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NORTH DAKOTA STATE PLANNING BOARD

SUMMARY REPORT

OF

A PLAN OF WATER CONSERVATION

FOR

NORTH DAKOTA

VOLUME 5

SLOPE AREA DRAINAGE BASIN

KNIFE RIVER
HEART RIVER
CANNONBALL RIVER
GRAND RIVER
LITTLE MISSOURI RIVER
YELLOWSTONE RIVER

JANUARY 1, 1937

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U.S. Biological Survey	U.S. Geological Survey
Soil Conservation Service	National Resources Committee
North Dakota State Geological Survey	Engineering College, Univ. of N.Dak.
Agricultural Dept., N. Dak. Agric. College	Resettlement Administration
State Department of Health	State Engineer

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1/ The Cooperating Agencies are not responsible for the opinions, conclusions, or recommendations of the State Planning Board as expressed in this report.

CHAPTER 1

KNIFE SUB-BASIN

CHAPTER I

KNIFE RIVER SUB-BASIN

GENERAL

The Knife River rises in the northeastern corner of Billings County and the southeastern corner of McKenzie County. From this point it flows in a tortuous course eastward and slightly southward to the Dunn-Mercer County line, crossing about 15 miles north of the southeast corner of Dunn County. From here the river turns and flows eastward and slightly northward to the Missouri River which it enters at Stanton in Mercer County, about 65 miles above Bismarck. The total area of 2,645 square miles drained by the Knife River lies in North Dakota and includes major portions of Dunn and Mercer Counties and lesser portions of Oliver, Billings, Morton, and Stark Counties.

POPULATION

The 1930 population of the Sub-basin was 18,500 persons of which 12,999 resided in rural areas and 5,501 resided in incorporated cities and villages. Hebron, Hazen, and Beulah are the only towns having a population in excess of 500. Hebron, the largest town, has a population of 1,348.

FEDERAL AID

During the month of peak load, March 1935, 5,350 persons or 28.9% of the total Sub-basin population were receiving federal aid. The state average for the same month was 31.6%. In the peak month of W. P. A. employment 352 persons were employed on works projects in or near cities and villages and 1650 persons were employed on rural projects, making a total of 2002 persons employed in October, 1936.

TOPOGRAPHY

The terrain is flat or gently rolling at the headwaters of the various streams in the Sub-basin but becomes roughly broken near the main stream. The source of the Knife River is at an elevation of approximately 2,600 feet above sea level. In its 165 mile journey, through a valley 90 miles in length, it drops to an elevation of approximately 1,670 feet. The drop for the first 33 miles of channel is about 13.5 feet per mile. The drop of the channel below this point is 3.8 feet per mile. The average drop of the valley is approximately 10.4 feet per mile.

TRIBUTARIES OF KNIFE RIVER

Spring Creek, the principal tributary of the Knife River, has its headwaters in the Killdeer Mountains of Dunn County at an elevation of approximately 3,300 feet above sea level. It drains an area, in Dunn and Mercer Counties, of 570 square miles. From its source to Killdeer, a channel distance of approximately 14 miles, this stream has a fall of 25 feet per mile. From this point to its confluence with the Knife, near Beulah, it has an average drop of 6 3/4 feet per mile. The little Knife River rises in the northeast corner of Stark County and flows northward to the Knife River.

It drains an area of 275 square miles. There are a large number of lesser tributaries in the Sub-basin. In general these have their source at high elevations and descend rather rapidly to the main stream in a course at right angles to that of the latter.

NATURAL RESOURCES

The entire drainage system of the Sub-basin cuts through the Fort Union formation which has a thin covering of glacial drift except in the extreme western portion. Strata of lignite coal are characteristic of such formations and deposits of great value are found in the Sub-basin. Lignite mining on large commercial scales is developed at Beulah and Zap. Local mines supply an abundance of cheap fuel for the inhabitants of the Sub-basin.

There are numerous deposits of gravel found in the glacial drift of the area. These deposits are valuable as surfacing material but require washing to meet standard specifications for concrete aggregate. There is an abundance of boulders in the Sub-basin which are suitable for the construction of rubble masonry, riprapping and other uses.

GROUND WATER

The sandstone and lignite beds of the Fort Union Formation furnish the major portion of the ground water supply of the Sub-basin. Where the river and its tributaries have cut through these strata, springs occur on the valley sides. In the valley bottoms an adequate supply of water of good quality is obtained from the alluvial deposits. Some weak flowing wells are present in the lower part of the Sub-basin. Water obtained from alluvial deposits is generally hard but of good quality. That obtained from the glacial drift is often highly mineralized. Water from the Fort Union Formation is of good quality except where it has dissolved organic matter from the lignite coal with which it comes in contact. This gives it a discoloration, odor, or taste that makes it objectionable for drinking purposes.

THE WATER PROBLEM

The primary water problem in the Knife River Sub-basin is that of stream flow regulation. During portions of each year there is a large flow in the streams but during the greater part of the year there is a great deficiency in stream flow. During such periods there is a need for stream flow for recreation, pollution abatement, municipal supply, and for irrigation purposes. Some headwater areas are in need of small reservoirs for recreational purposes. Water supply and sewage disposal problems, although present in the Sub-basin are not acute and are secondary to the problem of stream flow regulation.

PRECIPITATION

The 20 year annual average of precipitation in the Basin is 14.54 inches annually. That during the growing season, May through September, is 10-32 inches. On the basis that approximately 14 inches of precipitation during the growing season is required to produce a fair crop, it is apparent that large deficiencies of

rainfall prevailed during more than half of the 20-year period. This resulted in frequent crop failures. During such drouth years sufficient feed is not grown in the Sub-basin to sustain foundation herds of livestock. Feed is shipped in at high cost to the inhabitants and result in a loss of accumulated savings. There are large tracts of land in the Knife River Valley potentially well suited to irrigation, for which purpose the available waters of the Sub-basin should be utilized to full advantage. Nothing approaching maximum utilization is being practiced at the present time.

RUN-OFF

The run-off from the Sub-basin is rapid. The slope is great and there are no sloughs, reservoirs or trees to retard the run-off except in a very small portion of the Sub-basin, the Killdeer Mountains. The average annual run-off from the Sub-basin is approximately .88 inches or 125,000 acre feet. A large portion of this occurs during the spring months and, except immediately following violent storms, the streams are virtually dry during the summer months.

FLOODS

Frequent damaging floods occur along the lower reaches of the Knife River. During a period of excessive rains in July, 1935, floods caused damage in the immediate vicinity of Beulah totaling $15,000. Floods such as this occur at least once each five years. It is probable that the maximum flood flow has not been reached since the settlement of the Sub-basin. As mentioned above, there is a great deficiency of stream flow during summer months. Large reservoirs on the Knife River and its principal tributaries would result in great benefits to the area in flood control, pollution abatement, insured water supply for cities along the streams, and in increased recreational facilities. Such reservoirs would also make possible the irrigation of approximately 25,000 acres of river bottom land thus insuring an annual feed crop sufficient to maintain foundation herds in the Sub-basin.

BIOLOGICAL SURVEY

The U. S. Bureau of Biological survey has undertaken the construction of the Dunn Center Lake Reservoir located in Sec. 27-145-94. This reservoir will have a storage capacity of 7100 acre feet with a water surface of 1000 acres. Although the use of this project will be primarily as a waterfowl refuge, it will also support fish life and will be an excellent lake for recreational purposes. The Biological Survey has completed the Myron Slough Project in Dunn County, Twp. 142-93 as a waterfowl refuge.

The U. S. Biological Survey also contemplates the Krem Project in Mercer County, Twp. 145-86, for a waterfowl refuge.

WILD LIFE

There are some deer in the valleys of the Sub-basin; there are some fish and waterfowl in the streams. These will increase in numbers considerably with the development of the Biological Survey projects, but the utmost development of the wildlife resources

of the Basin can only be developed through stream regulation. Fish, in particular, find it difficult to survive drought years and hard winters when there is not sufficient flow in the streams to sustain them.

RECREATION

There are limited recreational facilities in the Knife River Sub-basin. The Killdeer Mountains, because of their high altitude and tree life, offer a relatively cool retreat during the excessive heat of summer months. Various towns along the Knife River and Spring Creek have developed small parks adjacent to the banks of these streams. During summer months such water as is present in these streams is unfit for bathing purposes and, as a result, recreational development is limited. If stream flow were regularized, recreational facilities along the streams would be greatly increased. There is a need for some small reservoirs in the headwater areas of the Sub-basin for recreational purposes.

POWER AND NAVIGATION

The streams of the Sub-basin are not navigable and because of the limited and intermittent flow the development of water power is not practicable. The power needs of the Sub-basin are served by generating plants utilizing lignite coal as fuel.

CHANNEL IMPROVEMENT

There has been little or no attempt made to improve the existing channels of the streams. The principal streams have well defined and uniform channels with considerable drop which could not be greatly improved without involving excessive costs.

MUNICIPAL WATER SUPPLY

The various towns in the Sub-basin have an ample ground water supply available for development. Several towns including Beulah have deep wells for their municipal supply. The water obtained from such wells contain an excessive amount of organic matter dissolved from the lignite coal veins through which it passes. It would be possible, in some cases, to change to shallow well supply or, if stream flow regulation becomes an accomplished fact, those towns along the principal streams could use a surface supply. Beulah would have available the Hazen-Beulah reservoir from which it could take its supply direct. The value to Beulah of this reservoir for a municipal water supply would be approximately $10,000.

STREAM POLLUTION

During times of ample flow in the Knife River and its tributaries there is not a serious stream pollution problem in the Sub-basin. However, some additional sewage systems and treatment plants and improvements in existing plants are needed in the Sub-basin. Hebron, dumps its sewage into the Little Knife after partially treating it by means of septic tanks. Beulah and Hazen dump their sewage into the Knife River without treatment. During summer months when stream flow becomes very low there is a considerable pollution of the streams due to accumulated sewage and dead animals.

POSSIBLE IRRIGATION

As elsewhere stated in this report, the average annual discharge of the Knife River into the Missouri River is approximately 125,000 acre feet. Preliminary surveys have estimated the irrigable land in the valleys of the Sub-basin to be 24,100 acres. Below the town of Marshall in Twp. 142-92, the Knife River bottom lands are exceptionally fertile and level and are up to 1½ miles in width. The bottom lands of Spring Creek are also fertile and suitable for irrigation although they are not as favorably situated nor as large as those of the Knife River.

Several irrigation projects are located along these two streams at the present time. These are individually owned and are very limited in size because of stream flow deficiency and the lack of adequate storage facilities. During average to medium dry years these small projects operate very satisfactorily but during drought years there is not sufficient water to supply the projects and crop failures result. Large storage reservoirs on the various streams to provide stream flow regulation would permit the utilization of nearly all available irrigable land for irrigation purposes either by gravity flow or by pumping projects. There are several possible sites for small flood irrigation projects on the various tributary streams of the Knife River.

USE OF IRRIGABLE LANDS

The primary purpose of the development of irrigation in the Sub-basin would be to grow sufficient feed within the Sub-basin drought years to sustain foundations herds without the necessity of shipping in expensive feeds during periods of rainfall deficiency. This would eliminate the necessity of depleting the savings of normal years during dry years and would lead to a more prosperous condition of the entire Sub-basin. The transportation facilities would permit the growing of sugar beets on irrigable land if the proposed sugar plant is established at Bismarck in connection with the Bismarck Irrigation Project. A network of state and county highways serve all localities in the Sub-basin and a railroad line follows the Knife River Valley from the Missouri River to Spring Creek and then follows the valley of Spring Creek throughout its entire length. Irrigation would tend to make the Sub-basin self-supporting whereas at the present time it requires considerable aid from other areas during drought years.

RESERVOIRS FOR FLOOD CONTROL, RIVER REGULATION, MUNICIPAL SUPPLY, AND IRRIGATION.

The construction of several large reservoirs on the principal streams of the Sub-basin is desirable. Flood damages totaling tens of thousands of dollars every 3 or 4 years and larger but less frequent flood damages would be eliminated. River regulation would provide water along the streams for the dilution of sewage, for municipal supply, for the maintenance of fish in the streams, and for recreation. It would also make water available at desired points for irrigation purposes.

EXISTING RESERVOIRS

A total of 23 dams now constructed in the Sub-basin impound a maximum of 8586 acre feet of water. These are used for various purposes such as recreation, stock watering and as waterfowl refuges. These existing reservoirs are listed in Table A. and are shown on Plate II.

PROPOSED PROGRAM

It is proposed;

1. That several large regulating reservoirs be constructed on the Knife River to control the run-off and thereby provide adequate flood control and stream flow regulation. Proper stream flow regulation would make water available during drouth years for purposes of pollution abatement, for recreation for the irrigation of large tracts of land in the Knife River Valley. Proposed large reservoirs are listed in Table D. and are shown on Plate II.

2. That assistance be given several towns in developing adequate water supply and sewage disposal facilities. Water supply problems and their proposed solutions are listed in Table B. Sewage disposal problems and their proposed solutions are listed in Table C. Both are shown on Plate I.

3. That several small dams be installed at desirable locations for recreation, for flood irrigation and as migratory waterfowl refuges. These are listed in Table D. and are shown on Plate II. All dams constructed hereafter in the Sub-basin should be provided with outlet gates for releasing the water stored when a great need arises for it downstream or when it becomes so polluted that it is a definite health hazard to the community. Many existing dams should also be provided with outlet gates.

4. That the stream gaging station on the Knife River at Hazen be rehabilitated and maintained as listed in Table E. and as shown on Plate III.

5. That a detailed soil survey and land classification be begun as soon as is possible on all lands that appear to be irrigable in order to ascertain the suitability of these lands for irrigation in each of the several areas. These surveys should follow the aerial mapping of the irrigable regions. This mapping will provide, in addition to its utility as the basis of the proposed soil survey and land classifications, much needed data on present land use. The cost of the aerial mapping would approximate 5¢ per acre. The cost of the detailed survey and land classification would be an additional 5¢ per acre. Thus, to properly predetermine the areas suited to irrigation would entail the expenditure of 10¢ per acre for 24,100 acres of irrigable land in the Knife River Sub-basin, or approximately $2,400.

RURAL WATER SUPPLY

A large number of small reservoirs have been proposed for the Sub-basin by various agencies. Those that would serve purposed of recreation irrigation and waterfowl refuges have been included in the proposed program. It is proposed that before any more small dams for stock water purposes be constructed in the Sub-basin, a

detailed survey of rural water supply be undertaken to determine the best and most economical method of securing adequate and satisfactory water supplies for stock watering purposes. Where an adequate ground water supply is available it is probable that this would be through the construction of community wells. In other localities not having a reliable ground water supply the construction of surface reservoirs would be the only alternative. Following such a survey it is proposed that assistance be given in developing an adequate rural water supply.

ULTIMATE DEVELOPMENT OF WATER RESOURCES.

The ultimate development of the water resources of the Knife River Sub-basin would be provided by certain storage reservoirs of proper design. Such reservoirs must be sufficiently large, must be provided with proper sluiceways and controlling devices, and must be properly located on the main streams and larger tributaries. These would maintain a regularized flow in the streams and would provide water for municipal supply , sewage, dilution, recreation, irrigation, and stock watering purposes. Small dams, creating reservoirs of ffom 5 to 20 acre feet capacity are needed at the headwaters of the various streams to supplement the well water supply for stock watering purposes.

BRONCHO RESERVOIR

It is proposed that the Broncho reservoir in S. 35-143-90 be constructed as soon as surveys can be completed. The location chosen would receive the run-off from approximately 1200 square miles or an average of 56,000 acre feet per year. There are approximately 5000 acres of irrigable land in the Knife River Valley between this reservoir and the proposed Hazen-Beulah Reservoir. It is estimated that 2000 acres or more would be irrigated by gravity flow and 3000 acres would be irrigated by pumping from the river channel. The additional storage over that needed to irrigate this 5000 acres would be used to supplement the Hazen-Beulah Reservoir and to maintain stream flow regulation for purposes of pollution abatement, recreation, and water supply.

HAZEN-BEULAH RESERVOIR.

The second proposed project for construction is the Hazen-Beulah Reservoir. It would make water availabe at points downstream for pollution abatement, recreation, and for the irrigation of 5500 acres of very fertile bottom lands. As originally surveyed the Hazen-Beulah Reservoir would necessitate the relocation of three miles of railroad tracks, relocation of a highway and would cause excessive flowage damages. It is proposed that the reservoir capacity be the maximum that will not necessitate such relocation of railroads and highways. The capacity as determined should be ample when used in conjunction with the Broncho Reservoir.

The third proposed project is the construction of the Albert Koesel Irrigation Dam in S. 15-141-91. This is particularly recommended for consideration by the Resettlement Administration and should be constructed at once.

The Broncho and Hazen-Beulah Reservoirs should be constructed at the earliest possible dates. Following a demonstration of the practicability of irrigation in the Basin, in connection with these reservoirs, other reservoirs should be constructed to provide additional stream regulation, pollution abatement, recreation and water for the irrigation of approximately 13,000 additional acres of irrigable land.

The proposed reservoirs for the improved use of surface water in the Sub-basin are listed in Table D. The storage capacity proposed for these reservoirs is that which would control practically all the run-off from the tributary drainage area but yet would not be so large as to cause excessive flowage damages and the relocation of highways and railroads at an additional expense. By limiting the proposed size of the reservoirs to the maximum storage capacity needed, a great reduction in the estimated cost of the proposed reservoirs is made possible.

ECONOMIC JUSTIFICATION FOR RESERVOIRS

Although the reservoirs in themselves are justified for purposes of flood control, river regulation, municipal supply, pollution abatement, and irrigation, an additional justification for their construction in the near future is the present financial condition of the inhabitants. The number receiving federal aid will increase during the coming year because of a complete crop failure during 1936. During the past two years approximately $600,000 of federal aid, exclusive of Farm Credit Administration Loans, has been given to the inhabitants of the Sub-basin. This has not made the Sub-basin more self-sustaining. If conditions continue as at present, it is to be expected that this amount of outside aid will be necessary during the expected two drought years in each five-year period, which records indicate is characteristic of this Sub-basin. On the other hand if these reservoirs are installed the Sub-basin would tend to become self-sustaining and would not require a large amount of outside aid at any time.

WEATHER OBSERVATION AND STREAM GAGING STATIONS

The proposed rehabilitation of the gaging station on the Knife River together with the existing weather recording stations in the Sub-basin are shown in Plate III. It is strongly urged that these facilities be maintained in a satisfactory manner.

ABLE A

EXISTING RESERVOIRS

KNIFE RIVER SUB-BASIN

o.	County	Sec.	Twp.	Rge.	Storage A. F.	Cost Est.	Use	Desig-nation	Description and Remarks	Legend
.	Dunn		142	93	300	$ 30,000	VII	E	Myron Slough Dam.	*****
.	Dunn	27	145	94	7,100	100,000	VII,III	E	Dunn Center Reservoir--Spring Creek.	*****
.	Dunn	24	145	92	15	5,500	VI,III	E	Dam--Spring Creek at Halliday.	****
.	Morton	33	140	90	25	6,500	VI,III	F	Dam--Creek at Hebron.	****
.	Mercer	16	144	89	1	2,100	VI,III	E	Dam--Spring Creek, at Zap.	****
.	Dunn	36	145	95	19	3,200	IV	F	Dam--Branch of Spring Creek.	*
.	Dunn	23	145	95	11	2,900	III	F	Dam--Creek. Near Killdeer.	*
.	Dunn	33	145	94	56	3,300	III	E	Dam--Spring Creek. (Inundated by Dunn Center Reservoir)	*
.	Dunn	14	145	95	10	3,000	III	F	Dam--Creek. At Killdeer.	(*) (**)
10.	Dunn	12	143	96	19	1,600	III,IV	E	Dam--Knife River. Near Manning.	*
11.	Dunn	6	143	95	17	1,100	III	E	Dam--Knife River. At Manning.	*
12.	Dunn	36	140	91	41	1,400	IV	G	Dam--Creek.	*
13.	Dunn	1	139	91	17	1,700	IV	F	Dam--Coulee.	*
14.	Dunn	3	140	91	72	7,200	IV	F	Dam--Creek.	*
15.	Dunn	3	140	94	30	3,000	IV	E	Dam--Little Knife River.	**

TABLE A (Cont'd.)

EXISTING RESERVOIRS

KNIFE RIVER SUB-BASIN

No.	County	Sec.	Twp.	Rge.	Storage A. F.	Cost Est.	Use	Desig-nation	Description and Remarks	Legend
16.	Dunn	33	144	92	37	$ 2,700	IV	F	Wilhelm Dam--Creek.	**
17.	Dunn	24/25	145	94	46	8,000	III,IV	E	Halliday Park Dam--Spring Creek.	**
18.	Dunn	10	144	91	60	11,000	IV	E	Dodge Dam--Spring Creek.	**
19.	Dunn	15	142	91	15	1,500	II,IV	E	Koesel Dam--Knife River.	***
20.	Mercer	13	145	89	12	1,200	IV	P	Dam--Creek.	**
21.	Mercer	13	145	87	10	1,000	IV	F	Dam--Creek.	**
22.	Mercer	17	145	90	23	2,300	IV	P	Dam--Coulee.	**
23.	Mercer	6	144	84	650	15,000	III	E	Dam--Knife River. Timbercrib dam at Stanton.	**
TOTAL EXISTING RESERVOIRS:					8,586	$215,200				

LEGEND:

*	Constructed by CCC
**	Constructed by FERA and WPA
***	Constructed by Individuals
****	Constructed by Railways and Municipalities
*****	Constructed by U. S. Biological Survey

USE:

II	Irrigation
III	Recreation
IV	Stock Watering and Water Conservation
VI	Railway Supply
VII	Waterfowl Refuge

DESIGNATION:

E	Excellent
G	Good
F	Fair
P	Poor

TABLE B

PROPOSED IMPROVEMENTS IN WATER SUPPLY

KNIFE RIVER SUB-BASIN

PLATE I MAP NO.	Municipality	Pop.	Objection to Present Supply	Proposed Improvements	Surveys	Wells	Total Estimate
1.	Golden Valley	294	Inadequate	Survey and 2 wells	$100	$1,200	$ 1,300

PROPOSED IMPROVEMENTS IN WATER SUPPLY

SUMMARY

CLASS "A" PROJECTS DEMANDING IMMEDIATE ATTENTION:

Local Survey for Golden Valley	$ 100

CLASS "B" PROJECTS DEMANDING IMMEDIATE ATTENTION UPON COMPLETION OF SURVEY

Two wells for Golden Valley	1,200
TOTAL PROPOSED IMPROVEMENTS IN WATER SUPPLY:	$ 1,300

TABLE C

PROPOSED IMPROVEMENTS IN SEWAGE DISPOSAL

KNIFE RIVER SUB-BASIN

PLATE I Map No.	Municipality	Pop.	Type and Adequacy of Sewage Treatment	Proposed Improvements	Estimated Cost
CLASS "A" PROJECTS DEMANDING IMMEDIATE ATTENTION:					
2.	Hazen	689	Comb.--No Treatment. Inadequate	Treatment Plant	$ 30,000
3.	Beulah	913	Open Storm Sewer, Septic Tank. S.C., G.C., P.S.	Treatment Plant and Pumping Station	35,000
4.	Hebron	1,348	Sep. Septic Tank, Inadequate	Treatment Plant	35,000
5.	Killdeer	495	No Sewage System	Sewage System with Treatment Plant.	35,000
TOTAL PROPOSED IMPROVEMENTS IN SEWAGE DISPOSAL:					$ 135,000

LEGEND FOR SEWAGE AND SEWAGE TREATMENT:

Comb.	Combined System
Sep.	Separate System
Sc.	Screened
G.C.	Grit Chamber
P.S.	Pumping Stations.

TABLE D

PROPOSED IMPROVEMENTS IN USE OF SURFACE WATER RESOURCES

KNIFE RIVER SUB-BASIN

Plate II Map No.	County	Sec.	Twp.	Rge.	Storage Cap. A. F.	Irr. Land-Acres	Cost Est.	Use	Designation	Description and Remarks	Survey
CLASS "A" PROJECTS DEMANDING IMMEDIATE ATTENTION:											
1.	Mercer	35	143	90			$ 9,000	I,II		Survey of Broncho Reservoir site on Knife River.	**
	Mercer	23	144	87						Complete survey of Hazen-Beulah Reservoir on Knife River.	***
2.	Dunn	22	143	94			3,000	I,II		Complete survey and design of Emerson Reservoir on Knife River.	***
3.	Dunn	9	141	91			3,000	I,II		Survey and design of Little Knife Reservoir.	**
4.	Entire Basin						10,000			Survey of small dams proposed for flood irrigation, recreation, and waterfowl refuge purposes. Survey of available water resources for stock watering where present supplies are inadequate. Recommendations to be made for the most satisfactory and economical solution to the problem through construction of community wells or surface reservoirs.	

TABLE D (Cont'd.) PROPOSED IMPROVEMENTS IN USE OF SURFACE WATER RESOURCES

KNIFE RIVER SUB-BASIN

Plate II Map No.	County	Sec.	Twp.	Rge.	Storage Cap.-A. F.-Est.	Irr. Land-Acres-Est.	Cost Est.	Use	Desig-nation	Description and Remarks	Survey
5.	Stark	32	141	91	520	300	$ 4,000	II	E	Emil Kuehn Dam--Branch Little Knife River. Recommended as Rural Resettlement Administration Project.	**
6.	Mercer	4	144	89	400		15,000	III,VII	E	Flemmer Dam-Creek. Large springs and flowing stream.	**
7.	Mercer	26	145	85	10		300	II	E	Dam--Raymond Creek.	**
8.	Mercer	32	145	85	15		500	II	E	Dam--Coal Creek.	**
9.	Mercer	4	144	87	10		500	II	E	Dam--Antelope Creek Branch.	**
10.	Mercer	16	145	90	5		400	II	E	Dam--Goodman Creek.	**
11.	Mercer	32	145	90	5		400	II	E	Dam--Goodman Creek.	**
12.	Mercer	4	144	90	5		400	II	E	Dam--Goodman Creek.	**
13.	Mercer	16	144	90	30		4,000	III	E	Dam--Spring Creek. In Golden Valley Park. Fair foot R. M. O. Dam.	**
14.	Dunn	19	145	95	30		1,500	III	E	Dam--Creek. Replacement of washed out dam. Spring fed creek.	**

TABLE D (Cont'd.) PROPOSED IMPROVEMENTS IN USE OF SURFACE WATER RESOURCES

KNIFE RIVER SUB-BASIN

Plate II Map No.	County	Sec.	Twp.	Rge.	Storage Cap.- A. F.-Est.	Irr. Land- Acres-Est.	Cost Est.	Use	Desig-nation	Description and Remarks	Survey
15.	Billings	33	144	98	147		$ 8,400	III,IV, VII	G	Twenty-foot dam--Knife River.	*****
16.	Dunn	30	145	92	19		10,000	III	E	Dam--Spring Creek. Includes park development.	**
17.	Dunn	20	144	86	121		15,000	III	E	Dam--Knife River. Includes park development.	****
18.	Dunn	4	141	94	85		12,000	III,IV	G	Dam--Knife River. Includes park development.	****
19.	Stark	3	140	91	20		1,500	II	E	Dam--Little Knife River. Dam would prevent erosion in natural spillway of existing dam just above.	**
20.	Stark	21	140	93	8		1,500	IV	E	Dam--Creek. Recommended as reservoir for stock in transit. Reservoir should be fenced and a pipe and tank provided.	**
21.	Dunn	10	142	91			200			Survey and design of Albert Koesel Reservoir on Schaffner Creek.	**
Total Class "A" Projects:					1,430	300	$100,600				

TABLE D (Cont'd.)

PROPOSED IMPROVEMENTS IN USE OF SURFACE WATER RESOURCES

KNIFE RIVER SUB-BASIN

Plate II Map No.	County	Sec.	Twp.	Rge.	Storage Cap.-A. F.-Est.	Irr. Land-Acres-Est.	Cost Est.	Use	Desig-nation	Description and Remarks	Survey
CLASS "B" PROJECTS DEMANDING IMMEDIATE ATTENTION UPON COMPLETION OFSURVEY:											
1.	Mercer	35	143	90	25,000	5,000	$450,000	I,II, III,IV VII	E	Construction of Broncho and Hazen-Beulah Reservoirs.	(**) (***)
1a.	Mercer	23	144	87	10,000	5,500					
21.	Dunn	10	142	91	2,500	600	30,000	II	G	Construction of Albert Koesel Reservoir on Schaffner Creek. This is recommended as a Rural Resettlement Administration Project.	**
Total Class "B" Projects:					37,500	11,100	$480,000				
CLASS "C" PROJECTS IN PLAN NOT INCLUDED IN CLASSES "A" AND "B":											
22.	Mercer	19	144	90			3,000	I,II		Survey of Spring Lake Reservoir on Spring Creek.	**
23.	Mercer	25/26	144	88	40		5,000	I	?	Survey and construction of two retention dams on coulees for protection of Beulah.	*
2.	Dunn	22	143	94	20,000	1,200	10,000	I,II, III,IV, VII	G	Construction of Emerson Reservoir on Knife River.	***

TABLE D (Cont'd.) PROPOSED IMPROVEMENTS IN USE OF SURFACE WATER RESOURCES

KNIFE RIVER SUB-BASIN

Plate II Map No.	County	Sec.	Twp.	Rge.	Storage Cap.- A. F.-Est.	Irr. Land- Acres-Est.	Cost Est.	Use	Desig-nation	Description and Remarks	Survey
3.	Dunn	9	141	91	7,830	4,000	$100,000	I,II	G	Construction of Little Knife Reservoir on Little Knife River.	**
24.	Dunn	26	144	97			5,000	I,II		Complete survey of Fayette Reservoir on Knife River.	***
22.	Mercer	19	144	90	6,000	6,000	120,000	I,II	G	Construction of Spring Lake Reservoir on Spring Creek.	**
24.	Dunn	26	144	97	4,300	1,500	75,000	I,II	F	Construction of Fayette Reservoir on Knife River.	***
25.	Mercer	35	141	90	33		4,000	IV	F	Dam--Creek.	****
26.	Oliver	25	143	87	38		5,700	IV	E	Dam--Creek.	****
27.	Mercer	10	145	86	200		5,000	VII	F	Dam--Creek. Recommended as Biological Survey Project.	****
28.	Dunn	NE¼ 17	145	92	50		10,000	IV	E	Dam--Creek.	**
29.	Dunn	21	145	92	20		600	II	F	Dam--Creek.	**
30.	Dunn	33	142	92	100		5,000	VII	F	Dam--Creek. Recommended as a Biological Survey Project.	****

TABLE D (Cont'd.) PROPOSED IMPROVEMENTS IN USE OF SURFACE WATER RESOURCES

KNIFE RIVER SUB-BASIN

Plate II Map No.	County	Sec.	Twp.	Rge.	Storage Cap.- A. F.-Est.	Irr. Land- Acres-Est.	Cost Est.	Use	Desig-nation	Description and Remarks	Survey
31.	Oliver	10	143	86	200		$ 5,000	VII	F	Dam--Creek. Recommended as a Biological Survey Project.	*
32.	Mercer	20	144	88	7		1,000	III	E	Dam--Spring Creek.	*
4.	Entire Basin				____	____	25,000	IV		Construction of community wells for stock watering and the construction of surface water reservoirs in certain communities after surveys have shown that ground water resources in the areas are unsatisfactory.	
Total Class "C" Projects:					38,818	12,700	$379,300				
TOTAL PROPOSED IMPROVEMENTS IN USE OF SURFACE WATER RESOURCES:					77,748	24,100	$959,900				

SURVEY:

* None
** Field Inspected by State Engineer
*** Surveyed by U. S. Army Engineers
**** Surveyed by CCC
***** Surveyed by FERA and WPA

USE:

I Flood Control and Stream Regulation
II Irrigation
III Recreation
IV Stock watering and Water Conservation

DESIGNATION:

E Excellent
G Good
F Fair
P Poor

TABLE E PROPOSED IMPROVEMENTS IN STREAM GAGING AND WEATHER OBSERVATION FACILITIES

KNIFE RIVER SUB-BASIN

PLATE III MAP NO.	Station	New or Rehabilitated	Type of Station	Reading to be Taken	Cost Estimate
CLASS "C" PROJECTS IN PLAN NOT INCLUDED IN CLASSES "A" AND "B":					
1.	Hazen	Rehabilitated	Staff Recorder	River Stages	$ 350.00

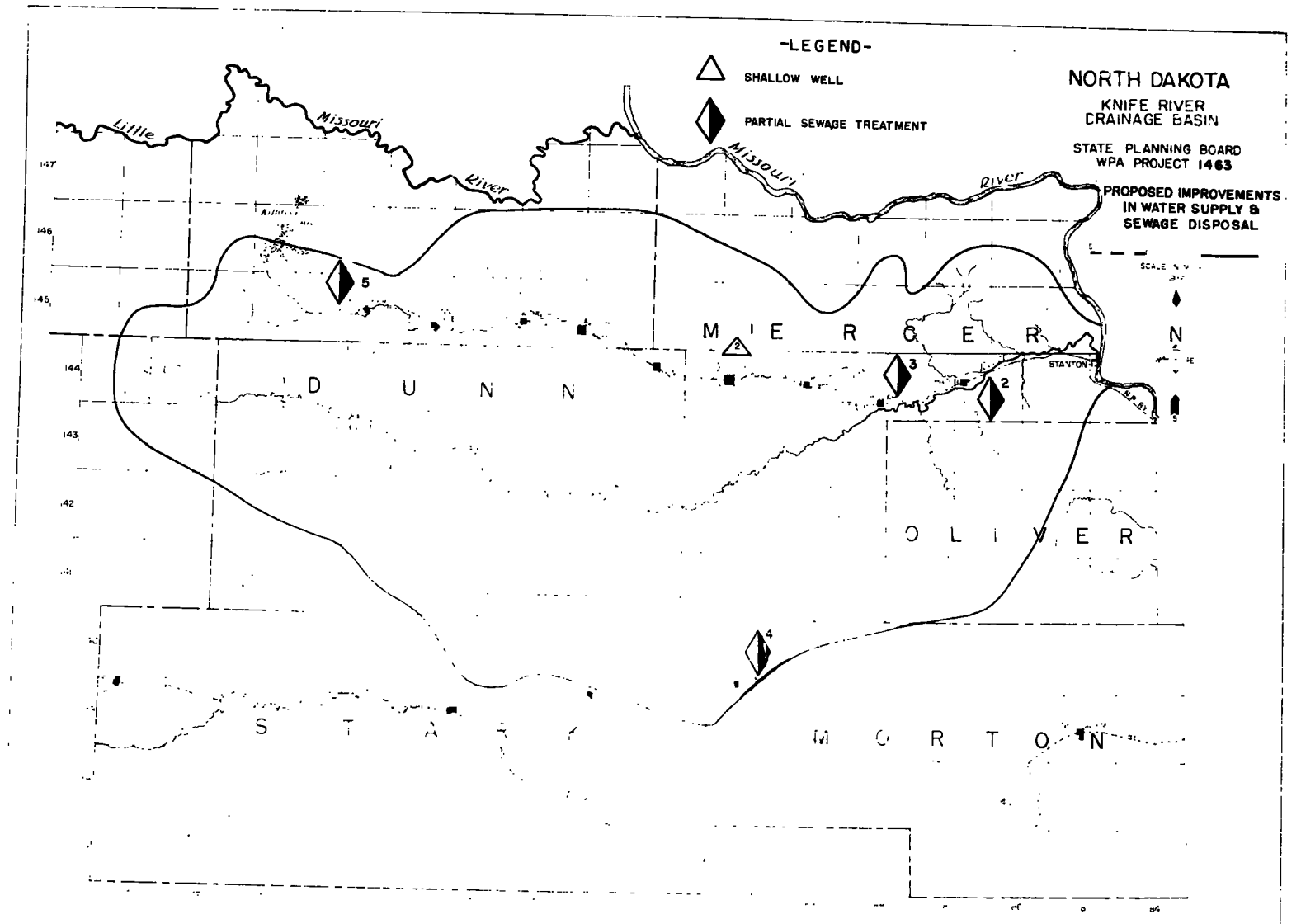
TABLE F

PROPOSED PROJECTS

KNIFE RIVER SUB-BASIN

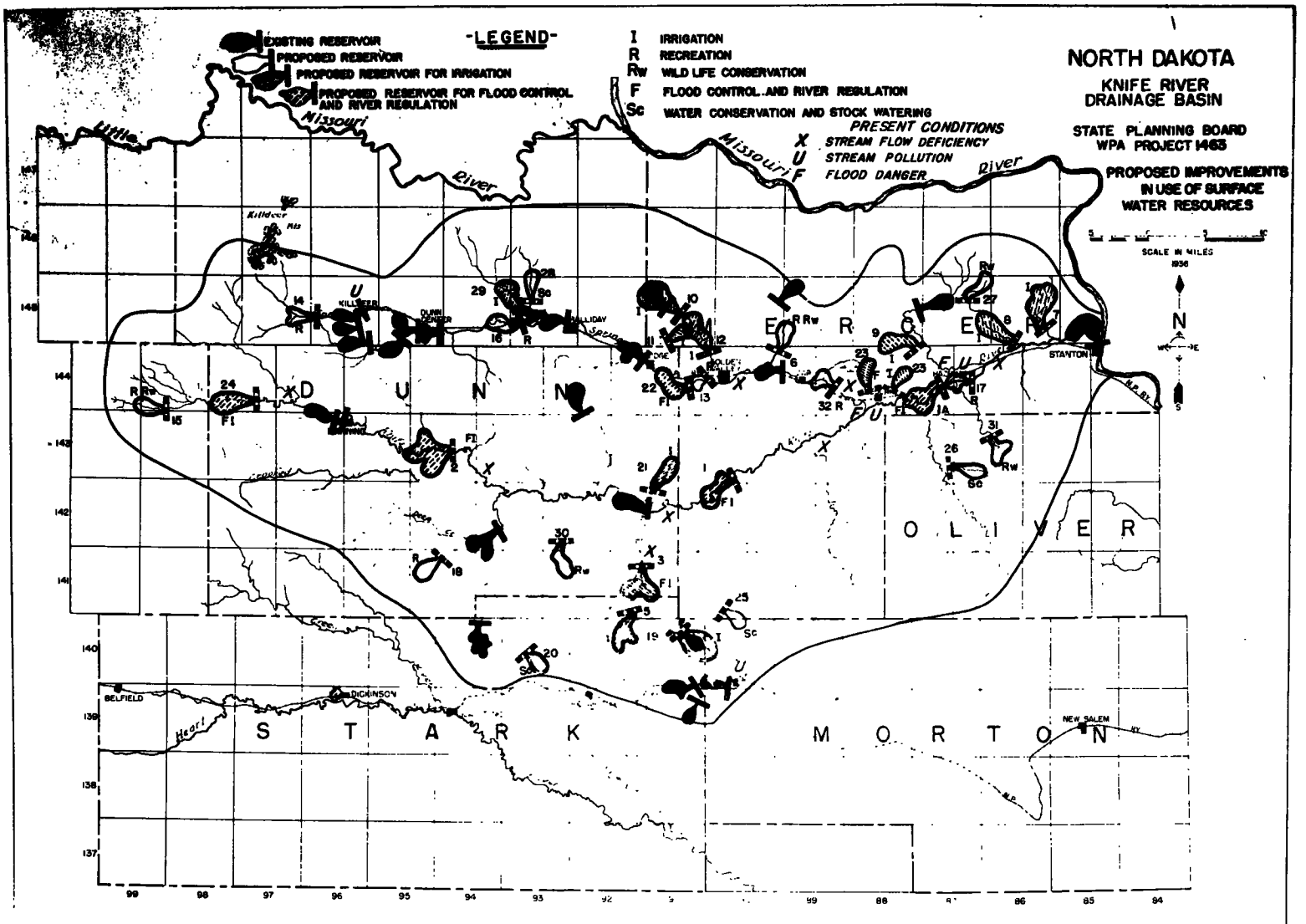
SUMMARY

CLASS "A" PROJECTS DEMANDING IMMEDIATE ATTENTION:		
Proposed Improvements in Water Supply	$ 100	
Proposed Improvements in Sewage Disposal	135,000	
Proposed Improvements in Use of Surface Water Resources.	100,600	
Total Class "A" Projects:		$ 235,700
CLASS "B" PROJECTS DEMANDING IMMEDIATE ATTENTION UPON COMPLETION OF SURVEY:		
Proposed Improvements in Water Supply	1,200	
Proposed Improvements in Use of Surface Water Resources	180,000	
Total Class "B" Projects:		181,200
CLASS "C" PROJECTS IN PLAN NOT INCLUDED IN CLASSES "A" AND "B":		
Proposed Improvements in Use of Surface Water Resources.	379,300	
Proposed Improvements in Stream Gaging and Weather Observation Facilities.	350	
Total Class "C" Projects:		379,650
TOTAL PROPOSED PROJECTS:		$ 1,096,550



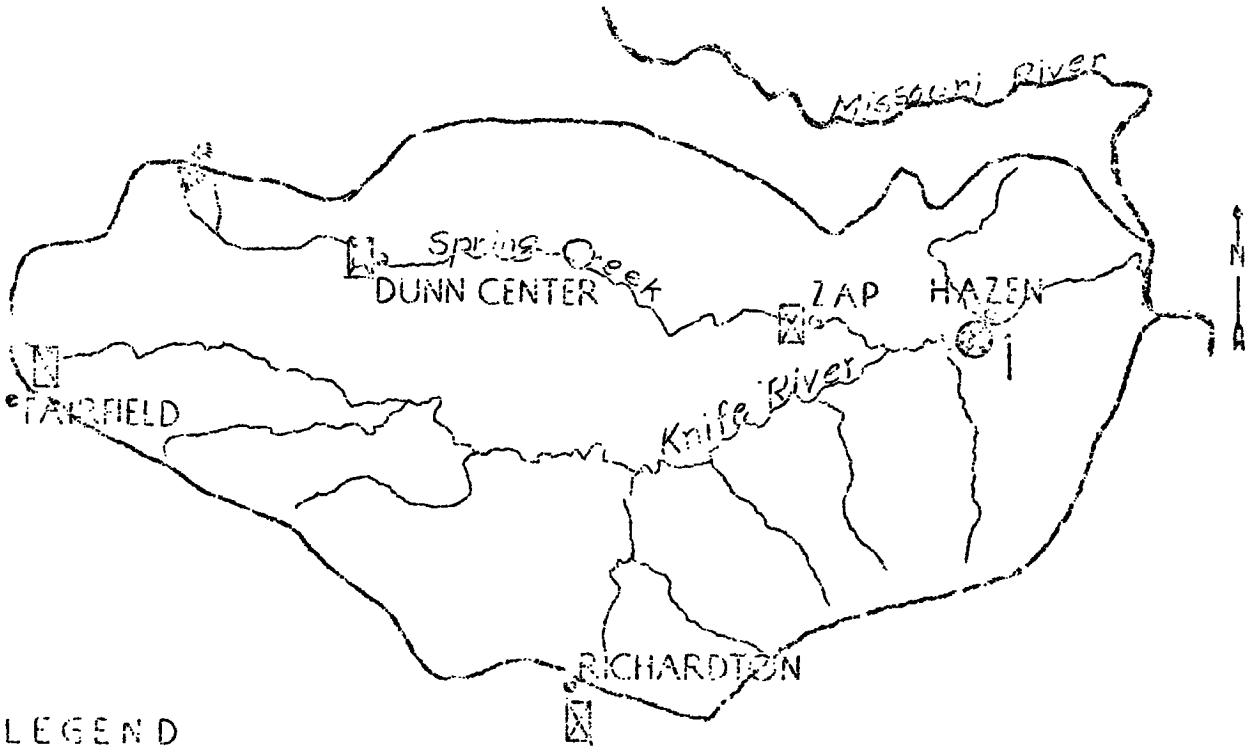
PREPARED IN OFFICE OF CONSULTANT

PLATE 1



PREPARED IN THE OFFICE OF THE CONSULTANT

PLATE II



LEGEND

Existing Weather Station

Proposed New Stream Gaging Station

KNIFE RIVER SUB-BASIN

STREAM GAGING
and
WEATHER OBSERVATION FACILITIES

Plate III

CHAPTER II

HEART SUB-BASIN

CHAPTER LI

HEART RIVER SUB-BASIN

GENERAL

The Heart River rises in Billings County near the northwestern corner of Stark County. It flows eastward in a tortuous course to its confluence with the Missouri River near Mandan, almost directly east of the source. At its most southerly point, where it crosses the Grant-Morton County line, it is perhaps 20 miles south of a straight line between the source and the mouth. The Sub-basin is approximately 120 miles in length, east and west, and has an average width of approximately 28 miles. The total area drained by the Heart River, all of which is in North Dakota, is 3,~~129~~ 343 square miles and includes most of Stark County and parts of Billings, Dunn, Hettinger, Grant, Morton, and Oliver counties.

POPULATION

The total population of the Sub-basin in 1930 was 31,913. 14,477 persons resided in incorporated cities and villages and 17,436 persons resided in more rural areas. Mandan and Dickinson, the two largest cities, have a population slightly in excess of 5,000 each.

FEDERAL AID

During the month of peak load, March 1935, there were 10,805 persons receiving federal aid in the Sub-basin. This was 33.9% of the total Basin population, an amount greater than the State average for the same month, which was 31.6%. In the peak month of W.P.A. employment, 785 persons were employed on works projects in or near cities and villages and 2,602 persons were employed on rural projects, making a total of 3,387 persons employed in October 1936.

TOPOGRAPHY

The entire Sub-basin lies in what is known as the Missouri Plateau. In the upper two-thirds of the Sub-basin the drainage courses are cut through the geological formation known as the Fort Union Formation. In the lower one-third they are cut through the Lance Formation. Part of the lower portion of the Sub-basin is covered by a thin layer of glacial drift.

The terrain varies from gently rolling prairies in the headwater areas to somewhat rough regions near the water courses. In some places the terrain becomes very hilly near the larger tributaries and the main stem. In the lower part of the Sub-basin the elevation of the upland is about 300 feet above the river channel. In the upper portion, the differences in elevation are not so great.

The elevation of the Heart River at its confluence with the Missouri River is approximately 1,615 feet above sea level, and at its headwaters it is approximately 3,000 feet above sea level. The total valley length is 130 miles and it has a drop of about 10 feet per mile. The length of the river channel is twice that of the valley. Although the average drop of the channel is 5 feet per mile, it is greatly in excess of this near the headwaters and becomes less as the stream approaches the Missouri River. The Heart River meanders from side to side through a valley about 1½ miles in width.

SOILS

The upland areas of the Sub-basin have good soil for agricultural purposes. It is composed of loam and silt loam, with patches of sandy loam. The bottoms are usually sandy loam to clay loam; clay to clay loam predominates in the breaks. Subsoils consist mainly of shale and sandstone. Natural drainage is good, and surface soils are generally free from excessive amounts of alkali. The farming lands are fertile and produce good grain crops in years of favorable precipitation.

TRIBUTARIES

There are several tributaries of the Heart River that are of importance in the development of a water program for the Sub-basin. On the north side of the river from west to east these are: Green River, Spring Creek, Muddy Creek, and Sweetbriar Creek. Those on the south side of the river are Antelope Creek of Stark County and Antelope Creek of Grant County.

NATURAL RESOURCES

Valuable deposits of lignite coal, bentonite, and clay are found in the Fort Union formation. Deposits of sand and gravel which are suitable for concrete aggregate are found in the Sub-basin. There are large quantities of boulders available for rubble masonry and riprapping purposes.

GROUND WATER

Water is found in the local alluvial deposits of the valley bottoms in the Heart River Sub-basin. The two important aquifers are the Fort Union and the Lance formations. Springs on the valley sides and deeper wells on the uplands secure their water from these sources.

THE WATER PROBLEM

The water problem is primarily one of stream flow regulation for purposes of flood prevention, for pollution abatement, for irrigation, and for recreational purposes.

There is a need for stream flow regulation in the Heart River Sub-basin. During portions of each year there is a large flow in the Heart River and its tributaries. However, during the greater portion of each year there is great stream flow deficiency.

Several towns in the Sub-basin are in need of improvements in their water supply and sewage disposal facilities. There is a need for several additional small reservoirs in the area for recreational purposes. Irrigation projects are needed to supplement upland farming and grazing operations and thus avert the feed shortage problem that is present during drought years.

PRECIPITATION

The 20 year average of precipitation in the Sub-basin is 14.83 inches annually. That during the growing season, May through September, is 9.98 inches. On the basis that approximately 14 inches of precipitation during the growing season is required to produce a fair crop in the Sub-basin, it is apparent that there was a deficiency of moisture for growing crops during at least one-half the twenty year period. There are several areas in the valleys of the Heart River and its tributaries that are potentially suitable for irrigation. Large storage reservoirs would have to be constructed to provide water for irrigation of these areas. This has not been done.

RUN-OFF

The run-off from the Sub-basin is rapid. The slope of the channels is great and little resistance to run-off in the form of sloughs, reservoirs or vegetation is present. The average run-off from the Sub-basin is about 0.80 inches or 152,000 acre-feet annually. A large portion of this occurs during spring months. The streams become very low and sometimes completely dry during the summer period.

FLOODS

Frequent damaging floods occur along the Heart River, particularly at Mandan where, it is estimated by the U. S. Army Engineers, the average annual flood damage done by the Heart River is $5,000. It is reasonable to expect a much greater flood at some future time than any that has been experienced since the settlement of the Sub-basin.

WILD-LIFE

The possibilities of developing the resources of the Heart Sub-basin are limited. The U. S. Bureau of Biological Survey has constructed only one project in this area because of the limited number of sloughs and shallow lakes suitable for development. Fish life in the streams would be greatly benefited by stream regulation.

RECREATION

There are no natural lakes in the Sub-basin suitable for recreational purposes. A number of reservoirs have been constructed in the Sub-basin in recent years. While a few of these are suitable for recreational purposes the greater portion of them become stagnant pools during the summer months. This is particularly true during drought years.

WATER POWER AND NAVIGATION

There is no water power or navigation development in the Sub-basin. The stream flow is so erratic that no developments of such character are contemplated. The U. S. Army Engineers gave some consideration to the development of power in connection with the proposed Heart Butte and Gladstone Reservoirs. There is an abundance of cheap fuel in the formation of lignite coal in the Sub-basin and the development of water power, even as a bi-product of proposed reservoir installations, would not be economical.

CHANNEL IMPROVEMENT

There has been no attempt made to improve existing stream channels in the Sub-basin. The streams have well defined and uniform channels which have considerable slope. These could not be greatly improved without involving excessive costs.

MUNICIPAL SUPPLY

The water supply problems of the towns in the Sub-basin are not acute. Several towns have inadequate supplies but in all probability a reliable source can readily be obtained by deepening existing wells or digging new wells at more favorable locations. Several towns are in need of assistance in installing water distribution and treatment systems for municipal supply.

STREAM POLLUTION

During summer months there is an accumulation of dead animals and municipal sewage in the streams which results in a health hazard to the inhabitants. Dickinson, in particular, is confronted with this problem. Their sewer outlet is just below a dam and the stream flow at this point is not sufficient for dilution purposes. A larger reservoir provided with gates is needed at Dickinson for purposes of sewage dilution. Improvements in the sewage treatment plant are also needed. Other towns in the Sub-basin are also in need of systems and treatment plants for disposal of their sewage. Adequate stream flow regulation is needed for sewage dilution purposes along the streams of the Sub-basin.

POSSIBLE IRRIGATION

As pointed out above, there are a number of areas in the valleys of the Heart River and tributary streams that are potentially well suited to irrigation. There is a deficiency in stream flow during periods when water would be needed for this purpose. Large regulating reservoirs properly located would provide water for irrigation of many of these areas by gravity flow. Additional areas could be irrigated by pumping from the stream channels which would be provided with an adequate flow. A number of proposed irrigation projects in the Sub-basin have been investigated by the U. S. Army Engineers, the State Engineer, the U. S. Bureau of Reclamation and other agencies.

USE OF IRRIGABLE LAND

The main objective of irrigation in the Heart River Sub-basin would be to supplement livestock and grazing operations carried on in the upland areas. During drought years sufficient feed would be grown on the irrigated areas to sustain foundation herds without the necessity of shipping in expensive feeds. If a sugar factory is established at Bismarck, as a result of the irrigation of Missouri River bottom lands, sugar beets could be profitably grown on irrigated areas in the Heart River Sub-basin.

STORAGE RESERVOIRS

The construction of several large reservoirs on the Heart River and its principal tributaries is desirable. In addition to preventing damaging spring floods these would provide a regulated stream flow for purposes of pollution abatement, recreation, and irrigation. The reservoirs would provide much needed lake areas in the Sub-basin.

EXISTING DAMS

A total of 51 existing dams in the Basin impound a maximum of 2,308 acres feet of water. These are used for the purposes of recreation, waterfowl refuges, stock watering, and railroad supply. The existing dams in the Basin are listed in Table A, and are shown on Plate II.

PROPOSED PROGRAM

It is proposed:

1. That several large reservoirs properly located and of suitable design be constructed on the Heart River and its principal tributaries to control the run-off from the Sub-basin and thereby provide adequate flood control and stream flow regulation. Proper stream flow regulation would make water available for purposes of pollution abatement, for recreation, and for the irrigation of large tracts of land in the stream valleys of the Sub-basin. Proposed large reservoirs are listed in Table D. and are shown on Plate II.

2. That levees be built to give additional flood protection to Mandan and the State Training School at Mandan. These are also listed in Table D. and are shown on Plate II.

3. That several small dams be installed at desirable locations for recreational purposes. Proposed small reservoirs are also listed in Table D. and are shown on Plate II. All dams constructed hereafter in the Sub-basin should be provided with outlet gates for releasing the water stored when a great need arises for it downstream or when it becomes so polluted that it is a definite health hazard to the community. Many existing dams should also be provided with outlet gates.

4. That assistance be given several towns in developing adequate water supply and sewage disposal facilities. Water

supply problems and their proposed solution are listed in Table B. Sewage disposal problems and their proposed solutions are listed in Table C. Both are shown on Plate I.

5. That stream gaging stations be installed and maintained for the recording of stream flow in the Heart River. There are no gaging stations maintained in the Heart River at the present time. Proposed stations are listed in Table E. and are shown on Plate III.

6. That a detailed soil survey and land classification be begun as soon as is possible on all lands that appear to be irrigable in order to ascertain the suitability of these lands for irrigation in each of the several areas. These surveys should follow the aerial mapping of the irrigable regions. This mapping will provide, in addition to its utility as the basis of the proposed soil survey and land classification, much needed data on present land use. The cost of the aerial mapping would approximate 5¢ per acre. The cost of the detailed soil survey and land classification would be an additional 5¢ per acre. Thus, to properly predetermine the areas suited to irrigation would entail the expenditure of 10¢ per acre for 19,500 acres of irrigable land in the Heart River Sub-basin, or approximately $2,000.

RURAL WATER SUPPLY

A large number of small reservoirs have been proposed for the Sub-basin by various agencies. Those that would serve purposes of recreation, irrigation, and waterfowl refuges have been included in the proposed program. It is proposed that before any more small dams for stock watering purposes be constructed in the Sub-basin, a detailed survey of rural water supply be undertaken to determine the best and most economical method of securing adequate and satisfactory water supplies for stock watering purposes. Where an adequate ground water supply is available, it is probable that this would be through the construction of community wells. In other localities not having a reliable ground water supply the construction of surface reservoirs would be only alternative. Following such a survey it is proposed that assistance be given in developing an adequate rural water supply.

HEART BUTTE RESERVOIR

The Heart Butte dam site would be located on the Heart River in section 13-136-89. Surveys and investigations have been made by former State Engineers, by the U. S. Bureau of Reclamation and by the U. S. Army Engineers. Plans and estimates were prepared by the Bureau of Reclamation and by the U. S. Army Engineers. Plans and estimates prepared by the Reclamation Bureau provide for a reservoir storage capacity of 180,000 acre feet. This would require a dam 89 feet high having a concrete

parapet wall three feet above the crest, a concrete lined horseshoe tunnel 14 feet in diameter with control works, and a concrete spillway equipped with five 16' x 17½' motor operated radial gates. The cost of this structure was estimated at one million dollars.

The primary objective of this reservoir would be to store water during periods of excessive run-off and to release it during periods of stream flow deficiency.

The Heart Butte project has not received favorable consideration in the past because of the high estimated cost of construction. The average annual run-off from the drainage area tributary to the proposed reservoir during the past 30 years was 72,000 acre feet. It is proposed that the Heart Butte Reservoir be designed and constructed to have an estimated storage capacity of 75,000 acre feet. This would provide ample flood protection for Mandan when supplemented by the proposed Gladstone and Green River reservoirs. It would also provide sufficient storage, to permit ample carry-over to provide adequate stream flow regulation during drought years, as the minimum annual run-off to the reservoir would be approximately 14,000 acre feet.

A further reduction in the cost of the dam could also be effected by the elimination of the radial gates and the 14 foot concrete tunnel. The tunnel was proposed to divert the river flow during construction. A conduit of 20 to 25 feet cross sectional area with proper control works would permit the release of sufficient water for use downstream. A study of the run-off graph shows that, with the proper planning of the construction program, this would also take the river flow during the construction period. The radial gates are unnecessary as the total combined storage of the proposed reservoirs would be 1½ times the average annual run-off from the tributary drainage area and the water would seldom reach spillway crest elevation.

The height for the dam, as proposed in this plan, is 65 feet. This is 24 feet less than that originally planned and would result in a considerable reduction in the cost. Other items would contribute to economical construction of the dam. There are sufficient boulders within a ten-mile radius of the dam site to provide stones for the riprapping of the dam. These would also be suitable for concrete aggregate if crushed. Sand from the river bed would be satisfactory for concrete if washed. Gravel could be secured from nearby gravel pits for a gravel blanket under the riprap. The reduced water level would materially reduce flowage damages.

A detailed estimate has not been prepared but a consideration of the reductions that would result from the redesign of the dam along the lines outlined above would indicate that $500,000 would be a liberal estimate. A more accurate estimate will be available upon completion of studies now being made by the U. S. Army Engineers.

A preliminary survey of the proposed large reservoir site on the Heart River above Dickinson was first made in 1924 by the State Engineer. This is an excellent natural reservoir site and has been proposed at this time by the Dickinson City Engineer.

THE GLADSTONE RESERVOIR

The Gladstone Reservoir site is located on the Heart River in Section 26-139-94. This dam was also surveyed by the U. S. Army Engineers and the U. S. Bureau of Reclamation. The reservoir capacity proposed was 75,000 acre feet. A reservoir having 75,000 acre feet storage capacity would inundate about 3 miles of Northern Pacific tracks in the vicinity of Gladstone and would submerge the valley crossing of a main county road entering Gladstone from the south.

The tributary drainage area of 800 square miles has an annual run-off of 33,600 acre feet. The proposed storage on Green River and other present and proposed uses of the water above the reservoir site would probably reduce the average annual yield to the Gladstone Reservoir to 25,000 acre feet. It is proposed to construct a reservoir having a storage capacity of 35,000 acre feet in the Heart River near Gladstone.

The proposed dam would be equipped with a controlled outlet conduit of approximately 20 square feet cross-sectional area. This outlet would take the river flow during construction and would maintain a satisfactory stream flow in the river below the reservoir after the completion of the reservoir for purposes of pollution abatement, recreation, and irrigation.

It is proposed that the dam be located above rather than below the mouth of Antelope Creek. This would confine the reservoir to the Heart River Valley and greatly reduce flowage damages. A better site is available here than below Antelope Creek. Local supplies of materials are available for construction.

GREEN RIVER DAM

The site for the proposed Green River dam has been field inspected by a representative of the North Dakota State Engineer. It is proposed to supplement the Heart Butte and the Gladstone reservoirs and would provide water for irrigation of 1,500 acres of bottom lands.

ECONOMIC JUSTIFICATION FOR RESERVOIRS

The proposed large reservoirs are necessary to the Sub-basin for purposes of stream flow regulation and to avert a possible major flood disaster to Mandan. Irrigation is necessary if the area is to become entirely self-sustaining. During the past two years more than $800,000 of federal aid, exclusive of Farm Credit Loans, has been necessary for the inhabitants of the Sub-basin. As stated elsewhere, 10,805 persons in the Sub-basin received federal aid during the month of March, 1935. This followed the drought of 1934. It is expected that the number receiving aid during the coming year will exceed this amount because of the extreme drought of 1936. The construction of these reservoirs would be an excellent form of work relief and the far-reaching results of their construction would tend to make the Sub-basin self-sustaining. Livestock and grazing operations of the farmers would be supplemented by the raising of winter feed on the irrigated areas.

Records show a crop failure due to drought during two years of each five-year period. Irrigation would greatly stabilize the farm industry within the Basin.

WEATHER OBSERVATION AND STREAM GAGING STATIONS

Proposed stream gaging stations on the Heart River and present weather recording stations in the Sub-basin are shown on Plate III. It is recommended that the State cooperate with the U. S. Weather Bureau and the U. S. Bureau of Geological Survey in establishing adequate facilities for the recording of weather and stream flow data in the Sub-basin.

TABLE A

EXISTING RESERVOIRS

HEART RIVER SUB-BASIN

No.	County	Sec.	Twp.	Rge.	Storage A. F.	Cost Est.	Use	Desig-nation	Description and Remarks	Legend
1.	Billings	3	139	100	10	$ 3,000	IV	F	Alex Monte Dam—Heart River.	***
2.	Grant	26	135	89	5	300	IV	E	Dam—Antelope Creek.	*
3.	Grant	1	134	88	5	500	IV	E	Dam—Antelope Creek.	*
4.	Grant	28	135	87	4	500	IV	F	Dam—Antelope Creek.	*
5.	Morton	16	138	81	3	1,300	IV	F	Dam—Coulee.	*
6.	Morton	9	138	81	2	1,500	IV	F	Dam—Coulee.	*
7.	Morton	19	139	85	14	5,000	III	E	Dam—South branch of Sweetbriar Creek. Near New Salem.	*
8.	Morton	15	139	86	38	6,500	IV	F	Dam—Muddy Creek.	*
9.	Morton	4	138	81	7	5,200	IV	F	Dam—Coulee.	*
10.	Stark	5	139	96	10	2,600	IV	F	Dam—Coulee.	*
11.	Stark	12	139	97	10	1,900	IV	F	Dam—Heart River.	*
12.	Stark	1	139	97	12	1,000	IV	F	Dam—Creek.	*
13.	Stark	19	138	94	4	4,000	IV	G	Dam—South branch of Antelope Creek.	*
14.	Stark	34	139	94	10	3,000	IV	G	Dam—Antelope Creek.	*
15.	Stark	13	139	97	49	7,000	IV	F	McBride Dam—Heart River.	*
16.	Stark	24	139	97	7	5,400	IV	E	Dam—Creek.	*

TABLE A (Cont'd.)

EXISTING RESERVOIRS

HEART RIVER SUB-BASIN

No.	County	Sec.	Twp.	Rge.	Storage A. F.	Cost Est.	Use	Desig-nation	Description and Remarks	Legend
17.	Stark	36	140	95	6	$ 2,200	IV	E	Dam--Green River.	*
18.	Stark	5	137	99	7	2,000	III	F	Molm Dam--Creek.	*
19.	Stark	9	138	99	13	1,600	IV	F	Jack Forest Dam--Creek.	*
20.	Stark	33	139	94	7	3,200	IV	F	Dam--Antelope Creek.	*
21.	Grant	24	134	88	66	400	III	G	Dam--Creek. Near Heil.	**
22.	Morton		139	81		4,000	I		Dike--State Training School at Mandan.	**
23.	Morton	11/12	139	90	7	500	IV	E	Dam--Creek.	**
24.	Morton		139	81		8,000	I		Dike--City of Mandan.	**
25.	Stark	13	138	96	48	14,200	IV	E	Frenzel Dam--Antelope Creek.	**
26.	Stark	14	139	99	25	7,300	IV	E	Indegaard Dam--Creek.	**
27.	Stark	1	139	97	10	3,000	IV	F	Whitney Dam--Creek.	***
28.	Stark	5	139	99	63	14,200	VI	F	Dam--Creek. At Belfield.	****
29.	Stark	8	139	96	367	77,300	VI	F	Dam--Heart River. Near Dickinson.	****
30.	Morton	31	139	88	111	41,800	VI	G	Dam--Creek. Near Glen Ullin.	****
31.	Morton	11	138	86	13	2,600	VI	G	Dam--Creek. At Sims.	****
32.	Stark	5	139	92	4	3,300	VI	F	Dam--Creek. At Richardton.	****

TABLE A (Cont'd.)

EXISTING RESERVOIRS

HEART RIVER SUB-BASIN

No.	County	Sec.	Twp.	Rge.	Storage A. F.	Cost Est.	Use	Desig-nation	Description and Remarks	Legend
33.	Morton	23	138	87	63	$ 8,000	III	G	Dam--Scab Creek.	**
34.	Morton	15	140	85	10	2,000	IV	G	Dam--Creek.	(***) (**
35.	Stark	6	139	97	46	6,000	III	E	Dam--North Creek.	**
36.	Stark	18	138	91	152	6,300	III,IV VII	E	Willows Dam--Spring Creek.	**
37.	Stark	27	140	95	60	11,400	IV	E	Dam--Green River.	*
38.	Stark	36	137	96	30	3,000	IV	P	Dam--Creek.	**
39.	Grant	2	135	85	30	3,000	IV	G	Dam--Creek.	**
40.	Hettinger	26	136	91	30	3,000	IV	G	Dam--Otter Creek.	**
41.	Billings	4	139	100	8	1,400	IV	P	Hahnvik Dam--Heart River Headwaters.	*
42.	Billings	26	140	100	8	1,500	IV	G	Talkington Dam--Coulee.	*
43.	Billings	28	139	100	20	2,000	IV	F	Emil Strand Dam--Coulee.	**
44.	Stark	2	139	98	13	1,500	IV	P	Herauf Dam--Coulee.	(***) (**
45.	Stark	12	139	96	50	5,000	IV	F	Schnell Dam--Coulee.	**
46.	Stark	4	140	95	42	2,500	IV	E	Burkhart Dam--Spring Creek.	**
47.	Oliver	36	141	85	500	5,000	VII	G	Lake Dillon Project.	(*****
48.	Morton	33	139	85	5	2,000	IV	P	Westmeyer Dam--Coulee.	**

TABLE A (Cont'd.)

EXISTING RESERVOIRS

HEART RIVER SUB-BASIN

No.	County	Sec.	Twp.	Rge.	Storage A. F.	Cost Est.	Use	Desig-nation	Description and Remarks	Legend
49.	Morton	22	138	88	4	$ 2,500	IV	P	Lidstron Dam—Coulee.	**
50.	Morton	22	138	89	35	2,500	IV	P	Hermes Dam—Coulee.	**
51.	Morton	17/18	138	87	45	3,000	IV	P	Bohr Dam—Coulee.	**
52.	Morton	16	140	84	80	3,000	IV	G	Kuether Dam—Coulee. Spring fed.	**
53.	Morton	24	139	89	79	3,000	IV	P	Meissner Dam—Coulee.	**
	TOTAL EXISTING RESERVOIRS:				2,308	$312,000				

LEGEND:

*	Constructed by CCC
**	Constructed by FERA and WPA
***	Constructed by Individuals
****	Constructed by Railways and Municipalities
*****	Constructed by U. S. Biological Survey

USE:

I	Flood Control and Stream Regulation
III	Recreation
IV	Stock Watering and Water Conservation
VI	Railway Supply
VII	Waterfowl Refuge

DESIGNATION:

E	Excellent
G	Good
F	Fair
P	Poor

TABLE B

PROPOSED IMPROVEMENTS IN WATER SUPPLY

HEART RIVER SUB BASIN

PLATE I MAP NO.	Municipality	Pop.	Objection to Present Supply	Proposed Improvements	Surveys	Wells	Treatment Plant	Dist. System	Total Estimate
1.	Belfield	653	High mineral content. Danger of pollution.	Treatment plant. Construction changes.			$ 10,000	$2,000	$12,000
2.	Dickinson	5025	Inadequate. Pumping equipment inadequate.	Survey and 3 wells. Pumping plant improvement.	100	$1,800		1,000	2,900
3.	Fryburg	50	Inadequate	Survey and 1 well.	100	600			700
4.	Glen Ullin	950	No Water System	Distribution System			10,000	30,000	40,000
5.	Lefor	100	Inadequate	Survey and 1 well.	100	600			700
6.	Mandan	5,037	Unsatisfactory	Treatment Plant			115,000		115,000
7.	New Salem	804	No Water System	Distribution System			10,000	30,000	40,000
8.	Taylor	263	Inadequate	Survey and 1 well	100	600			700
			Sub-Totals:		$400	$3,600	$145,000	$63,000	

TOTAL PROPOSED IMPROVEMENTS IN WATER SUPPLY: $ 212,000

TABLE B (Cont'd) PROPOSED IMPROVEMENTS IN WATER SUPPLY

HEART RIVER SUB-BASIN

SUMMARY

CLASS "A" PROJECTS DEMANDING IMMEDIATE ATTENTION:		
Local surveys of available sources	$ 400	
Distribution Systems	63,000	
Treatment Plants - Glen Ullin and New Salem	20,000	
Total Class "A" Projects;		$ 83,400
CLASS "B" PROJECTS DEMANDING IMMEDIATE ATTENTION UPON COMPLETION OF SURVEY:		
Shallow Wells		3,600
CLASS "C" PROJECTS IN PLAN NOT INCLUDED IN CLASSES "A" AND "B":		
Treatment Plants - Belfield and Mandan		125,000
TOTAL PROPOSED IMPROVEMENTS IN WATER SUPPLY:		$ 212,000

TABLE C

PROPOSED IMPROVEMENTS IN SEWAGE DISPOSAL

HEART RIVER SUB-BASIN

PLATE I MAP NO.	Municipality	Pop.	Type and Adequacy of Sewage Treatment	Proposed Improvements	Estimated Cost
CLASS "A" PROJECTS DEMANDING IMMEDIATE ATTENTION:					
9.	Glen Ullin	950	No Sewerage System	System and Treatment Plant	$ 45,000
10.	New Salem	804	No Sewerage System	System and Treatment Plant	45,000
11.	Richardton	710	No Sewerage System	System and Treatment Plant	40,000
12.	Belfield	653	No Sewerage System	System and Treatment Plant	35,000
13.	Elgin	505	No Sewerage System	System and Treatment Plant	35,000
14.	Dickinson	5,025	Sep. Septic Tank. S.C., G.C.	Treatment Plant	45,000
TOTAL PROPOSED IMPROVEMENTS IN SEWAGE DISPOSAL:					$ 245,000

LEGEND FOR SEWAGE AND SEWAGE TREATMENT:

Sep.	Separate System
S.C.	Screened
G.C.	Grit Chamber

BLE D

PROPOSED IMPROVEMENTS IN USE OF SURFACE WATER RESOURCES

HEART RIVER SUB-BASIN

ate II p No.	County	Sec.	Twp.	Rge.	Storage Cap.- A. F. Est.	Irr. Land Acres-Est.	Cost Est.	Use	Desig-nation	Description and Remarks	Survey
ASS "A" PROJECTS DEMANDING IMMEDIATE ATTENTION:											
	Grant	13	136	89			$ 5,000			Complete the survey and design of the Heart Butte Reservoir on the Heart River.	***
	Stark	7	139	96			3,000			Complete the survey and design of a large dam on the Heart River just above Dickinson.	(******)
	Stark	26	139	94			6,000			Complete the survey and design of the Gladstone Reservoir on the Heart River.	***
	Stark	5	140	96			5,000			Survey and design of Green River Reservoir.	**
	Morton		139	81			4,000	I		Construction of levees and straightening of channel of Heart River at State Training School.	*****
	Morton		139	81			14,000	I		Construction of levees and straightening of channel of Heart River at Mandan.	*****
	Entire Basin						5,000			Survey of small dams proposed for floor irrigation, recreation, and waterfowl refuge purposes. Survey of available water resources for stock watering where present supplies are inadequate. Recommendations to be made for the most satisfactory and economical solution of the problem through the construction of community wells or surface reservoirs.	*

TABLE D (Cont'd.) PROPOSED IMPROVEMENTS IN USE OF SURFACE WATER RESOURCES

HEART RIVER SUB-BASIN

Plate II Map No.	County	Sec.	Twp.	Rge.	Storage Cap.- A. F. Est.	Irr. Land Acres-Est.	Cost Est.	Use	Desig-nation	Description and Remarks	Survey
8.	Stark	3	139	96	147		$12,000	I,III	E	Repair and raising of the Dickinson Dam and the installation of a gate to assist in pollution abatement.	*****
9.	Morton	17	139	88	70		4,000	II	G	Construction of a series of 7 small dams for flood irrigation.	**
Total Class "A" Projects:					217		$58,000				

CLASS "B" PROJECTS DEMANDING IMMEDIATE ATTENTION UPON COMPLETION OF SURVEY:

1.	Grant	13	136	89	75,000	12,000	$500,000	I,II	E	Construction of Heart Butte Reservoir on Heart River south of Glen Ullin, North Dakota.	
2.	Stark	7	139	96	14,000	1,000	150,000	I,II III,IV, V,VI	E	Construction of Dickinson Reservoir on the Heart River.	(******)
3.	Stark	26	139	94	35,000	5,000	180,000	I,II	E	Construction of Gladstone Reservoir on the Heart River.	***
4.	Stark	5	140	96	10,000	1,500	200,000	I,II	E	Construction of the Green River Reservoir.	**
Total Class "B" Projects:					134,000	19,500	$1,030,000				

TABLE D (Cont'd.) PROPOSED IMPROVEMENTS IN USE OF SURFACE WATER RESOURCES

HEART RIVER SUB-BASIN

Plate II Map No.	County	Sec.	Twp.	Rge.	Storage Cap.- A. F. Est.	Irr. Land Acres-Est.	Cost Est.	Use	Desig-nation	Description and Remarks	Survey
CLASS "C" PROJECTS IN PLAN NOT INCLUDED IN CLASSES "A" AND "B":											
10.	Morton		139	81	200		$ 6,600	III	E	Dam--Heart River. After Construction of large reservoirs upstream. At Mandan.	*
11.	Billings	16	141	98	46		3,500	III,IV	E	Kordonowy Dam--Branch of Green River.	**
12.	Morton	10	138	88	31		4,000	III	F	Wisehart Dam--Couleo.	**
13.	Stark	15	138	93	60		12,000	III	G	Dam--Cannonball River.	**
14.	Morton	20	140	83	50		5,000	III	G	Dam--Creek.	*****
15.	Morton	28	139	88	20		2,000	III	G	Dam--Muddy Creek. Near Glen Ullin.	**
16.	Billings	29	142	98	84		8,000	III	E	Dennis Dam--Green River.	*****
17.	Grant	1	137	89	150		10,000	III	E	Dam--Creek.	**
7.	Entire Basin						50,000			Construction of community wells for stock watering and the construction of surface water reservoirs in certain communities after surveys have shown that ground water resources in the areas are unsatisfactory. Possible reservoir sites are: Grant County S 19/30-135, S 24-137-90, S 16-136-87, S 22-135-90, S 32-136-90, S 15-135-88, S 12-137-88 and S 18-134-88, and Hettinger County S 16-139-91.	
	Total Class "C" Projects:				641		$101,100				
	TOTAL PROPOSED IMPROVEMENTS IN USE OF SURFACE WATER RESOURCES:				134,858	19,500	$1,189,100				

TABLE D (Cont'd.)

PROPOSED IMPROVEMENTS IN USE OF SURFACE RESOURCES

HEART RIVER SUB-BASIN

SURVEY:

*	Nodo
**	Field Inspected by State Engineer
***	Surveyed by U. S. Army Engineers
****	Surveyed by CCC
*****	Surveyed by FERA and WPA
*******	Surveyed by State Engineers

USE:

I	Flood Control and Stream Regulation
II	Irrigation
III	Recreation
IV	Stock Watering and Water Conservation
V	Municipal Water Supply
VI	Railway Supply

DESIGNATION:

E	Excellent
G	Good
F	Fair
P	Poor

TABLE E PROPOSED IMPROVEMENTS IN STREAM GAGING AND WEATHER OBSERVATION FACILITIES

HEART RIVER SUB-BASIN

PLATE III MAP NO.	Station	New or Rehabilitated	Type of Station	Reading to be Taken	Cost Estimate
CLASS "C" PROJECTS IN PLAN NOT INCLUDED IN CLASSES "A" AND "B":					
1.	Richardton	Rehabilitated	Staff Recorder	River Stages	$ 350
2.	Sunny	Rehabilitated	Staff Recorder	River Stages	350
TOTAL PROPOSED IMPROVEMENTS IN STREAM GAGING AND WEATHER OBSERVATION FACILITIES:					$ 700

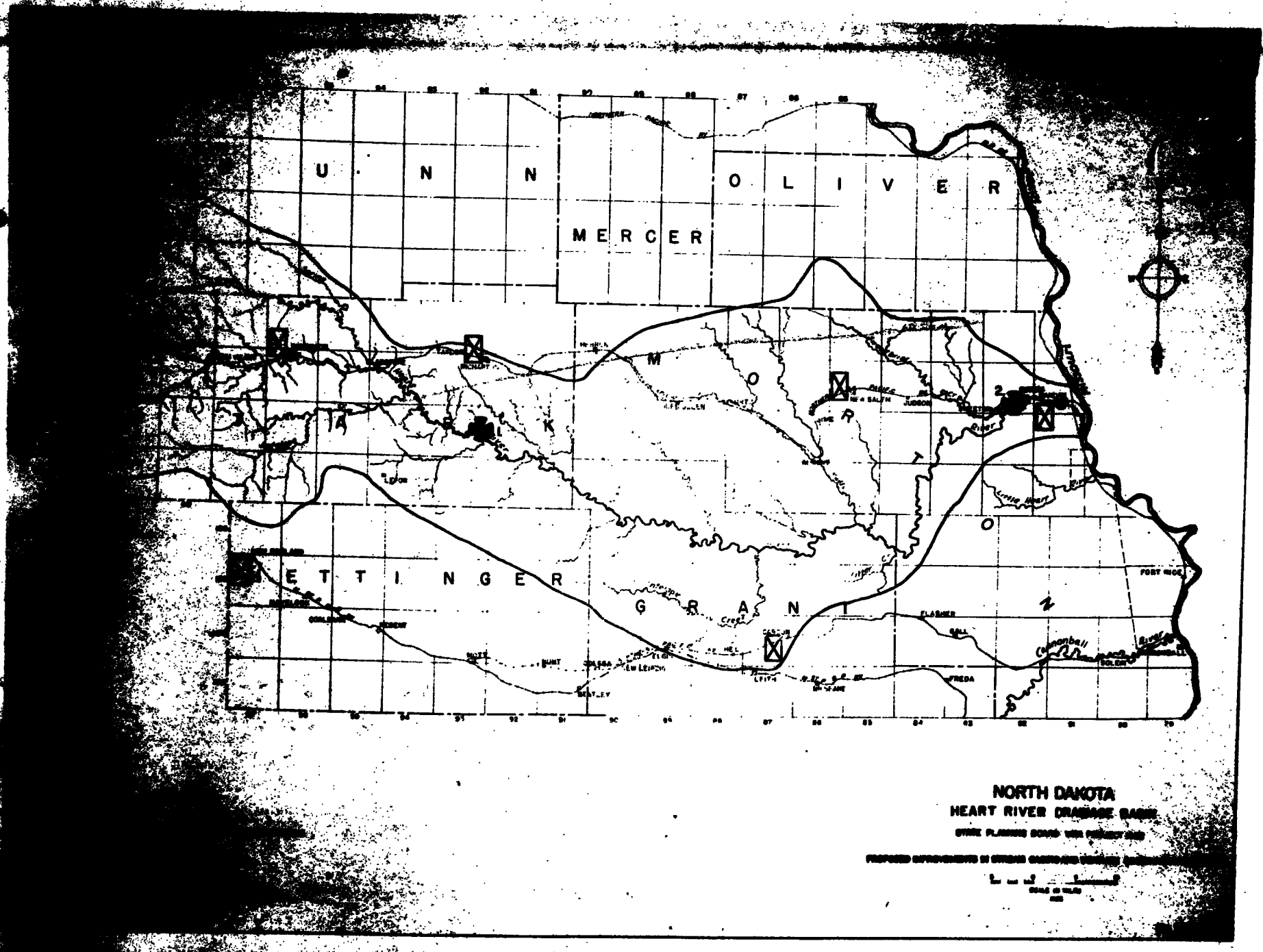
TABLE F

PROPOSED PROJECTS

HEART RIVER SUB-BASIN

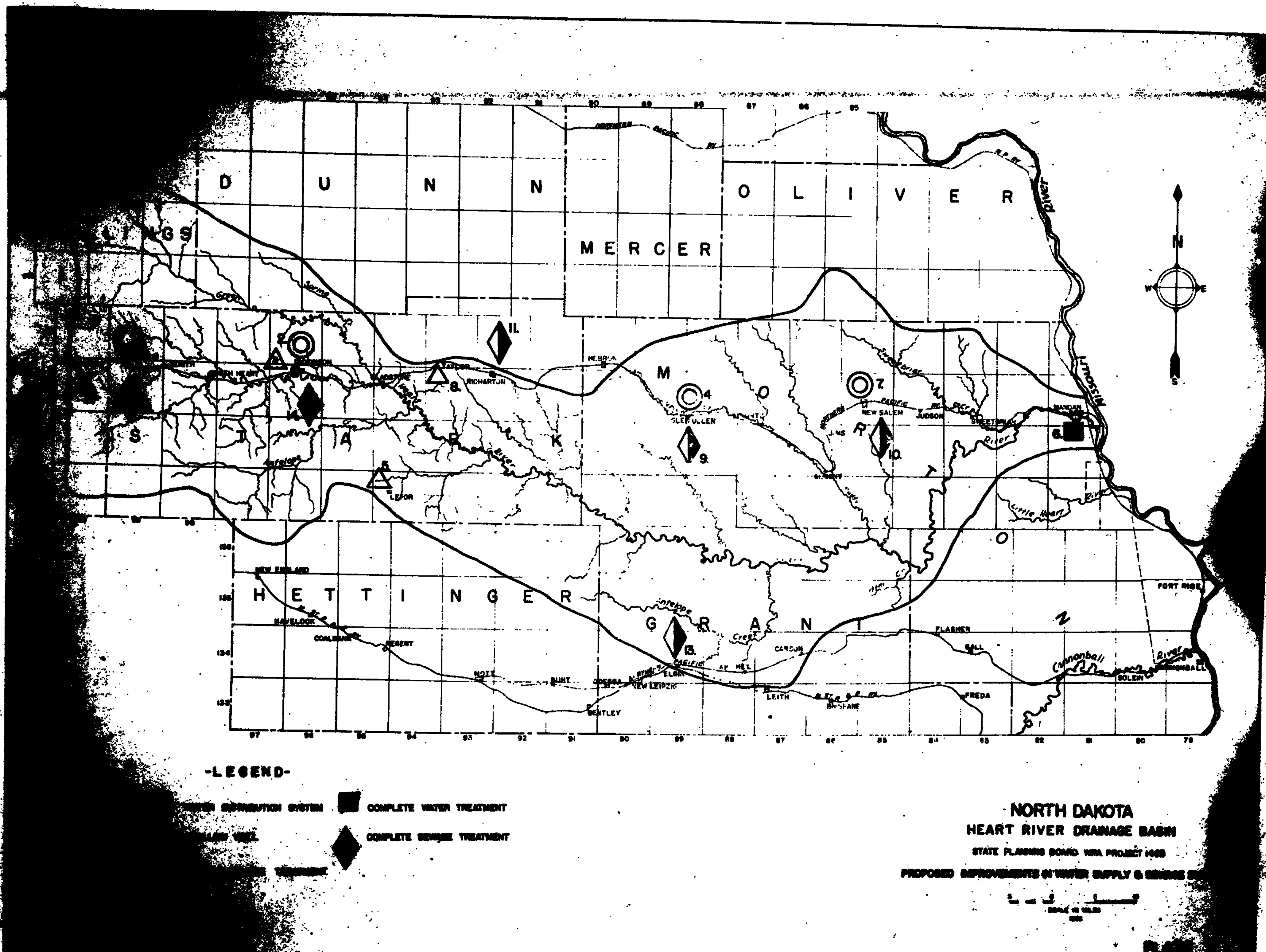
SUMMARY

CLASS "A" PROJECTS DEMANDING IMMEDIATE ATTENTION:		
Proposed Improvements in Water Supply	$ 83,400	
Proposed Improvements in Sewage Disposal	245,000	
Proposed Improvements in Use of Surface Water Resources.	58,000	
Total Class "A" Projects:		$ 386,400
CLASS "B" PROJECTS DEMANDING IMMEDIATE ATTENTION UPON COMPLETION OF SURVEY:		
Proposed Improvements in Water Supply	3,600	
Proposed Improvements in Use of Surface Water Resources.	1,030,000	
Total Class "B" Projects:		$ 1,033,600
CLASS "C" PROJECTS IN PLAN NOT INCLUDED IN CLASSES "A" AND "B":		
Proposed Improvements in Water Supply	125,000	
Proposed Improvements in Use of Surface Water Resources.	101,100	
Proposed Improvements in Stream Gaging and Weather Observation Facilities.	700	
Total Class "C" Projects:		$ 226,800
TOTAL PROPOSED PROJECTS:		$ 1,646,800



NORTH DAKOTA

HEART RIVER DRAINAGE BASIN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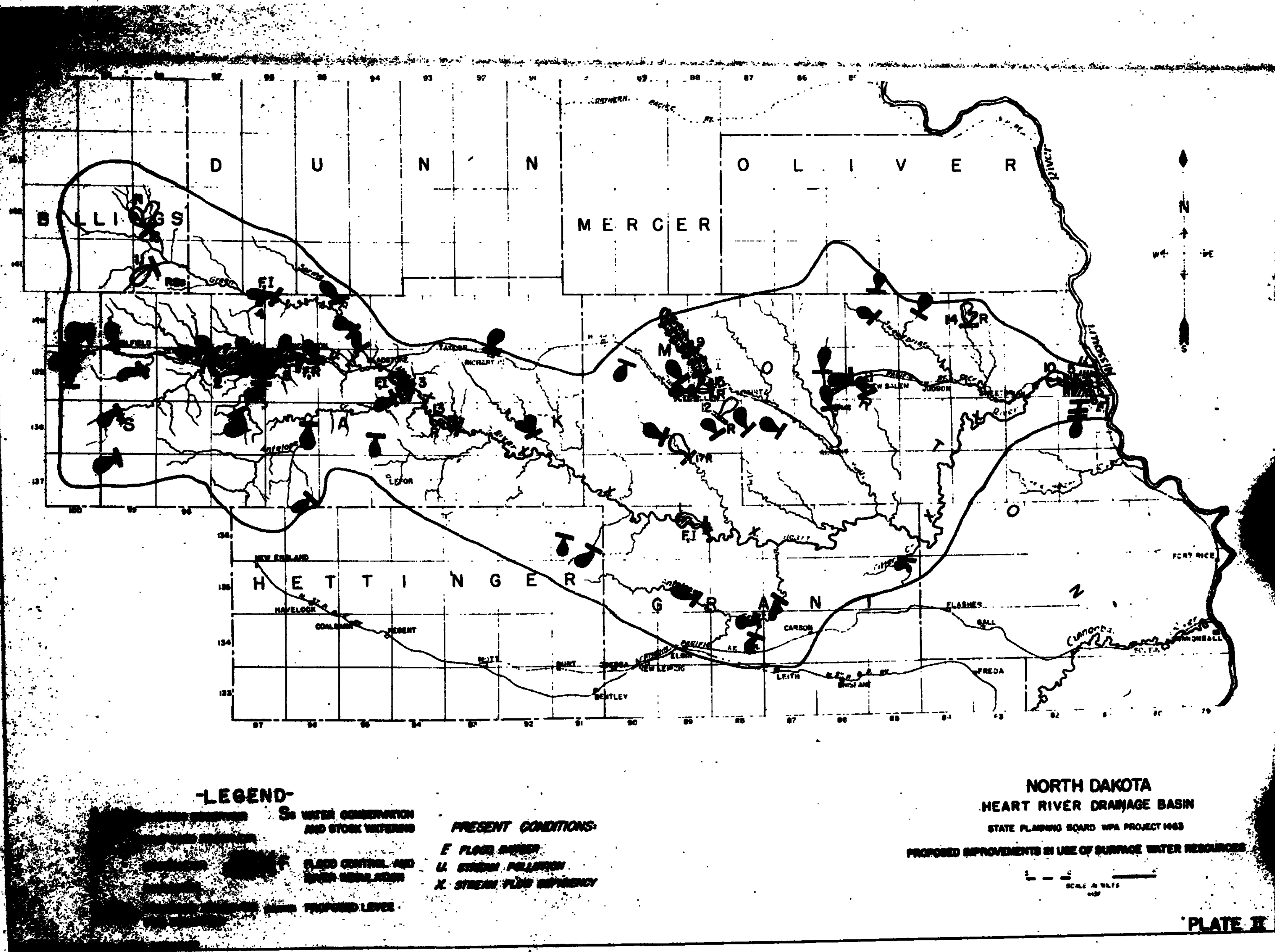
MERCER
OLIVER
MORTON
STARK
HETTINGER
GRANT
BILLINGS
Missouri River
Heart River
Cannonball River
Little Heart River
Antelope Creek
Sweetbriar
NEW SALEM
JUDSON
MANDAN
GLEN ULLEN
RICHARDTON
TAYLOR
LEFOR
FORT RICE
FLASHER
CARSON
ELGIN
NEW LEIPZIG
LEITH
BRISBANE
FREDA
SOLEN
MOTT
BENTLEY
REGENT
HAVELOCK
COALBANK
NEW ENGLAND
HEBRON
N
S
E
W
-LEGEND-
COMPLETE WATER TREATMENT
COMPLETE SEWAGE TREATMENT
NORTH DAKOTA
HEART RIVER DRAINAGE BASIN
STATE PLANNING BOARD WPA PROJECT
PROPOSED IMPROVEMENTS IN WATER SUPPLY & SEWAGE



D U N N
O L I V E R
MERCER
BILLINGS
S T A R K
M O R T O N
H E T T I N G E R
G R A N T
N
W
E
S
-LEGEND-
S WATER CONSERVATION AND STOCK WATERING
F FLOOD CONTROL AND RIVER REGULATION
PROPOSED LEVEE
PRESENT CONDITIONS:
F FLOOD DANGER
U. STREAM POLLUTION
X. STREAM FLOW DEFICIENCY
NORTH DAKOTA
HEART RIVER DRAINAGE BASIN
STATE PLANNING BOARD WPA PROJECT 1463
PROPOSED IMPROVEMENTS IN USE OF SURFACE WATER RESOURCES
PLATE II

CHAPTER III

CANNONBALL SUB-BASIN

CHAPTER III

CANNONBALL RIVER SUB-BASIN

GENERAL

The Cannonball River rises in the Northeastern corner of Slope County. Its main tributary, Cedar Creek, rises in the southeastern corner of Slope County. The two streams flow southeastward, and join on the Grant-Sioux county line. Cedar Creek and the Cannonball river form the north boundary of Sioux County and they flow northeastward in this area to the confluence with the Missouri River about 30 miles above the North Dakota-South Dakota state boundary line. The total area drained by the Cannonball River is about 4,600 square miles of which 4,513 are in North Dakota. The major part of Hettinger and Adams Counties, a large part of Grant County, portions of Slope, Sioux, and Morton Counties one or two townships in Stark County, and one or two townships in Bowman County are included within this Sub-basin.

POPULATION

The total population of the Sub-basin in North Dakota in 1930 was 24,925 of which 3,185 persons resided in incorporated cities and villages. Mott, the largest town in the Sub-basin, had a 1930 population of 1,036 persons; New England, second in size, had a 1930 population of 911 persons. The other towns in the Sub-basin had populations of less than 500 persons each. The major part of the inhabitants are dependent, directly or indirectly, on agriculture for a livelihood. The production of small grains, poultry, and livestock are the chief occupations.

FEDERAL AID

During the month of peak load, March 1935, 9690 persons or 38.9% of the total Basin population were receiving federal aid. The state average for the same month was 31.6%. In the peak month of W. P. A. employment, 440 persons were employed on works projects in or near cities and villages and 2,741 persons were employed on rural projects making a total of 3,181 persons employed in October, 1936.

TOPOGRAPHY

The total length of the Cannonball River is 295 miles and that of Cedar Creek is 221 miles. The headwater areas have an average elevation of nearly 3,000 feet above mean sea level. The elevation of the main stream at its confluence with the Missouri River is 1,592 feet above mean sea level. The Cannonball River thus shows the greatest variation in elevation of the rivers flowing eastward to the Missouri River.

The Cannonball River meanders through an irregular valley of from ¼ to 1½ miles in width. This valley has an average slope of approximately 8 feet per mile. The river channel, which is approximately twice as long as the valley, has an average slope of

about 4 feet per mile. The slope of most of the tributary stream channels is about 10 feet per mile.

The terrain is a comparatively rugged plateau area in the upper portion of the Sub-basin. There are numerous conspicuous buttes in this area. Black Butte rising to an elevation of 3,468 feet above mean sea level, is the highest point in the State. Much of the headwater area is a gently rolling prairie.

TRIBUTARIES

There are two important tributaries in addition to Cedar Creek that are of importance in preparing a water program for the Sub-basin. Trimmer, Freda, Raleigh, and Brisbane are located along Dogtooth Creek, and Flasher and Lark are located along its northern branch commonly called Louse Creek.

NATURAL RESOURCES

The Fort Union formation is exposed in the northern portion of the Sub-basin. Numerous deposits of lignite coal are found in this formation. The quality of the lignite from some of the deposits is said to be equal to any found in the state.

Field stones, suitable for rubble masonry, riprapping, and for concrete aggregate after crushing, are numerous in the upland areas of the Sub-basin. Gravel suitable for road material is also present but in most cases this is not suitable for concrete aggregate.

GROUND WATER

Adequate ground water supplies of fair quality are present in most portions of the Sub-basin. In some cases this water is discolored and has a strong taste and odor due to the dissolved organic matter obtained as it passes through the lignite coal veins. This is objectionable but usually not harmful. Springs are found on valley slopes in the Sub-basin and artesian wells can be obtained in the main valley.

THE WATER PROBLEM

The water problem of the Sub-basin is primarily one of stream flow regulation for purposes of flood prevention, for irrigation, and for recreational purposes. During portions of each year there is a large flow in the Cannonball River and its tributaries. However, during the greater portion of the year there is a great stream flow deficiency.

Several towns in the Sub-basin are in need of improvements in their water supply and sewage disposal facilities. There is a need for several additional small reservoirs in the area for recreational purposes. Irrigation projects are needed to supplement upland farming and grazing operations, and thereby avert the feed

shortage problem that is present during drought years.

PRECIPITATION

The twenty year average of annual precipitation in the Sub-basin was 14.87 inches; that during the growing season, May through September, was 9.96 inches. On the basis that approximately 14 inches of precipitation during the growing season is required to produce a fair crop in the Sub-basin, it is apparent that there was a deficiency of moisture for growing crops during more than one half the twenty year period. There are several areas in the Cannonball River Valley that are suitable for irrigation. Large storage reservoirs would have to be constructed to provide water for the irrigation of these areas.

RUN-OFF

The average annual run-off for the Sub-basin is 0.59 of an inch or 133,000 acre feet per year. The run-off is not as large as other Missouri Slope areas because of the many level bench land areas along the valleys. The major portion of the run-off occurs during the spring break-up period. The streams are virtually dry during summer months except during and immediately following violent storms.

FLOODS

The Cannonball River frequently exceeds flood stage. There are no towns located on the river bottom lands and therefore the flood damage is limited to that done to the farms in the valley.

WILD LIFE

The U. S. Bureau of Biological Survey is presently developing the waterfowl resources in the Sub-basin. In addition, there is a reservoir which was constructed by the State Game and Fish Department as a waterfowl refuge. Several of the small reservoirs in the area assist in the conservation of the wildlife of the area. However, the ultimate development can come only with the development of adequate stream flow regulation.

RECREATION

Several reservoirs in the Sub-basin serve the recreational needs of surrounding communities. These have not been ideal during recent drought years due to the early pollution of the water. Stream flow regulation is necessary to adequately develop the water resources of the Sub-basin for recreational purposes. Several additional small reservoirs at desirable locations would make water available for a larger portion of the Sub-basin for recreational purposes and would be particularly useful during normal years.

POWER AND NAVIGATION

The streams of the Sub-basin are not navigable and, because of the limited and intermittent flow, the development of water power is not practicable. The power needs of the Sub-basin are served by generating plants utilizing lignite coal as fuel.

CHANNEL IMPROVEMENTS

There has been some rock revetment work done on stream banks adjecent to the Northern Pacific Railway fills in the Sub-basin. No additional channel improvement is contemplated or proposed.

MUNICIPAL SUPPLY

The municipal water supply problem is not acute in the Sub-basin. Amidon reports an inadequate supply for fire protection and needs an additional well or wells for this purpose. Flasher has acquired the use of the railway reservoir located nearby for fire protection. There is a need for a pipe line to this reservoir.

STREAM POLLUTION

There is a serious stream pollution problem present in the Sub-basin which is particularly aggravated during drought years. New England and Mott dump their sewage into nearby streams which are virtually dry during summer months. This results in a serious health hazard, particularly downstream from Mott. In addition to pollution from sewage there is an accumulation of dead animals and other debris in stream channels which causes a contaminated condition of the small amount of water usually present in the streams during summer months. Stream flow regulation would greatly alleviate the pollution problem in the Sub-basin.

POSSIBLE IRRIGATION

Approximately 26,000 acres of bottom lands in the Sub-basin are potentially irrigable. Irrigation on a small scale has been tried by pumping from small reservoirs. This has been highly successful for small areas such as gardens. However, the irrigation of a large area would require the construction of a number of small reservoirs at considerable cost. Large reservoirs can be built at suitable locations and would store water much more economically than would a series of small reservoirs. Water could be released from these reservoirs as needed into ditches for irrigation by gravity flow and into the stream channel from which it could be pumped for projects farther downstream.

USE OF IRRIGABLE LAND

The main objective of irrigation in the Sub-basin would be to supplement the livestock and grazing operations of the upland areas. During drought years sufficient feed would be grown on the irrigated areas to sustain foundation herds without the necessity of shipping in expensive feeds. This would lead to a more prosperous condition throughout the Sub-basin.

EXISTING RESERVOIRS

A total of 38 existing dams in the Sub-basin impound a maximum of 6,561 acre feet of water. These are used for purposes of

recreation, stock watering, railroad supply, waterfowl refuges, and fire protection. Existing dams in the Sub-basin are listed in Table A and are shown on Plate II.

PROPOSED PROGRAM

It is proposed:

1. That three large reservoirs be constructed in the Sub-basin to provide stream flow regulation for purposes of irrigation, recreation, and pollution abatement. Proposed Projects are listed in Table D and are shown on Plate II.

2. That several additional small reservoirs be created where there is a definite need for them for recreation, stock watering, or other purposes. Proposed projects are also listed in Table D and are shown on Plate II. All dams constructed hereafter in the Sub-basin should be provided with outlet gates for releasing the water stored when a great need arises for it downstream or when it becomes so polluted that it is a definite health hazard to the community. Many existing dams should also be provided with outlet gates.

3. That assistance be given several towns in developing adequate water supply and sewage disposal facilities. Water supply projects are listed in Table B and sewage disposal projects are listed in Table C and both are shown on Plate I.

4. That weather observation stations be established at Amidon and at Stowers. These are listed in Table E and are shown on Plate III.

5. That a detailed soil survey and land classification be begun as soon as is possible on all lands that appear to be irrigable in order to ascertain the suitability of the lands for irrigation in each of the several areas. These surveys should follow the aerial mapping of the irrigable regions. This mapping will provide, in addition to its utility as the basis of the proposed soil survey and land classification, much needed data on present land use. The cost of the aerial mapping would approximate 5¢ per acre. The cost of the detailed soil survey and land classification would be an additional 5¢ per acre. Thus, to properly predetermine the areas suited to irrigation would entail the expenditure of 10¢ per acre for 26,000 acres of irrigable land in the Cannonball River Sub-basin, or approximately $2,600.

RURAL WATER SUPPLY

A large number of small reservoirs have been proposed for the Sub-basin by various agencies. Those that would serve purposes of recreation, irrigation and waterfowl refuges have been included in the proposed program. It is proposed that before any more small dams for stock watering purposes be constructed

in the Sub-basin, a detailed survey of rural water supply be undertaken to determine the best and most economical method of securing adequate and satisfactory water supplies for stock watering purposes. Where an adequate ground water supply is available it is probable that this would be through the construction of community wells. In other localities not having a reliable ground water supply the construction of surface reservoirs would be the only alternative. Following such a survey it is proposed that assistance be given in developing an adequate rural water supply.

PROPOSED STORAGE RESERVOIRS

A dam located in section 14-131-86 and another in section 8-129-87 would intercept large amounts of run-off. The sites would provide large amounts of storage with minimum flowage damages. Suitable local materials are available for construction. Only preliminary investigations of the sites have been made but these seem to offer definite possibilities.

SOLEN RESERVOIR

The U. S. Army Engineers have investigated the Solen Reservoir site and have found it to be feasible for a reservoir of storage capacity up to 160,000 acre feet. The cost was estimated at $1,749,000 for a 160,000 acre feet reservoir. In addition, a reservoir of such large capacity would flood the town of Solen, approximately 12 miles of the Northern Pacific track, and 1 mile of State Highway No. 12. This would result in enormous flowage damages.

A study of the run-off data for the Sub-basin has resulted in the conclusion that a reservoir of 50,000 acre feet capacity would amply serve the needs for which the project is intended, namely, the irrigation of 15,000 acres of Cannonball River bottom lands. The reduction in the size of the dam would materially reduce the flowage damages and would allow a more economical design for the dam. It is believed a liberal estimate of the cost of such a reservoir, including flowage damages, would be $500,000.

ECONOMIC JUSTIFICATION FOR LARGE RESERVOIRS

A total of 38 small dams have been constructed in the Sub-basin at an estimated cost of $279,100. In March of 1935, 38.9% of the population were dependent upon the federal government for subsistance. During the coming year there will be a great need for additional work relief within the Sub-basin due to the severe drought of 1936. A water program such as proposed here would tend to make this entire area self-dependent.

The irrigation that would develop in the Sub-basin as a result of the construction of the proposed large reservoirs would make the projects largely self-financing. However, in view of the large amount of work relief required in the Sub-basin and the great value to the entire State of developing a prosperous area, it is proposed that a large part of the cost of the reservoirs be charged to the rehabilitation of the Sub-basin.

WEATHER OBSERVATION AND STREAM GAGING STATIONS

Existing weather observation and stream gaging stations together with the proposed new weather recording stations at Amidon and Stowers are shown on Plate III. It is also strongly urged that all existing facilities be maintained.

TABLE A

EXISTING RESERVOIRS

CANNONBALL RIVER SUB-BASIN

No.	County	Sec.	Twp.	Rge.	Storage A. F.	Cost Est.	Use	Desig-nation	Description and Remarks	Legend
1.	Adams	1	129	94	200	$ 1,500	II, VII	G	Dam--Duck Creek.	(***) (********)
2.	Adams	5	130	91	15	2,000	IV	P	Dam--Coulee.	**
3.	Adams	22	129	91	190	6,600	III, IV	F	Dam--Coulee.	**
4.	Slope	17	136	98	25	1,500	IV	E	Dam--Creek.	*
5.	Slope	36	136	98	59	8,000	IV	G	Dam--Creek.	*
6.	Slope	35	133	98	2,750	29,400	II,III, IV,VII	E	Dam--Cedar Creek.	*
7.	Slope	26	135	100	711	22,800	VII	F	White Lake Dam.	*****
8.	Slope	16	136	98	123	10,000	IV	E	Dam--Cannonball River headwaters.	*
9.	Hettinger	13	134	97	10	1,500	IV	G	Dam--Coalbank Creek.	*
10.	Hettinger	5	133	97	28	4,000	IV	E	Dam--Chantapeta Creek.	*
11.	Hettinger	17	136	95	64	7,200	IV	E	Dam--Branch of Thirty Mile Creek.	*
12.	Hettinger	18	135	95	13	1,900	IV	E	Dam--Creek.	*
13.	Hettinger	8	134	94	1,167	13,200	III	G	Dam--Creek.	(*) (**)
14.	Hettinger	24	133	97	65	6,200	IV	E	Dam--Chantapeta Creek.	*
15.	Hettinger	34	135	96	45	4,900	III	G	Dam--Coalbank Creek.	*

TABLE A (Cont'd.)

EXISTING RESERVOIRS

CANNONBALL RIVER SUB-BASIN

No.	County	Sec.	Twp.	Rge.	Storage A. F.	Cost Est.	Use	Desig-nation	Description and Remarks	Legend
16.	Hettinger	17	133	92	32	$ 4,900	IV	E	Dam—Creek.	*
17.	Hettinger	20	136	97	20	3,600	IV	F	Dam—Coulee.	*
18.	Hettinger	27	136	97	55	7,000	IV	F	Dam—Coulee.	*
19.	Hettinger	10	135	96	40	3,200	IV	G	Dam—Creek.	*
20.	Hettinger	2	133	93	32	23,400	III,VI	E	Dam—Cannonball River. N. P. Railway.	****
21.	Hettinger	4	135	97	70	15,000	III	E	City Dam—Cannonball River. New England.	****
22.	Hettinger	14	134	97	182	9,000	IV	F	Culver Dam—Coalbank Creek.	*
23.	Hettinger	32	136	97	72	8,000	III,IV	F	Kary Dam—Cannonball River.	*
24.	Hettinger	27	134	95	55	4,000	IV	E	Dam—Creek.	**
25.	Grant	16	133	87	40	4,000	IV	F	Dam—Coulee. Near Leith.	**
26.	Grant	12	134	86	18	1,600	IV	F		*
27.	Morton	3	134	84	82	5,000	III,IV, V	G	Dam—Louse Creek. Near Flasher.	****
28.	Grant	29	134	89	35	1,400	IV	P	Dam—Coulee.	*
29.	Grant	36	133	85	30	2,000	IV	F	Dam—Coulee.	***
30.	Grant	36	131	90	30	2,000	IV	F	Dam—Coulee.	***
31.	Grant	2	132	83	104	14,000	IV	F	Carlson Dam—Cannonball River.	**

TABLE A (Cont'd.)

EXISTING RESERVOIRS

CANNONBALL RIVER SUB-BASIN

No.	County	Sec.	Twp.	Rge.	Storage A. F.	Cost Est.	Use	Desig-nation	Description and Remarks	Legend
32.	Morton	20	134	84	6	$ 1,200	IV	F	Dam--Coulee	**
33.	Morton	36	134	82	20	26,400	VI	E	Dam--Cannonball River. Brien. R. R. Supply,	****
34.	Sioux	7	129	90	30	4,000	IV	F	Dam--Creek.	***
35.	Stark	32	137	99	65	8,700	IV	G	Community Hall Dam--Coulee.	**
36.	Sioux	36	130	84	30	2,000	IV	F	Dam--Coulee.	***
37.	Sioux	8	129	90	30	2,000	IV	F	Dam--Coulee.	***
38.	Stark	27	137	99	58	6,000	IV	P	Hanson Dam--Coulee.	**
	TOTAL EXISTING RESERVOIRS:				6,561	$279,100				

LEGEND:

*	Constructed by CCC
**	Constructed by FERA and WPA
***	Constructed by individuals
****	Constructed by Railways and Municipalities
*****	Constructed by U. S. Biological Survey
********	State Game and Fish Department

USE:

II	Irrigation
III	Recreation
IV	Stock Watering and Water Conservation
V	Municipal Water Supply
VI	Railway Supply
VII	Waterfowl Refuge

DESIGNATION:

E	Excellent
G	Good
F	Fair
P	Poor

TABLE B

PROPOSED IMPROVEMENTS IN WATER SUPPLY

CANNONBALL RIVER SUB-BASIN

PLATE I MAP NO.	Municipality	Pop.	Objection to Present Supply	Proposed Improvements	Surveys	Wells	Dist. System	Total Estimate
(1)	Amidon	141	Inadequate for fire protection.	Survey and one well.	100	600		700
(2)	Flasher	336	Inadequate for fire protection.	Main to Railway Reservoir			3,000	3,000
(3)	New Leipzig	443	Needs Improvements	Improvements			50	50
			Sub-Totals:		100	600	$ 3,050	
TOTAL PROPOSED IMPROVEMENTS IN WATER SUPPLY:								$ 3,750

TABLE B (Cont'd)

PROPOSED IMPROVEMENTS IN WATER SUPPLY

CANNONBALL RIVER SUB-BASIN

CLASS "A" PROJECTS DEMANDING IMMEDIATE ATTENTION:		
Local surveys of available sources - Amidon	$ 100	
Distribution Systems - New Leipzig	50	
Total Class "A" Projects:		$ 150
CLASS "B" PROJECTS DEMANDING IMMEDIATE ATTENTION UPON COMPLETION OF SURVEY:		
Shallow Wells		600
CLASS "C" PROJECTS IN PLAN NOT INCLUDED IN CLASSES "A" AND "B":		
Distribution Systems - Flasher		3,000
TOTAL PROPOSED IMPROVEMENTS IN WATER SUPPLY:		$ 3,750

TABLE C

PROPOSED IMPROVEMENTS IN SEWAGE DISPOSAL

CANNONBALL RIVER SUB-BASIN

Plate I Map. No.	Municipality	Pop.	Type and Adequacy of Sewage Treatment	Proposed Improvements	Estimated Cost
CLASS "C" PROJECTS IN PLAN NOT INCLUDED IN CLASSES "A" AND "B":					
4.	Mott	1036	Sep. Septic Tank. G.C., P.S., Lift station. Inadequate.	Treatment Plant	$ 35,000
5.	New England	911	Sep. Septic Tank. S.C., G.C., Extensions needed	Extensions to sewage system.	25,000
6.	New Leipzig	413	No sewage system.	Sewage system and sewage treatment plant.	35,000
TOTAL PROPOSED IMPROVEMENTS IN SEWAGE DISPOSAL:					$ 95,000

LEGEND FOR SEWAGE AND SEWAGE TREATMENT:

Sep.	Separate System.
S.C.	Screened
G.C.	Grit Chamber
P.S.	Pumping Stations.

TABLE D

PROPOSED IMPROVEMENTS IN USE OF SURFACE WATER RESOURCES
CANNONBALL RIVER SUB-BASIN

Plate II Map No.	County	Sec.	Twp.	Rge.	Storage Cap.- A. F.-Est.	Irr. Land- Acres-Est.	Cost Est.	Use	Desig- nation	Description and Remarks	Survey
CLASS "A" PROJECTS DEMANDING IMMEDIATE ATTENTION:											
1.	Grant	14	131	86			$ 8,000			Survey and design of large dam on Cannonball River.	**
2.	Morton & Sioux		134	80			8,000			Survey and design of large dam on Cannonball River.	**
3.	Grant & Sioux	8	129	87			8,000			Survey and design of large dam on Cedar Creek.	*
4.	Entire Basin						10,000			Survey of small dams proposed for flood irrigation, recreation, and waterfowl refuges. Survey of available water resources for stock watering where present supplies are inadequate. Recommendations to be made for the most satisfactory and economical solution to the problem through the construction of community wells or surface reservoirs.	*
5.	Hettinger	34	134	93	150		12,000	I, III	E	Dam with control gates on Cannonball River above Mott, supplemental to present reservoir.	*
6.	Adams	16	131	91	60		4,000	VII	E	Dam—Timber Creek. Recommended to U. S. Biological Survey.	*
7.	Adams	24	132	95	200		10,000	III	G	Dam—Branch of Chantapeta Creek.	**
8.	Grant	18/20	132	87	120		10,000	III,IV	E	Dam—Cannonball River.	**
9.	Grant	9	134	85	50		2,000	II	E	Dam—Coulee.	**
10.	Grant	3	134	85	5		500	II	E	Dam—Louse Creek.	**
	Total Class "A" Projects:				585		$72,500				

TABLE D (Cont'd.)

PROPOSED IMPROVEMENTS IN USE OF SURFACE WATER RESOURCES

CANNONBALL RIVER SUB-BASIN

Plate II Map No.	County	Sec.	Twp.	Rge.	Storage Cap.- A. F.-Est.	Irr. Land- Acres-Est.	Cost Est.	Use	Desig-nation	Description and Remarks	Survey
CLASS "B" PROJECTS DEMANDING IMMEDIATE ATTENTION UPON COMPLETION OF SURVEY:											
1.	Grant	14	131	86	15,000	5,000	$250,000	I, II	E	Large Dam--Cannonball River.	**
2.	Morton & Sioux		134	80	50,000	15,000	500,000	I, II III,IV	E	Large dam--Cannonball River. Near Solen.	(**) (***)
3.	Grant & Sioux	8	129	87	50,000	6,000	500,000	I, II, III,IV	E		
	Total Class "B" Projects:				115,000	26,000	$1,250,000				
CLASS "C" PROJECTS IN PLAN NOT INCLUDED IN CLASSES "A" AND "B":											
11.	Hettinger	28	132	92	1,000		$25,000	IV,VII	G	Dam--Timber Creek.	*
11 a.	Hettinger	20	132	92		Alternate to No. 10.			G	Dam--Timber Creek.	*
11 b.	Hettinger	26	132	93		Alternate to Nos. 10 or 10a			G	Dam--Timber Creek.	*
12.	Hettinger	36	134	91	500		10,000	VII	E	Dam--Thirty-mile creek.	*
13.	Hettinger	12	133	91	80		10,000	I,III, IV,VII	E	Dam--Cannonball River.	*
14.	Hettinger	31	132	95	200		12,000	III	E	Dam--Cedar Creek.	**
15.	Grant	10	133	89	60		10,000	III	E	Dam--Cannonball River.	*
16.	Grant	1	133	84	17		2,000	III	E	Dam--Dog Tooth Creek.	****
17.	Adams	26	130	93	60		5,000	III	E	Dam--Cedar Creek.	*****
18.	Grant & Sioux	3	131	84	200		5,000	II	F	Dam--Cannonball River.	*

TABLE D (Cont'd.) PROPOSED IMPROVEMENTS IN USE OF SURFACE WATER RESOURCES

CANNONBALL RIVER SUB-BASIN

Plate II Map No.	County	Sec.	Twp.	Rge.	Storage Cap.- A. F.-Est.	Irr. Land- Acres-Est.	Cost Est.	Use	Desig-nation	Description and Remarks	Survey
CLASS "C" PROJECTS IN PLAN NOT INCLUDED IN CLASSES "A" AND "B": (Cont'd.)											
4.	Entire Basin						$150,000			Construction of community wells for stock watering and the construction of surface water reservoirs in certain communities after surveys have shown that the ground waters in these communities are unreliable or unsatisfactory for this purpose. Possible reservoir sites are: Grant County; S 29-133-83, S 4-133-83, S 35-133-86, S 1-133-86, S 15-133-85, S 11-130-87, S 27-132-85, S 7-132-85, S 9-133-84, S 24-130-89, S 16-134-86, S 34-134-86, S 26-134-90, S 16-131-88, S 16-133-90, S 35-133-90, S 15-130-90, S 5-131-88, S 22-131-90, S 17-131-89, S 16-133-88, S 35-133-87, S 33-133-89, S 14-131-85, S 19-132-89, S 28-132-84, and S 36-132-86; Adams County; S 20-131-94, S 24-131-92, and S 24-131-96; Hettinger County; S 3-133-94, S 13-134-94, and S 36-133-91; and Sioux County; S 28/29-129-87, S 32-129-86, S 24-130-85, and S 11/12-129-89.	*
Total Class "C" Projects:					2,117		$229,000				
TOTAL PROPOSED IMPROVEMENTS IN USE OF SURFACE WATER RESOURCES:					117,702	26,000	$1,551,500				

SURVEY:

*	None
**	Field Inspected by State Engineer
***	Surveyed by U. S. Army Engineers
****	Surveyed by CCC
*****	Surveyed by FERA and WPA

USE:

I	Flood Control and Stream Regulation
II	Irrigation
III	Recreation
IV	Stock Watering and Water Conservation
VII	Waterfowl Refuge.

DESIGNATION:

E	Excellent
G	Good
F	Fair
P	Poor

TABLE E

PROPOSED IMPROVEMENTS IN STREAM GAGING AND WEATHER OBSERVATION FACILITIES

CANNONBALL RIVER SUB-BASIN

PLATE III MAP NO.	Station	New or Rehabilitated	Type of Station	Reading to be Taken	Cost Estimate
CLASS "C" PROJECTS IN PLAN NOT INCLUDED IN CLASSES "A" AND "B":					
1.	Amidon	New	Cooperative	Temperature and Precipitation	$ 50.00
2.	Stowers	New	Cooperative	Precipitation	15.00
TOTAL PROPOSED IMPROVEMENTS IN STREAM GAGING AND WEATHER OBSERVATION FACILITIES:					$ 65.00

TABLE F

PROPOSED PROJECTS

CANNONBALL RIVER SUB-BASIN

CLASS "A" PROJECTS DEMANDING IMMEDIATE ATTENTION:

Proposed Improvements in Water Supply	$ 150	
Proposed Improvements in Use of Surface Water Resources.	72,500	
Total Class "A" Projects:		$ 72,650

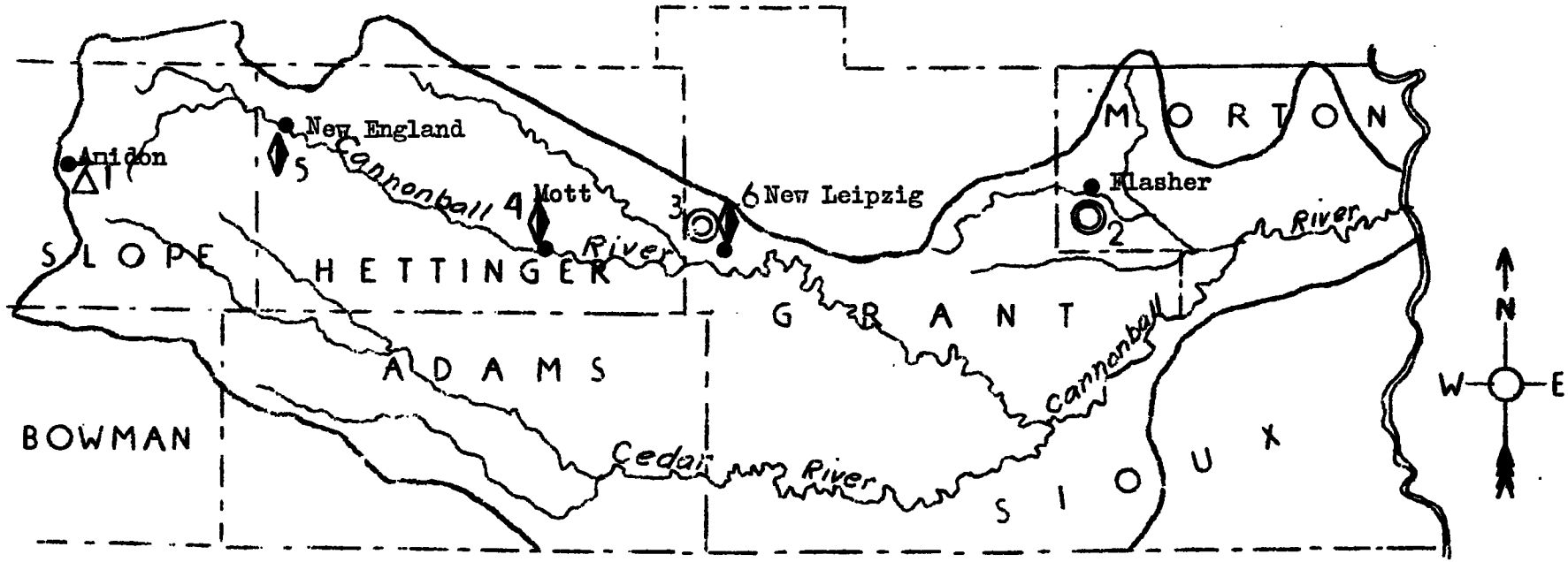
CLASS "B" PROJECTS DEMANDING IMMEDIATE ATTENTION UPON COMPLETION OF SURVEY:

Proposed Improvements in Water Supply	600	
Proposed Improvements in Use of Surface Water Resources.	1,250,000	
Total Class "B" Projects:		1,250,600

CLASS "C" PROJECTS IN PLAN NOT INCLUDED IN CLASSES "A" AND "B":

Proposed Improvements in Water Supply	3,000	
Proposed Improvements in Sewage Disposal	95,000	
Proposed Improvements in Use of Surface Water Resources.	229,000	
Proposed Improvements in Stream Gaging and Weather Observation Facilities	65	
Total Class "C" Projects:		$ 327,065

TOTAL PROPOSED PROJECTS: $ 1,650,313



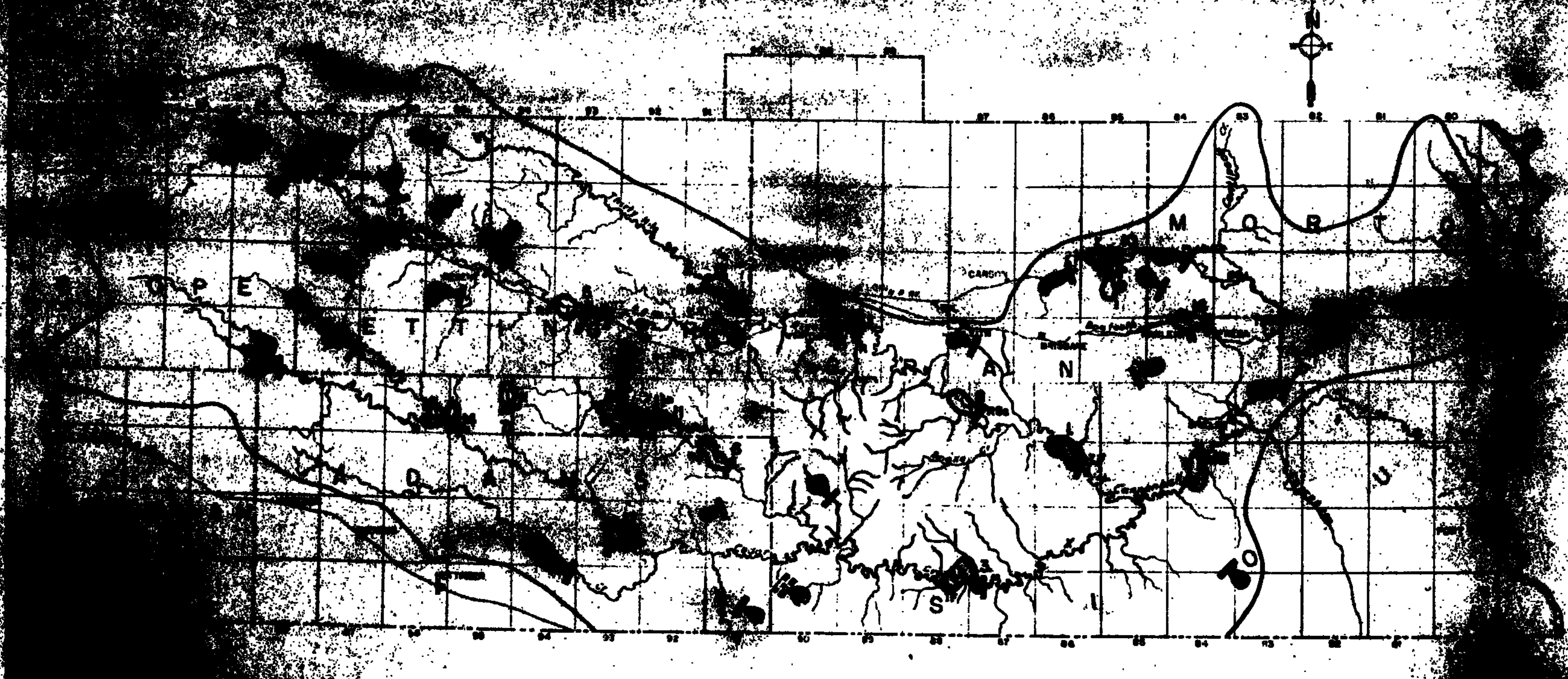
LEGEND

- Distribution System
- Sewage Disposal - Partial Treatment
- Shallow Well

CANNONBALL RIVER SUB-BASIN

PROPOSED IMPROVEMENTS
in
WATER SUPPLY and SEWAGE DISPOSAL

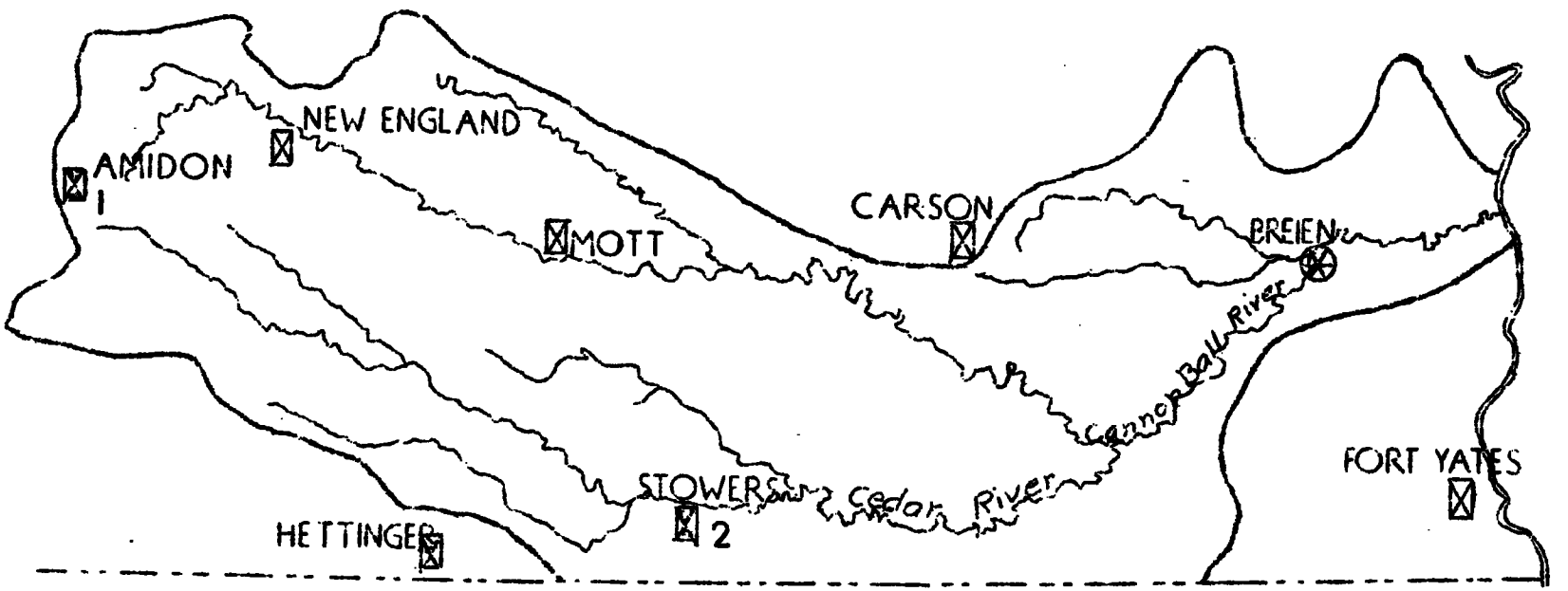
Plate I



...ND

...FOR FLOOD CONTROL

NORTH D...



LEGEND

- Existing gaging station
- Existing weather station
- Proposed weather station

CANNON BALL RIVER SUB-BASIN

STREAM GAGING
and
WEATHER OBSERVATION FACILITIES

Plate III

CHAPTER IV

GRAND SUB-BASIN

CHAPTER IV

GRAND RIVER SUB-BASIN

GENERAL

The Grand River Sub-basin in North Dakota consists of an area of 927 square miles drained by the north fork of the Grand River. This area lies in the eastern two-thirds of Bowman County and the southwestern one-third of Adams County. The north fork of the Grand River rises near the North Dakota-South Dakota boundary line about 20 miles southwest of Bowman, North Dakota. It flows within 1, 2, or 3 miles of the state-line for more than 40 miles. It leaves the State in the southwestern corner of Adams County and flows southeastward to its confluence with the Grand River near Shadehill, South Dakota. The north fork of the Grand River will be referred to merely as the Grand River in the following paragraphs.

The general elevation of the headwaters area of the Grand River is approximately 2,950 feet above sea level and at the point where the stream crosses the State line into South Dakota, the elevation is 2,570 feet above sea level.

POPULATION

The 1930 population of the Sub-basin was 6,490 persons of which 3,146 resided in rural areas and 3,344 in the several incorporated cities and villages. Hettinger with a 1930 population of 1,292 persons, Bowman with 888 persons, Reeder with 395 persons and Scranton with 381 persons are the larger communities in this area.

The principal industry of this Sub-basin is agriculture which engages the greater portion of the population.

FEDERAL AID

During the month of peak load, March 1935, 1315 persons or 20.3 per cent of the total population were receiving federal aid. The state average for this month was 31.6 per cent. In the peak month of W. P. A. employment 54 persons were employed on work projects in or near cities and villages and 418 persons were employed on rural projects, making a total of 472 persons employed in October, 1936.

TOPOGRAPHY

The Grand River Sub-basin lies entirely outside the glaciated region. For the most part, the uplands consist of flat to gently rolling terrain in which the water courses have quite thoroughly dissected the plateau surface. At the lower end of the main tributaries the valleys are deeper and, in general, have a fairly small drop per mile. The valley of the Grand River averages about 1½ miles in width through which the stream flows in a meandering course. The average slope of the valley floor

is 8 feet per mile.

TRIBUTARIES OF GRAND RIVER

Several tributary streams converge at a point approximately 12 miles west of the east boundary line of Bowman County to form the main channel of the Grand River in North Dakota. Spring Creek, one of the major tributaries, has its headwaters near Griffin and drains an area of approximately 220 square miles. Lightning Creek originates about six miles south of Buffalo Springs, drains an area of about 80 square miles and joins the Grand River near the North Dakota-South Dakota boundary. Other tributaries of some importance are Buffalo Creek and Hidden Wood Creek.

NATURAL RESOURCES

Extensive deposits of lignite coal are found in the Fort Union formation which comprises the geologic bed rock of the eastern part of Bowman and the southwestern part of Adams Counties and in the Lance formation of the upper reaches of the Grand River. Many of these coal deposits appear on side hills and mining is not difficult. Both strip methods and tunnelling are practiced in the production of this fuel. Lignite mining on commercial scales are developed at Scranton and Haynes. Several small mines, operated individually by farmers and others, are located throughout the northern portion of the Sub-basin.

Scattered throughout the Sub-basin are ridges and buttes that are covered with field stones of good quality. These stones can be used as material for rubble masonry construction, revetment work and can be crushed for use as concrete aggregate.

RUN-OFF

Very little run-off occurs in this Sub-basin, except during rapid spring thaws and during excessive rains, because of the flat to gently rolling terrain. The average run-off here is 0.57 of an inch. As a result, the streams are virtually dry during a large part of each year.

FLOODS

All of the towns in this Sub-basin are located near the drainage divide and as a result there has been but little flood damage in the past. This problem, therefore, is not serious in the Grand River Sub-basin.

WILD LIFE

Because there are only a very limited number of reservoirs that retain water throughout the year in this Sub-basin, only a limited number of waterfowl frequent this area. There are no projects constructed or contemplated at present in this Sub-basin by the U. S. Biological Survey. The construction of additional reservoirs as contemplated in the program proposed here will add to the waterfowl resources of the Sub-basin.

RECREATION

The recreational facilities within this Sub-basin are very

limited. The few dams that were constructed under the F.E.R.A. and C.C.C. programs have provided little increase in swimming or other recreational facilities because of the limited supply of available water to fill these during the past three years. A railroad dam near Hettinger has been used by residents in the vicinity for swimming during years of average run-off. The W.P.A. has completed the repair of an abondoned railroad dam at Buffalo Springs and this may make excellent swimming and picnic facilities available. An excellent growth of cottonwood trees adjoins the reservoir.

POWER AND NAVIGATION

The streams of this Sub-basin are not navigable and because of the limited and intermittent flow the development of water power is not practicable. The power needs of the Sub-basin are served by generating plants utilizing lignite coal as fuel.

CHANNEL IMPROVEMENTS

There has been little or no attempts made to improve the existing channels of the streams. The principal streams have well defined and uniform channels. Any additional improvements would involve large costs.

MUNICIPAL WATER SUPPLY

Bowman and Hettinger, the two largest towns in this Sub-basin, have wells over 1,000 feet in depth for their municipal supply. Other towns have drilled wells ranging from 60 to 100 feet deep.

Two of the towns in this area, Scranton and Reeder, have reported an inadequate water supply. Scranton has applied for W.P.A. help to improve this situation and Reeder will probably have to do likewise.

STREAM POLLUTION

The pollution problem on the Sub-basin is especially serious during periods of drought. Decay of organic matter, such as fish and animals, in many of the streams cause stagnant and polluted pools to form and present a health hazard to the inhabitants. Hettinger discharges its sewage into Hidden Wood Creek and, due to the extremely low flow for dilution purposes during the greater portion of each year, serious pollution of the stream results.

POSSIBLE IRRIGATION

There are available approximately 8,000 acres of land in the valley of the Grand River that could be used for irrigation farming if sufficient water were provided by a large storage reservoir on the Grand River. Surveys of these areas, in 1909 by W. A. Stebbins of the U. S. Bureau of Reclamation, in 1926 by G. E. Stratton also of the U. S. Bureau of Reclamation, in 1931 by the U. S. Army Engineers and in 1931 by the North Dakota State Engineer, have found this feasible from an engineering standpoint.

USE OF IRRIGABLE LAND

The primary purpose of the development of irrigation in the Sub-basin would be to grow sufficient feed during drought years to sustain foundation herds and thereby eliminate the necessity of shipping into the area the required feeds at high costs. This would tend to stabilize the agricultural income of this area with resulting benefits not only locally but statewide.

RESERVOIR FOR FLOOD CONTROL, RIVER REGULATION, MUNICIPAL SUPPLY AND IRRIGATION

There are no reservoirs proposed in the program for the minimizing of floods in this Sub-basin in North Dakota. A large reservoir on the Grand River and one on Lightning Creek are proposed in this program for the storing of sufficient water to irrigate 8,000 acres of land in the Grand River Valley. The retention of flood waters and the return flow from the irrigable lands would have a very beneficial effect on the stream flow below.

EXISTING RESERVOIRS

A total of 7 dams now constructed in the Basin impound a maximum of 1,712 acre feet of water. Reservoirs are listed in Table A and are shown on Plate II.

PROPOSED PROGRAM

It is proposed:

1. That a large reservoir be constructed on the Grand River and possibly another on Lightning Creek for purposes of conserving flood waters for irrigating several thousand acres of bottom lands. These reservoirs would have a beneficial effect on stream flow down stream. Proposed projects are listed in Table D and are shown on Plate II.

2. That several small dams be constructed at desirable locations for recreation and stock watering purposes. Proposed projects are listed in Table D and are shown on Plate II. All dams constructed hereafter in the Sub-basin should be provided with outlet gates for releasing the water stored when a great need arises for it downstream or when it becomes so polluted that it is a definite health hazard to the community. Some existing dams should also be provided with outlet gates.

3. That assistance be given towns in securing adequate water supply and sewage disposal facilities. Projects are listed in Tables B and C and are shown on Plate I.

4. That a detailed soil survey and land classification be begun as soon as is possible on all lands that appear to be irrigable in order to ascertain the suitability of these lands for irrigation in each of the several areas. These surveys should follow the aerial mapping of the irrigable regions. This mapping will provide, in addition to its utility as the basis of the proposed soil survey and land classification, much needed data on

present land use. The cost of the aerial mapping would approximate 5¢ per acre. The cost of the detailed soil survey and land classification would be an additional 5¢ per acre. Thus, to properly predetermine the areas suited to irrigation would entail the expenditure of 10¢ per acre for 8,000 acres of irrigable land in the Grand River Sub-basin, or approximately $800.00.

RURAL WATER SUPPLY

A large number of small reservoirs have been proposed for the Sub-basin by various agencies. Those that would serve purposes of recreation, irrigation, and waterfowl refuges have been included in the proposed program. It is proposed that before any more small dams for stock watering purposes be constructed in the Sub-basin, a detailed survey of rural water supply be undertaken to determine the best and most economical method of securing adequate and satisfactory water supplies for stock watering purposes. Where an adequate ground water supply is available it is probable that this would be through the construction of community wells. In other localities not having a reliable ground water supply the construction of surface reservoirs would be the only alternative. Following such a survey it is proposed that assistance be given in developing an adequate rural water supply.

ULTIMATE DEVELOPMENT OF WATER RESOURCES

The ultimate development of the surface water resources of this Sub-basin would be provided by the two large storage reservoirs of proper design to make possible the irrigation of suitable lands and by small dams and reservoirs to supplement the well water supply for stockwatering and recreation purposes.

BOWMAN PROJECT

It is proposed that the Bowman Irrigation Reservoir, located in Section 24-129-101, be placed under construction immediately. The surveys mentioned are complete enough to make possible the start of work on this project immediately. Soundings for the dam site were made by the F.E.R.A. and the results are available in the W.P.A. office at Bismarck, North Dakota.

Sufficient water to irrigate 8,000 acres of land by gravity flow would be provided by this reservoir. The irrigable acreage is limited to approximately 8,000 acres by the available water supply.

LIGHTNING CREEK DAM

An additional project on Lightning Creek, located in Section 19-129-98 is also recommended to supplement the supply of water obtainable from the main reservoir for irrigation purposes.

ECONOMIC JUSTIFICATION FOR RESERVOIRS

Recent events have materially altered the significance and justification of the Bowman Project. During the past three years about $125,000 of Federal Aid, exclusive of Farm Credit Administration loans have been advanced to the inhabitants of this area. Such aid is continuing at present because of the protracted drought

of 1936. Although many worth while and necessary projects have ~~been constructed throughout~~ the federal work relief program, the people have not been provided with a means of becoming more self-sustaining in the event of continuing drouth years.

The construction of the Bowman project would change this situation to a very marked degree. This project, if constructed, would insure an adequate feed supply for the livestock in the area; it would increase the value of taxable property in the Sub-basin, and above all, it would stabalize the income of the inhabitants so that federal or local aid would become a matter of far less concern than at present.

It is proposed that a definite part of the cost of this project be allocated for the rehabilitation of the people of this area.

COST OF BOWMAN PROJECT

The U. S. Army Engineers estimated the cost of construction of the Bowman Dam at $997,000. Detailed information concerning the design proposed by the U. S. Army Engineers is not available but it is the belief of the North Dakota State Planning Board that a dam adequately suited to the present and anticipated needs of the area could be constructed for approximately $350,000.

In a review of Mr. Stebbin's report, Mr. Stratton gives the estimated cost of storage at $10.80 per acre foot. The estimated storage capacity of the reservoir would be 19,500 acre feet, according to the U. S. Army Engineers. This would give an estimated cost for the dam of $210,600. The unit prices used by Mr. Stebbins in calculating the cost of the dam were:

Embankment	$ 0.40 per cubic yard
Rock Rip-Rap	5.00 per cubic yard
Reinforced concrete	20.00 per cubic yard
Lumber in place for spillway and flumes	50.00 per M.F.B.M.

The unit price for earth fill is high for present construction costs. The contract price for construction of the U. S. Bureau of Biological Survey Upper Souris Project was 11 cents per cubic yard for earth fill embankment. A large portion of the work consisted of construction of a large dam for impounding 112,000 acre feet of water in the Souris River Valley. The total construction cost of the entire project was approximately $300,000.

A rough estimate of the cost of the Bowman Dam has been made. The design would include a 437,500 cubic yard earth fill dam with clay or timber cut-off wall, a gravel blanket on the upstream face covered by 18 to 20 inches of rock rip-rap, a rubble masonary and

reinforced concrete spillway and the necessary outlets and controls. Cost items would be:

437,500 C. Y. earth fill	$0.25	$109,375
20,000 C. Y. rock rip-rap	5.00	100,000
6,000 C. Y. gravel blanket	1.00	6,000
Spillway, control gates etc.		50,000
Foundation preparation, cut off wall, engineering, and incidentals		84,625

This gives a total cost estimate of $350,000. No flowage damages would result as the area was reserved for irrigation development at the time of the original land survey.

No estimates are included for irrigation developments other than water storage. There is a definite need for irrigation in the area and irrigation districts will be formed and will construct their irrigation projects when water is made available.

STREAM GAGING AND WEATHER OBSERVATION STATIONS

Active weather recording and stream gaging stations in the Grand River Sub-basin are shown on Plate III. No additional stations of either type are included in the proposed program but it is strongly urged that all existing stations be maintained.

TABLE A

EXISTING RESERVOIRS

GRAND RIVER SUB-BASIN

No.	County	Sec.	Twp.	Rge.	Storage A. F.	Cost Est.	Use	Desig-nation	Description and Remarks	Legend
1.	Adams	4	129	98	74	$ 8,200	IV	E	Dam—Buffalo Creek.	**
2.	Adams	18	129	95	23	2,800	IV	E	Dam—Hidden Wood Creek.	*
3.	Bowman	30	131	99	38	2,200	III	E	Dam—Buffalo Creek. Near Gascoyne.	**
4.	Bowman	32	131	99	1,300	4,100	III	F	Dam—Creek. Near Gascoyne.	**
5.	Bowman	16	130	103	85	4,700	III,IV VII	F	Amor Township Dam—Creek.	**
6.	Adams	13	129	96	100	25,000	III,VI	E	Dam—Hidden Wood Creek. At Hettinger.	****
7.	Bowman	17	131	100	92	20,000	III	G	Dam—Buffalo Creek. At Buffalo Springs.	(****) (**)
TOTAL EXISTING RESERVOIRS:					1,712	$67,000				

LEGEND:

* Constructed by CCC
** Constructed by FERA and WPA
**** Constructed by Railways and Municipalities

USE:

III Recreation
IV Stock watering and water conservation
VI Railway Supply
VII Waterfowl refuge

DESIGNATION:

E Excellent
G Good
F Fair
P Poor

TABLE B

PROPOSED IMPROVEMENTS IN WATER SUPPLY

GRAND RIVER SUB-BASIN

Plate I Map No.	Municipality	Pop.	Objection to Present Supply	Proposed Improvements	Surveys	Wells	Treatment Plant	Dist. System	Total Estimate
(1)	Scranton	361	Inadequate	Survey and two wells.	100	1,200			1,300
(2)	Reeder	395	Inadequate	Survey and two wells.	100	1,200			1,300
		Sub-Total:			200	2,400			

TOTAL PROPOSED IMPROVEMENTS IN WATER SUPPLY: $ 2,600

TABLE B (Cont'd)

PROPOSED IMPROVEMENTS IN WATER SUPPLY

GRAND RIVER SUB-BASIN

SUMMARY

CLASS "A" PROJECTS DEMANDING IMMEDIATE ATTENTION:	
Local surveys of available sources	$ 200
CLASS "B" PROJECTS DEMANDING IMMEDIATE ATTENTION UPON COMPLETION OF SURVEY:	
Shallow Wells	2,400
TOTAL PROPOSED IMPROVEMENTS IN WATER SUPPLY:	$ 2,600

TABLE C

PROPOSED IMPROVEMENTS IN SEWAGE DISPOSAL

GRAND RIVER SUB-BASIN

Plate I Map No.	Municipality	Pop.	Type and Adequacy of Sewage Treatment	Proposed Improvements	Estimated Cost
CLASS "A" PROJECTS DEMANDING IMMEDIATE ATTENTION:					
3.	Bowman	888	No Sewage System	Sewage System with Sewage Treatment Plant.	$ 40,000
CLASS "C" PROJECTS IN PLAN NOT INCLUDED IN CLASSES "A" AND "B":					
4.	Hettinger	1,292	Comb.-Septic Tank. S.C.,G.C.	Additional Treatment Facilities	25,000
TOTAL PROPOSED IMPROVEMENTS IN SEWAGE DISPOSAL:					$ 65,000

LEGEND FOR SEWAGE AND SEWAGE TREATMENT:

Comb.	Combined System
S.C.	Screened
G.C.	Grit Chamber

TABLE D

PROPOSED IMPROVEMENTS IN USE OF SURFACE WATER RESOURCES

GRAND RIVER SUB-BASIN

Plate II Map No.	County	Sec.	Twp.	Rge.	Storage Cap.- A. F. Est.	Irr. Land- Acres-Est.	Cost Est.	Use	Desig- nation	Description and Remarks	Survey
CLASS "A" PROJECTS DEMANDING IMMEDIATE ATTENTION:											
1.	Bowman	24	129	101			$ 5,000	I,II		Complete survey and design of Bowman Reservoir on North Fork of Grand River near Haley, N. Dak.	***
2.	Adams	19	129	98			1,000	I		Make a survey to determine feasibility of creating a reservoir on Lightning Creek to supplement the Bowman Reservoir.	*
3.	Entire Basin						2,000	IV		Survey of small dams proposed for flood irrigation, recreation, and waterfowl refuge purposes. Survey of available water resources for stock watering where present supplies are inadequate. Recommendations to be made for the most satisfactory and economical solution of the problem through construction of community wells or surface reservoirs.	*
4.	Adams	33	129	94	15	50	3,000	II	E	Dam--Hidden Wood Creek. Would provide storage on a spring fed creek.	*****
	Total Class "A" Projects:				15	50	$11,000				

TABLE D (Cont'd.) PROPOSED IMPROVEMENTS IN USE OF SURFACE WATER RESOURCES

GRAND RIVER SUB-BASIN

Plate II Map No.	County	Sec.	Twp.	Rge.	Storage Cap.- A. F. Est.	Irr. Land- Acres-Est.	Cost Est.	Use	Desig- nation	Description and Remarks	Survey
CLASS "B" PROJECTS DEMANDING IMMEDIATE ATTENTION UPON COMPLETION OF SURVEY:											
1.	Bowman	24	129	101	19,500	8,000	$350,000	I,II	E	Construction of Bowman Reservoir on North Fork of Grand River near Haley.	***
CLASS "C" PROJECTS IN PLAN NOT INCLUDED IN CLASSES "A" AND "B":											
2.	Adams	19	129	98	2,500	1,000	50,000	I,II	G	Construction of Lightning Creek Reservoir to supplement Bowman Reservoir if survey shows it to be feasible.	*
5.	Bowman	21	130	100	(500)		(25,000)	III,IV	F	Dam--Lightning Creek. Should be constructed only in the event No. 2 is disapproved.	****
6.	Bowman	15	129	99	(100)		(15,000)	III,IV	E	Dam--Lightning Creek. Should be constructed only in the event No. 2 is disapproved.	*
3.	Entire Basin						20,000	IV		Construction of community wells for stock watering and the construction of surface water reservoirs in certain communities after surveys have shown that the ground water resources in the areas are unsatisfactory. Possible reservoir sites are: Bowman County, S 22-130-99 and S 29-130-99; Adams County, S 32-129-94, S 23-129-98, S 30-129-94, S 11-129-96, S 18-129-97, and S 22-129-97.	
	Total Class "C" Projects:				2,500	1,000	$70,000				
	TOTAL PROPOSED IMPROVEMENTS IN USE OF SURFACE WATER RESOURCES:				22,015	9,050	$431,000				

TABLE D (Cont'd.)

PROPOSED IMPROVEMENTS IN USE OF SURFACE WATER RESOURCES

GRAND RIVER SUB-BASIN

SURVEY:

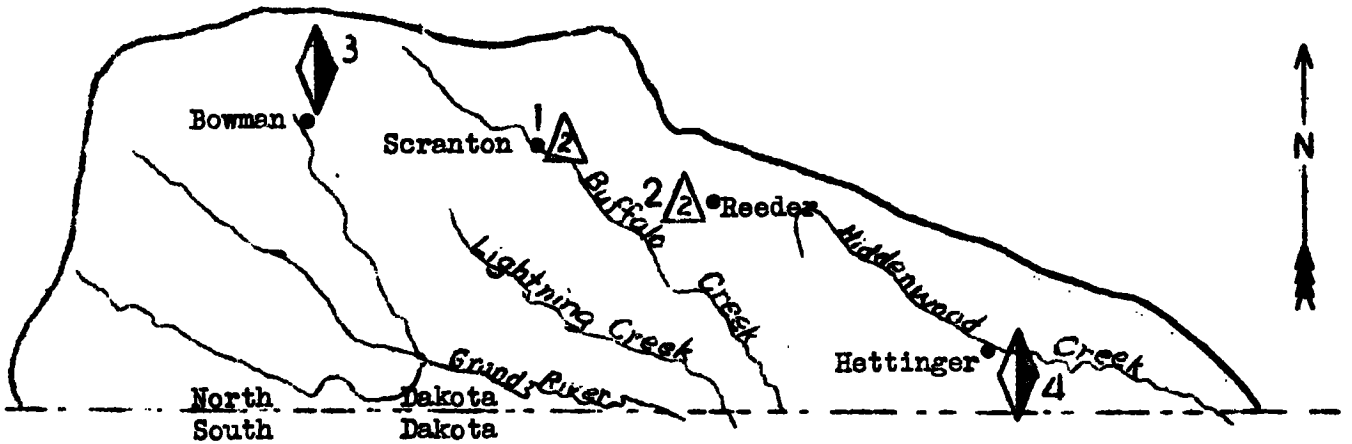
*	None
***	Surveyed by U. S. Army Engineers
****	Surveyed by CCC
*****	Surveyed by FERA and WPA

USE:

I	Flood Control and Strean Regulation
II	Irrigation
III	Recreation
IV	Stock Watering and Water Conservation

DESIGNATION:

E	Excellent
G	Good
F	Fair
P	Poor



LEGEND

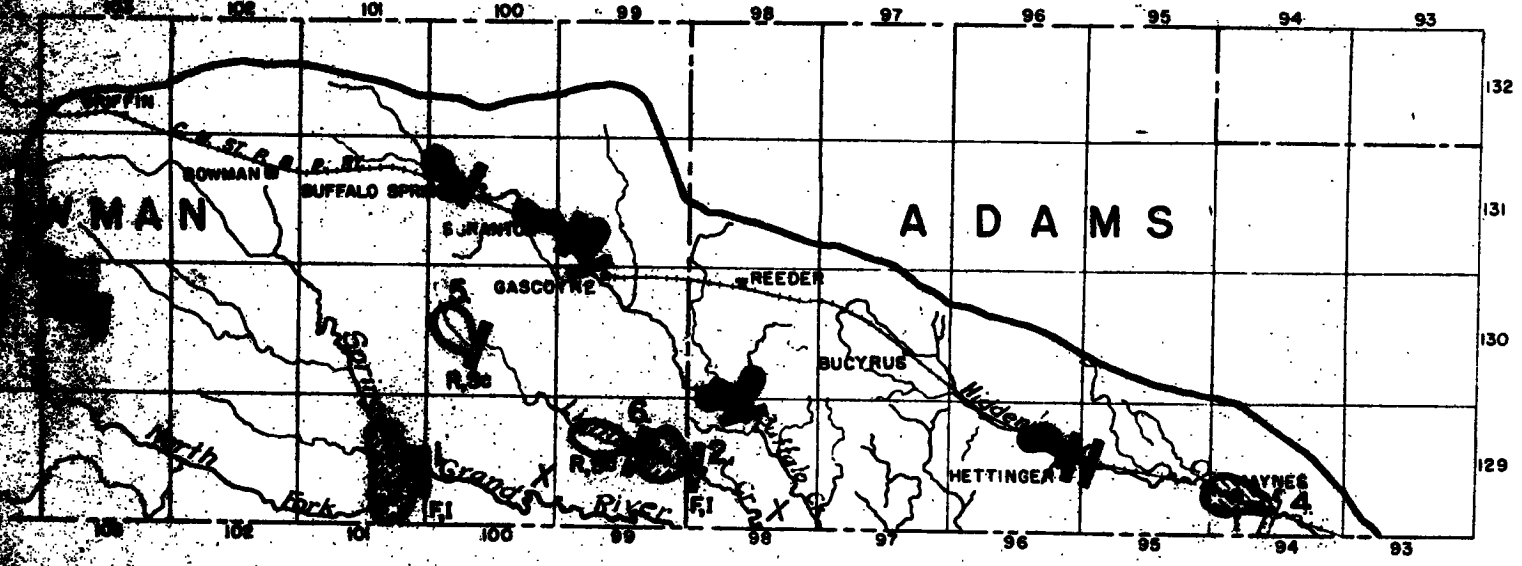
Sewage Disposal
Partial Treatment

Shallow Well

GRAND RIVER SUB-BASIN

PROPOSED IMPROVEMENTS
in
WATER SUPPLY AND SEWAGE DISPOSAL

Plate I



N

W E

S

NORTH DAKOTA

GRAND RIVER DRAINAGE BASIN

STATE PLANNING BOARD W.P.A. PROJECT 1463

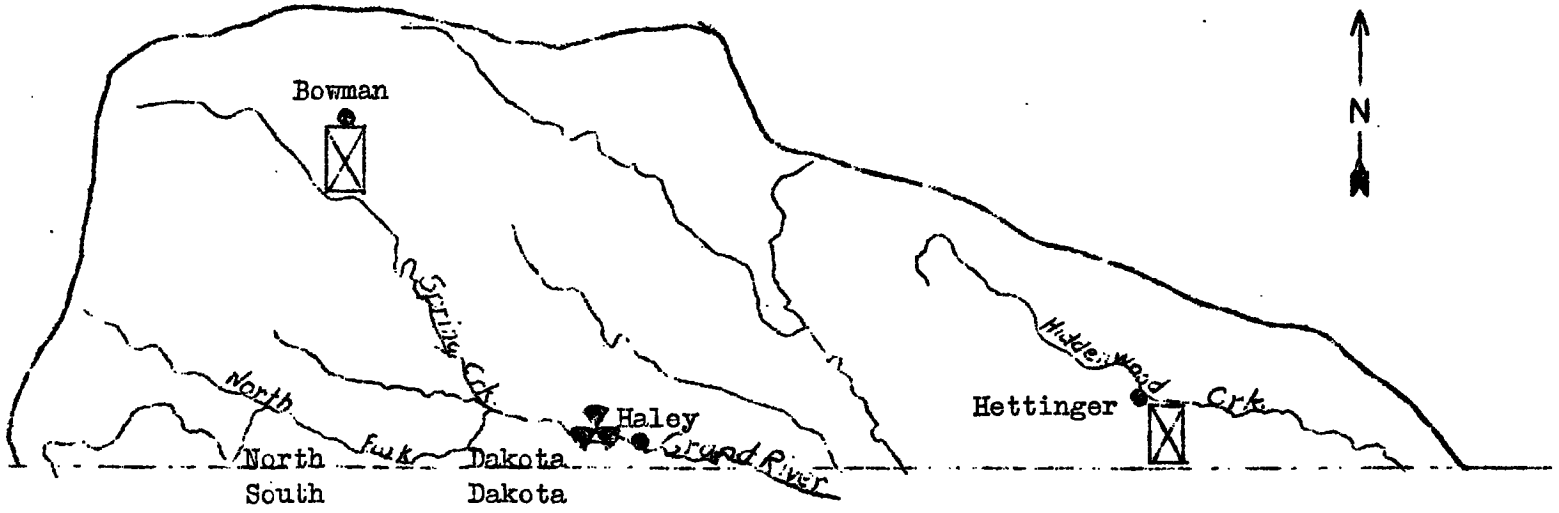
PROPOSED IMPROVEMENTS IN USE OF SURFACE WATER RESOURCES

5 0 5 10

SCALE IN MILES
1936

PREPARED IN THE OFFICE OF THE CONSULTANT

PLATE II



LEGEND

Existing Weather Station

Proposed Rehabilitated Stream Gaging Station

GRAND RIVER SUB-BASIN

STREAM GAGING
and
WEATHER OBSERVATION FACILITIES

Plate III

CHAPTER V

LITTLE MISSOURI SUB-BASIN

CHAPTER V

LITTLE MISSOURI RIVER SUB-BASIN

GENERAL

The Little Missouri River rises in northeastern Wyoming. It flows in a northerly direction and drains portions of northwestern South Dakota, southeastern Montana, and southwestern North Dakota. It enters North Dakota in the extreme southwest corner of the State. It flows northward in a very tortuous course to a point in south-central McKenzie County, approximately 30 miles south of the Missouri River, and then turns abruptly and flows to its confluence with the Missouri River near Elbowoods, about 65 miles to the east.

At the point where the Little Missouri River enters North Dakota, it has a tributary drainage area of 2,360 square miles. Between this point and the mouth the tributary drainage area is 7,100 square miles, 4,665 square miles of which is in North Dakota. The Little Missouri Sub-basin in North Dakota includes major parts of Slope, Golden Valley, and Billings Counties and lesser parts of Bowman, McKenzie, and Dunn Counties.

POPULATION

The 1930 population of the Sub-basin was 16,758. 3,328 persons resided in incorporated cities and villages, and the remainder, 13,430 persons, resided in more rural areas.

FEDERAL AID

During the month of peak load, March, 1935, 6,141 persons or 36.6 per cent of the Sub-basin population were receiving federal aid. The State average for the same month was 31.6 per cent. In the peak month of W. P. A. employment, October 1936, 3,328 persons were employed on works projects in or near cities and villages and 13,430 persons were employed on rural projects, making a total of 16,758 persons employed in October, 1936.

TOPOGRAPHY

Much of the area drained by the Little Missouri River in North Dakota is the so called "Badlands." Although the headwaters of the tributary creeks drain a prairie region, the rapid fall to the main stream has caused the formation of many gullies in the areas closer to the Little Missouri River. These gullies have slopes mostly barren of vegetation which erode very easily. The water picks up silt in these areas and deposits this on the river bottoms as it loses its velocity.

The total length of the Little Missouri River channel is approximately 530 miles. Its average grade is approximately one foot per mile. The valley is approximately 300 miles in length and averages about 4,000 feet in width. The river meanders from side to side through this valley and cuts the bottom lands into numerous tracts. These tracts of land vary in size from 50 to 700 acres. They are composed of dark fertile loam.

TRIBUTARIES

There are numerous small tributaries on both sides of the Little Missouri River. Two tributaries originating in Montana are of importance in preparing a water plan for the Sub-basin. These are Big Beaver Creek entering North Dakota in northwestern Golden Valley County and Little Beaver Creek having its confluence with the Little Missouri River at Marmarth, North Dakota.

NATURAL RESOURCES

There are considerable lignite coal deposits in the Sub-basin. There are a number of natural gas wells in the vicinity of Marmarth, and oil has been struck in paying quantities in Montana just across the state-line from Marmarth. Bentonite is also present in the Sub-basin. Gravel, satisfactory for surfacing material, is found, but it contains impurities rendering it unfit for use as concrete aggregate.

GROUND WATER

Artesian wells from 90 to 600 feet in depth located in the lower portion of the various tributary valleys furnish surrounding areas with an ample supply of fair quality water for human consumption and stock watering. In the areas more removed from the main stream water is secured in the stream valleys from wells 40 to 60 feet in depth and, in the prairie areas, from drilled or bored wells up to 200 feet in depth. There is a shortage of water for stock watering purposes in some areas. Wells in these areas need to be deepened, or new wells need to be dug.

THE WATER PROBLEM

There is a necessity for stream flow regulation in the Little Missouri River Sub-basin. During the spring run-off period and after heavy rains the river is taxed to capacity and often overflows its banks and causes considerable flood damage. During drought seasons the flow in the various streams is reduced to zero. There is a need for water for recreation, for pollution abatement, and for irrigation during such periods. In addition to damage caused by flooding during spring run-off, considerable damage is done by bank erosion. The flood danger is particularly acute because of the rapid fall of the tributaries in the area. These frequently bring in sufficient water to raise the river from normal to flood stage within a 24 hour period.

PRECIPITATION

The 20 year average of annual precipitation in the Sub-basin is 14.40 inches. That during the growing season, the period May through September, is 9.86 inches. On the basis that approximately 14 inches of precipitation are required during the growing season to produce a good crop, it is apparent that there was a deficiency of moisture for growing crops during more than one half the 20 year period. During drought years, expensive feeds are shipped into the Sub-basin to sustain foundation herds of livestock. This results in a loss of accumulated savings. There is approximately 20,000 acres of land along the Little Missouri River that is potentially suitable for irrigation to supplement upland farming and livestock operations.

RUN-OFF

The run-off from the Badland portion of the Sub-basin is very rapid. The average annual run-off over a thirty-one year period from the Sub-basin is approximately 1.43 inches or 356,000 acre feet. A large portion of this occurs during the spring months and, except immediately following violent storms, the streams are virtually dry during the summer months.

FLOODS

As noted above, floods cause considerable damage in the Sub-basin. Wibaux, Montana on Big Beaver Creek suffered $600,000 damages and the loss of 3 lives during the flood of 1929. Marmarth, North Dakota has suffered serious flooding both from the Little Missouri River and from Little Beaver Creek. Levees were started by C.W.A. and F.E.R.A. and completed by W.P.A. to give flood protection to Marmarth. The Little Beaver Creek channel has been straightened through the town to give additional protection. However, this development will not give complete flood protection to Marmarth. Some additional flood protection should be provided in the form of storage reservoirs both in the Little Missouri River and in Little Beaver Creek.

WILD-LIFE

The U. S. Biological Survey has no projects in the Basin because there are no sloughs or lakes suitable for the development of waterfowl refuges. Projects for the conservation of wild life are not proposed, but some wild life benefits would be derived from projects proposed primarily for other purposes.

RECREATION

There are no natural lakes suitable for recreational purposes. Several reservoirs have been constructed for this purpose, and several additional dams are proposed. Two state parks have been developed in the Badland areas. Stream flow regulation would increase recreational facilities in the Sub-basin.

POWER AND NAVIGATION

There is no development of water power or navigation on the Little Missouri River. It is unsuited for either purpose. Cheap fuel in the form of natural gas and lignite coal is available for the production of power in the Sub-basin.

CHANNEL IMPROVEMENT

There has been no channel improvement in the Sub-basin except for the short length of the Little Beaver Creek channel through Marmarth which has been straightened to allow quicker exit of flood waters. Channel erosion is a problem along the Little Missouri River.

MUNICIPAL SUPPLY

The towns of the Sub-basin in general have an adequate water supply. A reservoir upstream helps maintain the water level in the wells of Beach. Sentinal Butte has a reservoir available for fire protection. Marmarth needs some improvements in its water system.

STREAM POLLUTION

During summer months an accumulation of debris and sewage in the streams causes serious health hazards. Suitable sewage treatment plants and adequate stream flow regulation would greatly alleviate the situation.

POSSIBLE IRRIGATION

There are approximately 27,000 acres of bottom lands in the Little Missouri Sub-basin that might be irrigated by pumping from the river with a maximum lift of 35 feet if water were available for the purpose. Adequate stream flow regulation would stimulate the development of irrigation projects.

USE OF IRRIGABLE LAND

Irrigated land would be used to supplement farming and grazing on the upland areas. The Resettlement Administration is now engaged in developing the Badlands for grazing. Irrigation would greatly assist in this development by insuring a supply of feed within the Basin for needs during winter months and throughout drought periods.

EXISTING PROJECTS

A total of 18 dams now constructed in the Basin impound a maximum of 1,879 acre feet of water. These are used largely for stock watering and recreation. Existing projects are listed in Table A and are shown on Plate II.

PROPOSED PROGRAM

It is proposed:

1. That three large storage reservoirs be constructed for flood control and stream regulation through the cooperation of North Dakota, Montana, the federal government, and interested local agencies. One reservoir would be located on the Little Missouri River in Bowman County; one would be on Little Beaver Creek in Fallon County, Montana; and the other would be on Big Beaver Creek in Wibaux County, Montana. These reservoirs would permit the irrigation of approximately 27,000 acres of bottom lands by pumping and by gravity flow. These projects are listed in Table D and are shown on Plate II.

2. That several additional small reservoirs be constructed for recreational and stock watering purposes. Proposed small projects are also listed in Table D and are shown on Plate II. All dams constructed hereafter in the Sub-basin should be provided with outlet gates for releasing the water stored when a great need arises for it downstream or when it becomes so polluted that it is a definite health hazard to the community. Many existing dams should also be provided with outlet gates.

3. That towns in the Sub-basin be given assistance in developing adequate water supply and sewage disposal facilities. Projects for improvement of water supply are listed in Table B and are shown on Plate I. Projects for improvement of sewage disposal are listed in Table C and are also shown on Plate I.

4. That a detailed soil survey and land classification be begun as soon as is possible on all lands that appear to be irrigable in order to ascertain the suitability of the lands for irrigation in each of the several areas. These surveys should follow the aerial mapping of the irrigable regions. This mapping will provide, in addition to its utility as the basis of the proposed soil survey and land classification, much needed data on present land use. The cost of the aerial mapping would approximate 5¢ per acre. The cost of the detailed soil survey and land classification would be an additional 5¢ per acre. Thus, to properly predetermine the areas suited to irrigation would entail the expenditure of 10¢ per acre for 20,000 acres of irrigable land in the Little Missouri River Sub-basin, or approximately $2,000.

LITTLE MISSOURI RESERVOIR PROJECT

There is an excellent location for a large reservoir on the Little Missouri River in Section 28/29-130-106 in Bowman County. The Pierre Shale exposed at the site would permit a minimum of foundation preparation and would make excellent embankment material. This reservoir would prevent excessive flow in the Little Missouri River in North Dakota with its accompanying flood damages and excessive bank erosion. It would regulate the flow in the river and thereby provide water in the valley during summer months for recreation, for pollution abatement, and for possible irrigation developments.

LITTLE BEAVER CREEK RESERVOIR

A large reservoir located just across the Montana-North Dakota state line on Little Beaver Creek would provide protection for Marmarth from floods produced by that stream. It would regulate the flow in the stream and thereby provide water for recreation, pollution abatement, and for the possible irrigation of 3,000 acres of land in North Dakota. The Pierre Shale is also exposed at this site.

THE BIG BEAVER RESERVOIR

There is a suitable location for a large reservoir on Big Beaver Creek in Section 30-12-60, Wibaux County, Montana. This would give flood protection to Wibaux, Montana and would provide a regulated flow in the creek for purposes of recreation, pollution abatement, and for the irrigation of several thousand acres of bottom land, some of which would be in North Dakota.

The construction of these reservoirs within the next one or two years would provide a large amount of work relief which is especially needed at this time due to the extreme drought of 1936. Their construction would tend to make the Sub-basin self-sustaining. Farming and grazing operations of the upland areas could be supplemented by the irrigation of river bottom lands. This would permit the growing of feeds for winter months and for drought periods.

WEATHER OBSERVATION AND STREAM GAGING STATIONS

Active weather observation and stream gaging stations in the Little Missouri Sub-basin are shown on Plate III. No additional stations of either type are included in the proposed program, but it is strongly urged that all existing stations be maintained.

TABLE A

EXISTING RESERVOIRS

LITTLE MISSOURI RIVER SUB-BASIN

No.	County	Sec.	Twp.	Rge.	Storage A. F.	Cost Est.	Use	Desig-nation	Description and Remarks	Legend
1.	McKenzie	3	149	99	20	$ 3,200	IV	G	Dam--Cherry Creek.	*
2.	McKenzie	32	149	98	12	5,400	IV	E	Dam--Cherry Creek Branch at Cherry.	*
3.	McKenzie	2	149	96	76	5,800	III,IV	F	Dam--Creek at Croff.	(*) (**)
4.	McKenzie	24	150	97	70	7,300	IV	F	Dam--Creek.	(*) (**)
5.	McKenzie	11	150	98	101	4,600	IV	F	Dam--Cherry Creek. Near Schafer.	(*) (**)
6.	McKenzie	30	149	98	91	9,000	IV	F	Dam--Cherry Creek Branch.	*
7.	McKenzie	4	150	98	66	8,400	IV	E	Dam--Cherry Creek.	*
8.	McKenzie	18	150	98	82	6,800	III	E	Dam--Cherry Creek. Near Watford City.	*
9.	Golden Valley	29	140	104	48	5,800	III	F	Dam--Andrews Creek at Sentinal Butte. Repaired by W. P. A.	*
10.	Golden Valley	25	138	106	10	1,400	III	F	Dam--Bullion Creek. At Golva.	*
11.	Golden Valley	26	140	106	93	2,800	III	G	Dam--Little Beaver Creek. At Beach.	**
12.	Dunn	6	148	95	23	4,600	IV	F	Dam--Deep Creek.	*
13.	Golden Valley	8	141	105	731	18,000	III	E	Dam--Elk Creek.	**
14.	Slope	31	135	101	160	20,000	III	E	Dam--Sand Creek.	**
15.	Bowman	25	132	105	145	8,000	III	G	Dam--Cayote Creek.	**
16.	McKenzie	23	149	95	90	13,000	II	E	Dam--Creek.	**

TABLE A (Cont'd.)

EXISTING RESERVOIRS

LITTLE MISSOURI RIVER SUB-BASIN

No.	County	Sec.	Twp.	Rge.	Storage A. F.	Cost Est.	Use	Desig-nation	Description and Remarks	Legend
17.	McKenzie	7	149	98	50	$ 6,000	IV	F	Dam--Coulee.	**
18.	Golden Valley	8	136	105	11	2,000	IV	E	Dam--Williams Creek.	**
19.	Slope		133	106/105	____	16,500	I		Levee at Marmarth.	**
	TOTAL EXISTING RESERVOIRS:				1,879	$148,600				

LEGEND:

* Constructed by CCC
** Constructed by FERA and WPA

USE:

I Flood control and stream regulation
II Irrigation
III Recreation
IV Stock watering and water conservation

DESIGNATION:

E Excellent
G Good
F Fair
P Poor

TABLE B

PROPOSED IMPROVEMENTS IN WATER SUPPLY

LITTLE MISSOURI RIVER SUB-BASIN

Plate I Map No.	Municipality	Pop.	Objection to Present Supply	Proposed Improvements	Surveys	Wells	Dist. Systems	Total Est.
1.	Marmarth	721	Improvement needed.	Pumping Plant improvement.			1,500	$ 1,500
2.	Sentinel Butte	219	Inadequate for fire protection.	Pipe line for fire protection.			2,500	2,500
3.	Medora	210	Inadequate for fire protection.	Reservoir, pump and pumphouse for fire protection.			5,000	5,000
4.	Golva	200	Inadequate for fire protection.	Survey 2 wells	100	1,200		1,300
5.	Rhame	356	Wooden mains	Relocate well. New pumping equipment. Replace wooden mains.			4,000	4,000
	Sub-Totals:				100	1,200	13,000	

TOTAL PROPOSED IMPROVEMENTS IN WATER SUPPLY: $ 14,300

TABLE B (Cont'd)

PROPOSED IMPROVEMENTS IN WATER SUPPLY

LITTLE MISSOURI RIVER SUB-BASIN

SUMMARY

CLASS "A" PROJECTS DEMANDING IMMEDIATE ATTENTION:	
Local surveys of available sources - Golva	$ 100
CLASS "B" PROJECTS DEMANDING IMMEDIATE ATTENTION UPON COMPLETION OF SURVEY:	
Wells for Golva	1,200
CLASS "C" PROJECTS IN PLAN NOT INCLUDED IN CLASSES "A" AND "B":	
Distribution System Improvements - Marmarth, Sentinel Butte, Medora, and Rhame.	13,000
TOTAL PROPOSED IMPROVEMENTS IN WATER SUPPLY:	$ 14,300

TABLE C

PROPOSED IMPROVEMENTS IN SEWAGE DISPOSAL

LITTLE MISSOURI RIVER SUB-BASIN

PLATE I MAP NO.	Municipality	Pop.	Type and Adequacy of Sewage Treatment	Proposed Improvements	Cost Est.
CLASS "A" PROJECTS DEMANDING IMMEDIATE ATTENTION:					
6.	Watford City	769	No Sewage System	Sewage System with Treatment Plant. Plans and specifications prepared.	$ 35,000
7.	Marmarth	721	No Storm Sewer. Separate Septic Tank. Inadequate.	Treatment Plant	30,000
8.	Beach	1263	Comb. Septic Sc. G.C., Sl. B.	Treatment Plant and Extention of Sewage System.	25,000
9.	Golva	200	No Sewage System.	Disposal Plant for School	10,000
TOTAL PROPOSED IMPROVEMENTS IN SEWAGE DISPOSAL:					$ 100,000

LEGEND FOR SEWAGE AND SEWAGE DISPOSAL:

Sep.	Separate System
Sc.	Screened
Comb.	Combined System
G.C.	Grit Chamber
Sl.B.	Sludge Beds.

TABLE D

PROPOSED IMPROVEMENTS IN USE OF SURFACE WATER RESOURCES

LITTLE MISSOURI RIVER SUB-BASIN

PLATE II MAP NO.	County	Sec.	Twp.	Rge.	Storage Cap.- A. F.-Est.	Irr. Land- Acres-Est.	Cost Est.	Use	Desig-nation	Description and Remarks	Survey
CLASS "A" PROJECTS DEMANDING IMMEDIATE ATTENTION:											
1.	Fallon Co. Montana	8	5	61			$ 3,000			Survey of Little Beaver Creek Reservoir Project. Although this project is located in Montana, the benefits will be derived in North Dakota.	**
2.	Bowman	28/29	130	106			8,000			Survey and design of Little Missouri River Reservoir Project.	**
3.	Wibaux Co. Montana	30	12	60			1,000			Survey of Big Beaver Creek Reservoir Project.	**
4.	All Counties in Drainage Basin.						5,000			Survey of proposed dam sites not having such completed.	*
5.	Dunn	10	146	96	8	None	25,000	III	E	Dan a spring fed creek in a wooded area. Project is for picnic grounds in the Killdeer Mountains.	**
	Total Class "A" Projects:				8		$19,500				
CLASS "B" PROJECTS DEMANDING IMMEDIATE ATTENTION UPON COMPLETION OF SURVEY:											
1.	Fallon Co. Montana	8	5	61	15,000	4,000	$ 200,000	I,II	E	Construction of Little Beaver Creek Reservoir Project.	**
2.	Bowman	28/29	130	106	100,000	20,900	1,500,000	I,II	E	Construction of Little Missouri River Reservoir Project.	**
3.	Wibaux Co.	30	12	60	7,000	3,000	125,000	I,II	E	Construction of Big Beaver Creek Reservoir Project.	**
	Total Class "B" Projects:				122,000	27,000	$1,825,000				

TABLE D (Cont'd.) PROPOSED IMPROVEMENTS IN USE OF SURFACE WATER RESOURCES

LITTLE MISSOURI RIVER SUB-BASIN

PLATE II MAP NO.	County	Sec.	Twp.	Rge.	Storage Cap.- A. F.-Est.	Irr. Land- Acres-Est.	Cost Est.	Use	Desig- nation	Description and Remarks	Survey
CLASS "C" PROJECTS IN PLAN NOT INCLUDED IN CLASS "A" AND "B":											
6.	McKenzie	13	146	99	30		$ 5,000	IV	F	Dam on a coulee.	****
7.	McKenzie	21	145	100	30		3,000	IV	G	Dam on a coulee.	****
8.	McKenzie	20	145	99	30		5,000	IV	E	On Beicegel Creek.	****
9.	McKenzie	5	145	98	30		4,500	IV	G	Dam on a coulee.	****
10.	McKenzie	25	150	99	30	100	2,000	II	E	Dam on Cherry Creek, a spring fed stream. Storage to make additional water available for irrigation.	*
	Total Class "C" Projects:				150	100	$19,500				
TOTAL PROPOSED IMPROVEMENTS IN USE OF SURFACE WATER RESOURCES:					122,158	27,100	$1,864,000				

SURVEY:

* None
** Field Inspected by State Engineer.
**** Surveyed by CCC.

USE:

I Flood control and stream regulation.
II Irrigation.
III Recreation.
IV Stock watering and water conservation.

DESIGNATION:

E Excellent
G Good
F Fair
P Poor

TABLE E

PROPOSED PROJECTS

LITTLE MISSOURI RIVER SUB-BASIN

SUMMARY

CLASS "A" PROJECTS DEMANDING IMMEDIATE ATTENTION:

Proposed Improvements in Water Supply	$ 100	
Proposed Improvements in Sewage Disposal	100,000	
Proposed Improvements in Use of Surface Water Resources	19,500	
Total Class "A" Projects:		$ 119,600

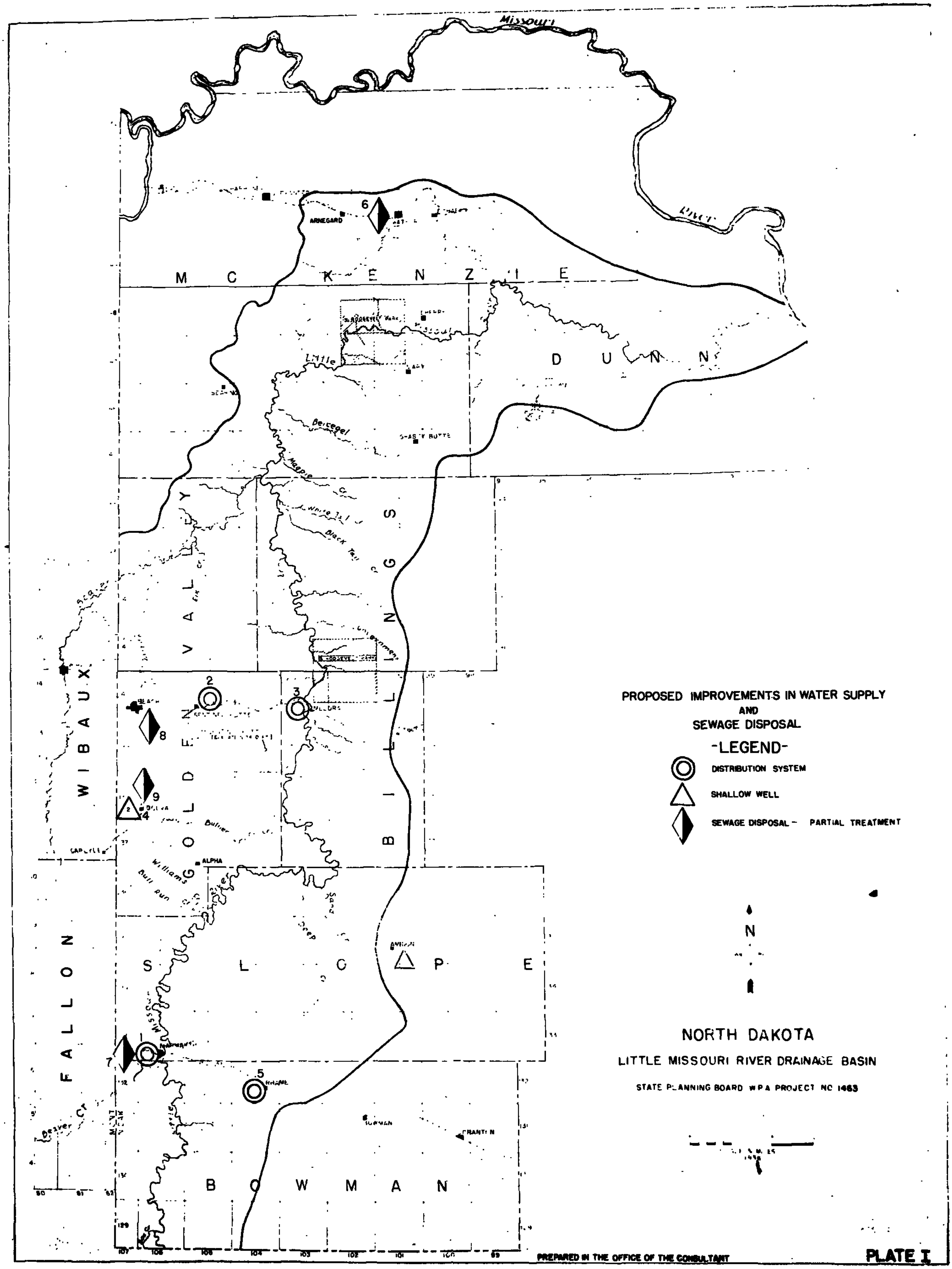
CLASS "B" PROJECTS DEMANDING IMMEDIATE ATTENTION UPON COMPLETION OF SURVEY:

Proposed Improvements in Water Supply	1,200	
Proposed Improvements in Use of Surface Water Resources.	1,825,000	
Total Class "B" Projects		$ 1,826,200

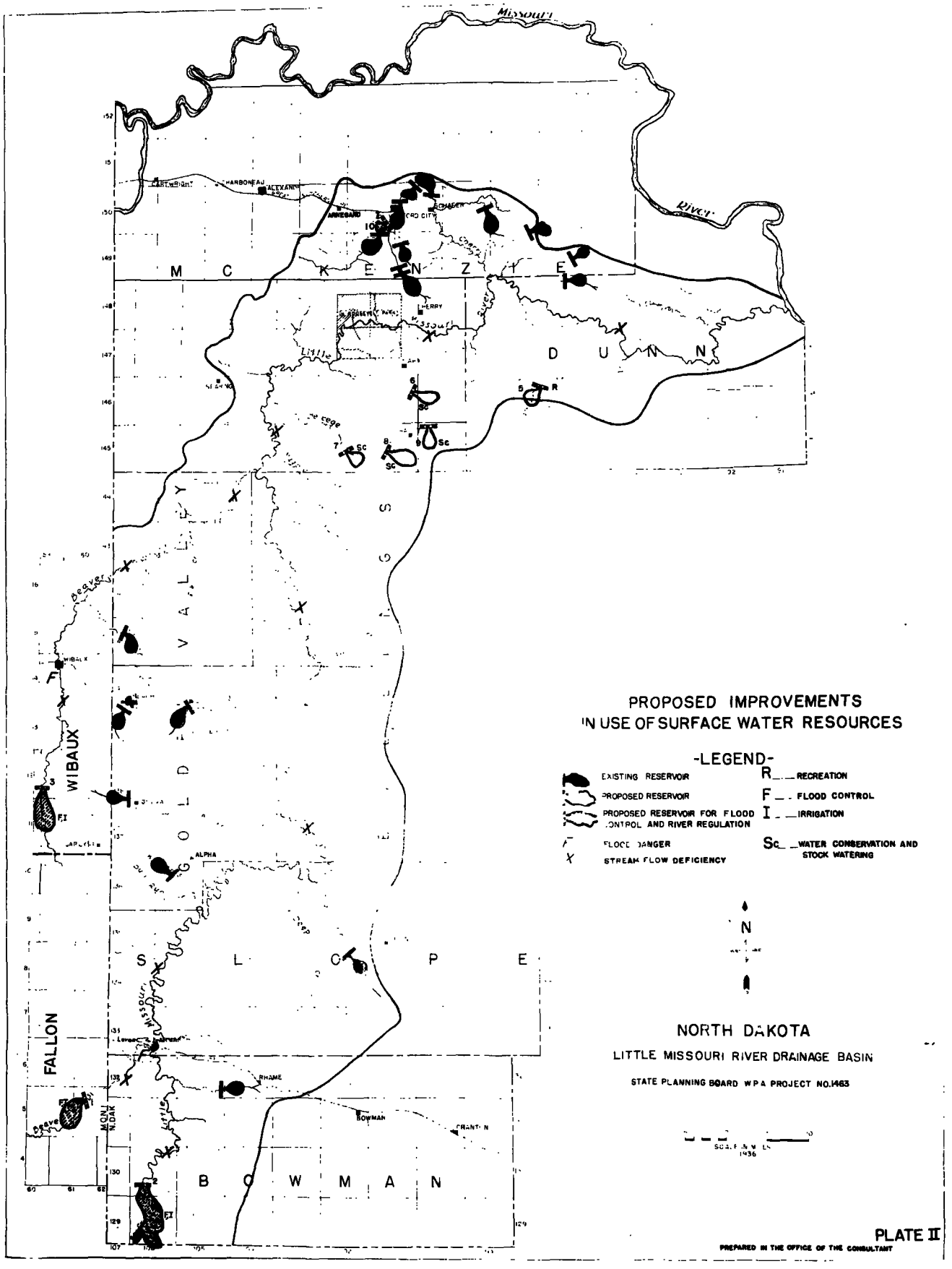
CLASS "C" PROJECTS IN PLAN NOT INCLUDED IN CLASSES "A" AND "B":

Proposed Improvements in Water Supply	13,000	
Proposed Improvements in Use of Surface Water Resources	19,500	
Total Class "C" Projects:		32,500

TOTAL PROPOSED PROJECTS: $ 1,978,300



PROPOSED IMPROVEMENTS IN WATER SUPPLY
AND
SEWAGE DISPOSAL
-LEGEND-
DISTRIBUTION SYSTEM
SHALLOW WELL
SEWAGE DISPOSAL - PARTIAL TREATMENT
N
NORTH DAKOTA
LITTLE MISSOURI RIVER DRAINAGE BASIN
STATE PLANNING BOARD W.P.A. PROJECT NO 1463
Missouri
River
MC KENZIE
DUNN
GOLDEN VALLEY
BILLINGS
SLOPE
BOWMAN
WIBAUX
FALLON
ARNEGARD
Little
ALPHA
Williams
Bull Run
Beaver Cr
PREPARED IN THE OFFICE OF THE CONSULTANT
PLATE I



PROPOSED IMPROVEMENTS IN USE OF SURFACE WATER RESOURCES

-LEGEND-

- EXISTING RESERVOIR
- PROPOSED RESERVOIR
- PROPOSED RESERVOIR FOR FLOOD CONTROL AND RIVER REGULATION
- FLOOD DANGER
- STREAM FLOW DEFICIENCY

R — RECREATION
F — FLOOD CONTROL
I — IRRIGATION
Sc — WATER CONSERVATION AND STOCK WATERING

N

NORTH DAKOTA

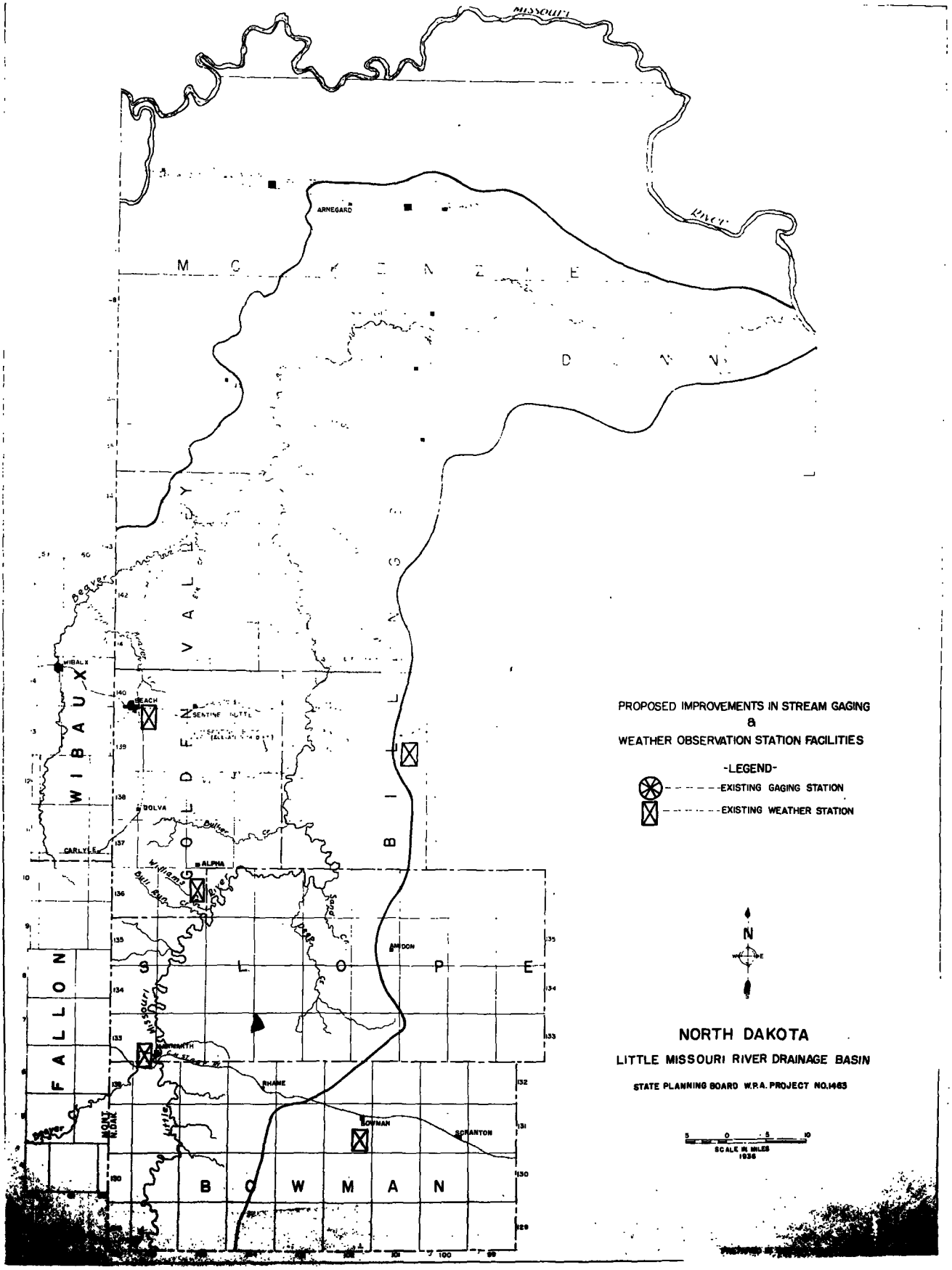
LITTLE MISSOURI RIVER DRAINAGE BASIN

STATE PLANNING BOARD W P A PROJECT NO. 1463

SCALE IN MILES
1936

PLATE II

PREPARED IN THE OFFICE OF THE CONSULTANT


MISSOURI
RIVER
ARNEGARD
M C K E N Z I E
D U N N
BILLINGS
GOLDEN VALLEY
SLOPE
BOWMAN
FALLON
WIBAUX
BEACH
SENTINEL BUTTE
BOLVA
CARLYLE
ALPHA
AMIDON
MARMARTH
RHAME
BOWMAN
SCRANTON
Beaver Creek
Williams Creek
Bull Butte Creek
Deep Creek
Spring Creek
Little Missouri River
Medicine Hole Creek
Beaver Creek
MONT.
N. DAK.
PROPOSED IMPROVEMENTS IN STREAM GAGING
&
WEATHER OBSERVATION STATION FACILITIES
-LEGEND-
EXISTING GAGING STATION
EXISTING WEATHER STATION
N
NORTH DAKOTA
LITTLE MISSOURI RIVER DRAINAGE BASIN
STATE PLANNING BOARD W.P.A. PROJECT NO.1463
5 0 5 10
SCALE IN MILES
1936

CHAPTER VI

YELLOWSTONE SUB-BASIN

CHAPTER VI
YELLOWSTONE RIVER SUB-BASIN

GENERAL

The Yellowstone River rises in the northwestern corner of the State of Wyoming and flows in a generally northeastward direction to its confluence with the Missouri River near Buford, North Dakota. The length of the main stream is 871 miles. The average slope of the river is 13.3 feet per mile from an elevation of 10,800 feet above mean sea level at the headwaters to 1,859 feet above mean sea level at the mouth. That portion of the stream which lies in North Dakota has a slope of less than one foot per mile of channel.

The total area drained by the Yellowstone River in Wyoming, Montana, and North Dakota is 69,820 square miles of which 718 square miles are in the northeastern corner of McKenzie County and in the northwest corner of Golden Valley County, North Dakota.

POPULATION

The total population of the Yellowstone Sub-basin in North Dakota in 1930 was 2,630 persons. This population was entirely rural. The largest town was Alexander which had a population of 386.

FEDERAL AID

In the peak month of W.P.A. employment approximately 20 persons were employed on work projects in or near cities and villages and about 300 persons were employed on rural projects, making a total of about 320 persons employed in October, 1936.

TOPOGRAPHY

That portion of the Yellowstone Sub-basin lying in North Dakota is a glaciated area with the drift and valley alluvium resting upon the Fort Union formation. The river valley is several miles wide and slopes gently toward the river. In the upper portions of the Sub-basin the rolling plateau country rises to an elevation of about 2,400 feet mean sea level. This region marks the divide between the Little Missouri and the Yellowstone Sub-basin.

SOILS

The soil of the Sub-basin, for the most part, is valley alluvium. This alluvium is also found in terraces and benches along the sides of the valleys. Alkali is present in the soil but not in sufficient quantities to affect agricultural development except where concentration has taken place due to the general topography of the local area or to the application of irrigation water without sufficient drainage.

TRIBUTARIES

The North Dakota tributaries of the Yellowstone River are Benne Pierre Creek, Horse Creek, and Charboneau Creek. These three streams are rather small and are not capable of much development because of the rapid drop in elevation of their channels. Of these

Benne Pierre Creek offers the greatest possibilities for development.

NATURAL RESOURCES

Lignite coal is present in the Fort Union formation of the Sub-basin. It is not mined on a large commercial scale in this region but affords an abundance of fuel to the inhabitants at low cost.

GROUND WATER

The main sources of water in the Sub-basin are the valley alluvium and the base of the upland drift which is tapped by shallow wells. Water is also secured from wells and springs in the lignite and sandstone beds of the Fort Union formation. This water is of fairly good quality, although that coming from the sandstone and some of that coming from the drift is highly mineralized.

PRECIPITATION

There is a marked deficiency of rainfall in the Sub-basin for the production of growing crops. The average annual precipitation is about 14 inches, and that from May through September is about 9½ inches.

THE WATER PROBLEM

There are several thousand acres of bottom lands along the east side of the Yellowstone River that are potentially well suited to irrigation. There is also a considerable area in the valley of Benne Pierre Creek that could be irrigated by the construction of a storage dam and a system of irrigation ditches. The necessity for irrigation in this area is made evident by the fact that, during the last twenty years, two crop failures have, on the average, occured in each five year period due, primarily, to rainfall deficiencies. However, on the west side of the river where the river bottom lands are irrigated, crop failures are unknown. Crops of wheat with a yield as high as 54 bushels per acre have been grown on the Yellowstone River bottom lands after spring flooding.

There are several sites for small dams which would create spring fed reservoirs suitable for stock watering and possible recreational use. The Resettlement Administration is presently developing such projects in the area.

Several thousand acreas of land on the west side of the river are water logged and saturated with alkali. This land needs to be rehabilitated and provided with suitable drainage ditches to become a valuable part of the Lower Yellowstone irrigation project.

RUN-OFF

The flow in the Yellowstone River at its confluence with the Missouri River is about equal to that of the main stream. The average annual run-off is approximately 10,500,000 acre feet, and the flow varies from 5,000 to 160,000 cubic feet per second. The local run-off in the Sub-basin in North Dakota is about one inch per year.

FLOODS

The Yellowstone River bottom lands are subject to frequent spring flooding due to the fact that the Yellowstone River breaks up before the Missouri River, and the resulting ice jams back the water over the valley. This flooding does no particular damage. In fact, the silt so deposited and the thorough soaking given the land are of definite value.

The rapid spring run-off that occurs in this Sub-basin is accompanied by excessive bank erosion. As a result pumping plants for irrigation projects must be protected by revetment work or by the construction of suitable concrete walls and intake pipes. The latter would eliminate the danger to these plants by removing them sufficiently far from the river.

WILD LIFE

Wild life resources of the Sub-basin consist largely of deer which are present in the wooded areas. No particular developments are present or are contemplated to increase the wild life resources.

RECREATION

The C.C.C. dams on Charbonneau Creek create reservoirs which are available for recreational purposes. The one in section 26-151-103 is of particular value for this purpose. However, the shores of this reservoir should be developed for picnic and camping facilities.

NAVIGATION

Previous to the construction of the railroad into Montana, there was considerable navigation on the Yellowstone River. From the year 1882, when the Northern Pacific Railway reached Billings, Montana to 1910 a small amount of river traffic continued between Glendive, Montana and the mouth of the river. However, there has been no commercial navigation on the river since that time except during recent years when a small boat has plied between Sidney, Montana and the mouth. In 1930 this boat handled approximately 60,000 pounds of produce. There are no large pleasure craft operated on the river. No development of navigation is contemplated in North Dakota.

WATER POWER

There is no proposal for the development of water power on the Yellowstone River in North Dakota. Cheap power is available from steam generating stations utilizing lignite coal and natural gas as fuels.

MUNICIPAL SUPPLY

There are only a few small towns in the Sub-basin, and these have not reported a water supply problem.

STREAM POLLUTION

There is no sewage discharged into the streams in the Sub-basin in North Dakota. There are a number of cities in Montana which discharge their sewage into the Yellowstone River. Data on the number of these and the type of sewage treatment are not available. This probably causes no serious pollution problem, however, because of the high minimum flow of the Yellowstone River. During drought

years dead animals and debris in tributary streams cause the greatest stream pollution in the Basin.

IRRIGATION

The United States Bureau of Reclamation Lower Yellowstone Irrigation Project on the west side of the Yellowstone River irrigates approximately 20,000 acres in North Dakota. Small grains, alfalfa, and sugar beets are grown on this land. That this project has been a success is attested by the following figures furnished by the manager of the Lower YellowstoneProject for that portion lying in North Dakota:

Year	Value Per Acre	
	Irrigated Crop	Dry Land Crop
1935	$ 37.50	0.50
1930 - 1935 (average)	$ 29.87	3.50

On the east side of the river there are approximately 5,000 acresof bottom land capable of being irrigated in a manner similar to that practiced by the Lower Yellowstone project. This area is divided into three natural project sites by two high bluffs along which it would be difficult to carry irrigation canals. The upper project would be a portion of the Sidney pumping project now being developed by the Water Conservation Department of Montana. Some clearing would have to be done before the maximum area could be irrigated. Irrigated land on the east side of the river could be used similarly to that under irrigation on the west side. Sugar beets grown in the area would be piled in the fields until the river was frozen over and then hauled across and shipped to the sugar factory at Sidney, Montana.

EXISTING RESERVOIR

Five reservoirs have been constructed in this Basin. When full, these reservoirs store about 608 acre feet of water.

PROPOSED PROGRAM

It is proposed:

(1) That surveys and designs be made for the upper and lower Cartwright irrigation projects and the Sidney pumping project on the east side of the Yellowstone River in North Dakota and that the bottom lands in this area be placed under irrigation as soon as possible.

(2) That a series of relatively small dams be built on Benne Pierre Creek for irrigating approximately 2,000 acres of land in the valley.

(3) That the Resettlement Administration build dams to conserve the water produced by springs in the area for stock watering and recreational purposes. All dams constructed hereafter in the

Sub-basin should be provided with outlet gates for releasing the water stored when a great need arises for it downstream or when it becomes so polluted that it is a definite health hazard to the community. Some existing dams should also be provided with outlet gates.

(4) That a detailed soil survey and land classification be begun as soon as is possible in order to ascertain the suitability of these lands for irrigation in each of the several areas. These surveys should follow the aerial mapping of the irrigable regions. This mapping will provide, in addition to its utility as the basis of the proposed soil survey and land classification, much needed data on present land use. The cost of the aerial mapping would approximate 5¢ per acre. The cost of the detailed soil survey and land classification would be an additional 5¢ per acre. Thus, to properly predetermine the areas suited to irrigation would entail the expenditure of 10¢ per acre for 6,600 acres of irrigable land in the Yellowstone River Sub-basin, or approximately $660.

Proposed projects are listed in Table B. Existing dams are listed in Table A. Plate I shows the present and proposed developments of the water resources of the Sub-basin.

WEATHER OBSERVATION AND STREAM GAGING FACILITIES

There are no weather recording stations located in the Yellowstone River Sub-basin in North Dakota, but a first class weather station is located at Williston just to the north and cooperative stations are located at Arnegard just to the east and at Beach just to the south of the Sub-basin. There are no stream gaging stations in the Sub-basin, but a good record of stream flow at and near Glendive, Montana is available. In 1934 a gaging station was established in the Yellowstone River at Sidney, Montana. No weather recording stations or stream gaging stations are included in the proposed program for the Sub-basin.

TABLE A

EXISTING DAMS AND RESERVOIRS

YELLOWSTONE RIVER BASIN

No.	County	Sec.	Twp.	Rge.	Storage A. F.	Cost Est.	Use	Desig-nation	Description and Remarks	Legend
1.	McKenzie	1	150	104	10	$ 500	II	G	Dam on a coulee. For irrigating gardens.	***
2.	McKenzie	26	151	103	449	11,800	III	E	Dam on Charbonneau Creek near Charbonneau.	*
3.	McKenzie	27	150	101	68	12,600	IV	G	Dam on branch of Charbonneau Creek.	(*) (**)
4.	McKenzie	32	150	101	52	3,000	IV	G	Dam on Antelope Creek.	
5.	McKenzie	14	146	105	29	3,000	IV	P	Dam on Coulee.	
	TOTAL EXISTING DAMS AND RESERVOIRS:				608	$30,900				

LEGEND:

* Dams constructed by CCC
** Dams constructed by FERA or WPA
*** Privately constructed

USE:

II Irrigation
III Stock watering and water conservation recreation
IV Stock watering and water conservation

DESIGNATION:

E Excellent
G Good
F Fair
P Poor

TABLE B

PROPOSED PROJECTS

YELLOWSTONE RIVER BASIN

Plate I. Map No.	County	Twp.	Rge.	Storage Capacity Acre Feet Est.	Irrigable Land Acres. Est.	Cost Est.	Desig-nation	Description of Project	Survey
CLASS "A" PROJECTS DEMANDING IMMEDIATE ATTENTION:									
1.	McKenzie	151	104			$1,000		Survey of Lower Cartwright irrigation project and design of necessary structures.	**
2.	McKenzie	150 151	103 104			2,000		Survey of upper Cartwright irrigation project and design of necessary structures.	**
3.	McKenzie	150	104			1,000		Complete survey and design of structures for North Dakota portion of Sidney pumping project.	**
4.	McKenzie	148 147	105 104			2,000		Survey of Benne Pierre Creek to determine possibility of irrigation.	**
	Total Class "A" Projects:					$6,000			
PROPOSED CLASS "B" PROJECTS DEMANDING ATTENTION UPON COMPLETION OF SURVEYS:									
1.	McKenzie	151	104	None	1,000	20,000	E	Construction of Lower Cartwright Irrigation Project.	**
2.	McKenzie	150 151	103 104	None	1,500	30,000	E	Construction ofUpper Cartwright Irrigation Project.	**
3.	McKenzie	150	104	None	2,100	42,000	E	Construction of North Dakota portion of Sidney pumping project.	**
	Total Class "B" Projects:				4,600	$92,000			

TABLE B (Cont'd.)

PROPOSED PROJECTS

YELLOWSTONE RIVER BASIN

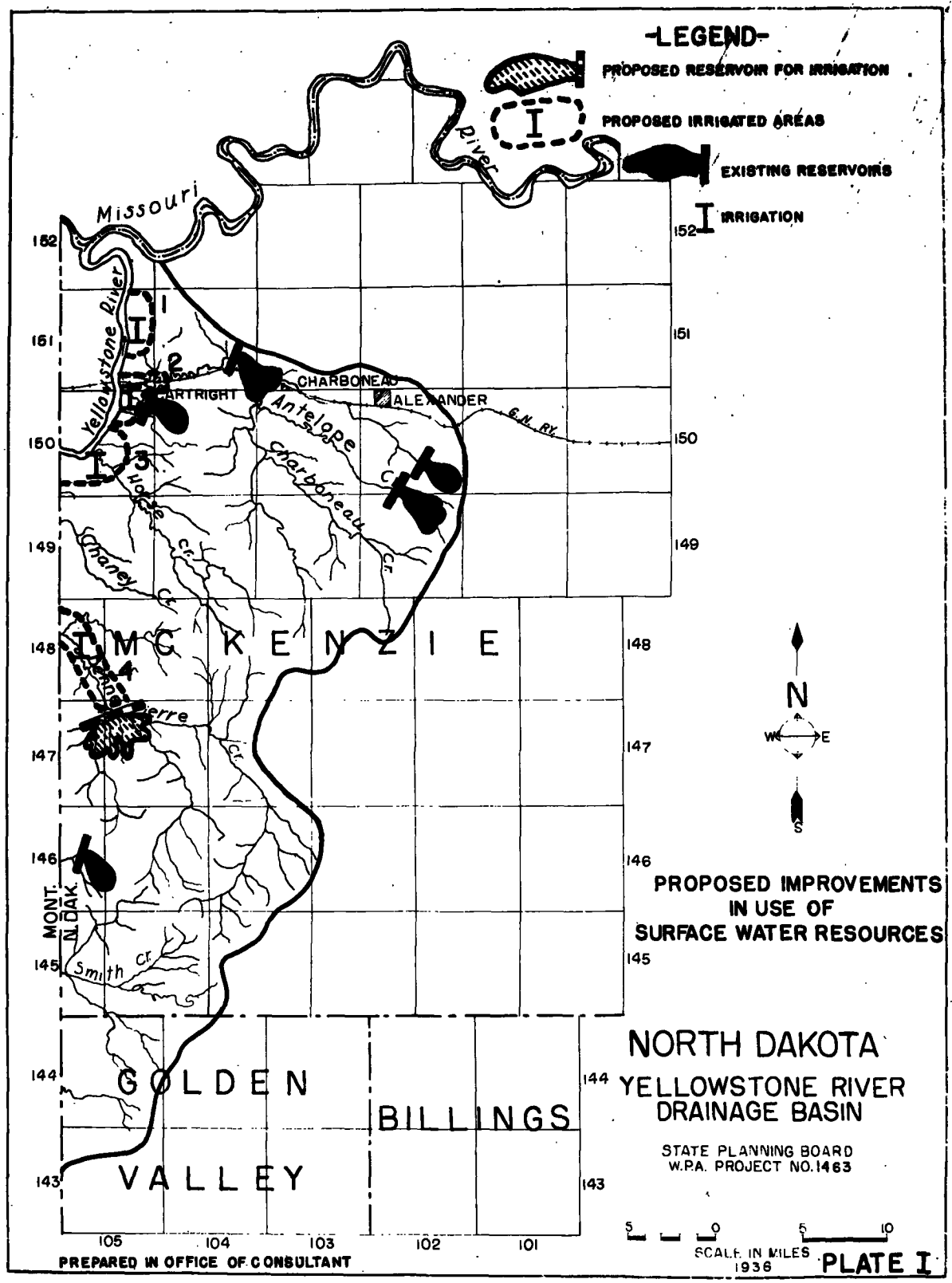
Plate I Map No.	County	Twp.	Rge.	Storage Capacity Acre Feet Est.	Irrigable Land Acres. Est.	Cost Est.	Designation	Description of Project	Survey
CLASS "C" PROJECTS IN PLAN NOT INCLUDED IN CLASSES "A" AND "B":									
4.	McKenzie	148 147	105 104	4,000	2,000	$100,000	G	Construct dams and irrigation works on Benne Pierre Creek if the survey shows the project to be feasible.	**
5.	McKenzie			250	____	25,000	G	Development of springs and stock watering ponds in the Basin. This program is being developed by the Rural Resettlement Administration and WPA.	**
	Total Class "C" Projects:			4,250	2,000	$125,000			
	TOTAL PROPOSED PROJECTS:			4,250	6,600	$223,000			

SURVEY:

** Field Inspected by State Engineer

DESIGNATION:

E Excellent
G Good
F Fair
P Poor


-LEGEND-
PROPOSED RESERVOIR FOR IRRIGATION
PROPOSED IRRIGATED AREAS
EXISTING RESERVOIRS
IRRIGATION
Missouri River
Yellowstone River
CHARBONEAU
ALEXANDER
CARTRIGHT
Antelope Creek
Charbonneau Cr.
Haskett Cr.
Chaney Cr.
Ft. Pierre Cr.
Smith Cr.
G.N. RY.
MONT.
N. DAK.
MCKENZIE
GOLDEN VALLEY
BILLINGS
152
151
150
149
148
147
146
145
144
143
105
104
103
102
101
N
W
E
S
PROPOSED IMPROVEMENTS IN USE OF SURFACE WATER RESOURCES
NORTH DAKOTA
YELLOWSTONE RIVER DRAINAGE BASIN
STATE PLANNING BOARD
W.P.A. PROJECT NO. 1463
5 0 5 10
SCALE IN MILES
1936
PREPARED IN OFFICE OF CONSULTANT
PLATE I

NORTH DAKOTA

STATE PLANNING BOARD

SUMMARY REPORTS

OF

A PLAN OF WATER CONSERVATION

FOR

NORTH DAKOTA