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BIOLOGICAL SURVEY OF THE RED RIVER OF THE NORTH

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BIOLOGICAL SURVEY OF THE RED RIVER OF THE NORTH[a]

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ABSTRACT

A stream survey was conducted on the Red River of the North during the autumn of 1983 and the summer of 1984. Stream characteristics and fish and wildlife habitat parameters were delineated. A total of 40 stations equalling 36.3 mi of river were electrofished in 14 study sectors. The catch was comprised of 36 fish species representing 12 families. Turbidity and deep water limited the effectiveness of electrofishing. Channel catfish and walleye were the most abundant game fish at 8.2% and 3.2% of the overall catch, respectively. The major river problems are agricultural encroachment, accelerated erosion rates and high turbidity. Continued improvements in municipal and industrial discharges are necessary to alleviate low dissolved oxygen under winter ice cover conditions. The wooded corridor and its associated edge provide critical wildlife habitat. With improved watershed management practices there is potential for increased recreational opportunity amidst a somewhat barren landscape.

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[a] This project was funded in part by Federal Aid in Fish and Wildlife Restoration FW-7-S.

Secchi disc transparencies ranged from 0.3-1.8 ft. There were no readings over 1.0 ft downstream of Sector 3, indicating an increasing trend in turbidity from suspended solids. The Red River flows through soils of small particle size, predominantly silt and clay, that are highly susceptible to erosion and long term suspension. The river typically carries a heavy load of suspended clay and silt particles except during the winter months when runoff is at a minimum. For substrate types and other physical characteristics by sector, refer to Appendix Table 1.

Flow Data

The source of the Red River is the confluence of the Otter Tail and Bois de Sioux Rivers. The average annual flow at this point is 519 cfs. There are 13 tributaries to the Red River that have gaging stations near their mouths. Six of these tributaries have average annual flows over 100 cfs. The Red River's principal tributaries are the Red Lake, Otter Tail and Wild Rice rivers with average annual flows of 489, 303 and 258 cfs, respectively. These three tributaries are in Minnesota. The Minnesota tributaries rise from the hilly area that was the eastern shore of glacial Lake Aggasiz. They flow westerly with rather steep gradients over the beach ridges left by the receding glacial lake before reaching the level plain of the Red River valley. Gradient is substantially lower in this flat area and channel flow capacities are frequently exceeded. The North Dakota tributaries begin on the dry, high plains to the west and are low to moderate gradient streams with generally less flow than the Minnesota tributaries. Location and flow at the time of the survey for the major tributaries to the Red River are found in Appendix Table 2.

INTRODUCTION

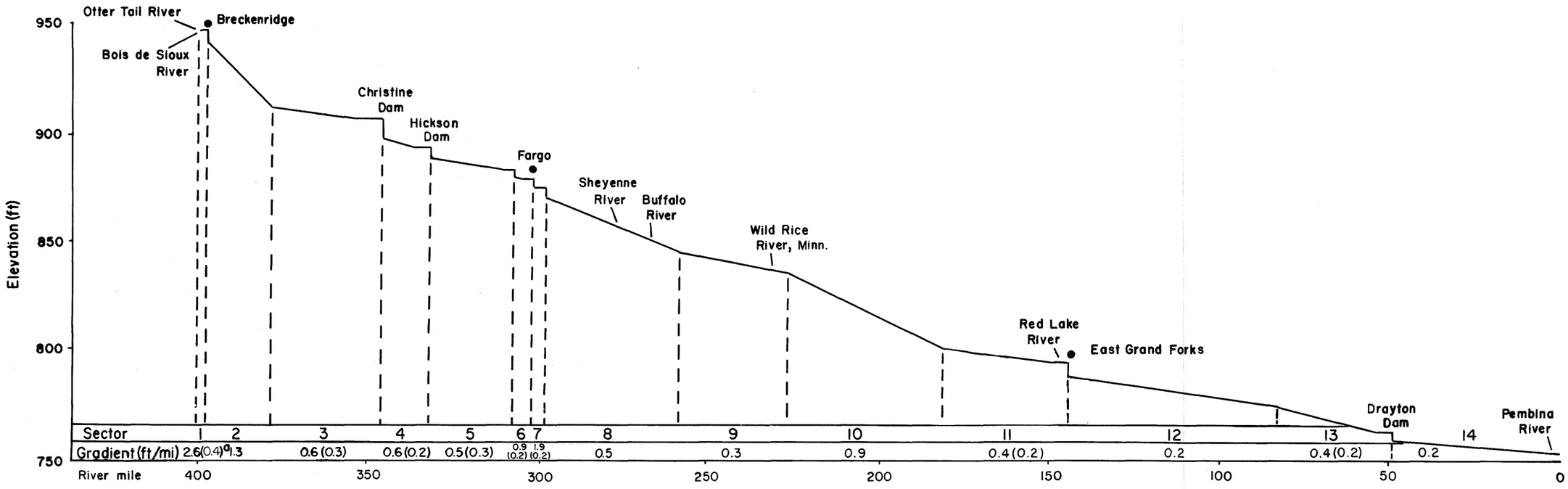
The Red River was surveyed to collect baseline data on the fish and wildlife resources of the river and its associated corridor. This survey report describes environmental conditions and provides resource management information for a variety of local, state and federal agencies as well as private organizations. The river was videotaped from the air to facilitate dividing it into study sectors and locating potential access sites. Portions of each sector were electrofished during the summers of 1983 and 1984 to determine fish population characteristics. Sector locations, electrofishing stations, river miles and access points are found in the map series following the Appendix.

PHYSICAL CHARACTERISTICS

The Red River watershed encompasses 17,500 mi^2 in Minnesota, 21,000 mi^2 in North Dakota and 800 mi^2 in South Dakota. The river begins in the prairie region of west central Minnesota and forms the boundary between Minnesota and North Dakota for 400 mi.

Glacial Lake Agassiz lay over northwest Minnesota 12,000 years ago. Sediment carried by glacial meltwater was deposited in the lake creating an extremely level lakebed that is the broad flat plain of the Red River valley. The river drops 200 ft in elevation from its source to the Canadian border and has an overall gradient of 0.5 ft/mi. Sectors 2 and 10 have the highest gradients at 1.3 ft/mi and 0.9 ft/mi, respectively (Fig. 1). Twenty-two riffle areas were observed on the Red River, 15 of which are in Sector 10. This higher gradient area (Sector 10) extends from Halstad to Climax and is known as "Goose Rapids". The natural river channel varies in width from 200-500 ft and the average thalweg depth was 3.0-7.0 ft during normal late summer flow.

Figure 1. Red River stream profile and gradient by sector.



[a] Dams have reduced the gradient to the figure in parentheses.

The Red River is highly susceptible to flooding due to low stream gradient, low channel capacity and the extreme flatness of its valley. Floods occur annually at some point on the main stem and the probability of a severe flood is once every seven years (Hydrologic Atlas of Minnesota 1959). The land surrounding the river is only a few feet higher than the channel banks so water spreads over an extensive area when channel capacities are even slightly exceeded. Floods can occur from March through November but are most common during April, May and June. Increased spring flows begin in the southern headwaters and may be blocked by ice cover downstream which frequently compounds flooding problems.

U.S. Geographical Survey stream gaging stations are located at Wahpeton and Fargo, ND, Halstad, MN, and Grand Forks and Drayton, ND. Average flows for the years of record at these stations and 13 major tributary stations are given in Table 1. Also shown are the average flows for the individual water years 1980-83 which demonstrate discharge variability when compared to the average flows for the years of record. Average monthly flows for the years of record show high seasonable variability as typified by the station at Drayton where the mean monthly flow ranges from 1,024 cfs in February to 14,080 cfs in April (Table 2).

Dams

There are eight dams on the Red River with the first at Wahpeton-Breckenridge used for municipal water supply (Appendix Table 3). The second dam, near Wolverton, and the dam at Hickson, ND control river levels. There are three dams in Fargo-Moorhead and all are used for river level control with the furthest one downstream (RM 288.4) also used for municipal water supply. The dam in Grand Forks-East Grand Forks retains water for municipal supply as does the dam in Drayton, ND.

Table 1. Average annual flows (cfs) at 5 gaging stations on the Red River and 13 tributaries, for the years of record and water years 1980-84. (USGS)[a]

Location	Average flow (cfs)	Years of record	Water years 1980	1981	1982	1983
Bois de Souix River near White Rock, SD	76.8	1941-83	17.7	2.0	26.0	3.2
Otter Tail River below Orwell Dam	303.0	1930-83	331.0	134.0	379.0	315.0
Red River at Wahpeton, ND	519.0	1943-84	421.0	153.0	454.0	361.0
Wild Rice River near Abercrombie, ND	72.0	1932-84	41.4	4.3	38.4	15.9
Red River at Fargo	552.0	1901-84	482.0	175.0	580.0	434.0
Sheyenne River at West Fargo, ND	176.0	1929-84	121.0	110.0	236.0	348.0
Buffalo River near Dilworth	128.0	1931-83	71.7	52.3	125.0	151.0
Wild Rice River at Hendrum	258.0	1944-83	107.0	89.3	298.0	278.0
Red River at Halstad	1,750.0	1961-83	838.0	462.0	1,538.0	1,488.0
Goose River at Hillsboro, ND	68.5	1931-84	-	-	-	91.8
Marsh River near Shelly	65.5	1944-83	9.4	5.1	37.9	65.6
Sand Hill River at Climax	69.5	1946-83	42.1	23.7	65.2	101.0
Red Lake River at Crookston	489.0	1933-83	978.0	497.0	710.0	1,787.0
Red River at Grand Forks, ND	2,528.0	1882-84	1,948.0	1,014.0	3,590.0	3,756.0
Middle River at Argyle	41.2	1951-83	10.6	3.7	N/A	54.8
Park River at Grafton, ND	58.7	1931-84	15.4	42.9	88.5	84.3
Red River at Drayton, ND	3,797.0	1949-84	2,087.0	1,140.0	4,386.0	4,437.0
Pembina River at Neche, ND	192.0	1919-84	38.6	55.2	191.0	173.0

[a] A water year runs from 1 October of previous year to 30 September of the year indicated.

Table 2. Monthly average flows (cfs) for years of record at 5 gaging stations on the Red River and for 12 tributaries.

	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.
Bois de Souix River near White Rock, SD	6.8	5.7	2.7	2.1	3.3	22.5
Otter Tail River below Orwell Dam	212.0	222.0	213.0	205.0	199.0	274.0
Red River at Wahpeton, ND	276.0	275.0	260.0	253.0	256.0	513.0
Wild Rice River near Abercrombie, ND	5.3	4.9	2.4	0.7	0.9	122.0
Red River at Fargo, ND	276.0	254.0	211.0	192.0	185.0	601.0
Sheyenne River at West Fargo, ND	57.7	69.5	55.9	45.7	53.3	198.0
Buffalo River near Dilworth	45.0	45.1	25.9	18.7	15.9	144.0
Wild Rice River at Hendrum, MN	110.0	102.0	60.1	42.2	38.9	226.0
Red River at Halstad, MN	625.0	618.0	473.0	400.0	400.0	1,755.0
Goose River at Hillsboro, ND	6.6	6.0	4.0	2.3	2.8	101.0
Marsh River near Shelly	15.2	12.3	6.4	4.5	3.8	61.0
Sand Hill River at Climax	30.3	27.6	15.4	11.1	10.5	60.9
Red Lake River at Crookston	795.0	666.0	539.0	483.0	459.0	898.0
Red River at Grand Forks, ND	1,286.0	1,138.0	921.0	772.0	729.0	2,127.0
Middle River at Argyle	7.2	5.6	2.2	0.9	0.7	11.7
Park River at Grafton, ND	5.4	3.4	2.3	1.1	2.0	55.7
Red River at Drayton, ND	1,737.0	1,546.0	1,201.0	1,055.0	1,024.0	2,222.0
Pembina River at Neche, ND	69.5	44.7	20.3	10.6	7.4	74.1

Table 2. Continued.

	Apr.	May	June	July	August	Sept.
Bois de Sioux River near White Rock, SD	185.0	261.0	245.0	149.0	56.5	17.9
Otter Tail River below Orwell Dam	431.0	536.0	532.0	379.0	241.0	203.0
Red River at Wahpeton, ND	1,177.0	993.0	996.0	714.0	362.0	261.0
Wild Rice River near Abercombie, ND	380.0	107.0	103.0	102.0	20.9	7.9
Red River at Fargo, ND	1,579.0	941.0	964.0	786.0	366.0	271.0
Sheyenne River at West Fargo, ND	678.0	412.0	252.0	179.0	81.0	58.4
Buffalo River near Dilworth	555.0	209.0	197.0	170.0	63.9	51.4
Wild Rice River at Hendrum	1,135.0	556.0	407.0	299.0	106.0	101.0
Red River at Halstad, MN	7,016.0	3,148.0	2,523.0	2,444.0	754.0	492.0
Goose River at Hillsboro, ND	453.0	112.0	61.1	24.1	8.8	8.1
Marsh River near Shelly	344.0	152.0	97.5	83.1	25.1	13.8
Sand Hill River at Climax	373.0	128.0	88.4	56.9	24.2	22.1
Red Lake River at Crookston	3,078.0	2,142.0	1,692.0	1,254.0	761.0	769.0
Red River at Grand Forks, ND	9,090.0	4,916.0	3,805.0	3,053.0	1,509.0	1,301.0
Middle River at Argyle	236.0	83.4	82.0	63.1	5.1	9.2
Park River at Grafton, ND	427.0	122.0	50.4	23.0	4.6	7.5
Red River at Drayton, ND	14,080.0	9,036.0	5,421.0	4,488.0	1,935.0	1,612.0
Pembina River at Neche, ND	761.0	654.0	321.0	161.0	91.1	71.8

The Wahpeton-Breckenridge, Fargo and Grand Forks dams were constructed in the early part of the century for water supply. At this time low flows were common and in winter there would be times of zero flow downstream of Fargo. These dams do not effectively reduce the hazards of flooding during periods of snowmelt and heavy rains. All of the dams effectively block fish movements except during times of exceptional high water levels. This limits the dynamic nature of riverine fish populations and impairs the fishery potential.

WATER QUALITY

The Red River of the North is characteristically a turbid, grayish-brown colored stream. The color and turbidity are caused by suspended sediments scoured from the bed of former glacial Lake Agassiz which the river courses through for its entire length. Runoff from farmland and encroachment of agricultural activities have compounded this phenomenon.

Post-settlement point source pollution brought decades of degraded conditions to the Red River. Municipal and industrial wastes particularly associated with Grand Forks-East Grand Forks and Fargo-Moorhead caused serious water quality problems. Impairment of municipal water supplies, unsafe ice for commercial and domestic food storage, and the virtual extinction of fish life were the result. The drought period of the 1930's caused the most severe conditions when little or no stream flow was available for dilution. Pollution control measures within the last two decades have substantially improved these conditions.

The Red River at its source, where the Otter Tail and Bois de Sioux rivers converge, is a turbid stream with high levels of dissolved salts. The Otter Tail River contributes the majority of stream flow and although it arises in higher elevation glacial moraines as a clear unpolluted stream it

takes on the characteristics of the Red River as it cuts through beach ridges, west of Fergus Falls, and courses through the bed sediments of glacial Lake Agassiz.

Seasonal median values of water quality sampling data for the 10 year period 1974-1984 were compiled for five stations on the Red River (Appendix Table 4). USEPA Storet information for water quality sampling locations at Brushvale, MN; Fargo, ND; Perley, MN; Grand Forks, ND; and Emerson, Man. were reviewed (Appendix Table 5). Progressing from source to mouth, suspended solids, conductivity, total phosphorus and total nitrogen generally exhibit increasing concentrations. With the exception of suspended solids, these parameters frequently show seasonal reductions in concentrations at the farthest downstream monitoring station at Emerson, Manitoba. This is presumably due to the influence of the Red Lake River which joins at East Grand Forks.

Dissolved oxygen (DO), fecal coliform and biochemical oxygen demand (BOD), while not exhibiting increasing downstream trends, responded to localized influences from point and non-point source pollution. Fecal coliform levels were generally highest at Station RE-452 located upstream of the wastewater treatment facility at Fargo suggesting the discharge of contaminated stormwater or untreated sewage. BOD was generally highest at Perley, downstream of the municipal and industrial waste sources at Fargo.

Water chemistry parameters necessary to support aquatic life are adequate except for winter declines of DO below the acceptable standard of 5 mg/l. Minimum DO values in the reach from Fargo to Grand Forks are at times unacceptable for aquatic life, particularly when ice cover prohibits stream reaeration. USEPA Storet data for the winter period (Dec.-Feb.) of the years of record indicates that the DO was 1.5 mg/l or less 10% of the time at

Perley, 2.7 mg/1 or less 10% of the time at Grand Forks and at Brushvale, downstream from Breckenridge-Wahpeton, winter values were 4.8 mg/1 or less 10% of the time.

The International Garrison Diversion Study Board - Water Quality Report (1976) discussed pesticide monitoring results based on U.S. (1968-75) and Canadian (1972-76) water samples of the Red River. Organochlorine pesticides were not detected in Canadian samples but were noted in 15% of U.S. samples. Diazinon was found in 12% of U.S. samples. The chlorophenoxy herbicide 2,4-D was found in over 50% of Canadian and U.S. samples at concentrations ranging from 0.01-0.71 ug/1. A related chemical, 2,4,5-T, was detected in 5% of the total samples at concentrations of 0.01 and 0.02 ug/1.

Fish consumption advisories based on flesh concentrations of mercury and polychlorinated biphenyls (PCB) have been established by the Minnesota Department of Health. Advisories for mercury were initiated in 1970 and for PCB's in 1985. Red River fish between Breckenridge and East Grand Forks exhibited higher contaminant levels than those fish tested near the Canadian border. Channel catfish, walleye, northern pike and carp are the primary species of concern with 1986 consumption advisories varying from unlimited consumption to no more than one meal per week at six locations along the Red River.

The Red River is classified by the Minnesota Pollution Control Agency as a 1C, 2B, 3B stream. The 1C designation indicates suitability for domestic consumption with appropriate treatment. The 2B designation indicates suitability for the propagation of cool and warmwater fish and aquatic recreation of all kinds. The 3B designation indicates suitability for general industrial purposes, except food processing, with only a moderate degree of treatment. The river generally conforms to this classification; however, fecal coliform and turbidity frequently exceed the standards of 200 organisms/100 ml and 25 FTU, respectively.

WATER USES

Water Appropriation

Water is appropriated from the Red River and the Red Lake River near the mouth by seven major users. The American Crystal Sugar plants in Drayton, ND and Moorhead each appropriate 0.30 mgd (million gallons/day) from the Red River. American Crystal Sugar in East Grand Forks appropriates 0.07 mgd from the Red Lake River. Fargo and Moorhead use 10.0 and 2.65 mgd, respectively and the town of Drayton, ND uses 0.16 mgd from the Red River. Grand Forks, ND and East Grand Forks appropriate 1.92 mgd and 1.48 mgd, respectively, from the Red Lake River. There are also numerous private users that appropriate for irrigation.

Waste Discharges

The Industrial and Municipal Waste Inventory (Minnesota Pollution Control Agency 1984) lists 12 cities that discharge effluent to the Red River. The cities in Minnesota that discharge 0.1 mgd or more are Moorhead (6.0 mgd), East Grand Forks (1.4 mgd), Breckenridge (0.5 mgd) and Oslo (0.1 mgd). American Crystal Sugar discharges 5.0 mgd of wastewater from the beet processing operation in East Grand Forks and 10.0 mgd in Moorhead when Red River flow exceeds 500 cfs (cubic feet/second). Moorhead Public Service discharges a maximum of 17.3 mgd of non-contact cooling water to the Red River.

VEGETATION

Aquatic vegetation is not common in the Red River due to the high turbidity previously discussed in the Physical Characteristics section. There are occasional beds of river pondweed in Sectors 1 and 2 with the remainder of the river devoid of vegetation except for sporadic outgrowths of smartweed and sedges along the river's edge.

In presettlement times, prairie was the dominant feature on the flat plains away from the river and floodplain forest dominated the river corridor. The common grass species of the prairie were bluestem, switchgrass, Indian grass and wild rye reaching an average height of 5 ft. Examples of the prairie community persist on tracts preserved by a number of public and private organizations. The bottomland forest consists of species tolerant of a high water table and frequent inundation. The elm-boxelder community is the major component of the bottomland along with green ash, cottonwood and willow. Common understory species include round-leaved hawthorn, gray dogwood and hazelnut. Bur oak and basswood occur further away from the river and on slightly higher ground with gooseberry, wild rose and Juneberry being common representatives of the shrub layer.

Agriculture is the primary land use in the valley with 81% of the floodplain used as agricultural land. Thirteen percent is wooded with the remainder consisting of native prairie and residential areas (U.S. Army Corps of Engineers 1978).

WILDLIFE CHARACTERISTICS

The Red River valley's character has changed dramatically since pre-settlement times. Gone are the herds of bison and the endless tallgrass prairie as well as a number of other native animal species that suffered habitat loss and over-harvest. Monoculture cropland has replaced the prairie and a majority of the wetlands in the main stem subbasin have been drained and converted to farmland. The wildlife habitat and cover that remains is limited to shelterbelts and woodlands.

Waterfowl habitat is marginal because there are few oxbows and marshes along the river and aquatic plants are virtually nonexistent. More favorable

conditions exist in the North Dakota pothole country and the lake-pothole area of the southeast portion of the watershed in Minnesota. Wood ducks were the most frequently observed waterfowl during the survey. The Red River corridor is used as a rest area by migrating waterfowl, shorebirds, birds of prey and other birds.

Gray partridge is the prevalent upland game bird because of abundant cropland and pastured grasslands. Sharp-tailed and ruffed grouse populations remain at low levels because of unfavorable habitat conditions. The principal pheasant range is the southern half of the Red River valley which extends to southern Polk County. Parcels of good prairie chicken habitat exist from Wilkin and Otter Tail Counties north to Red Lake County.

Beaver, mink, muskrat, raccoon and red fox are the primary furbearers in the watershed. Beaver sign were present along the entire length of the river and individual sightings were common; however, evidence of muskrat or mink was rare. Red fox and raccoon have adapted to environmental changes and are common throughout the watershed. Black bear, bobcat and wolves occasionally wander into the Red River valley but their habitat needs are not met in this part of the state and few are successful in establishing home ranges.

White-tailed deer are common along the river because of the riparian cover and available water. The river woodland habitat is enhanced where it meets agricultural land and creates an edge effect with a variety of intermediate plant species. The floodplain forest provides critical winter cover for deer and many other species in this part of the state. Moose occur sporadically and are hunted every other year in the northeastern portion of the basin. They are not native to the Red River valley but their range has expanded over the years. One moose was sighted during the survey 10 mi south of East Grand Forks.

FISHERIES

Fishery survey work was conducted on the Minnesota-North Dakota portion of the Red River of the North during September 1983 and August through September 1984. Various investigators have done fish sampling on portions of the Red River between 1895 and 1969 (Eddy et al. 1972). More recent work includes extensive seining and some elctrofishing in the Fargo-Moorhead area (J. Peterka, North Dakota State University, personal communication 1985). The North Dakota Game and Fish Department completed a fishery survey on the Red River. The work involved a gill and trap net fishery survey at 10 locations between Breckenridge and the Canadian border during August, 1976.

The initial phase of the MDNR survey involved an aerial reconnaissance and videotaping of the river from Breckenridge to the Canadian border. This provided visual information to aid in establishing sample sectors, locating access sites, determining shoreline cover type and surrounding land use. Sector subdivisions were planned by coordinating the video data with on-the-water observations made prior to the electrofishing activity. The established sector subdivisions exemplify areas of similar physical stream structure.

Electrofishing stations were located to include representative stream habitats within the various sectors. The number of electrofishing sampling stations per sector was determined by the length of the sector and diversity of habitat. Stations consisted of a single timed electrofishing run with one to five stations established per sector. A total of 40 stations were established in the 14 sectors with an accumulated electrofishing time of 19.7 hours. All electrofishing was done during daylight hours. Legal descriptions for the location of each electrofishing station are found in Appendix Table 6. Stations are also plotted in the map series in the Appendix.

Turbidity and deep water were limiting factors affecting electrofishing results. Gear adjustments and capture are more difficult when observation of fish response is inhibited. Long stretches of deep channel and pools below Grand Forks were beyond the effective range of available equipment. It is assumed that there was some negative sampling bias for a number of species, particularly channel catfish, which inhabit the deeper pools.

Catch

The total catch of fish from the 14 sectors of the Red River contained 36 species representing 12 families (Table 3). Twelve additional species have been reported by previous investigators. One species Hybopsis gracilis, taken in the MDNR 83-84 survey, had not been reported from any Minnesota waters. The total numbers of fish for all species collected in the present survey are found in Appendix Table 7.

Although the minnows and other small fish species are an integral component of the fish community structure, they are excluded from the percent composition analysis of the catch. Life cycles of these species are generally more ephemeral and electrofishing gear is frequently less efficient for small fish. Unusually high, low or unrepresentative catches of the small fish can confound the comparative analysis of the percent composition of large fish species from one area or time to another. Sampling with electrofishing gear is also less efficient for the large fish young-of-year; however, they are included in the percent composition analysis. Percent composition for the large fish species catch is in Appendix Table 8.

Game fish, for purposes of this report, will be defined to include northern pike, channel catfish, white bass, sauger and walleye. Channel catfish were the most common game fish taken at 8.2% of the large fish species catch.

Table 3. Fish species collected or reported from the Red River of the North by various sources between 1895 and 1984[a].

Scientific Name	Common Name	Reference[b]
	PETROMYZONTIDAE (Family)	
Ichthyomyzon castaneus	Chestnut lamprey	1, 3
Ichthyomyzon unicuspis	Silver lamprey	1, 3
	HIODONTIDAE	
Hiodon alosoides	Goldeye	1, 3
Hiodon tergisus	Mooneye	1, 3
	UMBRIDAE	
Umbra limi	Central mudminnow	2
	ESOCIDAE	
Esox lucius	Northern pike	1, 2, 3
	CYPRINIDAE	
Cyprinus carpio	Common carp	1, 2, 3
Hybopsis gracilis	Flathead chub	1
Hybopsis storeriana	Silver chub	1, 2, 3
Nocomis biguttatus	Hornyhead chub	2
Notemigonus crysoleucas	Golden shiner	2
Notropis atherinoides	Emerald shiner	1, 2, 3
Notropis blennius	River shiner	1, 2, 3
Notropis cornutus	Common shiner	1, 2
Notropis hudsonius	Spottail shiner	2, 3
Notropis rubellus	Rosyface shiner	2
Notropis spilopterus	Spotfin shiner	1, 3
Notropis stramineus	Sand shiner	1, 2, 3
Pimephales promelas	Fathead minnow	1, 2, 3
Rhinichthys atratulus	Blacknose dace	2
Rhinichthys cataractae	Longnose dace	1, 3
	CATOSTOMIDAE	
Carpiodes cyprinus	Quillback	1, 2, 3
Catostomus commersoni	White sucker	1, 2, 3
Ictiobus cyrinellus	Bigmouth buffalo	1, 3
Moxostoma anisurum	Silver redhorse	1, 3
Moxostoma erythrurum	Golden redhorse	1, 3
Moxostoma macrolepidotum	Shorthead redhorse	1, 2, 3
Moxostoma valenciennesi	Greater redhorse	1, 3

Table 3. (Continued)

Scientific Name	Family Common Name	Reference
	ICTALURIDAE	
Ictalurus melas	Black bullhead	1, 2, 3
Ictalurus nebulosus	Brown bullhead	2
Ictalurus punctatus	Channel catfish	1, 2, 3
Noturus flavus	Stonecat	1, 2, 3
Noturus gyrinus	Tadpole madtom	3
	PERCOPSIDAE	
Percopsis omiscomaycus	Trout-perch	1, 2, 3
	CYPRINODONTIDAE	
Fundulus diaphanus	Banded killifish	2
	GADIDAE	
Lota lota	Burbot	1, 2, 3
	PERCICHTHYIDAE	
Morone chrysops	White bass	1, 3
	CENTRARCHIDAE	
Ambloplites rupestris	Rock bass	1, 3
Lepomis cyanellus	Green sunfish	1, 3
Lepomis gibbosus	Pumpkinseed	3
Micropterus dolomieui	Smallmouth bass[c]	1, 3
Pomoxis annularis	White crappie[d]	1, 3
Pomoxis nigromaculatus	Black crappie	1, 3
	PERCIDAE	
Etheostoma nigrum	Johnny darter	3
Percina caprodes	Logperch	1, 3
Percina maculata	Blackside darter	1, 2
Percina shumardi	River darter	2
Stizostedion canadense	Sauger	1, 3
Stizostedion vitreum vitreum	Walleye	1, 2, 3

Table 3. (Continued)

Scientific Name	Family Common Name	Reference
	SCIAENIDAE	
Aplodinotus grunniens	Freshwater drum	1, 2, 3

[a] Species nomeuclature from AFS Special Publication No. 12
[b] Reference Numbers:
1 - MDNR 1983 and 1984
2 - Eddy et al. 1972
3 - Dr. John Peterka, North Dakota State University (personal communication)
[c] Taken during an unofficial sampling run just upstream of the Red Lake River.
[d] Taken on a sampling run in the Bois de Sioux River, 1983

Nearly 78% of the catfish collected were from Sectors 2, 3 and 10. In Sectors 2 and 3, catfish were 19.4% and 19.5% of the catch, respectively. Sector 5 was the only location where no channel catfish were collected.

Walleye and sauger were the second and third most abundant game fish collected at 3.2 and 3.1%, respectively. No walleye were collected from Sectors 6, 11, 12 and 13. Sauger did not show up in the catch until Sector 8. Sauger were the most common below the Drayton Dam (Sector 14) where they totaled 29.1% of the catch. An unusual concentration of sauger was noted within the tailwaters of the Drayton Dam where approximately 100 sauger were observed during an unrecorded four minute electrofishing trial. Northern pike were collected in Sectors 1, 6, 11, 12, 13, and 14 with an overall catch of 1.5% of the large fish species.

Carp, collected in all sectors, were the most abundant at 18.9% of the overall catch, goldeye were second at 18.3% and shorthead redhorse were 17.8% overall. Carp ranged from 6.9% in Sector 9 to 46.9% in Sector 4. Goldeye accounted for 10 to 43% of the catch in Sectors 7-14; however, no goldeye were

collected in Sectors 1-4 and 6. Shorthead redhorse were collected in all Sectors, except Sector 13, and totaled 37.2% of the catch in Sector 2.

The Minnesota River is comparable to the Red River in size, turbidity and dissolved solids (Table 4). Differences in overall catch per unit effort (CPUE) data between the two rivers is largely a result of dissimilarities in habitat (Table 4). The higher CPUE of the Minnesota River is in part due to the effects of the river's variable geology on the physical and chemical characteristics of the stream. The high percentage of game fish in the Red River is in part due to unusual numbers of channel catfish in Sectors 2 and 3 and sauger in Sector 14.

Table 4. Percent of the large fish catch for two groups of fish (game fish, carp and catostomids) in the Red River of the North and four tributaries with average flows greater than 100 cfs. The Minnesota River is included for comparative purposes.

River	Game Fish		Carp and Catostomids		Overall
	% (No.)	% (Wt.)	% (No.)	% (Wt.)	CPUE
Red (1983, 84)	16.0	12.4	54.3	75.7	105.1
Otter Tail (1979, 80)	7.1	4.1	65.1	89.0	154.2
Red Lake (1976, 77)	6.0	6.1	67.5	74.3	118.8
Wild Rice (1976)[b]	3.8	5.0	83.7	89.0	[a]
Roseau (1976)[c]	39.0	25.0	48.8	72.1	88.8
Minnesota (1980-82)	11.4	8.2	71.2	88.3	150.2

[a]Data was tabulated to show catch per acre only.

[b]Only an upper portion of the river was sampled.

[c]Only the river portion in Minnesota was surveyed. Game fish catch includes high numbers of small northern pike and walleye.

The large fish species total weight and percent composition by weight for the study areas are presented in Appendix Tables 9 and 10. Channel catfish were found to be the most abundant game fish by weight at 7.4%. Although higher numbers of channel catfish were collected in Sectors 2 and 3, Sector 10 had the highest biomass at 20.3%. Walleye were second overall at 2.7% by weight. The highest total biomass of walleye for the study areas was Sector 9 at 11.7%. Sauger provided only 0.9% of the overall catch biomass, primarily from Sector 14, in which they were 16.6% of the catch.

Carp were the most abundant species by weight at 39.1% overall. In Sectors 4, 6, 7, 11, 12 and 13, carp composed over 50% of the catch by weight. The only other species that comprised 10% or more of the total catch by weight was shorthead redhorse at 11.8%.

A total of 2,968 fish (including small fish species) were captured in 19.7 hrs of electrofishing on the Red River. Appendix Table 11 shows the CPUE for each of the 14 sectors. Catch rates ranged from 48.4 to 366.0 fish/hr. Catch rates for large fish species ranged from 41.3 to 248.3 fish/hr with a sector mean of 106.5 fish/hr. Sector 2 had the highest large fish catch as a result of lower suspended solids, coarser substrates and higher gradient. Carp and catostomids contributed 178.6 fish/hr or 71.9% of that total. Channel catfish, the most abundant game fish, was collected at a rate of 48.3 fish/hr and 19.4% of the total large fish catch for Sector 2.

For the composite catch, carp and goldeye were the most frequently collected species at 19.8 and 19.2 fish/hr, respectively. Carp were more predominant in the upper one-third of the river and goldeye appeared to be restricted to the lower two-thirds of the river (downstream from the dams at Fargo). Shorthead redhorse were collected at a rate of 18.7 fish/hr.

Channel catfish were the most frequently captured game fish overall at 8.6 fish/hr. Walleye and sauger were second and third at 3.4 and 3.2 fish/hr, respectively. The highest CPUE for walleye was in Sectors 2, 7 and 9 with a range of 8.9-13.1 fish/hr.

The majority of the channel catfish were immature fish. Only a few young-of-year were taken. The majority of immature fish were taken from Sector 2. Electrofishing catches indicate that mature fish were distributed throughout the river; however, deepwater habitats such as downstream from Drayton dam had small catches that probably were unrepresentative of the actual population. Appendix Table 12 provides the length-frequencies of the catch for the large fish species. Few young-of-year walleye were collected. Adult walleye were collected more frequently in the river reaches downstream from Breckenridge and Fargo. Sauger occurred exclusively downstream from the dams at Fargo and became particularily abundant near the Canadian border, below the Drayton dam. Most sauger were adult or sub-adult fish 9-13 inches long.

Fish community structure was predictably responsive to physical stream parameters along the Red River. Gradient, substrate, turbidity, tributary streams, flow and dams are factors that strongly influence fish populations from one area of the river to another (Figure 1 and Appendix Table 1). Although the Red River is characterized by low gradient and fine clay and silt substrates, those areas of river with higher gradient and coarser substrates generally had larger numbers of fish and percentage of game fish. Turbidity and chemical parameters such as dissolved oxygen may also be exerting some seasonal or areal influences on fish distribution. Although higher catch rates for game fish were often noted at the mouth of major tributaries, it is uncertain what affect tributary populations had on variable catch rates in different segments of the Red River.

Sauger and goldeye are species that prefer large river environments which may partially account for their abundance in the lower river; however, the apparent breaks in the catch data demonstrate the importance of dams relative to fish distribution. Dams on the Red River and a number of the dams on the lower portions of major tributaries effectively block fish movements except during extreme high flows.

Recent MDNR stockings include channel catfish fingerlings in 1978 (Wilkin County) and walleye fry in 1979 (Wilkin and Clay Counties). North Dakota stocked channel catfish fingerlings in Cass and Richland Counties in 1985.

Mussels

The available literature indicates that as many as 12 molluscan species in the families Amblemidae and Unionidae may exist in the Red River of the North. Extensive research on mussel distribution has been done by Dawley (1947) and Cvancara (1970). Dawley's work provides detailed mollusk survey data for all major watersheds of Minnesota. Specifically Dawley recorded 11 mussel species from the Red River. Cvancara's work is the most comprehensive to date. It includes surveys of the Red River and 18 of its tributaries south of the Canadian border. Cvancara reported taking 10 species from 26 sampling sites on the Red River during the summers of 1965 and 1966. The 1984 MDNR survey consisted of hand picking live or recently dead shells from four locations between Fargo and Grand Forks. Exact locations are shown in Appendix Table 13. A total of 10 mussel species were collected and identified (Table 6).

Table 5. Mussel species collected from the Red River of the North as recorded by three sources between 1947-1984.

Scientific name	Common Name	Source[a]
	FAMILY	
	AMBLEMIDAE	
Amblema costata	Threeridge	2,3
Amblema plicata		1
Fusconaia flava	Wabash pigtoe	1,2,3
Quadrula quadrula	Mapleleaf	1,2,3
	UNIONIDAE	
Anodonta grandis	Floater	1,2,3
Lasmigona complanata	White heelsplitter	1,2
Strophitis undulatus (Strophitis rugosus)[b]	Strange floater, Squawfoot	2,3
Actinonaias carinata	Mucket	1,3
Lampsilis ovata ventricosa (Lampsilis ventricosa)	Pocketbook	1 2,3
Lampsilis radiata siliquoidea (Lampsilis siliquoidea)	Fat mucket	1 2,3
Ligumia recta (Ligumia recta latissima)	Black sandshell	1 2,3
Proptera alata (Protera alata megaptera)	Pink heelsplitter	1,2 3
Obliquaria reflexa	Three-horned wartyback, Threehorn	3

[a]Source numbers: 1 - MDNR 1984; 2 - Cvancara 1970; 3 - Dawley 1947.

[b]Species nomenclature as listed by the author which was later changed.

CONCLUSIONS AND RECOMMENDATIONS

1. The Red River watershed is intensively utilized for agricultural purposes. Row crops abut the river banks in many areas and replace the more stable riparian vegetation. Restoration of the natural tree and shrub growth along the river would enhance water quality, recreational opportunity, aesthetic values, and fish and wildlife habitat.
2. Improved soil conservation practices, and wetland protection and restoration throughout the watershed would reduce erosion and flooding problems while improving water quality.
3. Turbidity remains as the most pernicious problem affecting aquatic life, water supplies and recreation along the Red River. Turbidity resulting from suspended solids is largely the result of instream factors and non-point source pollution. However, the municipal waterworks at Fargo was a gross example of point source turbidity at the time of survey.
4. Continued improvements in municipal and industrial point source discharges should be implemented to reduce noncompliance for dissolved oxygen and fecal coliform.
5. At present, there is one designated public access site located at the source of the Red River in Breckenridge. There are undesignated sites in Halstad, E. Grand Forks and Olso, that could provide adequate access but need improvement. Additional sites should be developed below dams.

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A P P E N D I X

Table 1. Stream physical characteristics of the Red River, 1983-84.

Sector	1	2	3	4	5
Date	23 Sept. 1983	20-21 Sept. 1983	22 Sept. 1983	27 Sept. 1983	27 Sept. 1983
T.R.S. to T.R.S.	132, 47, 8 133, 47, 33	133, 47, 33 134, 48, 15	134, 48, 15 136, 48, 18	136, 48, 18 137, 48, 19	137, 48, 19 139, 48, 30
Upstream end of sector (RM)	400.4	397.9	379.5	346.4	332.6
Length of sector (miles)	3.5	18.4	33.1	13.8	25.1
Sinuosity value	1.6	1.7	2.6	2.5	2.3
Depth-thalweg ave. (ft.)	4.0	2.5	2.7	5.8	7.0
Depth-maximum (ft.)				14.0	
Specific conductance range (umhos/cm)	270	270-275	275	305	
Number of riffles	0	4	0	0	0
Flow (cfs)	326			297	
Gradient (ft/mi)[a]	2.6 (0.4)	1.3	0.6 (0.3)	0.6 (0.2)	0.5 (0.3)
Stream stage	above normal	above normal	above normal	above normal	above normal
Secchi disc transparency (ft)		1.8	1.7	1.0	1.0
Dams (by river mile)		397.9		346.4	332.6
Substrate types (in order of abundance, excluding reservoirs)	sand-silt	sand-gravel-rubble-ledgerock	sand-silt	sand-silt-clay	sand-silt-clay

Table 1. Continued.

Sector	6	7	8	9	10
Date	28 Sept. 1983	29 Sept. 1983	27, 30 July 1984	28, 29 July 1984	31 July 1984 9, 12 August 1984
T.R.S to T.R.S.	139, 48, 30 139, 48, 7	139, 48, 7 140, 48, 32	140, 48, 32 142, 49, 2	142, 49, 2 145, 49, 25	145, 49, 25 148, 49, 22
Upstream end of sector (RM)	307.5	301.6	298.3	257.9	225.7
Length of sector (miles)	5.9	3.3	40.4	32.2	44.8
Sinuosity value	2.2	2.2	2.2	2.3	2.2
Depth-thalweg ave. (ft.)	9.0	7.8	5.6	6.6	4.9
Depth-maximum (ft.)	15.0				16.0
Specific conductance range (umhos/cm)	335		550-600	600-620	600-630
Number of riffles	0	0	1	2	15
Flow (cfs)		269		1,010	
Gradient (ft/mi)[a]	0.9 (0.2)	1.9 (0.2)	0.5	0.3	0.9
Stream stage	above normal	above normal	above normal	above normal	above normal
Secchi disc transparency (ft)	1.0	1.0	0.7	0.3	0.9
Dams (by river mile)	307.5	301.6	298.3		
Substrate types (in order abundance, excluding reservoirs)	sand-silt-clay-gravel-rubble	silt-clay-gravel-rubble	silt-clay-gravel rubble	silt-clay-gravel	gravel-clay rubble-boulder

able 1. Continued.

ector	11	12	13	14
ate	10, 14 August 1984	13, 27, 28 August 1984	28 August 1984	26, 29 August 1984
.R.S. to T.R.S.	148, 49, 22 152, 50, 34	152, 50, 34 157, 50, 18	157, 50, 18 159, 50, 18	159, 50, 18 164, 51, 26
pstream end of sector (RM)	180.8	144.6	82.4	49.5
ength of sector (miles)	36.2	62.2	32.9	49.5
inuosity value	1.6	1.9	2.6	1.7
epth-thalweg ave. (ft.)	8.7	7.9	6.6	5.2
epth-maximum (ft.)	15.0	25.0		
pecific conductance range (umhos/cm)	450-600	460-495	430	460-475
umber of riffles	0	1	0	0
low (cfs)	1,600		1,080	1,100
radient (ft/mi)	0.4 (0.2)	0.2	0.4 (0.2)	0.2
tream stage	above normal	above normal	normal	normal
ecchi disc transparency (ft)	0.9	0.9		0.5
ams (by river mile)		144.6		49.5
ubstrate types (in order f abundance, excluding eservoirs)	clay-silt-gravel	clay-silt-sand-gravel	clay-silt	clay-silt-gravel

Dams have reduced gradient to figure in parenthesis.

Table 2. Location and flow (cfs) at the time of survey for the major tributaries to the Red River (H-26).

Name	Location at mouth T.	R.	S.	Flow	Tributary Number
Pembina River	163	51	4	5.1	a
Two Rivers	162	50	32	2.5	H-26-9
Tamarac River	158	50	20	1.0	H-26-19
Park River	158	51	25	1.0	
Snake River	157	50	9	1.0	H-26-21
Forest River	156	51	2	3.0	
Marais River	156	51	13	1.0	
Turtle River	154	51	12	6.0	
Grand Marais Creek	153	50	22	2.0	H-26-29
Red Lake River	151	50	2	960.0	H-23-30
Cole Creek	150	50	36	1.0	
Sandhill River	148	49	36	17.0	H-26-38
Marsh River	146	49	11	10.0	H-26-42
Goose River	146	49	13	12.0	
Wild Rice River	144	49	1	47.0	H-26-47
Elm River	144	49	26	3.0	
Buffalo River	142	48	30	29.0	H-26-56
Sheyenne River	141	49	13	134.0	
Wild Rice River	138	48	19	4.0	
Whiskey Creek	134	48	3	1.0	H-26-77
Otter Tail River	132	47	8	295.0	H-26-81
Bois de Sioux River	132	47	8	0	

[a]Rivers without tributary numbers are in North Dakota.

Table 3. Dams on the Red River as observed during September 1983 and July-August 1984.

Type of dam	River mile	Hydraulic height	Use	Fish barrier	Year built	Owner
Concrete	384.8	6'	water supply	yes	1919	Wahpeton Park Board
Concrete	346.4	8'	river level control	yes	N/A	City of Fargo
Concrete	332.6	6'	river level control	yes	N/A	City of Fargo
Concrete	307.5	4'	river level control	yes	N/A	City of Fargo
Concrete	301.6	5'	river level control	yes	N/A	City of Fargo
Concrete	298.3	6'	water supply	yes	N/A	City of Fargo
Concrete	144.6	8'	water supply	yes	1925	City of Grand Forks
Concrete	49.5	6'	water supply	yes	1964	City of Drayton

Table 4. Description and location of water quality sampling stations.

1. RE-536 (MPCA)[a] - Located at bridge on CSAH-18 at Brushvale, MN. Approximately 13 mi downstream of Whapeton-Breckenridge. MDNR river mile 387.5.

2. RE-452 (MPCA) - Located at bridge on Main and First Avenues, Fargo, ND. Upstream of wastewater treatment facility and downstream of municipal waterworks. MDNR river mile 301.

3. RE-403 (MPCA) - Located at bridge on CSAH-39, west of Perley, MN and approximately 40 miles downstream from Fargo. MDNR river mile 253.3.

4. RE-300 (MPCA) - Located at Grand Forks, ND at waterworks intake, Almonte Avenue south and upstream of confluence of Red Lake River. MDNR river mile 146.5.

5. 000001 (Env. Canada/Manitoba Env.)[b] - Located at Emerson, Man. immediately across the US/Can. border.

[a]Station monitored by Minnesota Pollution Control Agency

[b]Station monitored by Environment Canada and Manitoba Department of Environmental and Workplace Safety

Table 5. Seasonal median values for selected water quality parameters at five stations on the Red River of the North, 1974-1984 (Storet).

	Dec. - Feb.			March - May			June - Aug.			Sept. - Nov.		
	No.	Median	Range	No.	Median	Range	No.	Median	Range	No.	Median	Range
Water Temperature - °F												
Brushvale, MN	22	32.0	32.0-33.8	30	47.8	32.0-68.9	33	73.4	60.8-84.2	27	50.9	32.0-78.8
Fargo, ND	24	32.0	32.0-33.8	33	48.0	32.0-68.9	33	73.4	65.3-82.0	27	51.8	32.0-75.2
Perley, MN	24	32.0	32.0-33.8	33	45.0	32.0-68.0	33	72.5	64.0-82.4	27	50.0	32.0-73.4
Grand Forks, ND	24	32.0	---	33	44.0	32.0-64.4	34	72.0	63.0-81.5	27	51.8	32.0-71.6
Emerson, Man.	919	33.4	21.9-42.8	933	40.1	32.0-75.2	993	71.6	51.4-82.8	1002	47.7	32.0-77.0
Dissolved Oxygen - mg/l												
Brushvale, MN	22	11.8	2.5-15.1	30	11.0	6.5-15.6	33	7.4	4.1-11.2	27	10.2	8.0-15.6
Fargo, ND	24	12.7	7.6-14.9	33	10.2	4.9-17.2	33	7.2	0.0- 9.1	27	9.7	5.9-13.3
Perley, MN	24	9.7	0.4-13.8	33	9.7	2.5-13.0	33	7.0	3.5-10.0	27	9.7	8.0-14.3
Grand Forks, ND	24	8.1	0.3-20.5	33	8.5	4.4-15.2	34	7.1	5.2-11.9	27	9.2	6.1-14.9
Emerson, Man.	918	11.2	5.5-17.5	984	9.1	0.2-15.5	987	7.4	1.8-12.8	1002	9.7	4.0-19.0
Fecal Coliform - MPN/100 ml												
Brushvale, MN	22	80	20- 5400	30	20	20- 2400	31	130	20- 2400	26	110	20- 790
Fargo, ND	24	120	20-160000	33	50	20-24000	31	490	70-460000	26	745	20-79000
Perley, MN	24	120	20- 28000	33	80	20- 5400	32	200	20- 33000	25	80	20-11000
Grand Forks, ND	24	20	20- 790	33	20	20- 330	33	50	20- 1300	26	20	20- 460
Emerson, Man.	20	11	2- 390	18	7	2- 280	24	16	2- 230	24	9	2- 260

Table 5. Continued.

	Dec. - Feb.			March - May			June - Aug.			Sept. - Nov.		
	No.	Median	Range	No.	Median	Range	No.	Median	Range	No.	Median	Range
Total Suspended Solids - mg/l												
Brushvale, MN	22	6.4	1.6-22.0	30	29.5	3.6-120.0	33	71.0	2.8-720.0	27	21.0	2.0- 79.0
Fargo, ND	24	5.3	0.8-14.0	33	46.0	0.5-300.0	33	55.0	25.0-970.0	27	26.0	2.4- 74.0
Perley, MN	24	8.0	1.6-17.0	32	104.0	2.8-870.0	33	160.0	10.0-890.0	26	41.5	0.5-120.0
Grand Forks, ND	24	5.0	0.5-14.0	33	42.0	0.5-250.0	34	55.0	17.0-560.0	26	24.0	6.8-110.0
Emerson, Man.	28	9.0	3.0-45.0	32	105.0	2.0-604.0	29	187.0	5.0-824.0	28	67.5	12.0-616.0
Turbidity - FTU												
Brushvale, MN	9	3	1-94	10	9	4- 19	12	22	12- 43	10	7	3-29
Fargo, ND	11	3	1- 9	12	24	2- 41	12	20	12- 39	10	9	2-31
Perley, MN	11	4	3-10	11	44	4-160	12	39	7-300	10	14	4-45
Grand Forks, ND	11	4	2- 6	12	32	3-140	12	23	13- 96	10	10	2-28
Emerson, Man.	--	-	-	--	--	-	--	--	-	--	--	-
Conductivity - micromhos/cm												
Brushvale, MN	22	525	430-1300	30	490	380- 970	33	470	330- 770	27	469	340-1060
Fargo, ND	24	550	420-1140	33	520	270- 860	33	490	280- 790	27	469	200- 940
Perley, MN	24	720	520-1500	32	635	431-1000	33	640	300- 940	26	685	470-1300
Grand Forks, ND	24	765	430-1600	33	600	320- 760	34	610	190- 840	26	665	500-1100
Emerson, Man.	413	685	475-1760	456	590	274-2000	397	588	325-9800	380	555	390-1210

Table 5. Continued.

	Dec. - Feb.			March - May			June - Aug.			Sept. - Nov.		
	No.	Median	Range	No.	Median	Range	No.	Median	Range	No.	Median	Range
Biochemical Oxygen Demand (5 day) - mg/l												
Brushvale, MN	22	1.5	0.5- 6.0	30	2.7	0.7- 7.8	33	3.1	0.7- 9.4	27	2.4	1.2- 6.6
Fargo, ND	24	1.4	0.6-6.3	33	2.6	0.8-10.0	33	2.4	0.5-22.0	27	2.3	1.3- 5.6
Perley, MN	24	1.5	0.8-5.2	32	3.4	0.5-11.0	33	2.6	1.1- 8.8	26	3.3	1.0-12.0
Grand Forks, ND	24	1.1	0.5-4.1	33	2.5	0.5- 8.7	34	2.0	0.5- 7.7	26	2.2	0.6- 5.7
Emerson, Man.	--	-	--	--	-	--	--	-	--	--	-	--
Total Phosphorous - mg/l												
Brushvale, MN	22	0.13	0.06-2.14	30	0.18	0.07-0.65	33	0.27	0.12-0.69	26	0.12	0.02-0.75
Fargo, ND	24	0.14	0.06-0.56	33	0.21	0.10-0.74	31	0.22	0.11-0.98	27	0.16	0.07-0.30
Perley, MN	24	0.28	0.15-7.20	32	0.39	0.01-0.91	31	0.46	0.22-1.67	27	0.49	0.19-2.37
Grand Forks, ND	24	0.25	0.07-4.90	32	0.33	0.14-0.65	34	0.34	0.13-0.81	27	0.29	0.11-2.30
Emerson, Man.	26	0.14	0.01-0.70	32	0.23	0.06-0.98	31	0.28	0.08-0.70	29	0.17	0.06-0.58
Total Nitrogen - mg/l[a]												
Brushvale, MN	8-16[b]	1.17	0.76-2.88	17-23	1.26	0.65-4.60	18-25	1.48	0.95-2.48	11-21	0.93	0.77-2.15
Fargo, ND	8-16	1.06	0.79-1.97	18-24	1.25	0.78-2.70	18-25	1.14	0.80-2.47	12-21	1.03	0.79-1.72
Perley, MN	8-16	1.74	1.16-3.30	18-24	2.07	1.00-4.70	18-25	1.70	0.99-3.87	12-21	1.63	0.92-3.00
Grand Forks, ND	8-16	1.67	1.14-2.46	17-24	2.05	0.90-4.02	19-26	1.30	0.69-2.99	12-21	1.12	0.78-2.64
Emerson, Man.	9- 8	1.18	0.81-6.40	12-12	2.60	0.52-4.72	11- 7	1.56	1.04-2.81	11- 9	1.02	0.81-2.30

Table 5. Continued.

	Dec. - Feb.			March - May			June - Aug.			Sept. - Nov.		
	No.	Median	Range	No.	Median	Range	No.	Median	Range	No.	Median	Range
Ammonia (un-ionized) - mg/l												
Brushvale, MN	22	0.005	0.001-0.043	30	0.004	0.002-0.023	33	0.010	0.002-0.049	26	0.005	0.001-0.025
Fargo, ND	24	0.003	0.001-0.034	33	0.003	0.001-0.045	33	0.010	0.002-0.069	27	0.005	
Perley, MN	24	0.004	0.001-0.033	32	0.004	0.001-0.020	33	0.011	0.003-0.035	26	0.006	0.001-0.044
Grand Forks, ND	24	0.004	0.001-0.018	32	0.004	0.001-0.034	34	0.009	0.003-0.033	26	0.005	0.001-0.018
Emerson, Man.	8	0.001	0.001-0.010	9	0.001	0.001-0.004	10	0.005	0.002-0.007	11	0.003	0.002-0.011

[a]Values derived by adding seasonal median Kjeldahl nitrogen and nitrite/nitrate values.

[b]Number of Kjeldahl samples - number of NO_2/NO_3 samples.

Table 6. Locations and lengths of electrofishing stations on the Red River, 1983-84.

Electrofishing stations	Legal Description T.	R.	S.	Length (miles)
1a	132	47	8 and 5	0.6
1b	132	47	4 and 5	0.5
2a	133	47	33	0.7
2b	133	47	21 and 16	0.7
2c	134	48	36	0.9
3a	134 and 135	48	3, 4 and 34	1.0
3b	135	48	16 and 17	1.3
4a	136	48 and 49	6 and 1	1.0
4b	137	48 and 49	19 and 24	0.5
5a	137 and 138	48	6 and 31	1.1
5b	138	48	19	0.5
6a	139	48	30 and 19	1.2
7a	139	48	7 and 8	0.4
8a	140	48	32	0.8
8b	140	48	19, 20 and 17	1.1
8c	141	48 and 49	23, 24, 13 & 18	0.9
8d	142	48 and 49	30, 25 and 19	1.2
9a	143	49	36 and 25	1.3
9b	143	49	13 and 14	1.2
9c	144	49	35 and 26	1.0
9d	144 and 145	48 and 49	1, 2, 36 and 31	0.8
10a	145	49	25 and 24	0.7
10b	145	49	13	0.8
10c	147	49	36	1.0
10d	147	49	14 and 13	0.8
10e	148	49	23 and 22	1.1
11a	149	49	27, 21 and 22	0.8
11b	150	49	7, 8 and 12	1.0
11c	151	50	2 and 3	0.8
12a	152	50	33, 34, 27 & 28	1.2
12b	153	50	16 and 17	0.7
12c	154	50 and 51	24, 25, 29, 30 and 19	1.1
12d	155	50 and 51	31 and 36	1.0
12e	157	50 and 51	31, 32, 36 & 25	1.0
13a	158	50	31, 32 and 33	1.0
13b	158	50 and 51	19, 20, 24, 13 and 17	1.0
14a	159	50 and 51	13, 17, 18, 7 and 8	0.9
14b	161	50	7, 8 and 9	0.9
14c	162	50 and 51	13 and 18	1.0
14d	163 and 164	51	2, 4, 33 and 35	0.8

Table 7. Total number of fish for the 14 sectors of the Red River, 1983-84.

Sector	1	2	3	4	5	6	7	8
Chestnut lamprey								1
Silver lamprey								1
Goldeye					1		7	152
Mooneye		1		3	9	5	2	4
Northern pike	4	8	5	1		5		
Carp	42	45	52	30	9	11	17	39
Quillback	18	11	8		5		2	12
White sucker		9	1					13
Bigmouth buffalo	24	8	4	7	7	6	9	5
Silver redhorse	2	19	7	2	1	1	2	7
Golden redhorse	4	32	2					2
Shorthead redhorse	4	134	37	8	4	2	12	47
Greater redhorse		1						
Black bullhead						1		6
Channel catfish	1	70	30	6		1	1	10
Burbot								6
White bass								1
Rock bass		1		1		7	7	13
Green sunfish						4		
Black crappie	1	1						4
Sauger								2
Walleye	2	19	6	1	5		4	6
Freshwater drum	2	1	2	5	3	1	5	19
Subtotal	104	360	154	64	44	44	68	350
Flathead chub								
Silver chub								1
Emerald shiner			1					
River shiner								
Common shiner								
Spotfin shiner	4	12	32	17	2	62	60	4
Sand shiner								1
Fathead minnow								
Longnose dace								
Stonecat								
Trout-perch		6	8	1				
Logperch		3						
Blackside darter		11						
Subtotal	4	32	41	18	2	62	60	6
TOTAL	108	392	195	82	46	106	128	356

Table 7. Continued.

Sector	9	10	11	12	13	14	Total
Chestnut lamprey		1					2
Silver lamprey	2	1					4
Goldeye	61	21	8	63	19	46	378
Mooneye	8	5	8	15	2	16	78
Northern pike			4	2	1	1	31
Carp	14	27	12	55	13	25	391
Quillback	1	5	9	9	11	3	94
White sucker	11	16		5	1	3	59
Bigmouth buffalo			2	1	1		74
Silver redhorse	22	17	3	5		2	90
Golden redhorse	5			2		2	49
Shorthead redhorse	49	59	2	9		1	368
Greater redhorse							1
Black bullhead							7
Channel catfish	3	32	2	8	1	5	170
Burbot	1		1	1			9
White bass							1
Rock bass	1	1	5	1	1		38
Green sunfish							4
Black crappie		1		1		1	9
Sauger	1	3		7	3	48	64
Walleye	18	4				1	66
Freshwater drum	5	12	6	11	1	11	84
Subtotal	202	205	62	195	54	165	2071
Flathead chub		1					1
Silver chub	4	2		6	1	10	24
Emerald shiner			10	13	2	511	537
River shiner			2	11		45	58
Common shiner			2				2
Spotfin shiner	5	6	8	7	2		221
Sand shiner		11	2			1	15
Fathead minnow			2	1			3
Longnose dace		1					1
Stonecat		2					2
Trout-perch	2	2					19
Logperch							3
Blackside darter							11
Subtotal	11	25	26	38	5	567	897
TOTAL	213	230	88	233	59	732	2968

Table 8. Percent composition (numbers) of the large fish species for the 14 sectors of the Red River, 1983-84.

Sector	1	2	3	4	5	6	7	8
Chestnut lamprey								0.3
Silver lamprey								0.3
Goldeye					2.3		10.3	43.4
Mooneye		0.3		4.7	20.5	11.4	2.9	1.1
Northern pike	3.8	2.2	3.2	1.6		11.4		
Carp	40.4	12.5	33.8	46.9	20.5	25.0	25.0	11.1
Quillback	17.3	3.1	5.2		11.4		2.9	3.4
White sucker		2.5	0.6					3.7
Bigmouth buffalo	23.1	2.2	2.6	10.9	15.9	13.6	13.2	1.4
Silver redhorse	1.9	5.3	4.5	3.1	2.3	2.3	2.9	2.0
Golden redhorse	3.8	8.9	1.3					0.6
Shorthead redhorse	3.8	37.2	24.0	12.5	9.1	4.5	17.6	13.4
Greater redhorse		0.3						
Black bullhead						2.3		1.7
Channel catfish	1.0	19.4	19.5	9.4		2.3	1.5	2.9
Burbot								1.7
White bass								0.3
Rock bass		0.3		1.6		15.9	10.3	3.7
Green sunfish						9.1		
Black crappie	1.0	0.3						1.1
Sauger								0.6
Walleye	1.9	5.3	3.9	1.6	11.4		5.9	1.7
Freshwater drum	1.9	0.3	1.3	7.8	6.8	2.3	7.4	5.4

Table 8. Continued.

Sector	9	10	11	12	13	14	Overall
Chestnut lamprey		0.5					0.1
Silver lamprey	1.0	0.5					0.2
Goldeye	30.2	10.2	12.9	32.3	35.2	27.9	18.3
Mooneye	4.0	2.4	12.9	7.7	3.7	9.7	3.8
Northern pike			6.5	1.0	1.9	0.6	1.5
Carp	6.9	13.2	19.4	28.2	24.1	15.2	18.9
Quillback	0.5	2.4	14.5	4.6	20.4	1.8	4.5
White sucker	5.4	7.8		2.6	1.9	1.8	2.8
Bigmouth buffalo			3.2	0.5	1.9		3.6
Silver redhorse	10.9	8.3	4.8	2.6		1.2	4.3
Golden redhorse	2.5			1.0		1.2	2.4
Shorthead redhorse	24.3	28.8	3.2	4.6		0.6	17.8
Greater redhorse							0.1
Black bullhead							0.3
Channel catfish	1.5	15.6	3.2	4.1	1.9	3.0	8.2
Burbot	0.5		1.6	0.5			0.4
White bass							0.1
Rock bass	0.5	0.5	8.1	0.5	1.9		1.8
Green sunfish							0.2
Black crappie		0.5		0.5		0.6	0.4
Sauger	0.5	1.5		3.6	5.6	29.1	3.1
Walleye	8.9	2.0				0.6	3.2
Freshwater drum	2.5	5.9	9.7	5.6	1.9	6.7	4.1

Table 9. Total weight (lbs) of the large fish species for the 14 sectors of the Red River, 1983-84.

Sector	1	2	3	4	5	6	7	8
Goldeye					1.0		3.0	93.0
Mooneye				1.0	2.5	1.5	0.5	1.0
Northern pike	4.5	10.0	11.5	1.0		2.0		
Carp	107.0	168.5	62.0	73.5	28.5	51.0	70.0	156.5
Quillback	35.5	24.0	18.0		8.0		3.5	18.5
White sucker		9.0	1.0					18.0
Bigmouth buffalo	100.5	24.0	15.5	15.0	43.5	21.0	24.0	17.0
Silver redhorse	2.0	51.0	11.5		2.0	2.5	6.5	19.0
Golden redhorse	1.0	36.0	1.5					2.5
Shorthead redhorse	1.5	125.0	31.5	7.0	6.0	3.5	11.5	59.0
Greater redhorse		6.0						
Black bullhead								1.0
Channel catfish	3.5	60.0	31.0	6.5		2.0	2.0	21.0
Burbot								9.0
Rock bass						1.5	2.0	2.5
Sauger								1.0
Walleye	8.0	18.5	6.0		0.5		1.0	10.5
Freshwater drum	5.0	3.0	4.5	9.0	5.5	1.5	13.0	24.0
TOTAL	268.5	535.0	194.0	113.0	97.5	86.5	137.0	453.5

Table 9. Continued.

Sector	9	10	11	12	13	14	Total
Goldeye	39.0	14.5	4.5	29.5	1.5	18.5	204.5
Mooneye	3.0	2.0	0.5	1.0		3.5	16.5
Northern pike			1.5	1.5	8.0	2.0	42.0
Carp	63.5	131.0	48.0	165.0	34.0	43.5	1202.0
Quillback	2.0	9.5	17.5	11.5	9.0	2.5	159.5
White sucker	13.5	22.5		4.0	1.0	2.0	71.0
Bigmouth buffalo			5.5				266.0
Silver redhorse	55.5	42.0	2.0	8.5		2.0	204.5
Golden redhorse	5.0			2.5		2.5	51.0
Shorthead redhorse	55.5	57.0	0.5	6.0			363.5
Greater redhorse							6.0
Black bullhead							1.0
Channel catfish	7.0	77.0	0.5	13.0		4.0	227.5
Burbot							9.0
Rock bass			1.5				7.5
Sauger	0.5	3.5		2.0	1.5	20.0	28.5
Walleye	33.0	4.0					81.5
Freshwater drum	4.5	15.5	13.5	10.5	1.0	20.0	130.5
TOTAL	281.5	378.5	95.5	255.0	56.0	120.5	3072.0

Table 10. Percent composition (weights) of the large fish species for the 14 sectors of the Red River, 1983-84.

Sectors	1	2	3	4	5	6	7	8
Goldeye					1.0		2.2	20.5
Mooneye				0.9	2.6	1.7	0.4	0.2
Northern pike	1.7	1.9	5.9	0.9		2.3		
Carp	39.9	31.5	32.0	65.0	29.2	59.0	51.1	34.5
Quillback	13.2	4.5	9.3		8.2		2.6	4.1
White sucker		1.7	0.5					4.0
Bigmouth buffalo	37.4	4.5	8.0	13.3	44.6	24.3	17.5	3.7
Silver redhorse	0.7	9.5	5.9		2.1	2.9	4.7	4.2
Golden redhorse	0.4	6.7	0.8					0.6
Shorthead redhorse	0.6	23.4	16.2	6.2	6.2	4.0	8.4	13.0
Greater redhorse		1.1						
Black bullhead								0.2
Channel catfish	1.3	11.2	16.0	5.8		2.3	1.5	4.6
Burbot								2.0
Rock bass						1.7	1.5	0.6
Sauger								0.2
Walleye	3.0	3.5	3.1		0.5		0.7	2.3
Freshwater drum	1.9	0.6	2.3	8.0	5.6	1.7	9.5	5.3
TOTAL	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Table 10. Continued.

Sector	9	10	11	12	13	14	Overall
Goldeye	13.9	3.8	4.7	11.6	2.7	15.4	6.7
Mooneye	1.1	0.5	0.5	0.4		2.9	0.5
Northern pike			1.6	0.6	14.3	1.7	1.4
Carp	22.6	34.6	50.3	64.7	60.7	36.1	39.1
Quillback	0.7	2.5	18.3	4.5	16.1	2.1	5.2
White sucker	4.8	5.9		1.6	1.8	1.7	2.3
Bigmouth buffalo			5.8				8.7
Silver redhorse	19.7	11.1	2.1	3.3		1.7	6.7
Golden redhorse	1.8			1.0		2.1	1.7
Shorthead redhorse	19.5	15.1	0.5	2.4			11.8
Greater redhorse							0.2
Black bullhead							0.1
Channel catfish	2.5	20.3	0.5	5.1		3.3	7.4
Burbot							0.3
Rock bass			1.6				0.2
Sauger	0.2	0.9		0.8	2.7	16.6	0.9
Walleye	11.7	1.1					2.7
Freshwater drum	1.6	4.1	14.1	4.1	1.8	16.6	4.2
TOTAL	100.0	100.00	100.0	100.0	100.0	100.0	100.0

Table 11. Catch per unit of effort (fish/hr) for the 14 sectors of the Red River, 1983-84.

Sector	1	2	3	4	5	6	7	8
Chestnut lamprey								0.5
Silver lamprey								0.5
Goldeye					1.1		15.6	76.0
Mooneye		0.7		3.5	9.5	8.3	4.4	2.0
Northern pike	6.2	5.5	4.0	1.2		8.3		
Carp	64.6	31.0	41.6	35.5	9.5	18.3	37.8	19.5
Quillback	27.7	7.6	6.4		5.3		4.4	6.0
White sucker		6.2	0.8					6.5
Bigmouth buffalo	36.9	5.5	3.2	8.2	7.4	10.0	20.0	2.5
Silver redhorse	3.1	13.1	5.6	2.4	1.1	1.7	4.4	3.5
Golden redhorse	6.2	22.1	1.6					1.0
Shorthead redhorse	6.2	92.4	29.6	9.4	4.2	3.3	26.7	23.5
Greater redhorse		0.7						
Black bullhead						1.7		3.0
Channel catfish	1.5	48.3	24.0	7.1		1.7	2.2	5.0
Burbot								3.0
White bass								0.5
Rock bass		0.7		1.2		11.7	15.6	6.5
Green sunfish						6.7		
Black crappie	1.5	0.7						2.0
Sauger								1.0
Walleye	3.1	13.1	4.8	1.2	5.3		8.9	3.0
Freshwater drum	3.1	0.7	1.6	5.9	3.2	1.7	11.1	9.5
Subtotal	160.0	248.3	123.2	75.3	46.3	73.3	151.1	175.0
Flathead chub								
Silver chub								0.5
Emerald shiner			0.8					
River shiner								
Common shiner								
Spotfin shiner	6.2	8.3	25.6	20.0	2.1	103.3	133.3	2.0
Sand shiner								0.5
Fathead minnow								
Longnose dace								
Stonecat								
Trout-perch		4.1	6.4	1.2				
Logperch		2.1						
Blackside darter		7.6						
Subtotal	6.2	22.1	32.8	21.2	2.1	103.3	133.3	3.0
TOTAL	166.2	270.3	156.0	96.5	48.4	176.7	284.4	178.0
Effort (hrs)	0.65	1.45	1.25	0.85	0.95	0.60	0.45	2.00

Table 11. Continued.

Sector	9	10	11	12	13	14	Overall
Chestnut lamprey		0.4					0.1
Silver lamprey	1.0	0.4					0.2
Goldeye	30.5	8.4	5.3	25.2	19.0	23.0	19.2
Mooneye	4.0	2.0	5.3	6.0	2.0	8.0	4.0
Northern pike			2.7	0.8	1.0	0.5	1.6
Carp	7.0	10.8	8.0	22.0	13.0	12.5	19.8
Quillback	0.5	2.0	6.0	3.6	11.0	1.5	4.8
White sucker	5.5	6.4		2.0	1.0	1.5	3.0
Bigmouth buffalo			1.3	0.4	1.0		3.8
Silver redhorse	11.0	6.8	2.0	2.0		1.0	4.6
Golden redhorse	2.5			0.8		1.0	2.5
Shorthead redhorse	24.5	23.6	1.3	3.6		0.5	18.7
Greater redhorse							0.1
Black bullhead							0.4
Channel catfish	1.5	12.8	1.3	3.2	1.0	2.5	8.6
Burbot	0.5		0.7	0.4			0.5
White bass							0.1
Rock bass	0.5	0.4	3.3	0.4	1.0		1.9
Green sunfish							0.2
Black crappie		0.4		0.4		0.5	0.5
Sauger	0.5	1.2		2.8	3.0	24.0	3.2
Walleye	9.0	1.6				0.5	3.4
Freshwater drum	2.5	4.8	4.0	4.4	1.0	5.5	4.3
Subtotal	101.0	82.0	41.3	78.0	54.0	82.5	105.1
Flathead chub		0.4					0.1
Silver chub	2.0	0.8		2.4	1.0	5.0	1.2
Emerald shiner			6.7	5.2	2.0	255.5	27.3
River shiner			1.3	4.4		22.5	2.9
Common shiner			1.3				0.1
Spotfin shiner	2.5	2.4	5.3	2.8	2.0		11.2
Sand shiner		4.4	1.3			0.5	0.8
Fathead minnow			1.3	0.4			0.2
Longnose dace		0.4					0.1
Stonecat		0.8					0.1
Trout perch	1.0	0.8					1.0
Logperch							0.2
Blackside darter							0.6
Subtotal	5.5	10.0	17.3	15.2	5.0	283.5	45.5
TOTAL	106.5	92.0	58.7	93.2	59.0	366.0	150.6
Effort (hrs)	2.00	2.50	1.50	2.50	1.00	2.00	19.70

Table 12. Length frequency distributions of large fish species in the Red River, 1983–84.

Species: Goldeye

	Length (mm & in)																																
	25	50	75	100	125	150	175	200	225	250	275	300	325	350	375	400	425	450	475	500	525	550	575	600	625	650	675	700	725	750	775	800	825
Sector	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33
5														1																			
7											2	5																					
8			1								11	72	44	21	3																		
9											3	25	21	10	1	1																	
10											1	6	10	3	1																		
11											1	5	1	1																			
12				2	1			2		1	10	39	8																				
13			1	7	8						2		1																				
14			2	3	2		1	1		1	11	24	1																				
TOTALS			4	12	11		1	3		2	41	176	86	36	5	1																	

Species: Mooneye

	Length (mm & in)																																
	25	50	75	100	125	150	175	200	225	250	275	300	325	350	375	400	425	450	475	500	525	550	575	600	625	650	675	700	725	750	775	800	825
Sector	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33
2						1																											
4								1		2																							
5								2		4	3																						
6									2	2	1																						
7											2																						
8				1					1	1	1																						
9									1	2	5																						
10									1	1	3																						
11				3	3				2																								
12			1	7	4			1		2																							
13					1			1																									
14				1	2	1	2	1	5	3	1																						
TOTALS			1	12	10	2	2	6	12	17	16																						

Table 12. Continued.

Species: Northern pike

	Length (mm & in)																																
	25	50	75	100	125	150	175	200	225	250	275	300	325	350	375	400	425	450	475	500	525	550	575	600	625	650	675	700	725	750	775	800	825
Sector	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33
1												1		2												1							
2													2			2			3									1					
3																1							2	1			1						
4																1																	
6							1						2	1		1																	
11											2		1			1																	
12															1		1																
13																																1	
14																					1												
TOTALS							1				2	1	5	3	1	6	1		3		1		2	1		1	1	1				1	

Species: Carp

	Length (mm & in)																																
	25	50	75	100	125	150	175	200	225	250	275	300	325	350	375	400	425	450	475	500	525	550	575	600	625	650	675	700	725	750	775	800	825
Sector	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33
1													1	5	4	4	5	5	6	6	2	3		1									
2														2	1	3	7	6	3	3	7	3	7	1	2								
3														1		2	5	13	14	8	5	3	1										
4														2	2	8	6	1	2	4	1	1	1	2									
5																	2	4		1	1		1										
6																			2	2	3	1	1	1			1						
7																1	1	2	5	2	1	2			1				2				
8														5	1	3	3	3	4	2	4	5	3	3	2	1							
9																3				4	3		1	1	2								
10															1		2	4	2	4	5	2	2	2	2						1		
11																			4	2	1	3	1		1								
12											1	2	2	5	6	12	6	5	2	1	4	1	3	2	1	1	1						
13					1						1	1	1	1	1	2	1			1		1	1			1							
14												1	2	1	3	7	7			2	1	1											
TOTALS					1						2	4	6	22	19	45	45	43	44	42	38	26	22	13	11	3	2		2		1		

Table 12. Continued

Species: Quillback

	Length (mm & in)																																				
	25	50	75	100	125	150	175	200	225	250	275	300	325	350	375	400	425	450	475	500	525	550	575	600	625	650	675	700	725	750	775	800	825				
Sector	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33				
1														2	6	3	6	1																			
2													1	1	3	2	1	3																			
3										1				1		3	1	2																			
5									1				1		1	1		1																			
7														1	1																						
8													4	1	3	3	1																				
9																	1																				
10														1	2	1			1																		
11												1	2		1	1		2	1	1																	
12												2	2	4			1																				
13				2						1	2	2	2	1	1																						
14				1									1			1																					
TOTALS				3					1	2	2	5	13	12	18	15	11	9	2	1																

Species: White sucker

	Length (mm & in)																																				
	25	50	75	100	125	150	175	200	225	250	275	300	325	350	375	400	425	450	475	500	525	550	575	600	625	650	675	700	725	750	775	800	825				
Sector	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33				
2												4	3	1	1																					
3														1																						
8											1		1	4	1	2	3	1																		
9										1		1	2	2	3	2																				
10											1	1	1	2	4	2	5																			
12										1	1	1	1			1																				
13													1																							
14								1			1					1																				
TOTALS								1		2	4	7	9	10	9	8	8	1																		

Table 12. Continued.

Species: Bigmouth Buffalo

	Length (mm & in)																																					
	25	50	75	100	125	150	175	200	225	250	275	300	325	350	375	400	425	450	475	500	525	550	575	600	625	650	675	700	725	750	775	800	825					
Sector	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33					
1															2	5	5		2	3	4	1	1	1														
2															2	3	2					1																
3																	2			1	1																
4															3	2	2																				
5														1		1	1			1				1				1		1							
6																	3	3																			
7																2	5	1	1																		
8												1						3						1													
11																1			1																		
12				1																																	
13				1																																	
TOTALS				2								1		1	7	14	20	7	4	5	5	2	1	3				1		1							

Species: Silver redhorse

	Length (mm & in)																																					
	25	50	75	100	125	150	175	200	225	250	275	300	325	350	375	400	425	450	475	500	525	550	575	600	625	650	675	700	725	750	775	800	825					
Sector	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33					
1									1							1																					
2							1								5			1	5	2	4	1															
3									1			1	1		2					1	1																
4						1				1																											
5																	1																				
6																		1																			
7																			1	1																	
8								1							1				1		4																
9									1				1	2		2	3	3	6		2	1	1														
10									1		1				1	2	4	3	3		2																
11									1	1								1																			
12								1								1		3																			
14														2																							
TOTALS						1	1	2	5	2	1	1	2	4	9	6	8	12	16	4	13	2	1														

Table 12. Continued

Species: Golden redhorse

	Length (mm & in)																																				
	25	50	75	100	125	150	175	200	225	250	275	300	325	350	375	400	425	450	475	500	525	550	575	600	625	650	675	700	725	750	775	800	825
Sector	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33
1								1	1		1	1																					
2						1	1	2		1	4	4	7	1	2	3	5	1															
3												2																					
8													1			1																	
9											1			2	1	1																	
12															1	1																	
14													1		1																		
TOTALS						1	1	3	1	1	6	7	9	3	5	6	5	1															

Species: Shorthead redhorse

	Length (mm & in)																																				
	25	50	75	100	125	150	175	200	225	250	275	300	325	350	375	400	425	450	475	500	525	550	575	600	625	650	675	700	725	750	775	800	825
Sector	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33
1							1				3																						
2				1	1		3	1	1	5	6	24	49	6	18	14	3	1	1														
3					2	3	1		1	1	1	7	10	4	3		2	2															
4											1	2	1	1	2	1																	
5														1	1		1	1															
6														1				1															
7							1	1				2	1	2	3	2																	
8					1		1			2		2	6	12	10	7	5	1															
9								1	1	2	4	5	9	6	6	10	3	2															
10							1		1	3	5	8	13	10	8	8	2																
11									1			1																					
12										2	2	1	2		1	1																	
14								1																									
TOTALS				1	4	3	8	4	5	15	22	52	91	43	52	43	16	8	1														

Table 12. Continued.

Species: Greater redhorse

	Length (mm & in)																																
	25	50	75	100	125	150	175	200	225	250	275	300	325	350	375	400	425	450	475	500	525	550	575	600	625	650	675	700	725	750	775	800	825
Sector	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33
2																						1											
TOTALS																						1											

Species: Black bullhead

	Length (mm & in)																																
	25	50	75	100	125	150	175	200	225	250	275	300	325	350	375	400	425	450	475	500	525	550	575	600	625	650	675	700	725	750	775	800	825
Sector	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33
6									1																								
8							4	2																									
TOTALS							4	2	1																								

Table 12. Continued.

Species: Channel catfish

	Length (mm & in)																																
	25	50	75	100	125	150	175	200	225	250	275	300	325	350	375	400	425	450	475	500	525	550	575	600	625	650	675	700	725	750	775	800	825
Sector	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33
1																					1												
2			4	1	10	16	6	5				2	4	2	1	4	1	3	2	2	1	2	4										
3					1		4	1			1	8	4	5				1		2	1	1	1										
4												1	1	2				1	1														
6																		1															
7																			1														
8										1	2					1	1			2	1	1	1										
9					1											1									1								
10			2			4			1		2			2	2	2	2	2	1	4	2	1	1	1		1		1				1	
11			1										1																				
12												1	1			1	1		1	3													
13					1																												
14			1											3		1																	
TOTALS			4	1	13	20	10	6	1	1	5	12	11	14	3	10	5	8	6	13	6	5	7	1	1	1		1				1	

Species: Burbot

	Length (mm & in)																																
	25	50	75	100	125	150	175	200	225	250	275	300	325	350	375	400	425	450	475	500	525	550	575	600	625	650	675	700	725	750	775	800	825
Sector	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33
8												1	1					1		1		2											
9												1																					
11							1																										
12											1																						
TOTALS							1				1	2	1					1		1		2											

Table 12. Continued.

Species: White bass

	Length (mm & in)																																
	25	50	75	100	125	150	175	200	225	250	275	300	325	350	375	400	425	450	475	500	525	550	575	600	625	650	675	700	725	750	775	800	825
Sector	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33
8										1																							
TOTALS										1																							

Species: Rock bass

	Length (mm & in)																																
	25	50	75	100	125	150	175	200	225	250	275	300	325	350	375	400	425	450	475	500	525	550	575	600	625	650	675	700	725	750	775	800	825
Sector	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33
2								1																									
4						1																											
6				2	1	1	2	1																									
7			1			1	3	1		1																							
8			2	2	2	3	2	1	1																								
9			1																														
10					1																												
11						2	2	1																									
12							1																										
13			1																														
TOTALS			5	4	4	8	10	5	1	1																							

Table 12. Continued.

Species: Green sunfish

	Length (mm & in)																																
	25	50	75	100	125	150	175	200	225	250	275	300	325	350	375	400	425	450	475	500	525	550	575	600	625	650	675	700	725	750	775	800	825
Sector	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33
6		1		3																													
TOTALS		1		3																													

Species: Black crappie

	Length (mm & in)																																
	25	50	75	100	125	150	175	200	225	250	275	300	325	350	375	400	425	450	475	500	525	550	575	600	625	650	675	700	725	750	775	800	825
Sector	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33
1								1																									
2								1																									
8						4																											
10						1																											
12						1																											
14							1																										
TOTALS						6	1	2																									

Table 12. Continued.

Species: Sauger

	Length (mm & in)																																		
	25	50	75	100	125	150	175	200	225	250	275	300	325	350	375	400	425	450	475	500	525	550	575	600	625	650	675	700	725	750	775	800	825		
Sector	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33		
8													1		1																				
9														1																				
10																3																		
12									1	1	2	2	1																					
13											2		1																					
14								2	10	9	3	12	7	2	3																			
TOTALS								2	11	10	7	14	10	3	4	3																		

Species: Walleye

	Length (mm & in)																																		
	25	50	75	100	125	150	175	200	225	250	275	300	325	350	375	400	425	450	475	500	525	550	575	600	625	650	675	700	725	750	775	800	825		
Sector	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33		
1																				1				1											
2							3				1	7	1			2	2	1	2																
3							3			1			1										1												
4										1																									
5								2	2	1																									
7		1							1	2																									
8													1		1	1	1		2																
9				1								1	4	3	1		2	1	1		1		3												
10											1			1				2																	
14						1																													
TOTALS		1		1		1	6	2	3	5	2	8	7	4	2	3	5	4	5	1	1		4	1											

Table 12. Continued.

Species: Freshwater drum

	Length (mm & in)																																		
	25	50	75	100	125	150	175	200	225	250	275	300	325	350	375	400	425	450	475	500	525	550	575	600	625	650	675	700	725	750	775	800	825
Sector	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33
1																1		1															
2																	1																
3																2																	
4													1	1	2			1															
5															2			1															
6														1																			
7																1	1	2	1														
8											4	4	2	3	2	1	1	1	1														
9											2	1	1	1																			
10											2	4	3			1		2															
11												1				2			2	1													
12			1								1	4	1	2		2																	
13																	1																
14													3	2	1	1	3	1															
TOTALS			1								9	14	11	10	7	11	7	9	4	1													

Table 13. Mussel occurence at four locations on the Red River (MDNR 1984).

Name	Source
Amblema plicata	1,4
Fusconaia flava	1,3,4
Quadrula quadrula	1,2,3,4
Anodonta grandis	1,2,4
Lasmigona complanata	3,4
Actinonaias carinata	1,2,3
Lampsilis ovata ventricosa	1,2,3
Lampsilis radiata siliquoidea	1,2,3,4
Ligumia recta	1,3,4
Proptera alata	1,3,4

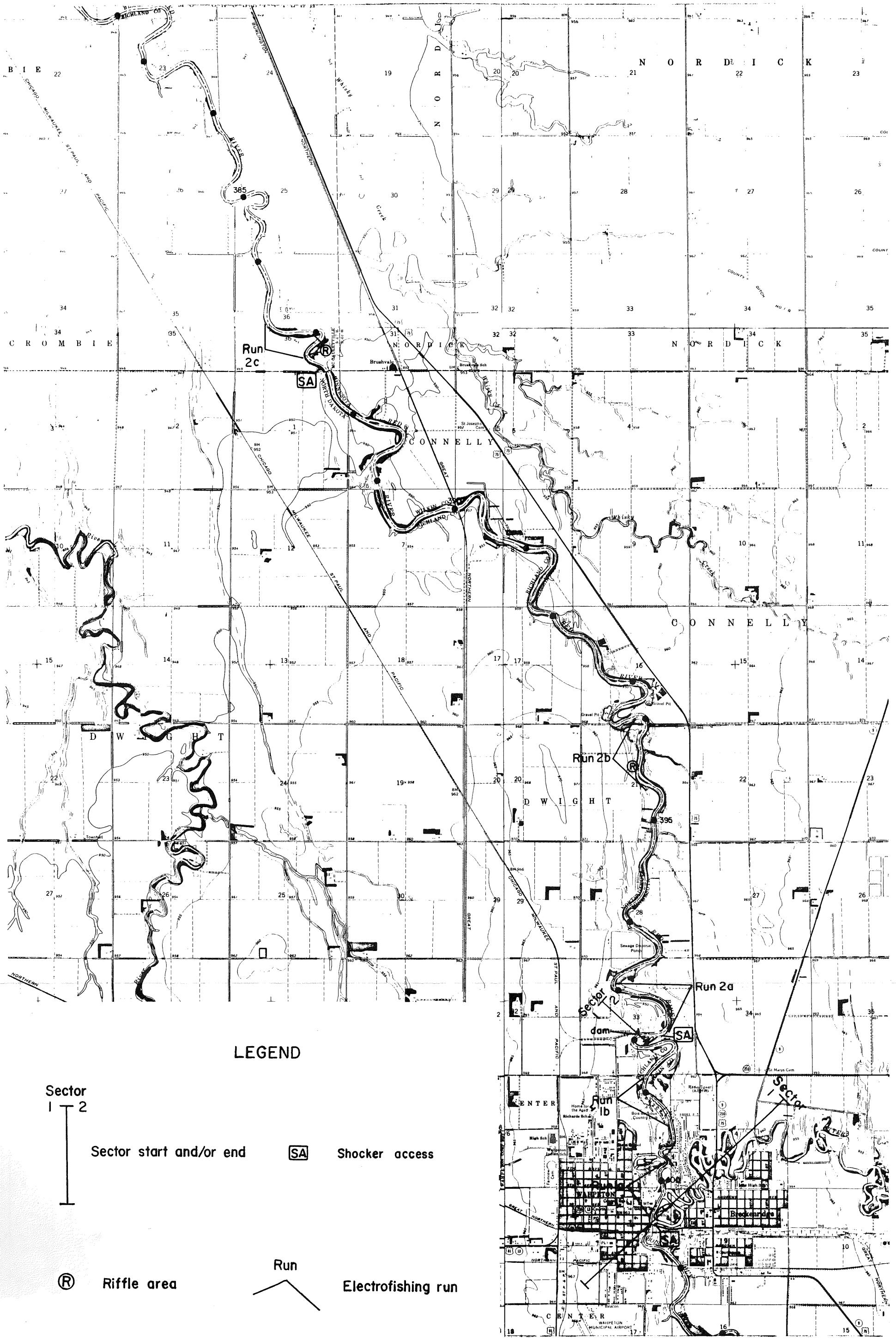
Source Numbers:

1 - River mile 267.0, near Georgetown, Clay County, Minnesota.

2 - River mile 220.7, downstream of Halstad, Norman County, Minnesota.

3 - River mile 201.8, near Shelly, Norman County, Minnesota.

4 - River mile 14.9, near the mouth of Two Rivers, Kittson County, Minnesota.



LEGEND

Sector 1 — 2

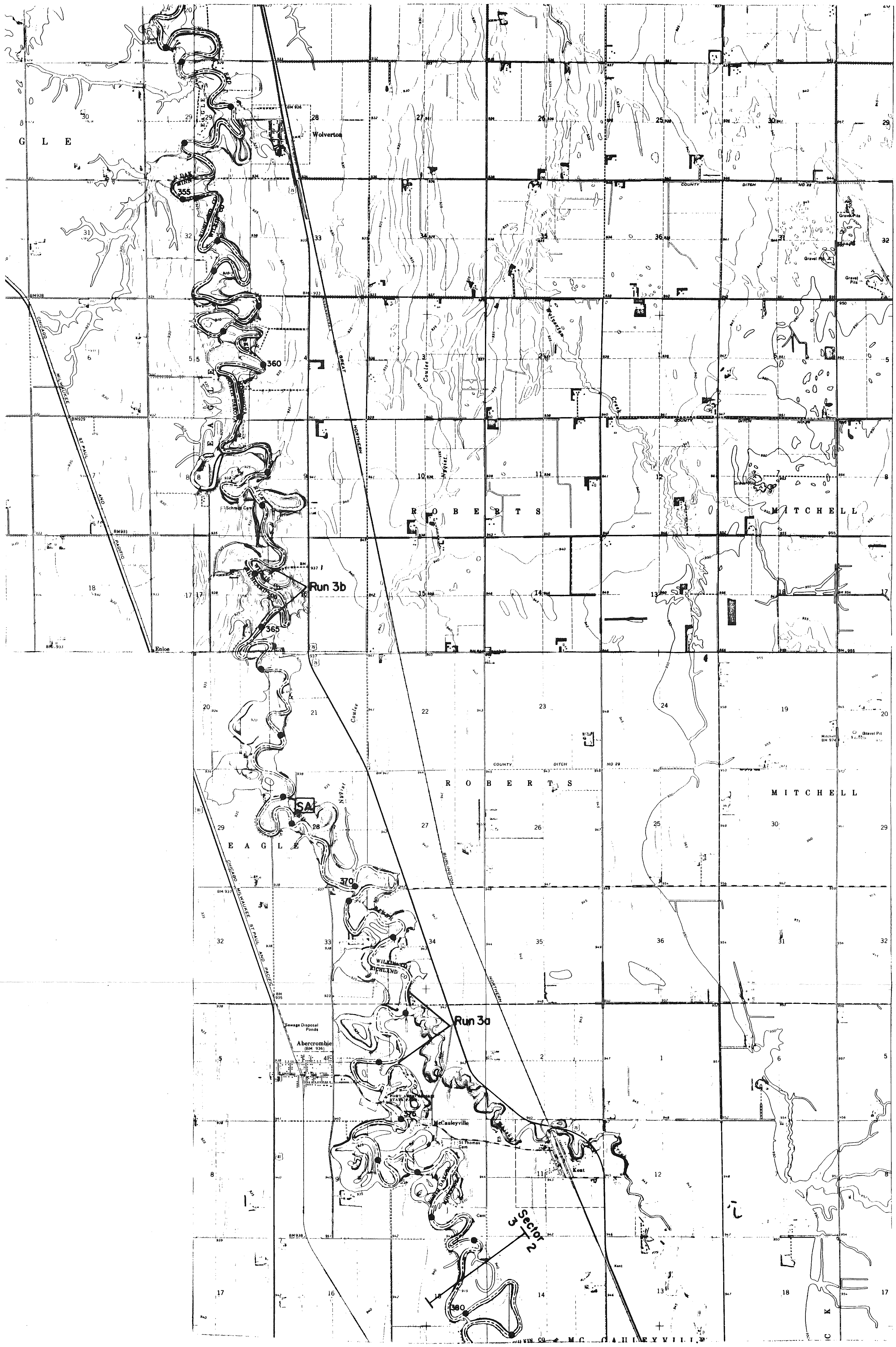
Sector start and/or end

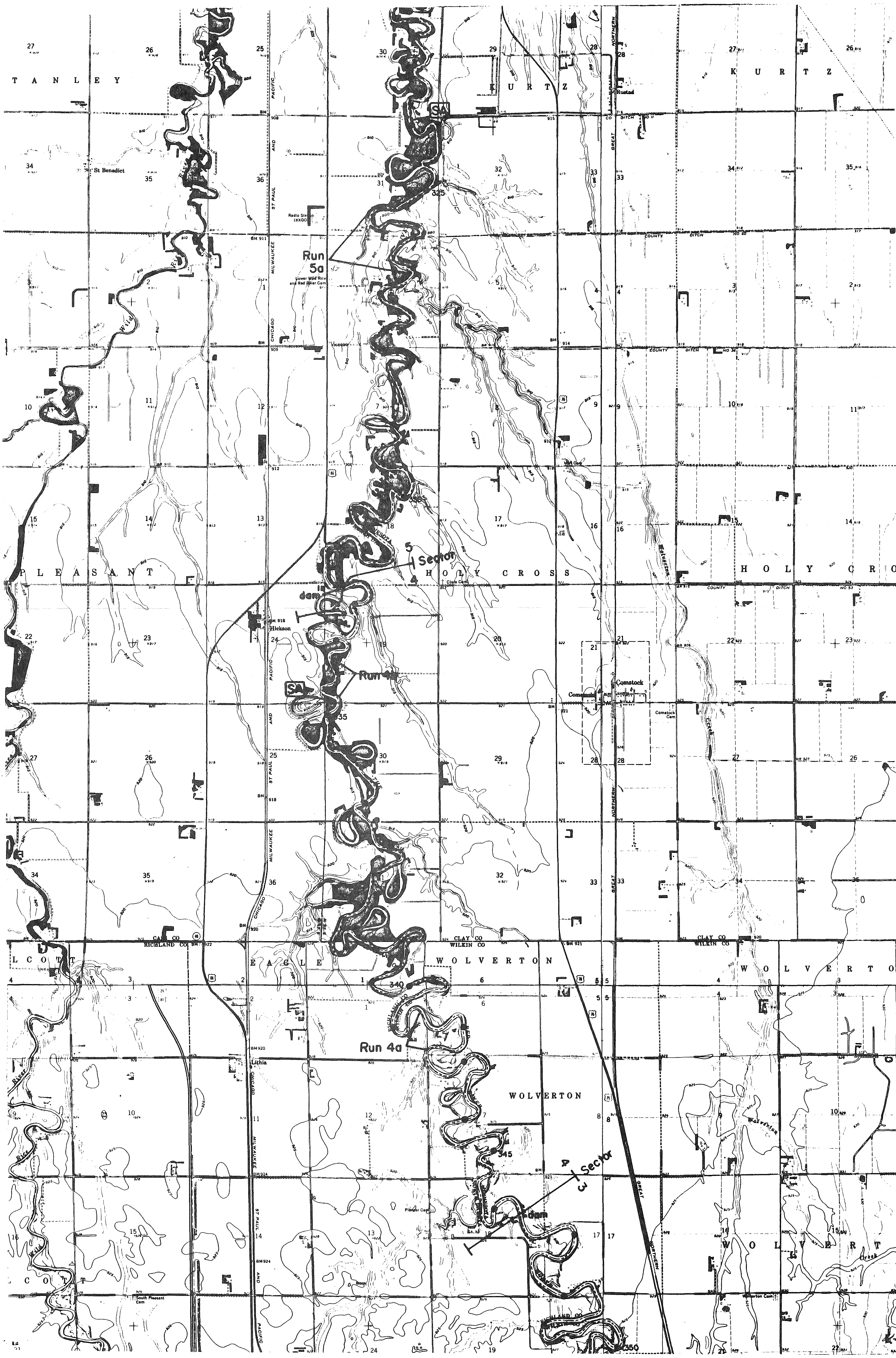
SA Shocker access

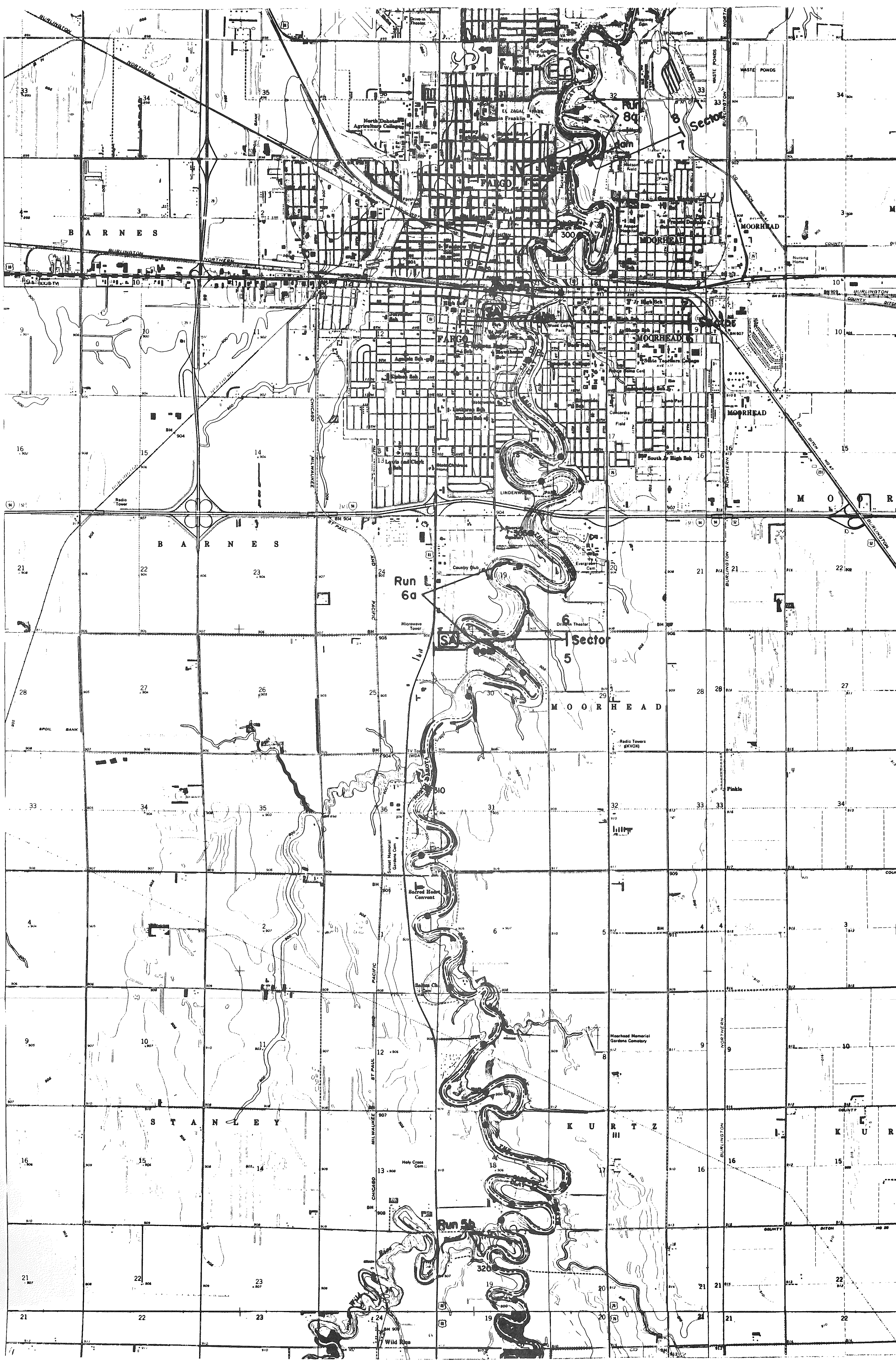
® Riffle area

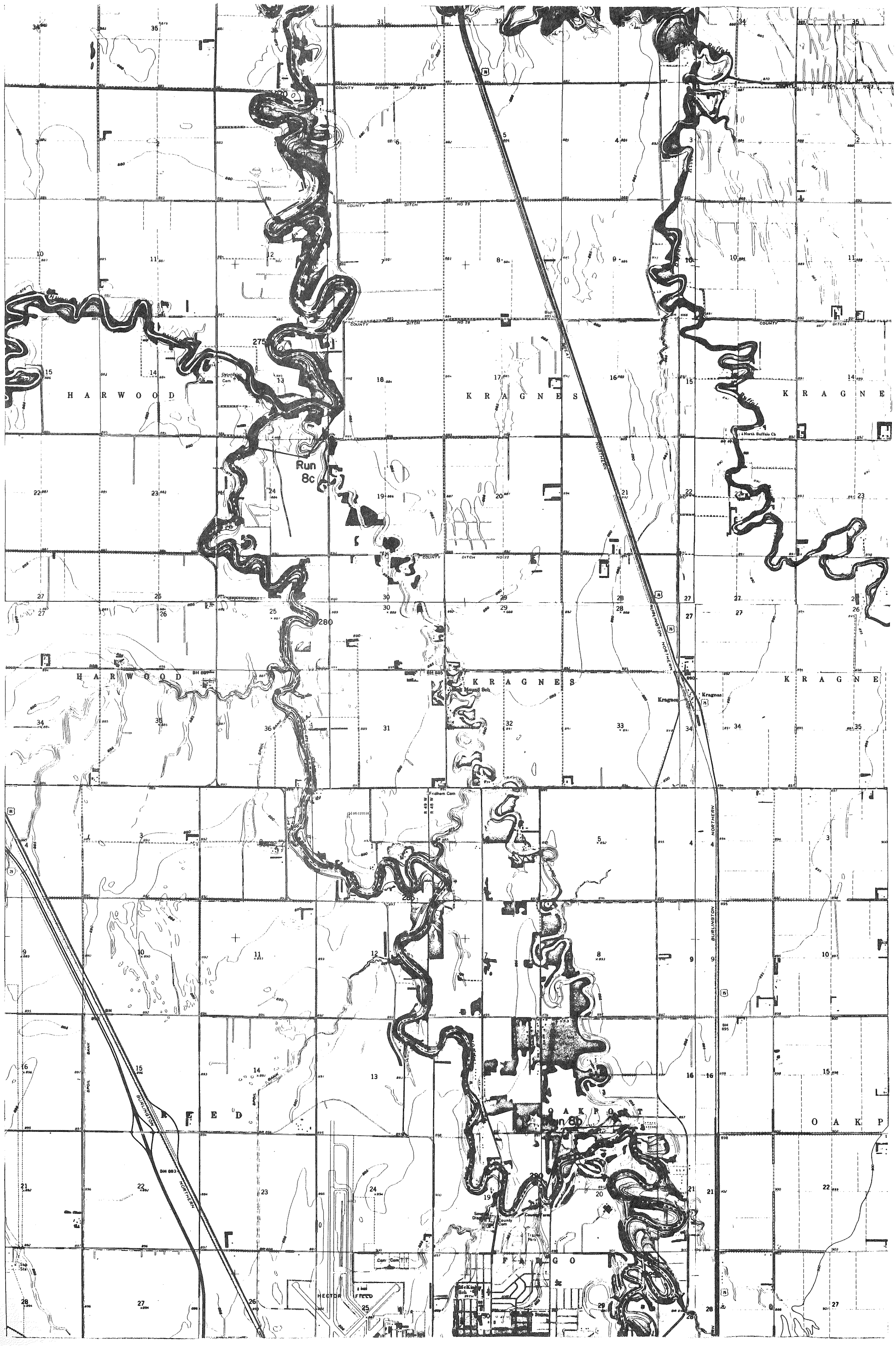
Run

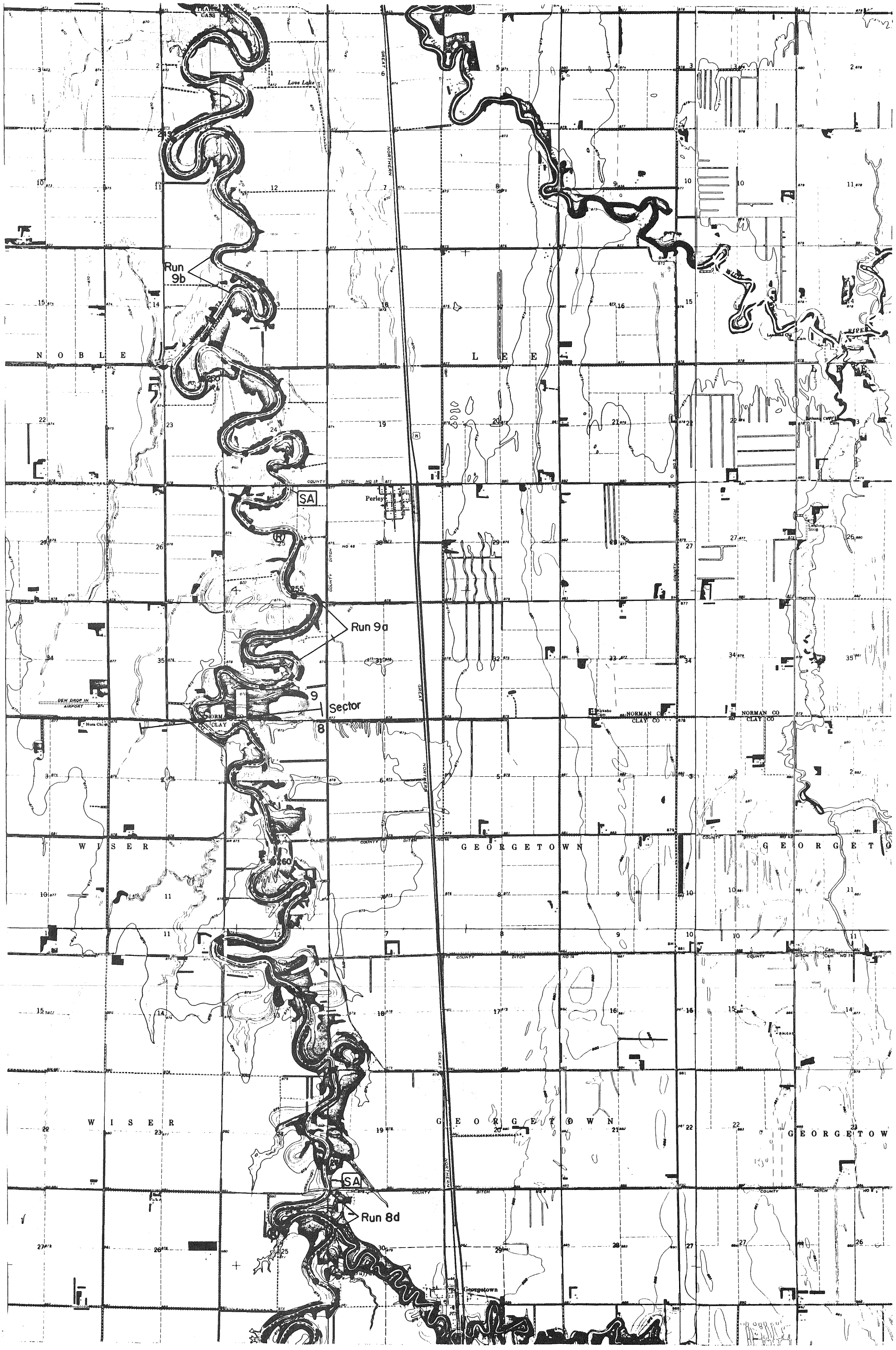
Electrofishing run

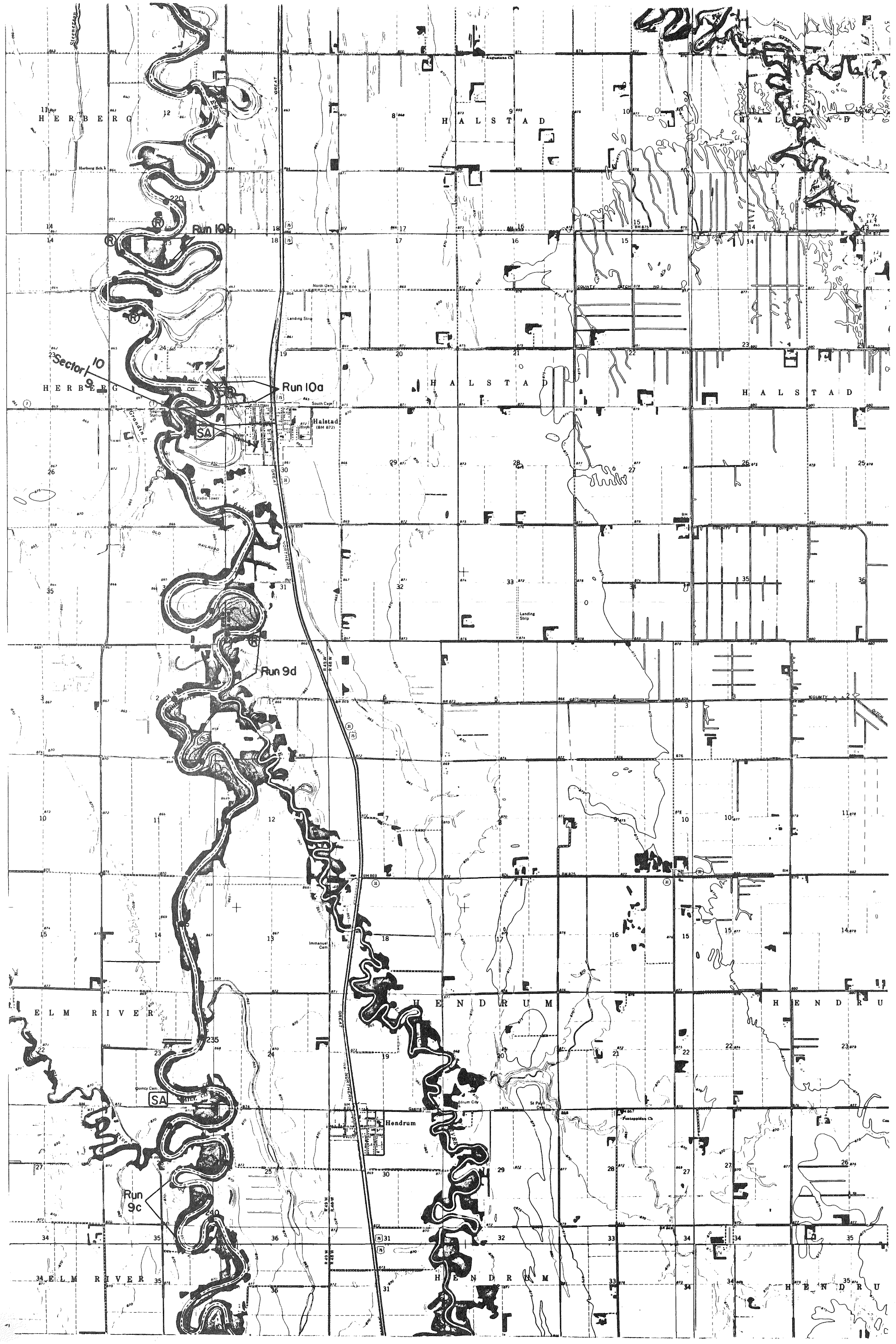

Wolverton
Enloe
Run 3b
Run 3a
SA
355
360
365
370
376
380
Sector
3
2
Abercrombie
(BM 936)
Sewage Disposal
Ponds
McCauleyville
Kent
St Thomas
Cem
Schroeder Cem
FORT ABERCROMBIE
STATE PARK
WILKIN CO
RICHLAND CO
NORTH DAKOTA
MINNESOTA
RED RIVER
CHICAGO MILWAUKEE ST PAUL AND PACIFIC
GREAT NORTHERN
BURLINGTON NORTHERN
COUNTY DITCH NO 22
COUNTY DITCH NO 29
Wolverton Creek
Nugget Coulee
Coulee
Gravel Pits
Gravel Pit
Mitchell
BM 974
E A G L E
R O B E R T S
M I T C H E L L
M C C A U L E Y V I L L E


Run
5a
Sector
5
4
dam
Run 4a
Run 4a
Sector
4
3
dam
325
330
335
340
345
350
SA
SA
T A N L E Y
K U R T Z
K U R T Z
P L E A S A N T
H O L Y C R O S S
H O L Y C R O
L C O T T
E A G L E
W O L V E R T O N
W O L V E R T O
WOLVERTON
W O L V E R T O
L C O T T
St Benedict
Rustad
Radio Station
(KXGO)
Lower Wild Rice and Red River Cem
Hickson
Clare Cem
Hart Cem
Comstock
Comstock Cem
Lithia
Pioneer Cem
South Pleasant Cem
Wolverton Cem
CHICAGO MILWAUKEE ST PAUL AND PACIFIC
GREAT NORTHERN
COUNTY DITCH NO 50
COUNTY DITCH NO 36
COUNTY DITCH NO 53
CO DITCH NO 11
CASS CO
RICHLAND CO
CLAY CO
WILKIN CO
Wild Rice River
Wolverton Creek


Run 8a
Sector 8
Sector 7
Run 6a
6
Sector 5
Run 5b
300
310
320
FARGO
MOORHEAD
B A R N E S
M O O R H E A D
S T A N L E Y
K U R T Z
K U R
North Dakota Agriculture College
State Teachers College
El Zagal Park
Wood Lawn Park
Lindenwood Park
Country Club
Evergreen Cem
Drive-in Theater
Microwave Tower
Radio Tower
Radio Towers (KVOX)
TV Tower (WDAY)
Sunset Memorial Gardens Cem
Sacred Heart Convent
Holy Cross Cem
Moorhead Memorial Gardens Cemetery
Nursing Home
Waste Ponds
Trailer Park
Concordia Field
South Jr High Sch
Lewis and Clark Sch
Finkle
Wild Rice
BURLINGTON
NORTHERN
CHICAGO
MILWAUKEE
ST PAUL
PACIFIC
COUNTY DITCH
SPOIL BANK

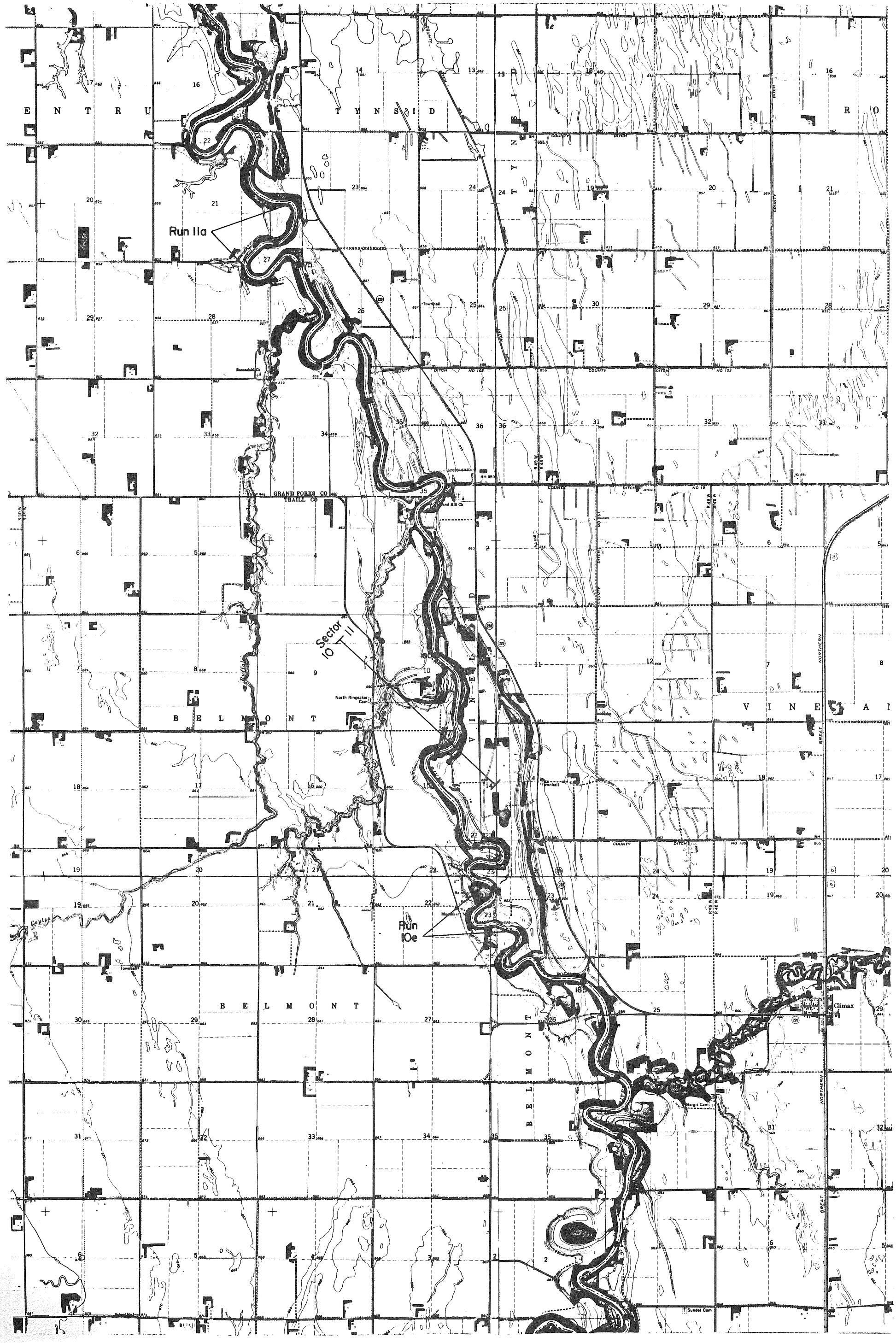

HARWOOD
KRAGNES
KRAGNE
FED
OAKPORT
OAKP
Run 8c
Run 8b
COUNTY DITCH NO 23B
COUNTY DITCH NO 23
COUNTY DITCH NO 78
COUNTY DITCH NO 22
COUNTY DITCH
GREAT NORTHERN
NORTHERN
BURLINGTON NORTHERN
BURLINGTON
Kragnes
Fridhem Cem
North Buffalo Ch
Trailer Park
HECTOR FIELD
BM 885
BM 893
BM 895
BANK
SPOIL

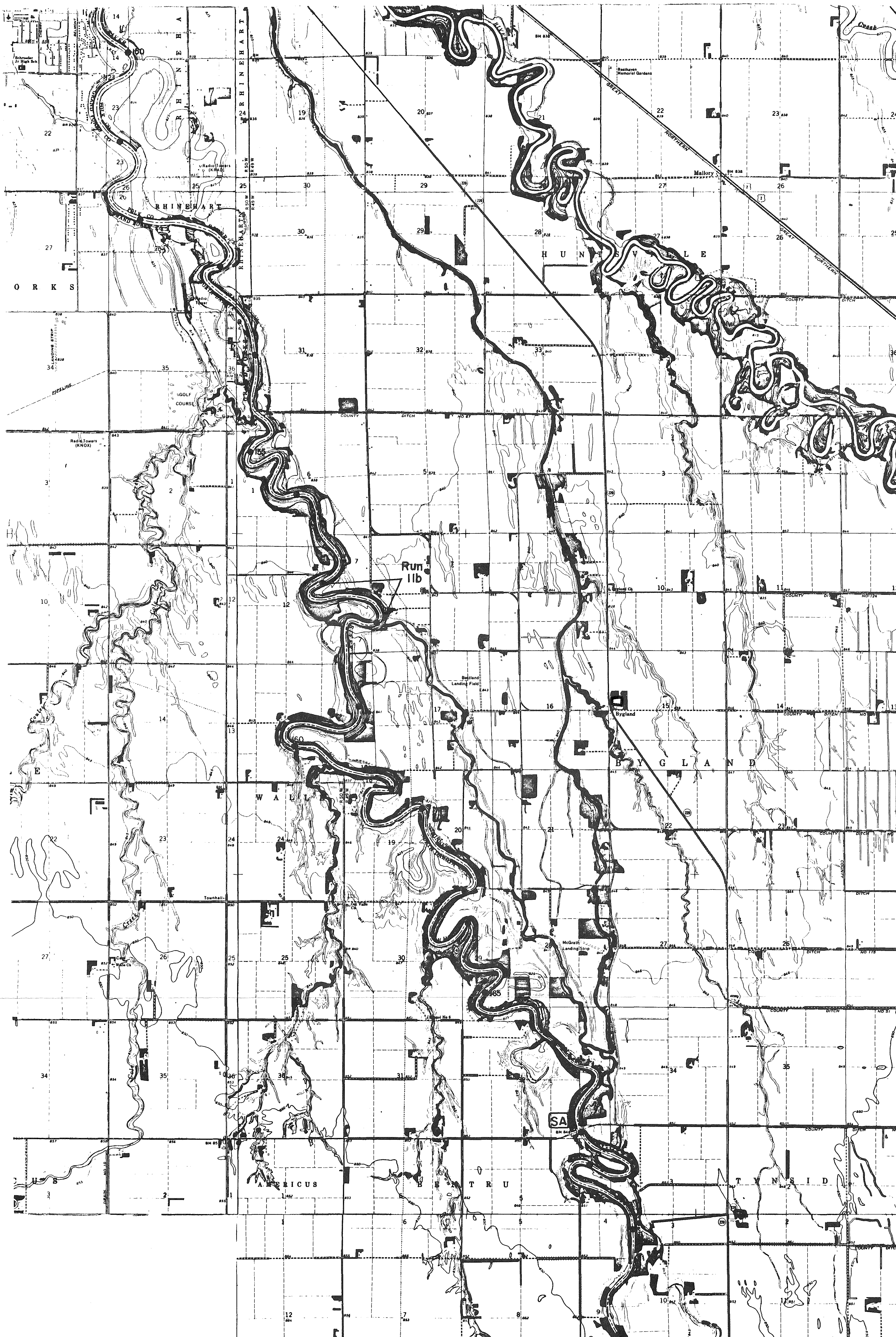

Love Lake
Run 9b
Run 9a
Run 8d
SA
Perley
Georgetown
Sector
NOBLE
LEE
WISER
GEORGETOWN
GREAT NORTHERN
COUNTY DITCH NO 13
COUNTY DITCH NO 40
COUNTY DITCH NO 45
COUNTY DITCH NO 14
COUNTY DITCH NO 49
NORMAN CO
CLAY CO
DEW DROP IN AIRPORT
Nora Ch
Ekvkabo Cem
Landing Strip


HERBERG
HALSTAD
HALSTAD
HALSTAD
HERBERG
HALSTAD
HALSTAD
ELM RIVER
HENDRUM
HENDRUM
ELM RIVER
HENDRUM
Run 10b
Run 10a
Run 9d
Run 9c
Sector 10
Sector 9
SA
SA
Halstad
(BM 872)
Hendrum
Augustana Ch
South Cem
Landing Strip
Radio Tower
Immanuel Cem
Quincy Cem
Hendrum City
St Paul Cem
Pontoppidan Ch
Harberg Meh S
North Cem
GREAT NORTHERN
RAILROAD
COUNTY DITCH NO 1
COUNTY DITCH NO 33
R 49 W
R 48 W

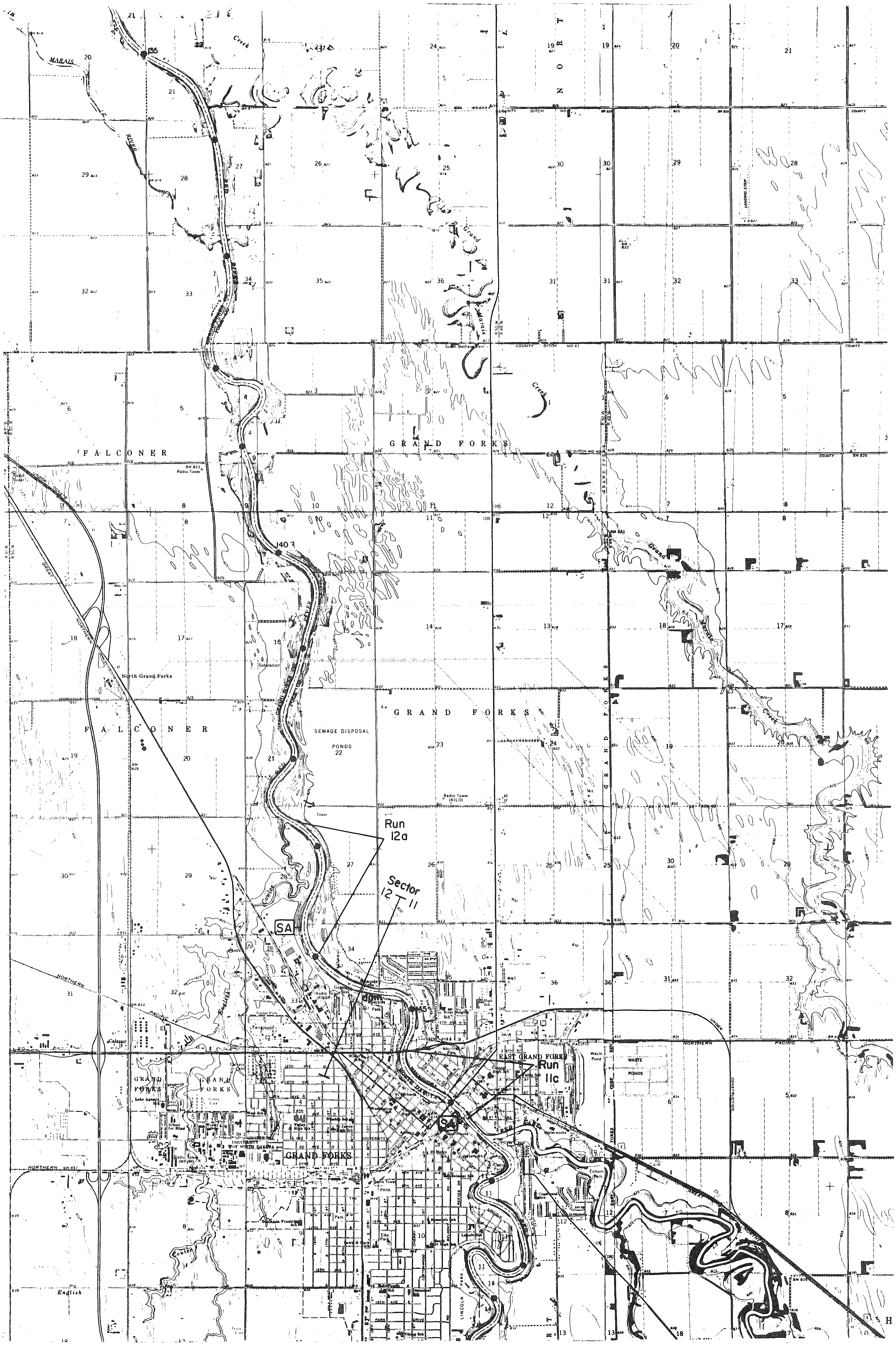
Run 10c

Run 10d

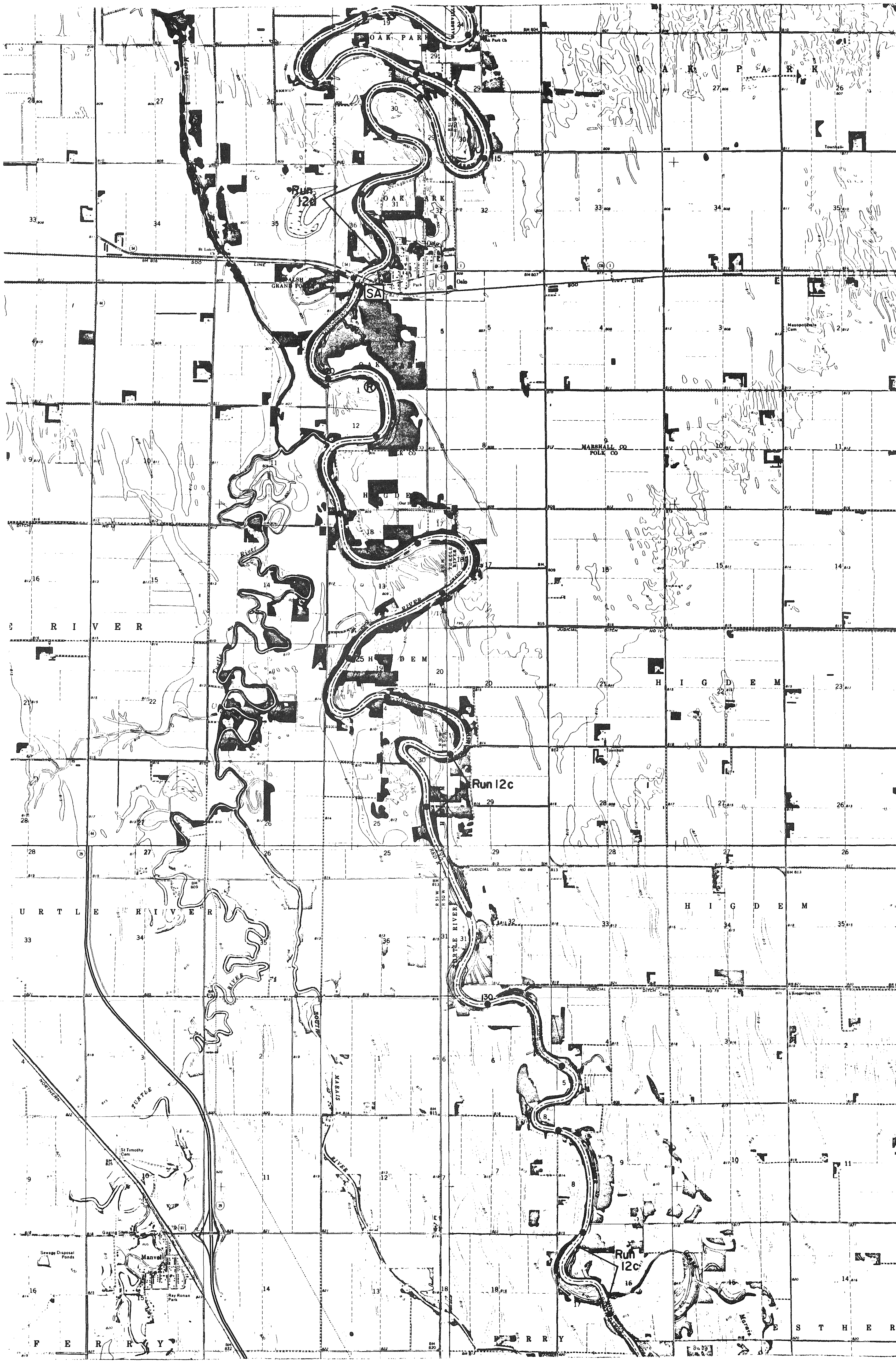

Run IIa
Run IOe
Sector IO T II
ENTRU
TYNSID
RO
BELMONT
VINE
GRAND FORKS CO
TRAILL CO
Townhall
North Ringsakor Cem
Coulee Cem
Bergit Cem
Sundet Cem
Climax
COUNTY DITCH NO 103
COUNTY DITCH NO 167
COUNTY DITCH NO 135
NORTHERN
GREAT



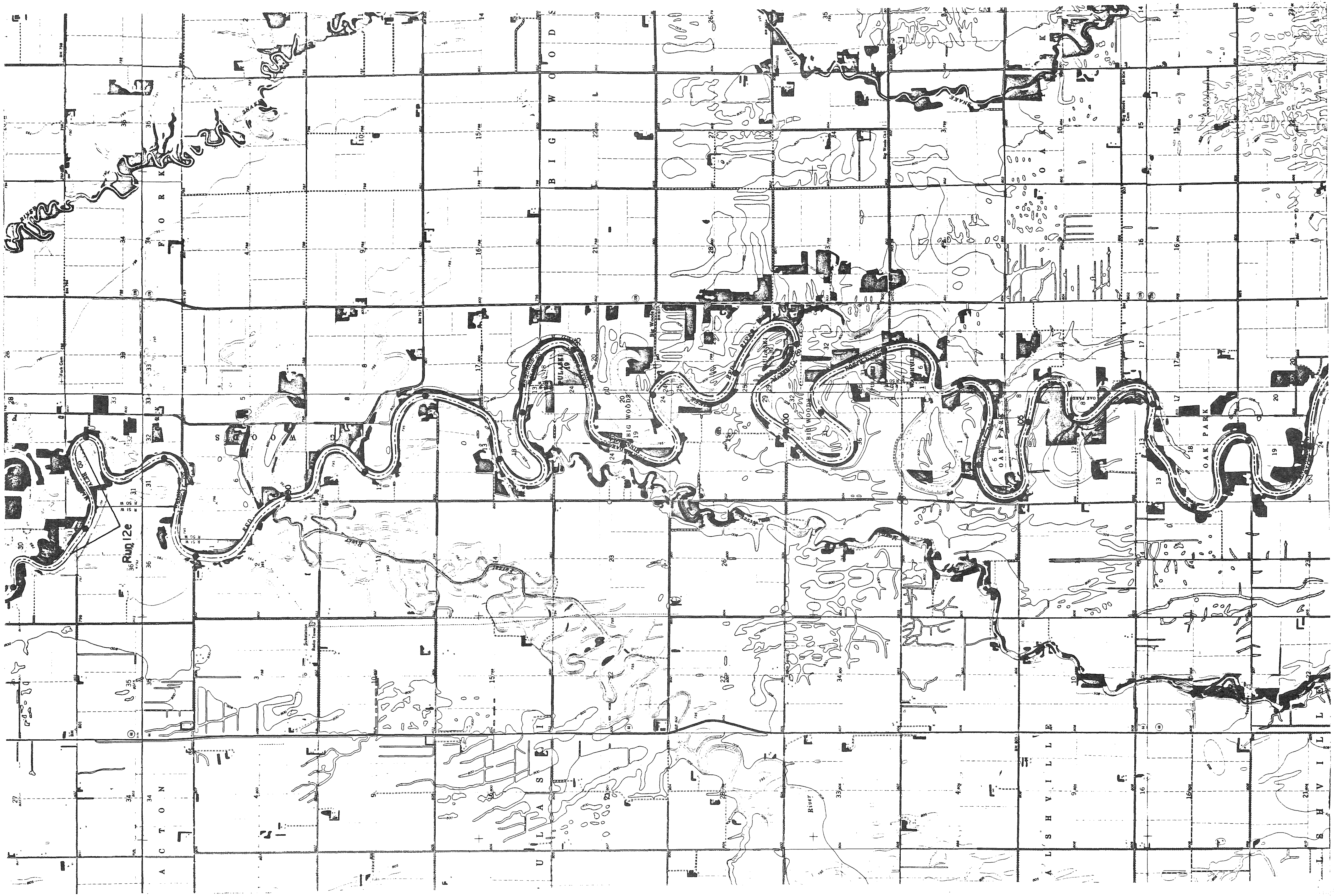
Run
IIb
RHINEHART
H U N T S V I L L E
B Y G L A N D
WALL
AMERICUS
GOLF COURSE
Radio Towers (KNOX)
Bygland
Mallory
McGrath Landing Strip
Townhall
GREAT NORTHERN
COUNTY DITCH



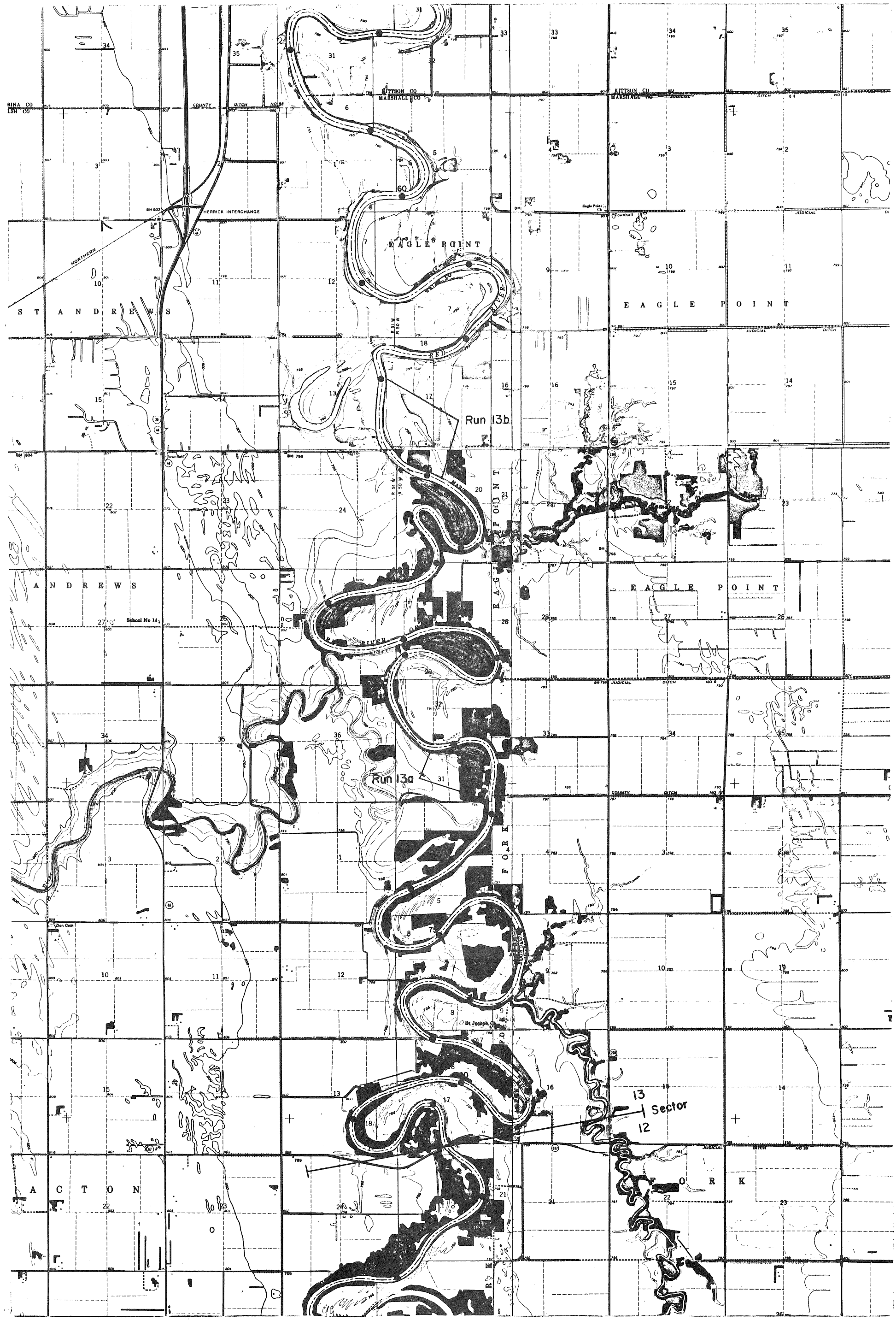
Run
12a
Sector
12
11
SA
Run
11c
MARAIS
RIVER
Creek
Grand
Marais
COUNTY DITCH NO 41
LANDING STRIP
South Bethany Cem
F A L C O N E R
G R A N D F O R K S
BM 823
Radio Tower
North Grand Forks
SEWAGE DISPOSAL
PONDS
Substation
Radio Tower
(KILO)
Tower
Coulee
English
NORTHERN
PACIFIC
GREAT NORTHERN
UNDER CONSTR
UNDER CONSTRUCTION
Trailer Park
Fairground
Calvary Cem
Calspur
Lake Agassiz Sch
School for Blind
UNIVERSITY OF NORTH DAKOTA
Radio Tower (WFJM)
GRAND FORKS
Radio Tower (KNOX)
Riverside Park
River Heights Park
EAST GRAND FORKS
Waste Pond
WASTE
PONDS
Central High Sch
City Hall
Sacred Heart Sch
Courthouse
Waterworks
Central Park
Folsom Park
Crestwood Sch
LINCOLN PARK
Lincoln Sch
Belmont Sch
Roosevelt Sch
Elks Park
Benjamin Franklin Sch
Lewis & Clark Sch
Valley High Sch
St James High Sch
Winship Sch
Wesley College
West Sch
Washington Sch
St Michaels Sch
St Marys Sch
Viking Sch
Driscoll

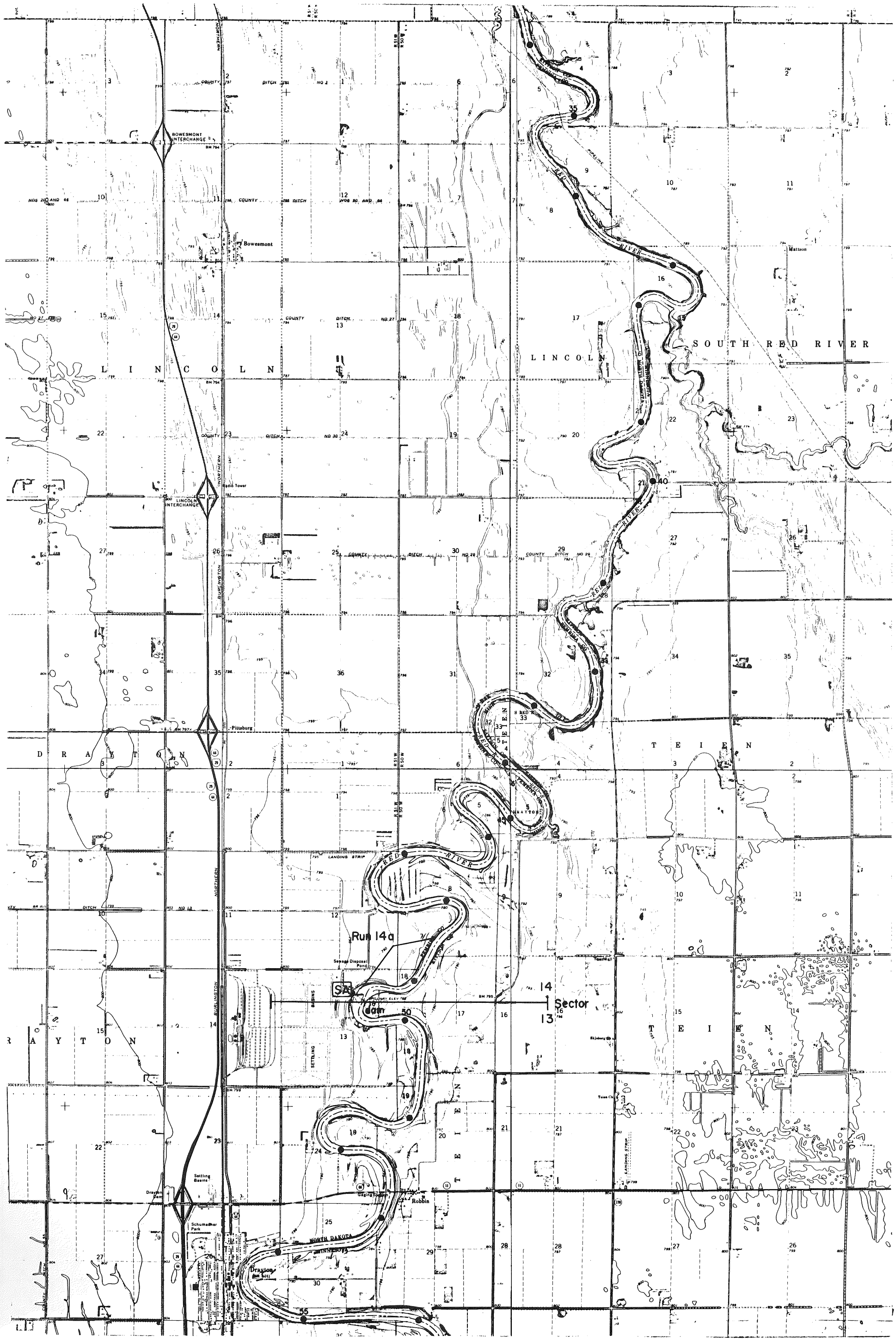


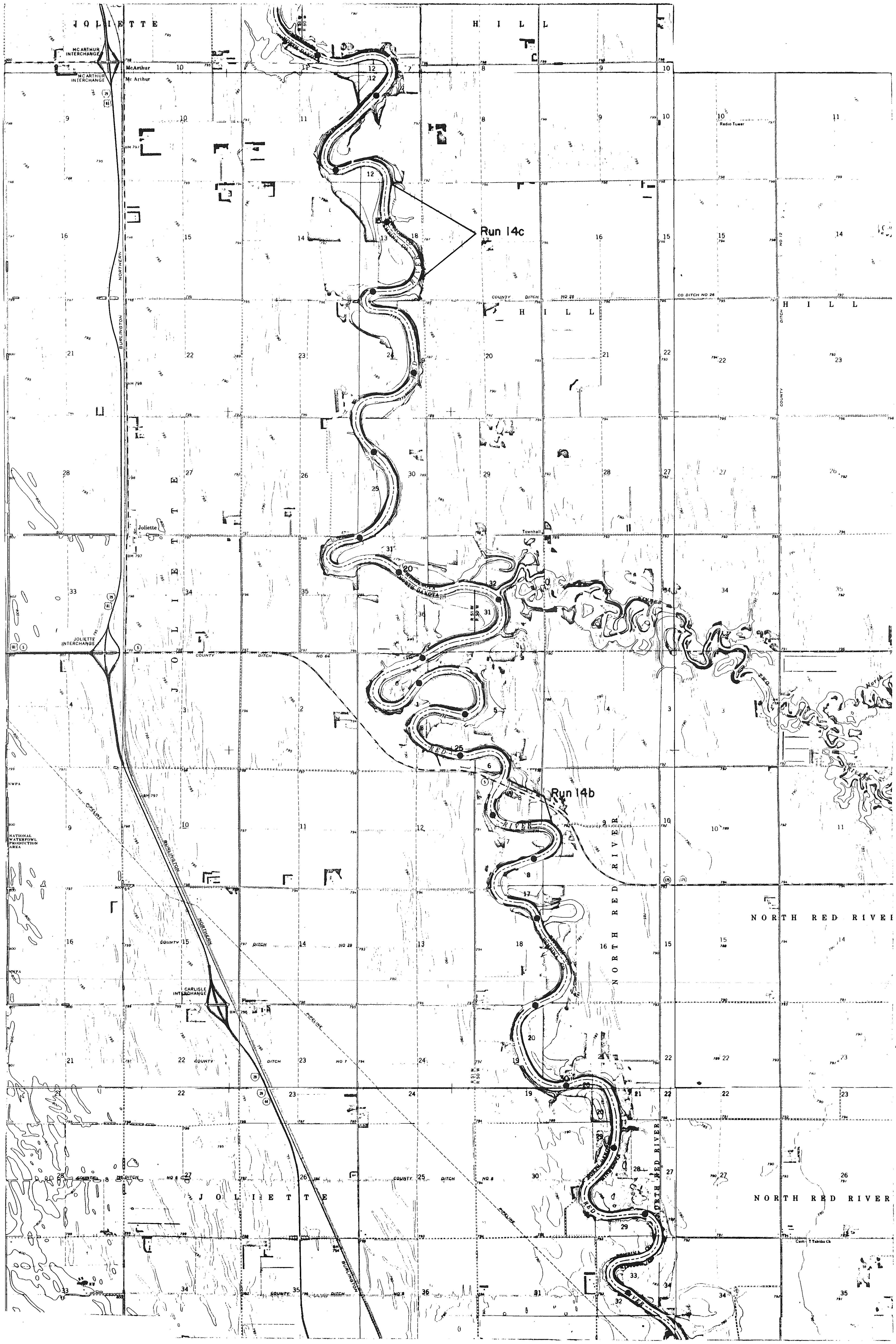
OAK PARK
Run 12d
Oslo
SA
MARSHALL CO
POLK CO
H I G D E M
Run 12c
Run 12c
R I V E R
U R T L E R I V E R
Manvel
Ray Ronan Park
Sewage Disposal Ponds
St Timothy Cem
F E R R Y
E S T H E R
Mesopotamia Cem
Townhall



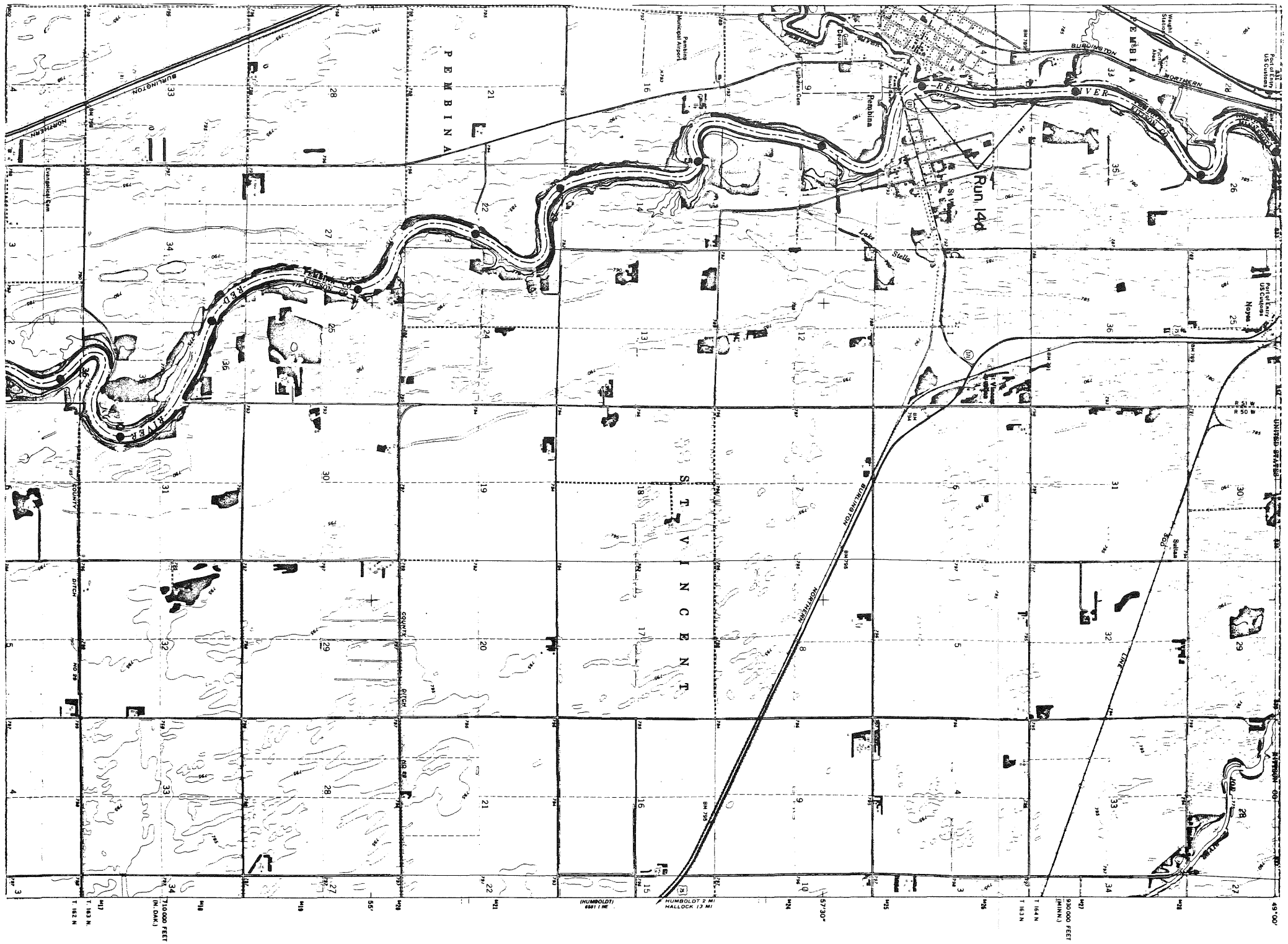
Run 12e
BIG WOODS
OAK PARK
SNAKE
River


BINA CO
LSH CO
KITTSON CO
MARSHALL CO
COUNTY DITCH NO 55
JUDICIAL DITCH NO 10
HERRICK INTERCHANGE
NORTHERN
EAGLE POINT
S T A N D R E W S
A N D R E W S
A C T O N
E A G L E P O I N T
RED LAKE RIVER
MARSH RIVER
Run 13b
Run 13a
13 Sector 12
School No 14
Townhall
Eagle Point Ch
Zion Cem
BM 802
BM 798
BM 799
R 51 W
R 50 W


L I N C O L N
LINCOLN
SOUTH RED RIVER
D R A Y T O N
T E I E N
Bowesmont
Mattson
Pittsburg
Drayton
Robbin
Run 14a
Sector
dam
BOWESMONT INTERCHANGE
LINCOLN INTERCHANGE
Radio Tower
Sewage Disposal Pond
Settling Basins
Schumacher Park
Drayton Dam
Gaging Station
Landing Strip
NORTHERN
BURLINGTON
RED RIVER
COUNTY DITCH NO 1
COUNTY DITCH NO 27
COUNTY DITCH NO 30
COUNTY DITCH NO 28
COUNTY DITCH NO 13
NOS 20 AND 66
NOS 80 AND 86
NORTH DAKOTA
MINNESOTA



Run 14c
Run 14b
JOLIETTE
HILL
NORTH RED RIVER
McARTHUR INTERCHANGE
JOLIETTE INTERCHANGE
CARLISLE INTERCHANGE
Joliette
Townhall
Radio Tower
BURLINGTON NORTHERN
COUNTY DITCH NO 26
CO DITCH NO 26
COUNTY DITCH NO 64
COUNTY DITCH NO 39
COUNTY DITCH NO 7
COUNTY DITCH NO 8
PIPELINE
NATIONAL WATERFOWL PRODUCTION AREA
NWPA
RED RIVER



ACKNOWLEDGEMENTS

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SPECIAL PUBLICATIONS*

No. 132 Lake Management Planning Guide. December 1982.

No. 133 Aeration and Mixing Systems in Minnesota Lakes, by D. Pederson. December 1982.

No. 134 Biological Survey of the Red Lake River, by P. Renard, S. Hanson and J. Enblom. June 1983.

No. 135 A Fish Management Guide for Northern Prairie Farm Ponds, by J. Schneider. August 1983.

No. 136 Water Quality Monitoring in Representative Fish Lakes 1979 and 1980, by D. Zappetillo, H. Fierstine and D. Pederson. April 1984.

No. 137 Biological Survey of the Otter Tail River, by S. Hanson, P. Renard, N. Kirsch and J. Enblom. June 1984.

No. 138 Indexing Minnesota Fish Lakes Relative to Potential Susceptibility to Acidic Deposition, by R. Payer. August 1984.

No. 139 Biological Survey of the Minnesota River, by P. Renard, S. Hanson, J. Enblom and N. Kirsch. March 1985.

No. 140 Large Lake Sampling Guide, by P. Wingate and D. Schupp. April 1984.

No. 141 Lake Superior Tributary Sampling Guide, by D. Pitman and P. Wingate. January 1986.

*Complete list of all publications in the series available from Minnesota Department of Natural Resources, Division of Fish and Wildlife, Section of Fisheries, Box 12, Lafayette Road, St. Paul, Minnesota 55146.