordering the Missouri river. More than 47,000 acres will be included in these projects. The Bureau of Reclamation headquarters for North Dakota is located in Bismarck and has an engineering force of sixty-five men on these and other irrigation projects.

The North Dakota State Water Conservation Commission is cooperating with the federal government on these and other North Dakota projects. Funds totalling $200,000 were appropriated by the North Dakota legislature for the biennium of 1943-45 for this purpose, and an additional $100,000 for the 1945-47 biennium for studying potential irrigation areas of North Dakota for irrigation. These funds have been a great aid in enlarging the possible irrigable areas and in speeding up the necessary preliminary work preparatory to irrigation construction.

Five of these proposed pumping projects have been authorized by Congress, including the Hancock Flats below the Garrison dam; the Oliver-Sanger unit west of Washburn; the Painted Woods unit south of Washburn; the Wogansport unit twelve miles north of Bismarck; and the Square Butte unit ten miles north of Mandan.

The other eight proposed units are the Fort Clark southeast of Stanton; the Manley unit seventeen miles northwest of Bismarck; the

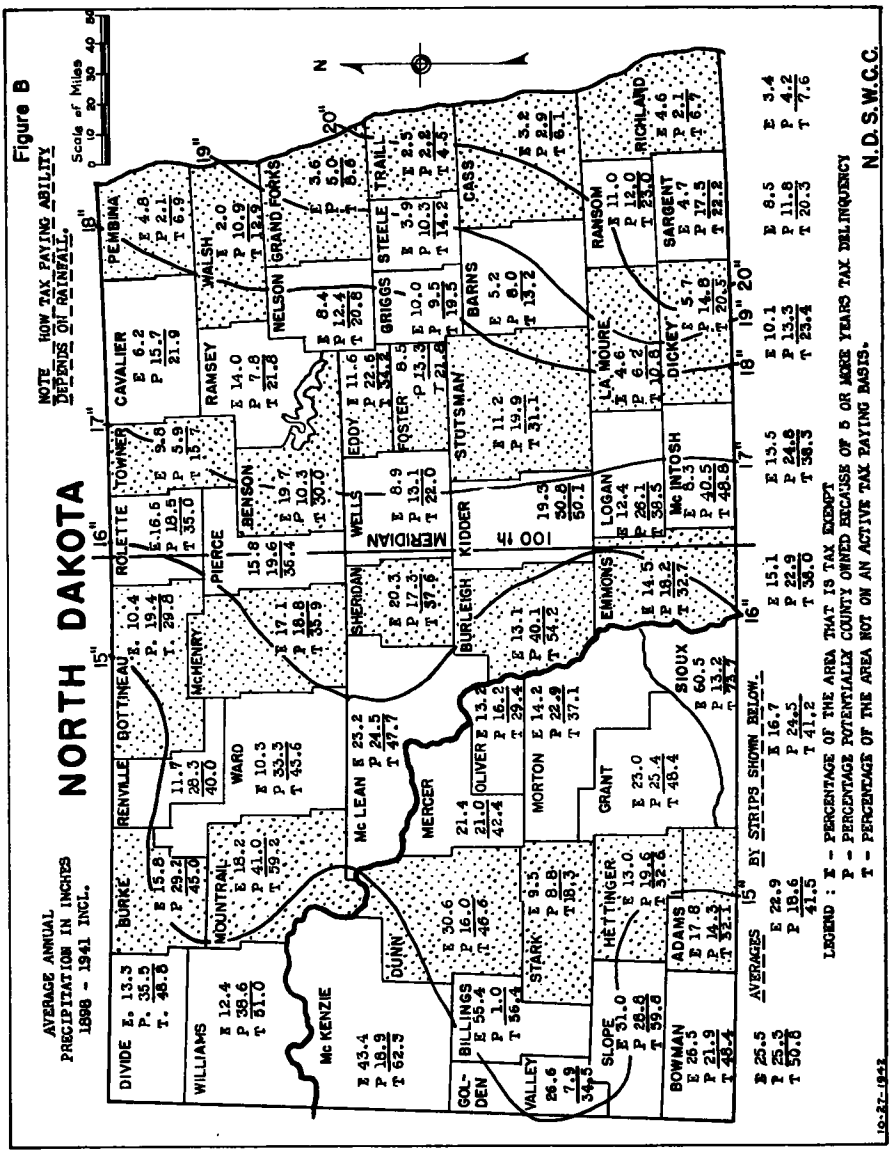


Figure B
NORTH DAKOTA
AVERAGE ANNUAL PRECIPITATION IN INCHES 1898 - 1941 INCL.
NOTE HOW TAX PAYING ABILITY DEPENDS ON RAINFALL.
Scale of Miles
0 10 20 30 40 50
N
DIVIDE E. 13.3 P. 35.5 T. 48.8
BURKE E 15.8 P 29.2 45.0
RENVILLE 11.7 28.3 40.0
BOTTINEAU E. 10.4 P. 19.4 T. 29.8
ROLETTE E 16.6 P 18.5 T 35.0
TOWNER E 9.8 P 5.9 T 15.7
CAVALIER E 6.2 P 15.7 21.9
PEMBINA E 4.8 P 2.1 T 6.9
WILLIAMS E 12.4 P 38.6 T 51.0
MOUNTRAIL E 18.2 P 41.0 T 59.2
WARD E 10.3 P 33.3 T 43.6
McHENRY
PIERCE
BENSON 15.8 19.6 36.4 E 17.1 P 18.8 T 35.9
RAMSEY E 14.0 P 7.8 T 21.8
WALSH E 2.0 P 10.9 T 12.9
NELSON E 8.4 P 12.4 T 20.8
GRAND FORKS E 3.6 P 5.0 T 8.6
Mc KENZIE E 43.4 P 18.9 T 62.3
DUNN E 30.6 P 16.0 T 46.6
Mc LEAN E 23.2 P 24.5 T 47.7
SHERIDAN E 20.3 P 17.3 T 37.6
WELLS E 8.9 P 13.1 T 22.0
EDDY E 11.6 P 22.6 T 34.2
FOSTER 8.5 P 13.3 T 21.8
GRIGGS E 10.0 P 9.5 T 19.5
STEELE E 3.9 P 10.3 T 14.2
TRAIL E 2.5 P 2.8 T 4.3
CASS E 3.2 P 2.9 T 6.1
RICHLAND E 4.6 P 2.1 T 6.7
RANSOM E 11.0 P 12.0 T 23.0
SARGENT E 4.7 P 17.5 T 22.2
DICKEY E 5.7 P 14.8 T 20.3
LA MOURE E 4.6 P 6.2 T 10.8
STUTSMAN E 11.2 P 19.9 T 31.1
BARNS E 5.2 P 8.0 T 13.2
MERIDIAN
100 th
KIDDER 19.3 30.8 50.1
BURLEIGH E 13.1 P 40.1 T 54.2
LOGAN E 12.4 P 26.1 T 38.5
Mc INTOSH E 8.3 P 40.5 T 48.8
EMMONS E 14.5 P 18.2 T 32.7
SIOUX E 60.5 P 13.2 T 73.7
MERCER 21.4 21.0 42.4
OLIVER E 13.2 P 16.2 T 29.4
MORTON E 14.2 P 22.9 T 37.1
GRANT E 23.0 P 25.4 T 48.4
STARK E 9.5 P 8.8 T 18.3
HETTINGER E 13.0 P 19.6 T 32.6
ADAMS E 17.8 P 14.3 T 32.1
GOLDEN VALLEY E 55.4 P 1.0 T 56.4
BILLINGS 26.6 7.9 34.5
SLOPE E 31.0 P 28.8 T 59.8
BOWMAN E 25.5 P 21.9 T 46.4
E 25.5 P 25.5 T 50.8
AVERAGES
E 22.9 P 18.6 41.5
BY STRIPS SHOWN BELOW.
E 16.7 P 24.5 T 41.2
E 15.1 P 22.9 T 38.0
E 15.5 P 24.8 T 38.3
E 10.1 P 13.3 T 23.4
E 8.5 P 11.8 T 20.3
E 3.4 P 4.2 T 7.6
LEGEND : E - PERCENTAGE OF THE AREA THAT IS TAX EXEMPT
P - PERCENTAGE POTENTIALLY COUNTY OWNED BECAUSE OF 5 OR MORE YEARS TAX DELINQUENCY
T - PERCENTAGE OF THE AREA NOT ON AN ACTIVE TAX PAYING BASIS.
N.D.S.W.C.C.
10-27-1943

Burnt Creek unit six miles northwest of Bismarck; the Bismarck unit south of that city; the Little Heart unit nine miles southeast of Mandan; the Horsehead Flats unit on Beaver Creek west of Linton; the Winono unit northeast of Winona; and the Fort Yates unit south of Fort Yates.

Plans for the Wogansport and Square Butte units were completed and others will be ready for construction in the spring of 1947. The letting of contracts for construction requires that plans and cost estimates be completed; funds for construction must be appropriated by Congress and that an irrigation district be formed by residents of each of the proposed irrigation projects. The order in which the different units will be constructed depends on appropriations from Congress.

Irrigation requires a change in the type of farming. Wheat is largely replaced by corn, potatoes, alfalfa and feed crops. The raising of sugar beets brings a high return per acre. Experience proves that a three-fold increase in returns per acre will come with irrigation. The average returns on the Lower Yellowstone Irrigation district, with about one-third the acreage in McKenzie County, North Dakota, has averaged approximated $60.00 per acre for the past four years.

Missouri River Diversion Projects

Two great plans for the diversion of the surplus waters of the Missouri River were consolidated by Congress and approved. This consolidation resulted in unified action which will mean ample funds will be provided and authorization given to these two government agencies to construct immense irrigation works in North Dakota and other states in the Missouri Basin, to provide for control of the flood waters of the Missouri and for the generating of low-cost hydroelectric power sufficient to supply great areas.

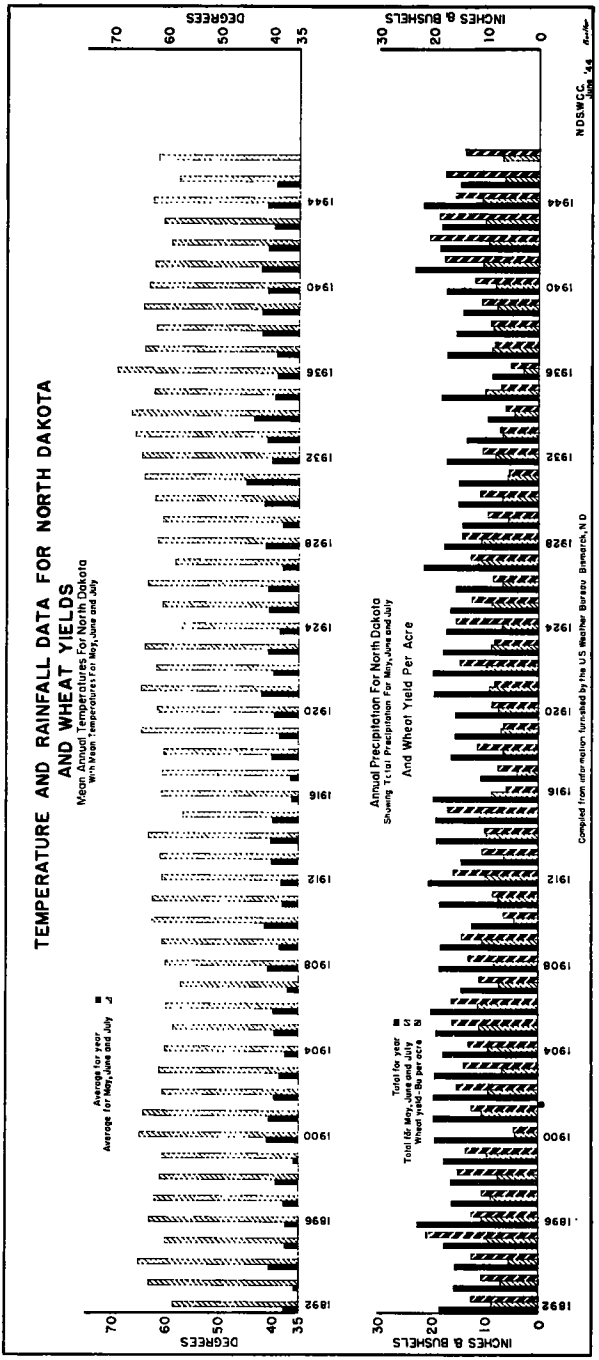
Central North Dakota Areas Served

The plan provides for irrigation in the Sheyenne and James river valleys and for diverting waters to raise the level of the waters of Devils Lake and Stump Lake, from which a steady flow of water in the Sheyenne river will care for sewage disposal and municipal water supply for cities along its course and the Red River from Fargo north.

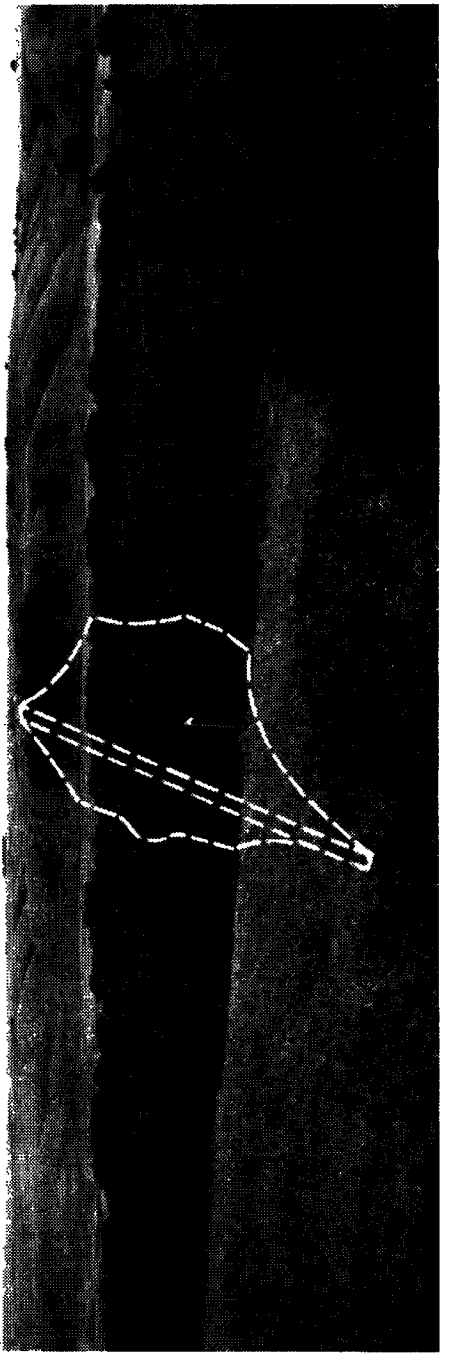
The plan will provide water for reservoirs on the Sheyenne near New Rockford, and the James river above Jamestown, with irrigated projects covering 55,000 acres below New Rockford, 22,000 acres below Jamestown and 33,000 acres below Oakes. An area of about 880,000 acres from Jamestown northwestward to Harvey is planned to be irrigated later from the Garrison reservoir.

Yellowstone Pumping Irrigation District

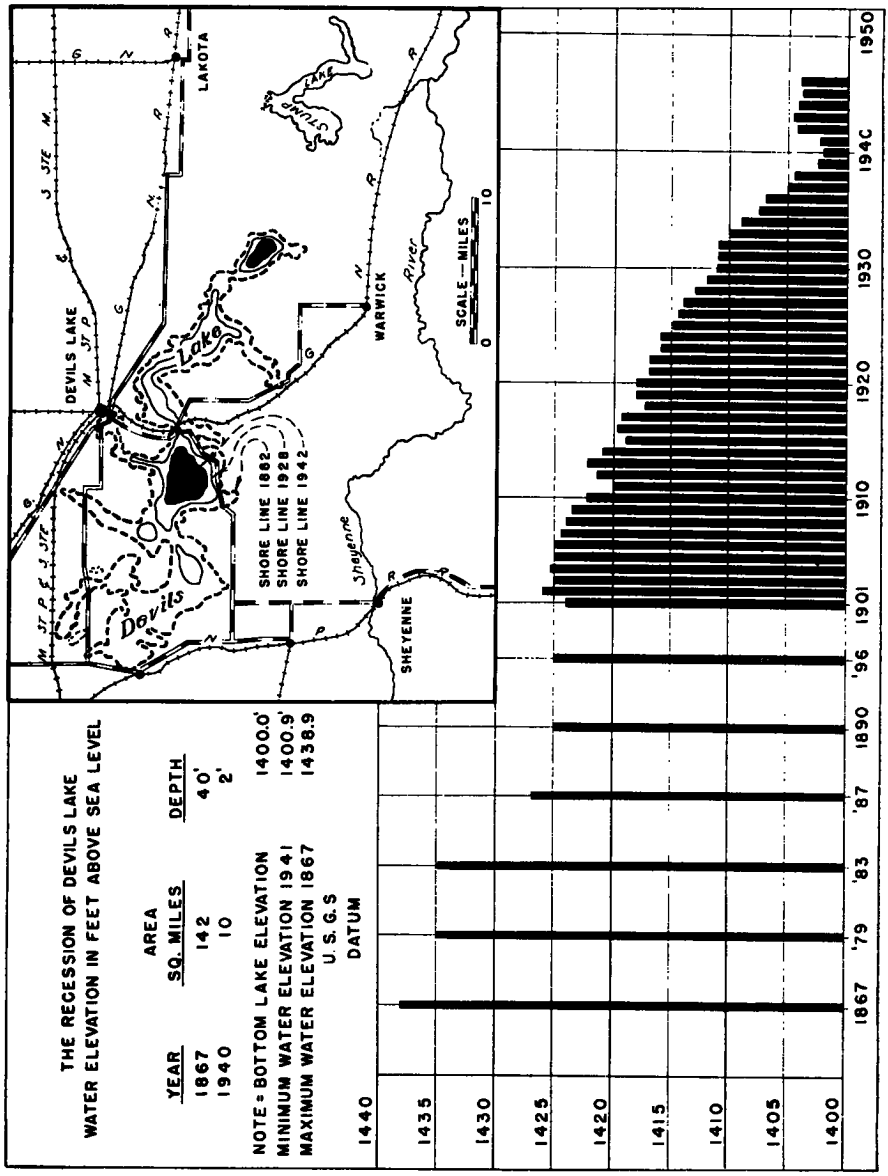
Originally this project was planned as a part of the Sidney Pumping Project of Montana. However, due to insufficient funds being made



This graph shows the average annual wheat yield per acre over a fifty-one-year period in North Dakota, from 1892 to 1943. The maximum average annual yield is over 20 bushels to the acre. The minimum is less than four bushels. The trend has been gradually downward until about 1940, since which the abnormal rainfall has brought greatly increased yields.



Site of Sheyenne River dam and reservoir, near New Rockford, North Dakota


THE RECESSION OF DEVILS LAKE
WATER ELEVATION IN FEET ABOVE SEA LEVEL
YEAR
AREA SQ. MILES
DEPTH
1867 142 40'
1940 10 2'
NOTE = BOTTOM LAKE ELEVATION 1400.0'
MINIMUM WATER ELEVATION 1941 1400.9'
MAXIMUM WATER ELEVATION 1867 1438.9
U. S. G. S DATUM
1440
1435
1430
1425
1420
1415
1410
1405
1400
1867
'79
'83
'87
1890
'96
1901
1910
1920
1930
1940
1950
DEVILS LAKE
LAKOTA
WARWICK
SHEYENNE
Devils
Lake
Sheyenne
River
STUMP LAKE
SHORE LINE 1882
SHORE LINE 1928
SHORE LINE 1942
SCALE — MILES
0
10

available to Montana by the Public Works Administration, only that portion in Montana was constructed.

During 1941 the State Water Conservation Commission made detailed surveys and estimates for the construction of that part lying within North Dakota. Due to the increased costs, construction material, labor, etc., the Directors of the District felt it would be advisable to delay construction.

Recently the State Water Conservation Commission engineers have resurveyed that portion of the lands paralleling the Yellowstone River that was destroyed by floods. This has resulted in reducing the original acreage by about 200 acres. Plans are under way to develop this project under the supervision of the Bureau of Reclamation.

Devils Lake

The water surface of Devils Lake has been gradually declining since the earliest year of record, 1867. At that time the lake covered an area of 142 square miles and reached an elevation of 1438.9 feet. The map shows the shore line in 1882. The area of the lake at that time was approximately 120 square miles and elevation of water surface was 1434 feet. The shore line shown in 1928 covered an area of approximately 35 square miles and lowered to elevation 1413.4 feet. The lowest elevation of record occurred during 1941 when the lake level reached 1400.9 feet and covered an area of approximately 4½ square miles. During the recent years of heavy precipitation, the lake has been gradually filling and during 1944, June 30, reached elevation 1404 feet, which level has been maintained for 1945 and 1946.

Restoration of Devils Lake to elevation 1420 feet is a part of the plan of both the U. S. Army Engineers and the Bureau of Reclamation, by diversion from the Missouri River.

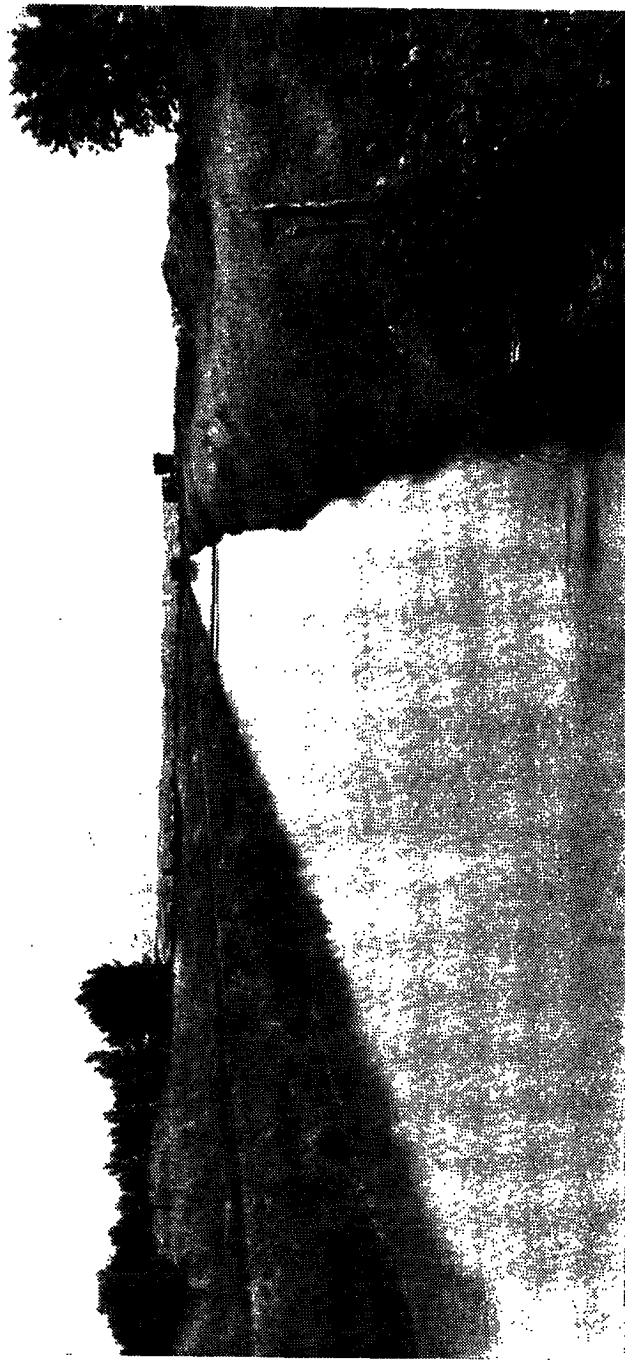
AVERAGE WHEAT YIELDS

The average wheat yield in the 26 counties of North Dakota west of the 100th meridian is shown in the page graph accompanying this report. On the left is indicated bushels per acre. The years are indicated at the bottom, from 1900 to 1946 inclusive, ranging from a low of two bushels to the acre to the high record of 1943 of slightly more than 20 bushels.

LOWER YELLOWSTONE IRRIGATION PROJECT

(In North Dakota and Montana)

Probably the best index as to what may be expected in returns from irrigated projects in North Dakota is the Lower Yellowstone Project, of which about 20,000 acres are located in McKenzie County, North Dakota, and 38,000 acres in Montana. This project has been operating for more than 35 years during which it has been developed into a very profitable area.



Main Canal on Lower Yellowstone Irrigation District irrigating about 20,000 acres in North Dakota and 28,000 acres in Mont.

During the last four years a gross crop return on this full acreage, equal to about two townships of land, has been $60 per acre. The construction cost for the installation of the irrigation system was $66 per acre. This is amortized over a period of 40 years, on which the average annual repayment per acre is now $1.60. In addition there is a charge for operating and maintaining the system of $1.10 per acre. This makes the total average cost for the farmer $2.70 per acre.

The principal crops are alfalfa, wheat, corn, barley, beans, and sugar beets. Alfalfa averages 3 tons per acre; wheat, 30 bushels; corn, 40 bushels; barley, 40 bushels; sugar beets, 15 tons. Truck gardening pays well. Berries and hardy varieties of apples and other fruits are being raised successfully.

Dairying, with hogs, sheep and chickens, together with feeding operations of range cattle is very successful. The average period between killing frosts is 129 days. The average rainfall for 30 years past has been 13 inches. The average farm on the project is about 100 acres.

The annual crop value per acre has jumped from $12 in 1912 to $63 in 1944 under irrigation. During this period, the acreage under cultivation has increased from 4,000 to 47,000. In 1912 the gross value of crops was less than $100,000. In 1944, the gross value was slightly under $3,000,000. In 1912, the yield per acre for sugar beets was .8 of a ton; in 1940, the yield was 16 tons per acre. Before irrigation there was less than 1,000 acres of alfalfa and hay; in 1944, the total was just under 10,000 acres.

Wheat showed a gain of over 3,000 acres under irrigation. In 1914, there were 960 acres, and in 1944, the total was 4,029 acres. The total bushels jumped from 20,000 to 123,000, the value increased from $13 to $40 per acre. Barley increased 10 bushels per acre, and the value of barley crop soared from $9,000 to $32,000. During this same period, the oat crop increased from $12,000 to $174,000. Figures are given in the following table showing returns from crops for the past four years. Feeding operations have proved to be very profitable. The sugar beet pulp, from the sugar factory, has proved to be a great aid in the feeding of stock for market.

Raising Fruit Under Irrigation

Millions of dollars are being spent annually in North Dakota for the fruit juices needed to provide a balanced diet. Nutritionists state that a minimum of at least two servings of fruit per day should be consumed by every individual, in order to be healthy. A survey made shows that western North Dakota people both in towns and country are consuming considerably less than this minimum requirement.

Heart River proposed irrigation district landowners made an inspection trip to the Lower Yellowstone irrigation areas, located in Montana and North Dakota, and were amazed at the apples, crabapples,

Irrigated oats and barley, John Hardy farm on Lower Yellowstone Irrigation District.

LOWER YELLOWSTONE IRRIGATION DISTRICTS 1 and 2
In North Dakota and Montana
45,026 Acres

Crop	1942 Av. Yield	1942 Acre Value	1942 Total	1943 Av. Yield	1943 Acre Value	1943 Total	1944 Av. Yield	1944 Acre Value	1944 Total	1945 Av. Yield	1945 Acre Value	1945 Total
CEREAL:												
Barley	38.0	$ 18.23		40.5	$ 32.46		41.2	32.93		33.4	28.41	
Corn	31.9	19.12		32.1	32.12		34.9	34.91		19.4	19.44	
Oats	58.0	20.87		55.3	29.31		54.2	27.12		44.2	22.18	
Wheat	31.9	31.87		31.4	36.68		30.6	39.81		26.5	37.16	
Speltz	36.1	16.59		61.2	30.59		44.9	22.47		30.2	16.60	
Totals			$ 282,451.00			$ 480,262.00			512,460.00			408,226.00
SEED:												
Alfalfa	1.4	14.20		2.7	55.65		1.1	23.01		1.2	25.59	
Clover	5.9	14.14					3.1	13.14		3.2	19.29	
Flax	9.9	21.04		10.6	28.14		10.5	29.15		7.0	19.40	
Millet	15.0	11.25					15.0	11.25				
Soybeans	7.8	7.03					7.8	7.03				
Totals			14,120.00			29,245.00			9,433.00			14,003.00
FORAGE:												
Alfalfa	2.2	16.84		2.1	22.89		2.1	22.61		1.9	22.40	
Other Hay	1.3	3.15		1.3	7.83		1.2	7.17		3.6	6.41	
Corn Fodder	1.9	4.80		2.1	7.24		1.4	4.74		2.1	7.18	
Corn Silage	5.6	8.40		6.5	13.04		6.6	13.17		5.2	10.46	
Sugar beet tops	12.6	3.15		10.0	4.02			2.22			1.95	
Natural pasture		.50			.50			.50			.50	
Tame pasture		10.00			10.00			12.00			12.00	
Other pasture		2.00			2.00			2.00			2.00	
Totals			$ 243,808.00			$ 303,962.00			291,422.00			259,809.00
VEGETABLES:												
Beans, commerce	12.5	12.46		9.4	34.96		9.7	35.84		11.1	65.76	
Onions, dry	39.4	47.30		125.0	150.00							
Potatoes, white	209.7	125.83		72.2	72.20		120.0	120.02		*88.8	53.31	
Gardens, truck		66.61			72.50			58.36			71.83	
Totals			76,174.00			181,158.00			99,491.00			52,551.00
Sugar beets	12.6	74.35	1,136,417.00	10.0	82.53	977,350.00	11.1	111.28	1,558,883.00	9.6	90.15	1,482,465.00
Additional revenues			538,554.00			770,345.00			460,256.00			463,260.00
TOTAL VALUE CROPS			$2,291,524.00			$2,742,322.00			2,931,996.00			2,680,320.00
AV. VALUE PER ACRE			50.89			59.65		62.69			57.13	

*(Hail damage reduced yields and returns for 1945 on part of project)

Hereford steers being fed for market on the Lower YellowstoneIrrigation project utilizing sugar beet pulp in a balanced ration

LOWER YELOWSTONE IRRIGATION DISTRICTS 1 and 2

In Montana and North Dakota

45,026 Acres

Livestock Inventories

	December 31, 1941			December 31, 1942			December 31, 1943		
	Number	Value	Total Value	Number	Value	Total Value	Number	Value	Total Value
Horses-Mules	1,401	$48.83	$ 68,410.00	1,269	$ 49.97	$ 63,415.00	1,007	$ 44.06	$ 44,371.00
Cattle, beef	1,888	47.89	90,410.00	3,922	65.87	258,340.00	2,986	67.60	201,863.00
Cattle, range feeders	5,670	56.11	318,139.00	3,910	73.52	287,464.00	5,762	73.54	423,755.00
Cattle, dairy	2,811	52.15	146,551.00	2,229	73.54	163,922.00	1,666	75.65	126,040.00
Purebred sires	55	118.38	6,465.00	55	145.09	7,980.00	66	197.42	13,030.00
Scrub sires	41	75.49	3,095.00	24	125.42	3,010.00	39	99.23	3,870.00
Sheep, farm flock	5,104	5.68	28,970.00	4,181	8.42	35,200.00	4,145	5.75	23,844.00
Sheep, range feeders	165,578	5.93	981,505.00	189,211	7.75	1,466,385.00	172,746	8.59	1,483,272.00
Hogs	4,715	2.25	1,420.00	728	2.50	1,821.00	10,959	16.53	181,144.00
Turkeys	631	2.25	1,420.00	728	2.50	1,821.00	385	4.28	1,647.00
Fowls	31,137	.54	16,718.00	36,323	.57	20,557.00	37,513	.82	30,928.00
Other fowl	----	--	318.00	----	----	455.00	----	----	509.00
Bees, hives	250	5.00	1,250.00	376	9.03	3,396.00	405	10.04	4,068.00
Totals	----	----	$1,715,840.00	----	----	$2,453,818.00	----	----	$2,538,341.00
Increased Values	----	----	----	----	----	737,978.00	----	----	84,523.00

pears, cherries, plums, raspberries and strawberries being produced. A few small irrigated acres are producing strawberries and small fruits which for several years have yielded more than a thousand dollars per acre, by the use of irrigation.

All this indicates that with the coming of irrigation, and training and experience in the raising of hardy fruits, that North Dakota can produce most of its own fruit juices, thus saving millions of dollars now being paid out by its residents. Harry Graves, Extension Horticulturist of the North Dakota Agricultural College at Fargo states "You can grow fruit in North Dakota." George Will, who, with his father, has been nurseryman at Bismarck for about sixty years, confirms this statement. Irrigation will revolutionize the fruit situation in North Dakota.

PROPOSED RESERVOIRS

The following information is taken from a report by the U. S. Army Engineers, at a Tri-State Water Commission meeting held at Pierre, South Dakota, on September 18, 1946, covering projects authorized by the Congressional Flood Control Act of December 22, 1944.

Baldhill Reservoir, on the Sheyenne River north of Valley City, construction was authorized and $300,000 allotted from appropriations made. The Presidential moratorium on government building funds has delayed action by the Army Engineers Corps. It is stated that local interest must urge construction after investigation as to results which can be expected from this reservoir.

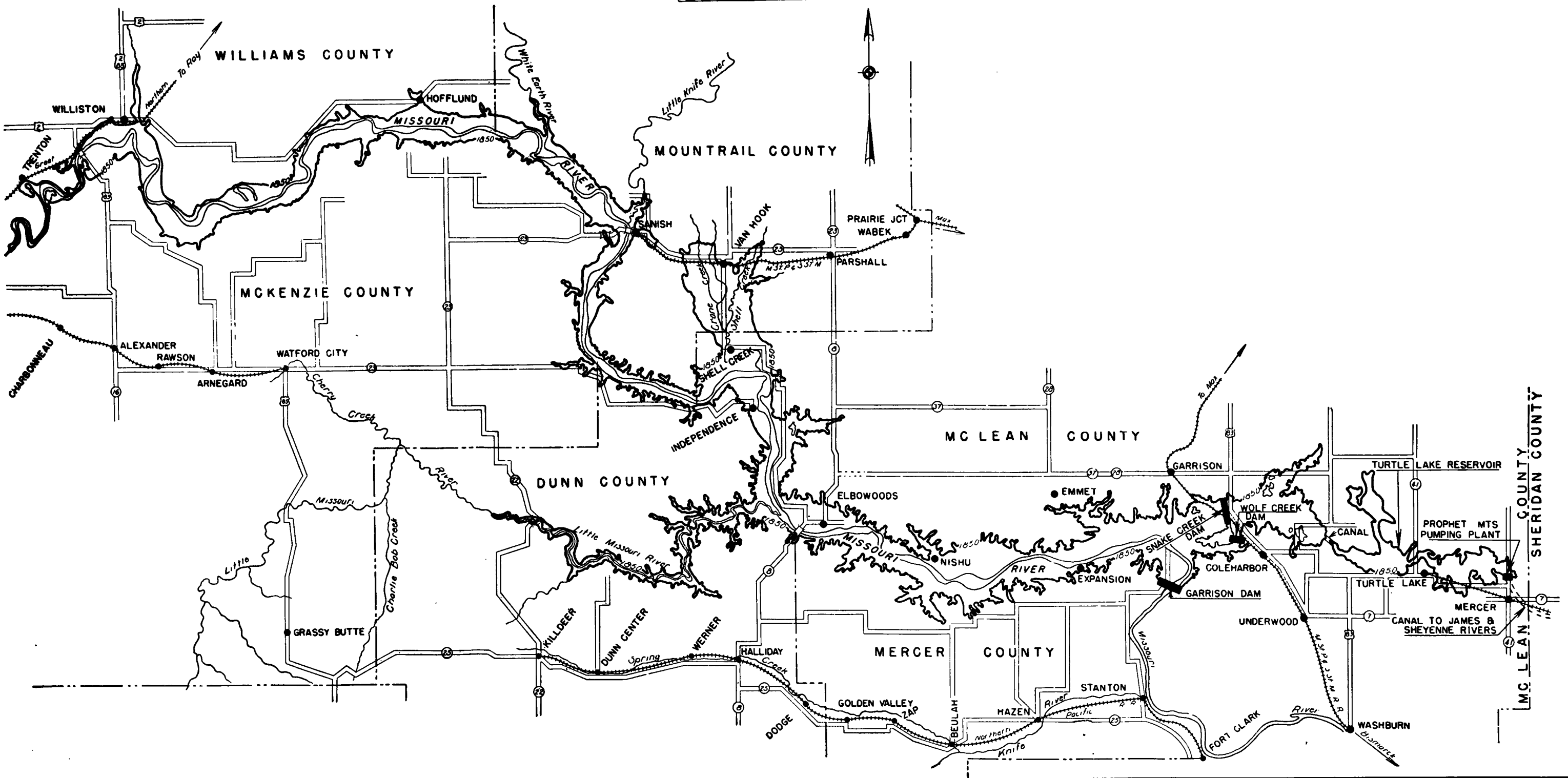
The Baldhill reservoir it is estimated would catch two-thirds of the flow in the Sheyenne river. The Army Engineers decided to make a re-evaluation of the water supply and sewage dilution needs of affected municipalities along the Sheyenne and Red Rivers. The Bureau of Reclamation was to submit a draft of repayments which would be required from municipalities receiving benefits.

It was reported that a study of the Baldhill reservoir possibilities for the period 1932 to 1942, had it been in operation, was completed. It was estimated by the engineers that starting with an empty reservoir on January 1, 1930, that it could have met all the water supply and sewage dilution needs along the Sheyenne river since March, 1930, and that in addition it could have met all the water supply and sewage dilution needs in the Fargo-Moorhead area on the Red river down to the mouth of the Sheyenne until September, 1939. From that date to March, 1941, it could have met all the water supply needs at Fargo-Moorhead, but could not have furnished dilution water for the sewage load in the Red River below Fargo. The estimated water supply requirements include a duplication of the present packing industry at West Fargo and an outright diversion of 7.5 second-feet to the sugar beet plant at Moorhead for four months each year, in addition to substantial municipal population increases.

GARRISON & TURTLE LAKE RESERVOIRS

SCALE IN MILES

5 0 5 10 15 20



Park River Reservoir. Advance planning is practically completed, with draft of project report submitted to the Division Office in July, 1946. Plans include a screened intake control valve and section of pipe-line through the dam to enable the cities to make a future water supply connection. The cost of this intake will be borne by local interests. The cities of Grafton and Park River, and the North Dakota Water Conservation Commission submitted assurances with respect to furnishing the required local cooperation. Work on plans and specifications has been suspended during the federal moratorium.

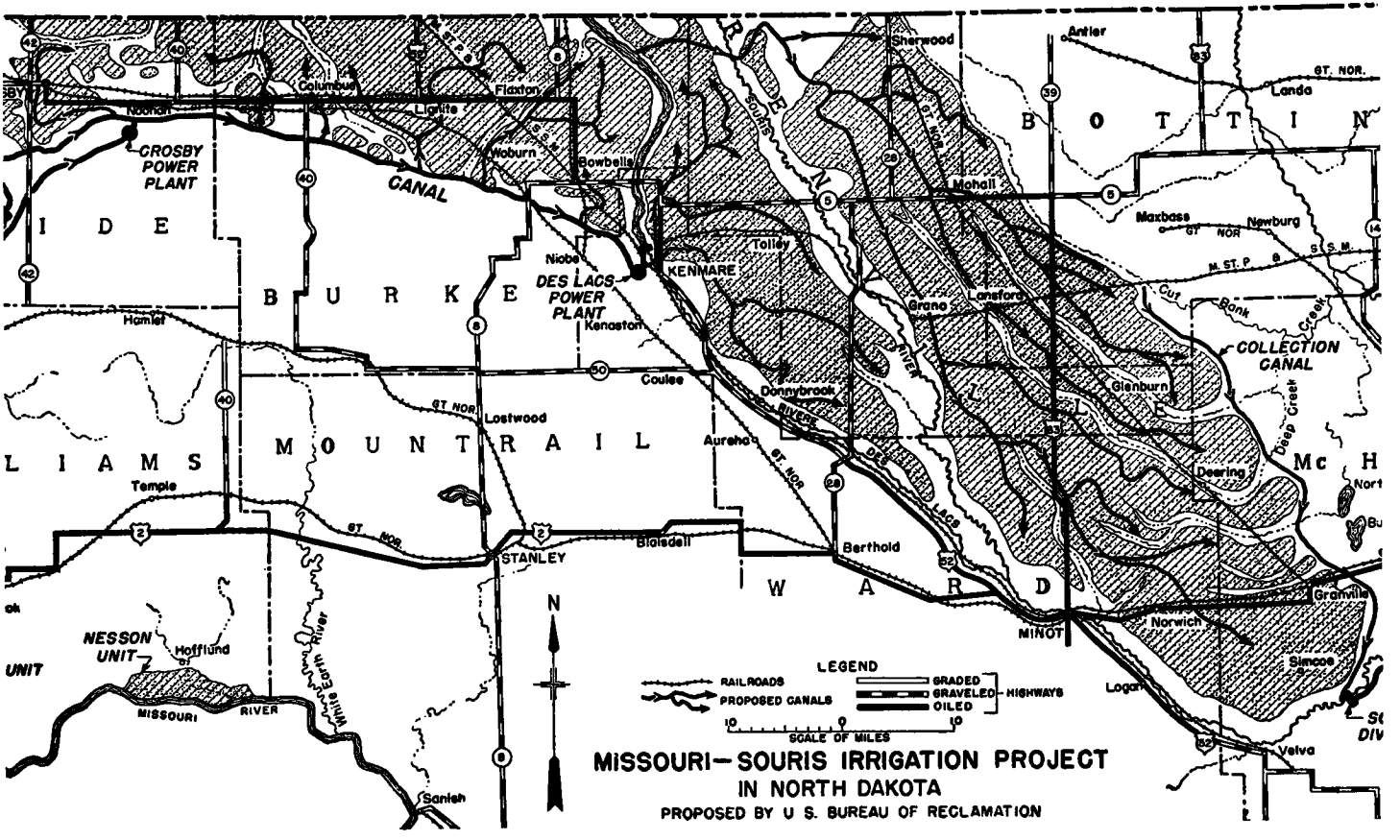
Tongue River Reservoir. Borings are being obtained on the Tongue Reservoir dam site. Report is scheduled for June, 1947, after the authorized review investigation of the Pembina River Basin has progressed sufficiently to indicate whether any modification of the proposed Tongue River dam should be made. Report has been suspended during the present moratorium.

Pembina Basin Review. Field work was initiated in September, 1946, on the economic study of damages caused by flooding and lack of drainage. It is expected that the review report will be completed by June, 1947.

Red River Drainage Basin. With respect to the development of an overall water-utilization plan, tentative consideration is being given to a reservoir for flood control and water use on the Otter Tail River, although its economic justification is in question. Such a reservoir, if operated in connection with the authorized projects at Baldhill and on Red Lake River, would go far towards meeting the estimated 1960 water supply and sewage dilution requirements along the Red River. The current restudy of operations of Baldhill Reservoir has delayed the work on the Red River report and use of the revised estimates of water needs will further delay its completion. It now appears that development of the water resources within the Red River Basin, including the tentative Otter Tail Reservoir, would meet a very high percentage of the estimated water demands during the occurrence of a drought similar to that of the 1930's. It is estimated that the final report will be submitted in February, 1947.

COOPERATING AGENCIES

State and national departments and agencies with which the work of the State Water Conservation Commission is coordinated have contributed their own statement of work accomplished, which in most cases had to be condensed to bring the total within the number of pages authorized for this report. On first glance it may appear to the reader that there is an over-lapping but on further study it will be found that each department or agency has performed its particular part of the work which when coordinated with the others covers all the phases of the planning, surveying, mapping, specifications, weather and stream-flow records required for estimates, and details which


MISSOURI—SOURIS IRRIGATION PROJECT
IN NORTH DAKOTA
PROPOSED BY U. S. BUREAU OF RECLAMATION
LEGEND
RAILROADS
PROPOSED CANALS
GRADED
GRAVELED
OILED
HIGHWAYS
SCALE OF MILES
N
CROSBY POWER PLANT
CANAL
DES LACS POWER PLANT
COLLECTION CANAL
NESSON UNIT
MISSOURI RIVER
MOUNTRAIL
BURKE
WARD
BOTTINEAU
Sherwood
Antler
Landa
Columbus
Flaxton
Lignite
Noonan
Noburn
Bowbells
Mohall
Maxbass
Newburg
Tolley
Niobe
KENMARE
Kenaston
Grano
Lansford
Hamlet
Coulee
Lostwood
Donnybrook
Glenburn
Aurelia
Deering
Temple
STANLEY
Blaisdell
Berthold
Granville
Norwich
MINOT
Hoffland
Simcoe
Logan
Velva
Sanish

make up the complete and detailed plans. This Commission is deeply indebted to the different cooperating agencies for their very fine cooperation.

REPORT OF BUREAU OF RECLAMATION COOPERATIVE INVESTIGATIONS

Cooperative investigations by Bureau forces under a North Dakota contract with the State Water Conservation Commission began in June of 1943 and have extended through the present biennium. Terms of the contract stipulate that cooperative investigations be conducted throughout North Dakota, to be financed jointly by the United States and the State. The United States is to contribute at least half of the funds required by these investigations.

The cooperative program thus far has permitted continuing reconnaissance of all irrigation possibilities in the state and has allowed Bureau field forces to advance detail surveys and estimates on two of the Missouri River tributaries and thirteen of the Missouri River pumping units so that construction can be started very shortly after appropriations are made. Thus the engineering studies of the Heart River Unit were so far advanced in 1945 that the project was placed at the top of the Bureau list for North Dakota, and high on the list for the entire Missouri Basin. Engineering work on the Heart River Unit is now sufficiently complete that construction contracts can be advertised whenever money already appropriated is released from administrative impoundment.

Wogansport and Square Butte Pumping Units will be ready for construction at any time that Congress appropriates money for this purpose. By means of cooperative funds, Knife River Unit and the Hancock Flats, Fort Clark, Oliver-Sanger, and Painted Woods Pumping Units will be ready for construction by July, 1947.

Detail engineering work has been well started on the Missouri Souris Unit and forces have been maintained at a satisfactory level through state funds despite Congressional curtailment of federal employment. By this device it will be possible to ask for bids on several major engineering features of the Missouri Souris Unit by July 1, 1947. At that time, the Grenora Pumping Plant, Souris Canal, Crosby Dam and Reservoir, and Sheyenne Dam and Reservoir should be ready for initial construction.

Reconnaissance surveys have been continued as manpower could be procured with the result that a preliminary study of the ultimate use of Garrison Reservoir for irrigation in central North Dakota has been prepared by the Bismarck Planning Office. Investigations of the most practicable use of Little Misouri water are now well underway and a report on this stream will be prepared during 1947. Continuing investigations of Garrison Diversion are planned in order that serious questions

Farm home of Nels Bach, on Lower Yellowstone Irrigation District.

of economic and agricultural feasibility may be answered at the earliest possible date.

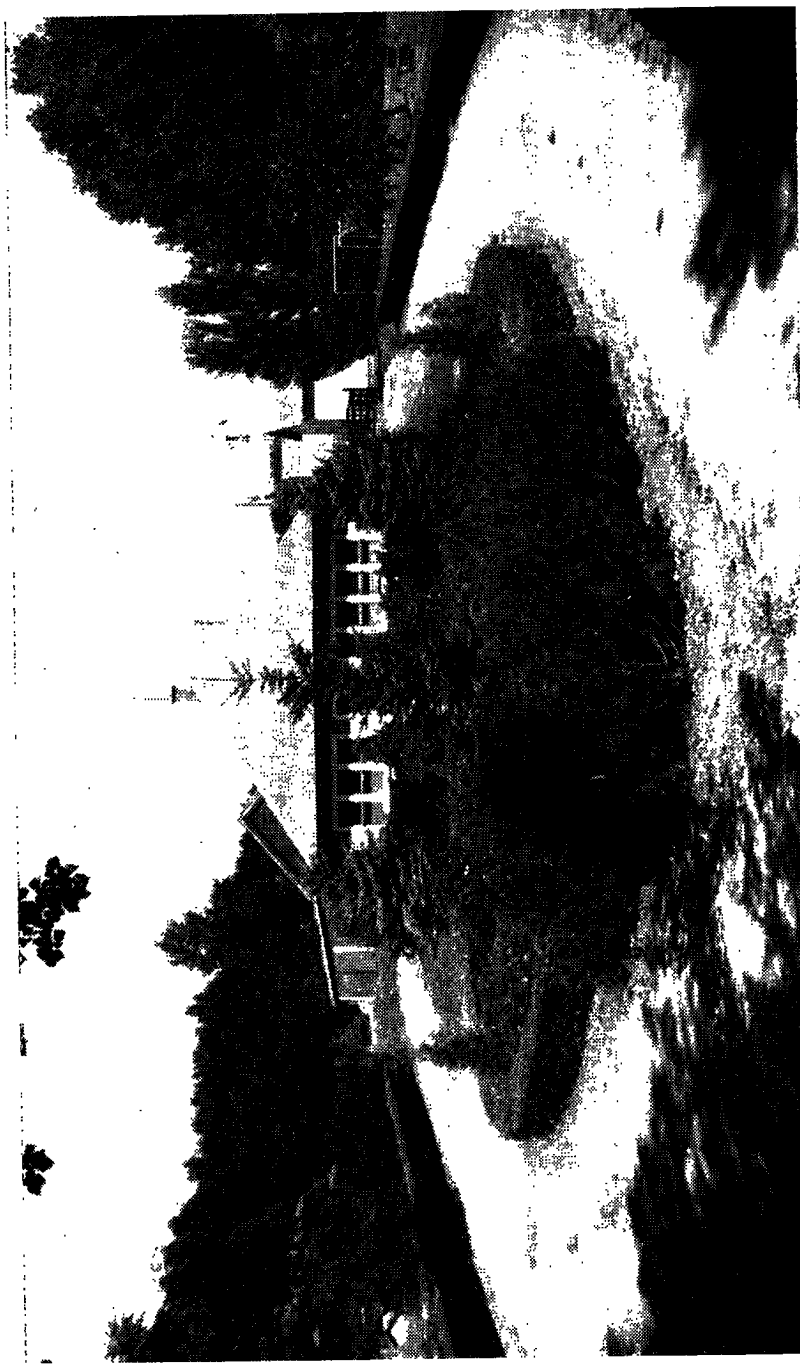
On October 1, 1946, after 18 months of cooperative work, the following major items have been completed:

	During 1943-44	During 1945-46
Detail Topographic Maps	110,710 acres	70,000 acres
Reconnaissance Topographic Maps	600,000 acres	1,400,000 acres
Reservoirs Mapped	1	4
Dam Sites Mapped	0	5
Land Classified in Detail	80,382 acres	58,000 acres
Reconnaissance Land Classification	270,000 acres	1,000,000 acres
Preliminary Canal Estimates	2 projects	5 projects
Field Canal Locations Completed	0	5 projects
Detail Canal Estimates	0	4 projects
Detail Drilling Completed:		
Storage Dams	0	3
Diversion Dams	0	2
Pumping Plants	5	26
Preliminary Drilling Completed:		
Storage Dams	3	2
Diversion Dams	0	1
Pumping Plants	0	2
Power Plants	0	2
Materials Exploration Completed	2 projects	2 projects
Detail Materials Surveys Completed	0	1 project
Highway Located and Designed	0	9 miles
Transmission Line Located	0	7 miles
Specifications Prepared:		
Dams	0	1
Highways	0	1
Detail Reports Drafted	1 project	2 projects
Reconnaissance Reports Drafted	0	1 project
Projects Ready for Construction	0	3 projects

As of September 1, 1946, $481,964 has been spent on cooperative investigations; $185,674 by the State and $296,290 by the United States.

Engineering work has been advanced to a point where it no longer constitutes the bottleneck in irrigation development in North Dakota. Upon completion of detailed engineering studies of the Heart River, it became necessary to organize the Heart River Irrigation District to fulfill repayment requirements of Reclamation law and permit expenditure of money for construction of the Heart River Unit. Such a district was organized through the efforts of a committee of interested local people. It was found at this time that the greatest obstacle to further irrigation development in North Dakota lies in the general lack of knowledge of irrigation farming which prevails throughout the state. It was found on the Heart River that rural opposition to irrigation development was replaced by support as soon as the farmers concerned were shown clearly the advantages and obligations of irrigated agriculture as now practiced along the western border of the state.

One of the greatest tasks prior to construction of authorized irrigation projects in North Dakota will consist of effectively presenting factual



Farm home of Axel Danielson, on Lower Yellowstone Irrigation District.

information to those rural areas slated for irrigation development. Even though engineering plans are complete and construction money may subsequently be appropriated, no irrigation development will take place without the approval and support of a substantial majority of the farmers now living on the projects.

The expenditure of cooperative funds by the State of North Dakota has thus far provided the following benefits to the development program:

A. During the war years the contract has provided employment flexibility which permitted hiring men at any time or place they could be found.

B. Under present conditions, with a tight ceiling on federal employment, field forces have been augmented by state employees and the work has gone forward at an encouraging rate.

C. Many units not yet on the federal investigation program have been advanced by means of state funds to a point where construction can begin at an early date. These projects can be recommended for construction at any time the people concerned indicate they desire development.

D. Sufficient manpower has been maintained that studies of Garrison Diversion could be conducted jointly with detail engineering work on the authorized units.

E. Procurement of supplies for large scale expansion of engineering forces in the state has been greatly speeded up.

F. The state has gone solidly on record as endorsing irrigation development and now has a substantial financial interest in this development.

1947 Funds Allocated

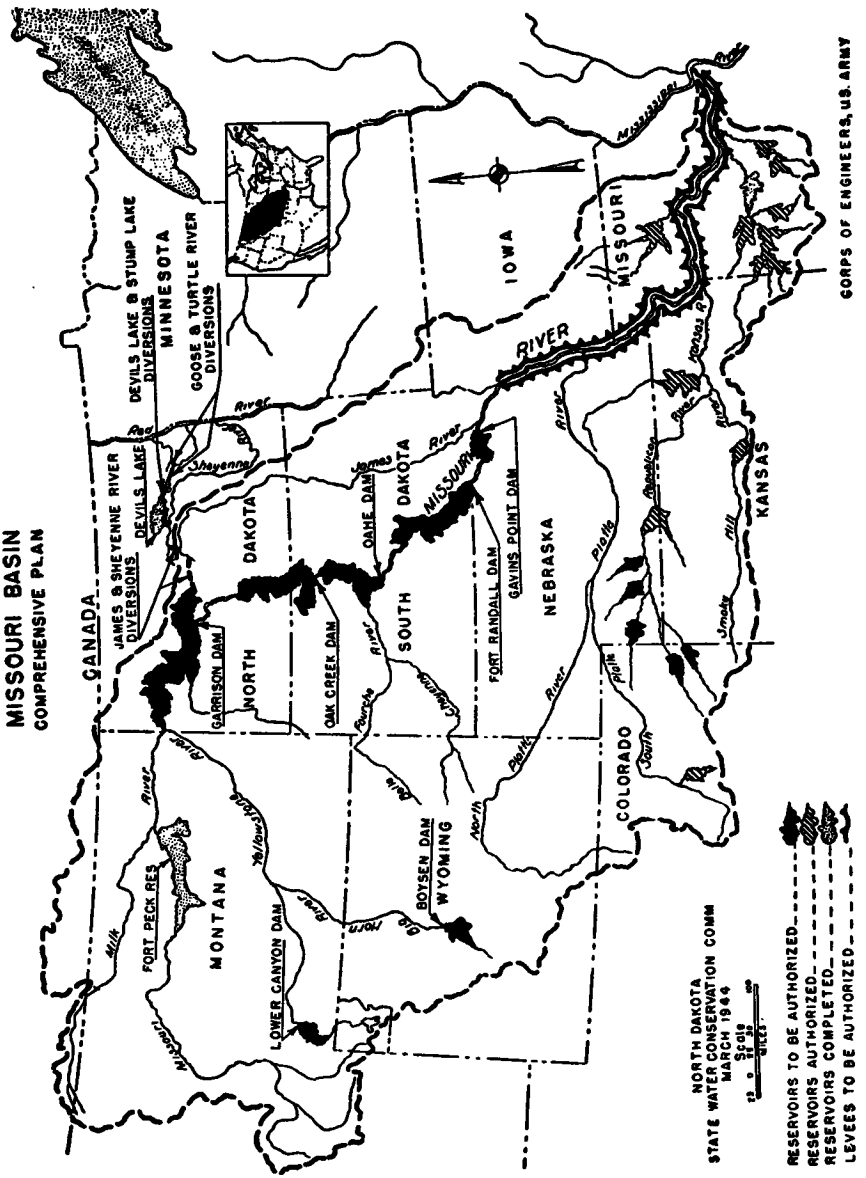
The Bureau of Reclamation has allocated $1,804,000 of its federal appropriation to four projects in North Dakota for 1947 development:

Heart River, including the dam at Dickinson, $640,000; Knife River, $43,000; Missouri-Souris project, $950,000; Missouri river pumping projects, $171,000.

The Heart River project is ready for contracting on construction work, but the work on other projects will be largely on plans and specifications for later construction work.

The estimated cost for the Heart River project is $4,283,000; Knife river, $4,321,900; Missouri-Souris, $133,795,000; and on the Missouri river pumping projects, $3,464,830; totalling $145,864,740.

The Missouri-Souris project, in the northwest part of North Dakota, is to irrigate about 1,000,000 acres and divert water into the Sheyenne river and Devils Lake, and on to Fargo for municipal and industrial uses.


MISSOURI BASIN
COMPREHENSIVE PLAN
CANADA
JAMES & SHEYENNE RIVER DIVERSIONS
DEVILS LAKE
DEVILS LAKE & STUMP LAKE DIVERSIONS
MINNESOTA
GOOSE & TURTLE RIVER DIVERSIONS
IOWA
MISSOURI
RIVER
NORTH DAKOTA
SOUTH DAKOTA
GARRISON DAM
OAHE DAM
OAK CREEK DAM
FORT RANDALL DAM
GAVINS POINT DAM
NEBRASKA
KANSAS
COLORADO
WYOMING
MONTANA
FORT PECK RES
LOWER CANYON DAM
BOYSEN DAM
Missouri
Milk
Yellowstone
Big Horn
Bighorn
Shoshone
Cheyenne
Belle Fourche
James
Niobrara
Platte
North
South
Republican
Smoky
Hill
Kansas
NORTH DAKOTA
STATE WATER CONSERVATION COMM
MARCH 1944
RESERVOIRS TO BE AUTHORIZED
RESERVOIRS AUTHORIZED
RESERVOIRS COMPLETED
LEVEES TO BE AUTHORIZED
CORPS OF ENGINEERS, U.S. ARMY

The Heart River and Knife River projects will combine irrigation with flood control and muncipal water supplies. The Missouri river pumping projects include fifteen river bottom irrigation units between the Garrison dam and the South Dakota line.

Bruce Johnson is the Engineer in charge of the Bureau of Reclamation personnel in North Dakota and maintains an office in Bismarck.

The Bureau's regional office is located at Billings, Montana, with H. D. Comstock as Regional Director. It includes Montana, North and South Dakota and part of Wyoming.

THE ARMY ENGINEERS PLAN

Construction of the Garrison Dam proper is expected to get under way early in 1947. This will be the largest rolled-fill dam ever attempted. Construction of an access railway, highway, and construction bridge, together with partial construction of the government townsite of Riverdale, will be largely completed in 1946. This is all a part of the Army Engineers plan to develop the Missouri River and its tributaries in the interest of flood control, irrigation, navigation, and hydroelectric power. The Garrison Dam is located 75 miles northwest of Bismarck on the Missouri River. It will be the largest rolled-fill dam in the world, estimated to require the moving of 75,000,000 cu. yd. of embankment. It will have a crest length of more than two miles, a base width exceeding one-half mile. It will be 210 feet high. A normal pool elevation of 1850 feet above sea level will impound 23,000,000 acre feet of water, and inundate 390,000 acres of land, creating a reservoir extending 200 river-miles upstream. It will impound the largest volume of water in the world behind an earth-fill dam. In comparison, Fort Peck dam in Montana, which is a 250 feet hydraulic fill dam, has a maximum reservoir capacity of 19,400,000 acre feet, a two mile crest, and inundates 245,000 acres of land.

The Garrison Dam outlet and spillway will require 2,000,000 cu. yd. of concrete, a volume that is exceeded only by four other all-concrete dams—Grand Coulee, Shasta, Boulder and Fontana.

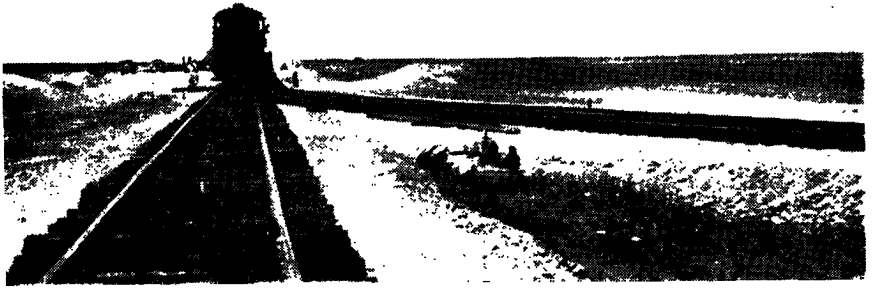
Two hydroelectric 40,000-kw. units will be installed in a powerhouse built to accommodate four such units, with plans for increasing the installation to eight such units, as the demand grows to utilize the power. This will make a potential average energy output of 1,520,000,000 kwh. annually.

The preliminary work under construction in 1946 includes a 10 mile access railway, 13.5 miles of concrete access highway, both approaching the site from the east, the erection of a 1350 foot steel deck girder construction bridge located 1,000 feet below the axis of the dam, to transport men and materials across the river to the west abutment. The government town, Riverdale, on the east side of the river, about one and one-

Immense machines move millions of yards of dirt

This picture shows dirt being moved on the grade of ten miles of highway built in 1946 to connect Highway No. 83 with the Garrison dam town of Riverdale.

Similar machines will move 75,000,000 cu. yds. of dirt in the next five years in the construction of the dam.



Ten-mile railroad spur to Garrison dam site

This railroad will reach the new town of Riverdale and also cross the Missouri river on the construction bridge, to haul men and supplies to the west side of the Garrison dam.

half miles from the site of the dam, is designed for a maximum occupancy of 5,400 construction men and government employees.

It is expected that contracts for excavation and embankment for the dam will be let late in 1946, with other contracts for spillway, outlet works, and power house to follow. The construction schedule contemplates seven years for the completion of the dam and initial power installation.

The strategic position of Garrison Dam will permit water to be diverted by canal and pumping lift into the James River basin, to provide domestic supplies, abate stream pollution, and aid irrigation in the eastern Dakotas, including replenishment of dwindling Devils Lake.

The personnel of the Garrison District is headed by Colonel W. W. Wanamaker, District Engineer. The District includes the watershed of the Misouri River and tributaries entering it between the mouth of the Yellowstone River in North Dakota and the line between that state and South Dakota, also that portion of the James River basin lying in North Dakota.

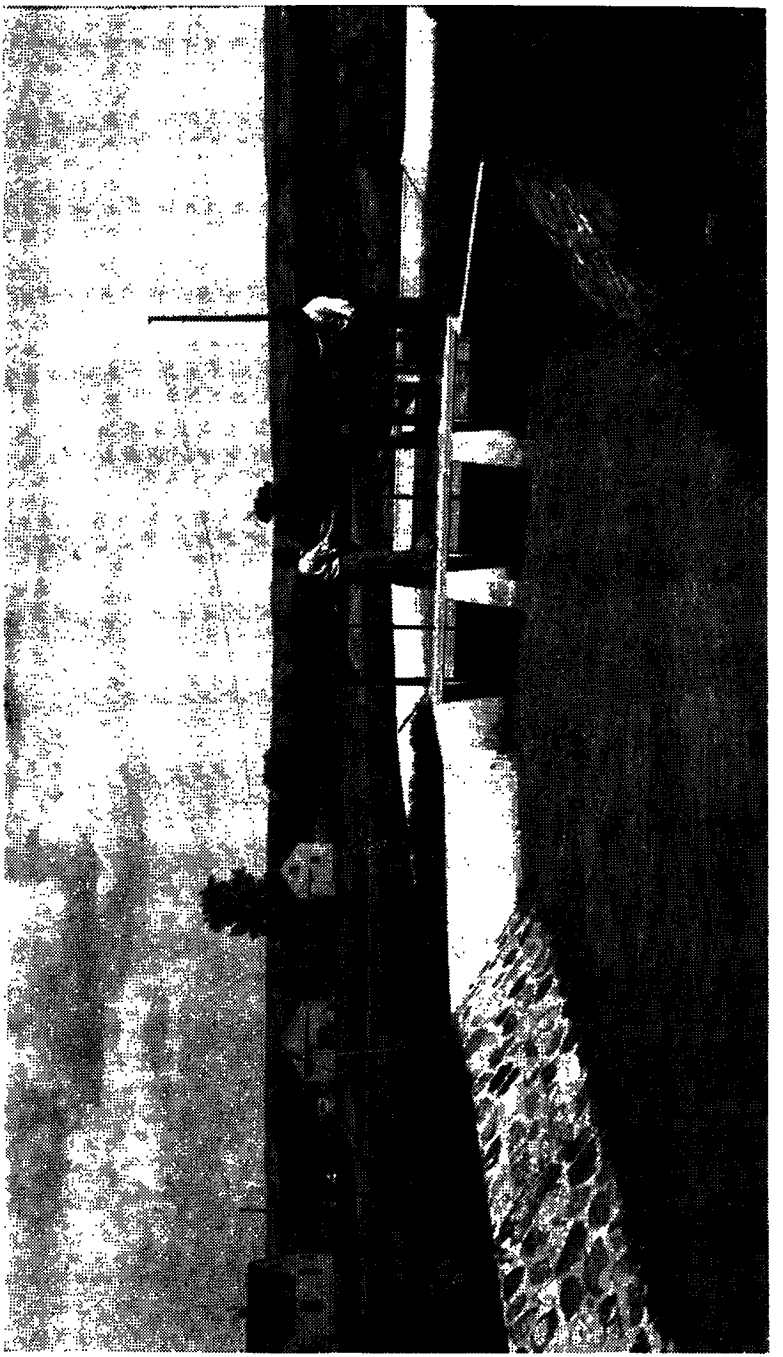
NORTH DAKOTA RURAL REHABILITATION CORPORATION

The funds of this corporation and the cooperation of its officials have been of very great aid to the Water Commission in the construction of the Lewis & Clark, the Sioux and the Grantier irrigation projects in McKenzie County, North Dakota, also in constructing an enlarged intake on the Yellowstone Pumping irrigation project. Without the financing through this corporation, very little could have been accomplished on the construction and practical demonstration of the increased returns from irrigated lands as compared to dry land farming.

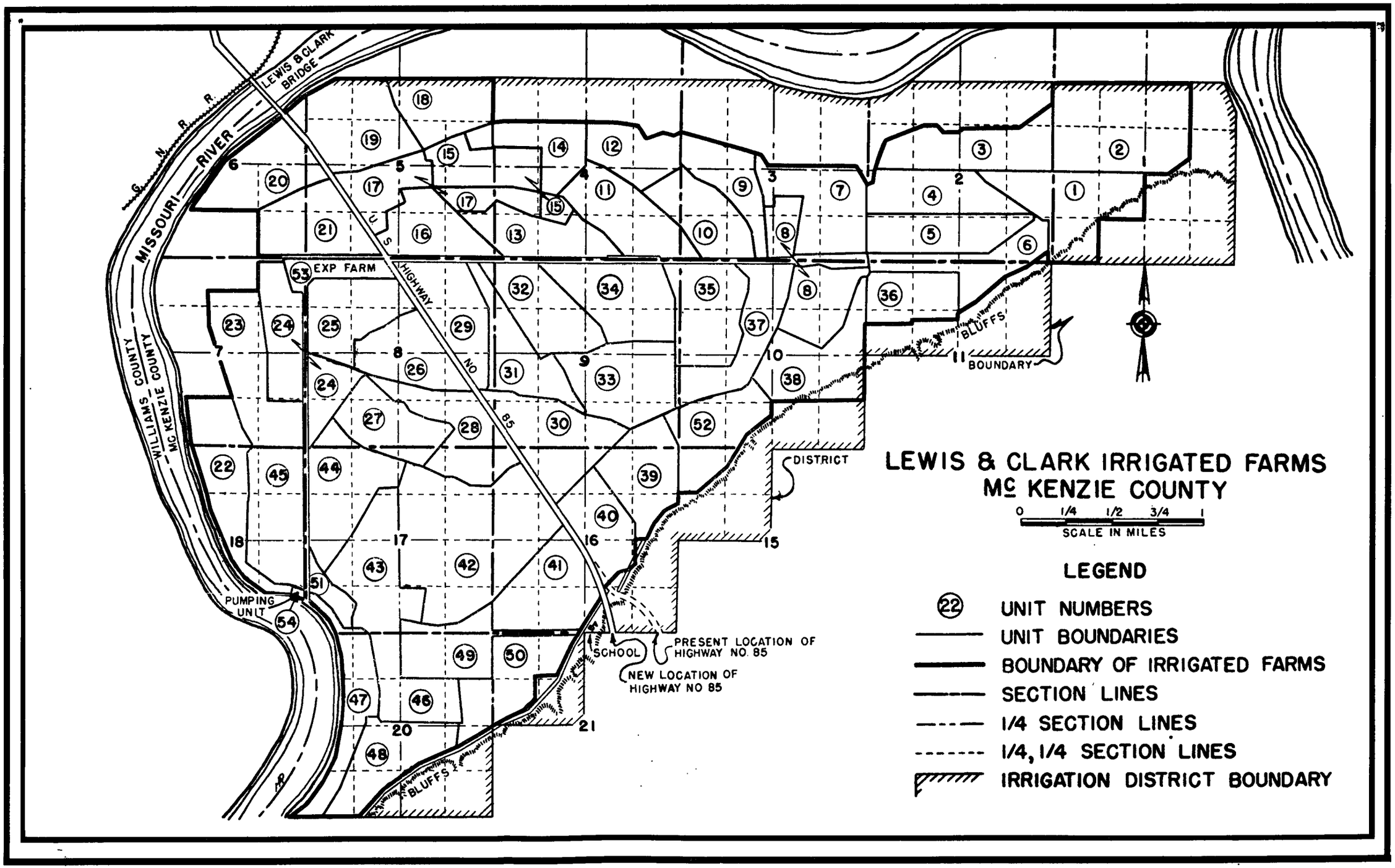
This corporation advanced a total of $175,000 used in the construction work, levelling and drainage works of these projects and on seven Cedar River and Cannonball River community garden projects which were much needed because of the drouth conditions at the time.

Lands to the value of $27,000 on the Lewis & Clark Irrigation District, which had been purchased by the State Water Conservation Commission at the time of irrigation construction, were purchased by the Rural Rehabilitation Corporation, which in turn resold all of the lands of the irrigation district to local farmers, and could have sold much more.

The Lewis & Clark Irrigation District was divided into fifty three irrigated tracts, as shown by accompanying plat, averaging a little over one hundred acres each. These were surveyed during 1944 by engineers of the State Water Conservation Commission for the Rural Rehabilitation Corporation. These plats have been filed for record for convenience in making transfers.



Control gates on main canal of Lewis & Clark Irrigation District, near Williston, N. D.


LEWIS & CLARK IRRIGATED FARMS
Mc KENZIE COUNTY
0 1/4 1/2 3/4 1
SCALE IN MILES
LEGEND
UNIT NUMBERS
UNIT BOUNDARIES
BOUNDARY OF IRRIGATED FARMS
SECTION LINES
1/4 SECTION LINES
1/4, 1/4 SECTION LINES
IRRIGATION DISTRICT BOUNDARY
LEWIS & CLARK BRIDGE
G. N. R. R.
MISSOURI RIVER
WILLIAMS COUNTY
Mc KENZIE COUNTY
U.S. HIGHWAY NO 85
EXP FARM
PUMPING UNIT
SCHOOL
PRESENT LOCATION OF HIGHWAY NO. 85
NEW LOCATION OF HIGHWAY NO 85
DISTRICT
BOUNDARY
BLUFFS

NATIONAL RIVERS AND HARBORS CONGRESS

This organization acts in an advisory capacity to Congress. Its engineers have recommended Congressional appropriations on several of the projects in North Dakota.

The annual meeting of this Congress was held at New Orleans, La., on Sept. 20, 1946, and was attended by Congressman Charles Robertson from North Dakota. There was considerable discussion regarding the plans for the utilization of the waters of the Missouri River Basin, flood control, irrigation and navigation. It was attended by more than 35 U. S. Senators, Congressmen and nominees from fifteen states. It asked the President by resolution to release funds for improvement of waterways and construction of dams.

STATE RECLAMATION ASSOCIATION

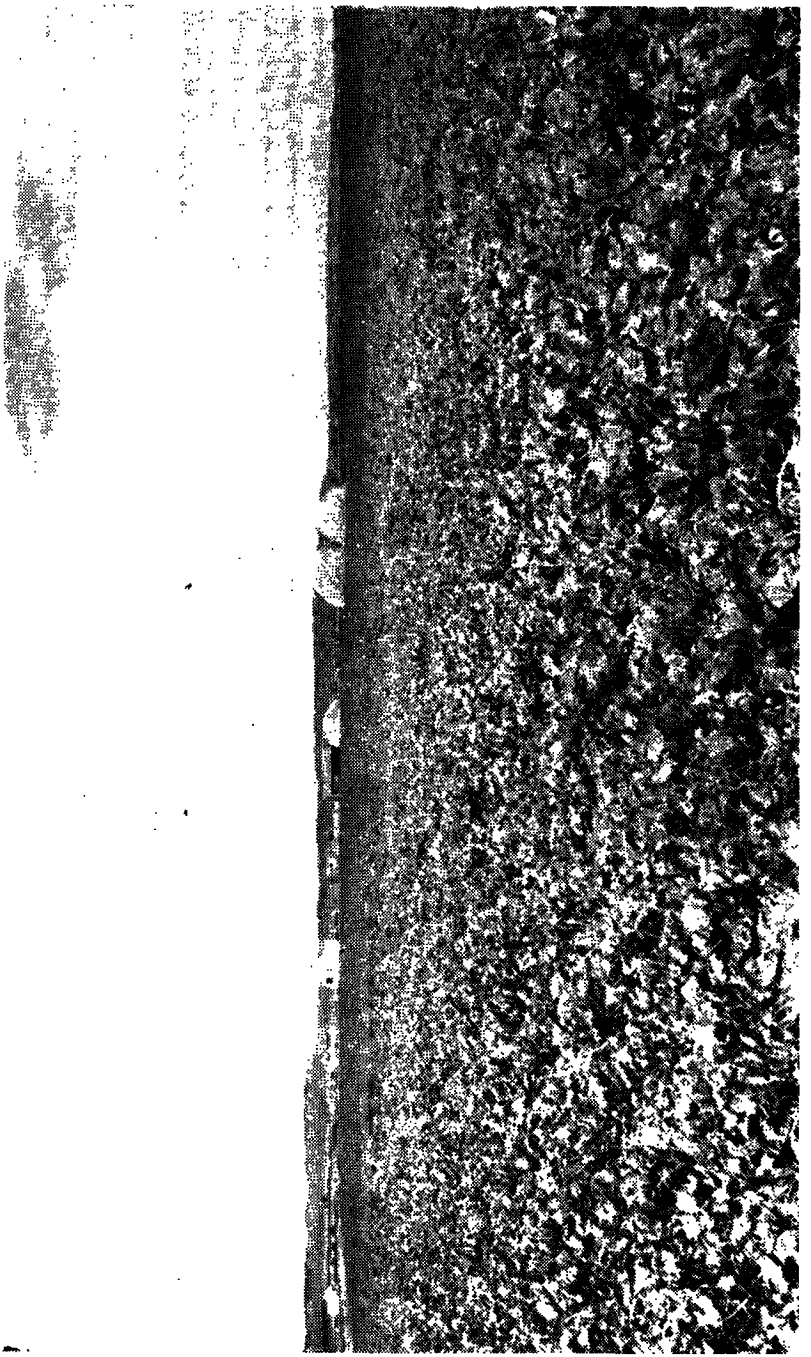
This organization, with Directors in every county in the state and a membership of about 3,500, has been active in the promotion of irrigation and Missouri River diversion. It has had active representation in all of the meetings of importance dealing with the water problems of North Dakota, and before Congressional committees where Missouri River diversion and irrigation plans are under consideration. Its statewide activities have greatly aided in educating the citizens as to the value of irrigation as a stabilizing factor in agriculture and stock raising.

It has sent representation of interested citizens to the meetings of the National Reclamation Association, of which one director is a citizen of North Dakota. These forces, working together, are gradually making the nation conscious of the value and need of a well-considered program of irrigation, reclamation and water conservation for the arid and semi-arid states of the West. W. L. Gardner, of New England, N. D., was president for the past year. Harry K. Polk of Williston, North Dakota, is First Vice President and a Director of the National Reclamation Association, and is also a Director of the state association.

SOIL CONSERVATION SERVICE

The period covered by this report is from January 1, 1945 to January 1, 1947. At the beginning of this period there were 37 Soil Conservation Districts organized under the North Dakota State Soil Conservation Districts law, which was enacted by the 1937 legislative assembly. These districts comprised 18,412,188 acres of farm land.

During the period covered by this report, 28 new soil conservation districts were organized, making a total of 65 soil districts for the entire state. These 65 districts have a total acreage of more than thirty million acres, or approximately 70 per cent of the farm land in North Dakota.



Sugar beets and alfalfa on Buford-Trenton Irrigation District in western N. D.

Red River Drainage

In addition to conducting a soil and water conservation program, a special drainage program in eight counties in the Red River valley has been carried on in cooperation with fourteen soil conservation districts and the State Water Conservation Commission.

Through the organized soil conservation districts, the Soil Conservation Service furnishes without charge all engineering and technical assistance. It is also furnishing some heavy dirt-moving equipment such as drag lines, tractors, etc. The State Water Conservation Commission contributes not to exceed 40% of the cost of the drainage projects. This is paid from a special appropriation made by the state legislature which is administered by the State Water Conservation Commission. This drainage program was started in 1944 since which there has been moved a total of 4,177,725 cubic yards of earth in constructing 848 miles of various types of drainage ditches.

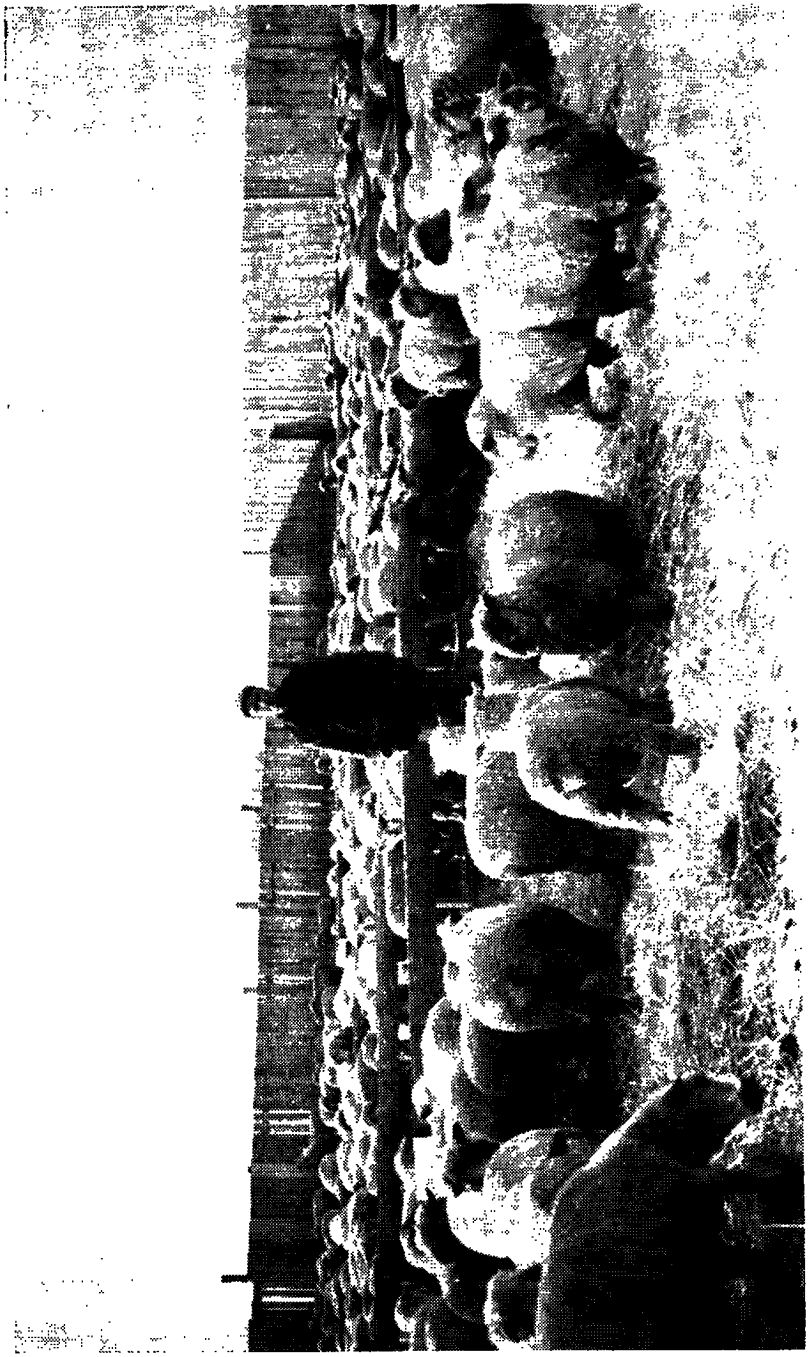
The following statement shows the types of drains constructed and the counties where located, with the cu. yds. of earth moved:

County	New Legal Drains	Clean Out Old Drains	Group Drains	Farm Drains	Total
	Cu. yds.	Cu. yds.	Cu. yds.	Cu. yds.	Cu. yds.
Pembina	99,226				99,226
Walsh			17,057	85,729	102,786
Grand Forks	2,395	91,544	106,736	86,863	309,093
Traill		30,329	107,839	256,158	394,326
Cass	47,653	811,455	160,966	512,326	1,532,400
Richland	830,316	119,669	133,238	376,250	1,459,473
Ransom				8,000	8,000
Sargent	58,388	6,500		218,533	283,421
Totals	1,059,533	1,059,497	525,836	1,543,859	4,177,725

Red River Valley Drainage

Of the $240,000 appropriated for drainage work or irrigation by the 1945 legislature, eighty percent was allocated by the State Water Conservation Commission on April 19, 1945, on the basis of flood damage in the respective counties as reported by the U. S. Statistician, as follows:

County	Acreage Damaged	% of Acreage	Allocated
Pembina	112,000	11%	$ 21,120.00
Walsh	82,000	8%	15,360.00
Grand Forks	41,000	4%	7,680.00
Traill	50,000	5%	9,600.00
Cass	246,000	24%	46,080.00
Richland	272,000	26%	49,920.00
Ransom	50,000	5%	9,600.00
Sargent	82,000	8%	15,360.00
LaMoure	40,000	4%	7,600.00
Dickey	51,000	5%	9,600.00
Totals	1,026,000	100%	$192,000.00



Feeder lambs, on the George Haffner farm, on Lower Yellowstone Irrigation Project.

At a meeting of the State Water Conservation Commission held July 30, 1946, the allocations of $9,600 to Dickey County, and $7,680 to La-Moure County were released by the County Commissioners of those counties.

On application from the counties named hereafter additional allocations of drainage funds were made, as follows:

Cass County	8,000.00	Traill County	4,000.00
Grand Forks County	4,000.00	Walsh-Pembina drain No. 50	18,000.00
Richland County	9,000.00		

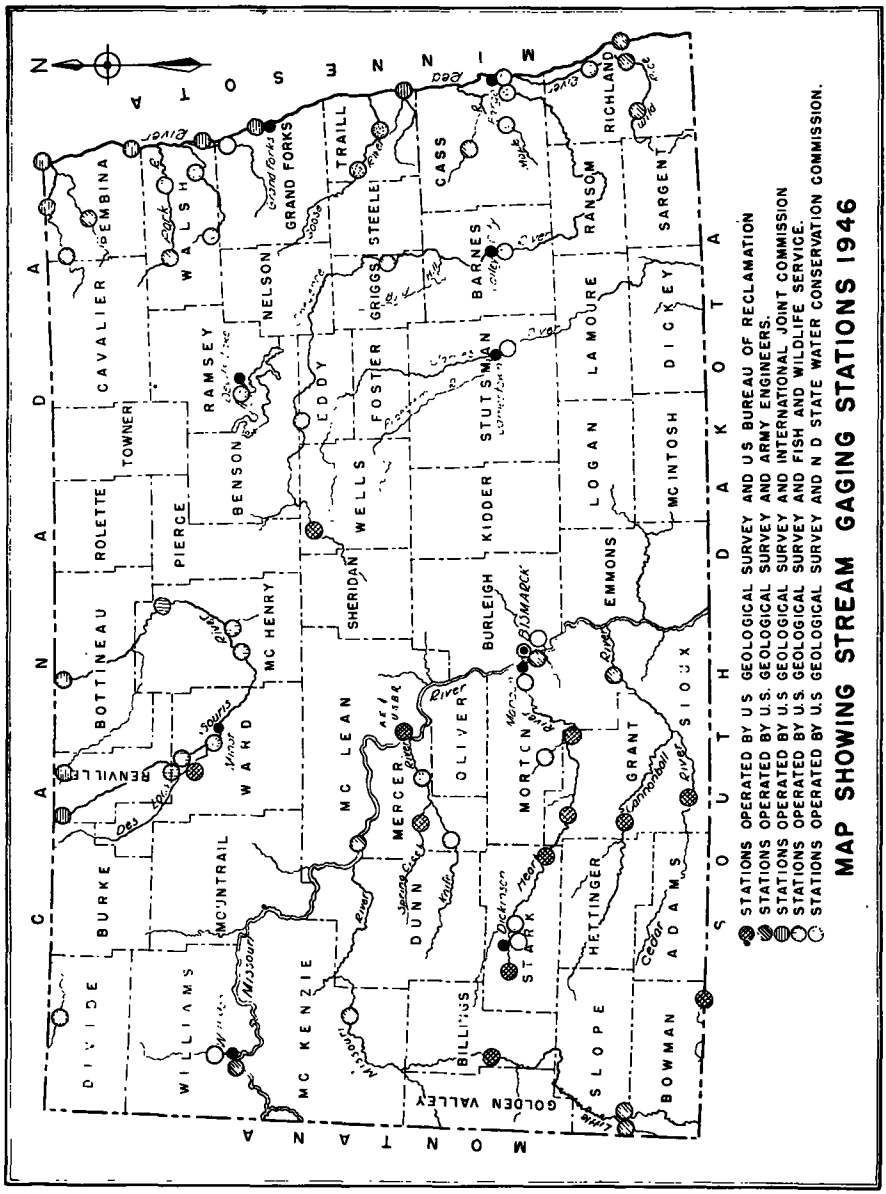
There is a big drainage construction program underway in the several counties, which would be extended for at least two years if state aid is continued. Drainage results already observed in the areas where construction is in progress have resulted in enthusiastic support of the enlarged drainage program.

Bottineau County Gessner Drain No. 2

The State Water Conservation Commission on application cooperated with the County Commissioners of Bottineau County, North Dakota, in the cost of construction of the Gessner Drain No. 2, the Commission paying 40% of the cost, and the county the balance. The total cost was $6,963.27, on which the Commission contributed $2,785.31. This action was approved by the office of the Attorney General. This drain is located in the Mouse or Souris river bottoms.

Sioux Irrigation District Canal Repair

The main canal of the Sioux Irrigation District, in McKenzie County, North Dakota, was undermined by the action of the Yellowstone river waters, and the district thus prevented from furnishing water from its pumping station to the irrigated acres. The State Water Conservation Commission purchased used 28 inch pipe from the U. S. Army Engineers at Fort Peck and installed 625 feet of same to repair the main canal, at a cost of $4,816.64. The biggest item was the cost of the pipe and transportation, $2,542.66, and the rental of a power shovel to install same, $1,260. The balance of the cost was mostly for labor.



MAP SHOWING STREAM GAGING STATIONS 1946

UNITED STATES
DEPARTMENT OF THE INTERIOR

Geological Survey

WATER RESOURCES BRANCH

Surface Water Division

The engineers of this organization operate 22 stream gaging stations in cooperation with the State Water Conservation Commission on a 50-50 basis with federal and state funds. In addition to this state cooperative program, 43 stations are operated by the Survey in cooperation with the U. S. Department of State, U. S. Fish and Wildlife Service, U. S. Bureau of Reclamation, and the Corps of Engineers, U. S. Army. The work of this organization in North Dakota and South Dakota is administered from the district office in Bismarck.

The Surface Water Division of the Geological Survey handles the installation and operation of all stream gaging stations in the state. Some of these stations are equpiped with automatic recording gages, but most of them are the non-recording type and must be read daily by local observers. Operation of the stations, regardless of type, includes making discharge measurements with current meters, collecting daily gage readings, computing daily discharge records, and compiling monthly and annual data for publication in the annual Water Supply Papers.

The statewide stream-gaging program is necessary in order that accurate records of surface run-off may be obtained for all streams in North Dakota, and these records put into usable form and furnished to all agencies engaged in preparing plans for irrigation projects, flood-control works, public water supplies, control of stream pollution, drainage canals, design of highways and bridges, propagation of wildlife, recreation, and industrial establishments using large quantities of water.

The records are available through the medium of the U. S. Geological Survey Water Supply Papers. Provisional records, usually fairly up-to-date, can be obtained from the Bismarck District office of the Survey upon formal request. These records are used extensively in the study, design, and construction of the many projects proposed in the development and utilization of the water resources of the Missouri River Basin.

MISSOURI RIVER NEAR WILLISTON, N. D.
Stream-Flow Information
(Addition to Supplement "B" of the Fourth Biennial Report.)

Month	Second Foot Days	Maximum	Minimum	Mean	Run-off in Acre-Feet
1944-1945					
October	654,800	27,600	17,000	21,090	1,297,000
November	614,600	36,100	17,200	20,490	1,219,000
December	799,160	51,000	8,960	25,780	1,585,000
January	489,200	19,700	10,100	15,780	970,300
February	208,300	11,500	5,260	7,439	413,200
March	665,400	50,600	5,680	21,460	1,320,000
April	281,130	13,500	7,590	9,371	557,600
May	420,090	18,800	7,810	13,550	833,200
June	1,258,100	68,600	21,800	41,940	2,495,000
July	1,105,600	63,300	20,200	35,660	2,193,000
August	564,900	20,500	16,000	18,220	1,120,000
September	752,000	30,200	18,800	25,070	1,492,000
Water year 1944-45	7,812,280	68,600	5,260	21,400	15,500,000

MISSOURI RIVER NEAR ELBOWOODS, N. D.
Stream-Flow Information
(Addition to Supplement "B" of the Fourth Biennial Report.)

Month	Second Foot Days	Maximum	Minimum	Mean	Run-off in Acre-Feet
1944-1945					
October	692,700	29,500	18,500	22,350	1,374,000
November	603,700	23,600	10,600	20,120	1,197,000
December	813,740	66,100	6,000	26,250	1,614,000
January	522,900	24,600	6,200	16,870	1,037,000
February	257,900	14,300	6,600	9,211	511,500
March	837,700	71,000	6,400	27,020	1,662,000
April	345,870	23,200	8,390	11,530	686,000
May	429,450	19,700	8,180	13,850	851,800
June	1,220,100	69,400	18,800	40,670	2,420,000
July	1,119,100	64,400	23,900	36,100	2,220,000
August	574,200	21,800	16,200	18,520	1,139,000
September	754,300	30,400	17,300	25,140	1,496,000
Water year 1944-45	8,171,660	71,000	6,000	22,390	16,210,000

MISSOURI RIVER AT BISMARCK, N. D.
Stream-Flow Information
(Addition to Supplement "B" of the Fourth Biennial Report.)

Month	Second Foot Days	Maximum	Minimum	Mean	Run-off in Acre-Feet
1944-1945					
October	704,900	28,300	19,400	22,740	1,398,000
November	643,100	25,100	17,900	21,440	1,276,000
December	498,000	21,600	9,400	16,060	987,800
January	479,800	21,600	8,700	15,480	951,700
February	344,040	20,200	7,900	12,290	682,400
March	1,016,520	78,000	7,500	32,790	2,016,000
April	380,320	23,200	9,020	12,680	754,400
May	440,550	20,200	9,090	14,210	873,800
June	1,161,200	71,300	18,300	38,710	2,303,000
July	1,228,000	70,600	26,000	39,610	2,436,000
August	580,000	24,300	15,900	18,710	1,150,000
September	733,000	31,300	16,400	24,430	1,454,000
Water Year 1944-45	8,209,430	78,000	7,500	22,490	16,280,000

LITTLE MISSOURI RIVER AT MARMARTH, N. D.
Stream-Flow Information
(Addition to Supplement "B" of the Fourth Biennial Report.)

Month	Second Foot Days	Maximum	Minimum	Mean	Run-off in Acre-Feet
1944-1945					
October	1,063	65	26	34.3	2,110
November	1,422	137	2	47.4	2,820
December	31	1	1	1.0	60
January	31	1	1	1.0	60
February	623	100	1	22.2	1,240
March	71,054	9,320	3	2,292	140,900
April	7,279	600	83	242	14,440
May	3,396	367	44	110	6,730
June	8,196	1,030	69	273	16,260
July	2,034	490	10	65.6	4,030
August	2,197	351	10	70.7	4,350
September	3,021	393	12	101	5,990
Water year 1944-45	100,347	9,320	1	275	198,990

LITTLE MISSOURI RIVER NEAR WATFORD CITY, N. D.
Stream-Flow Information
(Addition to Supplement "B" of the Fourth Biennial Report.)

Month	Second Foot Days	Maximum	Minimum	Mean	Run-off in Acre-Feet
1944-1945					
October	2,167	115	40	69.9	4,300
November	4,420	608	10	147	8,770
December	161	10	1	5.2	319
January	------	------	------	------	------
February	4,610	1,000	------	165	9,140
March	155,350	17,300	20	5,011	308,100
April	18,756	2,280	211	625	37,200
May	5,257	544	94	170	10,430
June	17,274	2,175	168	576	34,260
July	4,324	357	68	139	8,580
August	3,071	267	20	99.1	6,090
September	3,301	374	24	110	6,550
Water year 1944-45	218,691	17,300	------	599	433,739

LITTLE BEAVER CREEK NEAR MARMARTH, N. D.
Stream-Flow Information
(Addition to Supplement "B" of the Fourth Biennial Report.)

Month	Second Foot Days	Maximum	Minimum	Mean	Run-off in Acre-Feet
1944-1945					
October	120.3	8.8	2.8	3.88	239
November	240.4	19	1.0	8.01	477
December	15.9	1.0	.2	.51	32
January	3.1	.1	.1	.10	6.1
February	1,342.6	500	.1	48.0	2,660
March	12,845.4	2,100	.2	414	25,480
April	840	85	14	28.0	1,670
May	715.2	297	8.0	23.0	1,420
June	1,751.8	560	8.8	58.4	3,470
July	154.9	8.8	2.2	5.00	307
August	7.5	1.4	0	.24	15
September	38.8	4.9	0	1.29	77
Water year 1944-45	18,075.9	2,100	0	49.5	35,853.1

KNIFE RIVER NEAR GOLDEN VALLEY, N. D.
Stream-Flow Information
(Addition to Supplement "B" of the Fourth Biennial Report.)

Month	Second Foot Days	Maximum	Minimum	Mean	Run-off in Acre-Feet
1944-1945					
October	359	19	10	11.6	712
November	928	95	8	30.9	1,840
December	275	10	5	8.9	545
January	231	10	3	7.5	458
February	487	100	3	17.4	966
March	42,195	7,000	3	1,361	83,690
April	2,588	170	40	86.3	5,130
May	1,144	300	23	36.9	2,270
June	6,166	1,760	21	206	12,230
July	542	32	13	17.5	1,080
August	385.7	27	7.8	12.4	765
September	210.4	8.0	6.0	7.01	417
Water year 1944-45	55,511.1	7,000	3	152	110,103

KNIFE RIVER AT HAZEN, N. D.
Stream-Flow Information
(Addition to Supplement "B" of the Fourth Biennial Report.)

Month	Second Foot Days	Maximum	Minimum	Mean	Run-off in Acre-Feet
1944-1945					
October	1,090	45	32	35.2	2,160
November	1,835	171	25	61.2	3,640
December	566	25	11	18.3	1,120
January	545	40	10	17.6	1,080
February	2,782	400	10	99.4	5,520
March	65,489	8,520	25	2,113	129,900
April	5,404	453	77	180	10,720
May	2,247	110	62	72.5	4,460
June	9,240	2,180	71	308	18,330
July	1,743	160	33	56.2	3,460
August	1,112	51	23	35.9	2,210
September	810	30	21	27.0	1,610
Water year 1944-45	92,863	8,520	10	254	184,210

CANNONBALL RIVER NEAR NEW LEIPZIG, N. D.
Stream-Flow Information
(Addition to Supplement "B" of the Fourth Biennial Report.)

Month	Second Foot Days	Maximum	Minimum	Mean	Run-off in Acre-Feet
1944-1945					
October	380	14	10	12.2	754
November	901	94	11	30.0	1,790
December	280	13	4	9.0	555
January	167	8	4	5.4	331
February	1,602	200	4	57.2	3,180
March	21,051	4,080	15	679	41,750
April	2,030	200	26	67.7	4,030
May	923	95	20	29.8	1,830
June	3,407	343	16	114	6,760
July	1,183	263	11	38.2	2,350
August	362.3	35	4.4	11.7	719
September	129.7	10	1.7	4.32	257
Water year 1944-45	32,416	4,080	1.7	88.8	64,300

CANNONBALL RIVER AT BREIEN, N. D.

Stream-Flow Information

(Addition to Supplement "B" of the Fourth Biennial Report.)

Month	Second Foot Days	Maximum	Minimum	Mean	Run-off in Acre-Feet
1944-1945					
October	803	50	20	25.9	1,590
November	2,195	150	21	73.2	4,350
December	656	33	8	21.2	1,300
January	397	20	7	12.8	787
February	6,620	1,000	10	236	13,130
March	42,883	6,020	55	1,383	85,060
April	7,696	750	91	257	15,260
May	2,991	214	66	96.5	5,930
June	9,671	775	66	322	19,180
July	2,051	174	28	66.2	4,070
August	1,327	128	17	42.8	2,630
September	685.9	99	7.6	22.9	1,360
Water year 1944-45	77,975.9	6,020	7	214	154,647

CEDAR RIVER AT PRETTY ROCK, N. D.

Stream-Flow Information

(Addition to Supplement "B" of the Fourth Biennial Report.)

Month	Second Foot Days	Maximum	Minimum	Mean	Run-off in Acre-Feet
1944-1945					
October	162.8	15	3.0	5.25	323
November	324.3	28	5.7	10.8	643
December	167	10	2	5.4	331
January	70	3	2	2.3	139
February	2,237	300	2	79.9	4,440
March	9,179	1,500	10	296	18,210
April	1,398	164	15	46.6	2,770
May	528.6	36	6.9	17.0	1,050
June	2,519	215	12	84.0	5,000
July	211.9	33	1.5	6.84	420
August	151	45	0.3	4.87	300
September	19.1	1.5	0.1	0.64	38
Water year 1944-45	16,967.7	1,500	0.1	46.5	33,664

JAMES RIVER AT JAMESTOWN, N. D.

Stream-Flow Information

(Addition to Supplement "B" of the Fourth Biennial Report.)

Month	Second Foot Days	Maximum	Minimum	Mean	Run-off in Acre-Feet
1944-1945					
October	104.7	6.0	2.0	3.38	208
November	337.0	25	4.0	11.2	668
December	372.5	50	2.5	12.0	739
January	81.6	5.0	1.5	2.63	162
February	72.3	5.0	1.5	2.58	143
March	4,131.6	324	2	133	8,190
April	2,267	128	28	75.6	4,500
May	842	57	16	27.2	1,670
June	424.1	30	1	14.1	841
July	85.2	18	0.6	2.75	169
August	127.0	33	1.2	4.10	252
September	75.6	10	1.2	2.52	150
Water year 1944-45	8,920.6	324	0.6	24.4	17,692

GOOSE RIVER NEAR PORTLAND, N. D.
Stream-Flow Information
(Addition to Supplement "B" of the Fourth Biennial Report.)

Month	Second Foot Days	Maximum	Minimum	Mean	Run-off in Acre-Feet
1944-1945					
October	7.0	.5	.1	.23	14
November	47.4	6.4	.2	1.58	94
December	13.3	1.9	0	.43	26
January	0	0	0	0	0
February	0	0	0	0	0
March	1,920	315	0	61.9	3,810
April	356.3	28	4.5	11.9	707
May	182.8	9.5	3.8	5.90	363
June	174.1	16	.6	5.80	345
July	4.4	0.6	0	.14	8.7
August	0.7	0.2	0	.02	1.4
September	0	0	0	0	0
Water year 1944-45	2,706.0	315	0	7.41	5,369.1

FOREST RIVER NEAR FORDVILLE, N. D.
Stream-Flow Information
(Addition to Supplement "B" of the Fourth Biennial Report.)

Month	Second Foot Days	Maximum	Minimum	Mean	Run-off in Acre-Feet
1944-1945					
October	87.7	3.2	2.2	2.83	174
November	255.8	25	2.4	8.53	507
December	201.4	8.5	2.4	6.50	399
January	114.9	5.0	2.2	3.71	228
February	137.7	5.6	4.3	4.92	273
March	2,561.6	224	5.0	82.6	5,080
April	609	63	12	20.3	1,210
May	355	15	10	11.5	704
June	263.8	16	4.5	8.79	523
July	121.1	4.4	3.0	3.91	240
August	50.7	2.9	1.0	1.64	101
September	84.5	5.0	1.0	2.82	168
Water year 1944-45	4,843.2	224	1.0	13.3	9,607

FOREST RIVER AT MINTO, N. D.
Stream-Flow Information
(Addition to Supplement "B" of the Fourth Biennial Report.)

Month	Second Foot Days	Maximum	Minimum	Mean	Run-off in Acre-Feet
1944-1945					
October	75.5	3.0	2.3	2.44	150
November	440.0	26	2.3	14.7	873
December	347.2	18	3.7	11.2	689
January	79.2	4.5	1.2	2.55	157
February	45.8	2.3	1.2	1.64	91
March	2,776.2	239	0.8	89.6	5,510
April	1,418	127	24	47.3	2,810
May	622	24	18	20.1	1,230
June	455.6	19	9.3	15.2	904
July	173.2	9.3	2.3	5.59	344
August	89.8	4.5	.5	2.90	178
September	29.6	3.0	0	.99	59
Water year 1944-45	6,552.6	239	0	18.0	12,995

TONGUE RIVER AT CAVALIER, N. D.
Stream-Flow Information
(Addition to Supplement "B" of the Fourth Biennial Report.)

Month	Second Foot Days	Maximum	Minimum	Mean	Run-off in Acre-Feet
1944-1945					
October	112.8	4.8	3.2	3.64	224
November	1,358.9	321	3.4	45.3	2,700
December	310.2	18	4.4	10.0	615
January	113.1	4.4	3.1	3.65	224
February	79.3	3.4	2.4	2.83	157
March	5,717.3	855	2.2	184	11,340
April	1,808	130	38	60.3	3,590
May	1,318	114	27	42.5	2,610
June	899	130	13	30.0	1,780
July	530.5	114	5.7	17.1	1,050
August	106.9	6.2	1.8	3.45	212
September	127.1	8.1	1.8	4.24	252
Water year 1944-45	12,481.1	855	1.8	34.2	24,754

GOOSE RIVER AT HILLSBORO, N. D.
Stream-Flow Information
(Addition to Supplement "B" of the Fourth Biennial Report.)

Month	Second Foot Days	Maximum	Minimum	Mean	Run-off in Acre-Feet
1944-1945					
October	88.9	4.8	1.4	2.87	176
November	403.6	36.0	1.8	13.5	801
December	173.5	14.0	1.4	5.6	344
January	20.5	1.4	0.4	0.66	41
February	18.0	0.9	0.4	0.64	36
March	3,052.5	283.0	0.2	98.5	6,050
April	1,215.0	90.0	18.0	40.5	2,410
May	564.0	27.0	13.0	18.2	1,120
June	513.2	27.0	6.4	17.1	1,020
July	185.5	38.0	0.9	5.98	368
August	40.4	4.1	0.4	1.3	80
September	32.6	2.8	0.0	1.09	65
Water year 1944-45	6,307.7	283.0	0.0	17.3	12,511

PEMBINA RIVER NEAR MANITOU, MANITOBA, CANADA
Stream-Flow Information
(Addition to Supplement "B" of the Fourth Biennial Report.)

Month	Second Foot Days	Maximum	Minimum	Mean	Run-off in Acre-Feet
1944-1945					
October	--	--	--	--	--
November	--	--	--	--	--
December	--	--	--	--	--
January	--	--	--	--	--
February	--	--	--	--	--
March	7,414	1,480	472	927	14,710
April	25,535	980	700	851	50,650
May	16,256	710	383	524	32,240
June	8,259	366	192	275	16,380
July	6,156	480	136	199	12,210
August	2,961	131	70	95.5	5,870
September	1,913	81	54	63.8	3,790
Water year 1944-45	68,494	1,480	54	--	135,800

PEMBINA RIVER NEAR WALHALLA, N. D.
Stream-Flow Information
(Addition to Supplement "B" of the Fourth Biennial Report.)

Month	Second Foot Days	Maximum	Minimum	Mean	Run-off in Acre-Feet
1944-1945					
October	5,612	242	135	181	11,130
November	6,389	938	80	213	12,670
December	2,768	135	50	89.3	5,490
January	1,299	50	36	41.9	2,580
February	1,161	47	34	41.5	2,300
March	24,915	2,780	32	804	49,420
April	30,182	1,560	876	1,006	59,870
May	21,441	899	531	692	42,530
June	11,188	527	24.8	373	22,190
July	6,963	375	175	225	13,810
August	3,663	166	80	118	7,270
September	2,401	97	70	80	4,760
Water year 1944-45	117,982	2,780	32	323	234,020

RED RIVER AT EMERSON, MANITOBA
Stream-Flow Information
(Addition to Supplement "B" of the Fourth Biennial Report.)

Month	Second Foot Days	Maximum	Minimum	Mean	Run-off in Acre-Feet
1944-1945					
October	90,100	3,310	2,520	2,910	178,700
November	120,790	6,240	2,510	4,030	239,600
December	84,710	4,290	1,530	2,730	168,000
January	40,100	1,520	1,180	1,290	79,540
February	38,220	1,420	1,260	1,370	75,810
March	282,760	29,300	1,300	9,120	560,800
April	604,400	29,400	13,700	20,100	1,199,000
May	268,020	13,800	5,000	8,650	531,600
June	121,300	4,780	3,220	4,040	240,600
July	67,800	3,190	1,670	2,190	134,500
August	40,570	1,760	1,120	1,310	80,470
September	53,290	2,400	1,030	1,780	105,700
Water year 1944-45	1,812,070	29,400	1,030	4,960	3,594,000

RED RIVER AT GRAND FORKS, N. D.
Stream-Flow Information
(Addition to Supplement "B" of the Fourth Biennial Report.)

Month	Second Foot Days	Maximum	Minimum	Mean	Run-off in Acre-Feet
1944-1945					
October	74,150	2,680	2,120	2,392	147,100
November	69,640	3,040	1,760	2,321	138,100
December	51,710	2,240	1,140	1,668	102,600
January	42,700	1,430	1,330	1,377	84,690
February	38,440	1,420	1,260	1,373	76,240
March	281,880	21,000	1,230	9,093	559,100
April	365,790	18,300	9,720	12,190	725,500
May	181,720	9,540	3,230	5,862	360,400
June	94,830	3,650	2,480	3,161	188,100
July	50,450	2,410	1,220	1,627	100,100
August	31,537	1,220	851	1,017	62,550
September	40,080	1,860	933	1,336	79,500
Water year 1944-45	1,322,927	21,000	851	3,624	2,623,980

RED RIVER AT FARGO, N. D.
Stream-Flow Information
(Addition to Supplement "B" of the Fourth Biennial Report.)

Month	Second Foot Days	Maximum	Minimum	Mean	Run-off in Acre-Feet
1944-1945					
October	23,099	779	709	745	46,030
November	21,904	827	469	730	43,650
December	15,817	767	323	510	31,570
January	13,359	484	383	431	26,690
February	10,898	432	357	389	21,790
March	87,224	7,650	344	2,814	173,200
April	50,120	2,080	1,210	1,671	99,590
May	30,977	1,420	789	999	61,640
June	33,222	1,520	795	1,107	66,120
July	11,638	789	218	375	23,370
August	4,805	215	102	155	9,800
September	4,032	202	89	134	8,260
Water year 1944-45	307,095	7,650	89	841	611,691

RED RIVER AT HALSTAD, MINNESOTA
Stream-Flow Information
(Addition to Supplement "B" of the Fourth Biennial Report.)

Month	Second Foot Days	Maximum	Minimum	Mean	Run-off in Acre-Feet
1944-1945					
October	------	------	------	------	------
November	------	------	------	------	------
December	------	------	------	------	------
January	------	------	------	------	------
February	------	------	------	------	------
March	------	------	------	------	------
April	139,330	6,840	3,970	4,976	276,400
May	71,310	3,670	1,510	2,300	141,400
June	49,700	2,260	1,260	1,657	98,580
July	------	------	------	------	------
August	------	------	------	------	------
September	------	------	------	------	------
Water year 1944-45	260,340	6,840	1,260	------	516,380

RED RIVER AT WAHPETON, N. D.
Stream-Flow Information
(Addition to Supplement "B" of the Fourth Biennial Report.)

Month	Second Foot Days	Maximum	Minimum	Mean	Run-off in Acre-Feet
1944-1945					
October	23,362	811	706	754	46,340
November	20,786	773	416	693	41,230
December	13,206	493	236	426	26,190
January	12,057	422	331	389	23,910
February	10,248	429	319	366	20,330
March	38,741	3,740	328	1,250	76,840
April	33,987	1,460	758	1,133	67,410
May	25,963	1,100	706	838	51,500
June	27,488	1,170	729	916	54,520
July	9,546	620	184	308	18,930
August	4,532	202	112	146	8,990
September	4,222	208	94	141	8,370
Water year 1944-45	224,138	3,740	94	614	444,560

WILD RICE NEAR MANTADOR, N. D.
Stream-Flow Information
(Addition to Supplement "B" of the Fourth Biennial Report.)

Month	Second Foot Days	Maximum	Minimum	Mean	Run-off in Acre-Feet
1944-1945					
October	451.1	24	8.2	14.6	895
November	535.2	29	6.7	17.8	1,060
December	96.6	------	------	3.12	192
January	------	------	------	------	------
February	------	------	------	------	------
March	11,586	924	0.0	374	22,980
April	8,310	479	214	277	16,480
May	2,915	205	42	94	5,780
June	3,003	162	25	100	5,960
July	299.2	24	3.6	9.65	593
August	55.9	6.2	0	1.80	111
September	46.5	8.0	0	1.55	92
Water year 1944-45	27,298.5	924	0	74.8	54,143

HEART RIVER NEAR MANDAN, N. D.
Stream-Flow Information
(Addition to Supplement "B" of the Fourth Biennial Report.)

Month	Second Foot Days	Maximum	Minimum	Mean	Run-off in Acre-Feet
1944-1945					
October	1,197	50	34	38.6	2,370
November	2,162	581	15	72.1	4,290
December	617	30	10	19.9	1,220
January	435	20	8	14.0	863
February	4,693	800	6	168	9,310
March	100,387	13,400	10	3,238	199,100
April	13,850	1,290	159	462	27,470
May	3,675	153	93	119	7,290
June	10,342	906	96	345	20,510
July	2,359	95	57	76.1	4,680
August	1,754	196	31	56.6	3,480
September	926	43	25	30.9	1,840
Water year 1944-45	142,397	13,400	6	390	282,423

HEART RIVER NEAR GLEN ULLIN, N. D.
Stream-Flow Information
(Addition to Supplement "B" of the Fourth Biennial Report.)

Month	Second Foot Days	Maximum	Minimum	Mean	Run-off in Acre-Feet
1944-1945					
October	571	24	14	18.4	1,130
November	1,081	64	16	36	2,140
December	470	22	6	15.2	932
January	300	15	6	9.7	595
February	3,096	7,000	4	111	6,140
March	81,244	10,700	15	2,621	161,100
April	8,193	850	85	273	16,250
May	2,652	250	59	85.5	5,260
June	6,014	530	40	200	11,930
July	1,437	126	34	46.4	2,850
August	806	57	11	26	1,600
September	420	20	11	14	833
Water year 1944-45	106,284	10,700	4	291	210,760

HEART RIVER NEAR RICHARDTON, N. D.
Stream-Flow Information
(Addition to Supplement "B" of the Fourth Biennial Report.)

Month	Second Foot Days	Maximum	Minimum	Mean	Run-off in Acre-Feet
1944-1945					
October	421	16	12	13.6	835
November	1,468	642	10	48.9	2,910
December	356	20	5	11.5	706
January	209	12	3	6.7	414
February	2,497	500	2	89.1	4,950
March	65,871	9,690	10	2,125	130,700
April	6,474	981	66	216	12,840
May	1,743	116	41	56.2	3,460
June	5,582	1,980	32	186	11,070
July	1,332	294	23	42.9	2,640
August	479.9	24	7.9	15.4	952
September	297.5	13	7.6	9.91	590
Water year 1944-45	86,730.4	9,690	2	282	172,067

HEART RIVER NEAR LEHIGH, N. D.
Stream-Flow Information
(Addition to Supplement "B" of the Fourth Biennial Report.)

Month	Second Foot Days	Maximum	Minimum	Mean	Run-off in Acre-Feet
1944-1945					
October	111	10	2	3.6	220
November	229	25	3	7.6	454
December	109	5	2	3.5	216
January	143	10	2	4.6	284
February	2,362	500	2	84.4	4,680
March	20,121	4,090	3	649	39,910
April	1,946	256	16	64.9	3,860
May	444	43	11	14.3	881
June	1,069.1	208	7.4	35.6	2,120
July	206.1	19	3.8	6.65	409
August	75.4	5.5	1.3	2.43	150
September	113.4	6.4	2	3.78	225
Water year 1944-45	26,929	4,090	1.3	73.8	53,409

BOISE DE SIOUX RIVER NEAR WHITE ROCK, S. D.
Stream-Flow Information
(Addition to Supplement "B" of the Fourth Biennial Report.)

Month	Second Foot Days	Maximum	Minimum	Mean	Run-off in Acre-Feet
1944-1945					
October	87.4	11	0	2.82	173
November	37.8	5.7	0	1.26	75
December	3.0	-------	-------	0.10	6
January	0	0	0	0	0
February	0	0	0	0	0
March	491.9	104	0	15.9	976
April	11,256	875	227	375	22,330
May	1,284	255	9.0	41.4	2,550
June	6,419	487	32	214	12,730
July	182.1	12	3	5.87	361
August	99.4	9.5	0.8	3.21	197
September	34.6	2.6	0.2	1.15	69
Water year 1944-45	19,895.2	875	0	54.5	39,467

SHEYENNE RIVER AT WEST FARGO, N. D.
Stream-Flow Information
(Addition to Supplement "B" of the Fourth Biennial Report.)

Month	Second Foot Days	Maximum	Minimum	Mean	Run-off in Acre-Feet
1944-1945					
October	2,444	97	59	78.8	4,850
November	2,775	120	66	92.5	5,500
December	1,883	85	40	60.7	3,730
January	1,380	68	34	44.5	2,740
February	1,317	50	40	47.0	2,610
March	17,139	1,330	40	553	33,990
April	13,689	975	226	456	27,150
May	5,841	221	149	188	11,590
June	4,804	199	110	160	9,530
July	2,446	109	62	78.9	4,850
August	1,959	95	42	63.2	3,890
September	1,130	52	31	37.7	2,240
Water year 1944-45	56,807	1,330	31	156	112,670

SHEYENNE RIVER AT VALLEY CITY, N. D.
Stream-Flow Information
(Addition to Supplement "B" of the Fourth Biennial Report.)

Month	Second Foot Days	Maximum	Minimum	Mean	Run-off in Acre-Feet
1944-1945					
October	659	31	16	21.3	1,310
November	1,640	99	20	54.7	3,250
December	961	53	11	31.0	1,910
January	320.4	12	7.8	10.3	636
February	346.2	27	9.0	12.4	687
March	13,877	1,010	10	448	27,520
April	5,041	375	76	168	10,000
May	2,826	113	71	91.2	5,610
June	2,383	121	34	79.4	4,730
July	822	39	16	26.5	1,630
August	799.4	113	0.8	25.8	1,590
September	363	29	1.0	12.1	720
Water year 1944-45	30,038	1,010	0.8	82.3	59,593

SHEYENNE RIVER AT SHEYENNE, N. D.
Stream-Flow Information
(Addition to Supplement "B" of the Fourth Biennial Report.)

Month	Second Foot Days	Maximum	Minimum	Mean	Run-off in Acre-Feet
1944-1945					
October	9.6	2.0	0	0.31	19
November	302.2	27	0	10.1	599
December	162.3	10	2.5	5.24	322
January	12.5	2	0	0.4	25
February	5.6	.....	.....	0.2	11
March	6,614.2	901	0.2	213	13,120
April	1,058.8	84	7.4	35.3	2,100
May	328	25	3.0	10.6	651
June	221.1	16	1.6	7.37	439
July	28.7	3.6	0	0.93	57
August	117.9	16	0	3.8	234
September	1.2	.....	.....	0.4	2.4
Water year 1944-45	8,862.1	901	0	24.3	17,579.4

PARK RIVER AT GRAFTON, N. D.

Stream-Flow Information

(Addition to Supplement "B" of the Fourth Biennial Report.)

Month	Second Foot Days	Maximum	Minimum	Mean	Run-off in Acre-Feet
1944-1945					
October	25.9	4.0	0.4	0.84	51
November	436.5	35	0.5	14.6	866
December	216.6	29	0.4	6.99	430
January	8.2	.3	0.2	0.26	16
February	6.4	.3	0.2	0.23	13
March	12,709.8	1,140	0.1	410	25,210
April	4,029	536	52	134	7,990
May	1,758	75	44	56.7	3,490
June	945	54	21	31.5	1,870
July	227.4	20	1.6	7.34	451
August	26.2	.2	.1	0.85	52
September	18.3	1.6	.1	0.61	36
Water year 1944-45	20,407.3	1,140	.1	55.9	40,475

SOUTH BRANCH PARK RIVER NEAR PARK RIVER, N. D.

Stream-Flow Information

(Addition to Supplement "B" of the Fourth Biennial Report.)

Month	Second Foot Days	Maximum	Minimum	Mean	Run-off in Acre-Feet
1944-1945					
October	11.1	0.6	0.2	.36	22
November	111	8.0	1	3.7	220
December	86.1	4.1	1	2.78	171
January	8.5	0.5	0.1	2.74	17
February	5.6	0.2	0.2	0.20	11
March	4,772.8	581	0.2	154	9,470
April	703	56	11	23.4	1,390
May	354.6	18	6.1	11.4	703
June	202.5	17	1.1	6.75	402
July	74.8	6.1	0.1	2.41	148
August	7.0	0.4	0.1	2.25	14
September	4.9	0.2	0.1	1.63	9.7
Water year 1944-45	6,341.9	581	0.1	17.4	12,577.7

PEMBINA RIVER AT NECHE, N. D.

Stream-Flow Information

(Addition to Supplement "B" of the Fourth Biennial Report.)

Month	Second Foot Days	Maximum	Minimum	Mean	Run-off in Acre-Feet
1944-1945					
October	6,298	274	153	203	12,490
November	7,012	680	77	234	13,910
December	3,256	181	54	105	6,460
January	1,329	53	36	42.9	2,640
February	1,387	56	42	49.5	2,750
March	22,966	2,400	38	741	45,550
April	32,391	1,730	918	1,080	64,250
May	23,542	933	607	759	46,690
June	13,179	597	305	439	26,140
July	7,968	352	213	257	15,800
August	4,413	204	101	142	8,750
September	2,892	111	79	96.4	5,740
Water year 1944-45	126,633	2,400	36	347	251,170

WINTERING RIVER NEAR KARLSRUHE, N. D.
Stream-Flow Information
(Addition to Supplement "B" of the Fourth Biennial Report.)

Month	Second Foot Days	Maximum	Minimum	Mean	Run-off in Acre-Feet
1944-1945					
October	128	5.2	3.2	4.13	254
November	216.7	14	2.9	7.22	430
December	79.2	4	0.6	2.55	157
January	10.3	0.5	0.2	0.33	20
February	2.8	0.1	0.1	0.1	5.6
March	2,481.5	200	0.1	80	4,920
April	1,456	114	14	48.5	2,890
May	321.1	15	8.4	10.4	637
June	210.9	11	3.2	7.03	418
July	140.1	7	2.7	4.52	278
August	88.6	6.2	0.9	2.86	176
September	78.7	5.0	0.9	2.62	156
Water year 1944-45	5,213.9	200	0.1	14.3	10,341.6

SOURIS RIVER ABOVE MINOT, N. D.
Stream-Flow Information
(Addition to Supplement "B" of the Fourth Biennial Report.)

Month	Second Foot Days	Maximum	Minimum	Mean	Run-off in Acre-Feet
1944-1945					
October	3,501	119	105	113	6,940
November	3,582	142	89	119	7,100
December	2,622	100	82	84.6	5,200
January	2,653	93	84	85.6	5,260
February	2,238	98	38	79.9	4,440
March	2,960	425	36	95.5	5,870
April	921	53	15	30.7	1,830
May	578.5	34	8.1	18.7	1,150
June	416	41	2	13.9	825
July	104.8	8.1	0.8	3.38	208
August	26.1	3.2	0	0.84	52
September	0	0	0	0	0
Water year 1944-45	19,602.4	425	0	53.7	38,875

SOURIS RIVER NEAR SHERWOOD, N. D.
Stream-Flow Information
(Addition to Supplement "B" of the Fourth Biennial Report.)

Month	Second Foot Days	Maximum	Minimum	Mean	Run-off in Acre-Feet
1944-1945					
October	442.6	18	8.5	14.3	878
November	336.5	26	4.6	11.2	667
December	130.2	5.8	1.6	4.2	258
January	50.2	2	1.0	1.62	100
February	40.3	1.7	1.2	1.44	79.9
March	873.6	105	1.1	28.2	1,730
April	963	68	20	32.1	1,910
May	482	20	13	15.5	956
June	518	27	13	17.3	1,030
July	928	56	15	29.9	1,840
August	313.4	17	2.7	10.1	622
September	66	4.4	1.0	2.2	131
Water year 1944-45	5,143.8	105	1.0	14.1	10,201.9

SOURIS RIVER NEAR WESTHOPE, N. D.
Stream-Flow Information
(Addition to Supplement "B" of the Fourth Biennial Report.)

Month	Second Foot Days	Maximum	Minimum	Mean	Run-off in Acre-Feet
1944-1945					
October	2,920	346	19	94.2	5,790
November	2,015.7	157	0.5	67.2	4,000
December	4,357	149	130	141	8,640
January	3,638	146	68	117	7,220
February	2,015	79	68	72	4,000
March	4,874	1,040	1	157	9,670
April	22,631	1,020	213	754	44,890
May	5,208.3	650	0.2	168	10,330
June	784.9	47	0.3	26.2	1,560
July	591.4	41	2.5	19.1	1,170
August	2,757.5	196	3.9	89.0	5,470
September	545.9	37	1.9	18.2	1,080
Water year 1944-45	52,338.7	1,040	0.2	143	103,820

SOURIS RIVER NEAR FOXHOLM, N. D.
Stream-Flow Information
(Addition to Supplement "B" of the Fourth Biennial Report.)

Month	Second Foot Days	Maximum	Minimum	Mean	Run-off in Acre-Feet
1944-1945					
October	3,121	107	87	101	6,190
November	3,213	137	60	107	6,370
December	2,644	89	84	85.3	5,240
January	2,622	87	84	84.6	5,200
February	2,097	87	36	74.9	4,160
March	1,377	77	17	44.4	2,730
April	567.1	31	5.7	18.9	1,120
May	409.8	39	1.7	13.2	813
June	138.2	12	0.2	4.6	274
July	15.2	1.4	0.1	0.49	30
August	3.3	1.7	0	0.11	6.5
September	21.0	2	0.3	0.7	42
Water year 1944-45	16,228.6	137	0	44.5	32,175.5

SOURIS RIVER NEAR BANTRY, N. D.
Stream-Flow Information
(Addition to Supplement "B" of the Fourth Biennial Report.)

Month	Second Foot Days	Maximum	Minimum	Mean	Run-off in Acre-Feet
1944-1945					
October	3,501	135	92	113	6,940
November	3,838	150	115	128	7,610
December	3,152	130	77	102	6,250
January	2,561	91	75	82.6	5,080
February	2,539	102	84	90.7	5,040
March	9,015	766	75	291	17,880
April	5,586	381	63	186	11,080
May	2,042	72	62	65.9	4,050
June	2,135	169	40	71.2	4,230
July	1,208	54	28	39	2,400
August	856	40	13	27.6	1,700
September	276.3	17	6.9	9.21	548
Water year 1944-45	36,709.3	766	6.9	101	72,808

SOURIS RIVER AT VERENDRYE, N. D.
Stream-Flow Information
(Addition to Supplement "B" of the Fourth Biennial Report.)

Month	Second Foot Days	Maximum	Minimum	Mean	Run-off in Acre-Feet
1944-1945					
October	3,615	162	68	117	7,170
November	3,881	157	101	129	7,700
December	2,632	100	79	84.9	5,220
January	2,608	88	79	84.1	5,170
February	2,363	90	81	84	4,690
March	8,274	640	52	267	16,410
April	2,130	171	35	71	4,220
May	1,121	68	24	36.2	2,220
June	967	57	14	32.2	1,920
July	538	28	12	17.4	1,070
August	408.5	23	8	13.2	810
September	222.5	10	6	7.42	441
Water year 1944-45	28,760	640	6	78.8	57,041

SHEYENNE RIVER NEAR COOPERSTOWN, N. D.
Stream-Flow Information
(Addition to Supplement "B" of the Fourth Biennial Report.)

Month	Second Foot Days	Maximum	Minimum	Mean	Run-off in Acre-Feet
1944-1945					
October	------	------	------	------	------
November	------	------	------	------	------
December	------	------	------	------	------
January	------	------	------	------	------
February	------	------	------	------	------
March	1,037	------	------	------	2,060
April	3,845	278	64	128	7,630
May	2,424	100	61	78.2	4,810
June	1,968	114	26	65.6	3,900
July	613	37	11	19.8	1,220
August	265.8	24	2.6	8.57	527
September	306.3	29	2.0	10.2	608
Water year 1944-45	10,459.1	278	2.0	------	20,755

DEVILS LAKE NEAR DEVILS LAKE, N. D.

Month 1944-45	Elevation in feet
October 14th	1,403.40
November 18th	1,403.50
December	----------
January	----------
February	----------
March 5th	1,404.09
April 25th	1,404.31
May 10th	1,404.34
June 11th	1,404.36
July 12th	1,404.06
August 18th	1,403.90
September 25th	1,403.79

DEVILS LAKE NEAR DEVILS LAKE, N. D.

Month	Elevation in feet
1945-1946	
October 16th	1,403.69
November 30th	1,403.67
December 11th	1,403.69
January	------
February	------
March	------
April 17th	1,404.75
May 10th	1,404.70
June 21st	1,404.32
July 11th	1,404.27
August 11th	1,403.84
September 6th	1,403.47

LAKE DARLING NEAR FOXHOLM, N. D.

Month	Maximum		Minimum	
	Gage-height	Storage in Acre-feet	Gage-height	Storage in Acre-feet
1944-45				
October	16.4	70,400	15.3	61,400
November	15.3	61,400	14.9	58,300
December	14.9	58,300	14.4	54,800
January	14.4	54,800	13.5	49,000
February	13.5	49,000	13.0	46,000
March	13.0	46,000	12.7	44,200
April	13.0	46,000	13.0	46,000
May	13.0	46,000	12.6	43,600
June	12.6	43,600	12.5	43,000
July	12.5	43,000	12.5	43,000
August	12.1	40,600	11.8	39,000
September	12.0	40,000	11.0	35,000
1945-46				
October	12.4	42,400	11.7	38,500
November	12.0	40,000	12.0	40,000
December	12.0	40,000	12.0	40,000
January	12.0	40,000	12.0	40,000
February	12.0	40,000	12.0	40,000
March	15.0	59,000	12.0	40,000
April	17.4	78,900	14.9	58,300
May	17.0	75,500	16.7	72,950
June	16.7	72,950	16.6	72,100
July	16.6	72,100	16.1	67,850
August	16.1	67,850	15.9	66,200
September	15.9	66,200	15.0	59,000

Sugar beets under irrigation are yielding from $75 to $150 gross per acre in western North Dakota

THE TOPOGRAPHIC BRANCH

Department of the Interior

United States Geological Survey

Of the several methods of charting the lay of the land over a wide expanse of country, contour maps are the most accurate and logical. They present the information in the most usable form. They show each hill, valley, and stream to scale and show the heights and slopes of the ground surface. This information is necessary before engineers can plan and design reservoirs, canals, and irrigation projects.

In cooperation with the U. S. Geological Survey, topographic maps covering 1088 square miles have been prepared for the State in the period covered by this report. They cover areas in Eddy, Foster, Wells, Sheridan and McLean counties now in the program of the State Water Conservation Commission.

These maps have been prepared by the most modern instruments and techniques adaptable to this type of terrain. The mapping of roads, streams, and certain parts of the contour work was done from aerial photography by means of multiplex projectors. The other operations of mapping consists of preliminary control surveys, completion surveys, drafting, and publishing. Under the cooperative program 900 miles of control surveys have been executed and 1286 square miles of map drafting has been done. In addition to this the U. S. Geological Survey under Federal projects has mapped 68 square miles in Williams county and has executed 3300 miles of control surveys for anticipated work to follow in McHenry, Ward, Mountrail, Burke and Divide counties.

Progress of topographic mapping in North Dakota is indicated on the attached map. Areas mapped before 1896 were more of a preliminary nature. Quadrangles mapped since that date contain more information and are classed as adequate. The mapping accomplished during this biennium is of a higher quality in keeping with the advancements of technique within the profession.

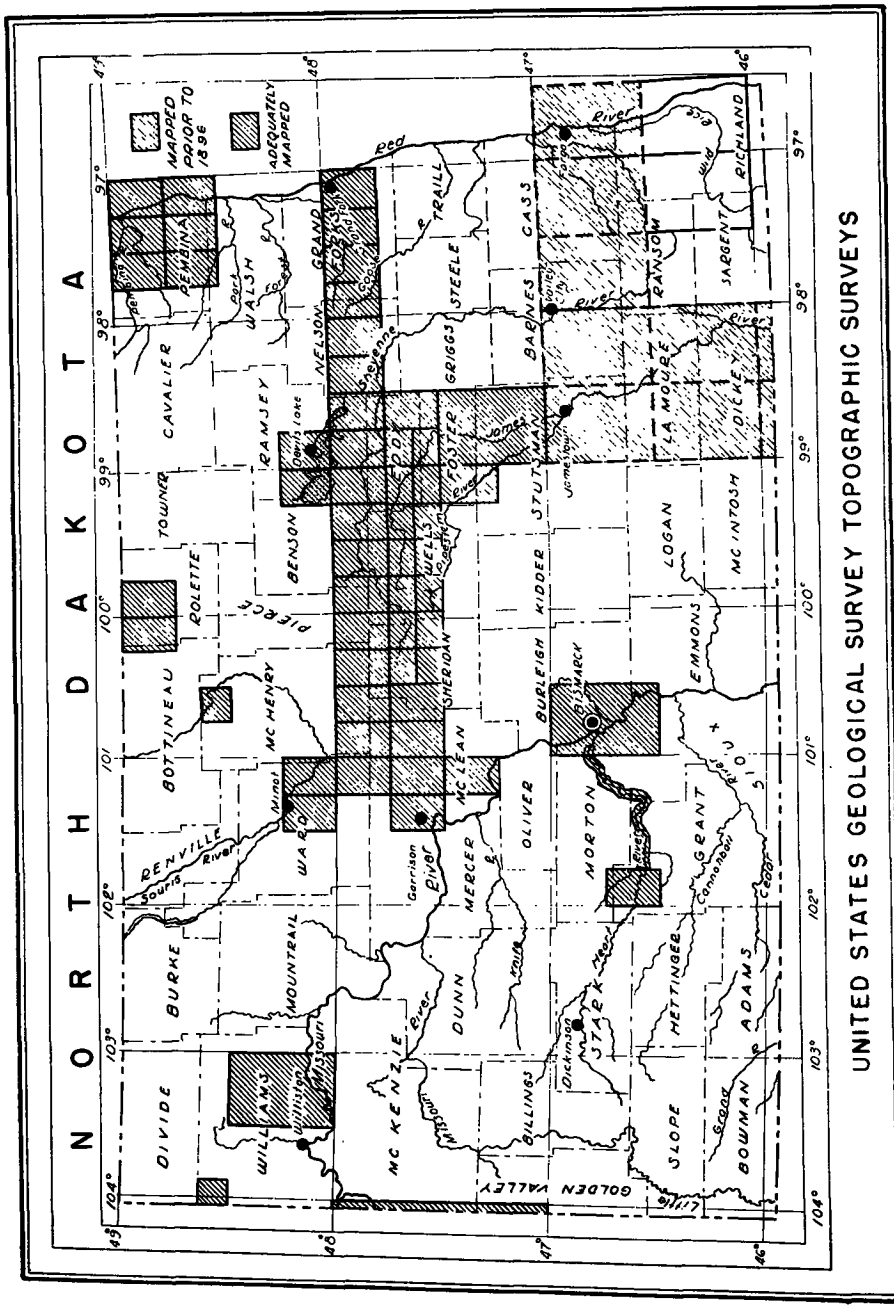
Topographic mapping is an essential part of pre-construction work for dams and reservoirs and for construction of irrigation works, and is being completed as rapidly as possible in areas of the state where such development is contemplated.

GEOGRAPHICAL DATA CONCERNING NORTH DAKOTA

By Alex Burr

North Dakota Research Foundation

I. Boundary Lines (to nearest tenth mile).
   A. North—310.0 miles—Approximately 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.



UNITED STATES GEOLOGICAL SURVEY TOPOGRAPHIC SURVEYS

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 Sq. M. (Approx.)
  - 2. Missouri to Gulf of Mexico ..... 41,200 Sq. M. (Approx.)

UNITED STATES WEATHER BUREAU

As of 1946 there are 4 first-order Weather Bureau stations in North Dakota and 10 Airway stations, all rendering 24 hour service. There are also 120 cooperative weather observers in North Dakota, supervised by the Bismarck office. These cooperative weather observers take daily readings, recording the high temperature, low temperature, 24-hour precipitation, sky condition and wind. The observers are scattered over the state usually 2 or 3 to a county. They receive no pay for the work, but there are many public-spirited citizens who are interested in the weather in all counties so that little difficulty is experienced in finding observers.

There are also records kept from more than 100 rain gages owned by State agencies, individuals, companies and other Federal agencies. About 25 of the cooperative observers have recording gages which indicate the time and rate of fall, besides the amount. The rate of fall is important for determining run-off from the fall per hour. One-half inch of rain falling slowly over a period of six hours is worth more to the state than an inch that falls in an hour. Fortunately, rainfalls of one inch per hour occur only twice in the average year in North Dakota.

The first weather records in North Dakota were made by Lewis & Clark in 1804-5. The army began regular observations in 1860 but a good distribution of stations was not secured until 1892 when 40 were in operation. Complete records for more than 50 years are available to the public and they include precipitation, temperature, sunshine, wind, humidity, state of the sky, etc. Records made by means of recording instruments sent up by means of helium filled balloons are also available. Weather maps showing weather conditions in all parts of the United States are drawn 4 times daily and forecasts are issued every 6 hours.

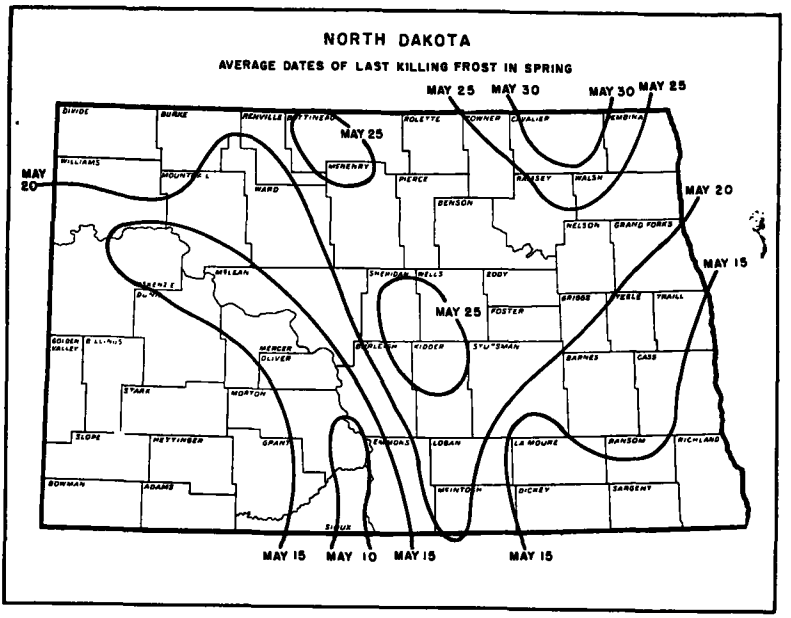
In an examination of North Dakota weather records for the past 75 years, there is found no evidence of any progressive change in tem-

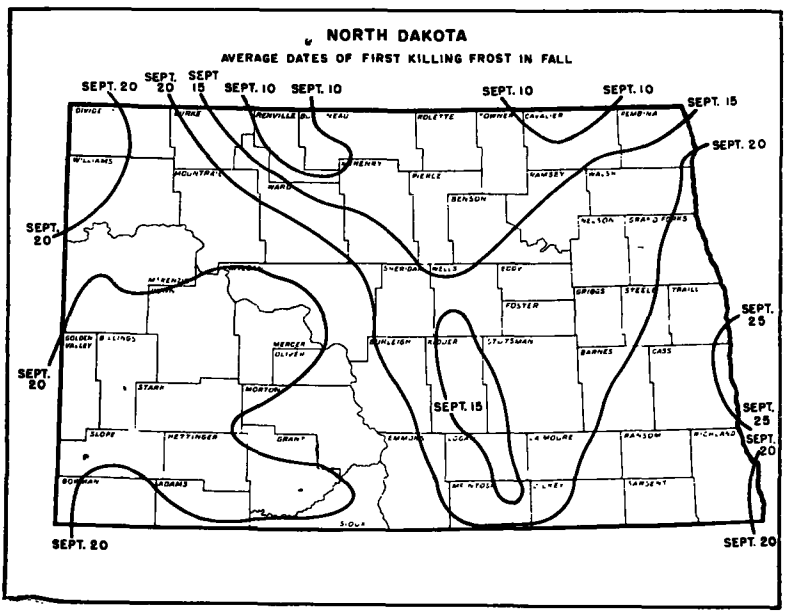
perature or in the amount of rain and snow. An outstanding period of extremes occurred between 1936 and 1945. During this decade, North Dakota experienced its highest and lowest temperatures and its driest and wettest years.

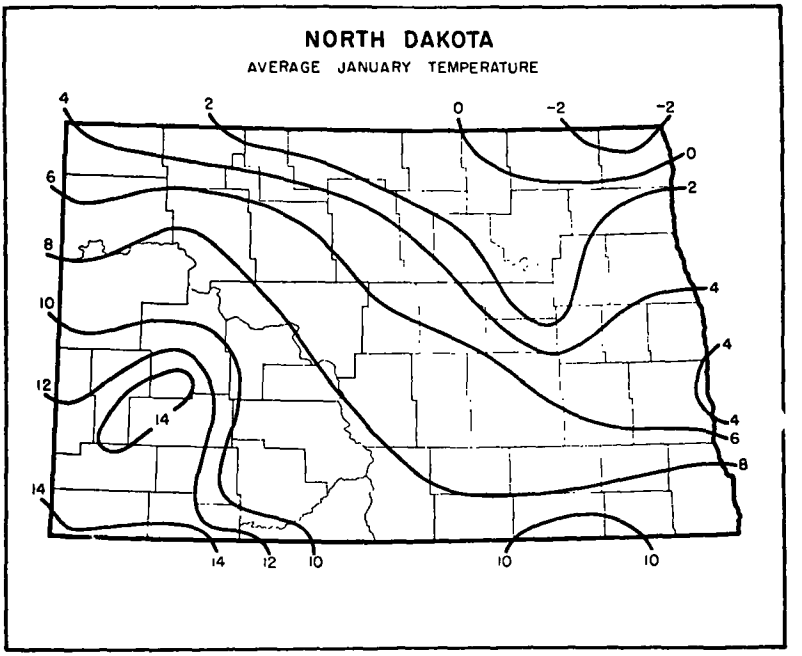
Climate is a natural resource that cannot be exhausted by exploitation as is the case with most natural resources, such as soils, forests, and mines. As civilization has become more complex, our dependence upon an intimate knowledge of climate and weather has increased. Today, this knowledge is so indispensable 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.

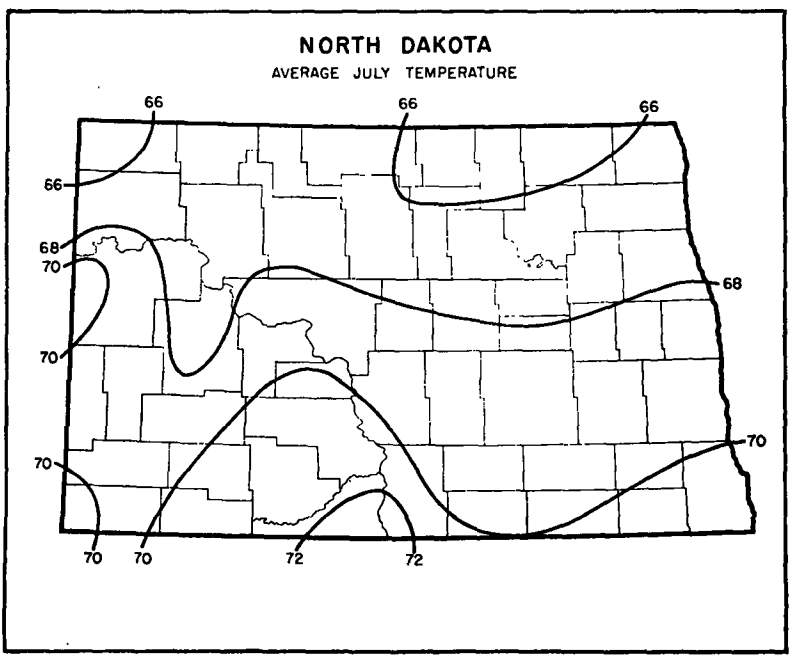
"Climate and Weather in North Dakota," prepared by Meteorologist Frank J. Bavendick and published by the State Water Conservation Commission, contains a digest of records for seventy five years. It notes unusual and unfavorable weather conditions to prepare residents for possible recurrences in future years. This booklet contains a wealth of information of the vagaries of North Dakota weather, including floods, blizzards, drought, dust storms, hail, precipitation, snowfall, sunshine, etc. A charge of $1 is made to cover a part of the cost. The first issue of 1,000 copies has been exhausted and a second issue printed, to meet the demand.

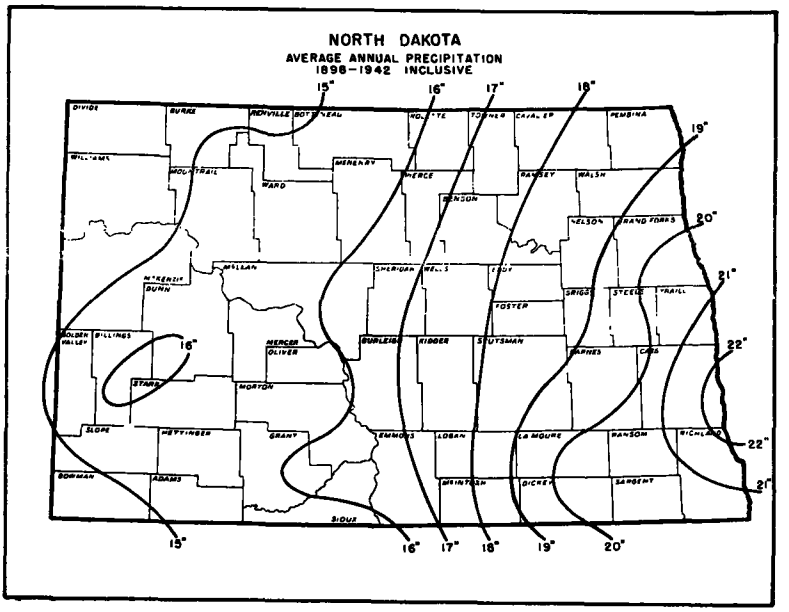
During the past four seasons, rainfall has been above normal and the need for irrigation has not been apparent and dry farming yields have been satisfactory. However, Weather Bureau records for about 70 years past indicate that on the average six out of eleven years have had insufficient rainfall to produce a paying crop. The only other five year period of continued good moisture supply was 1899 to 1904. A drouth preceded and followed this period, hence, it seems safe to conclude that this area is approaching a period of drouth years.

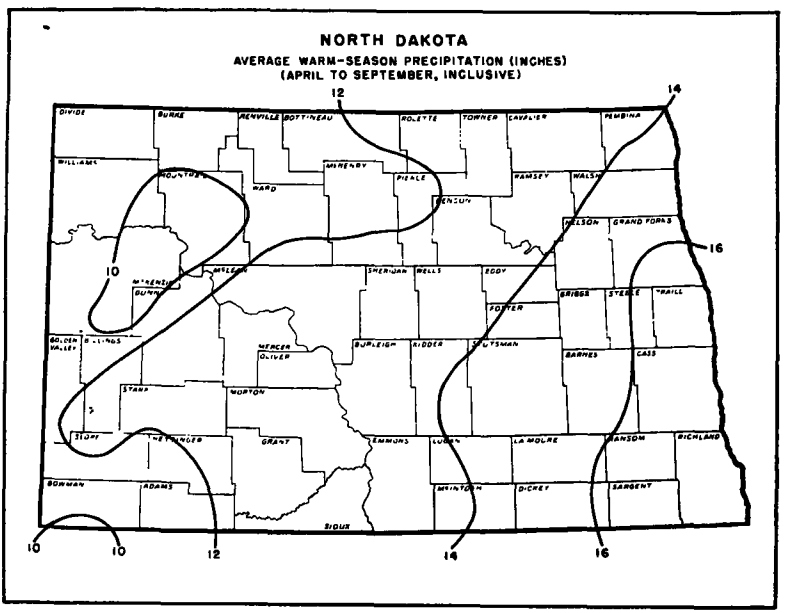

NORTH DAKOTA
AVERAGE DATES OF LAST KILLING FROST IN SPRING
MAY 25
MAY 30
MAY 30
MAY 25
MAY 25
MAY 20
MAY 20
MAY 15
MAY 25
MAY 15
MAY 10
MAY 15
MAY 15
DIVIDE
BURKE
RENVILLE
BOTTINEAU
ROLETTE
TOWNER
CAVALIER
PEMBINA
WILLIAMS
MOUNTRAIL
WARD
MCHENRY
PIERCE
RAMSEY
WALSH
BENSON
NELSON
GRAND FORKS
MCLEAN
SHERIDAN
WELLS
EDDY
GRIGGS
STEELE
TRAILL
FOSTER
GOLDEN VALLEY
BILLINGS
MERCER
OLIVER
BURLEIGH
KIDDER
STUTSMAN
BARNES
CASS
STARK
MORTON
SLOPE
HETTINGER
GRANT
EMMONS
LOGAN
LA MOURE
RANSOM
RICHLAND
BOWMAN
ADAMS
MCINTOSH
DICKEY
SARGENT
SIOUX

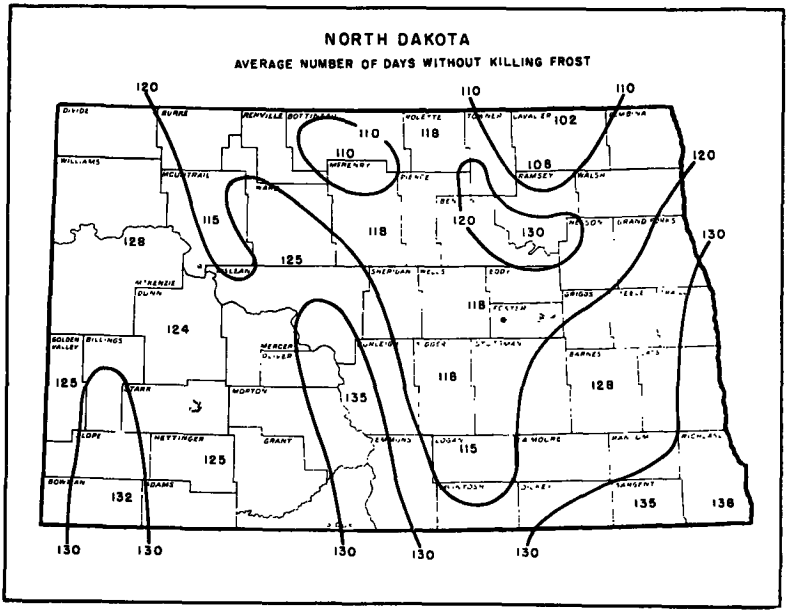

NORTH DAKOTA
AVERAGE DATES OF FIRST KILLING FROST IN FALL
SEPT. 20
SEPT. 20
SEPT 15
SEPT. 10
SEPT. 10
SEPT. 10
SEPT. 10
SEPT. 15
SEPT. 20
SEPT. 20
SEPT. 20
SEPT. 15
SEPT. 25
SEPT. 25
SEPT. 20
SEPT. 20
SEPT. 20
DIVIDE
BURKE
RENVILLE
ROLETTE
TOWNER
CAVALIER
PEMBINA
WILLIAMS
MOUNTRAIL
WARD
MCHENRY
PIERCE
RAMSEY
WALSH
BENSON
NELSON
GRAND FORKS
SHERIDAN
WELLS
EDDY
GRIGGS
STEELE
TRAILL
FOSTER
GOLDEN VALLEY
BILLINGS
MERCER
OLIVER
BURLEIGH
KIDDER
STUTSMAN
BARNES
CASS
STARK
MORTON
SLOPE
HETTINGER
GRANT
EMMONS
LOGAN
LA MOURE
RANSOM
RICHLAND
BOWMAN
ADAMS
MCINTOSH
DICKEY
SARGENT
SIOUX

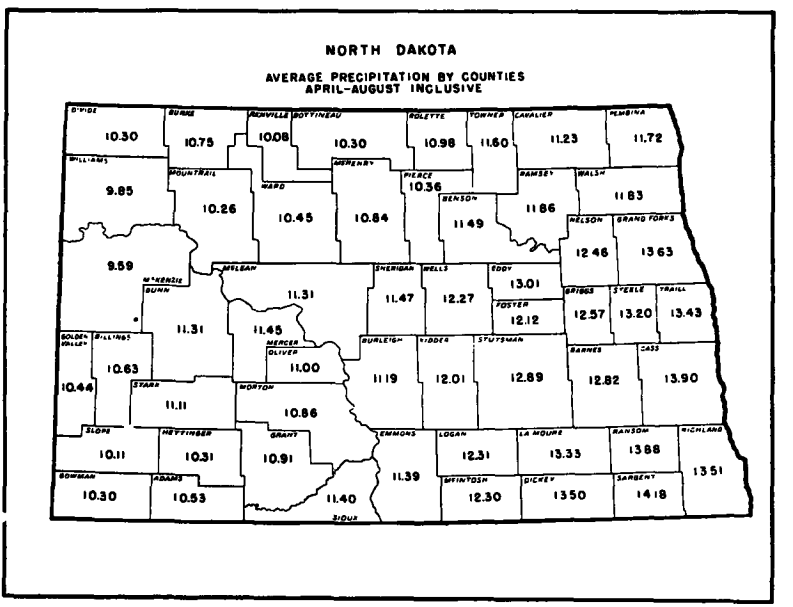

NORTH DAKOTA
AVERAGE JANUARY TEMPERATURE
4
2
0
-2
-2
0
2
6
8
10
4
4
12
14
4
6
8
14
14
12
10
10
10

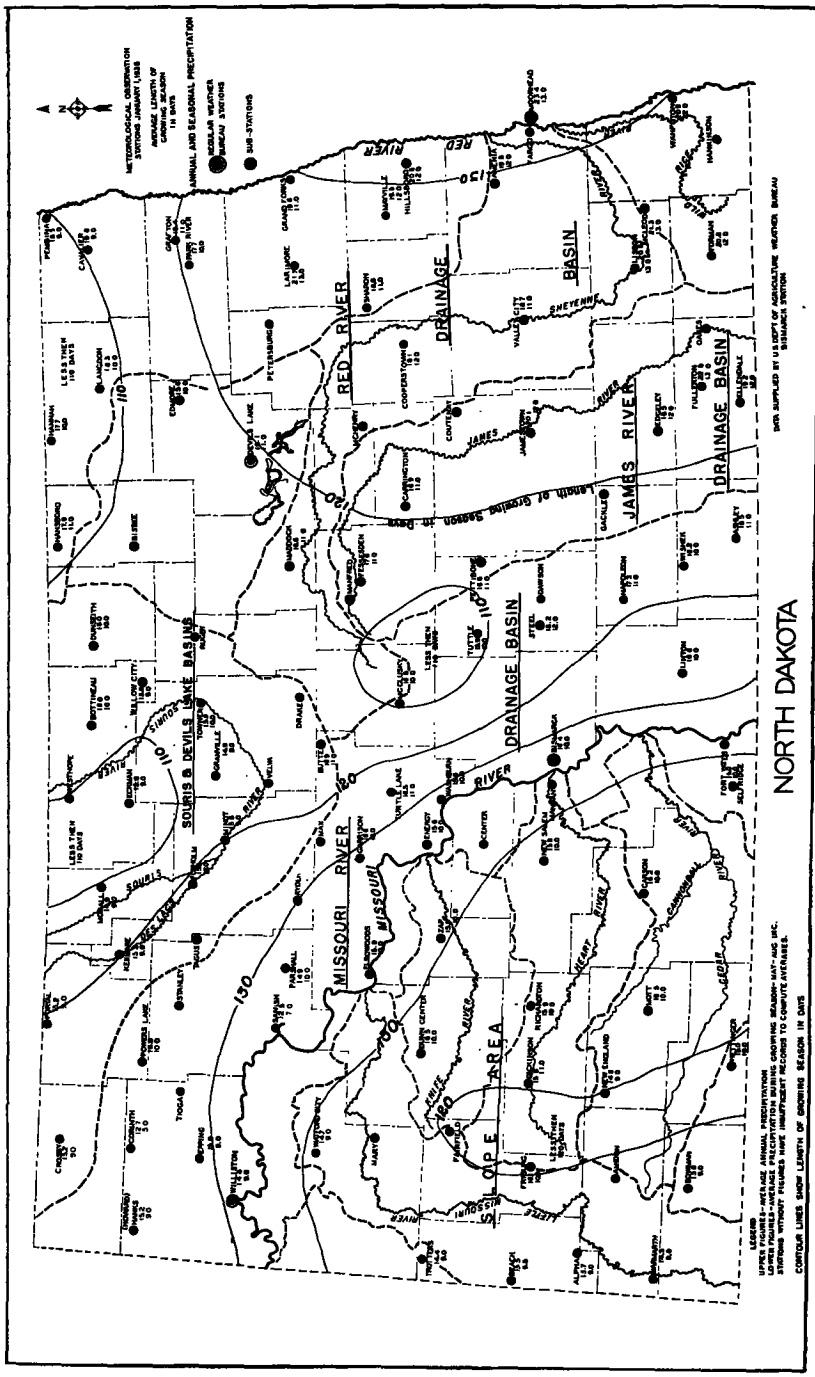

NORTH DAKOTA
AVERAGE JULY TEMPERATURE
66
66
66
66
68
70
68
70
70
70
70
72
72

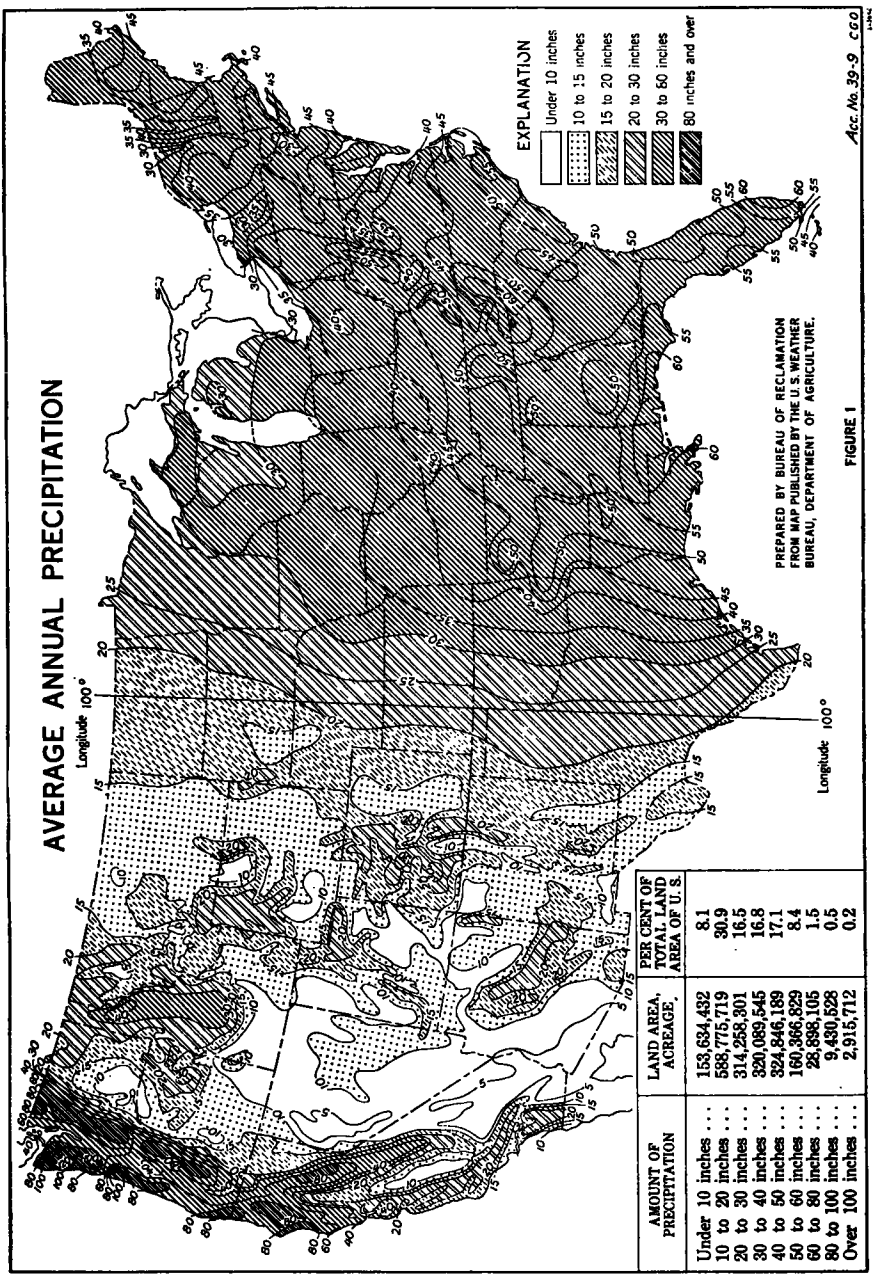

NORTH DAKOTA
AVERAGE ANNUAL PRECIPITATION
1898–1942 INCLUSIVE
15"
16"
17"
18"
19"
20"
21"
22"
DIVIDE
BURKE
RENVILLE
BOTTINEAU
ROLETTE
TOWNER
CAVALIER
PEMBINA
WILLIAMS
MOUNTRAIL
WARD
MCHENRY
PIERCE
RAMSEY
WALSH
BENSON
NELSON
GRAND FORKS
MCKENZIE
MCLEAN
SHERIDAN
WELLS
EDDY
DUNN
FOSTER
GRIGGS
STEELE
TRAILL
BILLINGS
MERCER
OLIVER
BURLEIGH
KIDDER
STUTSMAN
BARNES
CASS
STARK
MORTON
SLOPE
HETTINGER
GRANT
EMMONS
LOGAN
LA MOURE
RANSOM
RICHLAND
BOWMAN
ADAMS
MCINTOSH
DICKEY
SARGENT
SIOUX


NORTH DAKOTA
AVERAGE WARM-SEASON PRECIPITATION (INCHES)
(APRIL TO SEPTEMBER, INCLUSIVE)
10
12
14
16
DIVIDE
BURKE
RENVILLE
BOTTINEAU
ROLETTE
TOWNER
CAVALIER
PEMBINA
WILLIAMS
MOUNTRAIL
WARD
MCHENRY
PIERCE
RAMSEY
WALSH
BENSON
NELSON
GRAND FORKS
MCKENZIE
MCLEAN
SHERIDAN
WELLS
EDDY
DUNN
FOSTER
GRIGGS
STEELE
TRAILL
BILLINGS
MERCER
OLIVER
BURLEIGH
KIDDER
STUTSMAN
BARNES
CASS
STARK
MORTON
SLOPE
HETTINGER
GRANT
EMMONS
LOGAN
LA MOURE
RANSOM
RICHLAND
BOWMAN
ADAMS
MCINTOSH
DICKEY
SARGENT
SIOUX


NORTH DAKOTA
AVERAGE NUMBER OF DAYS WITHOUT KILLING FROST
120
110
110
110
118
102
110
108
120
115
118
120
130
130
128
125
118
124
125
118
128
135
115
125
132
135
138
130
130
130
130
130


NORTH DAKOTA
AVERAGE PRECIPITATION BY COUNTIES
APRIL-AUGUST INCLUSIVE
10.30
10.75
10.08
10.30
10.98
11.60
11.23
11.72
9.85
10.26
10.45
10.84
10.36
11.49
11.86
11.83
12.46
13.63
9.59
11.31
11.31
11.45
11.47
12.27
13.01
12.12
12.57
13.20
13.43
10.63
10.44
11.00
11.19
12.01
12.89
12.82
13.90
11.11
10.86
10.11
10.31
10.91
11.39
12.31
13.33
13.88
13.51
10.30
10.53
11.40
12.30
13.50
14.18


NORTH DAKOTA
RED RIVER DRAINAGE BASIN
JAMES RIVER DRAINAGE BASIN
MISSOURI RIVER DRAINAGE BASIN
SOURIS & DEVILS LAKE BASINS
OPEN AREA
RED RIVER
JAMES RIVER
MISSOURI RIVER
SOURIS RIVER
DEVILS LAKE
LEGEND
UPPER FIGURES—MEAN AVE. ANNUAL PRECIPITATION
LOWER FIGURES—MEAN AVE. PRECIPITATION DURING GROWING SEASON MAY-AUG INC.
STATIONS WITHOUT FIGURES HAVE NO RECORD TO COMPUTE AVERAGES.
CONTOUR LINES SHOW LENGTH OF GROWING SEASON IN DAYS
DATA SUPPLIED BY U.S. DEPT. OF AGRICULTURE WEATHER BUREAU
BISMARCK, DAKOTA



AMOUNT OF PRECIPITATION	LAND AREA, ACREAGE.	PER CENT OF TOTAL LAND AREA OF U. S.
Under 10 inches . . .	153,634,432	8.1
10 to 20 inches . . .	588,775,719	30.9
20 to 30 inches . . .	314,258,301	16.5
30 to 40 inches . . .	320,089,545	16.8
40 to 50 inches . . .	324,846,189	17.1
50 to 60 inches . . .	160,366,829	8.4
60 to 80 inches . . .	28,898,105	1.5
80 to 100 inches . . .	9,430,528	0.5
Over 100 inches . . .	2,915,712	0.2

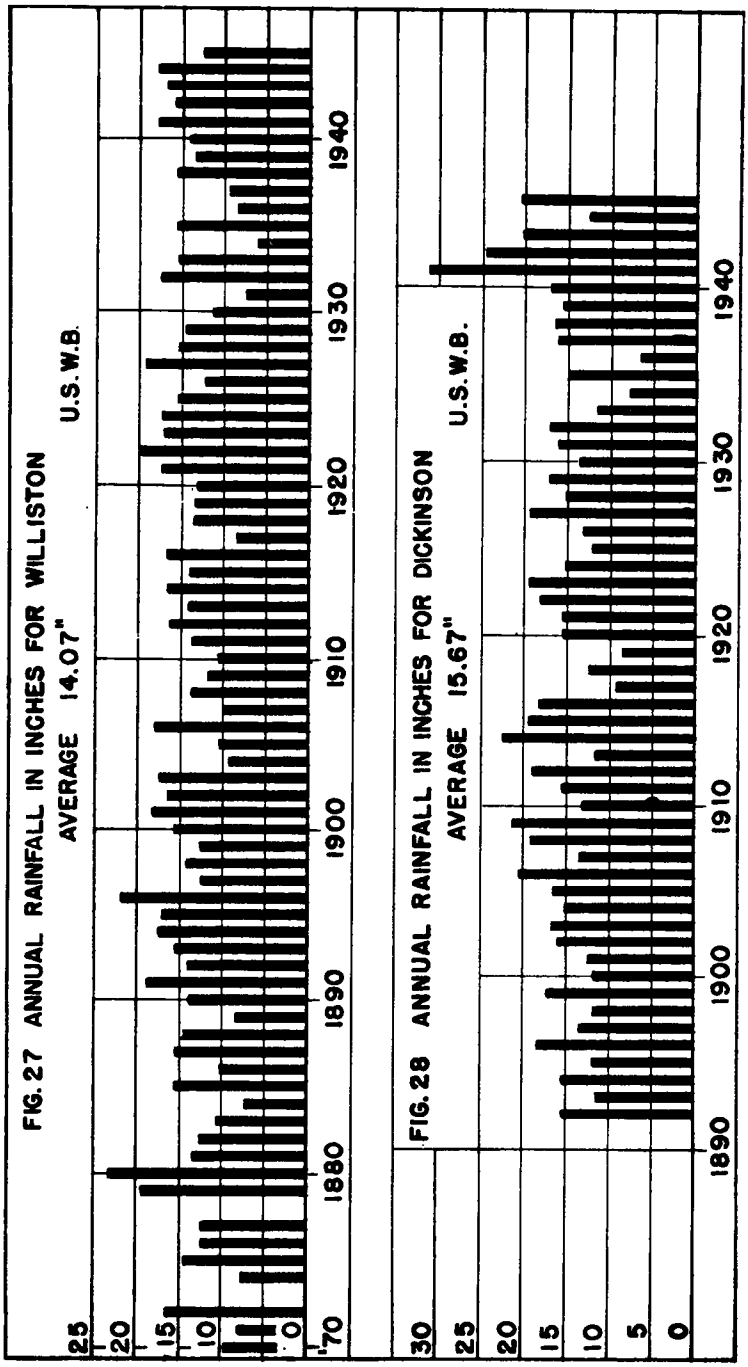


FIG. 27 ANNUAL RAINFALL IN INCHES FOR WILLISTON
AVERAGE 14.07"
U.S.W.B.
25
20
15
10
5
0
1880
1890
1900
1910
1920
1930
1940
FIG. 28 ANNUAL RAINFALL IN INCHES FOR DICKINSON
AVERAGE 15.67"
U.S.W.B.
30
25
20
15
10
5
0
1890
1900
1910
1920
1930
1940

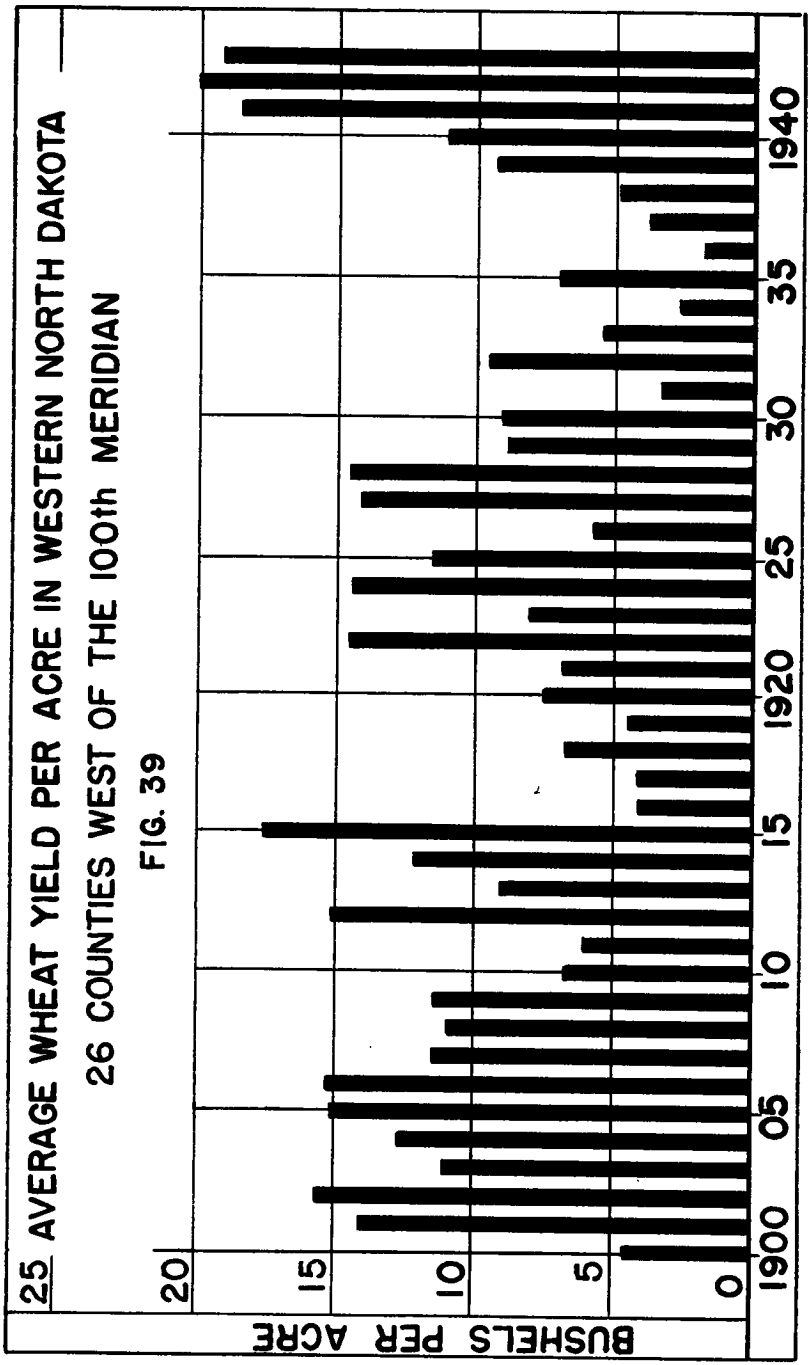

25 AVERAGE WHEAT YIELD PER ACRE IN WESTERN NORTH DAKOTA
26 COUNTIES WEST OF THE 100th MERIDIAN
FIG. 39
BUSHELS PER ACRE
20
15
10
5
0
1900
05
10
15
1920
25
30
35
1940

FIG. 29 ANNUAL RAINFALL IN INCHES FOR MOTT
U.S. WEATHER BUREAU
AVERAGE 16.21"

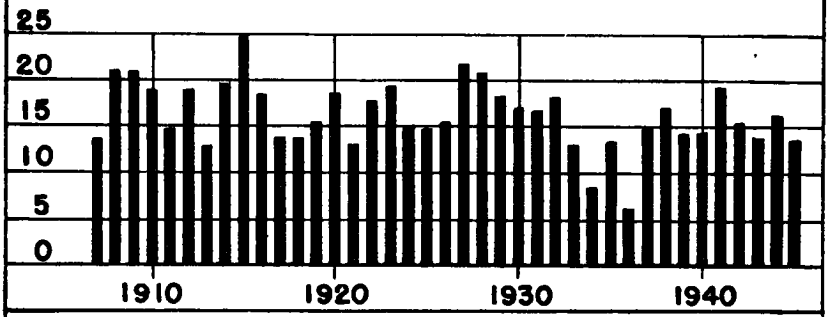


FIG. 30 ANNUAL RAINFALL IN INCHES FOR BOWMAN
U.S. WEATHER BUREAU
AVERAGE 15.24"

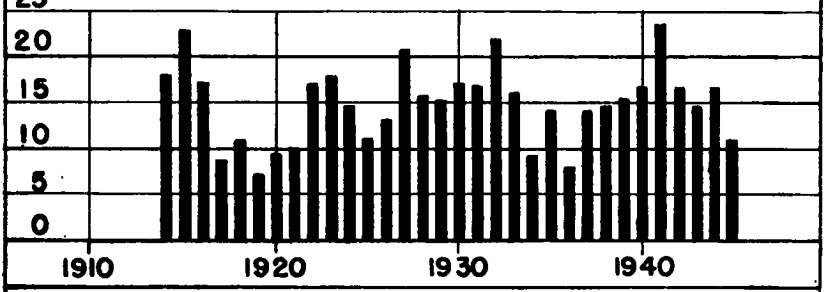
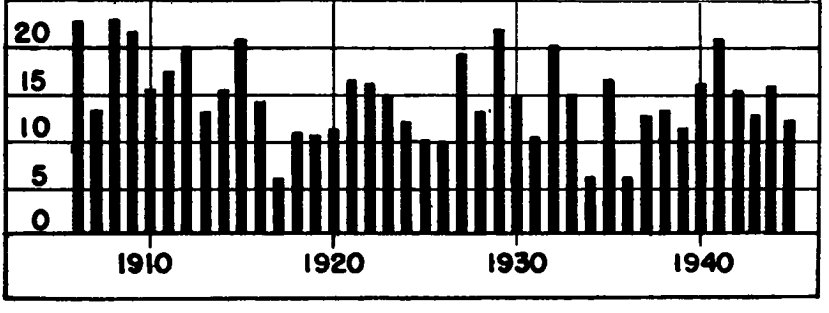


FIG. 31 ANNUAL RAINFALL IN INCHES FOR BEACH & GOLVA
U.S. WEATHER BUREAU
AVERAGE 15.21"



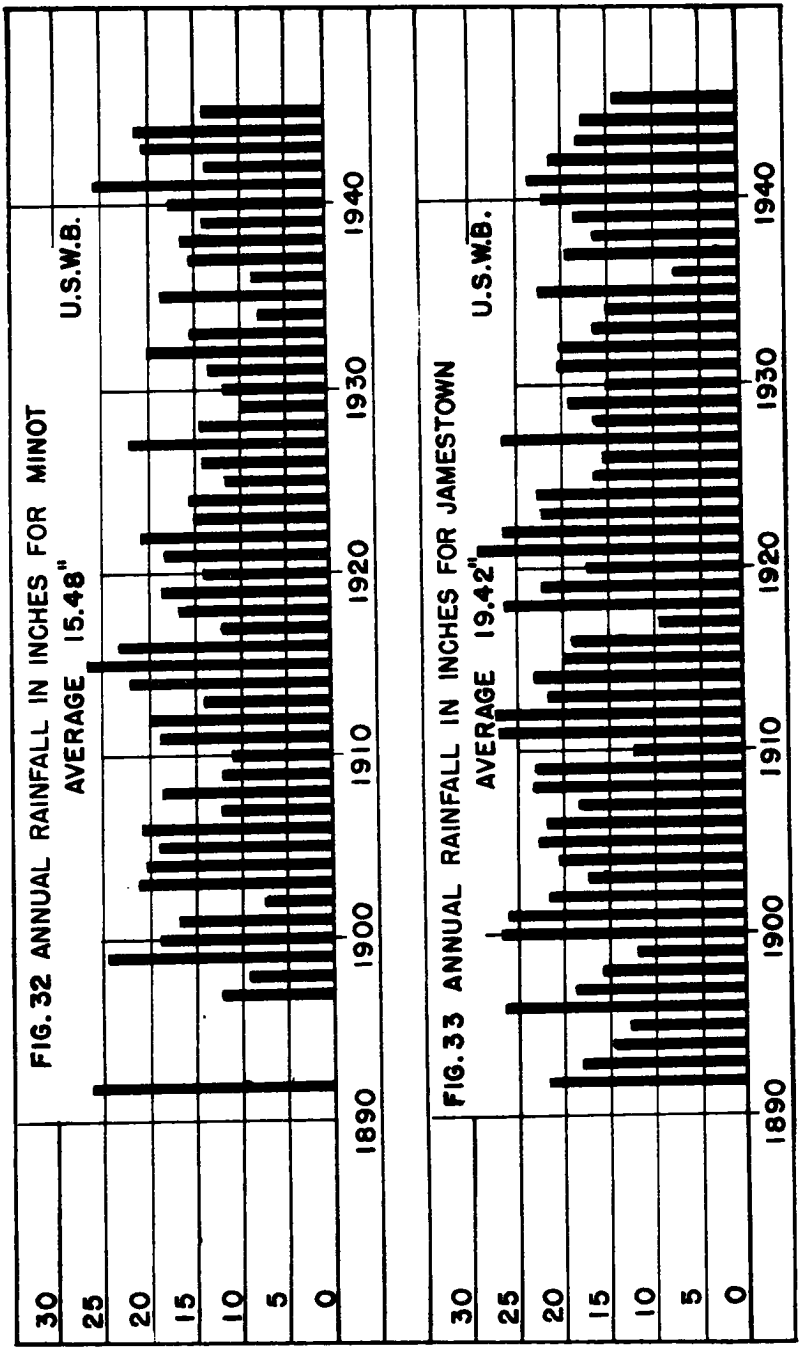


FIG. 32 ANNUAL RAINFALL IN INCHES FOR MINOT
AVERAGE 15.48"
U.S.W.B.
30
25
20
15
10
5
0
1890
1900
1910
1920
1930
1940
FIG. 33 ANNUAL RAINFALL IN INCHES FOR JAMESTOWN
AVERAGE 19.42"
U.S.W.B.
30
25
20
15
10
5
0
1890
1900
1910
1920
1930
1940

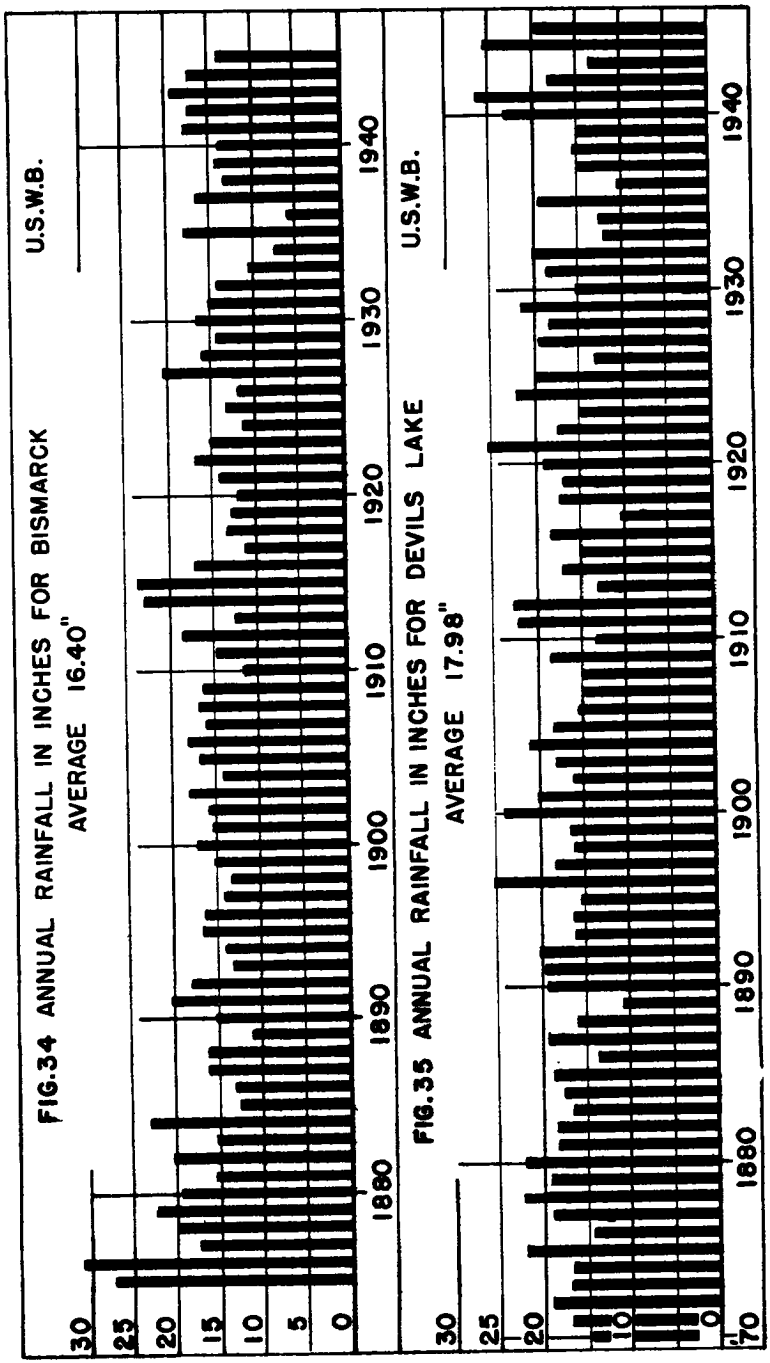


FIG.34 ANNUAL RAINFALL IN INCHES FOR BISMARCK
AVERAGE 16.40"
U.S.W.B.
30
25
20
15
10
5
0
1880
1890
1900
1910
1920
1930
1940
FIG.35 ANNUAL RAINFALL IN INCHES FOR DEVILS LAKE
AVERAGE 17.98"
U.S.W.B.
30
25
20
10
0
70
1880
1890
1900
1910
1920
1930
1940

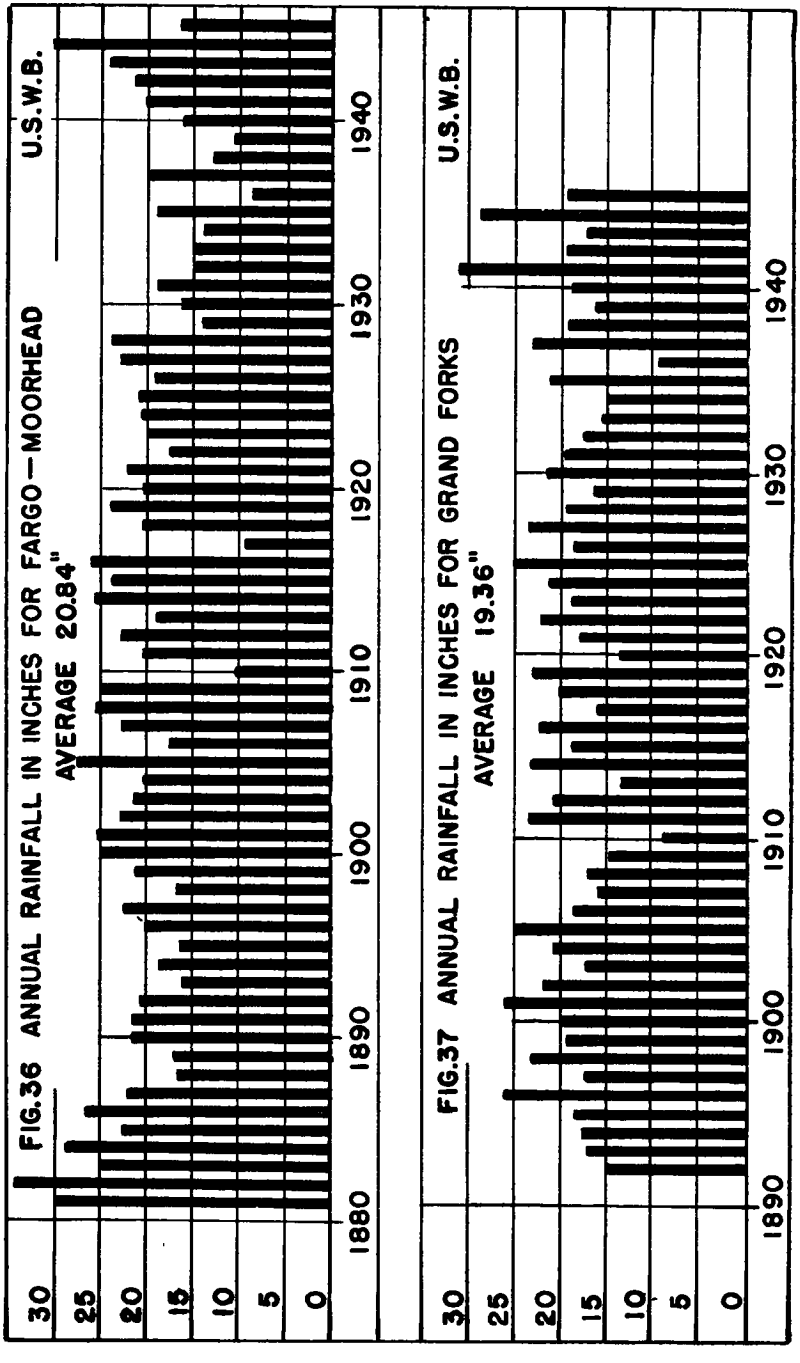


FIG.36 ANNUAL RAINFALL IN INCHES FOR FARGO—MOORHEAD
AVERAGE 20.84"
U.S.W.B.
30
25
20
15
10
5
0
1880
1890
1900
1910
1920
1930
1940
FIG.37 ANNUAL RAINFALL IN INCHES FOR GRAND FORKS
AVERAGE 19.36"
U.S.W.B.
30
25
20
15
10
5
0
1890
1900
1910
1920
1930
1940

Tree Ring Records Used in Dating Climate and Weather in the Northern Plains

By Geo. F. Will, Bismarck, N. D.

Climate and Weather statistics in this area date back only about seventy five years, but Geo. F. Will of Bismarck has evolved a reasonably accurate tree ring chart of the seasons and weather for a period of three hundred and seventy three years.

This chart depicted by the rings showing growth of trees confirms the records of the weather bureau that the periods of dry seasons slightly exceed the periods of wet seasons, indicating the absolute need of irrigation to establish a reliable agriculture and furnish necessary feed for livestock during periods of dry seasons.

The tree ring chart shows one wet period of thirty-nine years, one of twenty years, one of nineteen years and one of eighteen years. The longest dry period is sixteen years, but there are seven dry periods of thirteen to sixteen years. Some dry or wet periods lasted only one to four years.

Dean H. L. Walster Comments:

"Mr. Will's contribution to the history of North Dakota climate establishes the fact that its recent variability has occurred many times in past centuries. It further establishes that relatively wet and relatively dry periods have not occurred according to any cyclic or rhythmic pattern.

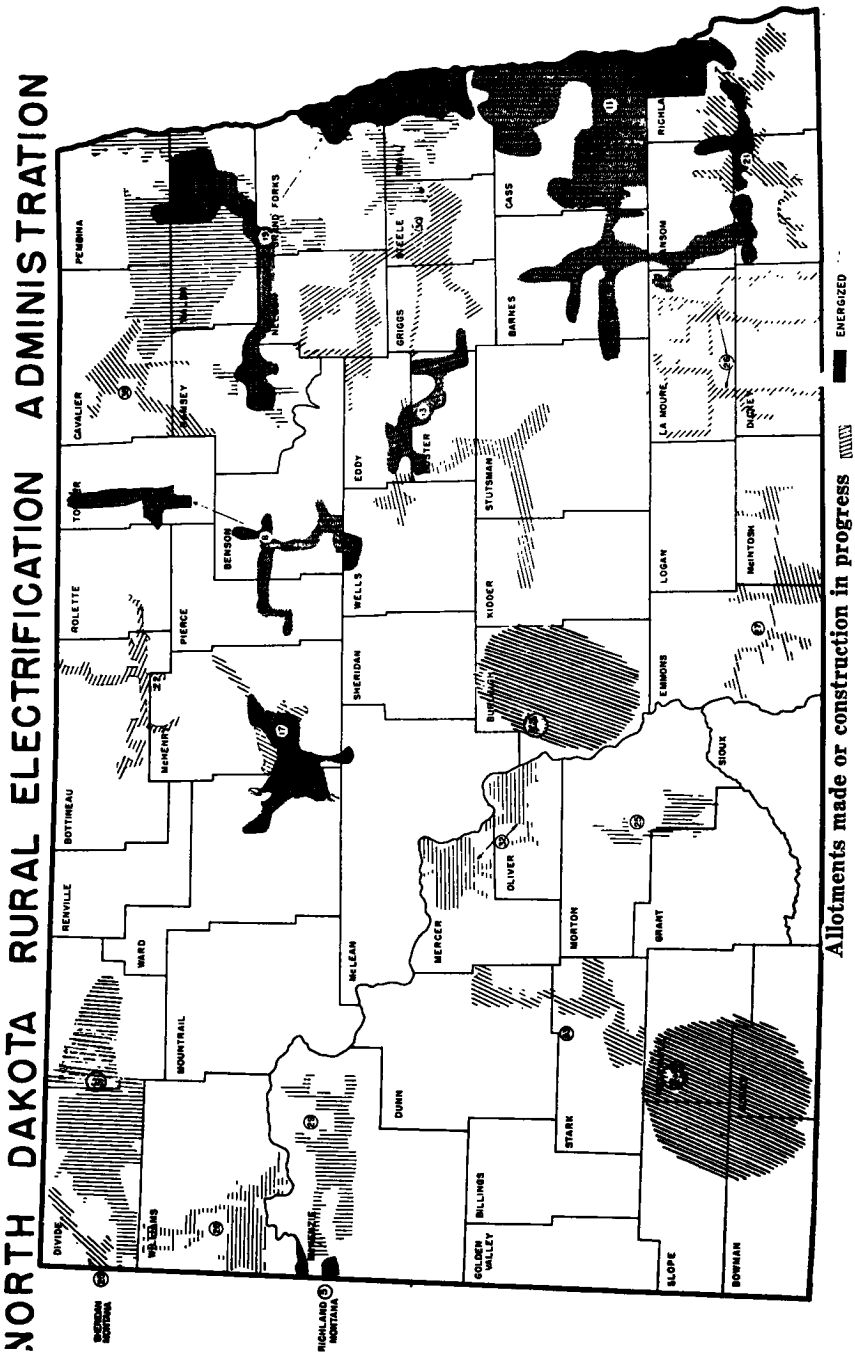
"Whether or not irrigation systems can be so designed and operated so as to permit periods of disuse is open to question; the alternative would appear to be finding of ways and means for the most economic supplemental use of water so that the irrigation works could be used to advantage practically every year. When the proper principles are fully recognized and followed, irrigation will find its proper place in both the 'wet' and the 'dry' years which lie ahead."

(See graph and story at end of this report, on pages 125 and 126.)

STATE GAME AND FISH DEPARTMENT

There should be more water in North Dakota for the sun to sparkle on and more recreational areas developed and maintained where the residents might enjoy leisure hours in fishing, hunting and relaxation.

The State Water Conservation Commission has cooperated with the Game and Fish Department in its program of dam repair. Reconstruction work has been authorized only for dams which are found to meet specifications necessary to provide suitable fish life, resting grounds for migratory waterfowl and proper habitat for muskrats. Birds are attracted by the greater number and variety of insect and small animal life as well as by increased plant growth.


NORTH DAKOTA RURAL ELECTRIFICATION ADMINISTRATION
DIVIDE
WILLIAMS
MOUNTRAIL
WARD
RENVILLE
BOTTINEAU
ROLETTE
TOWNER
CAVALIER
PEMBINA
MCHENRY
PIERCE
BENSON
NELSON
RAMSEY
WALSH
GRAND FORKS
EDDY
WELLS
SHERIDAN
FOSTER
GRIGGS
STEELE
CASS
BARNES
STUTSMAN
KIDDER
BURLEIGH
MERCER
OLIVER
MCLEAN
DUNN
MORTON
STARK
BILLINGS
GOLDEN VALLEY
SLOPE
BOWMAN
GRANT
SIOUX
EMMONS
LOGAN
LA MOURE
RICHLAND
DICKEY
MCINTOSH
SUBLETTE WYOMING
RICHLAND MONTANA
Allotments made or construction in progress
ENERGIZED

The importance of improvement of wildlife habitat has only recently been recognized in practical game management. For the past two years muskrats have been the most valuable fur bearer in North Dakota. During the 1945-1946 trapping season over $1,400,000 was realized by the trappers; 324,000 muskrats brought $688,595 and mink brought almost $332,000. In the beginning, game management stressed protection from poachers and predators where a new species was introduced or artifically propagated. It was believed that these activities brought the best returns and also were visible to the public at all times. Legislation or regulation continues to play an important part in managing game and fish surpluses, but artificial restocking and predator control are now considered of less importance and function only when synchronized with habitat improvement.

It is for this reason that emphasis is being placed on improving the shoreline of reconstructed dams so that we may insure wildlife productivity. As a first requisite, cattle should not be given free run of the area. This results in fouled water and a miry, overgrazed shoreline which decreases the value of the pond, even for livestock. Conditions can be best preserved if stock is kept away from the greater part of the shoreline.

The Soil Conservation Service through its program has encouraged the farmers to plant trees and vegetation along the shoreline and has given assistance in fish planting. Farmer cooperation has resulted in improved recreational areas as well, for the sharing of the actual work has given the local community pride in the project.

The recreational advantages of a well stocked pond, kept partly in its natural condition, with supplemental plantings for wildlife cover and parks, are an asset to the health and welfare of the community. Sanitation and orderliness are essential. Skating, hockey and ice-boating in winter, with fishing, swimming and picnicking in summer, bring pleasure and enjoyment for all. And the careful planning and developing of those ponds suitable for fish stocking brings back dividends to the Game and Fish Department through increased sales of fishing licenses.

The State Game and Fish Department and the Water Conservation Commission have cooperated very closely to bring added wildlife values to impounded waters. The possibilities of greater fur production in this period of high prices should not be overlooked by anyone interested in improving the wildlife value of a pond or lake.

RURAL ELECTRIFICATION IN NORTH DAKOTA

Plans are progessing rapidly for widespread electrification of farms in North Dakota so as to be ready to take advantage of the Fort Peck and Garrison dam hydroelectric power as soon as available. On the basis of contracts already in operation from power generated at the Fort Peck dam, the cost of the hydro-electric energy will be less than half that of present costs, and this saving must be passed on to the consumer under

government contracts. The result will be that North Dakota and the area served from Garrison dam will be one of the low-cost areas of the United States for electricity. It is believed that the coming generation will see most farms in North Dakota and surrounding areas served from Garrison equipped with all the modern electric devices.

Present electric distributing corporations are supplying electricity to approximately 3,000 farms in North Dakota, according to estimates, and will be able to reduce rates when their lines are energized from the Garrison dam. Rates have already been reduced to the consumer in western North Dakota where power from Fort Peck dam is being supplied from Glendive, Montana, connection. Further reductions will be made when power from the Garrison dam is available to the whole state, and further rural lines established.

The big growth of rural electrification in North Dakota is the result of the government organized and financed Rural Electrification Administration of the U. S. Department of Agriculture, commonly called the REA. Washington, D. C. officials have kindly supplied the details of the following report of progress made:

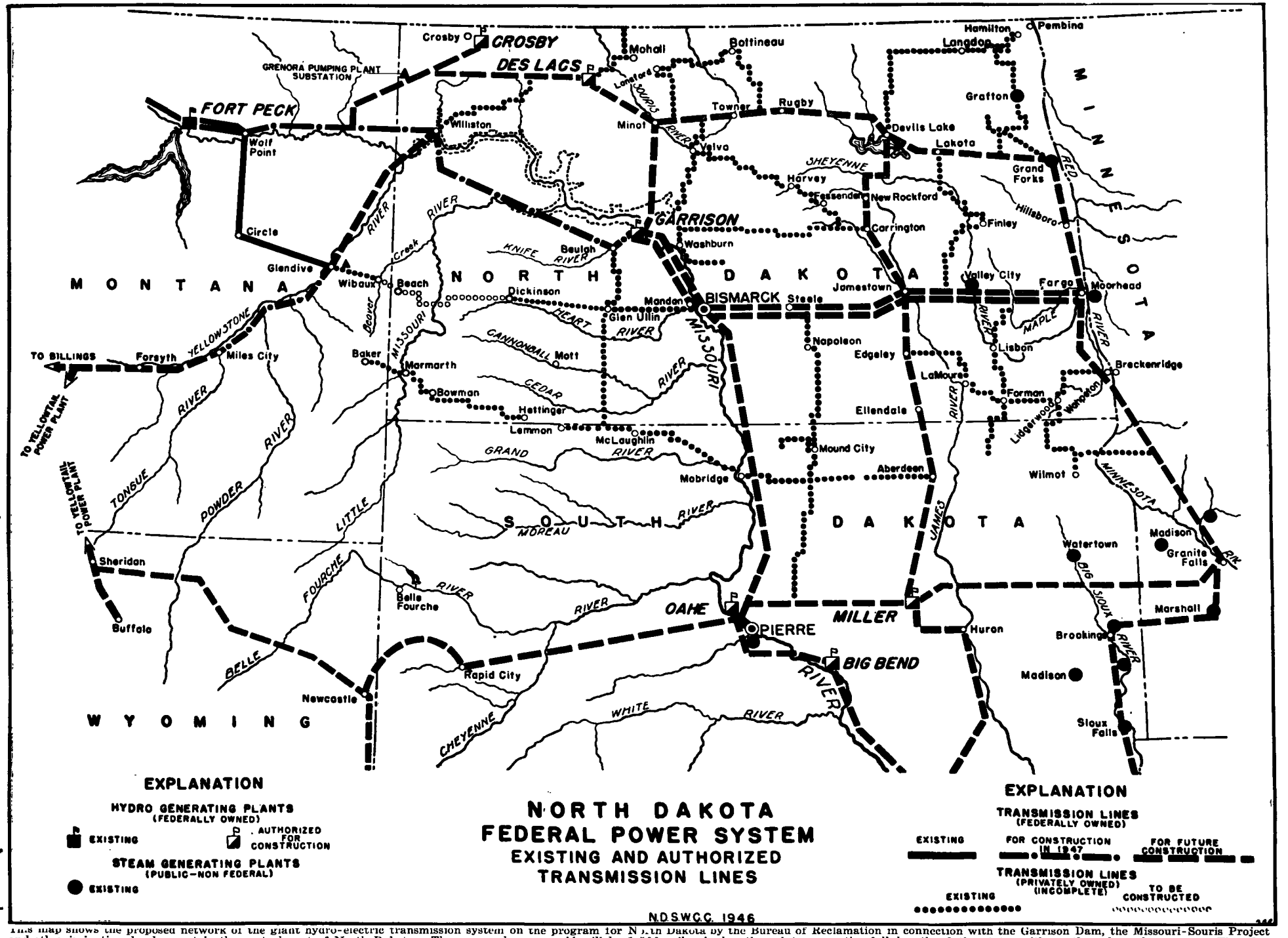
When the Rural Electrification Administration of the Federal Government was established in 1935, only 2,000 North Dakota farms, or a little more than 2 per cent, had central station electric service. Today, according to REA's latest official estimates, about 7,350 North Dakota farms, or 10.4 per cent of all farms in the State, have been electrified. Of this total, more than 60 per cent are on rural power lines financed by REA loans.

REA has made loans in North Dakota to 22 locally-controlled, member-owned rural electric cooperatives, which operate on a non-profit basis. Eight of these have energized their lines, while the other 14 have new rural electric systems under construction. The eight borrowers with energized systems operate 3,706 miles of lines serving 7,739 farms and other rural consumers. REA-financed lines now extend into 24 of the State's 53 counties.

The first allocation of REA loan funds for rural electrification in North Dakota was made in December 1936 and the first REA-financed rural electric line in the State went into operation in November 1937. As of July 31, 1946 REA had allocated $17,054,972 as loans to its North Dakota borrowers. Of this amount, nearly $12,000,000 is still available for further rural electrification, which has not yet been built because of scarcity of materials.

Up to June 30, 1946, REA had advanced a total of $5,924,777 on its loans to its North Dakota borrowers. The borrowers were operating their systems so successfully that they had paid $857,193 of principal and interest on their loans, including $115,665 paid on principal in advance of due dates.

Federal Hydro-Electric Power Line System Proposed for North Dakota



This map shows the proposed network of the giant hydro-electric transmission system on the program for North Dakota by the Bureau of Reclamation in connection with the Garrison Dam, the Missouri-Souris Project and other irrigation development in the central part of North Dakota. The proposed power grid will be 1,700 miles in length and traverse the full length of the state, with north and south systems. The plan as outlined to the State Water Conservation Commission, calls for a double grid loop from the Garrison dam south to Bismarck and east along the N. P. railroad to Fargo. Shorter lines will be built for connection with existing power transmission lines and particularly to join lines developed through the coop rative system. According to the contract proposed by the Bureau of Reclamation, all saving in cost must be passed on to the consumer.

Basic to the REA program in North Dakota and other states is the area coverage plan. Under this plan, service is made available to all consumers in a given area. Sparsely-populated sections are served along with those having a greater population. This makes is possible to build well-balanced rural electric systems which can operate economically and give ample service to all consumers at the lowest possible cost.

With more than 62,000 North Dakota farms remaining unelectrified, the area coverage plan in the State is one of the most ambitious in the nation, and the State's current electrification program is extremely vigorous. During the 1946 fiscal year, the North Dakota co-ops made a start on their postwar program by adding 900 new consumers to their lines. They also received REA approval of loans totalling $11,843,000, which will be used to construct 8,000 miles of new lines serving 12,200 new consumers. In the first four months of the 1947 fiscal year, six North Dakota cooperatives have received REA approval of almost $2,000,000 in loans to finance further new consumer connections.

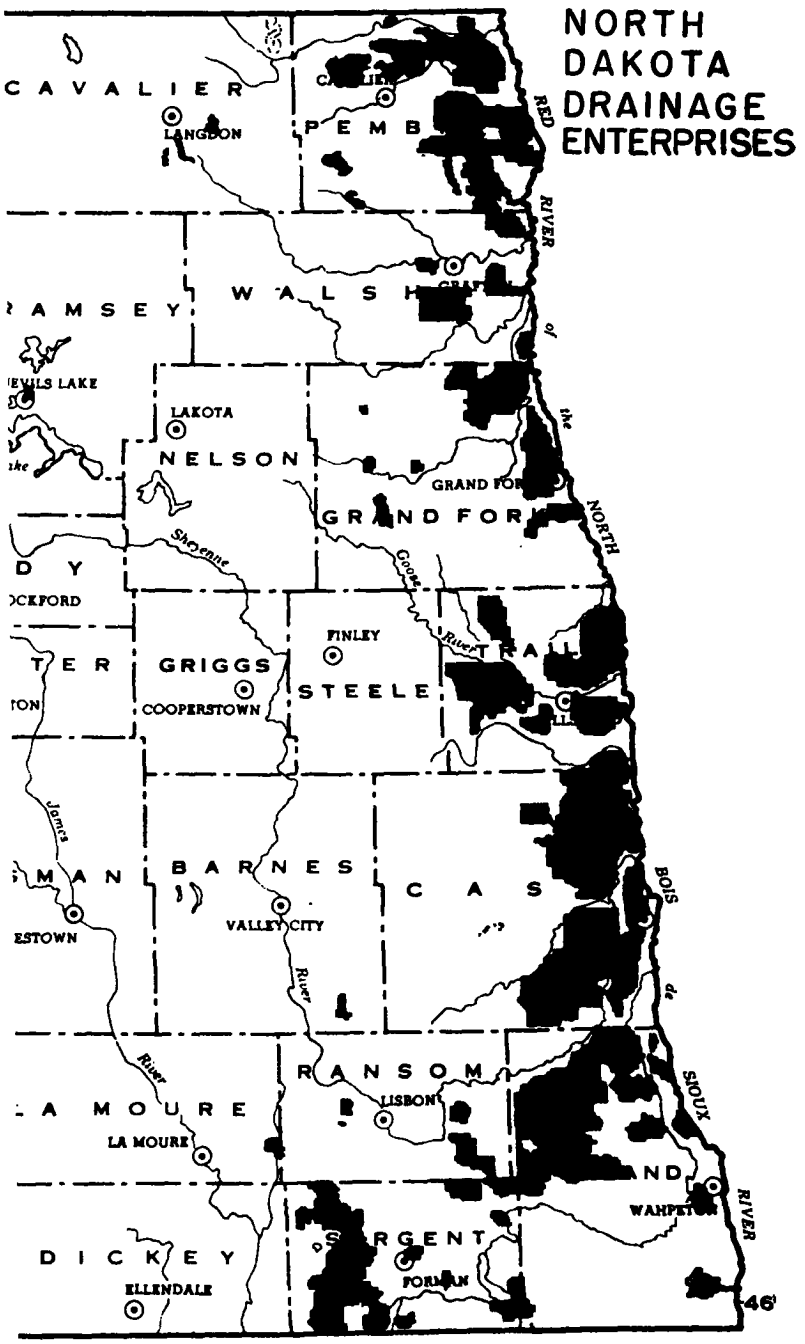
REA-Financed Systems in North Dakota

* Baker Electric Cooperative, Incorporated, Cando, N. D. (8)
* Cass County Electric Cooperative, Inc., Kindred, N. D. (11)
* Tri-County Electric Cooperative, Inc., Carrington, N. D. (13)
* Verendrye Electric Cooperative, Inc., Velva, N. D. (17)
* Nodak Rural Electric Cooperative, Inc., Grand Forks, N. D. (19)
* Minnkota Power Cooperative, Inc., Grand Forks, N. D. (20)
* R. S. R. Electric Cooperative, Inc., Milnor, N. D. (21)
* North Central Electric Cooperative, Inc., Bottineau, N. D. (22)
** Mor-Gran-Sou Electric Cooperative, Inc., Flasher, N. D. (25)
** James Valley Electric Cooperative, Inc., Edgeley, N. D. (26)
** Kem Electric Cooperative, Inc., Linton, N. D. (27)
** Williams Electric Cooperative, Inc., Williston, N. D. (28)
** McKenzie Electric Cooperative, Inc., Watford City, N. D. (29)
** Sheyenne Valley Electric Cooperative, Inc., Finley, N. D. (30)
** Mountrail Electric Cooperative, Inc., Stanley, N. D. (36)
** McLean Electric Cooperative, Inc., Garrison, N. D. (37)
** Cavalier Rural Electric Cooperative, Langdon, N. D. (38)
** Oliver-Mercer Elec. Cooperative, Inc., Hazen, N. D. (32)
** West Plains Electric Cooperative, Inc., Dickinson, N. D. (33)

(1946 Organizations)

** Slope Electric Cooperative, Inc., New England, N. D. (34)
** Capitol Electric Cooperative, Inc., Bismarck, N. D. (35)
** Burke-Divide Electric Cooperative, Inc., Bowbells, N. D. (31)

* Energized.
** Loans allocated but systems not energized.


NORTH
DAKOTA
DRAINAGE
ENTERPRISES
CAVALIER
LANGDON
PEMB
RED
RIVER
of
the
NORTH
RAMSEY
WALSH
DEVILS LAKE
LAKOTA
NELSON
GRAND FORKS
Sheyenne
Goose
River
DY
ROCKFORD
FINLEY
GRIGGS
COOPERSTOWN
STEELE
TRAIL
James
BARNES
VALLEY CITY
River
CASS
BOIS
de
SIOUX
RIVER
RANSOM
LISBON
LA MOURE
LA MOURE
River
WAHPETON
DICKEY
ELLENDALE
SARGENT
FORMAN
46

U. S. FISH AND WILDLIFE SERVICE

The National Wildlife Refuges that provide water and marsh areas for the nesting and breeding grounds for waterfowl as well as resting areas for the birds while in migration have had exceptionally good water conditions during the past two years.

Lake Darling the principal storage reservoir has a capacity of 112,000 acre feet and covers an area of 11,000 acres along the Souris (Mouse) River above Minot, North Dakota.

Operation of this reservoir is under the direction of the U. S. Fish and Wildlife Service. It serves to maintain stable water levels on over 20,000 acres of marshes on the river below the main storage dam. The Service cooperates with the State Water Conservation Commission in regulating the amount of water to be released for flood control, irrigation, storage and the release of water to Canada under orders of the International Joint Commission.

Other large wildlife refuges under the control of the U. S. Fish and Wildlife Service include the following:

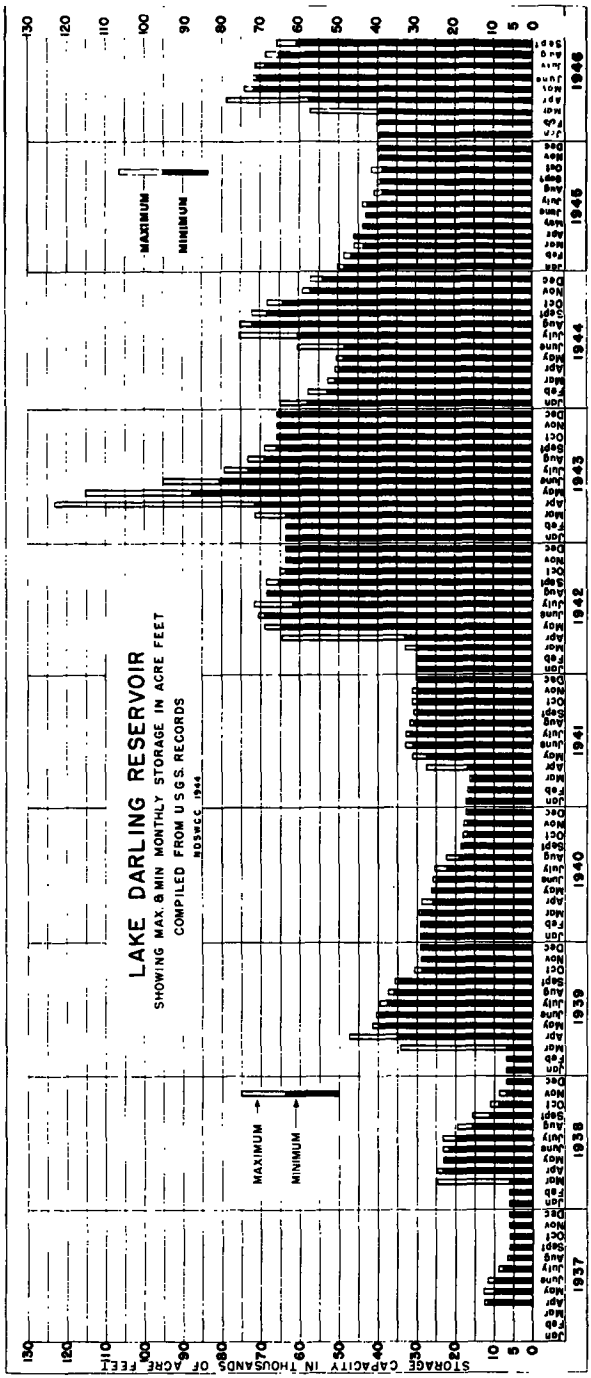
Name of Refuge	Drainage System	Marsh Area (Acres)	Storage Capacity (acre feet)
Below Lake Darling	Souris (Mouse) River	2,300	From Lake Darling
Lower Souris Refuge	Souris (Mouse) River	17,900	From Lake Darling
Des Lacs	Des Lacs River	6,855	65,000
Arrowood	James River	3,289	15,890
Lake Ardock	Forest River	1,150	2,875
Dakota Lake	James River	1,600	3,200
Chase Lake	Stutsman County	2,536	
Lac Aux Mortes (Lake Alice)	Ramsey County	3,067	
Lake Tewaukan	Sargent County	1,512	
Lake Zahl	Williams County	1,300	
Long Lake	Emmons County	13,700	
Rock Lake	Towner County	948	
Willow Lake	Rolette County	1,200	
Lake Ilo	Dunn County	1,240	

There are 60 additional areas containing nearly 100,000 acres of land developed for wildlife refuges that provide water and marsh areas for the waterfowl breeding grounds and resting areas for the birds while in migration.

STATE GEOLOGIST

Ground Water Studies

The underground water table fluctuates from year to year and from season to season, and is of interest to many individuals, communities and industrial concerns. Studies for years past have been made by the State Geologist cooperating with the U. S. Geological Survey and about one hundred and sixty wells are now being measured. Fifteen wells are measured by water-stage recorders and about sixty wells are measured weekly by local recorders, city water officials, etc., while other wells are measured each spring and fall.


LAKE DARLING RESERVOIR
SHOWING MAX. & MIN MONTHLY STORAGE IN ACRE FEET
COMPILED FROM U.S.G.S. RECORDS
N.D.S.W.C.C. 1944
MAXIMUM
MINIMUM
STORAGE CAPACITY IN THOUSANDS OF ACRE FEET
1937
1938
1939
1940
1941
1942
1943
1944
1945
1946

Most people require only enough water for the farm household and a few head of stock. Wells of this nature can be found almost everywhere throughout North Dakota. However, the need for water by municipalities and industrial concerns is necessarily large. Defining the location and size of large aquifers is often a difficult problem, especially when buried deep in the glacial drift. These often unseen aquifers are located by geological means and outlined by test drilling. The most promising areas are selected for more detailed drilling to determine the extent and exact location of the aquifers. Test pumping then determines the characteristics of the water and the amount which can safely be withdrawn from the formation.

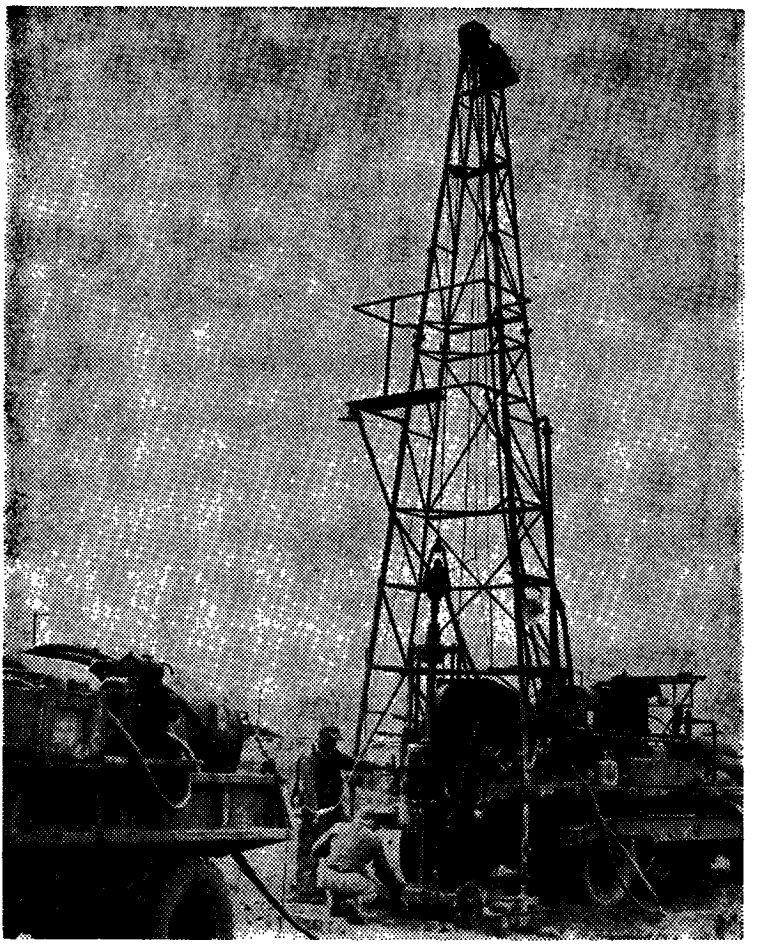
As this is written, well testing is being done in Wells and Benson counties, because there was a large number of cities needing help on securing adequate water supplies in that area. Forty-seven towns in the State have asked for assistance in securing adequate water supplies in the past two years. It has been impossible to give all the help needed. Investigations have been concentrated where there was the greatest need and where the service would aid the largest number of people. As funds are limited, each of the cities interested has advanced some money to help pay a small amount of the costs of the drilling in their immediate vicinty. In the case of the city of Fessenden, geologic work and test drilling covered an area of more than one hundred square miles.

During the biennium, assistance has been given the following cities and surrounding areas:

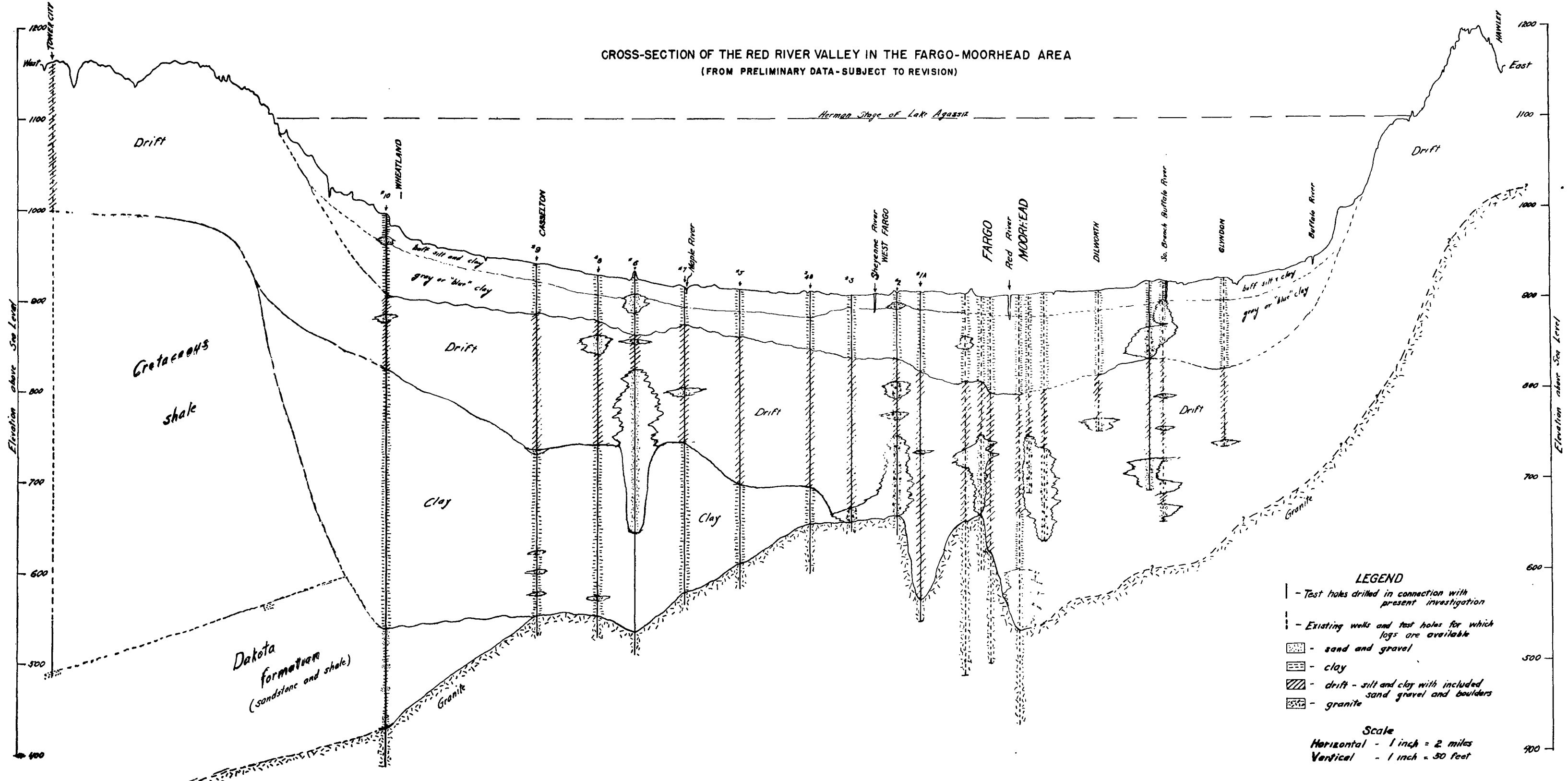
Aneta	Hope	Minot	Wimbledon
Beulah	Kindred	Mountain	Zeeland
Buxton	Maddock	Portland	
Fargo	Michigan	Sharon	
Fessenden	Minnewaukan	Wilton	

This is only about one-third of the areas requesting aid in locating an adequate and suitable water supply. Other areas will be assisted as rapidly as possible.

The city of Minot has made a cooperative investigation of possible water sources with the aid of the U. S. Geological Survey working through the office of the State Geologist. Fargo and Cass County and the State Water Conservation Commission each contributed $2500, which was matched by $7500 from U. S. Geological Survey funds to make a thorough survey by extensive test drilling in the Fargo area, the preliminary results of which are shown on the preliminary cross section plat accompanying this report. This is part of a larger study which encompasses the Moorhead area and is supported by contributions from the City of Moorhead, Clay County and the State of Minnesota, matched by funds of the U. S. Geological Survey. Several gravel lenses have been located in a cross section which was drilled west of Fargo by the state-owned drilling machine. Three wells encountered aquifers which may have possibilities



Hydraulic Rotary Drill used in making test holes on ground-water surveys in North Dakota. The drill is mounted on a trailer to make it portable. The truck with tank pulls the trailer and hauls water for drilling operations. This outfit was purchased by the State Water Conservation Commission for underground surveys, cooperating with the U. S. Geological Survey.


CROSS-SECTION OF THE RED RIVER VALLEY IN THE FARGO-MOORHEAD AREA
(FROM PRELIMINARY DATA-SUBJECT TO REVISION)
Herman Stage of Lake Agassiz
West
East
TOWER CITY
WHEATLAND
CASSELTON
Maple River
Sheyenne River
WEST FARGO
FARGO
Red River
MOORHEAD
DILWORTH
So. Branch Buffalo River
GLYNDON
Buffalo River
HAWLEY
Elevation above Sea Level
1200
1100
1000
900
800
700
600
500
400
Drift
Cretaceous shale
Dakota formation (sandstone and shale)
Clay
Granite
buff silt and clay
gray or "blue" clay
LEGEND
- Test holes drilled in connection with present investigation
- Existing wells and test holes for which logs are available
- sand and gravel
- clay
- drift - silt and clay with included sand gravel and boulders
- granite
Scale
Horizontal - 1 inch = 2 miles
Vertical - 1 inch = 50 feet

for municipal supplies, while other aquifers located would yield satisfactory farm supplies.

It has been found almost impossible to get private drilling contractors to do this test drilling because of their contracts for drilling for individuals, industries and municipalities. The State Water Conservation Commission purchased a Failing rotary drill in September, 1945, which has drilled 6,254 feet of hole on sixty-six test wells up to August 1, 1946, at a cost averaging about $1.28 per foot. A good, conscientious jetting-drill operator on the Moorhead side of the project was secured for drilling tests, on which the cost per foot of hole was $1.56, and the samples secured were not as satisfactory for a study of the formations as from the state-owned rotary drill. However, it is our policy to hire private well drillers wherever they can be secured, in order to speed up the test drilling work over the State. Usually, the money advanced by the cities for their part of the cost of the testing is used to help pay local drillers, supervised in their work by one of our geologists. It would be a tremendous help in our underground water program if the logs and other information on water wells were filed with the State Geologist, as the law requires, thus making this information available to the public.

A continued study of artesian wells in North Dakota is highly recommended. Pressures should be obtained and methods studied as to how best to conserve this valuable natural resource, now being wasted in many localities. Continued work on municipal studies and regional studies should also be emphasized.

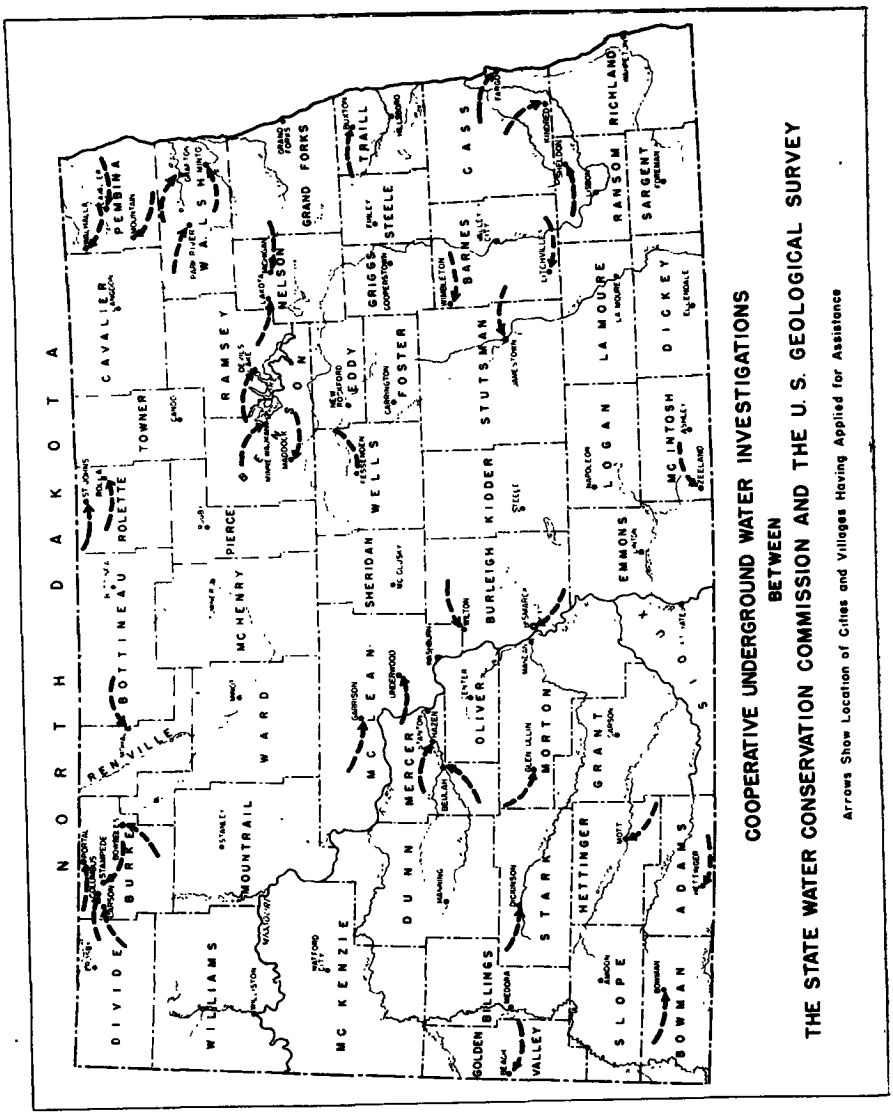
The underground water studies are under the direction of Wilson M. Laird, Ph. D., State Geologist. P. E. Dennis, M. A. Geologist in charge with eleven assistants and drillers are the U. S. Geological Survey crew doing the survey work.

STATE HEALTH DEPARTMENT

The State Department of Health, through the Division of Sanitary Engineering, cooperates closely with the Water Conservation Commission and the State Engineer on problems of mutual concern. Thirty plans and specifications for water and/or sewerage installations, or extensions thereto, have been examined by the Health Department. These plans require the joint approval of the Water Conservation Commission and the State Health Department before construction can be initiated.

The Sanitary Engineering Division has been represented at Army hearings on diversion of flood control projects. This representation has provided information on stream pollution, and on the water requirements of certain municipalities for water supply, and for sewage dilution purposes.

The Interstate Sanitation Committee, organized in May, 1944, and comprised of Health and Conservation Department officials from Minnesota, North and South Dakota, has continued to function during the



COOPERATIVE UNDERGROUND WATER INVESTIGATIONS
BETWEEN
THE STATE WATER CONSERVATION COMMISSION AND THE U. S. GEOLOGICAL SURVEY

Arrows Show Location of Cities and Villages Having Applied for Assistance

biennium. This committee established certain policies specifying the degree of waste treatment required of municipalities or industries which dispose of their effluents in the waters of the Red River Basin. A policy of joint reviewal of plans and specifications of proposed waste treatment plants, industrial or municipal, has been established.

In response to requests initiated by interested parties along the Mouse River, and directed by the State Water Conservation Commission, investigations of stream polution problems of that watershed will be performed. This project will be conducted by the State Health Department, with the Water Commission supplying information on past and future stream flows and uses. Preliminary work on the studies are under way at present.

BANK OF NORTH DAKOTA

This state-owned bank acts as Trustee for all the issues of bonds of the State Water Conservation Commission, to aid in securing funds for the construction and development of irrigation, and thus to aid landowners in producing larger yields and increasing their income.

The best of cooperation has been given by the officials of the Bank on all the transactions it has handled for the Water Commission. It is carrying the $63,000 unpaid balance on outstanding bonds, but has collected more than $40,000, to be used in payment of bonds or interest as payments become due, and has collateral bonds to cover the balance.

GREATER NORTH DAKOTA ASSOCIATION

One of the greatest forces working for the betterment of all of the people of North Dakota, is the Greater North Dakota Association. Its officials have always been ready to give this Commission any assistance requested for the betterment of the state as a whole. It recognizes that income from stock must be the foundation of agriculture and that the western two-thirds of the state must have irrigation to raise feed for that stock on drouth years, or suffer great losses and the steady income necessary to pay running expenses.

THE FARMERS UNION

The officers of this organization had cooperated in the distribution of information to its leaders and members regarding diversion of the Missouri and development of irrigation districts. They recognize the necessity of farmers having ample feed every year to sustain their livestock, and that irrigation is necessary to secure feed in drouth years, also that it will greatly increase the yields every year. The aim is to have ample feed within easy trucking distance of every farmer in the state. Members of the Farmers Union, through its president Glenn J. Talbott, have given outstanding service in promoting the development of the state's natural resources.

Irrigated alfalfa on the Clayton Worst farm in McKenzie County, North Dakota, yielded five tons to the acre.

TRI-STATE WATERS COMMISSION

This Commission was created by a compact between North Dakota, South Dakota and Minnesota. It supervises activities in the drainage basin of the Red River of the North in the coordination of state and federal agencies and in the development of the basin water resources, relief from floods, improvement of existing facilities for storage of water, stabilization and control of lake levels, dependable low-water stream flow, improvement of low water channels, land drainage, reduction of stream pollution, installation of water works and improvement of existing water treatment plants and distribution systems, construction of processing plants and factories dependent on adequate water supplies.

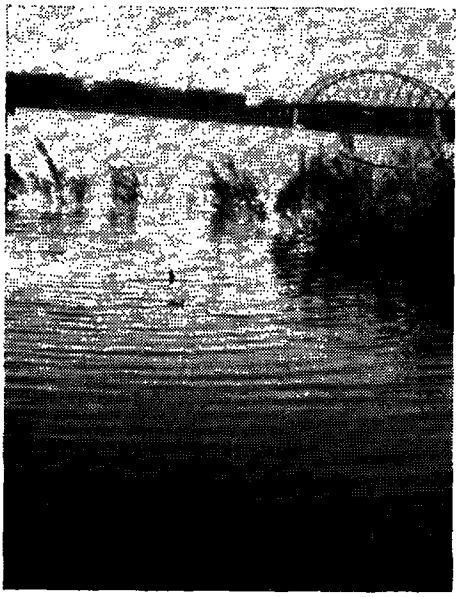
The personnel of the Commission as of Nov. 1, 1946, consists of H. L. Walster, Chairman, Governor Fred G. Aandahl, and H. G. Homme, with J. J. Walsh as Asst. Secy; all from North Dakota; F. F. Moore, Carsten Mead and Chester S. Wilson, with Robert L. Bard as Executive Secretary, all from Minnesota; G. T. Mickelson, Elmer Peterson and D. W. Loucks, from South Dakota; and Don L. Nichols of North Dakota as Consulting Engineer.

Eleven projects have been recommended for consideration: Lake Traverse, Boise de Sioux; Sheyenne river Bald Hill Dam; Red Lake River and tributaries; Pembina-Tongue River and tributaries; Park River, Red River; Little Minnesota Diversion; Forest River, Goose River; Rosau River and Missouri River diversion into this area.

The Lake Traverse-Boise de Sioux project has been in operation since its completion in 1941. The principal purpose is flood control and water conservation, and the protection of agricultural lands from flooding. The results during the high run-off years since this project has been in operation have demonstrated the value of flood control works.

The Sheyenne river Baldhill Dam proposed will be a large regulating reservoir upstream from Valley City which would provide a regulated flow of water in the Sheyenne river, aid in flood control of the Sheyenne and Red Rivers and provide needed water for municipalities on these rivers as well as aid in sewage disposal. It has been approved by Congress and an appropriation of $300,000 made to start construction under the supervision of the Army Engineers Corps. But under the Presidential moratorium order on all public works, further progress except preliminary studies has been suspended. This reservoir would have a maximum elevation above sea level of 1266 feet.

The Army Engineers have made detailed field surveys for the channel improvement and land improvement and it is expected plans and specifications will be completed soon for the flood control and regulated flow of Red Lake and Clearwater Rivers. Work has been suspended for the Presidential moratorium on public works.



Missouri river at Bismarck, highway bridge in background.

The Red River of the North Basin is being studied by the Corps of Engineers on an overall water utilization and flood control plan. Tentative consideration is being given to a reservoir for flood control and water use on the Otter Tail River. It is suggested that such a reservoir operated with the Baldhill reservoir and one on Red Lake would go far toward meeting the estimated needs for water supply and sewage dilution, under conditions similar to that of the 30's. It is thought the final report will be submitted about February, 1947.

A preliminary report on the Forest River and Goose River projects was unfavorable, but request has been made for a re-study of the possibilities for further water development along these streams.

On the Park River Reservoir project, report was submitted by the Corps of Engineers in July, 1946. A screened intake control valve would enable the cities of Park River and Grafton to make future water connections. These two cities with the State Water Conservation Commission have submitted assurances of local cooperation. Work on plans and specifications was suspended by the Presidential moratorium on public works.

KFYR RADIO STATION

Very wonderful cooperation has been freely given by KFYR radio station to the distribution of information over the air pertaining to the

Missouri river diversion and construction of irrigation. These programs have done much to give the citizens of North Dakota reliable information regarding these proposed projects and what it would mean to the future development and stability of agriculture and stockraising, as well as for business in general.

WDAY Radio Station of Fargo and KGCU at Mandan with the Mutual system of other stations in North Dakota have also cooperated liberally on broadcasting some of these discussions.

LITTLE MISSOURI RIVER COMPACT

Congress approved the forming of a compact for the states of Wyoming, Montana and North Dakota regarding an equitable distribution of the waters of the Little Missouri River, and streams tributary thereto. It was estimated that there are 24,000 acres of irrigable lands along the Little Missouri River in North Dakota, to which the equitable distribution of the river waters is important. Surveys and estimates are in process of completion by the Bureau of Reclamation engineers. The compact has been approved by North Dakota and Montana legislatures but is pending in Wyoming.

YELLOWSTONE RIVER COMPACT

Congress also gave consent to the making of a compact by the states of Wyoming, Montana and North Dakota regarding the use of the waters of the Yellowstone river and streams tributary thereto. A large amount of data on land and water use in the Yellowstone River Basin were compiled, and a compact was prepared to be presented to the legislatures of the three states. The 1945 North Dakota legislative session passed an Act to ratify and approve the Compact between the states of Montana, North Dakota and Wyoming, which Act was approved by the Governor on March 17, 1945.

The Montana legislature and Governor approved the compact.

The Wyoming legislature also approved the Compact, but the Governor vetoed it, so final approval is still pending.

MISSOURI RIVER STATES COMMITTEE

A compact has been proposed for the Missouri River Basin states to include Wyoming, Montana, North Dakota, South Dakota, Nebraska, Colorado, Iowa, Kansas and Missouri, covering the distribution and use of the waters of the Missouri River. Conferences resulted in the forming of the Missouri River States Committee composed of Dale L. Maffitt of Des Moines and Rudolph Olson of Sioux City to represent Iowa; George S. Knapp of Topeka and Paul D. Haney of Lawrence to represent Kansas; Lachlan MacLea of St. Louis and William Anderson of Jefferson City to

Heart River farmers inspect potatoes—Lower Yellowstone Irrigation District

represent Missouri; D. P. Fabrick of Choteau and O. S. Warden of Great Falls to represent Montana; W. H. Brokaw of Lincoln and Wardner G. Scott of Lincoln to represent Nebraska; Halvor L. Halvorson of Minot and Lewis T. Orlady of Jamestown to represent North Dakota, and L. C. Bishop of Cheyenne and L. F. Thornton of Thermopolis to represent Wyoming. Several meetings have been held and recommendations made regarding the development of the waters of the Missouri River and its tributaries on plans submitted by the U. S. Army Engineers and the Bureau of Reclamation. It endorsed the resolution of Congress giving irrigation priority over navigation in the use of the surplus waters of the Missouri River, and is active in influencing the development of plans for river development and irrigation.

AGRICULTURAL COLLEGE

Dean H. L. Walster of the North Dakota Agricultural College secured a leave of absence and cooperated with the engineers of the Bureau of Reclamation on the preparation of their report to Congress, and he later made trips to Washington, D. C., for consultation by the Congressional committees as to the agricultural and economic phases of the proposed Missouri River diversion and utilization of surplus waters for irrigation and domestic uses. He is an enthusiastic supporter of the consolidated plan and believes it will do much to stabilize agriculture and stockraising in the Missouri Basin.

BISMARCK IRRIGATION PROJECT

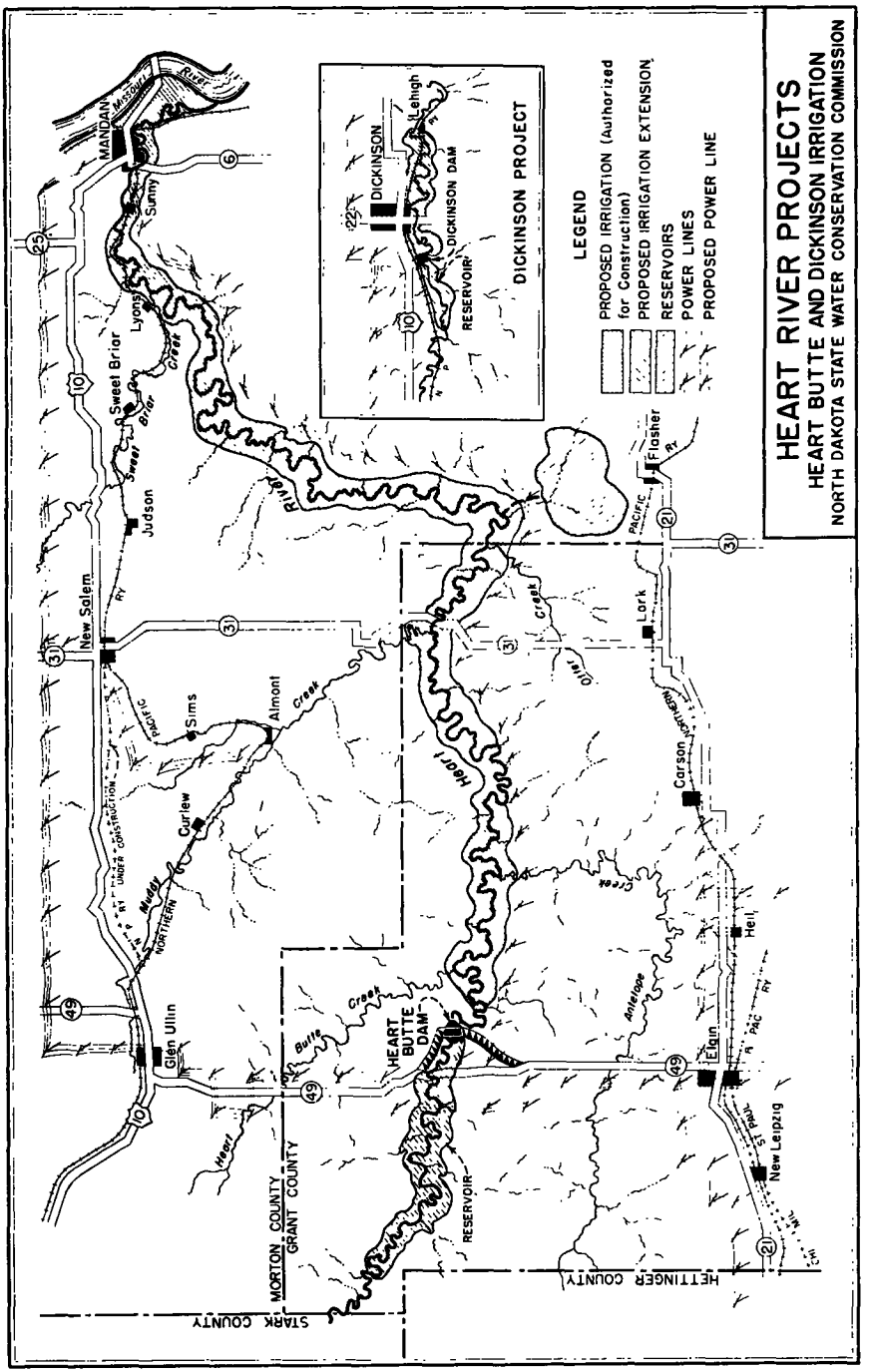
The original Bismarck Irrigation Project, by pumping from the Missouri river, contained an estimated 5,000 acres of land south of Bismarck and on the east bank of the Missouri river.

In 1943-44 topographic surveys were completed by the Water Commission engineers covering 15,876 acres in this area and eastward to Apple Creek and north to State Highway No. 10.

The Bureau of Reclamation engineers made soil and other surveys of the area and have the project on the list as one of the proposed Missouri river pumping areas to be developed. It is estimated that possibly 10,000 acres in the area are suitable for irrigation. Water Commission engineers have done this survey work at a cost of $12,533.98 paid from the appropriation for "Other investigations, surveys."

HEART RIVER IRRIGATION PROJECT

This project is divided into two areas proposed for development. The larger area extends from the proposed Heart Butte dam located about south of Glen Ullin, N. D., on the Heart River, to the Missouri river. The engineers of the Water Commission surveyed approximately 36,000 acres in 1944 and 1945 at a cost of $22,162.87 paid from its separate appropriation for "Other Investigations, surveys" and established 126


HEART RIVER PROJECTS
HEART BUTTE AND DICKINSON IRRIGATION
NORTH DAKOTA STATE WATER CONSERVATION COMMISSION
LEGEND
PROPOSED IRRIGATION (Authorized for Construction)
PROPOSED IRRIGATION EXTENSION
RESERVOIRS
POWER LINES
PROPOSED POWER LINE
DICKINSON PROJECT
DICKINSON
DICKINSON DAM
RESERVOIR
Lehigh
MANDAN
Missouri River
Sunny
Lyons
Sweet Brier
Sweet Brier Creek
Judson
New Salem
Sims
Almont
Curlew
Glen Ullin
Heart River
Heart Creek
Bulls Creek
HEART BUTTE DAM
RESERVOIR
Flasher
Lark
Carson
Hell
Elgin
New Leipzig
Antelope Creek
Oliver Creek
Northern Pacific Ry
Chicago Milw St Paul & Pac Ry
Under Construction
MORTON COUNTY
GRANT COUNTY
STARK COUNTY
HETTINGER COUNTY

cement-set permanent triangulation stations. The report of the Bureau of Reclamation engineers, earlier in these pages, states that this enabled it to place this project as No. 1 for construction on the plan for irrigation development in North Dakota.

The smaller area on the Heart river on which irrigation construction is planned is in the Dickinson, N. D., area, and includes a dam and reservoir near that city which is to be utilized partly for city water supply and partly to irrigate several small pumping projects below the city, aggregating about 720 acres. This was also surveyed by the Water Commission engineers and the cost included in the amount stated above, and its construction is on the No. 1 list.

The Presidential order suspending a part of government construction work for economic reasons has delayed contracting, but it is noted that there have been allocated funds to the Heart river construction totalling $640,000 for 1947. The total cost of construction of the two projects on the Heart river is estimated as $4,283,000.

CURLEW VALLEY EXTENSION

When the potential water storage was computed with the requirements for the irrigable acres, it was found that the reservoir capacity was ample for a considerable increased acreage for irrigation. Surveys indicate the possibility of installing a pumping plant in the big bend of the Heart river to carry water over the low divide into the Curlew valley and irrigate possibly 3,000 additional acres.

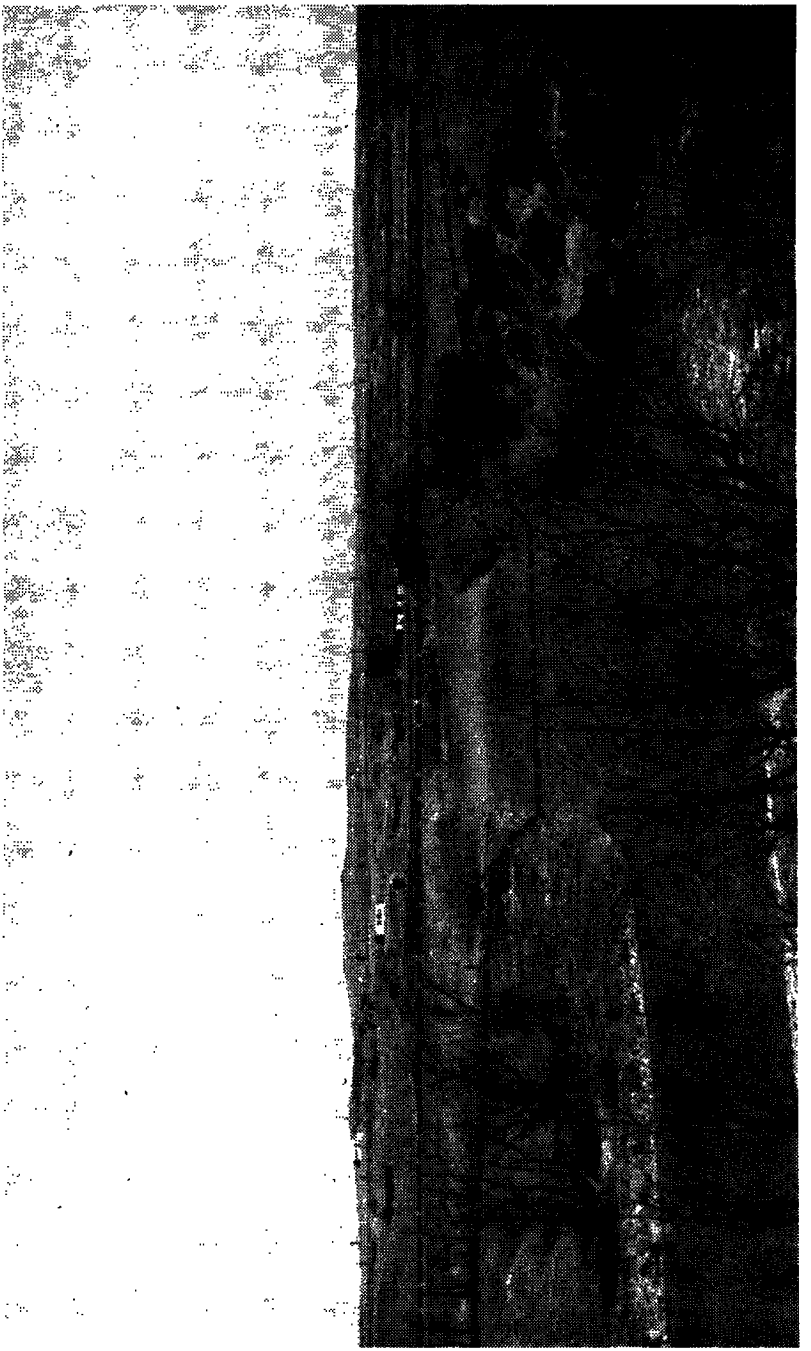
KNIFE RIVER IRRIGATION

Surveys, plans and specifications have been completed for irrigation of 15,380 acres of land in the valley of the Knife river, from the Broncho dam and reservoir located above the town of Beulah. This project is estimated to cost $4,321,000 and $43,000 of the government appropriation for 1947 has been allocated by the Bureau of Reclamation for preconstruction work.

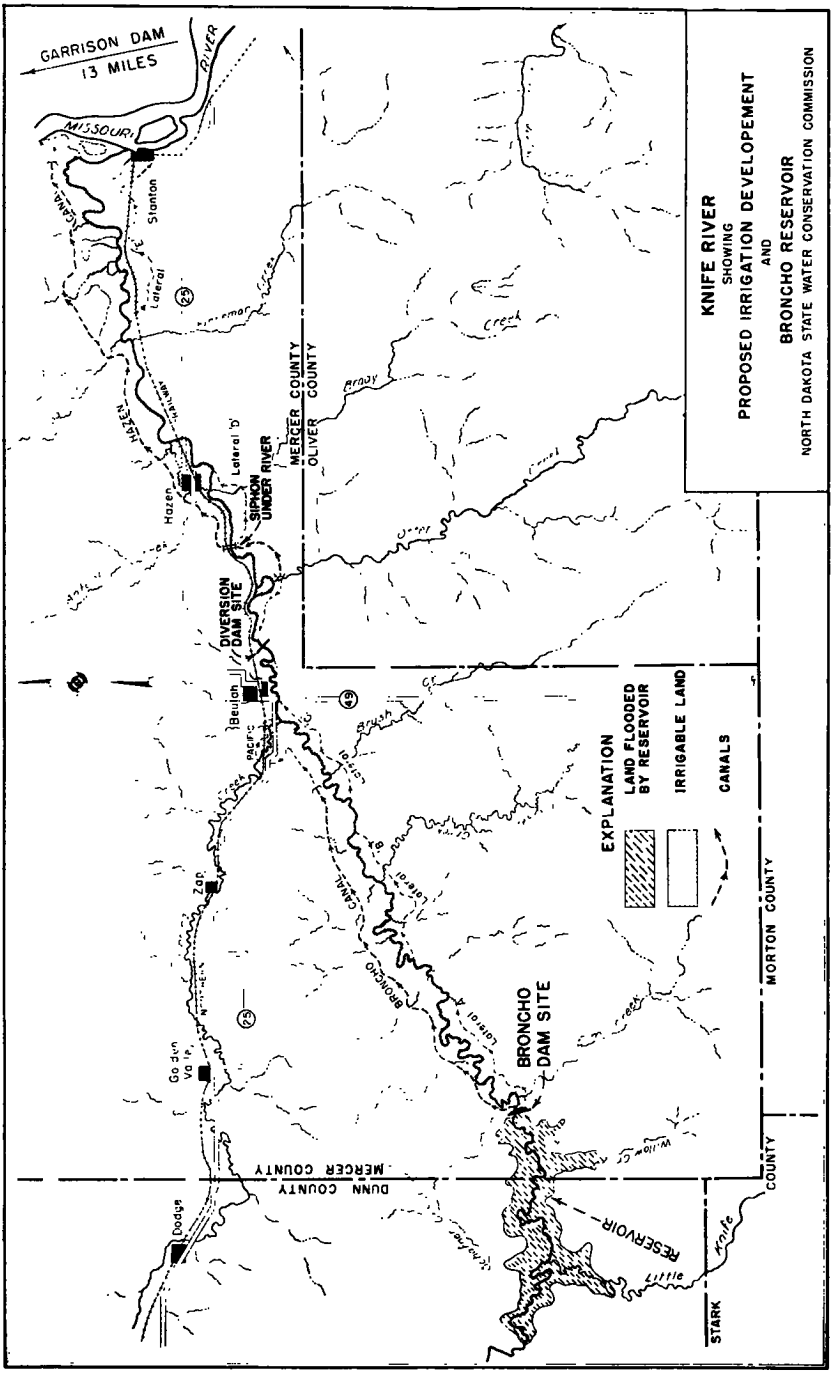
CANNONBALL RIVER IRRIGATION

Surveys of the Cannonball river valleys on its two branches, including the south branch commonly called the Cedar river, are nearly completed for irrigation of 22,068 acres. Water for the south branch irrigation will come from the Thunderhawk reservoir, located about north of the town of that name. Water for the north branch irrigation will come from the Elgin reservoir, located near that town. The Water Commission engineers have done much of this work to aid in the preparation for actual construction at the earliest possible date.

The engineers have surveyed approximately 38,800 acres from the junction of the two branches of this river to the Missouri river head-



Site of the dam and reservoir on the Heart river near Dickinson, North Dakota


KNIFE RIVER
SHOWING
PROPOSED IRRIGATION DEVELOPEMENT
AND
BRONCHO RESERVOIR
NORTH DAKOTA STATE WATER CONSERVATION COMMISSION
EXPLANATION
LAND FLOODED BY RESERVOIR
IRRIGABLE LAND
CANALS
GARRISON DAM
13 MILES
MISSOURI
RIVER
Stanton
Lateral
Hazen
Lateral "D"
SIPHON UNDER RIVER
DIVERSION DAM SITE
MERCER COUNTY
OLIVER COUNTY
Beulah
Zap
Gladstone
Dodge
BRONCHO DAM SITE
RESERVOIR
MORTON COUNTY
STARK COUNTY
DUNN COUNTY
MERCER COUNTY
Knife
Little
Heart
Creek
Brady
Willow Cr
Lone Oak
Cr
Brush
Cr
Cr
Creek
Creek
Creek

Feeding lambs for market is a big industry on the Lower Yellowstone Irr. District in western N. D. and eastern Montana.

waters of the Oahe reservoir; 44,000 acres on the south branch of Cedar river valley, to the site of the proposed dam and reservoir, about north of Thunderhawk, South Dakota, and about 14,000 acres on the north branch valley, from the junction of the two branches to the reservoir site, and have surveys which it is estimated can be completed about the end of 1946. 180 triangulation survey stations have been established. The expense has been paid from the appropriation for "Other Investigations, surveys" fund, amounting to $41,606.71 on Sept. 30, 1946. These surveys should greatly speed up construction of irrigation works in the Cannonball river valley and its two branches, in an area where feed is much needed on drouth years.

MISSOURI RIVER PUMPING DISTRICTS

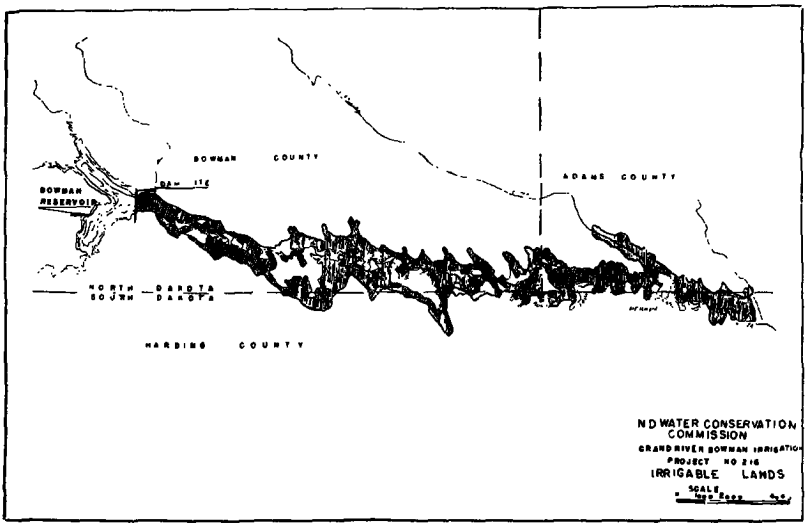
As a part of the Missouri river valley development below the Garrison Dam in North Dakota, it is planned to irrigate 47,000 acres in different areas along the river at an estimated total cost of $3,464,840 of which $171,000 has been allocated for work in 1947 from Congressional appropriations for the Bureau of Reclamation engineers. Proposed irrigation districts include Hancock Flats, 5,030 acres; Fort Clark, 2,750 acres; Oliver-Sanger, 6,880 acres; Manley, 2,160 acres; Wogansport, 2,400 acres; Painted Woods, 2,300 acres; Square Butte, 2,750 acres; Burnt Creek, 1,940 acres; Bismarck, 9,000 or more acres; Little Heart, 2,930 acres; Horsehead Flats, 9,000 acres; and Winona, 5,100 acres.

THE BIG MISSOURI-SOURIS PROJECT

The greatest activity for 1947 will be on the million acre Missouri-Souris irrigation project in Northwestern North Dakota, in the Crosby-Minot-Mohall area, which is estimated to cost $133,795,000 and on which $950,000 has been allocated for 1947 work from the Congressional appropriation to the Bureau of Reclamation. This includes the Sheyenne river dam and reservoir, near New Rockford, N. D., which is treated in greater detail on another page of this report.

BOWMAN-HALEY FLOOD AND IRRIGATION

This proposed project on the Grand River in Bowman and Adams counties in North Dakota and extending into South Dakota is for the purpose of flood control as well as irrigation. People along this river reported disastrous floods which resulted in the loss of human life, hundreds of heads of livestock, including cattle and sheep, and extensive damage to private property aggregating many thousands of dollars. Surveys made indicate that there are approximately 5,000 acres of irrigable lands in this area. The consolidated plan of the Army Engineers and the Bureau of Reclamation recommends some irrigation on the Grand River approximately south of Lemmon, South Dakota, but still has the Bowman-Haley project under consideration. It will be necessary to com-



plete a compact between North and South Dakota as to the use of the waters of the Grand River.

LELAND FLOOD IRRIGATION

Approximately 900 acres were surveyed for flood irrigation on the Leland ranch in western McKenzie County, North Dakota, including site for an earth fill dam. This project is to be used partly for flood irrigation of alfalfa and partly for flooding natural hay meadows, of which the land owners are to contribute twenty five per cent of the cost of engineering. Other flood irrigation projects in this county which have been in operation several years have demonstrated that flood irrigation on alfalfa and meadows for cutting hay has been very successful.

MISSOURI BASIN INTER-AGENCY COMMITTEE

The Missouri Basin Inter-Agency Committee was formed to provide a means for the Federal agencies participating in the Missouri Valley program to coordinate their activities among themselves and with the States in planning and executing works for the control and use of the waters of the Missouri River Basin.

Membership in the Committee consists of one representative from each of the four Federal Agencies, and four governors who represent the ten Missouri Valley states. It holds meetings monthly and has rotated its place of meeting to states within the Basin where progress has raised questions for consideration. By this arrangement, any single state, or group of states, will always be represented when its interests are affected. The results have been highly satisfactory and it has been a big

influence in bringing about unified action on the part of the different agencies cooperating in this immense project.

The members of the Committee are Brigadier-General Lewis A. Pick, Corps of Engineers, chairman; W. G. Sloan of the Bureau of Reclamation, Department of the Interior; A. E. McClymonds of the Department of Agriculture, Soil Conservation Service; B. H. Greene of the Federal Power Commission; Hon. Phil M. Donnelly, Governor of Missouri; Hon. Dwight Griswold, Governor of Nebraska; Hon. Sam C. Ford, Governor of Montana, and Hon. Lester C. Hunt, Governor of Wyoming.

APPROPRIATIONS EXPLAINED

As a preliminary to the explanation of appropriations made and to confirm the judgment of the legislators that it was a good investment for the State of North Dakota, attention is called to the fact that there has been expended to June 30, 1946, from congressional appropriations the sum of $376,300 and that a further allocation has been made of appropriations for 1947 of $1,804,000 making a total of $2,180,300. Also, that Congress has authorized irrigation works in North Dakota on which it is estimated the total cost will be $145,665,000. This is in addition to the $161,000,000 which it is estimated the Garrison Dam construction will cost. The cooperation of the state legislature with the citizens of North Dakota is opening up a future for the state even larger than the vision of its farseeing citizens.

Commissioner Per Diem

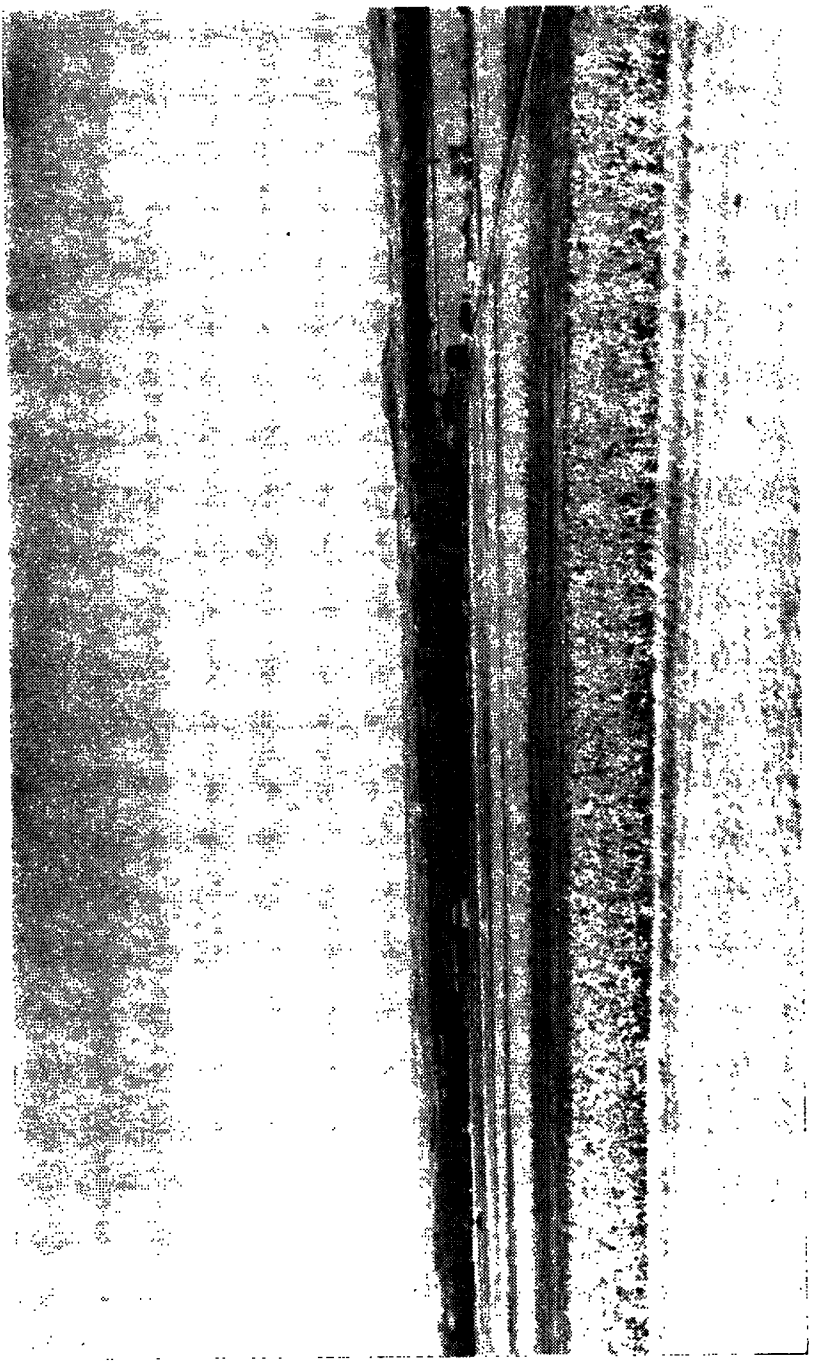
This appropriation is for payment of compensation and expenses of the members of the State Water Conservation Commission for actual days of service at the rate of $7.00 per day and actual travel expenses. This is less than the actual earning of any member of the Commission and has been used partly to pay actual expenses of the members which are not covered by state regulations but which are a necessary expense when away from home. This additional expense while traveling has been considerably increased during the war period. The result is that each member of the Commission shows his spirit of public service in serving as a member at considerable financial loss to himself.

Administration

This is a continuing appropriation to cover the part of Commission expenses which the word implies, and which are not covered by other specific appropriations. It covers largely the clerical work and supervision, with necessary stationery, postage, supplies, etc., required in the conduct of the office and supervision of the work. Amounts collected on refunds and collections help to serve as a revolving fund by being deposited with the State Treasurer to this fund.

Tri-State Waters—Red River Basin

As the basin of the Red River of the North includes the drainage of portions of Minnesota and South Dakota as well as North Dakota, the



Wogansport Unit of Missouri River Pumping Projects, located about 14 miles north of Bismarck, N. D.

regulation of the waters of this stream with its tributaries are a tri-state cooperative enterprise conducted by a Commission under authority of the legislatures of the three states. Necessary expenditures are on a cooperative basis between these states. The appropriation made by the North Dakota legislature is to cover its part of necessary expenses of supervision of the control of waters in the Red River basin.

International and Interstate Stream Compacts—Commissioner and Conference Expenses

The preliminary arrangements for a gigantic over-all Missouri River Basin flood control irrigation, navigation and electric generation plan of development has required many conferences arranging compacts or agreements as between states included in the watershed of the Missouri River and its tributaries. This has entailed a considerable expense for transportation and daily living of members of the Commission and its representatives while attending these conferences and appearing before Congressional committees for hearings on the different proposals.

This is necessary in order to protect the interest of the state and to avoid future expensive litigation as between states having an interest in the waters of these streams. The returns for the future from these efforts promise to refund this expenditure many, many fold. These conferences must be continued until the fullest possible benefits for the state have been secured.

Topographic and Conservation Branches in Cooperation with U. S. on 50-50 basis.

The surveying and preparation of topographic maps has been completed over a large portion of the United States by the U. S. Geological Survey engineers. The State Water Conservation Commission entered into an agreement with the Geological Survey to continue topographic mapping in the areas where irrigation works are contemplated along the headwaters of the Sheyenne and James Rivers, with water diverted from the Missouri River either from the proposed Garrison Dam reservoir or by the proposed Missouri-Souris River canal route. Under this agreement, the expense of these topographic surveys is shared on a fifty-fifty basis by the government and the State of North Dakota. The importance of having these surveys completed in advance of starting actual irrigation construction cannot be over-emphasized, because of the saving in expense on planning and the increased speed of construction which will result.

Hydrographic Surveys

The necessity of having dependable data on the flow of streams on which to base plans for water power, irrigation and flood control works emphasizes the importance of stream-gaging information over as long a period of time as possible.

The records of minimum and maximum flow of water in a stream indicate to the engineer the size of proposed reservoirs and how many

acres of land might be irrigated from the water available. Long-time records are important to show the fluctuations of the stream-flow of different seasons and different years. Much of the controversy on the Missouri River diversion is due to a lack of sufficient records over a period of years to definitely show the volume of water for different seasons and different years. With the prospect of utilizing surplus waters of the streams of North Dakota for irrigation, the importance of stream-flow records is increasingly evident, and the opportunity for securing these records with half the cost being paid by the U. S. Geological Survey is fortunate for the State.

The State Engineer

This official is the Executive Secretary of the State Water Conservation Commission and the directing head and supervisor of the use of the waters of the state. He arranges for cooperative Topographic and Hydrographic surveys with the U. S. Geological Survey; for cooperative plans and surveys by the U. S. Bureau of Reclamation and the U. S. Army Engineers; approves designs, plans and specifications for the construction of dams and irrigation works; he is Chief Engineer of the State Water Conservation Commission in irrigation development, cooperating with state, county and federal agencies; and is a member of the Mouse River Souris Valley Authority that controls and regulates the distribution of the Mouse River waters within the state.

Maintenance and Construction Drains

A government agricultural statistician made a survey of the crop losses from flooded lands in the Red River valley in North Dakota in 1943 and estimated the total loss to be $10,852,000.00 in six counties. A very heavy flood damage had been experienced in 1944, now estimated at $13,565,000. and in years previous to 1943. This brought home to the people of the State the necessity for the repair and cleanout of existing drainage channels and the construction of additional drainage ditches where needed.

The 1943 session of the North Dakota legislature appropriated $50,000, and the 1945 session appropriated $240,000 for aid and promotion of this work. The North Dakota State Water Conservation Commission allocated this money to the counties in proportion to their losses as determined by the government statistician, and entered into an agreement with the U. S. Soil Conservation Service to use their big machinery and supervise the drainage construction work. Rapid progress is being made on the construction and repair of these drainage ditches. The completion of adequate drainage for the Red River valley lands will require several years for construction work and continued cleanouts.

Cooperation with the Bureau of Reclamation and U. S. Army Engineers

Pursuant to the appropriation of the last session of the North Dakota legislature providing $100,000.00 for cooperation with the Bureau of

Reclamation and U. S. Army Engineers on a 50-50 basis, an agreement was made with the Bureau of Reclamation for the cooperative expenditure of $100,000.00 in conformity with the appropriation. Approximately $130,000 balance of the 1943 appropriation has been expended under this agreement as this is written, for surveys, plans and specifications which would place under irrigation approximately one and a quarter million acres of North Dakota lands, and the work was greatly accelerated by the use of the state appropriations.

Other Post-war Projects

There was also appropriated "For investigations, surveys and preparatory work on projects other than those approved by the Bureau of Reclamation, which may be matched either in whole or in part by State or Federal Agencies, $75,000.00." Under this appropriation, the engineers of the North Dakota State Water Conservation Commission have centered their efforts on surveys, plans and specifications for proposed irrigation works not included in the plans of the Bureau of Reclamation, or cooperating with the Bureau, with the idea of having as many work-projects ready for construction as soon as possible to utilize expected Congressional appropriations.

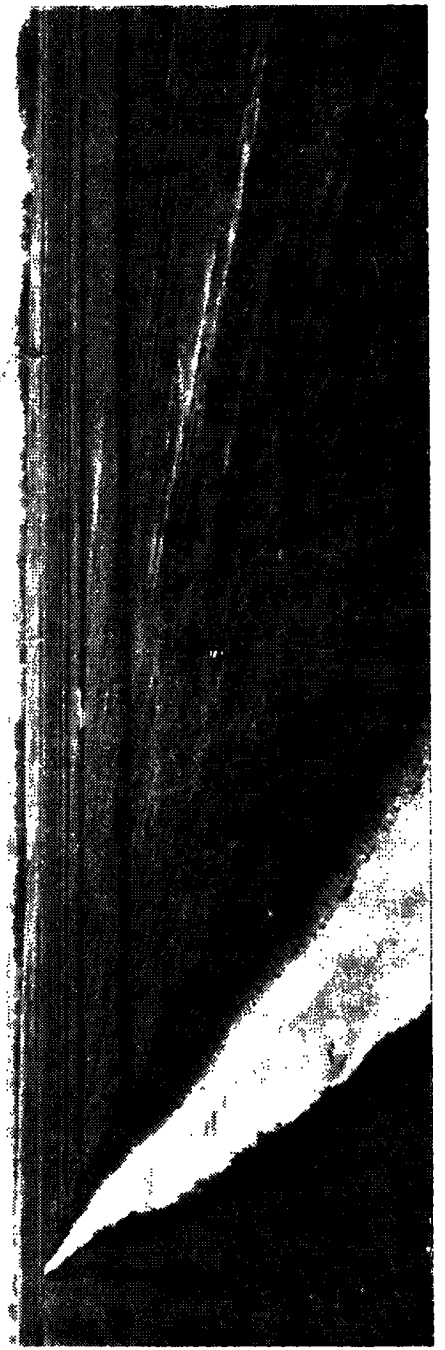
Underground Water Survey Cooperation with State Geologist and the U. S. Geological Survey

The 1945 session of the legislature made a $25,000 appropriation to carry on underground water surveys in cooperation with the State Geologist and the U. S. Geological Survey. Arrangements were completed for the State Geologist to represent the State Water Conservation Commission on a cooperative survey made by the U. S. Geological Survey engineers. Because commercial drillers had more contracts than they could do, the Water Commission purchased a drilling rig mounted on a trailer to make it portable, and a truck with tank to haul same and supply water for drilling. More than fifty communities have made requests for surveys because of diminishing supplies in wells being used. The results have been quite satisfactory and the communities reached have been pleased with the results. But not much over one-fourth of the territory on which requests were made for surveys has been served and it will be necessary to continue the drilling and tests in order to make the survey state-wide.

A much more detailed report is made under the head of State Geologist earlier in these pages. In every case, local interests are paying part of the cost of surveys. Fargo and Cass County each contributed $2,500, and the Water Commission a like amount, which was matched by $7,500 federal funds for a survey of the Fargo and Cass County underground waters.

Construction Bond Guarantee Fund

This is a revolving fund provided by the legislature to enable the State Water Conservation Commission to give additional security to bond



View on Buford-Trenton Irrigation project, west of Williston, N. D.

issues to raise funds for irrigation construction work, and thus make the bond issues more readily marketable and at a lower rate of interest because of the added security. No new bond issues have been made during this biennium. It is expected that there will be further bond issues needed to finance some of the irrigation construction work.

DAM REPAIR
Before and After

The picture at the left, below shows one the most serious washouts which have occurred.

The Hebron Lions Club, the State Game and Fish Department and the State Water Conservation Commission cooperated in the payment of repairs, which were surveyed, designed and work supervised by engineers of the Water Commission.

Hebron Dam Washout

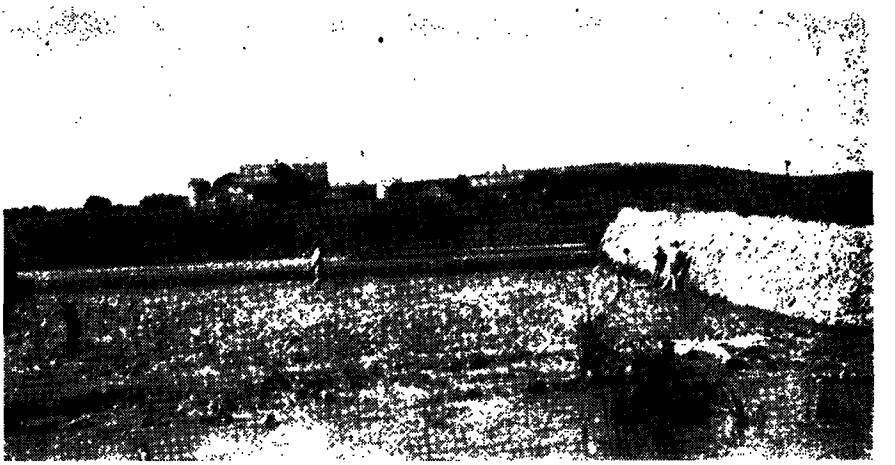
The reservoir created by this dam is the source of water supply for the city of Hebron, besides providing an excellent pool of sufficient depth for the propagation of fish, and is a center of recreation for the area surrounding it. The small boys are enjoying wading in the scene below.

About twelve hundred similar dams and reservoirs located over the state help to make up for a deficiency of lakes and to provide places for community gatherings where the people can relax and find recreation. Many of these are stocked with fish and provide added enjoyment for anglers.

MAINTENANCE OF EXISTING DAMS

During the drouth years of the middle thirties, numerous dams were built by various Federal Agencies to conserve water for farmers, stockmen, municipal use, recreational purposes and for conservation of wildlife. The problem of maintaining these dams in a suitable state of repair has been difficult. The problem of finding sufficient funds for this work has always been difficult and during the recent years the problems of obtaining sufficient materials and labor have been acute. In the pre-war period much of this work was accomplished by the aid of the Works Progress Administration but since this agency has been abolished all assistance must come from state and local interested agencies and organizations.

The law provides that dams constructed by these various Federal Agencies, and having no one responsible for their maintenance and opera-



Hebron Dam after repair

tion, and outside a water conservation district, shall come under the jurisdiction of the Board of County Commissioners of the county in which such dams are located. The Board of County Commissioners is authorized to exercise control and supervision over them and may make such provisions as they deem necessary or desirable for their proper maintenance. The counties are further authorized to finance this work by drawing from their general fund but cannot make a special levy for this purpose.

In many cases the county is the official sponsor of the project providing for repair and maintenance and is assisted by the State Water Conservation Commission, the State Game and Fish Department, and various local organizations. In practically all cases the State Water Commission assists by furnishing the necessary engineering services which include field inspection and survey and the preparation of plans and specifications plus a portion of the construction materials. In order to distribute this appropriation as evenly as possible throughout the state in such a manner as to benefit all localities, the Water Commission has limited its expenditures to a maximum of $500.00 to any one structure. On projects aiding the maintenance of fish and wildlife the State Game and Fish Department assists by contributing financially to the work. Local organizations such as sportsmen's clubs, park boards, city and village boards and other local organizations have contributed substantially to this work in order to maintain these structures which greatly benefit the entire community.

In most cases the repair work necessary is to the spillway structure. This damage is usually caused by water seeping through beneath the spillway and erosion takes place to the point where the spillway collapses and fails. By proper maintenance much of this damage can be averted by

making the necessary repairs before a major failure occurs. The State Water Commission, when notified of these troubles, has an inspection made by an engineer of the department who makes recommendations to the local authorities as to the method of eliminating the trouble and prepares plans and estimates for the necessary reconstruction work.

Following is a list of the projects in which the State Water Commission cooperated during the biennium, paid from state and cooperative funds:

Maintenance Existing Dams 1945-47 to Sept. 30, 1946:

Project No.	Dam	County	Amount Expended
246	Antelope Creek	Mercer	$1,095.60
270	Noonan	Barnes	108.61
271	Meissner	Morton	2,046.42
272	Richland County	Richland	967.57
300	Baldhill Reservoir	Barnes	6.76
316	Lisbon	Ransom	786.46
317	Hebron	Morton	3,358.55
318	Valhalla	Wells	9.35
338	Timber Creek	McKenzie	296.94
341	Center	Oliver	405.13
344	State Line	Dickey	197.50
346	Epping	Williams	1,589.08
348	Westfield	Emmons	9.62
350	Regent	Hettinger	1,004.13
352	Jung	Hettinger	220.41
353	Cedar River	Slope	718.20
354	Jamestown	Stutsman	407.81
355	Loftus	Nelson	21.62
357	Kelly Creek	Foster	44.59
362	Balta	Pierce	57.03
363	Iverson	Benson	402.19
364	Yanktony	McLean	25.62
368	Hesper	Benson	206.29
370	Johnson	Mercer	5.73
372	Oliver Lake	Oliver	6.36
373	Halliday	Dunn	105.99
375	Hurdsfield	Wells	12.05
376	Crystal Lake	Wells	89.48
377	Lehr	McIntosh	49.86
378	School Section	Slope	7.73
380	Williams Creek	Golden Valley	908.68
381	Schlenker	McIntosh	36.65
382	Elgin	Grant	849.87
384	Lake Sheyenne	Sheridan	20.41
386	Monango	Dickey	114.64
388	Coyote Creek	Bowman	558.63
389	Fessenden	Wells	19.45
390	Beaver Lake	Logan	740.31
391	Silver Lake	Sargent	780.86
392	Talkington	Billings	23.35
393	Memorial Park	LaMoure	319.35
394	Odland	Golden Valley	955.52
395	Weisser	Emmons-McIntosh	46.35
396	Filipi	Hettinger	16.07
	Total		$19,652.82

WATER RIGHT FILINGS
Applied for since November 1 ,1944
(Addition to list compiled on that date)

No.	Name of Applicant	Lands to be Irrigated	Source of Supply	Amount of Water Claimed in Second Feet	No. of Acres	Date of Claim
250	U. S. Bureau of Reclamation	Heart River Irrigation District and Dickinson Unit	Heart River	460	14,338	March 13, 1946
251	American Crystal Sugar Company	Moorhead, Minn	Red River of the North	7.75		March 25, 1946
252	V. L. Gilbreath	NE¼ NE¼ Sec. 1-133-93; SW¼, SE¼ Sec. 31-134-92; N½ NE¼ NW¼, N½ NW¼ NW¼, N½ NE¼ NE¼, N½ NW¼ NE¼, Sec. 6-133-92	Cannonball River	2.0	80	April 11, 1946
253	J. B. Satterthwaite	NE¼ Sec. 6-153-92	Springs tributary to Little Knife River	1	73.5	June 10, 1946
254	Otter Tail Power Co.	Devils Lake, N. D.	Sweetwater Lake	100,000 gal. per day		June 22, 1946
255	William Hadden & William Schule	SE¼ Sec. 31-154-92	Spring (Gibb Spring) tributary to Little Knife River	1	39	July 10, 1946
256	Otter Tail Power Co.	Langdon, N. D.	Mulberry Creek Tributary to Park River	4,000 gal. per day		August 12, 1946
257	Fred Schaff	SE¼ NE¼ Sec. 2-133-93	Cannonball River	.075	6	August 20, 1946
*	Frank Banks	SE½ SE¼ Sec. 29; SW¼ SW¼ Sec.28; W½ NW¼ Sec. 33-154-96; Lot 6 Sec. 28; E½ NW¼, NW¼ NE¼ Sec. 33-154-96	Sand Creek	4,000 inches		July 18, 1902 Sept. 16, 1904

* Correcting omission on former list.

FINANCIAL STATEMENT

As of September 30, 1946

Appropriation approved March 13, 1943, Chapter 76 of 1943 Session Laws State Water Conservation Commission—Projects:

For cooperating with Bureau of Reclamation or Army Engineers, to be expended only when matched in equal amounts by Federal Funds, and under the direction of the Bureau of Reclamation or Army Engineers	$200,000.00
Expended in cooperation with the Bureau of Reclamation	194,004.93
Balance to be expended in October, 1946	5,995.07

For investigations, surveys and preparatory work on projects other than those approved by the Bureau of Reclamation, which may be matched either in whole or in part by state or federal agencies	$100,000.00
Expended on other post-war projects	97,730.47
Balance	2,269.53

Appropriation approved March 12, 1945, Chapter 133 of 1945 Session Laws—State Water Conservation Commission—Projects:

For cooperating with Bureau of Reclamation or Army Engineers, to be expended only when matched in equal amounts by Federal Funds, and under the direction of the Bureau of Reclamation, Army Engineers or other United States Agencies	$100,000.00
For investigations, surveys and preparatory work on projects other than those approved by the Bureau of Reclamation, which may be matched either in whole or in part by State or Federal Agencies	75,000.00

Because of war conditions, shortages of men and materials, the progress of the surveys, plans and specifications was slow, but since the release of war forces and defense workers, progress has been greatly accelerated. The $200,000 appropriation first mentioned will be exhausted in October, 1946, and work will be continued under the new contract with the Bureau of Reclamation under the 1945 $100,000 appropriation, which at present rate of expenditure will be exhausted about the end of this biennium, or soon thereafter.

On the $75,000 1945 appropriation, last mentioned above, there has been expended to Sept. 30, 1946, $62,434.14, leaving a balance of $12,565.86, which at the present rate of expenditure will be exhausted before the end of 1946.

Appropriation Approved March 12, 1945, Chapter 140 of the 1945 Session Laws, Water Commission, Administration:

	Appropriated	Expended	Balance
Commissioners per diem and expen.	$ 4,000.00	$ 1,568.58	$ 2,431.42
Administration	25,000.00	.....	.....
Refunds and collections	4,329.09	10,966.61	18,362.48
Maintenance of Dams	45,000.00	7,632.15	37,367.85
Tri-State Waters	5,500.00	3,100.13	2,399.87
International and Interstate, Commissioners expenses	5,000.00	3,704.90	1,295.10
Topography and Conservation Branches, cooperation with U. S. Geological Survey	30,000.00	6,974.01	23,025.99
Hydrographic Surveys, coop. with U. S. Geological Survey	15,000.00	8,427.85	6,572.15
Salary—State Engineer	5,000.00	3,124.95	1,875.05
Assistance on Reconstruction of Drains or Irrigation	240,000.00	.....	.....
Plus refund	59.56	70,868.71	169,190.85
Engineering and Geological Surveys and Demonstrations	25,000.00	6,165.88	18,834.12
	$403,888.65	$122,533.77	$281,354.88*

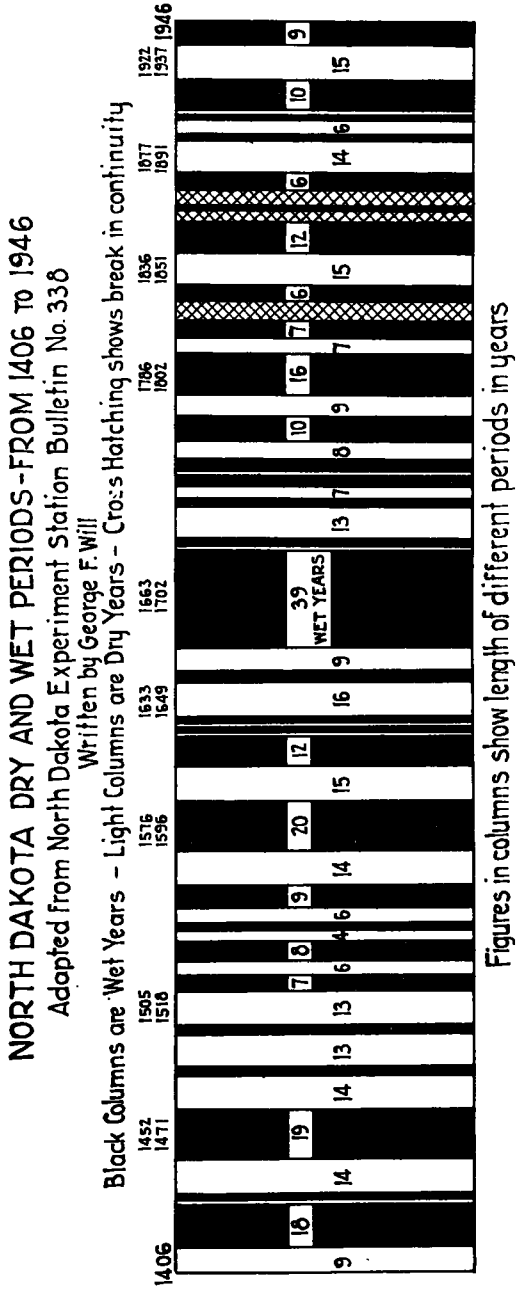
* Work done and contracted will absorb most of the balance shown.

BONDS OUTSTANDING

As of September 30, 1946

Refunding bonds Series J, issued 1944, mature serially on or before December 10, 1955.

$63,000 Interest rate, 2%. Sold to Bank of North Dakota. This money was borrowed to finance irrigation construction, for which the irrigation districts gave bonds to the Water Commission. $44,923.26 has been collected and deposited in the sinking fund with the Bank of N. D. $25,000 bonds of the Sioux Irrigation District in McKenzie County are held as collateral. In addition $19,459 has also been deposited with the Bank of N. D. as additional guarantee for the payment of these bonds in case of default of interest of principal payments. $63,000 from the sinking fund and guarantee fund has been invested in government bonds drawing 2½% interest, thus making ½% margin over the 2% interest on the bonds. Judge A. M. Christianson is entitled to credit for negotiating the sale of these bonds on an unusually favorable basis for the state.



(See story on next page)

540 YEARS OF DAKOTA WEATHER

George F. Will Found No Pattern for Wet and Dry Cycles in Research Going Back to 1406

Maybe you should throw away your ideas about the weather and then look at the tree rings. Your should if you are convinced that the last seven or eight years of good rainfall in North Dakota can't last another season, that a drouth is overdue after so much good fortune. It is known now that in the last 540 years North Dakota once had 39 consecutive wet years. Other periods of continually high moisture in the state during those five and a half centuries stretched into 20 years, 19, 18, 16, 12 and 10 years each before they were broken by dry spells of varying length.

Conversely, we can look back through history as written by the tree rings and learn that the state once had a 16-year unbroken dry spell, that it had three dry periods of 15 years each, that there were three 14-year drouths, four of 13 years each and that the great drouth of the 1930's, that really began in the 1920's, was one of the longest and one of the most severe ever experienced.

If all of this leaves your weather perspective confused, let's put it this way—since 1406 North Dakota has had 302 years capable, as far as moisture is concerned, of producing an average crop or better and 238 years which might have brought less than average. In no year in the last 540 did trees fail to make some growth, as disclosed by the rings, which could be interpreted as meaning there are no years of complete crop failure in the state's known history.

It has been indicated above that these amazing facts are disclosed by tree rings. Where and how? We read about them in a new bulletin called "Tree Ring Studies in North Dakota," published by the North Dakota Agricultural Experiment station but written by George F. Will, Bismarck, N. D., seedsman. With friends in the state historical society and elsewhere, Will has made a distinguished inquiry into past performance of the weather as revealed by tree rings in western North Dakota.

It previously has been established in other areas of the world that tree rings are a reliable source of rainfall history. This is the first time their story in North Dakota has been interpreted and set down as a part of the historical record. Will and others interested in the subject trekked over extensive portions of Missouri valley terrain in their state in search of a living tree of age sufficient to carry them back beyond the 75 years of U. S. weather bureau records which are available at Bismarck. Finally they found one, a burr oak, a few miles north of Bismarck, with a diameter some three to four feet. Cut in 1940 and carted to the laboratory, this ancient oak had 373 growth rings, each showing one year of age, or a total of 373 years. Prying from these rings the rainfall secrets of past centuries requires knowledge and skill but, briefly, the amount of growth shown in each ring is the key to the determination—a wide growth ring denotes heavy rainfall that particular year. A narrow one reveals drouth.

The burr oak's story plotted on a chart was correlated with other information Will gleaned from older timbers, cut by the Indians and found by white men on grounds where various Indian villages once flourished in the area. By these means he put together a rainfall picture going back to 1406, nearly five and a half centuries.

The longest wet period, 39 years, occurred between 1663 and 1702. A nine-year dry period preceded it, from 1654 to 1663. From 1922 to 1937, an elapse of 15 years, is shown on the Will chart as a dry period. Two other 15-year dry spells are shown, one between 1836 and 1851 and another from 1596 to 1611.

"It becomes perfectly clear," Mr. Will said, "that years of drouth and moisture seem to run in series, sometimes separated by from one to several years of average rainfall."

He adds, however, that it appears impossible to work out any definite pattern as to the number of years in succeeding series. That number varies greatly from one year to a maximum of 39 wet years and 16 dry years. Thus, there are both long periods and short periods, in no particular pattern.—From THE NORTHWEST.

INDEX

Aandahl, Governor, and Gen. Pick picture 6
Agencies cooperating with Water Commission 35
Agricultural College cooperator 105
Alfalfa picture, 5 tons to acre under irrigation 100
Appropriations Explained 113
Army Engineers, Missouri Basin plan map 42
Army Engineers, Missouri basin plan 43
Artesian wells, proposed study 97
Average wheat yields in western North Dakota 27
Bach, Nels farm home picture, Yellowstone 38
Baldhill Reservoir proposed 34
Bank of North Dakota, cooperator 99
Beach-Golva annual rainfall graph 83
Bismarck annual rainfall graph 85
Bismarck Irrigation Project 105
Bismarck Irrigation Project 111
Bonds outstanding 124
Bottineau County - Gessner drainage 51
Bowman annual rainfall graph 83
Bowman-Haley flood and irrigation project 111
Buford-Trenton irrigation district 15
Buford-Trenton, pumping plant picture 16
Buford-Trenton irrigation picture 118
Bureau of Reclamation investigations 37
Bureau of Recl. progress report 39
Bureau of Recl. 1947 funds allocated 41
Burnt Creek irrigation 111
Canal repair on Sioux Irr. Dist. 51
Cannonball river irrigation 107
Cattle feeders on beet pulp, etc. 32
Cattle feeding on Lower Yellowstone returns 33
Climate and Weather report printed 74
Compacts—Little Missouri river 103
Compacts—Yellowstone river 103
Contents, list of shown on page 3
Cooperating agencies 35
Cooperative financing with Bureau of Reclamation 37
Curlew Valley irrigation proposed 107
Dam repair and maintenance, pictures 119
Dam repaired during bienium 121
Danielson, Axel farm home, Yellowstone District 41
Devils Lake annual rainfall graph 85
Devils Lake water elevations by months 68-69
Devils Lake water recession graph, map 26
Devils Lake water recession story 27
Dickinson annual rainfall graph 81
Dickinson dam site picture 108
Dickinson reservoir and dam 17
Dirt moving machinery, Garrison dam 44
Drainage, in Red River valley 11
Drainage areas in the Red River valley map 92
Drainage, Red River valley 49
Drainage, Red River, fund allocations 49
Drill rig for groundwater surveys 96
Duties of Water Commission 7
Electrification, rural, in North, Dakota 88
Fargo annual rainfall graph 86
Farmers Union, cooperator 99
Feeding returns on Lower Yellowstone 33
Financial statement 23
Fish and Wild Life Service, U. S. 93
Funds, 1947, allocated by Bureau of Reclamation 41
Fort Clark irrigation 111
Frosts, killing, average days between 78
Frosts, killing, av. earliest and latest, graph 75
Fruit raising under irrigation 29
Gaging tables, streams of N. D. 54-69
Game and Fish Department report 87
Garrison dam and reservoir perspective 3
Garrison dam, aerial river view 11
Garrison dam, on map of N. D. 9
Garrison dam, Army Engineers plan 43
Garrison dam construction personnel 45
Garrison dam—hydroelectric power 11
Garrison dam, hydroelectric generation 43
Garrison reservoir, irrigation from 37
Garrison dam, water into central N. D. 45
Geographical data, N. D. borders 71
Gessner drainage in Bottineau County 51
Golva-Beach annual rainfall graph 83
Grand Forks annual rainfall graph 86
Graphs, list shown on page 2
Greater North Dakota Assn., cooperator 99
Groundwater survey, State Geologist 93
Ground Water Surveys made, State Geologist 95
Ground Water Surveys requested, map 98
Hancock Flats irrigation 111
Health Department, State, report 97
Heart Butte dam site picture 19
Heart River irrigation 17
Heart River—Dickinson reservoir 17
Heart River—Heart Butte reservoir 17
Heart river farmers inspect irri. potatoes 104
Heart River Irrigation Project 105
Heart River Irrigation, map 106
Heart river reservoirs and irrigation map 20
Hebron dam, before and after repair 119
Horsehead Flats irrigation 111
Hydroelectric generating, Garrison dam 43
Hydroelectric power—distribution map 91
Inter-Agency Committee, Missouri Basin 112
Illustration, maps, graphs, list on page 2
Irrigation, history of 13
Irrigated lands in U. S.—map 12
Irrigation development in N. D. 17
Irrigation from Garrison reservoir 37
Irrigation—Heart River unit 17
Irrigation, Lewis & Clark District 15
Irrigation, Buford-Trenton District 15
Irrigation, Missouri-Souris unit 21
Irrigation, Missouri river pumping 21
Irrigation, progress in N. D., graph 18
Irrigation pumping plant, Buford-Trenton 16
Irrigated oats and barley on Yellowstone 30
Jamestown annual rainfall graph 84
Killing frosts, average days between 78
Knife River irrigation 107-9
Knife river reservoir and irrigation, map 20
Lake Darling reservoir water elevations 69
Lake Darling reservoir operation 93
Lake Darling Reservoir, water level graph 94
Leland Flood irrigation project 112
Lewis & Clark Irr. Dist. control gates 46
Lewis & Clark construction financing 45
Lewis & Clark Irrigation Districts 15
Little Heart irrigation 111
Little Missouri river investigations 37
Little Missouri River compact 103

(Continued on next page)

INDEX—(Continued)

Livestock feeding returns on Yellowstone 33
Lower Yellowstone Irr. in western N. D. 27
Lower Yellowstone irrigation yields 31
Maintenance existing dams 119
Manley irrigation 111
Map list shown on page 2
Minot average rainfall graph 84
Mott annual rainfall graph 83
Missouri river diversion projects, plans, 23
Missouri Basin plan, Army Engineers 43
Missouri Basin Inter-Agency Committee 112
Missouri river pumping projects map 20
Missouri river pumping units proposed 21
Missouri River pumping irrigation 111
Missouri river reservoirs planned, map 42
Missouri-Souris irrigation map 36
Missouri-Souris unit 21
Missouri-Souris Project 111
Missouri River States Committee 103
National Rivers and Harbors Congress 47
N. D. Research Foundation, border data 71
North Dakota Reclamation Assn. 47
Objectives and program of Water Commission 10
Oliver-Sanger irrigation 111
Organization and duties of Water Commission 7
Painted Woods irrigation 111
Park River reservoir proposed 35
Park River reservoir report 102
Pembina river flood damage 35
Personnel of Water Commission 7
Pick, Brig. Gen. and Gov. Aandahl picture 6
Pictures, list shown on page 2
Powers and duties of Water Commission 7
Precipitation, annual and seasonal map 79
Precipitation, average by counties, graph 78
Precipitation, averages, and summer months 77
Precipitation averages in N. D., map 22
Precipitation average for U. S. map 80
Program of Water Commission 10
Progress report of Bureau of Recl. 39
Progress of irrigation in N. D., graph 18
Projects on Missouri river diversion 23
Pumping plant, Buford-Trenton irri. 16
Radio Station, KFYR, cooperator 102
Railroad, access to Garrison dam 44
Rainfall and temperature, wheat yields 24
Rainfall averages in N. D., map 22
Rainfall above normal, U. S. Weather Bureau 74
Rainfall, annual and seasonal map 79
Rainfall, average by counties, graph 78
Rainfall, average, and summer months 77
Rainfall average for U. S. 80
REA organization map of N. D. 88
Reclamation Assn. of N. D. 47
Red River basin studies by Army Engineers 102
Red River valley drainage 11
Red River drainage 49
Red River over-all water utilization plan 35
Red River valley reservoirs proposed 34
Reservoir water elevations, Lake Darling 69
Reservoir, Lake Darling, water level graph 94
Returns per acre on Lower Yellowstone 31
Rural electrification map of N. D. 88
Rural Rehabilitation Corporation 45
Sheep feeders on Lower Yellowstone District 50
Sheep feeders on Lower Yellowstone, picture 110
Sheep feeding returns on Lower Yellowstone 33
Sheyenne river Baldhill dam 101
Sheyenne river, site of dam and reservoir 25
Sioux Irri. Dist. canal repairs 51
Square Butte irrigation 111
Square Butte and Wogansport pumping units 37
Soil Conservation Service 47
State Engineer, powers and duties 9
State Game & Fish Dept. report 87
State Geologist report, groundwaters 93
State Health Department report 97
Stream gaging station in N. D., map 52
Stream gaging tables 54-69
Sugar beets under irrigation on Yellowstone 48-70
Surface water resources of N. D. 53
Temperature, av. January and July, graphs 76
Temperature and rainfall graph, wheat yields 24
Tongue river reservoir proposed 35
Topographic Mapping on N. D. map 72
Topographic surveys by Geological Survey 71
Tree ring climate records, George Will 87
Tri-State Waters Commission report 101
Underground Water Survey, State Geologist 93
U. S. Fish and Wild Life Service 92
U. S. Geol. Survey, topographic mapping 71
U. S. Geological Survey—water resources 53
U. S. Weather Bureau, report 73
Water Commission, organization, personnel 7
Water Commission, powers and duties 7
Water elevations in Lake Darling 69
Water elevations by months, Devils Lake 68-69
Water Resources of North Dakota 53
Water Right filings for biennium 122
Wheat yields average in Western N. D. 27
Wheat yields, temperature, rainfall, graphs 24
Weather report by U. S. Bureau 73
Western N. D. annual rainfall graph 82
Wildlife refuges in North Dakota 93
Will, George, tree ring climate records 87
Williston annual rainfall graph 81
Winona irrigation 111
Wogansport and Square Butte pumping units 37
Wogansport irrigation 111
Wogansport unit, Missouri river pumping 114
Worst, Clayton, 5 tons alfalfa to acre 100
Yellowstone irrigation project in western North Dakota 27
Yellowstone farm homes, Bach-Danielson 38-41
Yellowstone irri. potatoes, Heart river farmers 104
Yellowstone river compact 103
Yields under irrigation on Lower Yellowstone 31