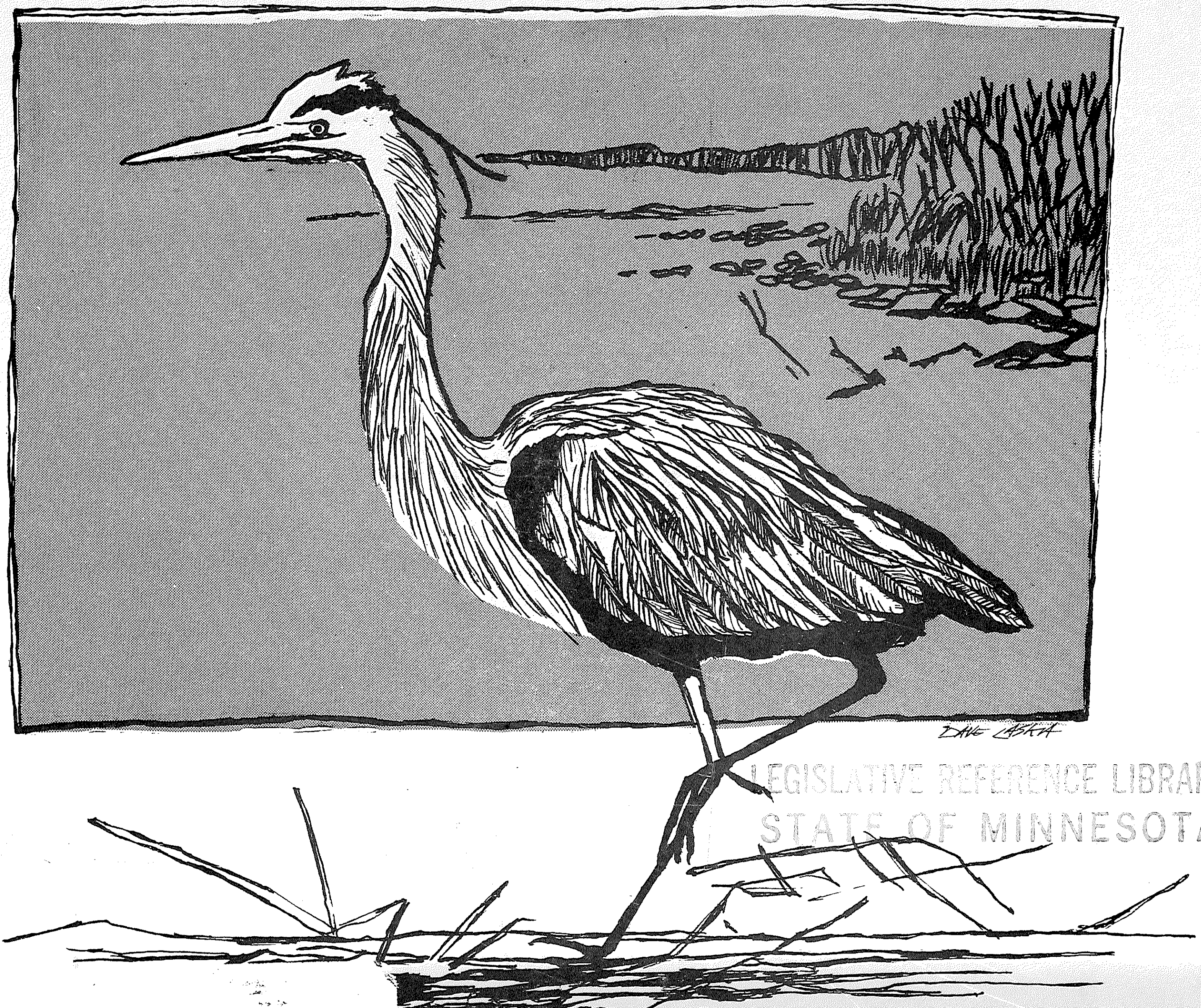
...gical Reconnaissance of the Upper Mississippi River

St. Cloud to Fridley



...DEPARTMENT OF NATURAL RESOURCES
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Mississippi River above Clearwater, Minnesota

A BIOLOGICAL RECONNAISSANCE OF THE UPPER MISSISSIPPI RIVER

by:

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TABLE OF CONTENTS

TABLE OF CONTENTS (Cont'd)

SUMMARY

A survey was made in September and October of 1974 to collect biological and other related information on the Mississippi River. The survey area extended from the base of the St. Cloud dam to Fridley. Within the study area, the river is characterized by long, straight stretches with occasional gentle curves in the channel. Depth is quite variable with frequent riffles. Typical depth is three to five feet with occasional deep pools and channels. Flow is regulated by the six headwaters reservoirs and current indications are that the reservoirs are operated in a less than satisfactory manner in regard to low flows of late summer and autumn. Critical low flows and flow instability in general constitute a major limiting factor to biological production.

Water quality in this area of the Mississippi River is generally good excluding times of excessive turbid runoff within the watershed. Mercury accumulation in fish tissue has been documented and will continue to be monitored, and the NSP Monticello nuclear plant has some problems with waste heat and chlorine that require further study.

Carp, smallmouth bass, and northern redhorse comprised over 80 percent of the electrofishing catch by number and 89.5 percent by weight. Most carp and redhorse were of mature size while over 80 percent of the bass were young-of-the-year fish.

Walleye was the game fish of secondary abundance and it appears that spawning requirements are met for both walleye and

smallmouth. The number of adult walleyes in the electrofishing catch was lower than might be expected. This may be due in part to the inefficiency of electrofishing gear in deep water areas. Present physical and biological factors of this portion of the Mississippi River such as flow instability and the lack of submerged aquatic vegetation limit walleye production.

Approximately 70 percent of the immediate shoreline in the study area of the Mississippi River corridor is wooded. Three reasonably distinct vegetation types are evident along the river. These are the bottomland woods, upland deciduous woods, and the oak savannah prairie groves with an occasional remnant of open prairie. Although agricultural activity surrounds the river, much of the corridor has retained a sense of remoteness and scenic beauty.

Dutch elm disease was evident in several areas along the river and it can be expected that the American elms will be eliminated from these forests.

Oak wilt is another disease of serious consequence to this area. Its primary effects are on the pin oak stands of the savannah above the floodplain.

The greatest threat to the forest resources and scenic qualities of the corridor are the inroads being made by private and commercial land developers. The regulations of the Wild, Scenic, and Recreational Rivers System constitute a positive step toward natural resource management and preservation, however, the assistance of local units of government is essential to maintaining the continuity and intergrity of this great resource.

Agricultural practices, other than occasional grazing, are not well suited to the terrain of the river corridor. It is because of this that the tree cover and other natural plant communities have been sustained. Even though much of this vegetation is confined to a narrow belt along the river, it provides food, shelter, and a corridor for wildlife movement. The variety of habitat types here promotes the diversity of animal life to be found.

Aquatic furbearers and waterfowl are not abundant in this portion of the Mississippi due to the physical nature of the corridor and lack of aquatic vegetation. Few backwaters exist here and destructive land use practices have caused the deterioration of waterfowl area adjacent to the corridor.

Water for condenser cooling is used at several electrical power generating plants—the two most significant being the NSP Monticello nuclear plant and the NSP SHERCO facility. Environmental monitoring was initiated before plant start-up and will continue for a number of years for these two facilities.

The cities of St. Paul and Minneapolis appropriate municipal water supplies from the Mississippi River. Low river flows approach critical levels for this use and it is important to limit any future activities which reduce the flow or water quality of the river.

Other uses of the river include fishing, boating, canoeing, camping, and hiking. The present condition of the resource allows for a quality experience in any of these activities. Wise management in the future will ensure the continued benefits to be derived from the Mississippi River.

INTRODUCTION

During the months of September and October, 1974, a wildlife reconnaissance and electrofishing survey was conducted on the Upper Mississippi River by the Ecological Services Section of Minnesota Department of Natural Resources. The study area included that portion of the river from the St. Cloud Dam downstream to the I-694 bridge on the outskirts of the Twin Cities Metropolitan Area. The purpose of the study was to collect, analyze, and record information on the physical, chemical, and biological characteristics of the river. This will serve to provide a more factual basis for future administration and management decisions in the formulation of ecologically sound policies regarding the river corridor.

Information gathered by the survey crew assisted in determining the Upper Mississippi River's status for the Minnesota Wild and Scenic Rivers Program. Plans are now under way for inclusion of the Upper Mississippi River, from the headwaters to St. Cloud, into the National Wild and Scenic Rivers Program.

Previous Surveys

Previous investigations have been primarily fisheries oriented and have included only parts of the present study area with the exception of Moyle (1940) who did a comprehensive biological survey of the Upper Mississippi River Watershed. Fraune and Schneider (1965) investigated the Upper Mississippi River from Brainerd to Elk River. Other work, by Reedstrom (1960), Schneider (1966), Huber (1970, 1973), Sternberg and Krosch (1972), and Hawkinson (1974), has been confined to the stretch of river from Monticello to Elk River. An electrofishing survey of the Mississippi River from Coon Rapids to the Minneapolis waterworks was conducted by Shodeen (1965).

The present study incorporates the data collected by Hawkinson (1974) as it was done in August, 1974, with the same electrofishing gear.

Present Survey

The biological reconnaissance of the Upper Mississippi was conducted in collaboration with the Division of Parks and Recreation, Minnesota Department of Natural Resources. A history and description of the watershed may be found in A Management Plan for the Mississippi River, St. Cloud to Anoka (Minn. DNR, Div. of Parks and Recreation 1975). Biological data was collected by the river survey crew of the Division of Fish and Wildlife during an extended canoe trip in September, 1974. Fish sampling was done during October, 1974, using a 230-volt Onan generator with a pulsed DC Smith-Root Type VI electrofisher and a boat-mounted boom shocker apparatus.

THE WATERSHED AND RIVER

Topography and Geology

The study area of the Mississippi River is part of the Mississippi-Sauk watershed unit. A variety of glacial landforms characterize the 3,890 square mile watershed. The following excerpt is taken from Water Resources of the Mississippi-Sauk River Watershed (USGS 1974): "The Mississippi follows a regional topographic low and transects the watershed from north to south.

Greatest relief is in the morainal area in the west-central part of the watershed. The outwash plain in the southeastern part of the watershed and associated terrace deposits along the Mississippi River form a large area of relatively low relief."

"Agriculture is the major economic activity. Small communities are scattered throughout the watershed; most larger municipalities and related development are concentrated along the Mississippi River."

Source of Water

The Mississippi River's principal tributaries in the study area are the Elk, Crow, and Rum rivers draining areas of 640, 2,756, and 1,552 square miles respectively (Hydrologic Atlas of Minnesota, 1959). In addition to these, there are 27 smaller tributaries and many small spring seepages. The names, locations, and flow characteristics may be found in Table 1 of the Appendix.

The following information concerning precipitation and runoff is taken from the previously mentioned USGS publication and pertains to the entire watershed: "Average annual inflow to the watershed as precipitation was 26.6 inches in the period 1939-68. Average annual outflow from the watershed during the same period was 4.4 inches as runoff and 22.2 inches as evapotranspiration. Prolonged periods of high flow generally occur in the spring when the winter accumulation of snow melts. Precipitation in the form of rain frequently occurs during this period and contributes to the magnitude and duration of the spring flow."

"Flow characteristics of the Mississippi River are affected by regulation of six reservoirs* located upstream from the watershed. During periods of high flow, flood runoff is stored in the reservoirs for release later to augment base flows during prolonged dry spells and in the winter when there is little or no surface runoff." Otherwise, low flows in streams are sustained primarily by discharge from ground water sources.

The operational procedures for the reservoir dams fall within the guidelines set forth in the Findings of Fact, Conclusions, and Order (Minnesota Department of Conservation, 1963). Current evidence regarding the operation of these reservoirs indicates that one of their primary functions is to maintain stable water levels within the reservoirs for recreational and residential amenities and to a lesser extent, their original purpose of flow stabilization in the Mississippi River.

The construction of locks and dams on the lower Mississippi eliminated the need for reservoir manipulation to augment flows for navigation. This and other factors account for the shift in operational policies for the reservoir system.

During the recreation season, efforts are directed towards maintenance of reservoir levels within a very narrow range; often

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* Lake Winnibigoshish, Leech Lake, Pokegama Lake, Big Sandy Lake, and Cross Lake on the Pine River. Sixth Dam at Gull Lake in Crow Wing River watershed. These dams are maintained and operated by the U.S. Army Corps of Engineers.

times at the expense of downstream river flows. The minimum reservoir discharge established in the guidelines is not always a sufficient amount of water to maintain normal and desirable downstream river levels (refer to figure 1 on page 6). Frequent late summer and autumn low flows come at a time when natural river temperatures are at their maximum and the addition of waste heat from power plants, sewage, industrial waste, and agricultural contributions can cause unsatisfactory water quality conditions.

Instability of water levels in the Mississippi River below the headwaters reservoirs is a major limiting factor to the aquatic plant and animal communities. Fluctuations in reservoir levels over a wide range would be equally undesirable. The establishment of biologically acceptable ranges of fluctuation for both systems and proper phasing of the two has not been accomplished, however, the Corps is presently studying the reservoir system and its operation.

Intermittant side channel below St. Cloud.

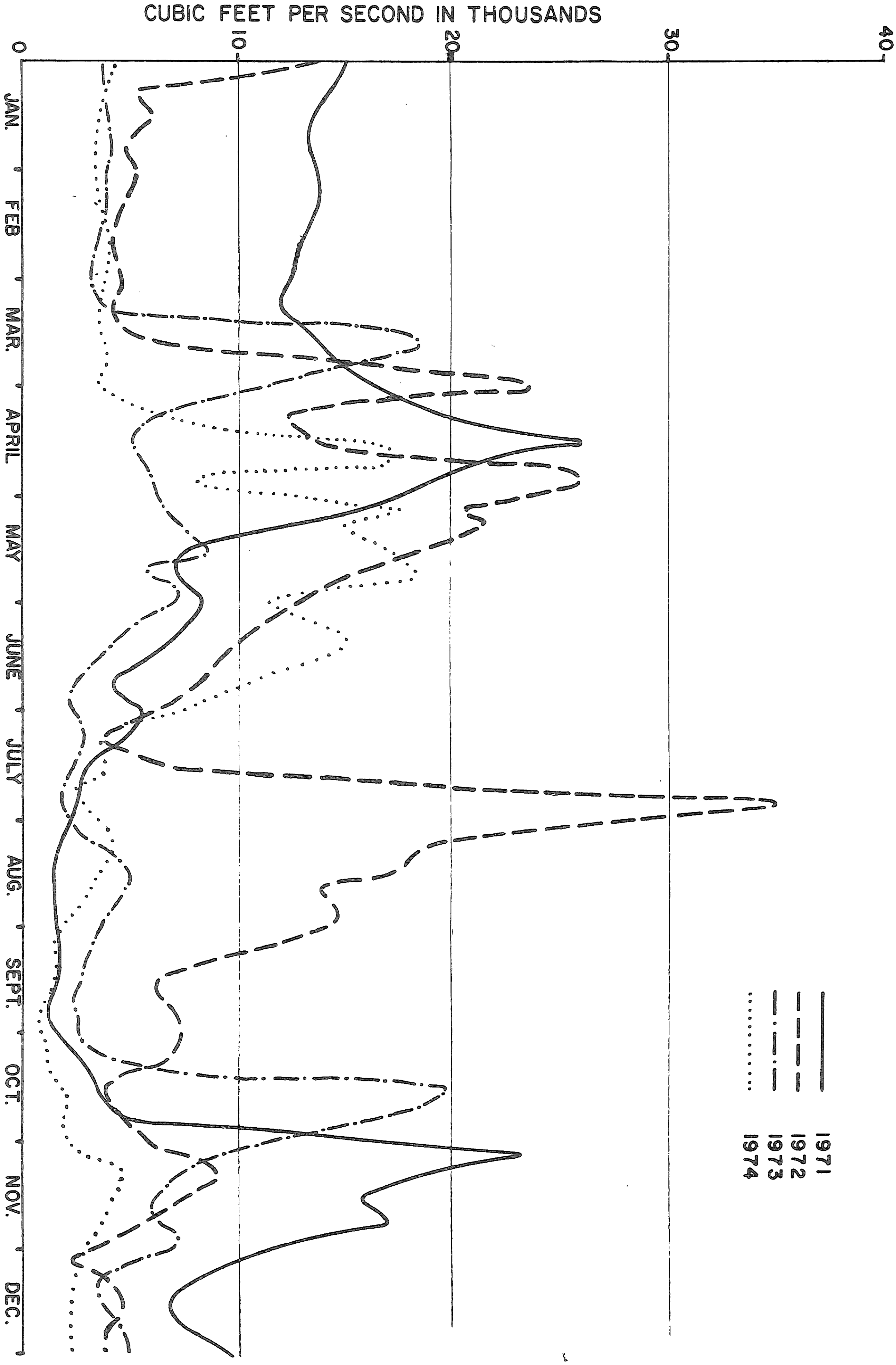


FIGURE I. FLOW CHART – MISSISSIPPI RIVER AT MONTICELLO

Stream Flow and Characteristics of the Channel

Mississippi River flows recorded at the U.S.G.S. gauging stations at Elk River and near Anoka below the Coon Rapids dam are given below:

	Elk River	Anoka (Coon Rapids)
Average discharge	5,324 cfs	7,166 cfs
Minimum discharge	278 cfs	586 cfs
Maximum discharge	49,200 cfs	91,000 cfs
Runoff, average annual	4.99 in.	5.09 in.
Drainage area (approx.)	14,500 mi^2	19,100 mi^2
Years of record (water years)	1916 - 56	1932 - 71

The stream profile is given in Figure 2 showing the river to have an average gradient of 2.19'/mile in the study area with exclusion of the 19-foot head on the Coon Rapids dam.

The Mississippi takes a reasonably direct course between St. Cloud and Minneapolis. The channel is characterized by long straight stretches with occasional gentle curves in the channel. Depth is quite variable with frequent riffle areas and shallow gravel bars interspersed between the deeper slower segments of the river. Typical average depth would fall in the three-to-five-foot range with occasional deep pools and channels. Current is moderate but variable. Median width is 600 feet not considering the impounded area above Coon Rapids.

The overall composition of the bottom soils would be approximately 75% gravel, 20% sand, and 5% rubble and boulders.

Impoundments

The St. Cloud dam at the beginning of the study area, is approximately 650 feet wide and is a barrier to fish migration. The fourteen-foot head creates an impoundment which extends approximately two miles up to Sauk Rapids. It is used for fishing, boating, water skiing, swimming, and winter sports. In the late 1960's, controversy over removing, repairing, or building a new dam resulted in the latter in 1970.

The only impoundment within the study area is the Coon Rapids dam. Its width is approximately 1470 feet with a head of 19 feet. The reservoir is drawn down during the winter months for greater reserve capacity during the spring runoff. Since the construction of the two locks over St. Anthony Falls, this dam has become the migration barrier maintaining the two distinct fisheries populations of the upper and lower river.

WATER QUALITY

The Mississippi River from St. Cloud to Fridley would be generally classified as a moderately fertile hard-water stream with changes in water quality being the greatest throughout different times of the year rather than with distance downstream or from one year to another. Localized variances in water quality are evident where tributary streams enter the river or where significant waste sources are discharged but the basic water quality indices average and remain fairly uniform throughout the study area.

Significant water quality parameters for this portion of the Mississippi River are given in Table 1 of the report as median values of monthly samples. Data was obtained primarily from the Storet system of the Minnesota Pollution Control Agency, Water Quality Monitoring program. Information from the U.S. Geological Survey and

TABLE I
WATER QUALITY PARAMETERS AS MEDIAN VALUES

YEARS	STATION	FECAL COLI MPN/100ml	TURB JTU	COLOR PT-CO UNITS	TOTAL ALK mg/l	pH	TOTAL P mg/l	ORG-N mg/l	NH_3-N mg/l	NO_2-N mg/l	NO_3-N mg/l	TOTAL N mg/l
1953 TO 1957	ST. CLOUD	—	14	32.5	160	8.0	—	—	—	—	—	—
	ANOKA	—	12.5	35.5	170	8.1	—	—	—	—	—	—
	FRIDLEY	—	13.0	*	*	8.0	—	—	—	—	—	—
1958 TO 1965	ST. CLOUD	*	12.0	—	—	7.9	.15	—	.05	—	*	*
	ANOKA	*	10.0	—	—	7.8	.16	—	.05	—	*	*
1967 TO 1970	ST. CLOUD	170	8.2	30.0	150	7.9	.11	.76	.08	.02	.10	1.04
	CLEARWATER	490	6.2	30.0	150	7.9	.10	.73	.08	.02	.11	1.06
	FRIDLEY	195	9.3	32.0	155	7.9	.12	.81	.12	.02	.11	1.17
1971 TO 1974	ST. CLOUD	230	5.4	*	152	7.8	.14	*	.10	*	.16	*
	CLEARWATER	490	4.2	*	145	7.9	.11	*	.07	*	.17	*
	ANOKA	230	*	30.0	168	8.1	.10	1.4	.08	*	*	1.6

*SOME INFORMATION AVAILABLE BUT NOT IN SUFFICIENT QUANTITY FOR AN ACCURATE MEDIAN.

the Metropolitan Waste Control Commission was also reviewed. Gaps in the table of values are attributed to frequent past changes in sampling stations and analytical procedures.

Temperature, Dissolved Oxygen and Potential Effects of the Monticello Nuclear Generating Plant

Water temperature and dissolved oxygen in the study area of the river are more than satisfactory for a warm-water fisheries. Summer temperature maxima usually range from the low to upper seventies and infrequently above eighty. These peaks appear to be related to river discharge.

Environmental monitoring of the thermal discharge from the Monticello Nuclear Generating Plant, in Sector 2, has been in progress since before plant operation. Acute effects resulting from the thermal discharge have not been observed in the river itself, but it is known that extremely high mortality results when small fish and other organisms pass through the cooling system or when winter shutdown results in a rapid temperature drop of up to 30°F. in the discharge canal.

Fish attraction to warm-water effluents has been well exhibited. Presumably this occurs to the greatest extent at those times when the ambient temperature of the receiving water is below the optimum or "desired" temperature ranges of the fish species concerned. In Minnesota this amounts to 50% of the year or more for many species. During these periods fish and other aquatic organisms attracted to or residing in areas of thermal effluent may be exposed to periodic or continual doses of the various forms of chlorine. These can produce acute or chronic toxicological effects.

The NSP Monticello facility utilizes chlorine as a biocide in the cooling system. Chlorination is conducted for one hour/day, during the winter and one half hour/6 hours during the summer. Proposed NPDES permit restrictions will limit total residual chlorine at the end of the discharge canal to 0.2 mg/l. For a period of not more than two hours per day. This limit seems excessive in view of the recommendation made in WATER QUALITY CRITERIA 1972 (EPA 1973). It reads as follows:

"Aquatic life should be protected where the concentration of residual chlorine in the receiving system does not exceed 0.003 mg/l at any time or place. Aquatic organisms will tolerate short-term exposure to high levels of chlorine. Until more is known about the short-term effects, it is recommended that the total residual chlorine should not exceed 0.05 mg/l for a period up to 30 minutes in any 24-hour period."

Mattice and Zittel (1976) developed acute and chronic toxicity thresholds that would result in no toxicity. These were derived for freshwater and marine organisms by summarizing available experimental data regarding chlorine toxicity. Log total residual chlorine concentrations versus log time plots exhibited a chronic toxicity threshold of 0.0015 mg/l for freshwater organisms. The acute toxicity concentration value for a 30 minute exposure was approximately 0.09 mg/l TRC, and 0.05 mg/l TRC for 60 minutes.

Another consideration is the avoidance response of fish to chlorine forms. At times when a high thermal gradient exists between the discharge canal and plume, and the receiving waters; sufficient levels of chlorine to repel fish out of the warmed waters could subject them to temperature zones capable of inducing thermal shock or other more subtle physiological impairment. Sprague and Drury (1969) have shown an avoidance response of rainbow trout to free chlorine at 0.001 mg/l.

Bogardus (in press JWPCF) et. al. working with selected minnow species found that the mimic shiner, bullhead minnow, and river shiner avoided test concentrations at or above 0.005 mg/l, 0.03 mg/l, and 0.15 mg/l TRC respectively.

Color and Turbidity

These parameters vary over a wide range and are directly related to surface drainage. Late summer and winter with the usual corresponding low flow exhibit the lowest values.

Summer values for turbidity in the upstream portions of the study area average below 10 JTU in low runoff years and averages can range from 10 to 20 JTU or more during summers of greater flow. Downstream below the principal tributaries (Elk, Crow, and Rum rivers) these summer turbidity values usually average only slightly higher but can be considerably higher on occasion due to varying patterns of precipitation on the contributing watersheds.

Turbidity caused by phytoplankton blooms is of little significance due to the scarcity of plankton algae in the main river. A microscopic analysis of the Mississippi River water near Monticello was made by Arthur R. Peterson, Aquatic Biologist, (Minn. DNR) in August of 1970. The turbidity at this time was 10.5 JTU. The analysis showed that 99 percent of the suspended particulate matter was cellular debris and 1 percent diatoms (*Navicula* and *Tabellaria*). At times of greater flow and higher turbidity, these percentages would include varying amounts of inorganic particulates from natural and other erosion.

True or dissolved color is attributed to humic and the similar yellow carboxylic acids. The ability of these compounds to complex in a colloid with iron and manganese further increases their potential for coloring waters. These complexes are quite stable even at the relatively high pH and redox potential typical of the river. Photochemical breakdown by sunlight is a factor in lessening color with distance downstream.

Although the typical yearly median color value would be 30, the summer values range to 90 and would average more in the area of 40 to 50.

Total Alkalinity

The values for total alkalinity vary inversely with flow. Generally the lowest values are associated with the large river volumes during the spring melt and the highest values will be found at those times when ground water discharge is the major source of stream flow; during the winter months. Total alkalinity increases slightly with distance downstream and in the summer months usually averages lower than the values given in Table 1.

Nitrogen and Phosphorus

The levels of total nitrogen and total phosphorus in the river would be indicative of fertile water in a lake situation. Excessive phytoplankton populations are absent despite the adequate amounts of these two nutrients. This can be attributed to the color, turbidity, and turbulence factors of the river in order of ascending importance.

Iron and Manganese

The levels of these two metals frequently exceed the applicable standard as established by the Minnesota Pollution Control Agency. WPC 15 states that the levels of iron in the stream should not exceed 0.3 mg/l and 0.05 for manganese. This standard applies to water used as a public water supply and the naturally occurring levels would not be considered detrimental to aquatic organisms.

Mercury

During 1970 and 1971, 587 fish were collected from 28 Minnesota waters and analyzed for mercury levels in the flesh. Sampling was widely distributed and represented many lakes and the more important watersheds. Several areas suspected of having potential mercury problems were also included. One of these suspected areas of river was the Mississippi River from Grand Rapids downstream.

Results of the sampling program indicated that fish in the Mississippi River from Grand Rapids to Monticello had levels considerably higher than anywhere else in the state. The second ranking river for high mercury was the St. Louis below Cloquet. "Both of these waters have woodpulp and paper industries discharging into them which probably used mercury compounds as slimicides in the past. This is now prohibited but some residues may remain in the bottom sediments. For both of these stretches of river, the Minnesota Department of Natural Resources recommended in 1970 that consumption of fish be limited to one meal a week, " (Moyle, March 1972). This was based on the F.D.A. action level of 0.5 ppm.

The upper half of the study area concerned with in this report is included in the mercury problem area outlined above. The average mercury values for all fish collected each year at Monticello 1970-73 were, respectively: 0.95, 0.51, 0.24, and 0.51 ppm. On the basis of this data, the warning on fish consumption of 1970 is still in effect.

Mercury in the environment occurs naturally in all types of rock in various strata. Processes of weathering, dissolution, and biological activity cause natural releases of the element into the environment. This accounts for what is considered to be natural background levels in water, fish flesh, bottom sediment etc. Results of sampling investigations in Minnesota and Wisconsin indicate that the average background levels are well within FDA guidelines for human consumption.

In the areas where the range of natural background levels is exceeded, additional unnatural sources of mercury are probable. This can be in the form of municipal or industrial waste outfalls or methylation of bottom sediments containing inorganic mercury deposited by these sources.

It was initially believed that the methylation of mercury by bacteria occurred in bottom sediments under anaerobic conditions. Subsequent investigations have shown that this process takes place at a much greater rate under aerobic conditions (Krenkel et. al., May, 1972).

Mercury is accumulated by fish directly from the water and through the food chain. Mercury is accumulated at a faster rate than it is eliminated varying with environmental conditions. Concentration factors of 10,000 or more have been reported from water to brook trout and to some invertebrates (Hannerz, 1968). Northern pike exhibited a concentration factor of 2,000 for methylmercury added experimentally to the water (Kleinert and Degurse, 1971). Methylmercury is the form of greatest concern regarding toxicity to man and aquatic organisms, but the ability of certain microorganisms to synthesize methylmercury from the inorganic forms renders all mercury in waters potentially dangerous.

Fecal Coliform

The Mississippi River in the study area is classified for aquatic recreation of all kinds. The applicable MPCA standard (WPC15) for fecal coliform outlines a value of 200 most probable number per 100 milliliters. Examination of analytical values shows that this level was often exceeded particularly below the city of St. Cloud. The problem has, for the most part, been alleviated with the construction of the new wastewater treatment plant in St. Cloud.

St. Cloud is partially serviced with a combined sewer system. Plans are underway to eliminate the combined sewers and separate the storm and wastewater. Until that time, heavy rains will continue to divert raw sewage to the river and may cause occasional fecal coliform problems.

Effluent compliance of municipal waste sources should bring fecal coliform levels within recreational guidelines excluding times of excessive runoff from agricultural lands.

AQUATIC VEGETATION

Aquatic plants are scarce in this portion of the Mississippi River as a result of various interacting factors; flow instability being of major concern. The turbid, high water, spring discharges have a scouring effect on bottom soils and shade out plant communities in normal photosynthetic zones. The extended high flows often continue into early summer. Rooted aquatic plants and attached algae able to establish in the limited photosynthetic zone during early summer high flows would be left exposed during frequent late summer and autumn low water conditions (refer to figure 1).

The abundance of coarse stream substrate, current velocity, turbidity, color, and rough fish action are additional factors negatively affecting the aquatic plants even under normal stream flow conditions. It is felt, however, that these factors are of lesser consequence and that aquatic plant populations could increase appreciably with moderation of high flows and augmentation of low flows.

Among the emergent vegetation present is *Equisetum fluviatile* (horsetail), *Eleocharis* spp. (spikerush and needlerush), *Phalaris arundinacea* (reed canary grass), *Scirpus validus* (softstem bulrush), *Polygonum* spp. (smartweeds), *Carex* spp. (sedges), and *Typha latifolia* (common cattail). Watercress grows in spring areas along the river.

Aquatic floating or submerged vegetation include *Potamogeton nodosus* (river pondweed), *Potamogeton pectinatus* (sago pondweed), *Vallisneria americana* (wild celery), *Lemna minor* (lesser duckweed), and unidentified species of algae. While sago pondweed, wild celery, and smartweed are considered excellent waterfowl food they are too uncommon to provide forage to any appreciable degree.

FISHERIES

The fisheries survey began while the wildlife reconnaissance was being conducted. Biological characteristics such as fish habitat changes along the course of the river were noted during this period. Upon completion of the wildlife reconnaissance the river was divided into six sectors. Since the Mississippi is quite homogeneous in its stream characteristics in the study area, distances play a more important role in subdividing the river into sectors rather than actual habitat differences.

Equipment and Methods

All fish collected during the survey were electrofished. Sampling included the use of an Onan 230-volt, 4000-watt, gas-powered AC generator. The control panel used to rectify the current to DC and regulate the desired electric field was a Smith-Root type VI. This equipment was mounted in a 14-foot flat-bottom work boat.

The electrode arrangement consisted of a bow-mounted single anode and two stern cathodes trailing the boat. The anode was made of a 1/2-inch stainless steel tubing shaped into two concentric rings, designed by Earl Huber, biologist (Minnesota DNR). The cathodes were made of two individual pieces of 1 1/2-inch flexible conduit tubing with the bottom ends filled with lead. Each set of cathodes was composed of a 5- and 7-foot piece of conduit. It was felt that these cathodes were a practical design for working in river situations.

A three-man fisheries crew was utilized for the survey. Two men in the bow used aluminum handled nets wrapped with fiberglass tape to dip the stunned fish. They also actuated the foot power switch at the desired intervals. The shocking run was navigated by the third crew member who also monitored the control panel to administer the desired electrical field for capturing fish.

Electrofishing was done at a 60 pulse per second (slower pulse rates not available with this unit) DC setting, using a 7 millisecond pulse width at 4-5 amperes. This mode of operation seemed to sample a wide range of species and was felt to most proportionately describe the actual populations present.

A set distance for shocking runs was not considered practical so sampling was conducted until a reasonable number of fish had been taken at each station. Legal descriptions of each electrofishing run are given in Table 2 of the Appendix and they are shown on the Appendix map series.

Standard departmental procedure was used to record catch data. Total length and weight were recorded for each game and rough fish. Scale samples for age and rate of growth determinations were taken from game fish. Minnows and related species were tabulated by number only.

It should be noted that electrofishing has some limitations. One factor is size selectivity. There is a greater capture affinity with increased fish surface area, making larger fish more susceptible. Some species are sampled more readily than others and it is theorized that fish such as northern pike and largemouth bass sense the approaching electrical field and may avoid capture. Habitat preference is another factor influencing catch rates. Those species occupying deeper waters, such as walleyes, may not be sampled in proportion to their actual numbers because of the depth limitation of the electrical field. All of the sampling was conducted during daylight hours which could account for some bias against light sensitive species.

Results

In the six sectors of the study area, 40 species of fish were captured, representing 13 families of fishes. Sampling consisted of 30 shocking runs comprising 25.0 river miles. The species found are listed in Table 4 of the Appendix, in order of abundance. The table gives the number, percent of catch, weight, percent by weight, catch per effort in fish per hour, and median length in inches for each species. The number of minnows and minnow-like species is also given but not included in the catch analysis. A similar tabulation of species for each sector is given in Tables 5 thru 10 of the Appendix. A composite of length frequencies for each fish species is given in Table 11 of the Appendix.

Carp, smallmouth bass and northern redhorse comprise over 80 percent of the catch in the study and 89.5 percent by weight. Most of the carp and redhorse were of mature size while over 80 percent of the bass were young-of-the-year fish.

The nine most numerously sampled species, carp, smallmouth bass, northern redhorse, black bullhead, black crappie, silver redhorse, walleye, white sucker, and channel catfish, are graphically represented in Table 3. The percent of catch that each species comprised is represented under each histogram. Each fish stock is broken down further into three categories of sexual maturity (young of year, immature, and adult).

In Figure 2 a sector breakdown of catch percentages of the more abundant species in this reach of the Mississippi River is given. Although the river is quite similar in each sector, particularly 1 - 4, catch rates exhibit some changes. The stream profile and average gradient per sector is also shown.

Peterson (1975) expresses the variety of fish within a particular system with a mathematical expression, the diversity index ($\bar{d}$). The diversity index reflects species variety and the distr bution of individuals among the species. He found the median value for large warmwater Minnesota streams to be 2.23 (excluding minnows and other small fishes). The total diversity index for the six sectors of the survey area was 2.80 in the fall of 1974. Two sectors (3 and 5) were below the state median due primarily to the dominance of carp. The diversity index values for each sector are given in the following table.

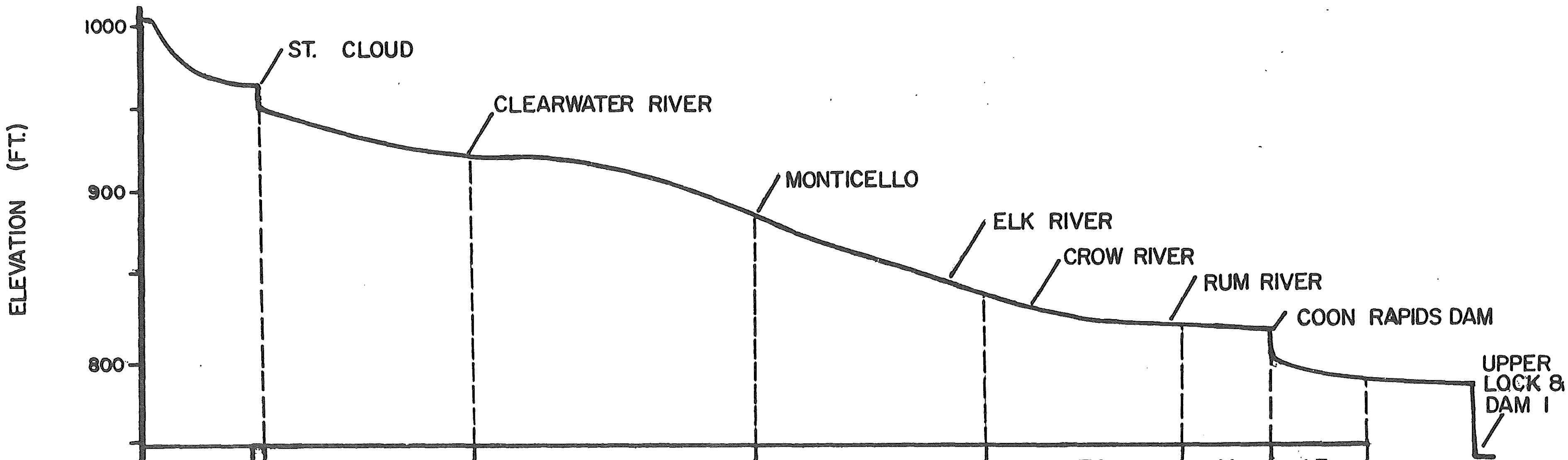
Table 3 Diversity index values determined by electrofishing in the Mississippi River by sector

Sector	$\bar{d}$ Value	
	Excl. minnows	Incl. minnows
1	2.40	2.76
2	2.53	3.05
3	2.10	3.11
4	2.48	3.16
5	1.24	1.39
6 *	3.00	3.17

* Sector 6, below the Coon Rapids Dam, has more indigenous species than the five upstream sectors.

FIGURE 2.
MISSISSIPPI RIVER

STREAM PROFILE
AND
PERCENT OF CATCH BY SECTOR SAMPLED AUGUST AND OCTOBER 1974



SECTOR	I	II	III	IV	V	VI	
GRADIENT (FT./MI.)	2.3	2.3	3.5	1.7	—	3.1	OVERALL
	SMB 32.7	NR 36.1	C 41.8	C 32.7	C 76.5	C 22.6	C 29.2
	NR 28.8	C 23.8	SMB 29.0	SMB 26.2	SMB 8.8	BLC 20.2	SMB 25.9
	C 22.6	SMB 22.8	NR 19.3	NR 20.9	BLB 5.9	BLB 16.8	NR 24.0
	BLB 4.5	SR 2.7	SR 3.9	SR 7.2	NP 2.9	NR 16.2	BLB 4.1
	W 3.1	W 2.7	WS 1.8	WS 3.8	—	SMB 6.9	BLC 4.0
	SR 2.5	RB 2.5	BUR 1.1	BLC 3.0	—	SR 2.4	SR 3.3
	WS 2.1	WS 2.1	RB 0.6	W 3.0	—	W 2.4	W 2.0
	BUR 1.2	BLC 1.2	BLB 0.2	NP 1.1	—	NP 0.8	WS 1.9
	BLC 0.2	BUR 1.2	BLC 0.2	RB 1.1	—	WS 0.5	RB 0.9
	RB 0.2	BLB 0.8	W 0.2	BUR 0.4	—	RB 0.3	BUR 0.6
	NP 0.2	—	NP 0.2	—	—	—	NP 0.5

RIVER MILE 410 420 430 440 450 460 470 480

LEGEND

BLB- BLACK BULLHEAD
BLC- BLACK CRAPPIE
BUR- BURBOT
C- CARP
NP- NORTHERN PIKE
NR- NORTHERN REDHORSE
RB- ROCK BASS
SR- SILVER REDHORSE
SMB- SMALLMOUTH BASS
W- WALLEYE
WS- WHITE SUCKER

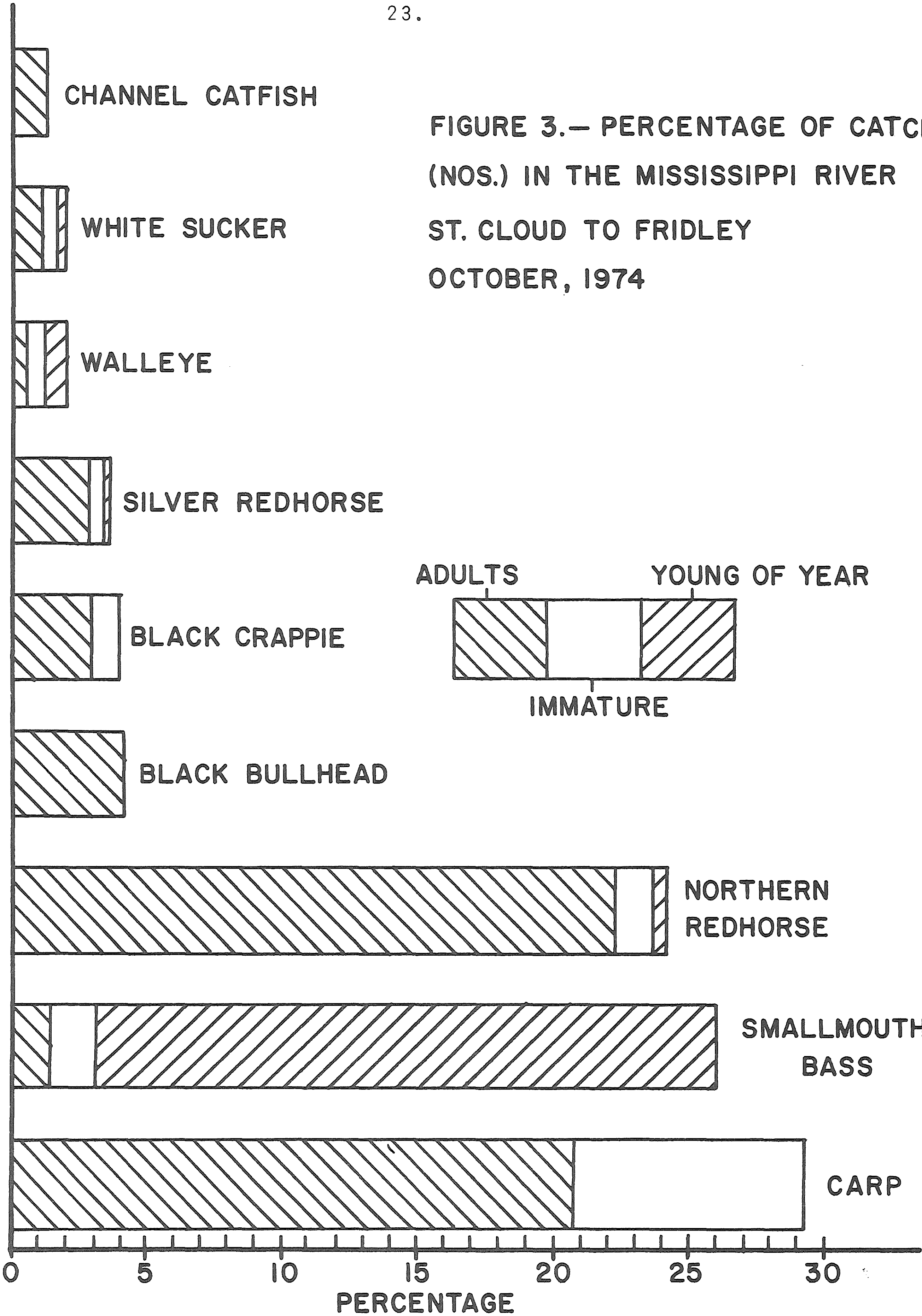


FIGURE 3.— PERCENTAGE OF CATCH (NOS.) IN THE MISSISSIPPI RIVER ST. CLOUD TO FRIDLEY OCTOBER, 1974

Peterson states that streams with diversity indices less than 1.8 are being influenced by some form of environmental stress. Only Sector 5 had a $\bar{d}$ lower than 1.8, and the value there was 1.24. This may not be expressing environmental stress so much as inefficiency of the electrofishing gear in the deep water of the reservoir above the Coon Rapids dam.

The $\bar{d}$ value including minnows and other small fishes was 3.46 for a total of the six Mississippi River sectors. This represents an increase of 19.1% from the $\bar{d}$ value including large fish only. When all fish species are included in the calculation of the diversity index there is usually an increase of about 10 percent in the $\bar{d}$ value for large warm-water streams and ranging to approximately a 30 percent increase for small warm-water streams.

Notes on Fishes

Smallmouth Bass

At present the smallmouth bass is probably the greatest asset to the sport fishery. Present throughout the study area, it appears to be thriving and sustaining a somewhat stable population. The relatively flat, shallow riffles on much of the river provide an abundance of food in the form of invertebrates and forage fish. Spawning habitat is more than adequate, and recent spawning success has been good as evidenced by 84.3 percent of the population being under 5.0 inches.

Catch rates were the highest below the St. Cloud Dam in Sector 1 in the braided, boulder-strewn side channels of the Beaver Islands. Of the smallmouth sampled here 10.7 percent were over 10 inches in total length. Sectors 2 through 4 had an average of 26.0 percent smallmouth bass but only 2.7 percent (10 fish) of 365 captured were over 10.0 inches. Although ranking second by number in catch statistics the smallmouth only comprised 2.1 percent of the total catch by weight.

Carp

In Table 4 , which is a composite view of the fishery survey, the European carp ranks first in all categories except median length. Average weight was 2.7 pounds.

Looking at the individual sectors (Figure 2) the catch percentage of carp is higher than for other species except in Sectors 1 and 2 where it ranks third and second respectively.

Submerged lowlands, tributary creeks and braided stream channels create adequate spawning habitat for carp. No young of year carp were captured suggesting that the young fish utilize tributary streams and adjacent lakes as nursery areas.

Known as a detriment to game fish and waterfowl populations the European carp poses a management problem to the river and the lakes and streams tributary to it.

Northern Redhorse

Another fish of considerable significance is the northern redhorse. Its domain in many of the riffle areas makes it competitive with other riffle inhabiting fish. Feeding on aquatic macrocrustacea and other invertebrates the northern redhorse could be a food and space competitor of the smallmouth bass.

Black Bullhead

Although representing 4.1 percent of the catch the black bullhead does not constitute a significant population by sector, for 85 of the 95 fish sampled were captured below the spillways of the St. Cloud and Coon Rapids dams. Here it competes for forage fish and invertebrates with other tailwater species. Natural reproduction in the river proper would be confined to impounded areas or pools supporting aquatic vegetation. No doubt many of the fish are actually recruited from adjacent lakes.

Black Crappie

Catch percentages for the black crappie should also be noted. Although comprising 4 percent of the catch 76 of the 92 taken were sampled below the Coon Rapids Dam tailwaters.

Walleye

Most of the walleyes sampled were in the confines of deep holes and the tailwaters of the St. Cloud and Coon Rapids dams. During low flows much of the river is quite broad and flat. This predominantly shallow environment is not preferred by walleyes and thus low water levels reduce available habitat. As stated earlier this preference of habitat may also reflect lower catch rates for the walleye than actually exist, due to the limitations of the sampling gear.

Although walleyes made up only 2.0 percent of the catch, by number, in the Upper Mississippi River study area it appears that the suitable spawning sites are present and utilized. The shortage of adjacent nursery areas to spawning grounds and barriers on tributary streams, however, reduce successful reproduction. This situation is antagonized by rapidly fluctuating water levels characterized by excessively high flows during and after spawning. Extreme low flows as early as midsummer often result in isolation and desiccation of off-channel areas. Integrated with these factors are food and space competition with other species, and predation. The cummulative effects constitute a deterrent to the maintenance of an exploitable walleye population.

During the first part of October, walleye fishing pressure below the St. Cloud Dam by bank fishermen was moderate to heavy and many young fish were taken. Angler interest in this species is apparent.

Muskellunge

Although no specimens were captured during the survey their presence in the study area has been documented by angler harvest of an occasional trophy fish. Some natural reproduction is thought to take place but only on a minimal scale. The muskie is native to these waters and interest groups such as Muskies Incorporated together with the D.N.R. have planted fingerlings. Establishment of the muskellunge as a trophy fish will enhance angler incentive and future utilization of the river.

Other Fishes

Species sampled below the Coon Rapids Dam which are not native to the waters above include the channel catfish, American eel, and freshwater drum. The largemouth buffalo was also sampled below the dam and several historical accounts indicate its occasional presence in the upper river (Eddy, Moyle and Underhill 1963).

The channel catfish has been introduced by stocking (1963, and 1974) above the Coon Rapids Dam, but no specimens were collected during the fishery survey. Successful establishment of a naturally propagating population could potentially supplement the sport fishery, however, it is not known what effect this may have on existing fisheries.

Forage Species

Although no seine hauls were made during the survey, five species of minnows and other small fishes were taken by electrofishing which made up 83 percent of the forage fish captured. These five minnows included: logperch, bluntnose minnow, spotfin shiner, troutperch, and Johnny darters.

Thirteen minnow or minnow-like species make up the remaining 17 percent.

Stocking

Up to the present the stocking program in the Upper Mississippi River includes attempts at the establishment of a self-sustaining channel catfish population, a muskie sport fishery and a walleye stocking program to supplement natural reproduction. Current stocking records are as follows:

Wright County

Year	Species	Type	Number
1972	Walleye	fgl.	902
1973	Ch. catfish	fgl.	9,000
1974	Walleye	fgl.	14,500
1974	Muskie	fgl.	600

Anoka County

Year	Species	Type	Number
1963	Ch. catfish	adult	1,000
1974	Ch. catfish	fgl.	15,200

Hennepin County

Year	Species	Type	Number
1975 (Muskies Inc.)	Muskie	fgl.	200

TERRESTRIAL VEGETATION

Approximately 70 percent of the immediate shoreline in the study area of the Mississippi River corridor is wooded. This is exclusive of the many islands, the larger and more elevated of these often having luxuriant growths of bottomland forest species. The upper half of the survey area, from Monticello to St. Cloud, has a larger proportion of the total tree cover due to more prairie type flora on the lower half together with greater encroachment upon shoreline and bluffline by residential development.

Three reasonably distinct vegetation types are evident along the river. These consist of the bottomland woods, upland deciduous woods, and the oak savannah prairie groves with an occasional remnant of open prairie. Of these three types, only the bottomland woods remain very little altered from their natural state. The steep wooded slopes of upland deciduous species and oak grove have also changed very little due to the difficulty in exploiting these areas. Although agricultural activity surrounds the river, much of the corridor itself has retained a sense of remoteness and scenic beauty.

Of the species composing the bottomland woods, the willow is the one most prevelant in those areas of lowest elevation in relation to the river. These are the areas of high water table and frequent inundation. In such places, it was common to see a shoreline bordered with willow spp. in short dense stands rarely exceeding 15 feet in height.

The common species on slightly higher ground were silver maple, American elm, and green ash. Cottonwood was less common. Basswood was occasional throughout the upper half of the study area and

and sometimes was found intermingled with the bottomland associated species. Box elder was occasional throughout the survey as a bottomland forest species and like the basswood sometimes reaches relatively high proportions in small tracts. Grapevine and Virginia creeper were common.

The second type to be discussed is the upland deciduous woods. This classification is in fact a composition of several forest types and intergrades between the bottomland woods, the "Big Woods," and the oak savannah. There is no sharp demarcation between the bottomland forest and upland forest, but rather a gradual blending coinciding with high water marks and soil types, etc. Soil conditions again account for a shift from the upland deciduous woods to oak grove savannah.

The upland deciduous woods are those of the river hills and the higher ground beyond the corridor. Typical species are American elm and white oak, with occasional scattered red cedar and stands of aspen and birch. Northern pin oak are common on the more sandy areas.

Included in the category of upland deciduous woods are a few remaining vestiges of the "Big Woods" which at one time surrounded much of the present study area. This forest is typified by hard maples, basswood, elm, and red oak. The most common tree of secondary size is the ironwood.

Where grazing was not in evidence many of the areas of denser deciduous woods supported a good understory of woody and herbaceous plants. Some of these, such as the dogwood together with the mast producing species, provide good browse and forage for wildlife.

The frequent glacial outwash plains are often characterized by oak savannah with an occasional piece of original prairie. The oak savannah, which is usually comprised of prairie shrubs and grasses and widely-spaced, scrub bur oak, is a transition zone between the deciduous woods and open prairie. The infrequent remnants of prairie are usually found on sheer sand hill slopes for the prairie areas on more level ground were rapidly converted to agricultural purposes. The transition zone of the savannah together with the open prairie form the third vegetation type outlined for purposes of this survey. The eastern side of the river in the Clearwater and Monticello areas contain some of the best examples of prairie vegetation in the study area.

Dutch elm disease was evident in several areas along the river. It seems reasonably certain at this time that the disease will decimate the elm population here as well as other areas of the state. The probable resulting climax will be a filling of their niche by other species presently associated with them in the various forest types.

Oak wilt is another disease affecting the forests in the area between Minneapolis and St. Cloud. The extent and consequences of this disease in relation to the oak forest common along this part of the Mississippi are not certain. The disease is limited in range in Minnesota by climatic factors but the survey area is included. The disease attacks oaks of the red and scarlet-pin group. Oak wilt is a fungal disease very similar to Dutch elm disease and it is likely that the fate of the scarlet-pin oak stands is the same as that of the American elm.

A listing of trees and shrubs and also wild flowers encountered during the autumn reconnaissance is given in Table 18 of the Appendix. Seasonal and temporal variations will reveal many species not listed here to the careful observer.

As with many of our natural areas, the greatest threat to this resource are the inroads being made by private and commercial land developers. The protection afforded by the regulations of the Wild, Scenic, and Recreational Rivers System constitutes a positive step toward natural resource management and preservation, however the assistance of local units of government is essential to maintaining the continuity and integrity of this great resource.

WILDLIFE

Agricultural practices, other than occasional grazing, are not well suited to the terrain of the river corridor. It is because of this that the tree cover and other natural plant communities have been sustained. Even though much of this vegetative cover is confined to a narrow belt along the river, it provides food, shelter, and a corridor for wildlife movement between larger tracts of woodland and other wildlife habitat. Increasing land development will restrict wildlife movements and stress existing populations.

Stream banks and woodlands throughout much of the study area support varying amounts of sumac, hazel, and dogwood intermixed with serviceberries, brambles, grapes and numerous other seed plants utilized by all varieties of animals.

Because of the variety of habitat types the study area of the Mississippi corridor supports a large diversity of bird life. A list including resident summer resident, and transient bird

bird species identified during the autumn reconnaissance is given in Table 17 of the Appendix.

During the survey the river flow was low exposing sand, gravel, and rubble bars. Many of these bars had shore birds and an occasional heron. A number of ospreys were also observed during September and October and bald eagles are known to frequent the river during migration.

As was discussed earlier, in the water quality section, the mercury levels in fish tissue from these waters often exhibit values higher than what is regarded as normal background levels. The effects upon predatory animals of the higher trophic levels utilizing fish and other aquatic organisms are not documented for this area. Herons, ospreys, eagles and mink are some of the animals present in the study area which fall into this classification. The likelihood of sublethal physiological impairment of reproductive capacity has been discussed in the literature (Fimreite, 1971), and it is possible that high concentrations of mercury are being accumulated by predators making heavy use of fish from these waters.

Some other fauna observed during the survey excluding the birds and mammals were spiny softshell turtle, snapping turtle, map turtle, northern prairie skink, garter snake and leopard frog. Twelve orders of insects were represented including terrestrial and aquatic forms.

A variety of small mammals and larger furbearers are associated with the river corridor. This is promoted by the different vegetation types and edge ecotones providing food and cover.

Squirrels, deer and other animals consume the fruits of the pin, white, and bur oaks when in season as well as agricultural crops, and the forage plants and shrubs mentioned earlier in this section. Grey, fox and red squirrels were seen during the survey. Flying squirrels are also known to be present. Cottontail and jack rabbits utilize grasses, legumes, etc. when available and woody plants at other times.

Other mammals include fox, badger, raccoon, skunk, woodchuck, gopher, chipmunk, bats, and various mice, voles, and shrews.

Aquatic furbearers appear limited due to the lack of desired habitat although signs of mink, muskrat, and beaver were noted. Mink are probably the most suited to the area as the lack of emergent vegetation and the rugged restricted nature of the stream channel least affects this species.

Whitetail deer occur throughout the undeveloped reaches of the river corridor. Natural stands of oak, red cedar and occasional windbreaks of evergreens provide winter cover. The Clear Lake Game Refuge supports a healthy herd within its 885 acres.

Varying edge effects create some good summer cover for upland birds. Some ruffed grouse and woodcock are associated with the lowlands and understory thickets while ringneck pheasants occur adjacent to the corridor. Prairie remnants, hayfields, soilbank, small grain cropland and shrub thickets afford food and nesting sites for pheasants.

Waterfowl

Due to the lack of marsh habitat in the study area of the Mississippi River from St. Cloud to Fridley, the waterfowl usage and potential is minimal. Few backwaters and oxbows exist here and aquatic plant and animal species associated with good waterfowl production are in short supply in the river corridor. The river does play some part in providing resting and marginal feeding areas during the spring and fall migration, although this part of the Mississippi cannot be considered as the major artery of migration that it is farther to the south.

Goldeneye's utilize the open water below the Coon Rapids dam during the winter and flocks of mallards were occasionally seen during an autumn reconnaissance. The mallards were more common in some areas, as around Anoka and Fridley, probably because of artificial propagation and the inducements of human feeding. Mallards and wood ducks not associated with areas of human population probably utilize the river for nesting on a limited basis and more commonly for resting area in transit between small lakes and wetland areas outside the river corridor.

Many small lakes, marshes, and lowland areas adjacent to the corridor have deteriorated over the years due to drainage, destructive farming practices, rough fish access through tributary streams and ditches, and improper or insufficient zoning practices. Greatest benefits in waterfowl production would be achieved by the proper management practices in these areas.

PRESENT AND POTENTIAL USES OF THE RIVER

Non-recreational Uses

Power

The Mississippi River in the study area does not serve as a direct source of hydroelectric power although the dams at St. Cloud and Coon Rapids formerly served this purpose. Water for condenser cooling and plant services is appropriated from and returned to the river by the NSP Monticello Nuclear Generating Plant north of Monticello and the United Power Association at Elk River. The NSP SHERCO facility, units 1 and 2, will appropriate up to 38 cubic feet per second from the river. With the addition of the proposed 3 and 4 units, the total water appropriation for NSP SHERCO would be a maximum of 78 c.f.s. Approximately 10 c.f.s. or less would be returned to the river by the four SHERCO units, the rest being lost by evaporation in this primarily closed cycle operation.

Current proposals would place permit restrictions preventing water appropriation from the river by SHERCO when river flows fall below 2,000 c.f.s. This is an amount determined to be the minimum required for drinking water, sewage dilution, and and miscellaneous needs for the Twin Cities Metropolitan Area. At the Anoka gauging station, flows at or below 2,000 c.f.s. occur for one day every two years and up to 120 days every five or six years. This means that a supplementary source of water will be necessary for full-time operation. Some of the problem could be alleviated by discharging more water from the headwaters reservoirs but there are years when the surplus does not exist.

Waste Disposal

According to the Wastewater Disposal Facilities Inventory (MPCA 1974) the river receives treated effluent from sewage treatments works at Anoka, Elk River, Monticello, St. Cloud and the River Bend Mobile Home Park in Otsego Township.

Water treatment wastes and other miscellaneous wastes are discharged to the river from the Monticello nuclear plant after sedimentation.

Wastewater is discharged from the cooling system at SHERCO. With all four units in operation this flow will range from a typical flow of 2.5 c.f.s. to a maximum of 9.5 c.f.s. Total dissolved solids will be approximately 12,000 mg/l of which calcium, magnesium, and sodium sulfates compose the major portion.

Water treatment wastes and other miscellaneous wastes are discharged to the river from the United Power Association facility in Elk River. This discharge is separate from the cooling water discharge and imparts a highly turbid, milky color to the river along the east bank. MPCA staff indicated that a discharge permit was issued in July, 1975 and that construction of facilities to bring this source into compliance is scheduled for 1977.

This plant has been the source of fuel oil leaks to the river but in-plant controls were initiated in the fall of 1975 to alleviate this situation.

Water from the river is used in a gravel dredging and washing operation on the west shore approximately 2.5 miles below the St. Cloud dam.

Irrigation and Water Supply

Consumptive uses of the river include agricultural and residential irrigation and at Fridley the cities of St. Paul and Minneapolis appropriate municipal water supplies.

Recreational Uses

Fishing and Boating

A considerable amount of fishing was being done at the time of the survey particularily below the St. Cloud and Coon Rapids dams. Fishing was primarily by bank fishermen due to the poor navigability of the main river for motorized craft and lack of access points immediately below the dams.

Canoeing, Camping, and Hiking

The entire survey area provides good canoeing and it is expected that this usage will increase. Many reaches of the river have excellent potential for camping and hiking. There are riverside parks offering picnic facilities at Sportsmen's Club Park in St. Cloud, wayside rest parks at Clearwater and Elk River, Elm Creek Park in Champlin, Coon Rapids Dam Park, Riverside Park, and Rice Creek Park in Hennepin County.

CONCLUSIONS AND RECOMMENDATIONS

1. Discharge from the Mississippi Headwaters Reservoirs should not be held to the present guideline minimum at times when adequate reservoir capacity is available and low flow augmentation is desirable. An adjustment of priorities and reservoir operations is necessary to ameliorate low flow conditions.

2. Moderation of high flows and augmentation of low flows would be of great benefit to the biological communities of the river. Augmentation should be considered to be for the benefit of aquatic life only and no present or future design criteria should be contingent upon any additional flow.

3. Future water appropriations must be curtailed and existing appropriations during low flows should be closely scrutinized to ensure adequate municipal supplies and at the same time provide a high level of protection for aquatic life.

4. Present and proposed concentrations of total residual chlorine (TRC) in the Monticello Nuclear Generating Plant cooling water discharge are excessive in respect to their toxicity to aquatic life. As discussed in the text, the

threshold levels developed by Mattice and Zittle (1976) will be greatly exceeded according to current information regarding plant operations. In situ bioassay work should be done concurrently with water chemistry studies in relation to TRC levels and temperature regimes.

5. Serious consideration should be given to constructing an appurtenance at the end of the discharge canal which would serve to keep fish out and more effectively dissipate the effluent plume at the NSP Monticello facility.

6. The protection afforded the Mississippi by the regulations of the Wild, Scenic, and Recreational Rivers System constitutes a positive step toward natural resource management and preservation. Although these regulations will adequately protect many areas along the corridor additional protection in the form of acquisition of title or easement rights is necessary. Many such acquisitions are being studied but this is subject to the capriciousness of state funding and private landowner attitudes. This all points to the vital need for local units of government to become significantly involved in the protection of our natural resources.

7. The provision of wood duck houses along suitable stretches of the river would very likely increase the number of this species.

8. It is strongly recommended that boat launching facilities not be created below the two dams. This will help preserve the quality of the sport for bank fishermen and canoeists and in turn provide more enjoyment for children and senior citizens.

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Table 1- List of Mississippi River tributaries from St. Cloud to Fridley

Name	T.	R.	S.	County	Source	Trib. No.	Flow	Barrier
Rice Creek	30	24	15	Anoka	Locke L.	M-59		
Unnamed Creek	119	21	25	Hennepin	Locke L.	M-60		
Unnamed Creek	30	24	3	Anoka	marsh	M-60.5	Int.	
County Ditch	119	21	13	Hennepin		M-60.6		
Unnamed	31	24	35	Anoka	marsh	M-60.7	Int.	
Coon Creek	31	24	35	Anoka	marsh	M-61		
Unnamed Creek	120	21	33	Hennepin	marsh	M-61.5	Int.	
Elm Creek	120	21	19	Hennepin	Hayden L.	M-62		barrier
Rum River	31	25	12	Anoka		M-63		barrier
Unnamed Creek	120	22	10	Hennepin	marsh	M-63.5	Int.	
Crow River	121	23	36	Wright		M-64		no barrier
Unnamed Creek	121	23	26	Wright	swamp	M-64.5		no barrier
Unnamed Creek	32	26	3	Sherburne	swamp	M-64.6		no barrier
Elk River	32	26	4	Sherburne	Orono L.	M-65		barrier 3/4 mile upstream
Unnamed Creek	32	26	4	Sherburne	pond	M-65.4		
Unnamed Creek	121	23	17	Wright	swamp	M-66.0		
Unnamed Creek	121	23	18	Wright	swamp	M-66.5		
Unnamed Creek	121	24	10	Wright	swamp	M-66.6	Int.	
Unnamed Creek	33	27	32	Sherburne	swamp	M-67	Int.	
Unnamed Creek	121	24	8	Wright	swamp	M-68	Int.	
Unnamed Creek	121	25	12	Wright	swamp	M-68.5		
Otter Creek	121	25	3	Wright	Berham L.	M-69		
Silver Creek	122	26	10	Wright		M-70		
Fish Creek	123	27	35	Wright		M-70.5		
Clearwater River	123	27	35	Stearns		M-71		
Plum Creek	123	27	28	Stearns		M-72		
Johnson Creek	123	27	7	Stearns		M-73		

Table 2 - List of 1974 Mississippi river study sectors

Sector	Location	Legal Description
1	St. Cloud dam to Clearwater S.T. Highway 24 bridge	T. 124 N., R. 28 W., S. 13 T. 34 N., R. 30 W., S. 23
2	Clearwater S.T. Highway 24 bridge to Monticello S.T. Highway 25 bridge	T. 34 N., R. 30 W., S. 23 T. 121 N., R. 25 W., S. 11
3	Monticello S.T. Highway 25 bridge to Elk River Co. Road 130 bridge	T. 121 N., R. 25 W., S. 11 T. 121 N., R. 23 W., S. 10
4	Elk River Co. Road 130 bridge tO Anoka U.S. Highway 52 bridge	T. 121 N., R. 23 W., S. 10 T. 120 N., R. 22 W., S. 19
5	Anoka U.S. Highway 52 bridge to Coon Rapids dam	T. 120 N., R. 22 W., S. 19 T. 119 N., r. 21 W., S. 2
6	Coon Rapids dam to I-694 bridge	T. 119 N., R. 21 W., S. 2 T. 119 N., R. 21 W., S. 36

Table 3 - List of Locations of Electrofishing Stations

Sector	Station	Location
1	a	Just so. of St. Cloud Dam to a spot ¼ mi. downstream on east bank of river. T. 124N, R. 28W, S. 13 to T. 35N R. 31W, S. 12. Approx. 0.5 mi.
	b	1.1 river miles so. of St. Cloud Dam in eastern channel. T. 35N, R. 31W, S. 12 to T. 35N, R. 31W, S. 13. Approx. 0.5 mi.
	c	Directly east of sportsmen club boat access in east channel. T. 35N, R. 31W, S. 13 to T. 124N, R. 28W, S. 36. Approx. 1.0 mi.
	d	Start 2.0 miles up from St. Hwy. 24 bridge in riffle at mid-river. T. 123N, R. 27W, S. 35 to just so. of Clearwater River inlet on west bank of Miss. Approx. 1.7 mi.
2	a	T. 122N, R. 27W, S. 1 to T. 122N, R. 26W, S. 7. From west shore to mid-stream to east shore through and around Big Eddy to west shore. Approx. 1.5 mi.
	b	West bank T. 33N, R. 29W, S. 12 to T. 122N, R. 25W, S. 30 near undeveloped access. Approx. 1.1 mi.
	c	T. 33N, R. 28W, S. 19 from above access 0.6 mi. to T. 122N, R. 25W, S. 32.
	d	From T. 122N, R. 25W, S. 32 east channel to T. 122N, R. 25W, S. 33 adjacent to NSP Monticello plant. Approx. 1.1 mi.
	e	From within discharge canal at NSP Minticello plant T. 122N, R. 25W, S. 33 to a point 1.3 mi. downstream on west bank T. 122N, R. 25W, S. 34.
3	1	South shore, from public access, past the sewage disposal plant to the Section 12 line of T. 121N, R. 24W.
	2	North shore, same length of Station 1.
	3	Mid-river, beginning at sewage plant to end of Stations 1 and 2.
	4	South shore, beginning in Section 18, through Section 7 and part of 8, of T. 121N, R. 24W.
	5	North shore, part of Section 6, T. 32N, R. 27W.
	6	Mid-river, beginning middle of Section 18 to part of Section 17, T. 121N, R. 24W.

Table 3-List of Locations of Electrofishing Stations (continued)

Sector	Station	
3	7	North shore, beginning in Section 31 and ending in 32 of T. 33N, R. 24W.
	8	North shore, beginning in Section 4 of T. 32N, R. 27W, and ending in Section 33 of T. 33N, R. 24W.
	9	South shore, Section 10 of T. 121, R. 24W.
	10	North shore, Section 34 of T. 33N, R. 27W.
	a	(3A)South shore, part of Section 11 of T. 121N, R. 24W.
	b	(4A)Beginning at High Line River crossing on the tip of the island Section 13, T. 121N, R. 24W, for approx. 0.9 mile crossing the main thread of the stream to end on the south shore.
	c	(5A)North shore, part of Section 1, T. 33N, R. 27W, ending in Section 6 of T. 33N, R. 26W.
4	a	East bank, 3.5 mi. downstream from Hwy 101 bridge at mid-riffle T. 32N, R. 26W, S. 14 along main channel to west bank at jct. of Crow R. T. 120N, R. 22W, S. 9 approx. 1.4 mi.
	b	From main channel at Goodin Island T. 121N, R. 22W, S. 30 to T. 120N, R. 22W, S. 9. Approx. 1.5 mi.
	c	From main channel near Cloquet Island T. 120N, R. 22W S. 10 to west bank T. 32N, R. 25W, S. 34. Approx 1.4 mi.
5	a	In area 1.2 mi. N. of Coon Rapids Dam, T. 120N, R. 21W, S 34 to west bank T. 119N, R. 21W, S. 2. Approx. 0.9 mi.
6	a&b	South of Coon Rapids Dam 0.5 mi. run in tailwater area T. 119N, R. 21W, S. 2.
	c	West channel 0.3 mi. up to and near powerhouse. T. 31N, R. 24W, S. 26.
	d	1.0 mi. south of dam T. 31N, R. 24W, S. 35 to 0.9 mi. downstream to Banfill Island, T. 119N, R. 21W, S. 13.

Table 4- Species composition in the Mississippi River from St. Cloud to Fridley as determined by electrofishing in August and October, 1974 (16 hours)

Species		No.	% of catch	wt.	% by wt.	CPE in fish/hr.	Median length in inches
Cyprinus carpio	Carp	681	29.2	1805.4	50.9	42.6	17.0 - 17.9
Micropterus dolomieui	Smallmouth bass	604	25.9	74.6	2.1	37.8	≤ 5.0
Moxostoma macrolepidotum	Northern redhorse	560	24.0	1293.0	36.5	35.1	18.0 - 18.9
Ictalurus melas	Black bullhead	95	4.1	12.7	0.4	5.9	6.0 - 6.4
Pomoxis nigromaculatus	Black crappie	92	4.0	21.0	0.6	5.8	7.0 - 7.4
Moxostoma anisurum	Silver redhorse	77	3.3	202.4	5.7	4.8	20.0 - 20.9
Stizostedion vitreum	Walleye	47	2.0	20.7	0.6	2.9	10.0 - 10.4
Catostomus commersoni	White sucker	44	1.9	39.3	1.1	2.7	14.0 - 14.9
* *Ictalurus punctatus*	Channel catfish	27	1.2	24.9	0.7	1.7	14.0 - 14.9
Ambloplites rupestris	Rock bass	21	0.9	7.0	0.2	1.3	7.5 - 7.9
Lota lota	Burbot	20	0.9	4.8	0.1	1.2	9.0 - 9.4
Lepomis macrochirus	Bluegill	15	0.6	1.2	-	0.9	4.5 - 4.9
Esox lucius	Northern pike	12	0.5	18.7	0.5	0.7	18.0 - 18.9
Perca flavescens	Yellow perch	9	0.4	1.0	-	0.6	3.5 - 3.9
Micropterus salmoides	Largemouth bass	8	0.3	0.5	-	0.5	≤ 5.0
Pomoxis annularis	White crappie	6	0.3	0.8	-	0.4	≤ 3.0
* *Ictiobus cyprinellus*	Largemouth buffalo	5	0.2	13.0	0.4	0.3	16.0 - 16.9
Lepomis gibbosus	Pumpkinseed	3	0.1	0.2	-	0.2	4.5 - 4.9
Ictalurus natalis	Yellow bullhead	2	0.1	0.6	-	0.1	9.0 - 9.4
* *Anguilla rostrata*	American eel	2	0.1	1.1	-	0.1	17.0 - 17.9
Amia calva	Bowfin	1	-	0.9	-	0.1	17.0 - 17.9
* *Aplodinotus grunniens*	Freshwater drum	1	-	0.3	-	0.1	9.5 - 9.9
	Subtotal	2,332	Total	3544.1	Total	145.8	
Hybopsis biguttata	Hornyhead chub	9					
Semotilus atromaculatus	Creek chub	4					
Rhinichthys cataractae	Longnose dace	20					
Notropis cornutus	Common shiner	1					
Notropis spilopterus	Spotfin shiner	72					
Notropis hudsonius	Spottail shiner	31					
Notropis volucellus	Mimic shiner	1					
Notropis dorsalis	Bigmouth shiner	2					
Pimephales promelas	Fathead minnow	2					
Pimephales notatus	Bluntnose minnow	101					
Noturus gyrinus	Tadpole madtom	1					
Fundulus diaphanus	Banded killifish	1					
Labidesthes sicculus	Brook silverside	1					
Percina caprodes	Logperch	108					
Etheostoma nigrum	Johnny darter	44					
Percopsis omiscomaycus	Troutperch	50					
Notropis stramineus	Sand shiner	1					
Hybognathus hankinsoni	Brassy minnow	1					
		2,782					

* Collected below Coon Rapids Dam

Table 5 - Species composition as determined by 2.67 hours of electrofishing in Sector 1 of the Mississippi River from St. Cloud to Clearwater, October 8-10, 1974

Species		No.	Percent of Catch	Weight (lb.)	Percent by Weight	CPE in Fish/Hr.
Cyprinus carpio	Carp	110	22.6	332.7	43.9	41.2
Micropterus dolomieui	Smallmouth bass	159	32.7	27.2	3.6	59.6
Moxostoma macrolepidotum	Northern redhorse	140	28.8	321.6	42.4	52.4
Ictalurus melas	Black bullhead	22	4.5	4.7	0.6	8.2
Pomoxis nigromaculatus	Black crappie	1	0.2	1.0	0.1	0.4
Moxostoma anisurum	Silver redhorse	12	2.5	39.5	5.2	4.5
Stizostedion vitreum	Walleye	15	3.1	10.5	1.4	5.6
Catostomus commersoni	White sucker	10	2.1	16.5	2.2	3.8
Ambloplites rupestris	Rock bass	1	0.2	0.9	0.1	0.4
Lota lota	Burbot	6	1.2	2.2	0.3	2.4
Lepomis macrochirus	Bluegill	1	0.2	0.1	-	0.4
Esox lucius	Northern pike	1	0.2	0.8	0.1	0.4
Perca flavescens	Yellow perch	1	0.2	0.1	-	0.4
Micropterus salmoides	Largemouth bass	6	1.2	0.2	-	2.4
Ictalurus natalis	Yellow bullhead	1	0.2	0.6	0.1	0.4
	Subtotal	486		758.6 Total		182.5 Total
Hybopsis biguttata	Hornyhead chub	2				
Rhinichthys cataractae	Longnose dace	4				
Notropis cornutus	Common shiner	1				
Notropis spilopterus	Spotfin shiner	3				
Notropis hudsonius	Spottail shiner	2				
Pimephales notatus	Bluntnose minnow	1				
Percina caprodes	Logperch	16				
Etheostoma nigrum	Johnny darter	5				
Percopsis omiscomaycus	Troutperch	1				
	Total	521				

Table 6-Species composition as determined by 3.67 hours of electrofishing in Sector 2 of the Mississippi River from Clearwater to Monticello, October 15-17, 1974

Species		No.	Percent of Catch	Weight (lb.)	Percent by Weight	CPE in Fish/Hr.
Cyprinus carpio	Carp	258	41.8	663.0	64.0	56.7
Micropterus dolomieui	Smallmouth bass	179	29.0	15.5	1.5	39.3
Moxostoma macrolepidotum	Northern redhorse	119	19.3	258.8	25.0	26.2
Ictalurus melas	Black bullhead	4	0.6	1.9	0.2	0.9
Pomoxis nigromaculatus	Black crappie	1	0.2	0.6	0.1	0.2
Moxostoma anisurum	Silver redhorse	24	3.9	76.2	7.4	5.3
Stizostedion vitreum	Walleye	1	0.2	0.5	-	0.2
Catostomus commersoni	White sucker	11	1.8	13.6	1.3	2.4
Ambloplites rupestris	Rock bass	4	0.6	1.1	0.1	0.9
Lota lota	Burbot	7	1.1	3.5	0.3	1.5
Lepomis macrochirus	Bluegill	3	0.5	0.3	-	0.7
Esox lucius	Northern pike	1	0.2	1.3	0.1	0.2
Perca flavescens	Yellow perch	1	0.2	0.1	-	0.2
Promoxis annularis	White crappie	4	0.6	0.1	-	0.9
		617 Subtotal		1036.5 Total		135.6 Total
Hybopsis biguttata	Hornyhead chub	4				
Semotilus atromaculatus	Creek chub	4				
Rhinichthys cataractae	Longnose dace	11				
Notropis spilopterus	Spotfin shiner	44				
Notropis hudsonius	Spottail shiner	22				
Notropis dorsalis	Bigmouth shiner	1				
Pimephales promelas	Fathead minnow	2				
Pimephales notatus	Bluntnose minnow	95				
Noturus gyrinus	Tadpole madtom	1				
Percina caprodes	Logperch	56				
Etheostoma nigrum	Johnny darter	23				
		880 Total				

Table 7 - Species composition as determined by 4.55 hours of electrofishing in Sector 3 of the Mississippi River from Monticello to Elk River, August 19-20, 1974

Species		No.	Percent of Catch	Weight (lb.)	Percent by Weight	CPE Fish/Hr.
Cyprinus carpio	Carp	122	23.8	396.1	42.5	33.2
Micropterus dolomieui	Smallmouth bass	117	22.8	13.4	1.4	31.9
Moxostoma macrolepidotum	Northern redhorse	185	36.1	463.2	49.6	50.4
Ictalurus melas	Black bullhead	4	0.8	1.0	0.1	1.1
Pomoxis nigromaculatus	Black crappie	6	1.2	2.4	0.3	1.6
Stizostedion vitreum	Walleye	14	2.7	1.6	0.2	3.8
Moxostoma anisurum	Silver redhorse	14	2.7	38.0	4.1	3.8
Catostomus commersoni	White sucker	11	2.1	4.8	0.5	3.0
Ambloplites rupestris	Rock bass	13	2.5	5.3	0.6	3.5
Lota lota	Burbot	6	1.2	0.6	0.1	1.6
Lepomis macrochirus	Bluegill	8	1.6	1.1	0.1	2.2
Esox lucius	Northern pike	4	0.8	4.5	0.5	1.1
Perca flavescens	Yellow perch	4	0.8	0.3	-	1.1
Micropterus salmoides	Largemouth bass	1	0.2	0.1	-	0.3
Lepomis gibbosus	Pumpkinseed	3	0.6	0.3	-	0.8
Ictaluris natalis	Yellow bullhead	1	0.2	0.3	-	0.3
		513 Subtotal		933.0 Total		139.7 Total
Hybopsis biguttata	Hornyhead chub	2				
Rhinichthys cataractae	Longnose dace	5				
Notropis spilopterus	Spotfin shiner	1				
Notropis hudsonius	Spottail shiner	6				
Notropis dorsalis	Bigmouth shiner	1				
Pimephales notatus	Bluntnose minnow	5				
Labidesthes sicculus	Brook silverside	1				
Percina caprodes	Logperch	3				
Etheostoma nigrum	Johnny darter	7				
Percopsis omiscomaycus	Troutperch	13				
		Total				

Table 8. Species composition as determined by 2.17 hours of electrofishing in Sector 4 of the Mississippi River from Elk River to the Rum River, October 18-22, 1974

Species		No.	Percent of Catch	Weight (lb.)	Percent by Weight	CPE in Fish/Hr.
Cyprinus carpio	Carp	86	32.7	287.7	53.8	39.2
Micropterus dolomieui	Smallmouth bass	69	26.2	16.1	3.1	31.8
Moxostoma macrolepidotum	Northern redhorse	55	20.9	149.5	28.5	25.3
Pomoxis nigromaculatus	Black crappie	8	3.0	1.5	0.3	3.7
Moxostoma anisurum	Silver redhorse	19	7.2	60.0	11.5	8.8
Stizostedion vitreum	Walleye	8	3.0	4.2	0.8	3.7
Catostomus commersoni	White sucker	10	3.8	6.7	1.3	4.6
Ambloplites rupestris	Rock bass	2	0.8	0.6	0.1	0.9
Lota lota	Burbot	1	0.4	0.1	-	0.5
Lepomis macrochirus	Bluegill	1	0.4	0.1	-	0.5
Esox lucius	Northern pike	3	1.1	3.0	0.6	1.4
Perca flavescens	Yellow perch	1	0.4	0.2	-	0.5
		263 Subtotal		523.7 Total		120.9 Total
Hybopsis biguttata	Hornyhead chub	1				
Notropis spilopterus	Spotfin shiner	24				
Percina caprodes	Logperch	32				
Etheostoma nigrum	Johnny darter	6				
Percopsis omiscomaycus	Troutperch	33				
		359 Total				

Table 9. Species composition as determined by 0.83 hours of electrofishing in Sector 5 of the Mississippi River in the impoundment above the Coon Rapids Dam, October 23, 1974

Species		No.	Percent of Catch	Weight (lb.)	Percent by Weight	CPE in Fish/Hr.
Cyprinus carpio	Carp	26	76.5	81.0	97.1	31.3
Micropterus dolomieui	Smallmouth bass	3	8.8	0.3	0.4	3.6
Ictalurus melas	Black bullhead	2	5.9	0.5	0.6	2.4
Esox lucius	Northern pike	1	2.9	0.8	1.0	1.2
Pomoxis annularis	White crappie	2	5.9	0.8	1.0	2.4
		34 Subtotal		83.4 Total		40.9 Total
Fundulus diaphanus	Banded killifish	1				
		35 Total				

Table 10. Species composition as determined by 2.08 hours of electrofishing in Sector 6 of the Mississippi River from the Coon Rapids Dam to the I-694 bridge, October 23-25, 1974.

Species		No.	Percent of Catch	Weight (lb.)	Percent by Weight	CPE in Fish/Hr.
Cyprinus carpio	Carp	85	22.6	136.7	38.5	40.9
Micropterus dolomieui	Smallmouth bass	26	6.9	8.4	2.4	12.5
Moxostoma macrolepidotum	Northern redhorse	61	16.2	112.5	31.7	29.3
Ictalurus melas	Black bullhead	63	16.8	6.5	1.8	30.3
Pomoxis nigromaculatus	Black crappie	76	20.2	13.9	3.9	36.5
Moxostoma anisurum	Silver redhorse	9	2.4	19.9	5.6	4.3
Stizostedion vitreum	Walleye	9	2.4	4.6	1.3	4.3
Catostomus commersoni	White sucker	2	0.5	2.8	0.8	1.0
Ictalurus punctatus	Channel catfish	27	7.2	24.9	7.0	13.0
Ambloplites rupestris	Rock bass	1	0.3	0.3	0.1	0.5
Lepomis macrochirus	Bluegill	2	0.5	0.2	0.1	1.0
Esox lucius	Northern pike	3	0.8	8.9	2.5	1.4
Perca flavescens	Yellow perch	2	0.5	0.1	-	1.0
Micropterus salmoides	Largemouth bass	1	0.3	0.1	-	0.5
Ictiobus cyprinellus	Largemouth buffalo	5	1.3	13.1	3.7	2.4
Anguilla rostrata	American eel	2	0.5	1.1	0.3	1.0
Amia calva	Bowfin	1	0.3	1.0	0.3	0.5
Aplodinotus grunniens	Freshwater drum	1	0.3	0.3	0.1	0.5
		376 Subtotal		355.3 Total		180.0 Total
Notropis hudsonius	Spottail shiner	1				
Notropis volucellus	Mimic shiner	1				
Percina caprodes	Logperch	1				
Etheostoma nigrum	Johnny darter	3				
Percopsis omiscomaycus	Troutperch	3				
Notropis stramineus	Sand shiner	1				
Hybognathus hankinsoni	Brassy minnow	1				
		387 Total				

Table 11- Length-frequency distributions in the Mississippi River between St. Cloud and Fridley (all sectors)

Species and Numbers of Fish in Length Groups

Total Length in Inches	Bowfin	Big-mouth buffalo	White sucker	Silver red-horse	No. red-horse	Carp	Channel catfish	Black bull-head	Yellow bull-head
- 2.9			1	1	3				
3.0 - 3.4			2		3				
3.5 - 3.9									
4.0 - 4.4			1					4	
4.5 - 4.9								6	
5.0 - 5.4				1	1			20	
5.5 - 5.9				2	2			16	
6.0 - 6.4				2				10	
6.5 - 6.9			1	3	3			14	
7.0 - 7.4			1	1	6			8	
7.5 - 7.9			3		4			6	
8.0 - 8.4			2	1	3			9	
8.5 - 8.9			1		5				1
9.0 - 9.4			2		5			2	
9.5 - 9.9			2		4				1
10.0 - 10.4					3	1			
10.5 - 10.9					1		1		
11.0 - 11.4			1			1			
11.5 - 11.9			1	1	1	4	1		
12.0 - 12.9			1	1	1	15	3		
13.0 - 13.9			2		3	48	7		
14.0 - 14.9			7	2	4	65	9		
15.0 - 15.9		2	8	3	5	62	6		
16.0 - 16.9		1	8	3	50	82			
17.0 - 17.9	1	1		3	152	105			
18.0 - 18.9		1		3	182	95			
19.0 - 19.9				8	103	98			
20.0 - 20.9				16	12	58			
21.0 - 21.9				20		23			
22.0 - 22.9				6	1	7			
23.0 - 23.9					1	6			
24.0 - 24.9						4			
25.0 - 25.9					2	3			
26.0 - 26.9						3			
27.0 - 27.9						1			
28.0 - 28.9									
29.0 - 29.9									
30.0 - 30.9									
31.0 - 31.9									
32.0 - 32.9									
33.0 - 33.9									
34.0 - 34.9									
35.0 - 35.9									
36.0 - 36.9									
TOTALS	1	5	44	77	560	681	27	95	2

Table 11-Length-frequency distributions in the Mississippi River between St. Cloud and Fridley (all sectors) (continued)

Species and Numbers of Fish in Length Groups

Total Length in Inches	No. pike	American eel	Yellow perch	Walleye	Small-mouth bass	Large-mouth bass	Pump-kin seed	Blue-gill	Rock bass
- 2.9			1						2
3.0 - 3.4			1						
3.5 - 3.9			3		509	7	1	1	
4.0 - 4.4									1
4.5 - 4.9			1	3			1	7	
5.0 - 5.4				4	1			6	
5.5 - 5.9			1	11	1		1		2
6.0 - 6.4				2	3	1		1	2
6.5 - 6.9				1	4				1
7.0 - 7.4			1	1	15				2
7.5 - 7.9			1		8				3
8.0 - 8.4					16				3
8.5 - 8.9					6				1
9.0 - 9.4				1	6				2
9.5 - 9.9					4				1
10.0 - 10.4				6	1				
10.5 - 10.9				3	2				1
11.0 - 11.4	1			3	2				
11.5 - 11.9	1			3	5				
12.0 - 12.9	1			6	4				
13.0 - 13.9					2				
14.0 - 14.9					4				
15.0 - 15.9		1		1	3				
16.0 - 16.9	1				5				
17.0 - 17.9	2				1				
18.0 - 18.9	2			1	2				
19.0 - 19.9									
20.0 - 20.9	1	1							
21.0 - 21.9	2								
22.0 - 22.9	1								
23.0 - 23.9									
24.0 - 24.9									
25.0 - 25.9				1					
26.0 - 26.9									
27.0 - 27.9									
28.0 - 28.9									
29.0 - 29.9									
30.0 - 30.9									
31.0 - 31.9									
32.0 - 32.9									
33.0 - 33.9									
34.0 - 34.9									
35.0 - 35.9									
36.0 - 36.9									
TOTALS	12	2	9	47	604	8	3	15	21

Table 11 Length-frequency distributions in the Mississippi River between St. Cloud and Fridley (all sectors) (continued)

Species and Numbers of Fish in Length Groups

Total Length in Inches	Black crappie	White crappie	Burbot	Fresh-water drum
- 2.9		4	2	
3.0 - 3.4				
3.5 - 3.9				
4.0 - 4.4	1			
4.5 - 4.9			3	
5.0 - 5.4	1		1	
5.5 - 5.9	9		2	
6.0 - 6.4	7			
6.5 - 6.9	6			
7.0 - 7.4	28		1	
7.5 - 7.9	25	1		
8.0 - 8.4	9			
8.5 - 8.9	5			
9.0 - 9.4			1	
9.5 - 9.9		1	2	1
10.0 - 10.4	1		1	
10.5 - 10.9			1	
11.0 - 11.4				
11.5 - 11.9			1	
12.0 - 12.9			1	
13.0 - 13.9			1	
14.0 - 14.9			1	
15.0 - 15.9				
16.0 - 16.9			2	
17.0 - 17.9				
18.0 - 18.9				
19.0 - 19.9				
20.0 - 20.9				
21.0 - 21.9				
22.0 - 22.9				
23.0 - 23.9				
24.0 - 24.9				
25.0 - 25.9				
26.0 - 26.9				
27.0 - 27.9				
28.0 - 28.9				
29.0 - 29.9				
30.0 - 30.9				
31.0 - 31.9				
32.0 - 32.9				
33.0 - 33.9				
34.0 - 34.9				
35.0 - 35.9				
36.0 - 36.9				
TOTALS	92	6	20	1

Table 12 Length-frequency distributions in Mississippi River between St. Cloud and the Clearwater River, Sector 1, from October 8-10, 1974

Species and Numbers of Fish in Length Groups

Total Length in Inches	White sucker	Silver red-horse	No. red-horse	Carp	Black bull-head	Yellow bull-head	No. pike	Walleye	Small-mouth bass
3.0 - 3.4			2						
3.5 - 3.9									YY
4.0 - 4.4									139
4.5 - 4.9								2	
5.0 - 5.4								1	
5.5 - 5.9					2			4	
6.0 - 6.4					7				
6.5 - 6.9			1		5			1	
7.0 - 7.4					4				
7.5 - 7.9			2		3				2
8.0 - 8.4			1						
8.5 - 8.9			2		1				
9.0 - 9.4			1						
9.5 - 9.9			3			1			
10.0 - 10.4			2					1	1
10.5 - 10.9									
11.0 - 11.4							1		2
11.5 - 11.9			1						4
12.0 - 12.9								5	3
13.0 - 13.9	2		2	3					2
14.0 - 14.9	1		2	11					2
15.0 - 15.9	4	1	1	8					1
16.0 - 16.9	3		13	18					2
17.0 - 17.9			38	18					
18.0 - 18.9		2	50	16					1
19.0 - 19.9			16	19					
20.0 - 20.9		4	3	9					
21.0 - 21.9		5		1					
22.0 - 22.9				1					
23.0 - 23.9				2					
24.0 - 24.9				2					
25.0 - 25.9				2				1	
26.0 - 26.9									
27.0 - 27.9									
28.0 - 28.9									
29.0 - 29.9									
30.0 - 30.9									
31.0 - 31.9									
32.0 - 32.9									
33.0 - 33.9									
34.0 - 34.9									
35.0 - 35.9									
36.0 - 36.9									
TOTALS	10	11	140	110	22	1	1	15	159

Table 12 Length-frequency distributions in Mississippi River between St. Cloud and the Clearwater River, Sector 1, from October 8-10, 1974 (Continued)

Species and Numbers of Fish in Length Groups

Total Length in Inches	Large-mouth bass	Blue-gill	Black crappie	Burbot					
	1								
3.0 - 3.4	4								
3.5 - 3.9	1								
4.0 - 4.4									
4.5 - 4.9									
5.0 - 5.4		1							
5.5 - 5.9									
6.0 - 6.4									
6.5 - 6.9									
7.0 - 7.4				1					
7.5 - 7.9									
8.0 - 8.4									
8.5 - 8.9									
9.0 - 9.4				1					
9.5 - 9.9				1					
10.0 - 10.4			1	1					
10.5 - 10.9									
11.0 - 11.4									
11.5 - 11.9									
12.0 - 12.9				1					
13.0 - 13.9				1					
14.0 - 14.9									
15.0 - 15.9									
16.0 - 16.9									
17.0 - 17.9									
18.0 - 18.9									
19.0 - 19.9									
20.0 - 20.9									
21.0 - 21.9									
22.0 - 22.9									
23.0 - 23.9									
24.0 - 24.9									
25.0 - 25.9									
26.0 - 26.9									
27.0 - 27.9									
28.0 - 28.9									
29.0 - 29.9									
30.0 - 30.9									
31.0 - 31.9									
32.0 - 32.9									
33.0 - 33.9									
34.0 - 34.9									
35.0 - 35.9									
36.0 - 36.9									
TOTALS	6	1	1	6					

Table 13-Length-frequency distributions in the Mississippi River between Clearwater River and Monticello, Sector 2, from October 15-17, 1974

Species and Number of Fish in Length Groups

Total Length in Inches	White sucker	Silver-red-horse	No. red-horse	Carp	Black bull-head	Yellow bull-head	No. pike	Yellow perch	Walleye
			1						
3.0 - 3.4	2							1	
3.5 - 3.9								1	
4.0 - 4.4	1								
4.5 - 4.9									1
5.0 - 5.4									1
5.5 - 5.9			2					1	7
6.0 - 6.4									2
6.5 - 6.9		2			1				
7.0 - 7.4			3		2			1	
7.5 - 7.9	1								
8.0 - 8.4	1	1			1				
8.5 - 8.9			1			1			
9.0 - 9.4	1								
9.5 - 9.9	2		1						
10.0 - 10.4									3
10.5 - 10.9									
11.0 - 11.4	1								
11.5 - 11.9							1		
12.0 - 12.9		1		1			1		
13.0 - 13.9				3					
14.0 - 14.9				7					
15.0 - 15.9		1	1	9					
16.0 - 16.9	1		11	7					
17.0 - 17.9	1		47	22					
18.0 - 18.9			69	16					
19.0 - 19.9			41	27					
20.0 - 20.9		2	7	19					
21.0 - 21.9		6		6			2		
22.0 - 22.9		1		2					
23.0 - 23.9				2					
24.0 - 24.9									
25.0 - 25.9			1						
26.0 - 26.9				1					
27.0 - 27.9									
28.0 - 28.9									
29.0 - 29.9									
30.0 - 30.9									
31.0 - 31.9									
32.0 - 32.9									
33.0 - 33.9									
34.0 - 34.9									
35.0 - 35.9									
36.0 - 36.9									
TOTALS	11	14	185	122	4	1	4	4	14

Table 13 Length-frequency distributions in the Mississippi River between the Clearwater River and Monticello, Sector 2, from October 15-17, 1974 (continued)

Species and Number of fish in Length Groups

Total Length in Inches	Small-mouth bass	Large-mouth bass	Pump-kin-seed	Blue-gill	Rock bass	Black crappie	Burbot		
3.0 - 3.4									
3.5 - 3.9	108	1	1						
4.0 - 4.4					1				
4.5 - 4.9			1	5			2		
5.0 - 5.4				3			1		
5.5 - 5.9			1		2		2		
6.0 - 6.4					1				
6.5 - 6.9					1				
7.0 - 7.4					1	1			
7.5 - 7.9	1				3	1			
8.0 - 8.4	1				1	1			
8.5 - 8.9	1				1	3			
9.0 - 9.4					1				
9.5 - 9.9	3								
10.0 - 10.4									
10.5 - 10.9					1				
11.0 - 11.4									
11.5 - 11.9									
12.0 - 12.9									
13.0 - 13.9									
14.0 - 14.9									
15.0 - 15.9	1								
16.0 - 16.9	1								
17.0 - 17.9									
18.0 - 18.9	1								
19.0 - 19.9									
20.0 - 20.9									
21.0 - 21.9									
22.0 - 22.9									
23.0 - 23.9									
24.0 - 24.9									
25.0 - 25.9									
26.0 - 26.9									
27.0 - 27.9									
28.0 - 28.9									
29.0 - 29.9									
30.0 - 30.9									
31.0 - 31.9									
32.0 - 32.9									
33.0 - 33.9									
34.0 - 34.9									
35.0 - 35.9									
36.0 - 36.9									
TOTALS	117	1	3	8	13	6	6		

Table 13 Length-frequency distributions in the Mississippi River between Monticello and Elk River, Sector 3, from August 19-20, 1974 (continued)

Species and Numbers of Fish in Length Groups

Total Length in Inches	Blue-gill	Rock bass	Black crappie	White crappie	Burbot				
- 2.9		2		4	2				
3.0 - 3.4									
3.5 - 3.9									
4.0 - 4.4									
4.5 - 4.9	1								
5.0 - 5.4	2								
5.5 - 5.9									
6.0 - 6.4									
6.5 - 6.9									
7.0 - 7.4									
7.5 - 7.9									
8.0 - 8.4									
8.5 - 8.9			1						
9.0 - 9.4		1							
9.5 - 9.9		1			1				
10.0 - 10.4									
10.5 - 10.9									
11.0 - 11.4									
11.5 - 11.9					1				
12.0 - 12.9									
13.0 - 13.9									
14.0 - 14.9					1				
15.0 - 15.9									
16.0 - 16.9					2				
17.0 - 17.9									
18.0 - 18.9									
19.0 - 19.9									
20.0 - 20.9									
21.0 - 21.9									
22.0 - 22.9									
23.0 - 23.9									
24.0 - 24.9									
25.0 - 25.9									
26.0 - 26.9									
27.0 - 27.9									
28.0 - 28.9									
29.0 - 29.9									
30.0 - 30.9									
31.0 - 31.9									
32.0 - 32.9									
33.0 - 33.9									
34.0 - 34.9									
35.0 - 35.9									
36.0 - 36.9									
TOTALS	3	4	1	4	7				

Table 14 Length-frequency distributions in the Mississippi River between Monticello and Elk River, Sector 3, from August 19-20, 1974

Species and Numbers of Fish in Length Groups

Total Length in Inches	White sucker	Silver-red-horse	Short-head redhorse	Carp	Black bull-head	No. pike	Yellow perch	Walleye	Small-mouth bass
- 2.9	1	1	2						
3.0 - 3.4									YY
3.5 - 3.9							1		
4.0 - 4.4									156
4.5 - 4.9									
5.0 - 5.4		1	1						
5.5 - 5.9		2							
6.0 - 6.4		2							
6.5 - 6.9			2						1
7.0 - 7.4									5
7.5 - 7.9	1				1				2
8.0 - 8.4			2		3				8
8.5 - 8.9			1						4
9.0 - 9.4			3						2
9.5 - 9.9									
10.0 - 10.4				1					
10.5 - 10.9			1						2
11.0 - 11.4								1	
11.5 - 11.9				2					
12.0 - 12.9				2					
13.0 - 13.9				8					
14.0 - 14.9	4		1	23					
15.0 - 15.9	2	1	1	18					
16.0 - 16.9	3	1	12	38					
17.0 - 17.9		2	25	38		1			
18.0 - 18.9			40	60					
19.0 - 19.9		3	27	34					
20.0 - 20.9		4		19					
21.0 - 21.9		6		9					
22.0 - 22.9		1		3					
23.0 - 23.9									
24.0 - 24.9				1					
25.0 - 25.9			1	1					
26.0 - 26.9				1					
27.0 - 27.9									
28.0 - 28.9									
29.0 - 29.9									
30.0 - 30.9									
31.0 - 31.9									
32.0 - 32.9									
33.0 - 33.9									
34.0 - 34.9									
35.0 - 35.9									
36.0 - 36.9									
TOTALS	11	24	119	258	4	1	1	1	179

Table 14 Length-frequency distributions in the Mississippi River between Elk River and the Rum River, Sector 4, from October 18, 22, 1974 (continued)

Species and Numbers of Fish in Length Groups

Total Length in Inches	Rock bass	Black crappie	Burbot						
3.0 - 3.4									
3.5 - 3.9									
4.0 - 4.4		1							
4.5 - 4.9			1						
5.0 - 5.4									
5.5 - 5.9									
6.0 - 6.4	1	1							
6.5 - 6.9		1							
7.0 - 7.4		1							
7.5 - 7.9		2							
8.0 - 8.4	1	1							
8.5 - 8.9		1							
9.0 - 9.4									
9.5 - 9.9									
10.0 - 10.4									
10.5 - 10.9									
11.0 - 11.4									
11.5 - 11.9									
12.0 - 12.9									
13.0 - 13.9									
14.0 - 14.9									
15.0 - 15.9									
16.0 - 16.9									
17.0 - 17.9									
18.0 - 18.9									
19.0 - 19.9									
20.0 - 20.9									
21.0 - 21.9									
22.0 - 22.9									
23.0 - 23.9									
24.0 - 24.9									
25.0 - 25.9									
26.0 - 26.9									
27.0 - 27.9									
28.0 - 28.9									
29.0 - 29.9									
30.0 - 30.9									
31.0 - 31.9									
32.0 - 32.9									
33.0 - 33.9									
34.0 - 34.9									
35.0 - 35.9									
36.0 - 36.9									
TOTALS	2	8	1						

Table 15 Length-frequency distributions in the Mississippi River between Elk River and the Rum River, Sector 4, from October 18, 22, 1974

Species and Numbers of Fish in Length Groups

Total Length in Inches	White sucker	Silver red-horse	No. red-horse	Carp	No. pike	Yellow perch	Walleye	Small-mouth bass	Blue-gill
3.0 - 3.4			1					50	
3.5 - 3.9									1
4.0 - 4.4									
4.5 - 4.9									
5.0 - 5.4									
5.5 - 5.9									
6.0 - 6.4									
6.5 - 6.9	1	1							
7.0 - 7.4	1		2					4	
7.5 - 7.9	1					1		1	
8.0 - 8.4	1							4	
8.5 - 8.9	1		1						
9.0 - 9.4	1							3	
9.5 - 9.9								1	
10.0 - 10.4			1				1		
10.5 - 10.9							2		
11.0 - 11.4							2		
11.5 - 11.9	1	1					2	1	
12.0 - 12.9				1			1	1	
13.0 - 13.9				1					
14.0 - 14.9	2			5				1	
15.0 - 15.9	1		1	10					
16.0 - 16.9		2	1	8	1			2	
17.0 - 17.9			13	14				1	
18.0 - 18.9			13	15	1				
19.0 - 19.9		3	18	15					
20.0 - 20.9		5	2	6	1				
21.0 - 21.9		3		5					
22.0 - 22.9		4	1	1					
23.0 - 23.9			1	2					
24.0 - 24.9				1					
25.0 - 25.9									
26.0 - 26.9				1					
27.0 - 27.9				1					
28.0 - 28.9									
29.0 - 29.9									
30.0 - 30.9									
31.0 - 31.9									
32.0 - 32.9									
33.0 - 33.9									
34.0 - 34.9									
35.0 - 35.9									
36.0 - 36.9									
TOTALS	10	19	55	86	3	1	8	69	1

Table 15 Length-frequency distributions in the Mississippi River between the Rum River to the Coon Rapids Dam, Sector 5, October 23, 1974 (continued)

Species and Numbers of Fish in Length Groups

Total Length in Inches	Carp	Black bull-head	No. pike	Small-mouth bass	White crappie				
3.0 - 3.4									
3.5 - 3.9									
4.0 - 4.4				1					
4.5 - 4.9									
5.0 - 5.4									
5.5 - 5.9									
6.0 - 6.4									
6.5 - 6.9				1					
7.0 - 7.4				1					
7.5 - 7.9					1				
8.0 - 8.4		1							
8.5 - 8.9									
9.0 - 9.4		1							
9.5 - 9.9					1				
10.0 - 10.4									
10.5 - 10.9									
11.0 - 11.4									
11.5 - 11.9									
12.0 - 12.9									
13.0 - 13.9									
14.0 - 14.9	1								
15.0 - 15.9	1								
16.0 - 16.9	6								
17.0 - 17.9	5		1						
18.0 - 18.9	3								
19.0 - 19.9	3								
20.0 - 20.9	5								
21.0 - 21.9	2								
22.0 - 22.9									
23.0 - 23.9									
24.0 - 24.9									
25.0 - 25.9									
26.0 - 26.9									
27.0 - 27.9									
28.0 - 28.9									
29.0 - 29.9									
30.0 - 30.9									
31.0 - 31.9									
32.0 - 32.9									
33.0 - 33.9									
34.0 - 34.9									
35.0 - 35.9									
36.0 - 36.9									
TOTALS	26	2	1	3	2				

Table 16 Length-frequency distributions in the Mississippi River between the Coon Rapids Dam to I-694, Sector 6, October 23, 25, 1974

Species and Numbers of Fish in Length Groups

Total Length in Inches	Bowfin	Big-mouth buffalo	White sucker	Silver red-horse	No. red-horse	Carp	Channel catfish	Black bull-head	No. pike
3.0 - 3.4									
3.5 - 3.9									
4.0 - 4.4								4	
4.5 - 4.9								6	
5.0 - 5.4								20	
5.5 - 5.9								16	
6.0 - 6.4								8	
6.5 - 6.9								6	
7.0 - 7.4				1	1			1	
7.5 - 7.9					2			1	
8.0 - 8.4								1	
8.5 - 8.9									
9.0 - 9.4					1				
9.5 - 9.9									
10.0 - 10.4									
10.5 - 10.9							1		
11.0 - 11.4						1			
11.5 - 11.9						2	1		
12.0 - 12.9			1		1	11	3		
13.0 - 13.9					1	23	7		
14.0 - 14.9				2	1	18	9		
15.0 - 15.9		2			1	16	6		
16.0 - 16.9		1	1	1	13	5			
17.0 - 17.9	1	1		1	29	8			
18.0 - 18.9		1		1	10	1			1
19.0 - 19.9				2	1				
20.0 - 20.9				1					
21.0 - 21.9									
22.0 - 22.9									1
23.0 - 23.9									
24.0 - 24.9									
25.0 - 25.9									
26.0 - 26.9									
27.0 - 27.9									
28.0 - 28.9									1
29.0 - 29.9									
30.0 - 30.9									
31.0 - 31.9									
32.0 - 32.9									
33.0 - 33.9									
34.0 - 34.9									
35.0 - 35.9									
36.0 - 36.9									
TOTALS	1	5	2	9	61	85	27	63	3

Table 16 Length-frequency distributions in the Mississippi River between the Coon Rapids Dam to I-694, Sector 6, October 23, 25, 1974 (continued)

Species and Numbers of Fish in Length Groups

Total Length in Inches	American eel	Yellow perch	Walleye	Small-mouth bass	Large-mouth bass	Blue-gill	Rock-bass	Black crappie	Fresh-water drum
3.0 - 3.4									
3.5 - 3.9		1		5					
4.0 - 4.4									
4.5 - 4.9		1				1			
5.0 - 5.4			2	1				1	
5.5 - 5.9				1				9	
6.0 - 6.4				3		1		6	
6.5 - 6.9				2	1			5	
7.0 - 7.4			1	5			1	26	
7.5 - 7.9				2				22	
8.0 - 8.4				3				7	
8.5 - 8.9				1					
9.0 - 9.4			1	1					
9.5 - 9.9									1
10.0 - 10.4			1						
10.5 - 10.9			1						
11.0 - 11.4									
11.5 - 11.9			1						
12.0 - 12.9									
13.0 - 13.9									
14.0 - 14.9									
15.0 - 15.9	1		1						
16.0 - 16.9									
17.0 - 17.9									
18.0 - 18.9			1						
19.0 - 19.9									
20.0 - 20.9	1								
21.0 - 21.9									
22.0 - 22.9									
23.0 - 23.9									
24.0 - 24.9									
25.0 - 25.9									
26.0 - 26.9									
27.0 - 27.9									
28.0 - 28.9									
29.0 - 29.9									
30.0 - 30.9									
31.0 - 31.9									
32.0 - 32.9									
33.0 - 33.9									
34.0 - 34.9									
35.0 - 35.9									
36.0 - 36.9									
TOTALS	2	2	9	26	1	2	1	76	1

Table 17 List of the common names of birds observed during the survey

Pied-billed grebe	Common flicker
Great blue heron	Pileated woodpecker
Green heron	Red-headed woodpecker
Mallard	Hairy woodpecker
Wood duck	Eastern wood pewee
Red-tailed hawk	Tree swallow
Broad-winged hawk	Bank swallow
Marsh hawk	Barn swallow
Osprey	Blue jay
American kestrel	Common crow
Ruffed grouse	Black-capped chickadee
Ring-necked pheasant	White-breasted nuthatch
Killdeer	Gray catbird
American woodcock	American robin
Common snipe	Cedar waxwing
Spotted sandpiper	Starling
Lesser yellowlegs	Red-winged blackbird
Herring gull	Northern oriole
Ring-billed gull	Common grackle
Mourning dove	Cardinal
Common nighthawk	American goldfinch
Chimney swift	Dark-eyed junco
Belted kingfisher	White-throated sparrow

Table 18 List of the common names of trees, shrubs, and flowers observed during the survey

American elm	Wild grape
Basswood	Poison ivy
Silver maple	Closed gentian
Box-elder	Bur-marigold
Cottonwood	Great lobelia
Quaking aspen	Harebell
Paper birch	Spotted blazing-star
Bur oak	Spotted touch-me-not
Pin oak	Wild asparagus
Northern red oak	Wild Onion
White oak	Velvet grass
Green ash	Dandelion
Ironwood	Thin-leaved coneflower
Locust	Goldenrod
Red cedar	Butter-and-eggs
American hazel	Milkweed
Red-osier dogwood	Sneezeweed
Sandbar willow	Spotted joe-pye-weed
Wild raspberry	Spiny-leaved sow thistle
Prickly ash	White snakeroot
Sumac	Dock
Dull-leaf indigobush	Wild iris
Creeping juniper	Wild mint
Climbing bittersweet	Woundwort

MISSISSIPPI RIVER

LEGEND

Sector start and/or end — 1 2 sector

Shocking boat Access — S.A.

Shocking run — 1c

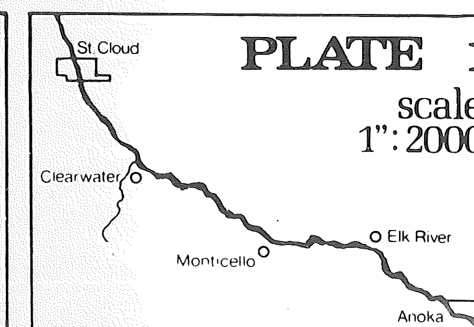

PLATE 1

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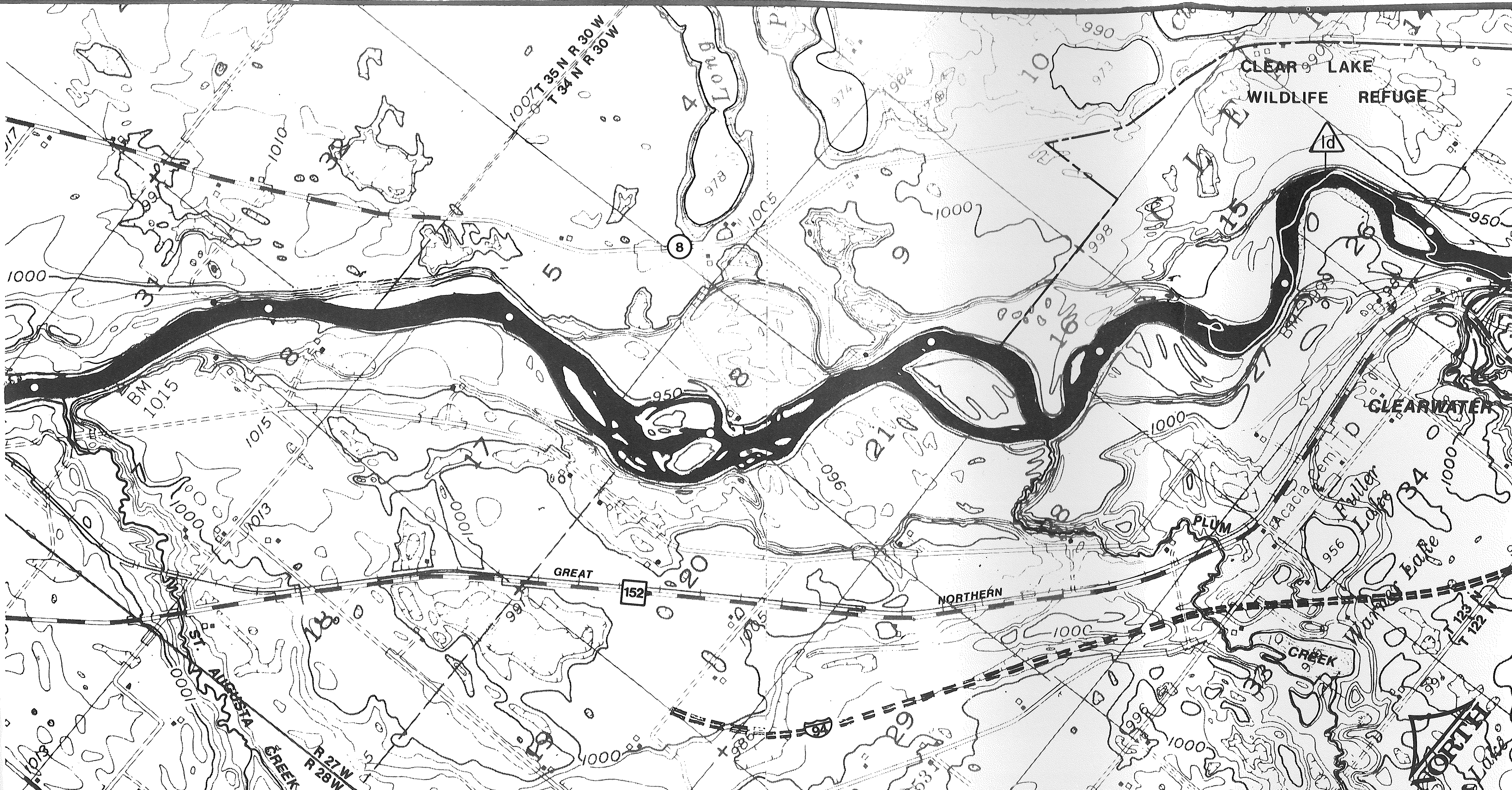

MISSISSIPPI RIVER

PLATE 2
scale:
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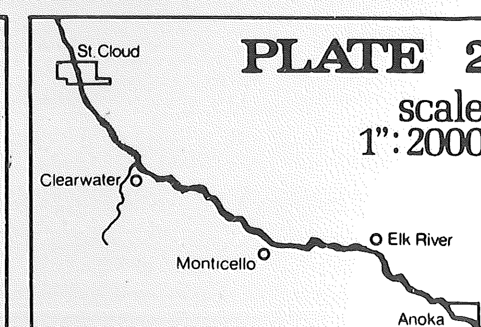

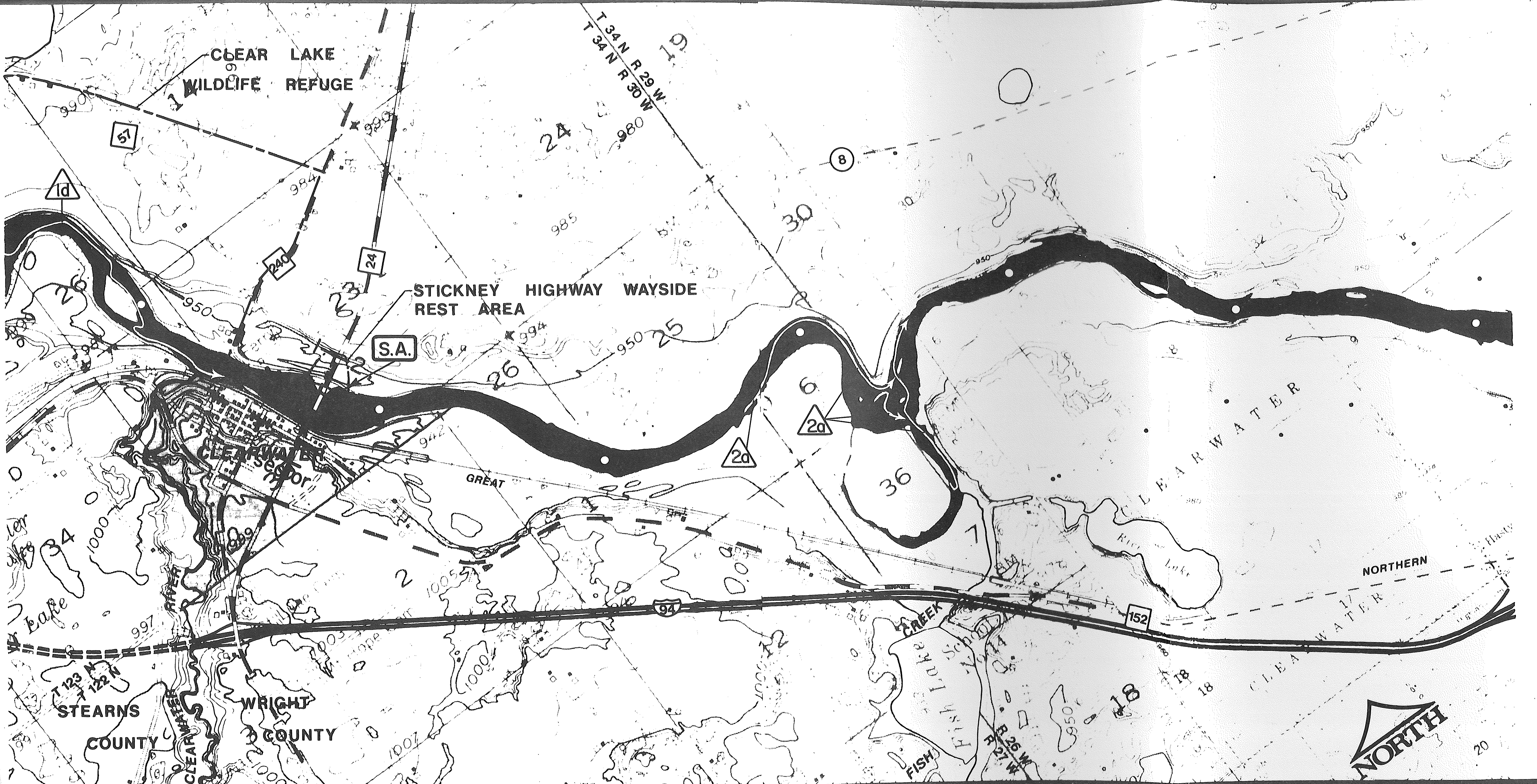

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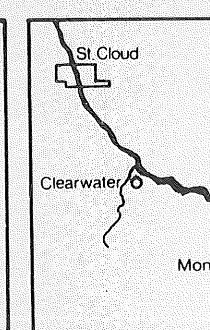

PLATE 3

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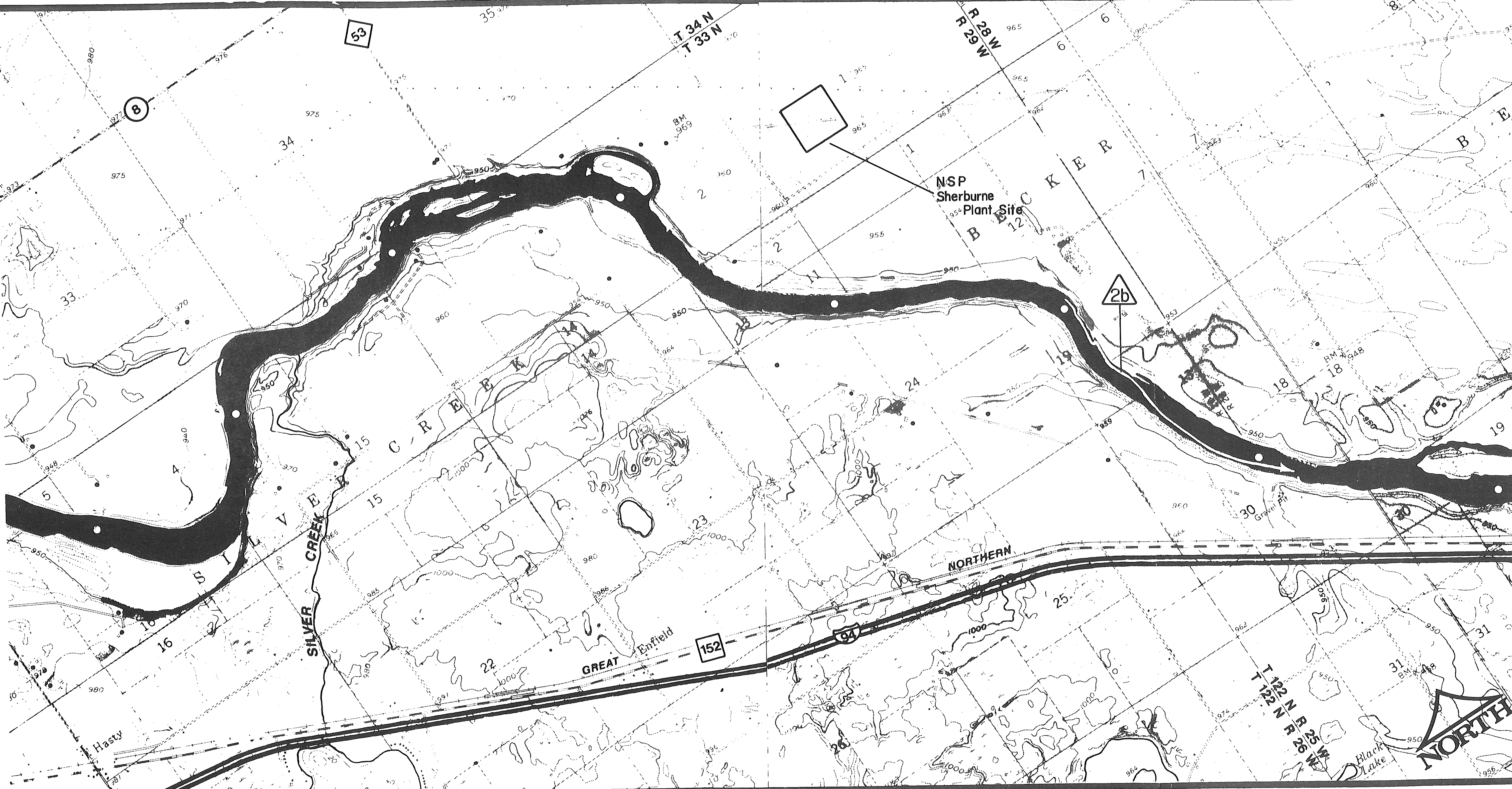

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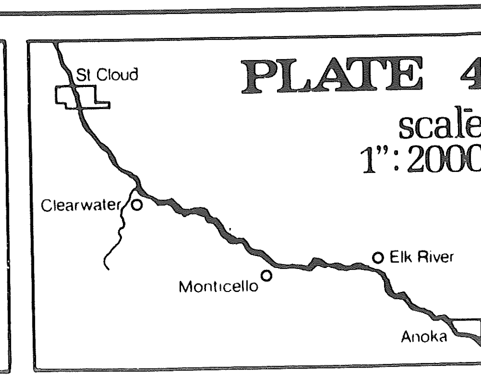

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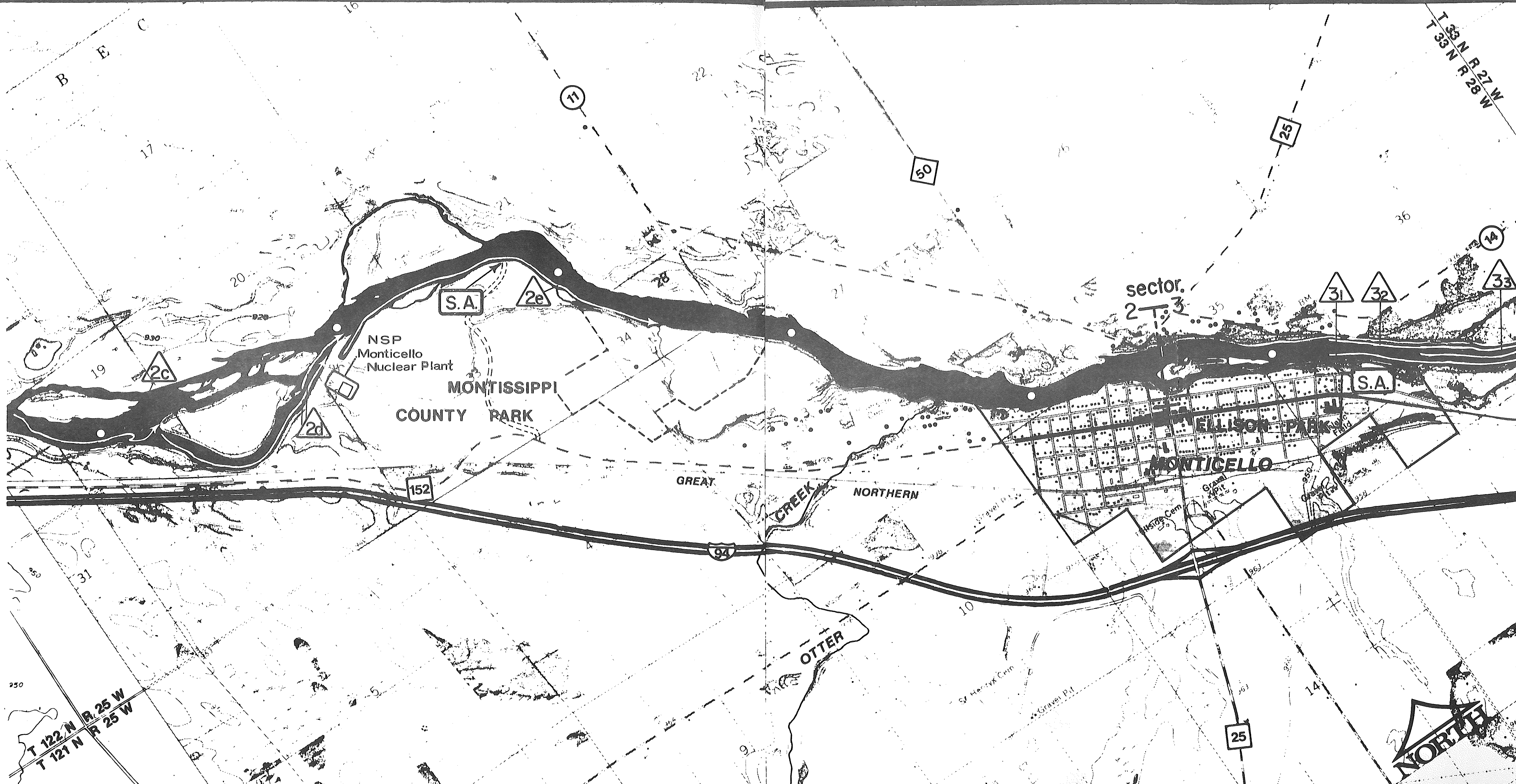

MISSISSIPPI RIVER

PLATE 5

scale:
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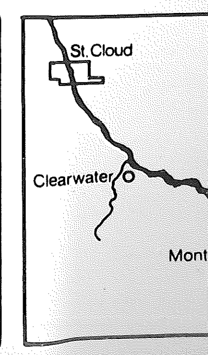

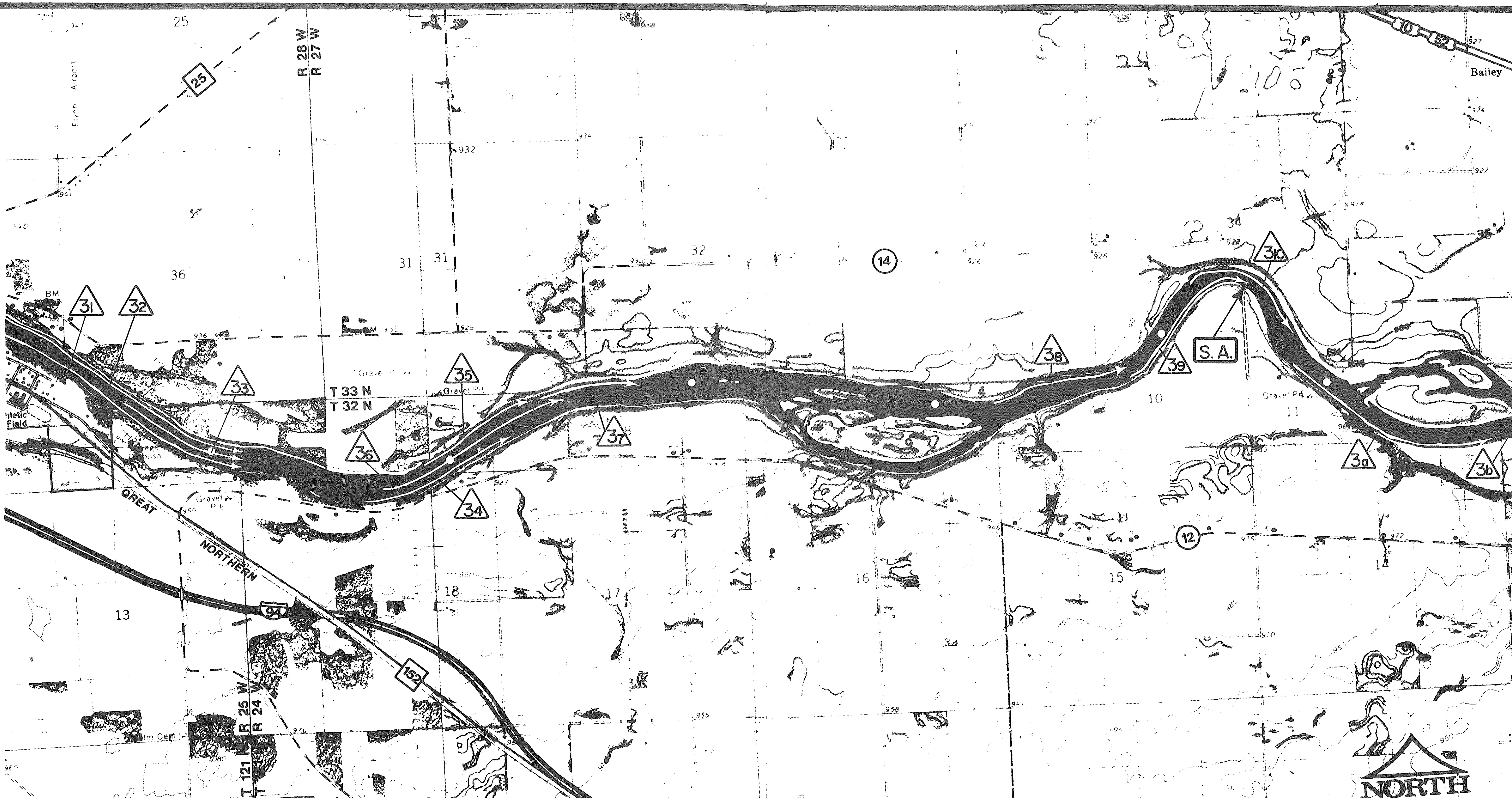

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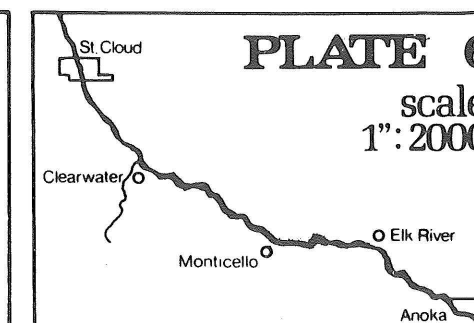

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scale:
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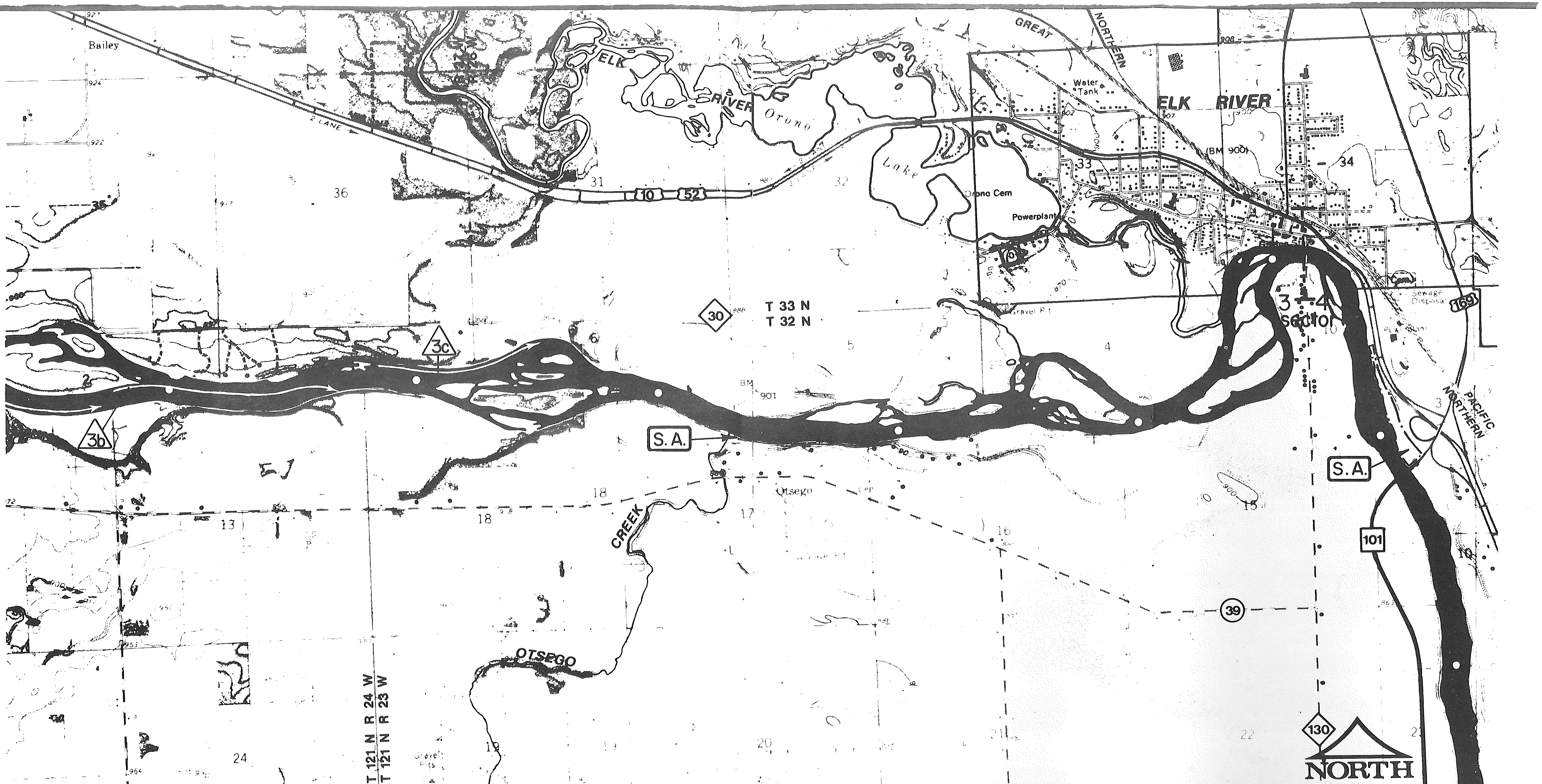

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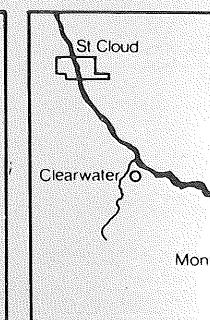

PLATE 7

scale:
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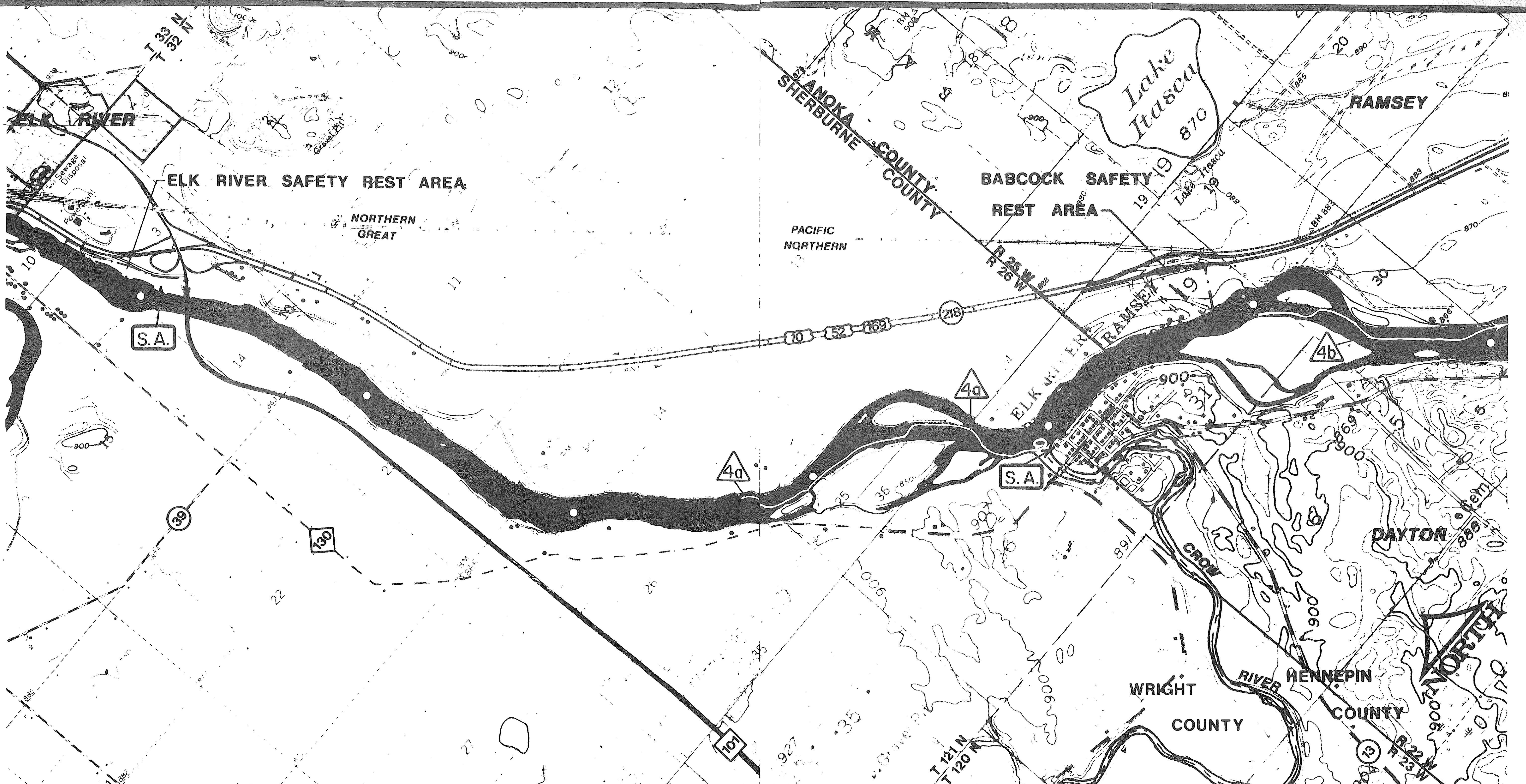

MISSISSIPPI RIVER

PLATE 8

scale:
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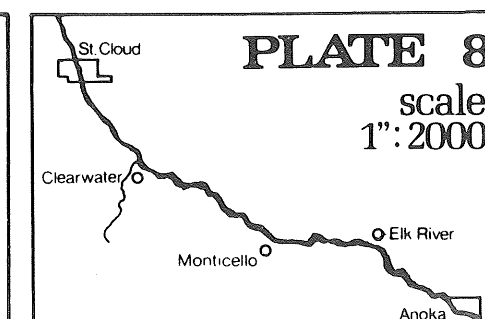
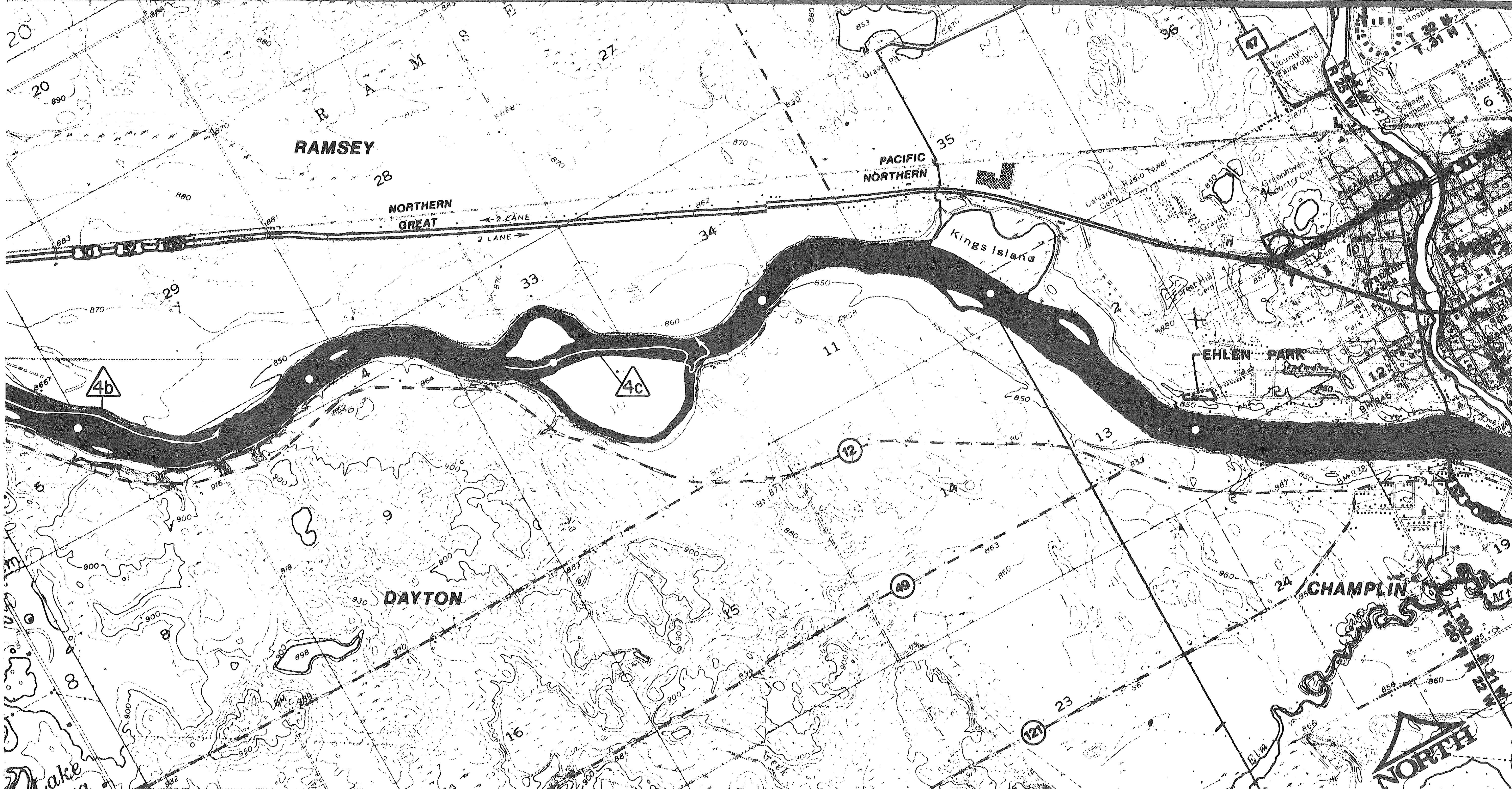
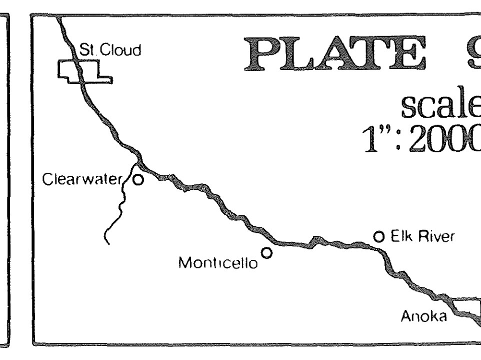
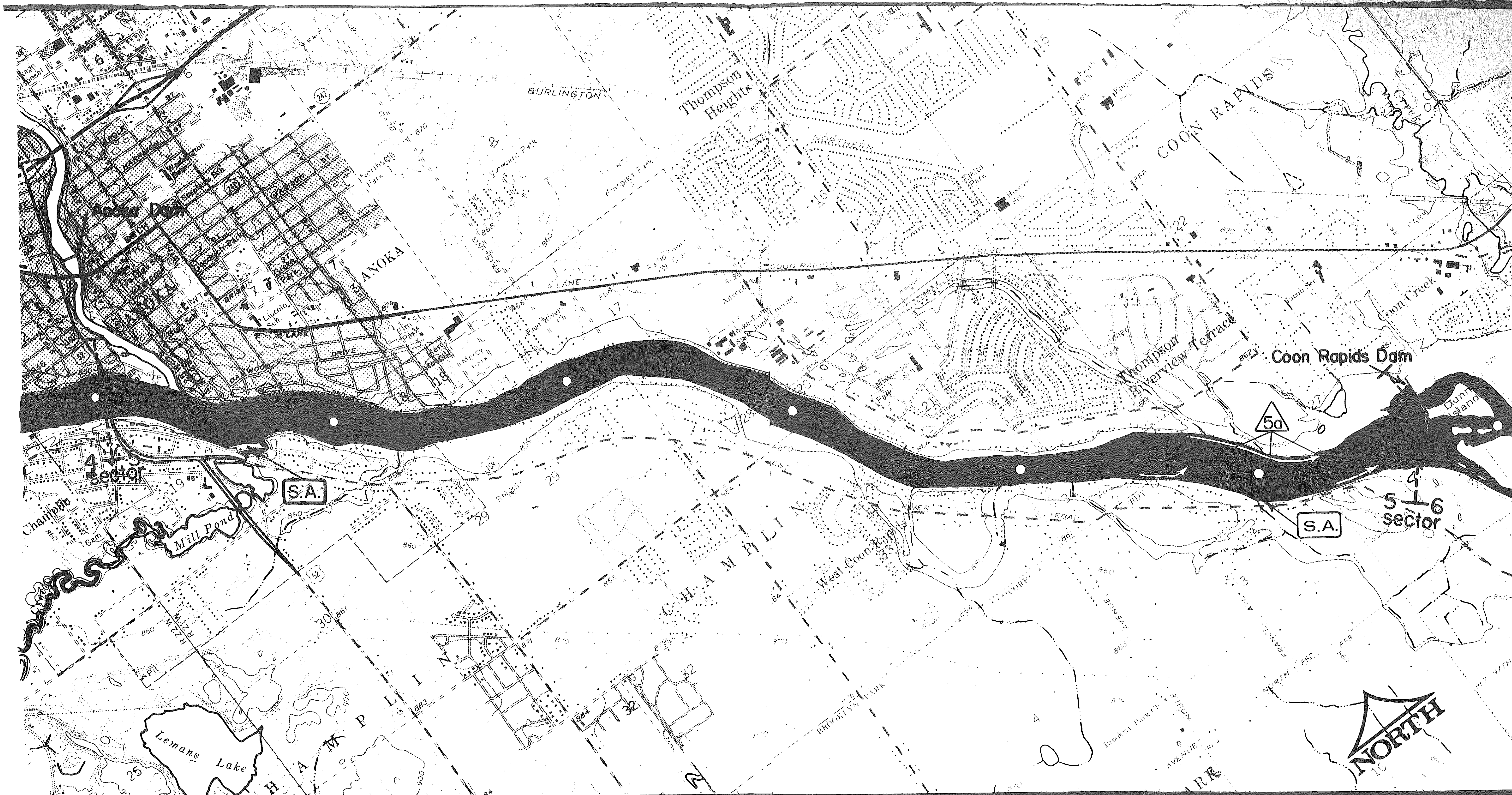


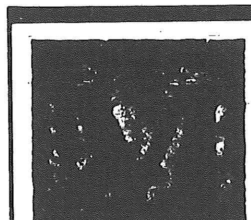




MISSISSIPPI RIVER

PLATE 9
scale:
1": 2000'





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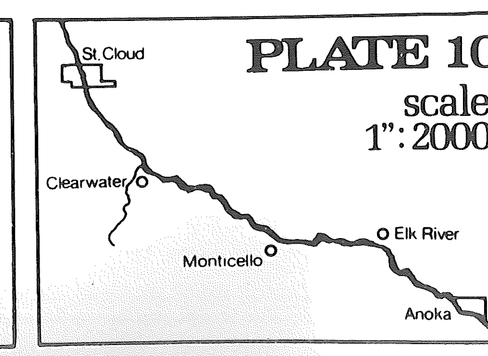
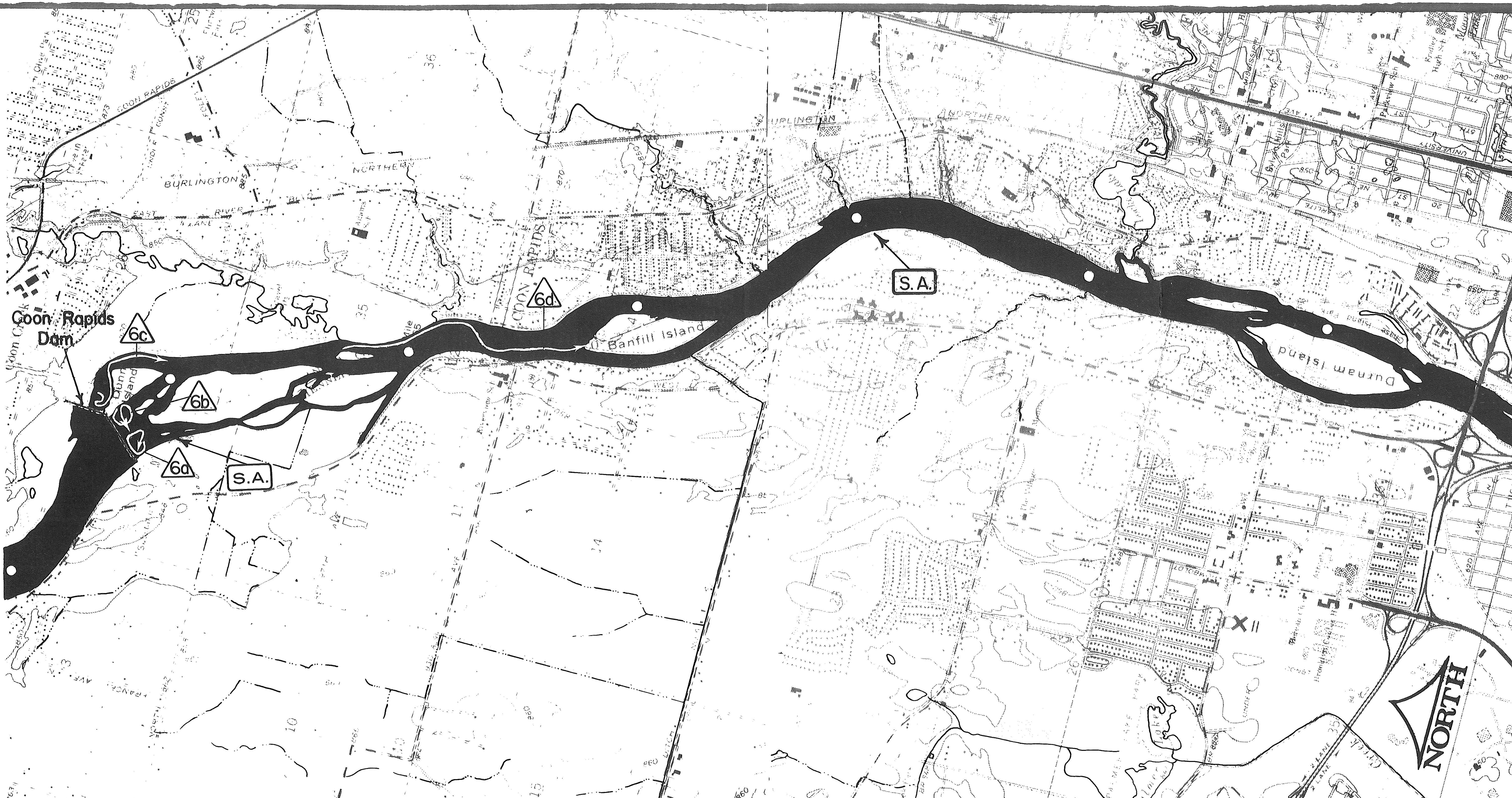
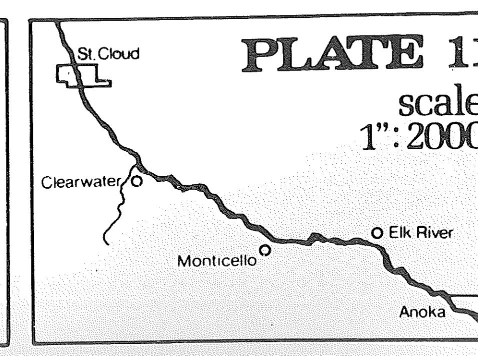


PLATE 10

scale: 1": 2000'





MISSISSIPPI RIVER

PLATE 11

scale: 1":2000'