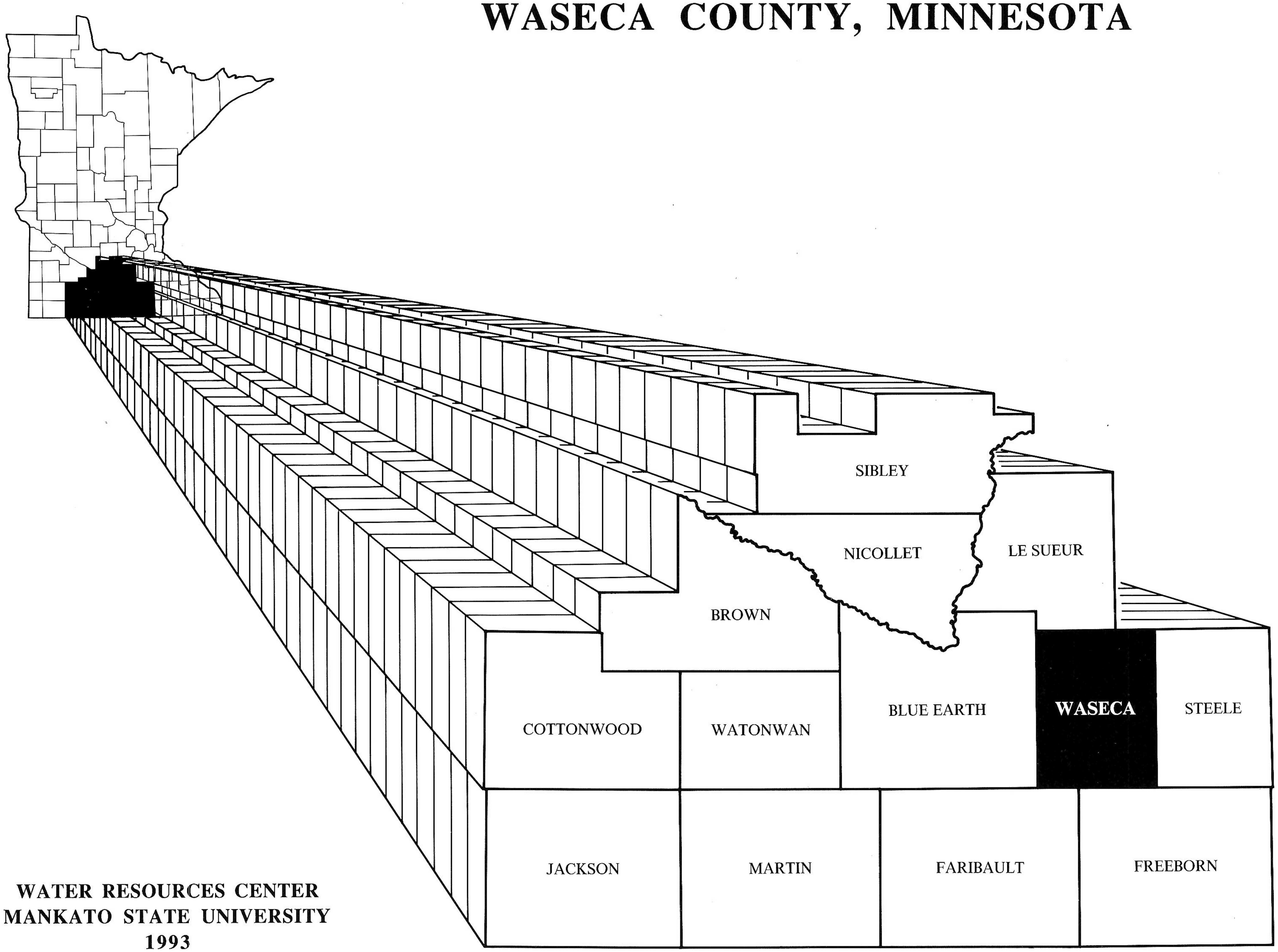
SURFACE WATER HYDROLOGY ATLAS

WASECA COUNTY, MINNESOTA



WATER RESOURCES CENTER
MANKATO STATE UNIVERSITY
1993

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JULY, 1993

The Waseca County Surface Water Hydrology Atlas was prepared and published with the support of a grant from the Legislative Commission on Minnesota Resources and the Waseca County Board of Commissioners. The project involves the production of county surface water hydrology atlases for each of the 13 counties of south central Minnesota and a Geographic Information System (GIS) containing the maps and data presented in this atlas. In addition the GIS contains information on precipitation gauges, demography, and potential point source pollution. A separate lake data base for the 13 counties of South Central Minnesota has also been developed. Principal investigators for the project are John Rongstad, Cis Berg, and Henry Quade.

The following people and agencies have provided valuable assistance to this project by providing information, reviewing or contributing to the content, or by making helpful comments. While their contributions are acknowledged, the responsibility for errors or omissions rests with the principal authors.

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INTRODUCTION

This is one of thirteen surface hydrology atlases that were prepared for the South Central Minnesota Comprehensive County Water Planning Project consisting of Blue Earth, Brown, Cottonwood, Faribault, Freeborn, Jackson, LeSueur, Martin, Nicollet, Sibley, Steele, Waseca, and Watonwan Counties. The basic surface water drainage information presented in these atlases was gathered from the thirteen county participants in the form of county ditch maps. The minor watershed boundaries were obtained from the U.S. Geological Survey Water Resources Division and the Minnesota Department of Natural Resources. Information pertaining to lakes and wetlands was obtained from the National Wetland Inventory. The maps and data presented in this atlas are available in GIS format at the Water Resources Center, Mankato State University. The surface hydrology atlases are the second of two reports on the water resources of south central Minnesota. Subsurface geology and groundwater resources were the subjects of a 13 county atlas series completed in 1991.

The primary objective of the 13 county surface water hydrology mapping project was to map county ditch systems, delineate ditchshed and lakeshed boundaries, and update minor watershed boundaries onto a standard map base. The U.S. Geological Survey 7-1/2 minute topographic map series was chosen as the standard map base for the project. The surface water mapping was coordinated with the St. Paul office of the U.S. Geological Survey Water Resources Division and the Minnesota Department of Natural Resources Division of Waters. Both of these agencies have previously mapped minor watershed boundaries for all or part of the state of Minnesota and are actively involved in updating minor watershed maps. Existing minor watershed boundaries, previously mapped by the USGS and MDNR were incorporated to provide consistent and compatible minor watershed mapping.

Waseca County is located in south central Minnesota, in the second tier of counties north of the Minnesota-Iowa border. The county is rectangular in shape and has an area of approximately 415 square miles. The population of Waseca County, according to the 1990 census (U.S. Bureau of the Census, 1990), was 18,079. The largest center of population is the city of Waseca, containing 8,385 people or about 46 percent of the total. Approximately 65 percent of the total population is located within urban areas that are served by municipal systems; the remaining population is located in rural areas that are served by private or cooperative systems.

PHYSIOGRAPHY AND DRAINAGE

The characteristics of the present land surface in Waseca County, including the topography and nature of surficial materials, are the result of the action of glacial ice and flowing water. The surficial materials are chiefly glacial deposits, collectively called drift, from the continental glaciers that covered Waseca County during the last million years. The continental glaciers were centered over southern Canada and extended into southern Minnesota. These continental glaciers expanded and contracted several times.

The northern and eastern parts of Waseca County are covered by recessional moraines that exhibit a rolling to steep hilly landscape with relief ranging from 10 to 50 feet. In the northern moraine area the hills are circular with flat tops, exhibiting a rolling landscape. In the eastern moraine area the hills are more irregular in shape. The hills are separated by lowlands that serve as drainage ways and contain lakes and other wetlands. The southwestern part of the county contains a nearly level to gently rolling ground moraine that exhibits a local relief of 5 to 25 feet. Along the central edge of the county the relief may be as much as 50 feet where the LeSueur River has carved a valley into the nearly level uplands. Many of the nearly flat areas of the ground moraine are artificially drained to improve agricultural conditions. The highest surface elevation, about 1190 feet mean sea level, is located in the north central portion of the county. The lowest elevation, about 1000 feet mean sea level, is located on the west central edge of the county where the LeSueur River leaves Waseca County to the west. The maximum total relief is approximately 190 feet.

The northeastern corner of Waseca County lies within the Cannon River major watershed. In this area the local drainage is north and east along artificial and natural drainage channels. The southern and eastern portions of Waseca County lie within the LeSueur River major watershed. In this area the regional drainage is form east to west toward the Minnesota River. The local drainage is toward the Cobb River, Little Cobb River, and Bull Run Creek in the southwestern part of the county and toward the LeSueur River, Little LeSueur River, and Boot Creek in the southeastern, central, and northeastern parts of the county (Figure 1).

Figure 1. Major watersheds, drainage channels, and lake basins in Waseca County.

MINOR WATERSHEDS

The Minnesota Department of Natural Resources adopted height-of-land watershed delineation methodology and completed a standard delineation of minor watershed boundaries for the State of Minnesota in 1979. The MDNR defined minor watershed outlets and delineated height-of-land minor watershed boundaries for all watersheds greater than five square miles. Minor watershed boundaries were delineated onto U.S. Geological Survey 7-1/2 minute series topographic maps (1:24,000 scale) for most of the state. For areas of the state that 7-1/2 minute map coverages were not available, minor watershed boundaries were delineated onto U.S. Geological Survey 15 minute series topographic maps (1:62,500 scale).

The U.S. Geological Survey Water Resources Division delineated subsheds for gauging stations and waste treatment outfalls onto 7-1/2 minute topographic maps and reviewed the previously established minor watershed boundary lines for accuracy and consistency of height-of-land delineation within the Minnesota River Basin (1983-84). Data from field investigations and drainage ditch maps were included to improve the accuracy of minor watershed boundary line placement. The purpose was to develop a standard 7-1/2 minute topographic map base to digitize the watersheds into a Geographic Information System.

The Mankato State University Water Resources Center manually copied minor watershed boundary lines from the 7-1/2 minute topographic maps contained in files at the U.S. Geological Survey Water Resources Division and Minnesota Department of Natural Resources Division of Waters. Sheets of matte finish acetate were cut and taped onto the 7-1/2 minute topographic maps and the minor watershed boundaries were traced, using a 0.3 mm pencil, onto the acetate sheets; cross-hair targets drawn over the four corners of the topographic maps. The acetate sheets were removed and attached to paper copies of 7-1/2 minute topographic maps at the Water Resources Center. The minor watershed boundary lines were reviewed for accuracy and consistency of height-of-land delineation on the 7-1/2 minute series topographic maps (1:24,000 scale). For areas where minor watershed boundaries were only available on 15 minute series topographic maps (1:62,500 scale), the minor watershed boundary lines were re-delineated using height-of-land delineation methodology onto 7-1/2 minute topographic maps.

WATERSHED DELINEATION AND MAPPING PROCEDURE

HEIGHT-OF-LAND WATERSHED DELINEATION

The height-of-land method of delineating watershed boundaries requires an interpretation of the surface topography to determine the drainage pattern of surface water flow. The challenge of height-of-land delineation is to determine how precipitation, upon impact with the land surface, will run overland in rivulets and streams to rivers, lakes, or wetlands. The objective is to locate the watershed ridge line along which the surface relief slopes in downhill directions on both sides diverting surface water flow between neighboring watersheds. The chief merit of a height-of-land watershed boundary line is that it provides a physiographic water divide boundary; however, a height-of-land watershed boundary line gives no information about the physical relief over any part of its length.

The position of watershed outlets were located and used as starting points when delineating height-of-land watershed boundaries. Watershed outlets are commonly the confluence points of streams and rivers or lake inlets and outlets. Delineation of a height-of-land watershed boundary line started at the watershed outlet, and working uphill, the watershed line was drawn so that the surface relief would slope in downhill directions on both sides of the watershed boundary line (Figure 2). Water falling inside the watershed boundary line was interpreted to flow to the main drainage channel upstream from the watershed outlet while water falling outside the watershed boundary line was interpreted to flow elsewhere.

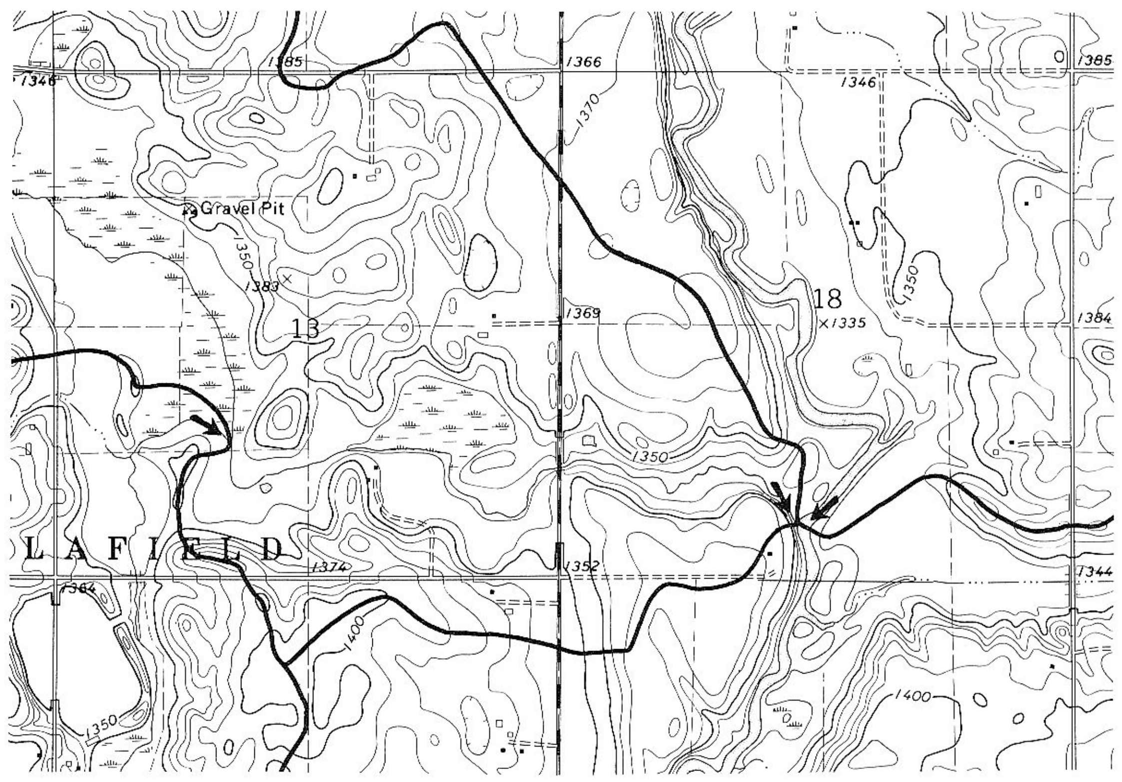


Figure 2. Minor watershed boundary lines that follow height-of-land delineation assessment through contour data on a 7-1/2 minute topographic map. Watershed outlets are marked by arrows (←), showing direction of flow.

Guidelines for height-of-land watershed delineation:

1. Water tends to flow perpendicular across contour lines in the direction of decreasing elevation. Watershed boundary lines should be drawn perpendicular to and not parallel to adjacent contours of different elevation.

2. Ridges are indicated by "V" or "U" shaped contours that point downhill, in the direction of lower elevation. Watershed boundary lines will parallel contour lines of equal elevation along narrow ridges that represent the highest ground.

3. Drainage or water flow courses are indicated by "V" or "U" shaped contours that point uphill, in the direction of increasing elevation.

4. In areas of relatively flat topography that contain few contour lines and no continuous ridges, a watershed boundary line may follow impermeable cultural features such as roadway embankments. Drainage areas can be altered by culverts, storm sewers, or drainage ditch and tile lines.

Watersheds are not immediately discernible from a topographic map and the placement of a height-of-land watershed boundary line is not always apparent: many regions exhibit only subtle physical irregularities that are expressed as highly ambiguous patterns on a topographic map. The 7-1/2 minute topographic maps used in this study show streams, lakes, wetlands, forest vegetation, and a variety of cultural features that helped guide the positioning of watershed boundary lines. The position of watershed boundary lines in areas of relatively flat topography that contain few contour lines and no continuous ridges are more accurately delineated when the existing ditch and tile systems are taken into account.

IMPACT OF DRAINAGE DITCH SYSTEMS ON WATERSHED DELINEATION

The height-of-land delineation of a minor watershed boundary line may not represent the most accurate hydrologic boundary. More accurate hydrologic boundary lines may be determined by plotting the location of subsurface drainage ditch systems that artificially divert water through height-of-land barriers. Minor watershed boundaries that incorporate artificial surface water drainage systems are more accurate and will increase the reliability of assessing the environmental impact of present land use and future changes in land use for local water planning.

Copies of historic and current county drainage ditch maps were obtained by the Water Resources Center from each of the 13 counties. The information from each county drainage ditch map was manually transferred onto acetate sheets that overlay the 7-1/2 minute topographic maps. Open drainage ditches were drawn as solid lines and tile drainage ditches were drawn as dashed lines. Arrows were placed to indicate the direction of water flow through the ditch system. When plotting a drainage ditch line across adjacent topographic maps, the maps were edge-matched and the ditch line was matched up graphically, labeled appropriately, and arrows drawn to indicate direction of flow.

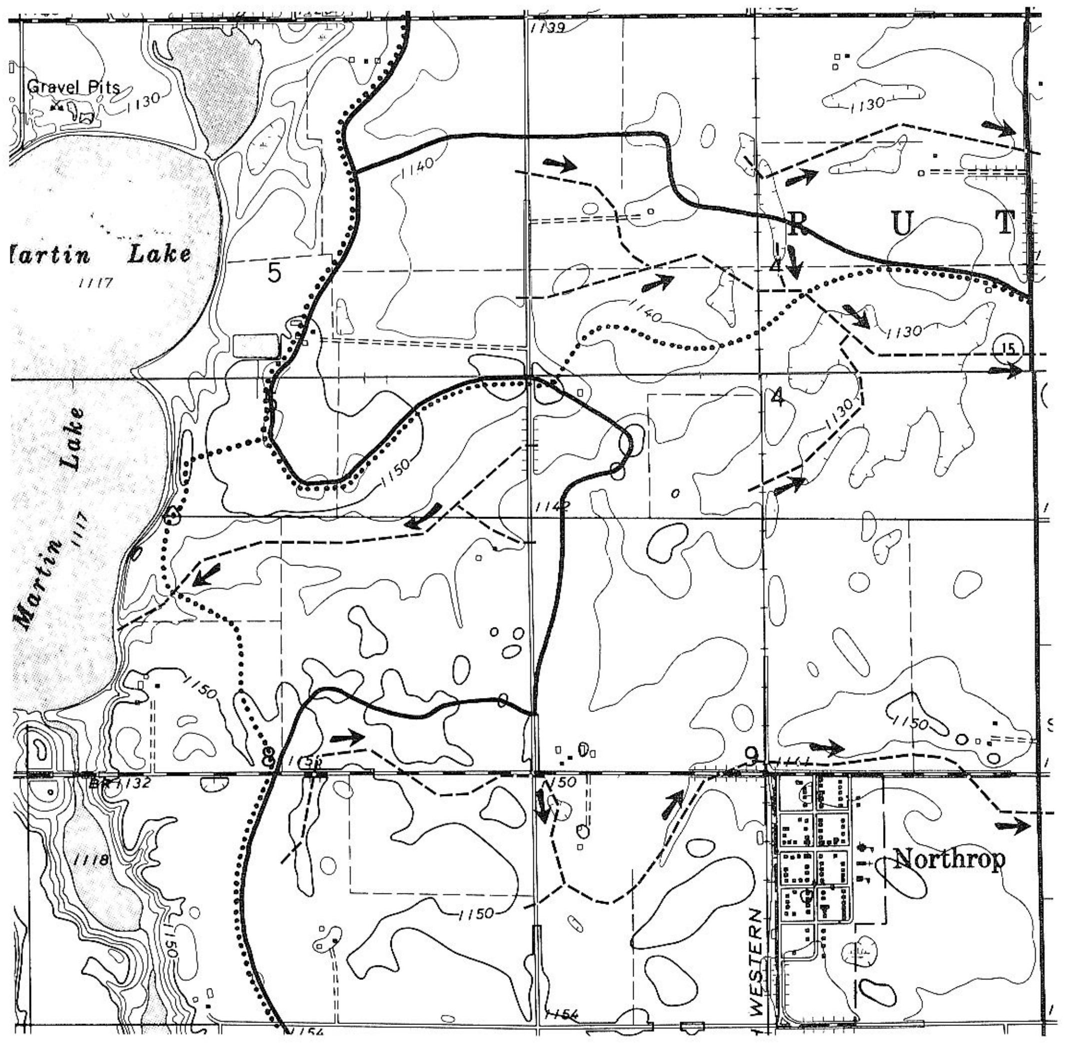


Figure 3. Dotted lines (·····) represent the previously established minor watershed boundary lines. The solid lines (——) represent the minor watershed boundary lines that were redelineated to accommodate county drainage ditches (tile lines). Dashed lines (-----) represent county tile lines. Arrows (←) show direction of water movement through county tile lines.

Minor watershed boundary lines were re-delineated in areas where drainage ditches violate the previously established height-of-land minor watershed boundaries (Figure 3). The re-delineation of minor watershed boundary lines required a comparison of the location of ditchshed lines on the drainage ditch maps with the local topography presented on the 7-1/2 minute topographic maps. The placement of minor watershed boundary lines follow height-of-land interpretation of the local topography. The location of ditchshed lines were used as reference guides in areas where the local topography is such that several height-of-land interpretations of minor watershed boundary lines were equally valid.

DITCHSHED DELINEATION

Ditchshed boundaries were delineated onto the 7-1/2 minute topographic maps after the drainage ditch and tile lines had been mapped and minor watershed boundaries were adjusted to fit the artificial drainage systems. The ditchshed line presented on the ditch map was used for guidance while the placement of ditchshed boundary lines onto 7-1/2 minute topographic maps was determined by height-of-land delineation rules. Ditchshed boundary lines were drawn so that the surface relief and water flow courses were interpreted to channel water toward the open ditch or tile lines on the 7-1/2 minute topographic maps. Delineation of the ditchshed began at the ditch outlet, and working uphill, the ditchshed boundary line was drawn until it intersected a minor watershed boundary line. A ditchshed boundary line will follow an established minor watershed boundary line (Figure 4). The outlet point of a drainage ditch system may be a lake, wetland, stream, another drainage ditch, or the head of a ravine or other natural waterway that leads to a major river, lake, wetland or stream.

Guidelines for delineating ditchsheds:

1. A ditchshed includes all area upstream of the drainage ditch outlet.

2. When a drainage ditch serves as the main drainage channel for two or more minor watersheds, the ditchshed includes the area contained within each of the minor watersheds it drains.

3. The area drained by any natural waterway that outlets into a drainage ditch system is included in the ditchshed.

4. Within a large drainage ditch system there may be numerous tributary drainage ditch systems that outlet into the main channel of the larger ditch system; tributary ditchsheds are included as part of the major ditchshed.

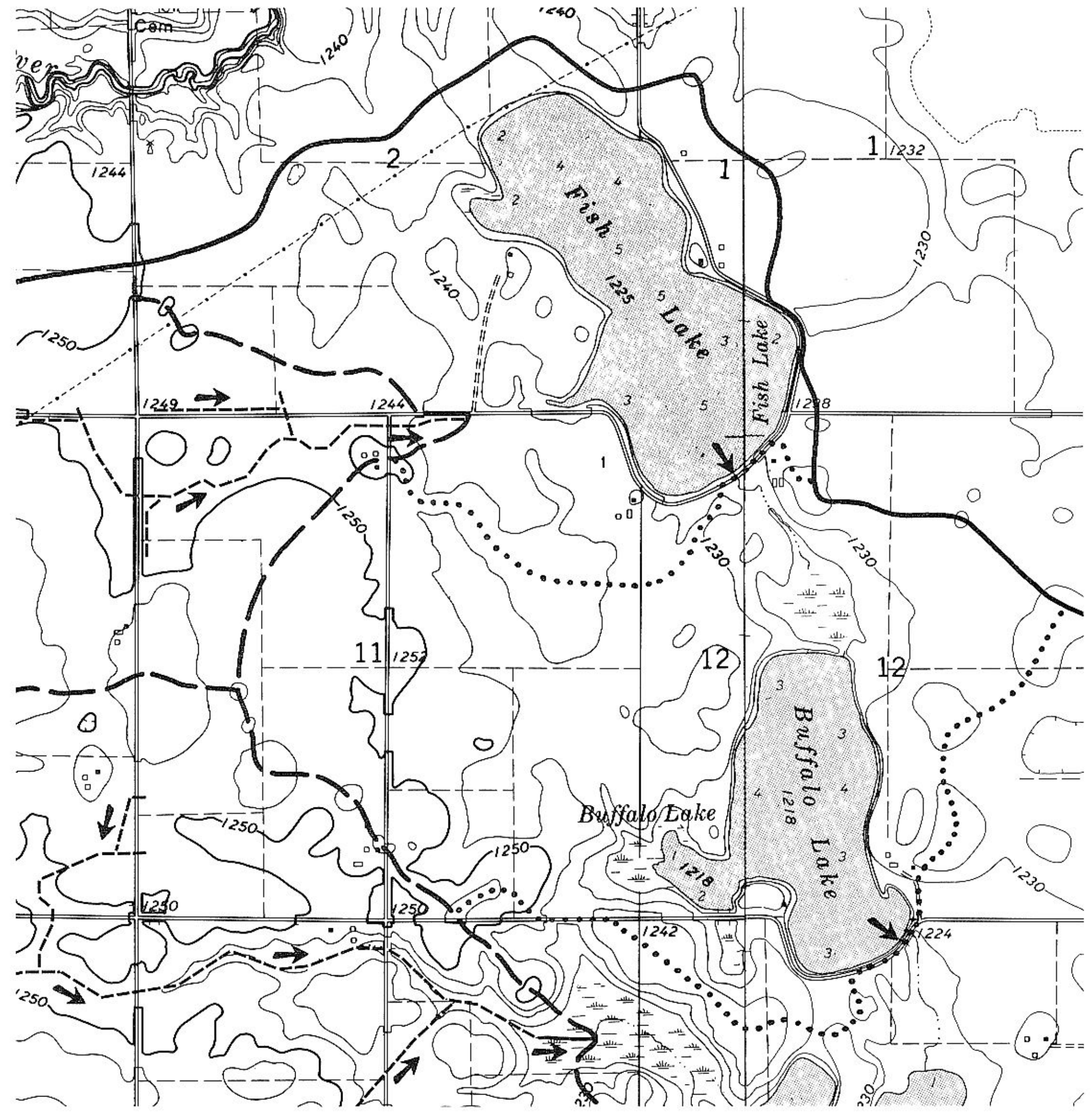


Figure 4. Shows the hierarchical relationship between the three kinds of watershed boundary lines that were delineated onto 7-1/2 minute topographic maps. Minor watershed boundary lines (——) were established first. The ditchshed boundary lines (-—-—), established second, were drawn until they intersected a minor watershed boundary line The lakeshed boundary lines (·······), established last, were drawn until they intersected ditchshed or minor watershed boundary lines. Dashed lines (------) represent county drainage ditch (tile lines). Arrows (←) show direction of water movement through county tile lines.

LAKESHED DELINEATION

Lakeshed boundaries were delineated onto the 7-1/2 minute topographic maps after delineation of the minor watershed and ditchshed boundary lines was completed. The placement of lakeshed boundary lines onto the 7-1/2 minute topographic maps was determined by height-of-land delineation rules. Delineation of the lakeshed began at the lake outlet, and working uphill, the lakeshed boundary line was drawn until it intersected a previously established minor watershed or ditchshed boundary line. A lakeshed boundary line will follow an established minor watershed or ditchshed boundary line (Figure 4).

Guidelines for delineating lakesheds:

1. A lakeshed includes all area upstream of the lake outlet.

2. A lake is sometimes part of a natural waterway, a widening in a major river or stream that serves as the main drainage channel of a minor watershed. The area drained by any natural waterway that outlets into a lake is included in the lakeshed. A lakeshed may be very large, hundreds of square miles, if a major natural waterway outlets into the lake. A lakeshed may be very small, a subshed within a minor watershed, if a main drainage channel does not outlet into the lake.

3. When a drainage ditch system outlets into a lake, the ditchshed will be a subshed within that lakeshed. When a lake outlets into a drainage ditch system, the lakeshed will be a subshed within that ditchshed.

NATIONAL WETLANDS INVENTORY (NWI)

The U.S. Fish and Wildlife Service established the National Wetland Inventory Project (NWI) in 1975. In 1980, the Fish and Wildlife Service adopted a wetlands classification system that was developed with assistance from various government agencies, private groups and individuals (Cowardin et al. 1979). The NWI process was designed to inventory wetlands and determine trends according to standardized environmental characteristics.

The purpose of the NWI was to conduct a nationwide inventory of wetlands, to generate and distribute information on the characteristics and extent of the nations wetlands, and to providing national uniformity in wetland classification and terminology. Federal, state, and local regulatory agencies with jurisdiction over wetlands, generally delineate wetlands in a manner different than that used by the NWI. There is no attempt by the NWI to define the limits of proprietary jurisdiction of any government agency or to establish the geographical scope of the regulatory programs of government agencies.

Remote sensing was the technique selected for inventorying the United States wetlands. The NWI selected high altitude aerial photography as its primary remote sensing tool and established an agreement with NASA to obtain 1:60,000 color infrared aerial photography for the United States. With this imagery the NWI was able to map wetlands, generally between 1-3 acres in size (minimum mapping unit). Stereoscopic analysis of high altitude color infrared aerial photographs makes it possible for an interpreter to identify trees from shrubs and the photo interpreter was not confused by slope, aspects or conditions of the vegetation, shadows, or variations in flooding. The wetlands were identified on the aerial photographs based on visible vegetation, hydrology, and geography. There is a margin of error inherent in the use of aerial photographs as they reflect conditions during the specific year and season when they were taken. Thus, revisions of wetland information established by the NWI may result from field checking and examination of other existing wetland information.

The NWI defines wetlands as being transitional areas between terrestrial and aquatic systems where the water table is usually at or near the surface and where shallow or deep water covers the land. The wetland classification arranges wetlands in a hierarchical system from general to specific. At its most general level the wetland classification divides all wetlands among five major Systems: Marine, Estuarine, Riverine, Lacustrine, and Palustrine. Each of the five major systems are divided by Subsystems which describe hydrologic conditions. Each Subsystem is divided into Classes which further describe the wetland in terms of vegetation or substrate where vegetation is absent.

Principles to use when deciphering the NWI classification system:

The Marine and Estuarine Systems describe coastal area environments that are not present in Minnesota.

The Riverine System (Rivers) contains the deepwater and wetlands associated with river or stream channels. The Riverine System is divided into four Subsystems: Lower Perennial, Upper Perennial, and Intermittent. The Tidal Subsystem is not present in Minnesota and the Intermittent Subsystem may not meet the definition of wetland in some areas.

The Lacustrine System (Lakes) are water bodies that do not contain persistent emergents, trees, or shrubs. The Lacustrine System is divided into two Subsystems: Limnetic (open water) and Littoral (shoreline). Open water bodies are 20 acres or greater in size, but may be smaller than 20 acres if the water bodies are greater than 2 meters (6.6 feet) deep or have a wave-formed shoreline.

The Palustrine System (traditional wetlands) are freshwater areas that do not contain deepwater habitats. These areas support emergent wetland plants where the water is usually at or near the surface or shallow water covers the land. Other areas may contain trees or shrubs.

Vegetated Classes include moss-lichen, aquatic beds, emergent, scrub-shrub, and forested. Vegetation must have 30 percent aerial coverage to be classified. Forested and scrub-shrub are differentiated by vegetation height; forest vegetation is greater than 20 feet tall.

Substrate Classes include rock bottom, rocky shore, unconsolidated bottom, unconsolidated shore, stream bed, and reef. Unconsolidated bottom and shore may be gravel, sand, mud, or organic. Rock bottom and shore are composed of 10 inch diameter or larger rocks.

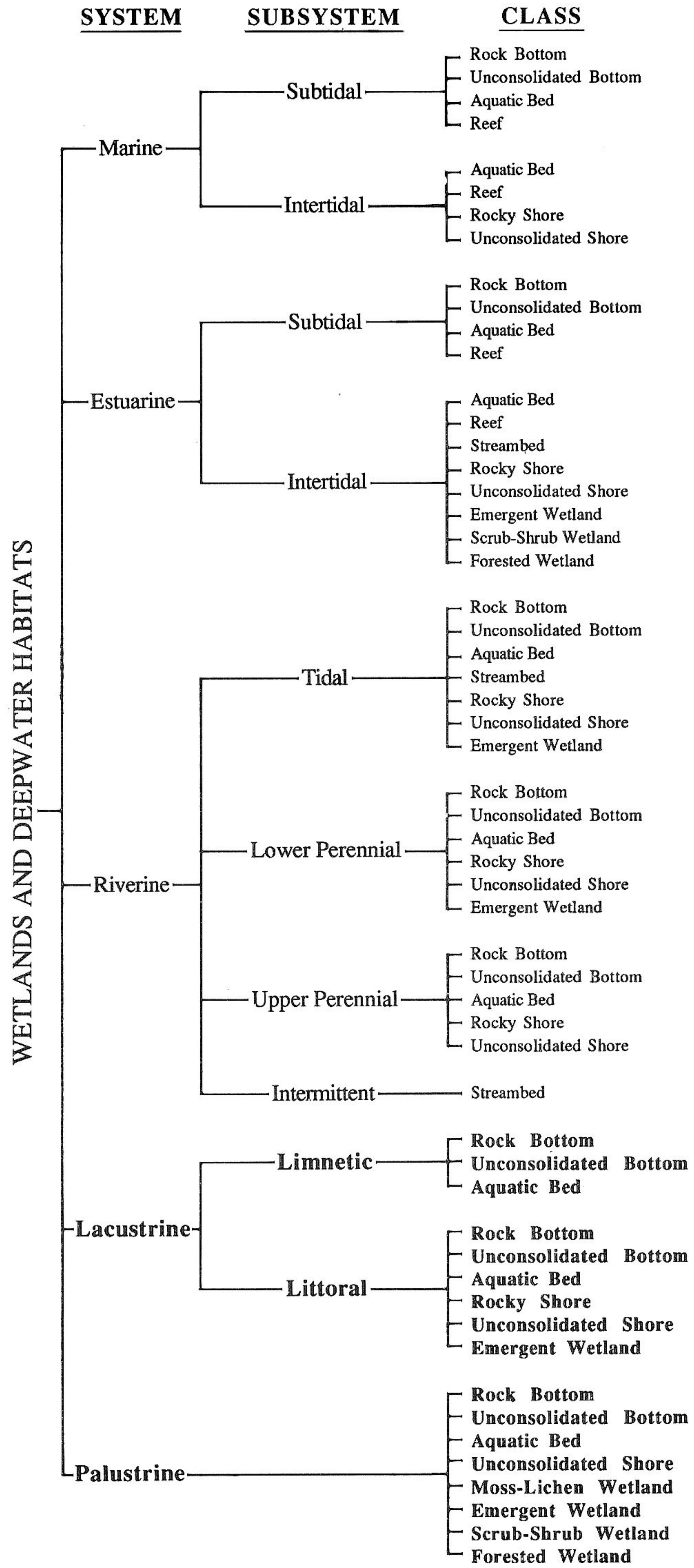


Figure 5. Breakdown of NWI classification of wetlands and deepwater habitats showing relationship between systems, subsystems, and classes. In south central Minnesota wetland habitats include the Riverine, Lacustrine, and Palustrine systems; only the Lacustrine and Palustrine systems are presented on the maps in this atlas (printed in bold above).

GENERAL LAND SURVEY

To Native American people the land was not something to be owned by an individual person but was something to be used and shared. Because people of European ancestry thought about land as something they could own, the United States government had to devise an orderly system to describe the boundaries of each piece of land in terms which could be understood by settlers on the frontier. The system devised by the federal government was called the Land Ordinance of 1785, more commonly known as the United States Public Land Survey System (USPLS). The USPLS was based upon a rectangular grid system that partitioned the land into parcels that gave a checkerboard appearance to maps of the land. In Minnesota the first survey of government lands started in 1848 and the last survey crews finished in the 1890's. In south central Minnesota much of the land survey was done at the time when Minnesota was entering the union in 1858.

The U.S. Public Land Survey began at an initial starting point that was arbitrarily selected. The parallel (base line) and meridian (principal meridian) which intersected at the initial starting point was determined by field survey. Southern Minnesota was surveyed west from the 5th principal meridian and north from an initial starting point and base line located in Arkansas. Township lines were surveyed at six mile intervals east of the 5th principal meridian and range lines were surveyed at six mile intervals north of the base line in Arkansas. Each township was precisely described by numbers, for example, Township 102 North, Range 32 West, 5th Principal Meridian meant that the township was located 102 times six miles north of the base line in Arkansas and 32 times six miles west of the 5th meridian. The surveyor townships were divided into 36 square mile parcels of 640 acres each, called sections. Each section could be further divided into halves, quarters, or smaller fractional parts. Since meridian lines converge toward the North Pole, a square grid could not be surveyed indefinitely outward from the initial starting point. The western row and northern tier of sections in each township were distorted in shape and area to compensate for meridian convergence.

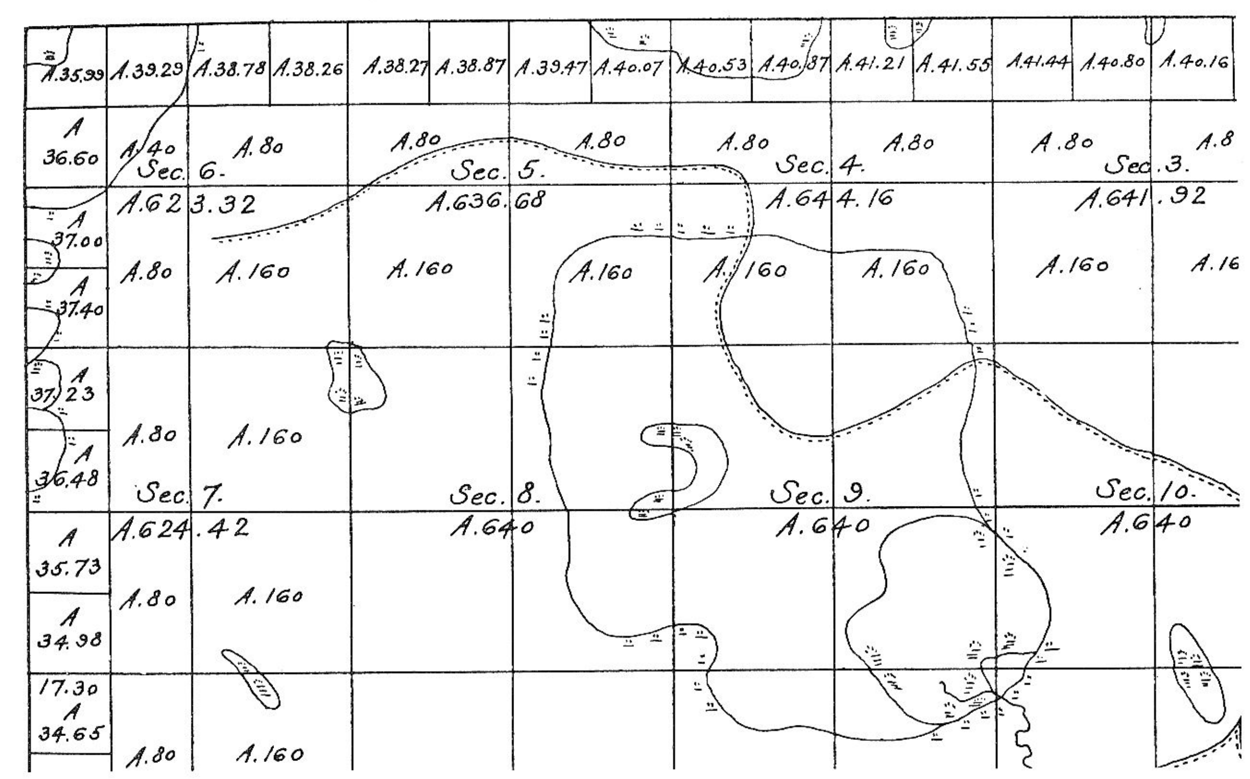


Figure 6. Detail of the US Public Land Survey plat map of Township 107 North Range 23 West 5th Principal Meridian, Sections 3 through 10. The plat map shows sections 3 through 10. The total number of acres that were surveyed for each section have been recorded below the section numbers that are located near the section centers. Note: sections 8, 9, and 10 each contain 640 acres; sections 3 and 4 each contain more than 640 acres; sections 5, 6, and 7 each contain less than 640 acres. The western row and northern tier of quarter-quarter sections were distorted in shape and area to compensate for meridian convergence or survey errors.

Surveyors were required to record all landmarks that lay in the path of the section lines and to note import resources within each section. In south central Minnesota the surveyors noted and mapped rivers, streams, marshes, wetlands, lakes, prairie, woodlands, and other natural resources. As the surveyors laid down townships and sections, the survey crews built monuments to mark the corners of each township and section, and to record the distance and direction to all major landmarks from the monuments. People who came later could look for the landmarks, locate the monuments, and determine the section line. Eventually surveyors took all of their records and information they had noted and drew maps of each township. The land office used the surveyors maps and notes to make the official plat maps of each township.

Errors in the original Public Land Survey occurred due to poor instrumentation, rugged terrain, or sloppy work on the part of the surveyors. These survey errors are allowed to persist because the historical survey lines hold legal precedence over new survey lines. The survey errors of the original US Public Land Survey grid are best expressed on USGS 7-1/2 minute topographic series quadrangle maps. On these maps, township, range, and section lines show that the USPLS section line grid are not always well surveyed squares or rectangles.

INTERPRETING ATLAS MAPS

SURFACE WATER HYDROLOGY MAPS

Preparation of the Surface Water Hydrology maps presented in this atlas required the evaluation of information concerning the land surface topography, natural waterways, and artificial drainage ditch systems. A Surface Water Hydrology map was constructed for each surveyor township at 1:32,000 scale. The Surface Water Hydrology maps include information on minor watersheds, ditchsheds, lakesheds, county drainage ditch systems, and area wetlands (NWI). U.S. Geological Survey 7-1/2 minute series topographic maps are printed as the background base for each Surface Water Hydrology map.

MINOR WATERSHED IDENTIFICATION

Minor watershed boundaries are delineated on the Surface Water Hydrology maps as thick black lines and are labeled along the edge of each Surface Water Hydrology map with a unique five digit minor watershed identification number that was assigned by the MDNR in 1981 (Figure 7). The minor watershed boundary lines follow the height-of-land delineation rules described on page 2 in this atlas; the height-of-land assessment is based upon contour data presented on USGS 7-1/2 minute series topographic maps.

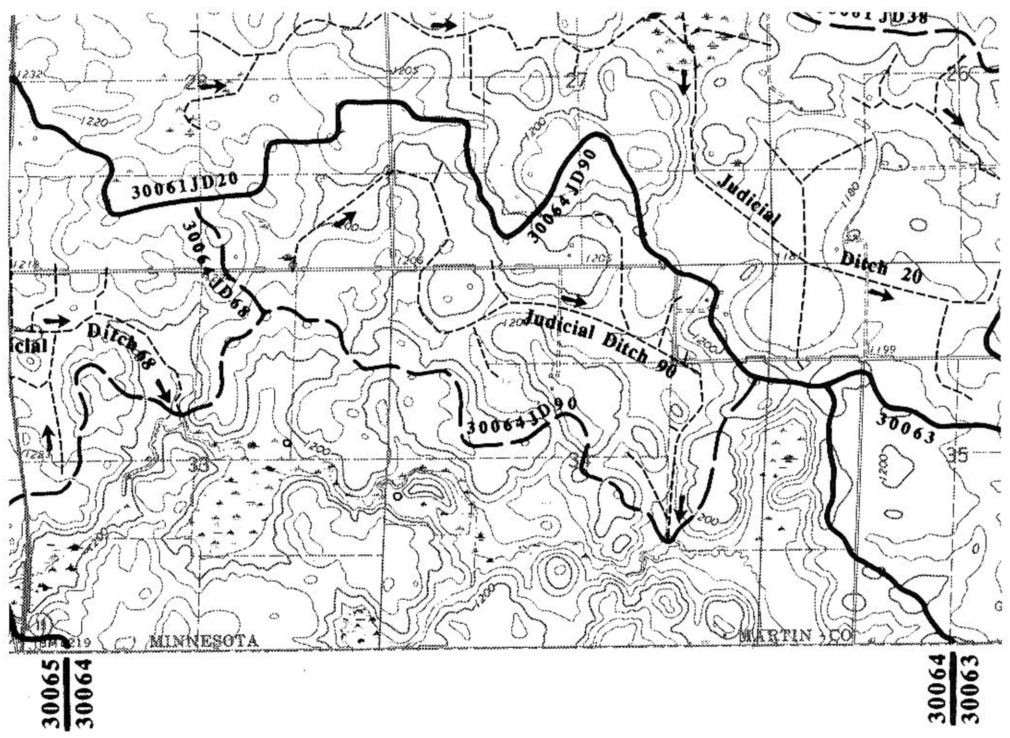


Figure 7. The above minor watershed, 30064, is delineated with a thick black line and labeled along the bottom edge of the map with its unique minor watershed identification number. Note that minor watershed 30064 is bordered on the west and east by minor watersheds 30065 and 30063 respectively.

The unique five digit minor watershed identification number can be broken down into two parts (Figure 8). The first two digits of the five digit minor watershed identifier establishes the minor watershed within a major watershed. For example: the Blue Earth River major watershed and the East Fork Des Moines River major watershed were assigned the identification numbers 30 and 53 respectively. The last three digits of the five digit minor watershed identification numbers were randomly assigned and are unique to each minor watershed within a major watershed. For example: minor watersheds that are located within the Blue Earth River major watershed are numbered 30001, 30002, 30003 and so on, while the minor watersheds located within the East Fork Des Moines River major watershed are numbered 53001, 53002, 53003 and so fourth.

53 032 Unique Minor Watershed Number
└-------- Randomly Assigned Number
└----------- Major Watershed Number

Figure 8. Breakdown of a minor watershed identification number.

Minor watershed 30031 (Figure 9) contains four drainage ditch systems; Judicial Ditch 2, Judicial Ditch 95, County Ditch 69, and Joint County Ditch 202. Judicial Ditch 2 serves as the main drainage channel for Minor Watershed 30031, hence, the minor watershed boundary line delineates the ditchshed boundary for Judicial Ditch 2. The interior side of minor watershed boundary line 30031 has been labeled with the unique ditchshed identifier for Judicial Ditch 2 (30031JD2). Judicial Ditch 95, County Ditch 69, and Joint County Ditch 202 represent tributary drainage ditch systems that outlet into Judicial Ditch 2. Separate ditchshed boundary lines are delineated for each tributary ditch system and the interior side of each ditchshed boundary line has been labeled with its unique ditchshed identifier; 30031JD95, 30031CD69, and 30031JC202. Note that Judicial, County, and Joint County ditches have been assigned the two letter abbreviations JD, CD, and JC respectively within the unique ditchshed identifier code.

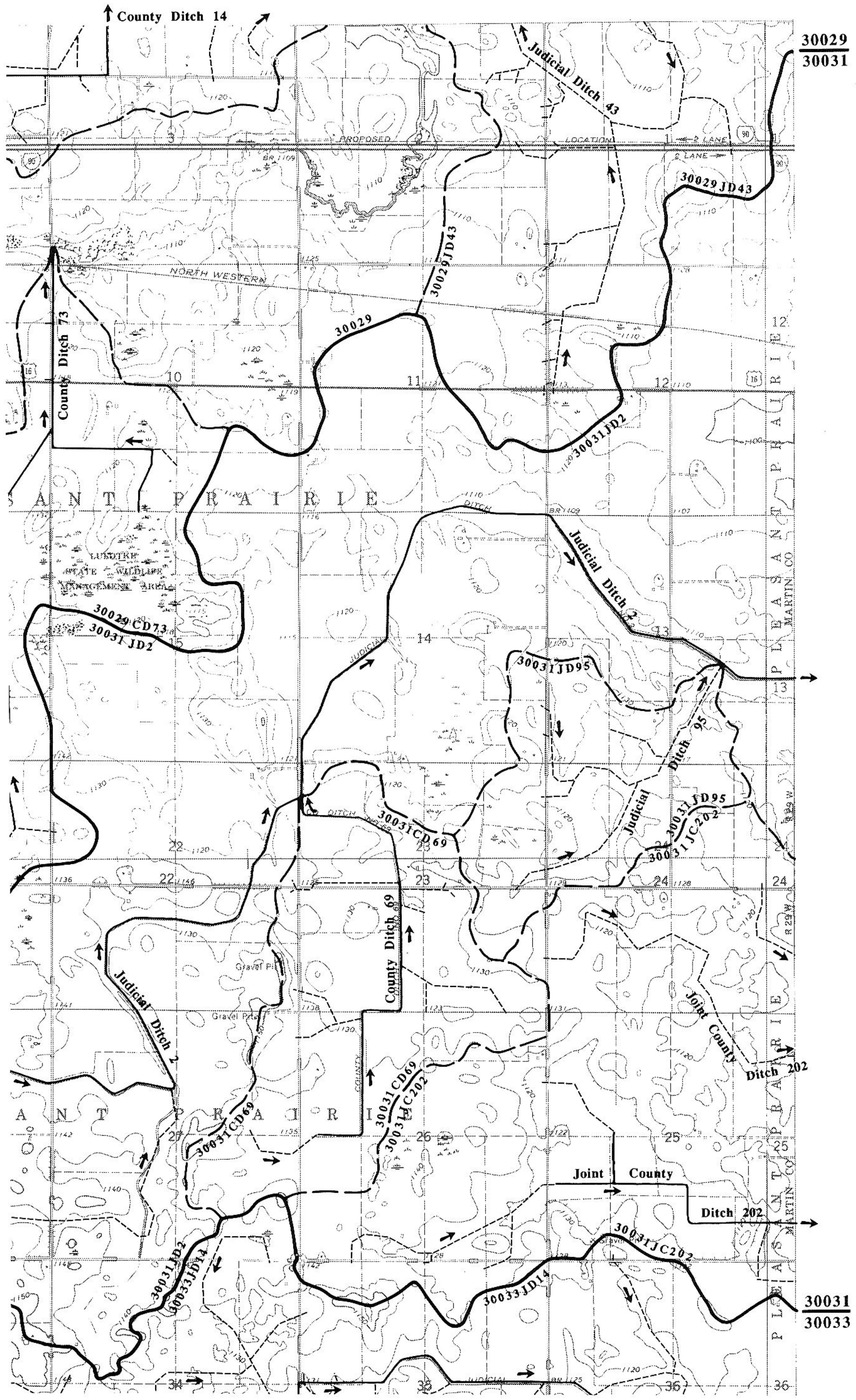


Figure 9. Drainage ditch and ditchsheds within minor watershed 30031.

The unique minor watershed identification numbers were assigned without regard to hydrologic relationships and therefore cannot be used to establish a hydrologic order among minor watersheds. The five digit numbers are simply codes that are used to identify a minor watershed with corresponding data that is stored in a data base system. A table of major watershed codes, unique minor watershed numbers, and corresponding data can be found on pages 8 and 9 in this atlas.

DRAINAGE DITCH SYSTEMS AND DITCHSHEDS

Drainage ditch systems that have been constructed and are presently maintained by the county have been plotted onto the Surface Water Hydrology maps in this atlas. Each drainage ditch system was plotted onto USGS 7-1/2 minute series topographic maps from copies of historic and current drainage ditch maps that were provided by the county. Open drainage ditches are shown on the Surface Water Hydrology maps as solid lines and tile drainage ditches are shown as dashed lines. Each drainage ditch system has been labeled with its proper name and arrows show the direction of water movement through the ditch system.

The ditchshed boundaries are delineated on the Surface Water Hydrology maps as long dashed lines and are labeled with unique ditchshed identifiers along their interior sides. The ditchshed boundary lines follow the height-of-land delineation rules that are described on page 2 in this atlas; the height-of-land assessment is based upon contour data as presented on USGS 7-1/2 minute series topographic maps. A ditchshed boundary line is delineated from the drainage ditch outlet to a point of contact with an established minor watershed boundary line or another ditchshed boundary line.

The unique ditchshed identifier can be broken down into two parts. The first five digits of the ditchshed identifier is a unique minor watershed identification number. This number establishes the ditchshed within a minor watershed. The five digit minor watershed number is followed by an alpha-numeric sequence that represents the proper name of the drainage ditch system (Figure 10).

53032 CD69 Unique Ditchshed Identifier
└------ Abbreviation for County Ditch 69
└------------- Unique Minor Watershed Number

Figure 10. Breakdown of a unique ditchshed identifier.

Minor watershed boundary lines that delineate a ditchshed boundary line are labeled with a ditchshed identifier. Minor watershed boundary lines that are not part of a ditchshed boundary are not labeled or are labeled with five digit minor watershed identification numbers (Figure 11).

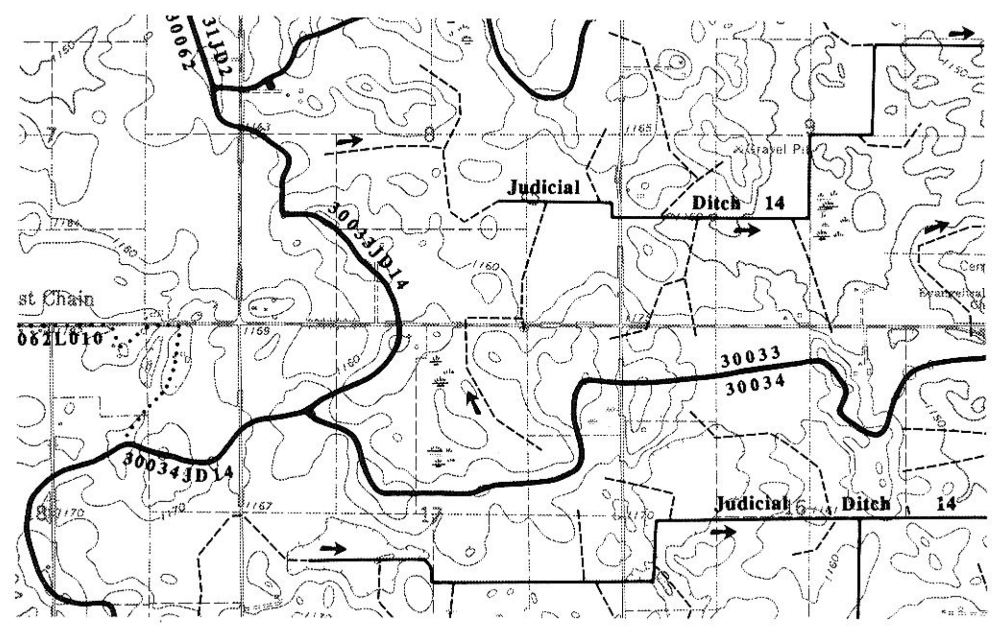


Figure 11. The above minor watersheds, 30033 and 30034, are drained by Judicial Ditch 14. The minor watershed boundary segments of 30033 and 30034 that delineate the Judicial 14 ditchshed are labeled 30033JD14 and 30034JD14 respectively. Note that the minor watershed boundary line that separates the two branches of Judicial Ditch 14 is not a ditchshed boundary line and therefore is labeled only with the unique five digit minor watershed identification numbers.

LAKESHEDS

Lakeshed boundary lines are delineated on the Surface Water Hydrology maps as dotted lines and are labeled with unique lakeshed identifiers. The lakeshed boundary lines follow the height-of-land delineation rules that are described on page 2 in this atlas; the height-of-land assessment is based upon contour data as presented on USGS 7-1/2 minute topographic maps.

The interior side of each lakeshed boundary line is labeled with a unique lakeshed identifier. The unique lakeshed identifier can be broken down into three parts (Figure 12). The first five digits of the lakeshed identifier is a unique minor watershed identification number. This number establishes the lakeshed within a minor watershed. The five digit minor watershed number is followed by the letter "L" (for Lakeshed). The letter "L" is followed by the unique lake identification number that was assigned in MDNR Bulletin No. 25, An Inventory of Minnesota Lakes.

```
53032 L 052   Unique Lakeshed Identifier
  |   |  └--- Unique Lake Identification Number
  |   └------ "L" (Lakeshed)
  └---------- Unique Minor Watershed Number
```

Figure 12. Breakdown of the unique lakeshed identifier.

A lakeshed will include all area upstream of the lake outlet. Some lakesheds will encompass only a few square miles and their total extent can be easily determined from the Surface Water Hydrology maps (Figure 13). However, when a main drainage channel outlets into a lake, the lakeshed may encompass hundreds of square miles and include many minor watersheds and ditchsheds within its drainage area. The total extent of a large lakeshed may be difficult if not impossible to determine from the Surface Water Hydrology maps in this atlas.

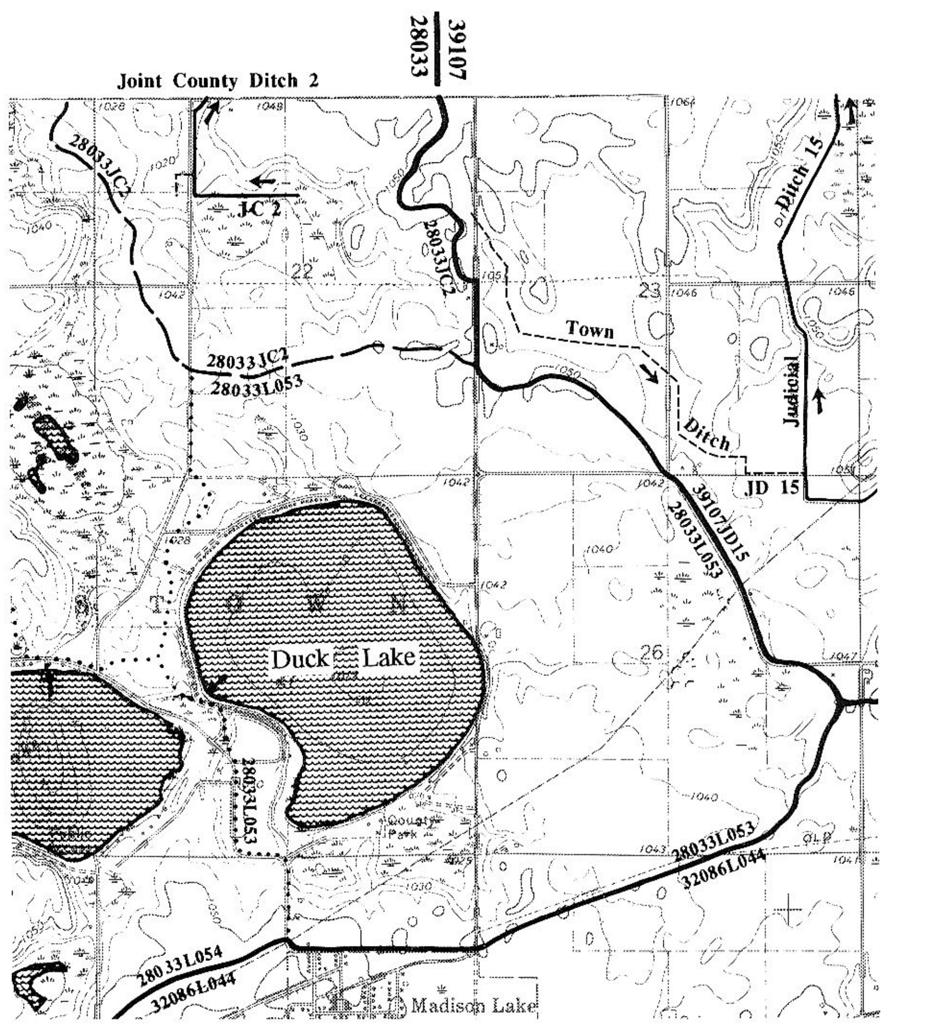


Figure 13. Above, the Duck Lake lakeshed is delineated with a dotted line from the lake outlet; south to minor watershed 28033 boundary line and north to Joint County 2 ditchshed boundary line. The sections of minor watershed 28033 boundary line that delineates the Duck Lake lakeshed are labeled with the lakeshed identifier 28033L053. Note: the section of ditchshed boundary line that delineates the northern part of Duck Lake lakeshed is labeled with the lakeshed identifier since the ditchshed is not included in the lakeshed.

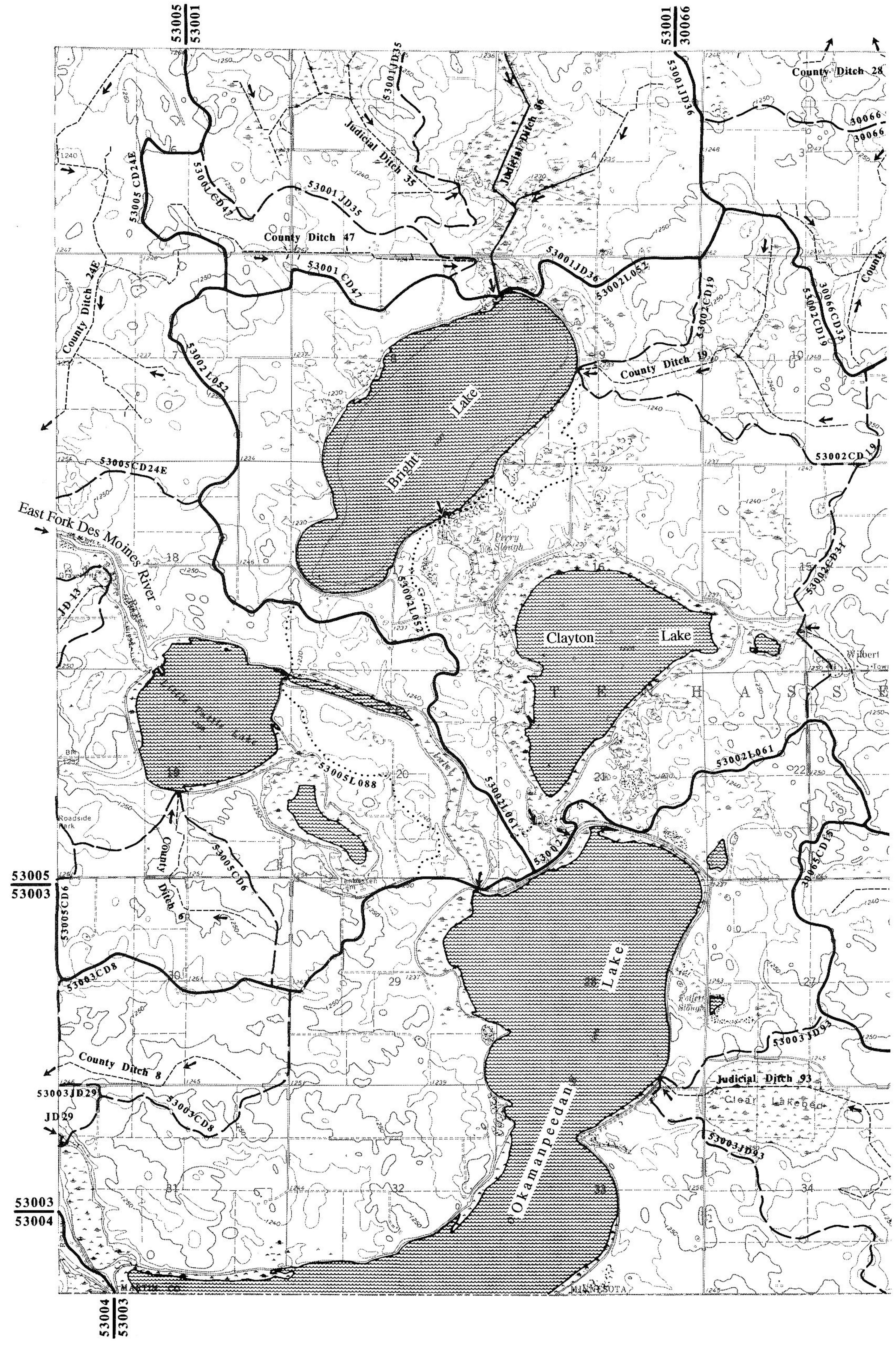
The total extent of a lakeshed may not be immediately discernible from the Surface Water Hydrology maps due to the hierarchal relationship between the three kinds of watershed boundary lines that are delineated onto the atlas maps; minor watershed, ditchshed, and lakeshed boundary lines (Figure 14). Lakeshed boundary lines are delineated from lake outlets, as dotted lines, to a point of contact with established minor watershed boundary lines or ditchshed boundary lines. Lakeshed boundary lines are defined by sections of minor watershed boundary lines that delineate common drainage areas or by sections of ditchshed boundary lines that delineate common or adjacent drainage areas.

Guidelines used when labeling lakeshed boundary lines.

1. A section of minor watershed boundary line that delineates part of a lakeshed boundary line is labeled with a lakeshed identifier.
2. A section of minor watershed boundary line that delineates part of a lakeshed boundary line and ditchshed boundary line is labeled with a ditchshed identifier.
3. A section of ditchshed boundary line that delineates part of a lakeshed boundary line is labeled with the lakeshed identifier if the ditchshed is not included in the lakeshed.
4. A section of ditchshed boundary line that delineates part of a lakeshed boundary line is labeled with the ditchshed identifier if the ditchshed is included in the lakeshed.

Figure 14. On the figure at the right the lakeshed boundary line for Bright Lake is delineated with a dotted line from the lake outlet north to County 19 ditchshed boundary line. The Bright Lake lakeshed boundary line intersects and follows County Ditch 19 ditchshed boundary line which, in turn, intersects and follows the minor watershed 53002 boundary line. County Ditch 19 outlets into Bright Lake, hence, the ditchshed is included in the lakeshed and the section of County 19 ditchshed boundary line that delineates part of Bright Lake lakeshed is not labeled with the lakeshed identifier since the ditchshed is included in the lakeshed. Minor watershed 53001 outlets into Bright Lake from the north and is included in the Bright Lake lakeshed.

Two minor watersheds, 53002 and 53005, outlet into Okamanpeedan Lake from the north. Minor watershed 53002 contains Bright Lake lakeshed which is described above. The East Fork Des Moines River serves as the main drainage channel for minor watershed 53005 which outlets into Okamanpeedan Lake from the north. Okamanpeedan Lake lakeshed includes all area upstream that contributes water to the East Fork Des Moines River. Consequently, Okamanpeedan Lake lakeshed includes the entire Major Watershed of the East Fork Des Moines River which includes hundreds of square miles.



MINOR WATERSHED INDEX MAP

EXPLANATION

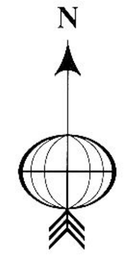
Major Watershed Boundary

Minor Watershed Boundary

30079

Minor Watershed Number

Minor Watershed Outlet
(Arrow points in direction of flow)

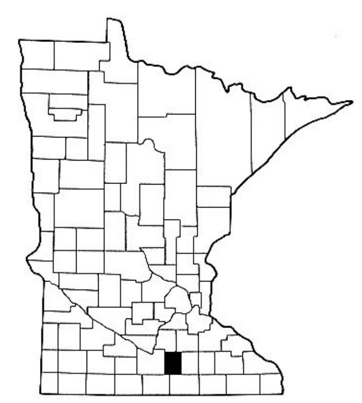


SCALE 1:125,000

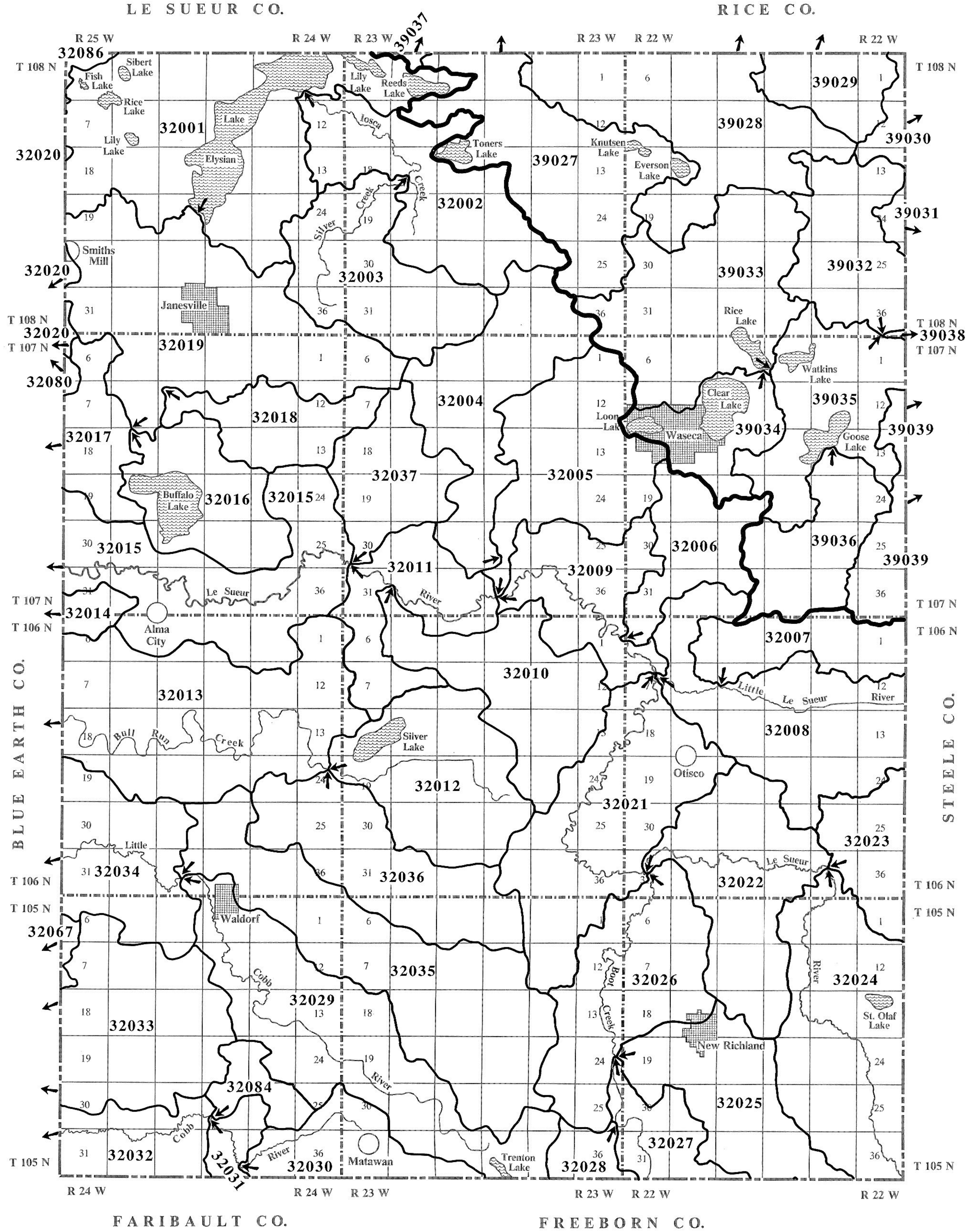
KILOMETRES

MILES

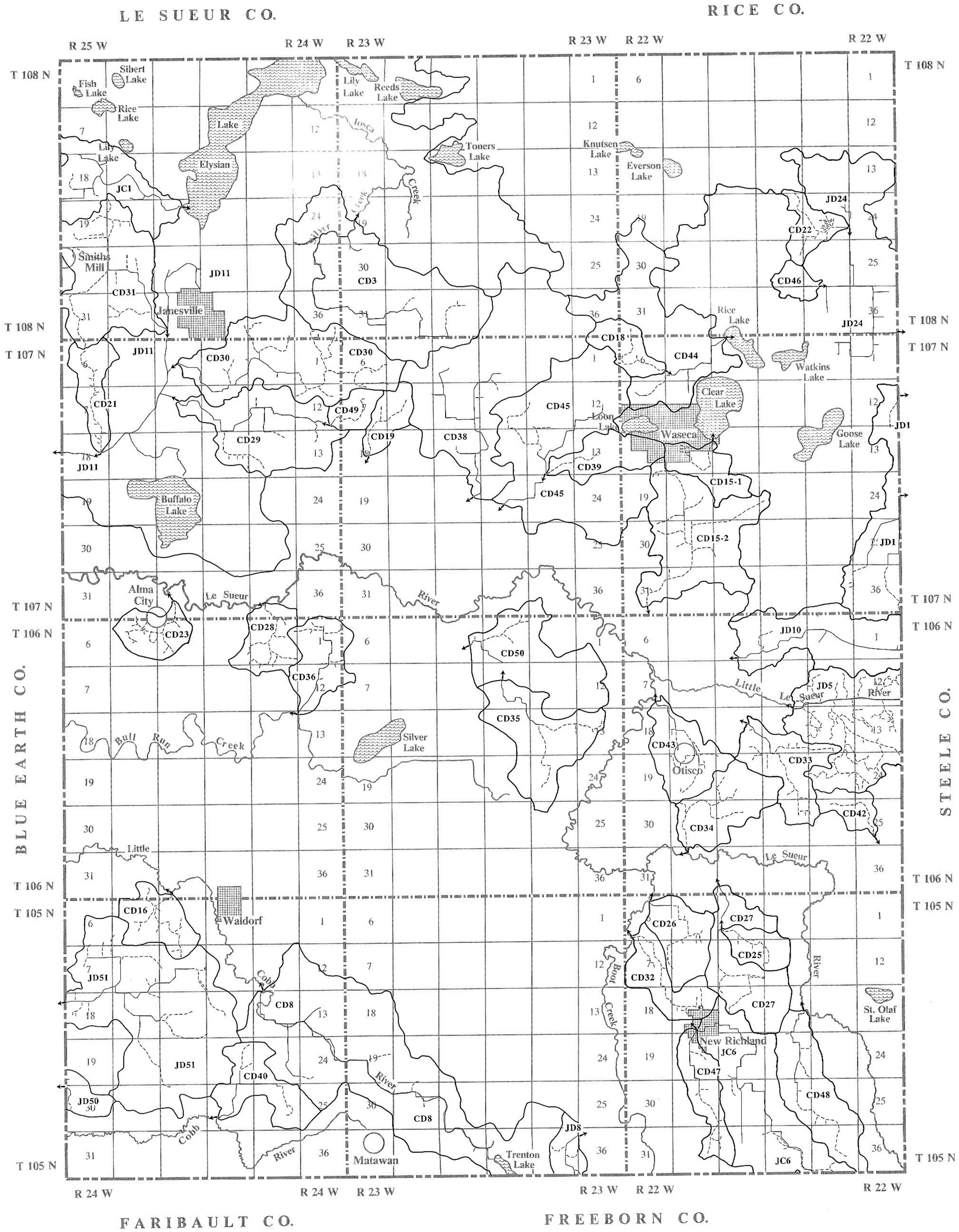
FEET



LOCATION DIAGRAM



PUBLIC DRAINAGE DITCH AND DITCHSHED MAP



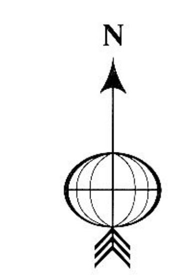
EXPLANATION

Ditchshed Boundary

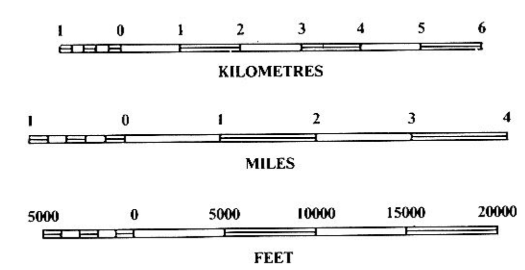
Open Drainage Ditch

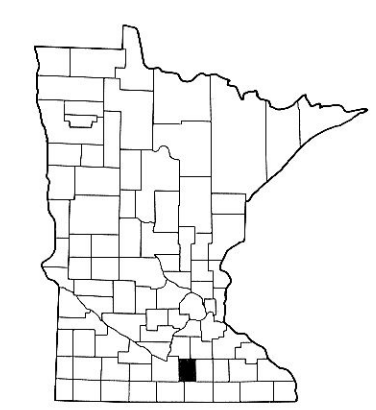
Tile Drainage Ditch

Drainage Ditch Outlet
(Arrow points in direction of flow)



SCALE 1:125,000





LOCATION DIAGRAM

WASECA COUNTY MINOR WATERSHEDS

Minor Watershed Identifier			Outlet Location				Area (sq. miles)		Order	CSAW Number	
ID #	Major Watershed	Outlet Stream Name	Twp	Rng	Sec	USGS Quad	Total	County		Stream	Minor Watershed
32001	LeSueur River	Lake Elysian	108	24	21	Elysian	24.04	21.86	2	1-55-76-1-7	18-18-1-5-3
32002	LeSueur River	Isoco Creek	108	24	1	Elysian	11.22	11.22	2	1-55-76-1-7-3	18-18-1-5-3-1
32003	LeSueur River	Silver Creek	108	23	17	Waterville	10.20	10.20	1	1-55-76-1-7-3-1	18-18-1-5-3-1-1
32004	LeSueur River	Creek to Creek to LeSueur River	107	23	27	Waseca	10.92	10.92	1	1-55-76-1-10-1	18-18-1-6-1-1
32005	LeSueur River	Creek to LeSueur River	107	23	34	Waseca	10.93	10.93	2	1-55-76-1-10	18-18-1-6-1
32006	LeSueur River	Creek to LeSueur River	106	23	1	Waseca	5.64	5.64	1	1-55-76-1-11	18-18-1-7-1
32007	LeSueur River	Creek to Little LeSueur River	106	22	9	Meriden	7.31	5.28	1	1-55-76-1-12-1	18-18-1-7-1-1
32008	LeSueur River	Little LeSueur River	106	22	7	Waseca	16.96	13.32	2	1-55-76-1-12	18-18-1-7-1
32009	LeSueur River	LeSueur River	107	23	34	Waseca	7.52	7.52	3	1-55-76-1	18-18-1-7
32010	LeSueur River	Creek to LeSueur River	107	23	32	Janesville	9.92	9.92	1	1-55-76-1-9	18-18-1-6-1
32011	LeSueur River	LeSueur River	107	23	30	Janesville	7.14	7.14	3	1-55-76-1	18-18-1-6
32012	LeSueur River	Creek from Silver Lake	106	24	24	Waldorf	10.90	10.90	1	1-55-76-1-2-2-2-1	18-18-1-2-2-2-1-1
32013	LeSueur River	Bull Run Creek	106	25	13	Mapleton NE	20.14	18.27	2	1-55-76-1-2-2-2	18-18-1-2-2-2-1
32014	LeSueur River	Little Cobb River	106	25	6	St. Claire	13.28	1.25	3	1-55-76-1-2-2	18-18-1-2-2-2
32015	LeSueur River	LeSueur River	107	25	9	St. Claire	21.91	14.50	1	1-55-76-1	18-18-1-5
32016	LeSueur River	Judicial Ditch 11	107	24	8	Janesville	7.69	7.69	1	1-55-76-1-7-1	18-18-1-5-1-1
32017	LeSueur River	Creek from Judicial Ditch 11	107	25	14	St. Claire	7.17	4.31	2	1-55-76-1-7	18-18-1-5-1
32018	LeSueur River	Judicial Ditch 11	107	24	9	Janesville	5.30	5.30	1	1-55-76-1-7-2	18-18-1-5-2-1
32019	LeSueur River	Judicial Ditch 11	107	24	8	Janesville	19.46	19.26	2	1-55-76-1-7	18-18-1-5-2
32020	LeSueur River	County Ditch 2	108	25	11	Madison Lake	7.35	0.39	1	1-55-76-1-4-2-1	18-18-1-3-1-1-1
32021	LeSueur River	LeSueur River	106	22	7	Waseca	15.04	15.04	3	1-55-76-1	18-18-1-8
32022	LeSueur River	LeSueur River	106	22	31	Otisco	11.46	11.46	2	1-55-76-1	18-18-1-9
32023	LeSueur River	Creek to LeSueur River	106	22	35	New Richland	22.93	4.59	1	1-55-76-1-14	18-18-1-9-1
32024	LeSueur River	LeSueur River	106	22	35	New Richland	26.29	14.14	2	1-55-76-1	18-18-1-10
32025	LeSueur River	Creek to Boot Creek	105	23	24	Otisco	9.76	8.80	1	1-55-76-1-13-1	18-18-1-8-1-1
32026	LeSueur River	Boot Creek	106	22	31	Otisco	11.46	11.46	2	1-55-76-1-13	18-18-1-8-1
32027	LeSueur River	Boot Creek	105	23	24	Otisco	20.68	3.73	2	1-55-76-1-13	18-18-1-8-2
32028	LeSueur River	Creek to Boot Creek	105	23	25	Freeborn	8.22	1.67	1	1-55-76-1-13-1	18-18-1-8-2-1
32029	LeSueur River	Little Cobb River	106	24	33	Waldorf	17.54	16.37	1	1-55-76-1-2-2	18-18-1-2-2-4
32030	LeSueur River	Creek to Cobb River	105	24	34	Matawan	10.21	4.98	1	1-55-76-1-2-7	18-18-1-2-6-1
32031	LeSueur River	Cobb River	105	24	27	Matawan	28.83	1.58	2	1-55-76-1-2	18-18-1-2-6
32032	LeSueur River	Cobb River	105	25	23	Mapleton NE	18.87	4.75	2	1-55-76-1-2	18-18-1-2-5
32033	LeSueur River	Creek from Judicial Ditch 50 & 51	105	25	23	Mapleton NE	16.61	12.22	1	1-55-76-1-2-5	18-18-1-2-4-1
32034	LeSueur River	Little Cobb River	106	25	13	Mapleton NE	14.27	8.52	2	1-55-76-1-2-2	18-18-1-2-2-3
32035	LeSueur River	Creek to Little Cobb River	106	24	33	Waldorf	18.75	18.75	1	1-55-76-1-2-2-4	18-18-1-2-2-3-1
32036	LeSueur River	Bull Run Creek	106	24	24	Waldorf	10.50	10.50	2	1-55-76-1-2-2-2	18-18-1-2-2-2-2
32037	LeSueur River	Creek to LeSueur River	107	23	30	Janesville	6.26	6.26	1	1-55-76-1-8	18-18-1-5-1
32067	LeSueur River	County Ditch 5	106	25	23	Mapleton NE	16.34	0.37	1	1-55-76-1-2-2-3	18-18-1-2-2-3-1
32080	LeSueur River	County Ditch 26	107	25	9	St. Claire	9.78	0.23	1	1-55-76-1-6	18-18-1-4-1
32084	LeSueur River	County Ditch 40	105	24	27	Matawan	2.16	2.16	1	1-55-76-1-2-6	18-18-1-2-5-1
32085	LeSueur River	LeSueur River (County Ditch 28)	104	21	6	Hartland	9.40	0.11	1	1-55-76-1	18-18-1-11
32086	LeSueur River	Creek from Madison Lake	108	25	21	Madison Lake	11.67	0.32	2	1-55-76-1-4-2	18-18-1-3-1-1
39027	Cannon River	White Water Creek	109	23	26	Waterville	15.80	13.61	2	1-48-37	15-12-1
39028	Cannon River	Waterville Creek	109	23	27	Waterville	20.99	13.90	1	1-48-37-1	15-12-1-1
39029	Cannon River	Creek to Cannon River	109	22	23	Morristown	7.42	3.85	1	1-48-33	15-11-1
39030	Cannon River	Mackenzie Creek	109	21	9	Faribault	24.02	1.19	1	1-48-31	15-10-1
39031	Cannon River	Judicial Ditch 24	108	21	32	Meriden	14.18	0.52	1	1-48-26-5-2	15-8-4-1-1
39032	Cannon River	Judicial Ditch 24	108	22	36	Meriden	7.80	7.48	1	1-48-26-5-3	15-8-4-1-1
39033	Cannon River	Rice Lake (Crane Creek)	107	22	3	Meriden	13.96	13.96	2	1-48-26-5	15-8-4-3
39034	Cannon River	Crane Creek	107	22	4	Meriden	5.19	5.19	1	1-48-26-5	15-8-4-4
39035	Cannon River	Judicial Ditch 24 (Crane Creek)	107	22	1	Meriden	9.49	9.29	2	1-48-26-5	15-8-4-2
39036	Cannon River	Creek to Crane Creek	107	22	14	Meriden	6.66	6.66	1	1-48-26-5-4	15-8-4-2-1
39037	Cannon River	Creek to Lake Tetonka	109	23	28	Waterville	12.21	0.17	1	1-48-38	15-13-1
39038	Cannon River	Judicial Ditch 24 (Crane Creek)	108	20	21	Medord East	28.88	0.07	3	1-48-26-5	15-8-4-1
39039	Cannon River	Judicial Ditch 24	107	21	5	Meriden	8.77	3.28	2	1-48-26-5-1	15-8-4-1-1

DATA TABLES

The data tables describe the minor watersheds in Waseca County. The minor watersheds are ordered sequentially and therefore grouped by the LeSueur River and the Cannon River major watersheds. The following information is contained in the data tables:

ID# identifies the minor watershed with a unique five digit number. The first two numbers identify the major watershed river which will receive drainage from the minor watershed. The last three numbers are randomly assigned and are unique within the major watershed.

Major Watershed names the major watershed identified by the first two digits of the ID#.

Outlet Stream Name identifies the stream, ditch, or lake which flows out of the minor watershed. All surface runoff will exit the minor watershed through the outlet stream.

Outlet Location (Twp, Rgn, Sec, USGS Quad) locates the outlet of the minor watershed within a specific township, range and section using the U.S. Public Land Survey numbering system. USGS Quad is the name of the U.S. Geological Survey 7 1/2 minute series quadrangle where the minor watershed outlet is located. When the minor watershed outlets in Iowa, the USGS quad locates the outlet stream as it exits Minnesota into Iowa.

Area is the square miles of land area which contributes surface runoff and subsurface drainage to a receiving stream within the defined minor watershed boundary. Area may include water storage basins such as wetlands or lakes which do not contribute drainage to the minor watershed. Total area includes all drainage of the minor watershed extending beyond county boundaries. County area refers to that portion of the minor watershed drainage area which lies within the county boundary. Minor watershed boundaries were digitized from USGS 7 1/2 minute series quadrangles using AutoCAD and converted into ARC/INFO for area calculations.

Order is a hydrologic classification of minor watersheds within a drainage network. Using this classification system, a 1st order minor watershed has no surface water flowing into it, similar to Strahler's 1st order (headwater) stream. Order of a minor watershed will increase after receiving the outflow of two minor watersheds of the same hydrologic order. For example, two 1st order minor watersheds join to create a 2nd order; two 2nd order minor watersheds join to create a 3rd order, and so forth. When two minor watersheds of different hydrologic order join, the higher order will be assigned to the minor watershed receiving the outflow. For example, a 1st order minor watershed joins with a 2nd order to create a 2nd order. A minor watershed may receive outflow from another minor watershed at any point along its outlet stream. For example, when a 1st order minor watershed joins a 1st order minor watershed at the upper reaches of the outlet stream, the receiving minor watershed becomes 2nd order (Figure 14).

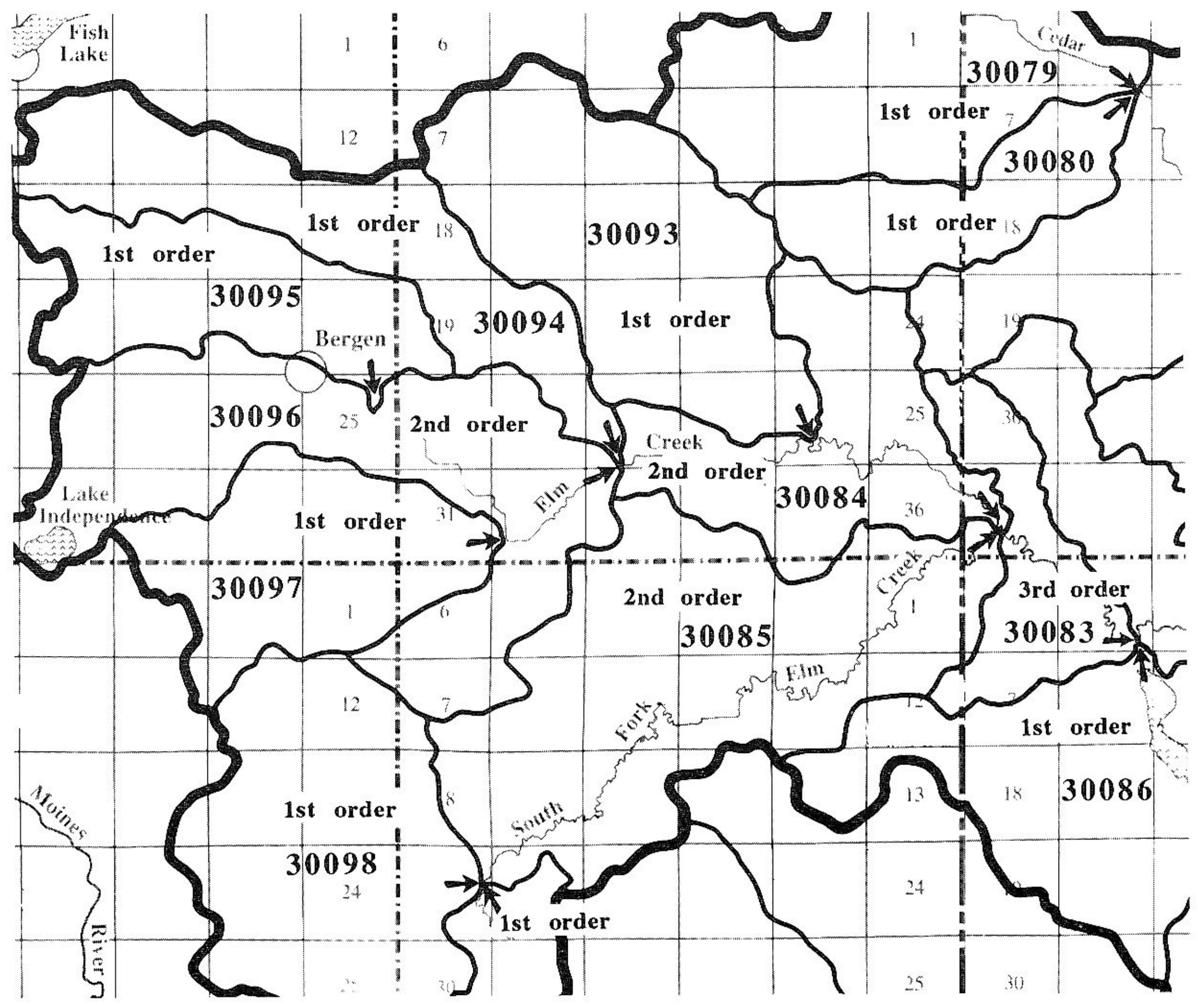


Figure 14. Hydrologic Order of Minor Watersheds. The outflow from 1st order minor watershed 30095 enters minor watershed 30096, creating a 2nd order minor watershed; 30096 remains a 2nd order minor watershed after receiving the outflow of 1st order minor watershed 30097. 1st order minor watershed 30094 joins with 2nd order minor watershed 30096, to create 2nd order minor watershed 30084; 2nd order minor watershed 30084 joins with 2nd order 30085 to create 3rd order minor watershed 30083.

DATA TABLES

Order (continued) This system of hydrologic order relates the minor watershed to the water quality of its outlet stream. Water quality of the outlet stream from a 1st and 2nd order minor watershed reflects the physical nature of its watershed as well as land use activities. The water quality of an outlet stream from a higher order minor watershed (3rd through 6th) represents its watershed drainage, cumulative upstream drainage, and in-stream processing; consequently, the effect of surface runoff from land use of the related minor is not as apparent as in a 1st and 2nd order minor watershed. A minor watershed assessment to determine relationships between water quality and land use activities involves consideration of minor watershed order, physical characteristics and biological processes for meaningful comparison of water quality results.

CSAW Number refers to the Common Stream and Watershed (CSAW) Numbering System, developed by the Minnesota Department of Natural Resources in 1981 to identify hydrologic order among the minor watershed drainage areas for the state of Minnesota. The Minnesota Land Management Information Center maintains the CSAW numbering system data base. The CSAW number is comprised of two parts: the first half of the number identifies the main stream draining the minor watershed; the second half of the CSAW number relates the location of the minor watershed drainage area to a stream segment within the drainage network. Numbers in each part of the CSAW number are separated by a hyphen. A space or a slash separate the stream number from the minor watershed number. A one to one relationship is always maintained between the stream numbers and the minor watershed numbers. Assigning the numerical code to the stream and to the minor watershed is done independently; the codes are then combined to form the CSAW number as follows:

1-55-76-12	**18-18-4-7**
(stream number)	(minor watershed number)

CSAW NUMBERING PROCEDURE

The CSAW stream numbering procedure is a hierarchical approach of ordering, reflecting the drainage pattern of each stream. Minnesota is divided into four drainage systems for the stream numbering procedure: St. Lawrence, Hudson Bay, Mississippi, and Iowa. Each system has one or more terminal streams through which surface water flows out of Minnesota. The terminal stream begins the sequence of hyphenated numbers which describe the relative position of the stream as tributaries join other tributaries, draining toward the terminal stream.

In south central Minnesota, stream flow is a part of the Mississippi or Iowa drainage systems. In the Mississippi drainage system, the Mississippi River is the terminal stream and is numbered as stream 1. The Iowa drainage system is comprised of many streams which flow out of Minnesota into Iowa or South Dakota before confluence with the Mississippi River. Each stream flowing out of Minnesota into Iowa or South Dakota is designated as a terminal stream. Consecutive numbering of these streams begins at the southeastern border of Minnesota along the southern state line to the western Minnesota border, continuing north along the western state line.

Tributaries to the terminal stream and the tributaries to tributaries are numbered consecutively upstream to reflect the order of each stream's confluence along the terminal stream or main tributary. These tributary numbers are added to the sequence of hyphenated numbers following the number of the tributary joined. In the Mississippi drainage system, the stream number 1-55 identifies the Minnesota River as the 55th tributary to the Mississippi River from the southern state border. The stream number 1-55-76 identifies the Blue Earth River as the 76th tributary to the Minnesota River; stream number 1-55-76-12 identifies Elm Creek as the 12th tributary to the Blue Earth River. In the Iowa drainage system, stream number 37 is the West Fork Des Moines River which is the 37th stream from the eastern border of Minnesota. The stream 37-11 refers to Judicial Ditch 6 which is the 11th tributary to the West Fork Des Moines River.

The second half of a CSAW number (1-55-76-12 / **18-18-4-7**) identifies the hydrologic order of the minor watershed drainage area. A sequence of numbers, separated by hyphens, orders the minor watershed relative to the minor watersheds downstream and its hydrologic association to the terminal stream and any other tributary streams. Minor watershed numbers are assigned as follows :

> Minor watersheds of terminal streams are numbered consecutively upstream, beginning at the Minnesota state line, reflecting the minor watershed's position along the terminal stream (**18**-18-4-7).
>
> Minor watersheds of tributary streams are numbered consecutively upstream from their junction with the terminal stream (18-**18**-4-7).
>
> Minor watersheds of tributary to tributary streams are numbered consecutively upstream from their junction with the tributary stream (18-18-**4-7**).

CSAW numbers are used to determine hydrologic relationships among the minor watersheds. Figure 15 shows minor watersheds located in the Blue Earth River Major Watershed. Elm Creek is the main tributary stream which outlets minor watersheds 30096, 30084, and 30083. 30096 is the 7th minor watershed upstream from the mouth of Elm Creek and is located upstream from 30084 and 30083. Surface water from minor watershed 30096 will flow into 30084; 30084 will flow into 30083; therefore surface water exiting minor watershed 30084 is impacted by surface drainage from minor watershed 30096, but not affected by surface drainage from 30083.

Minor Watershed	CSAW Number
30083	1-55-76-12 / 18-18-4-5
30084	1-55-76-12 / 18-18-4-6
30096	1-55-76-12 / 18-18-4-7
30095	1-55-76-12-9 / 18-18-4-7-1
30097	1-55-76-12-8 / 18-18-4-7-1

The outlet stream of minor watershed 30095 is the 9th tributary to Elm Creek and therefore is upstream from the outlet stream of minor watershed 30097, which is the 8th tributary to Elm Creek. 30095 is the 1st minor watershed along its tributary stream; 30097 is the 1st minor watershed along its tributary stream. Minor watersheds, 30097 and 30095, enter Elm Creek at its 7th minor watershed, 30096. The surface water outflow from minor watershed 30095 does not enter 30097; the outflow is related only by the receiving stream, Elm Creek. Surface water flow from minor watershed 30096 can be followed through the drainage network toward the terminal stream using the CSAW numbers.

> Elm Creek is the outlet stream of minor watershed 30096 at the 7th minor watershed upstream from the confluence of Elm Creek with the Blue Earth River. Elm Creek travels through 7 minor watersheds before joining the Blue Earth River.
>
> Elm Creek enters the Blue Earth River (1-55-76) at the 4th minor watershed (18-18-4) upstream from the outlet of the Blue Earth River.
>
> The Blue Earth River enters the Minnesota River (1-55) at the 18th minor watershed (18-18) upstream from outlet of the Minnesota River.
>
> The Minnesota River enters the terminal stream, the Mississippi River (1) at the 18th minor watershed (18) from the Mississippi River's exit from the state of Minnesota.
>
> Surface water drainage from minor watershed, 30096 will travel through 47 minor watersheds before exiting Minnesota through the Mississippi River (18+18+4+7).

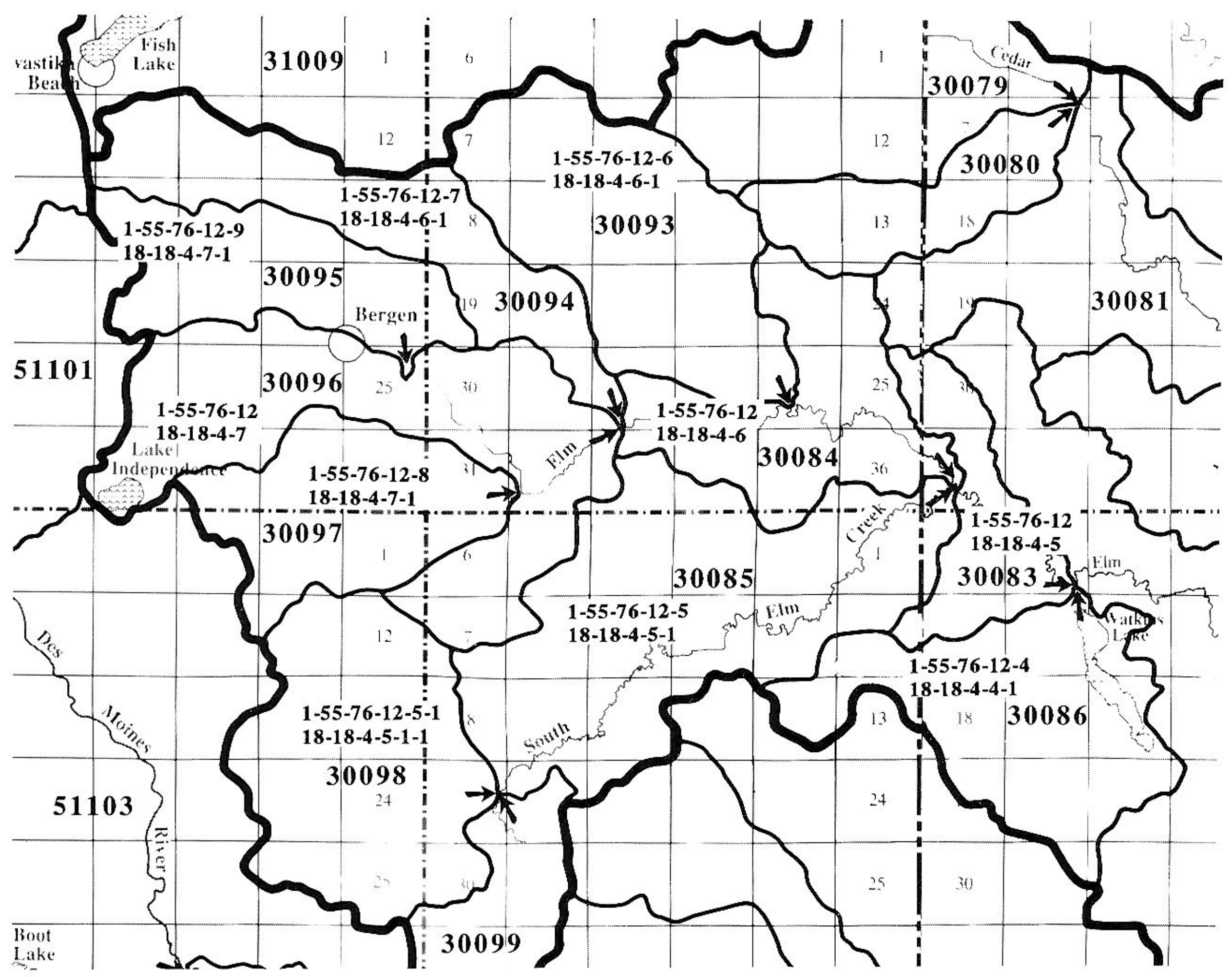
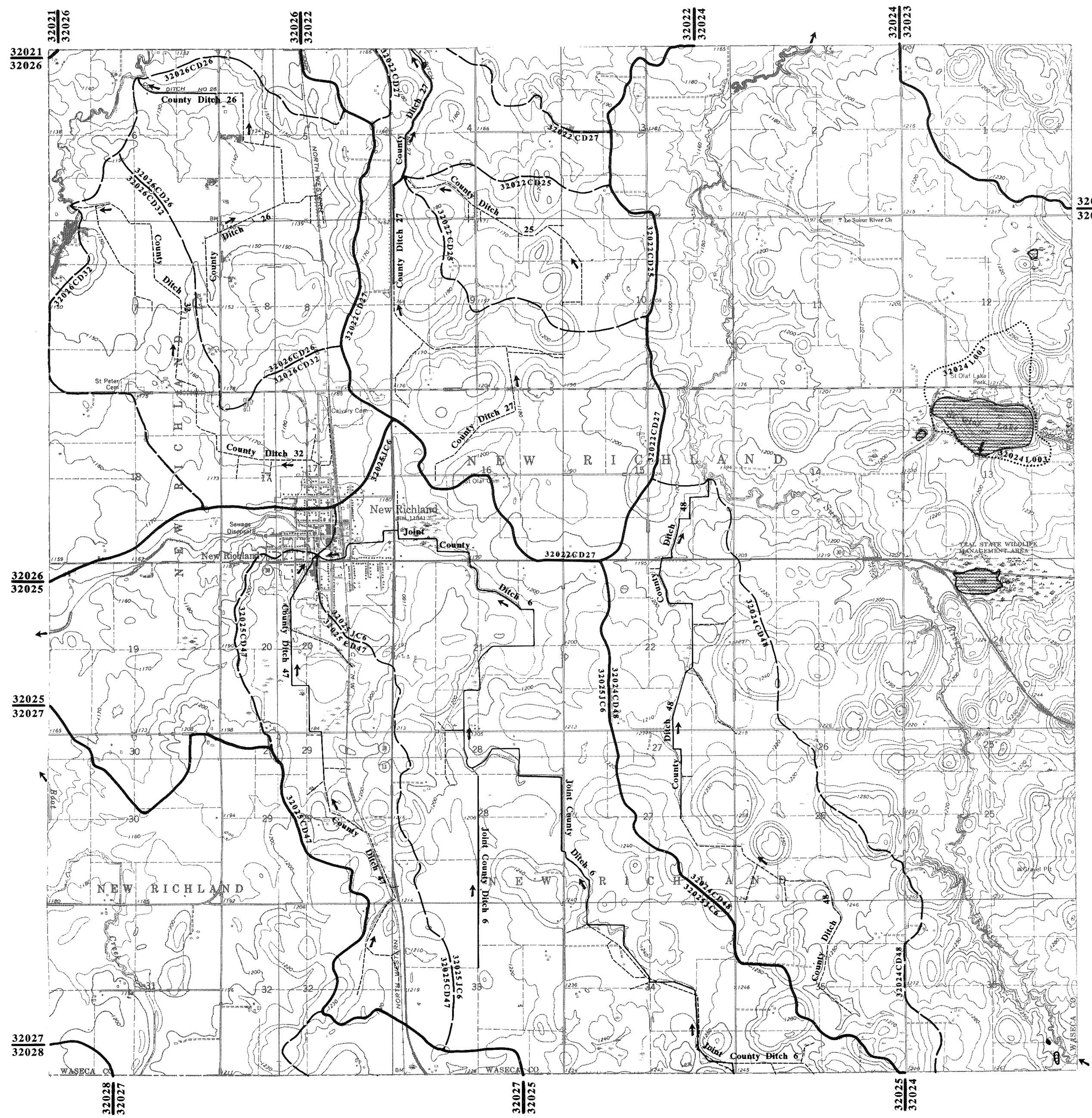


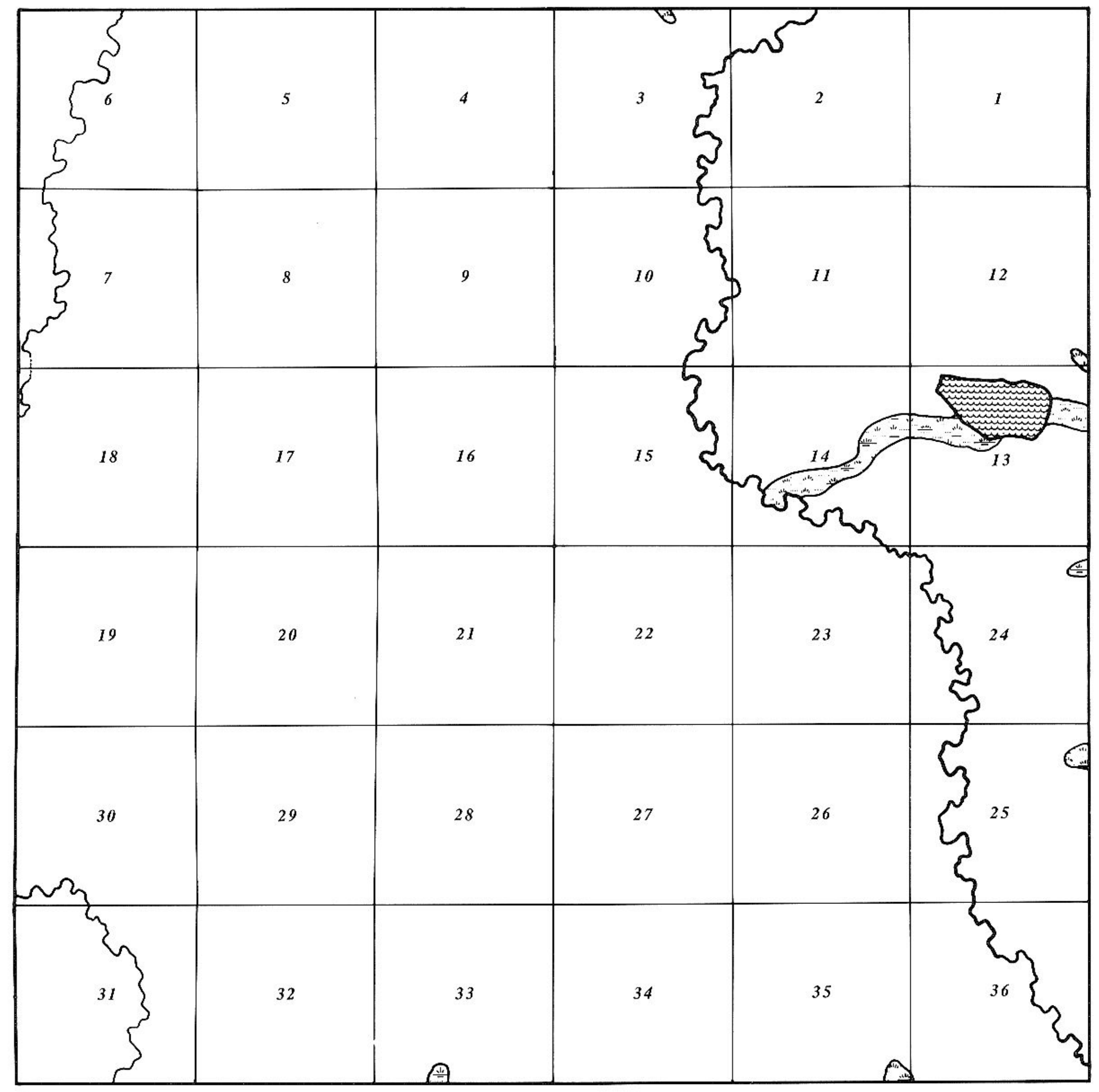
Figure 15. Hydrologic relationships of minor watersheds using CSAW numbering system.

SURFACE WATER HYDROLOGY MAP

T. 105 N. R. 22 W.



GENERAL LAND SURVEY MAP



SCALE: 1 : 64,000 1 inch = 1 mile

EXPLANATION

Wetland (Marsh, Slough)

Open Water (Lake, Pond)

Riverine (River, Stream)

EXPLANATION
Surface Water Hydrology Map

Minor Watershed Boundary

Ditchshed Boundary

Lakeshed Boundary

Open Drainage Ditch (Arrow points in direction of flow)

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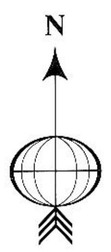
Forested Wetlands (NWI Palustrine: Forested)



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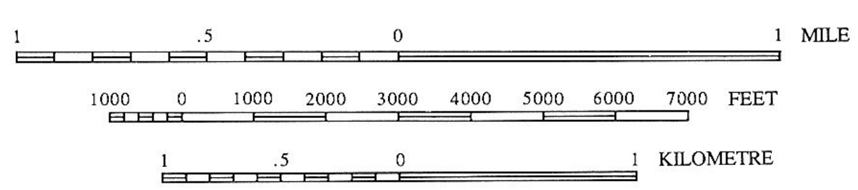
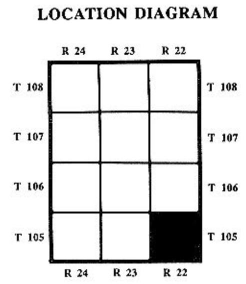


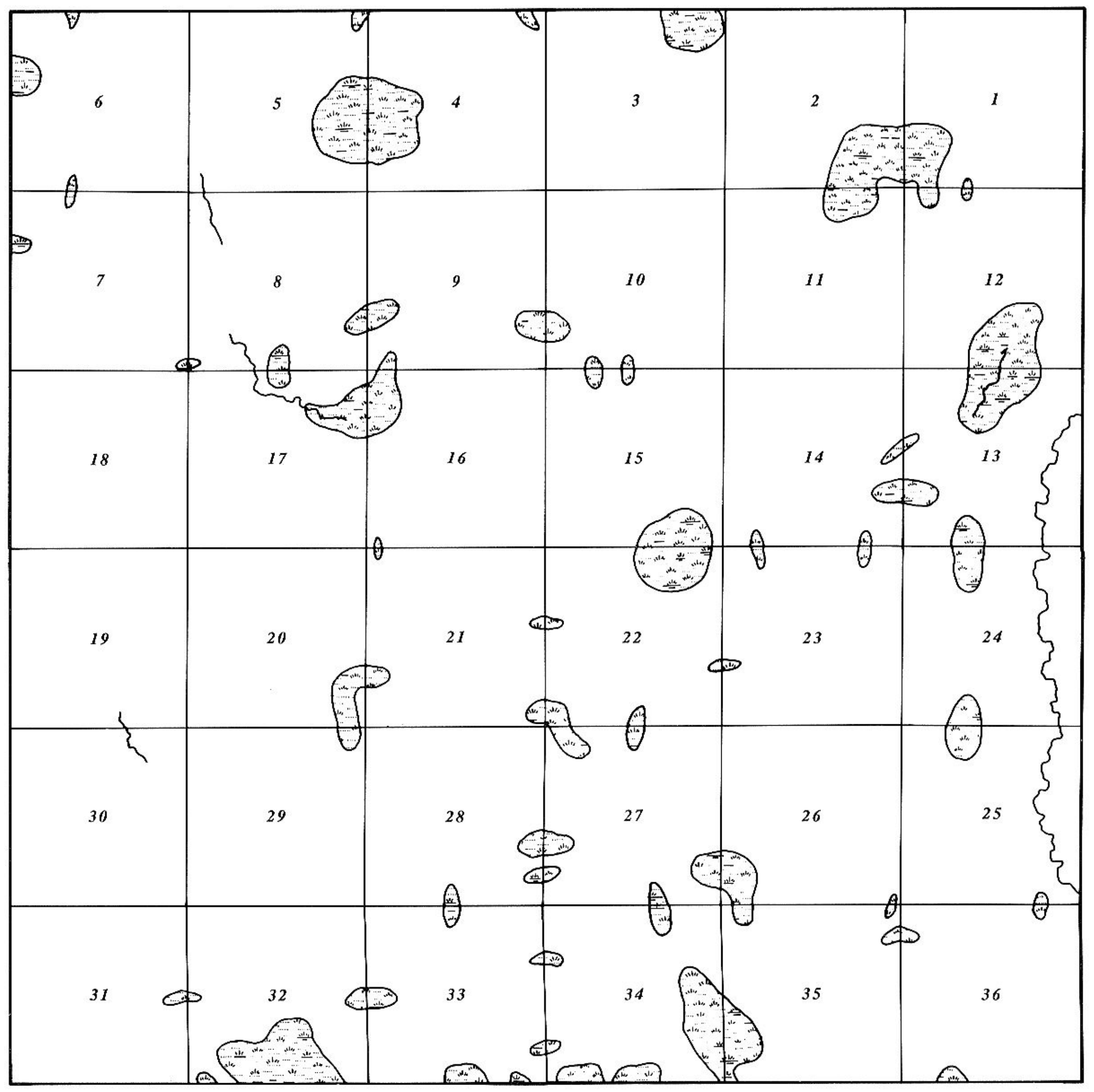
LOCATION DIAGRAM



T. 105 N. R. 23 W.

SURFACE WATER HYDROLOGY MAP

GENERAL LAND SURVEY MAP



SCALE: 1 : 64,000 1 inch = 1 mile

EXPLANATION

Wetland (Marsh, Slough)

Open Water (Lake, Pond)

Riverine (River, Stream)

EXPLANATION
Surface Water Hydrology Map

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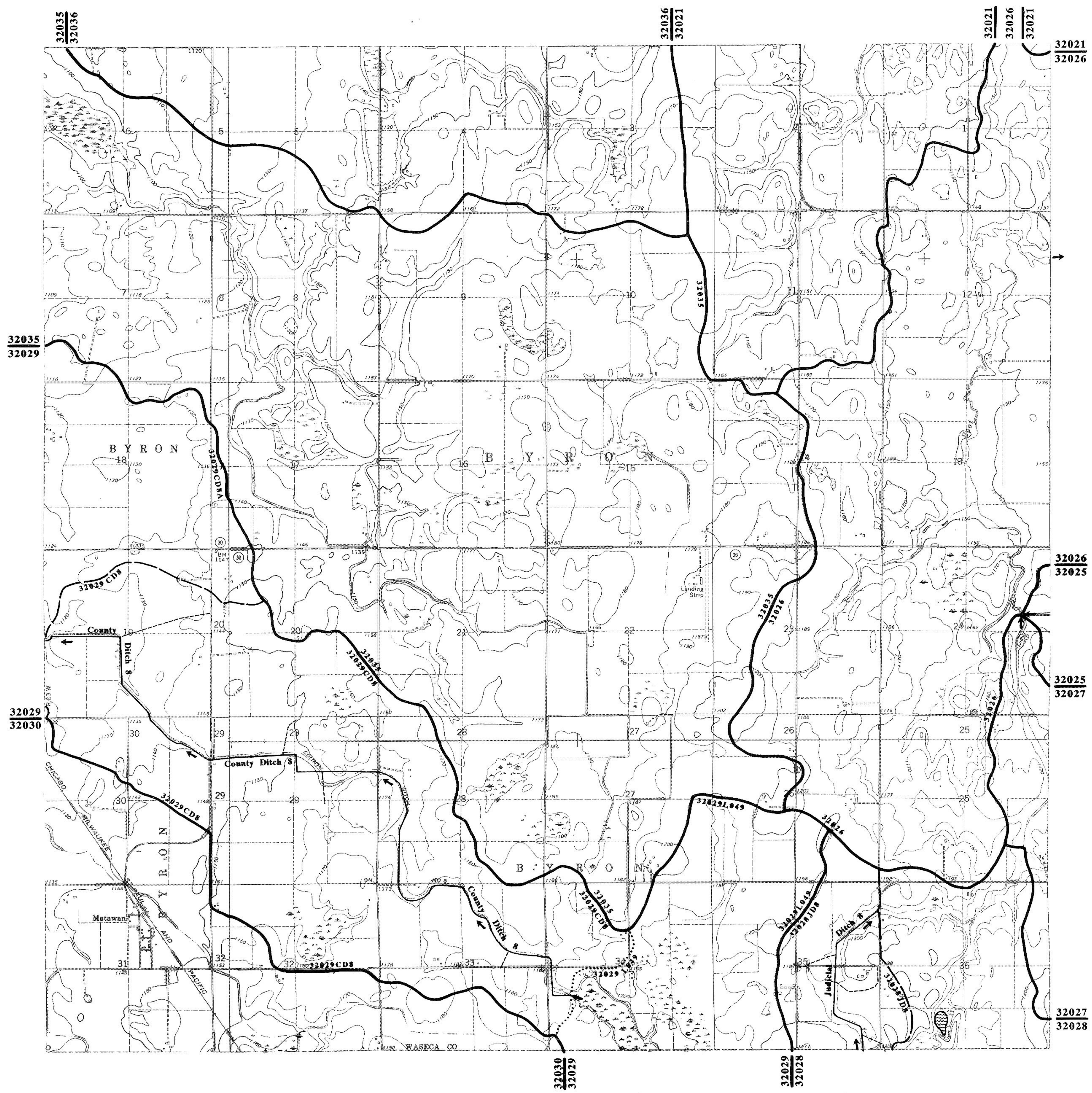
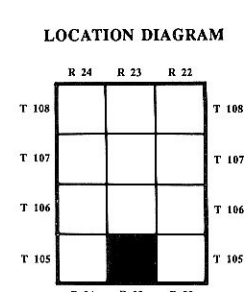




SCALE 1:32,000

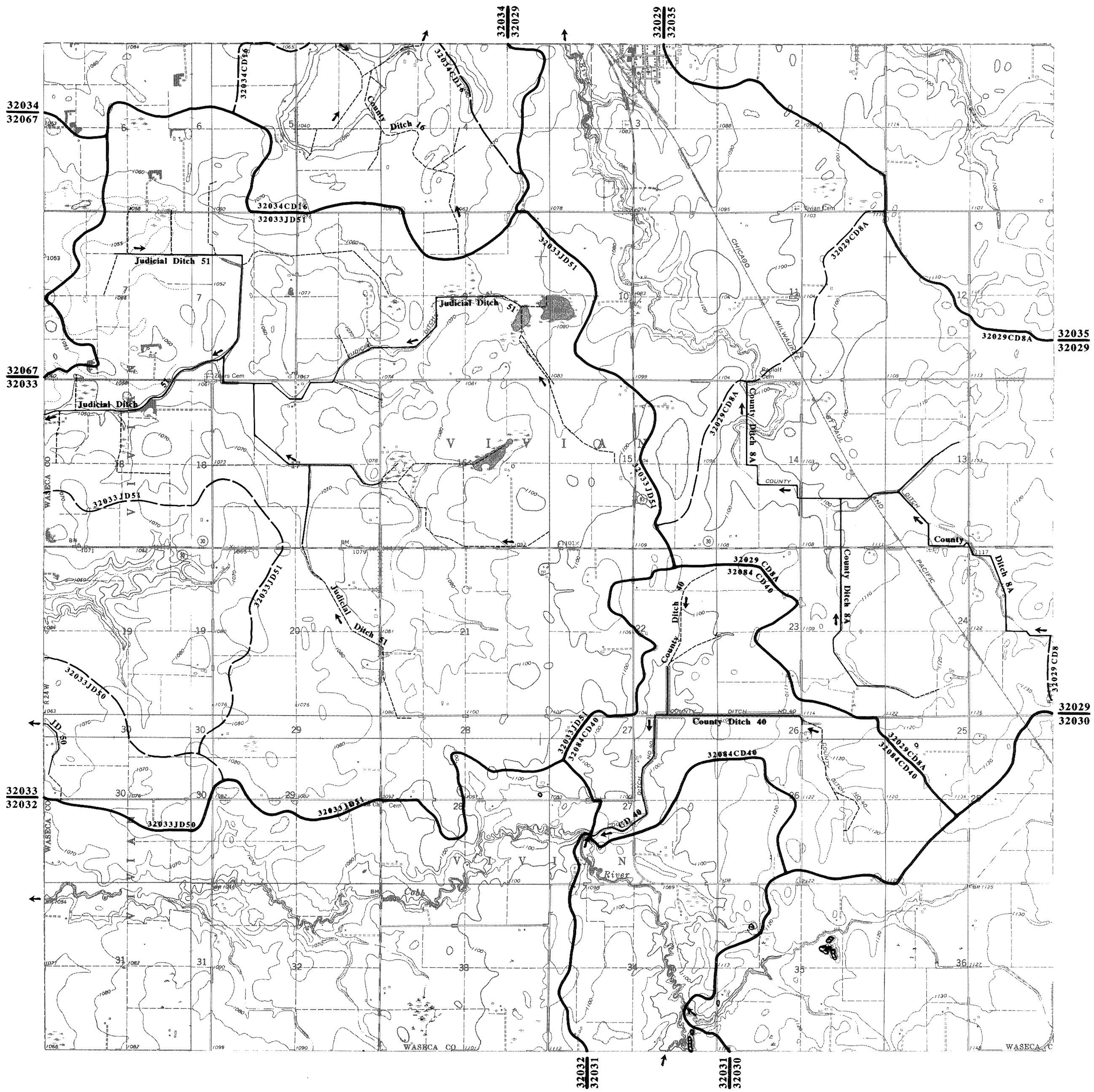
1 .5 0 1 MILE

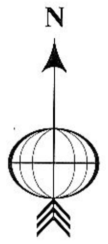
1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 .5 0 1 KILOMETRE

N

SURFACE WATER HYDROLOGY MAP





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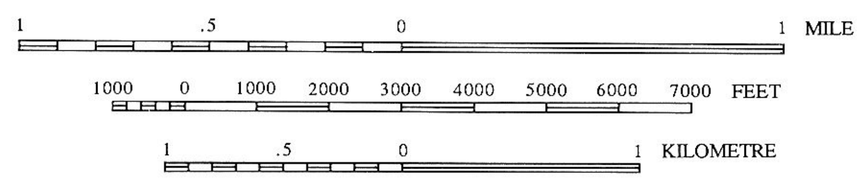
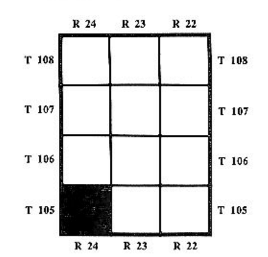
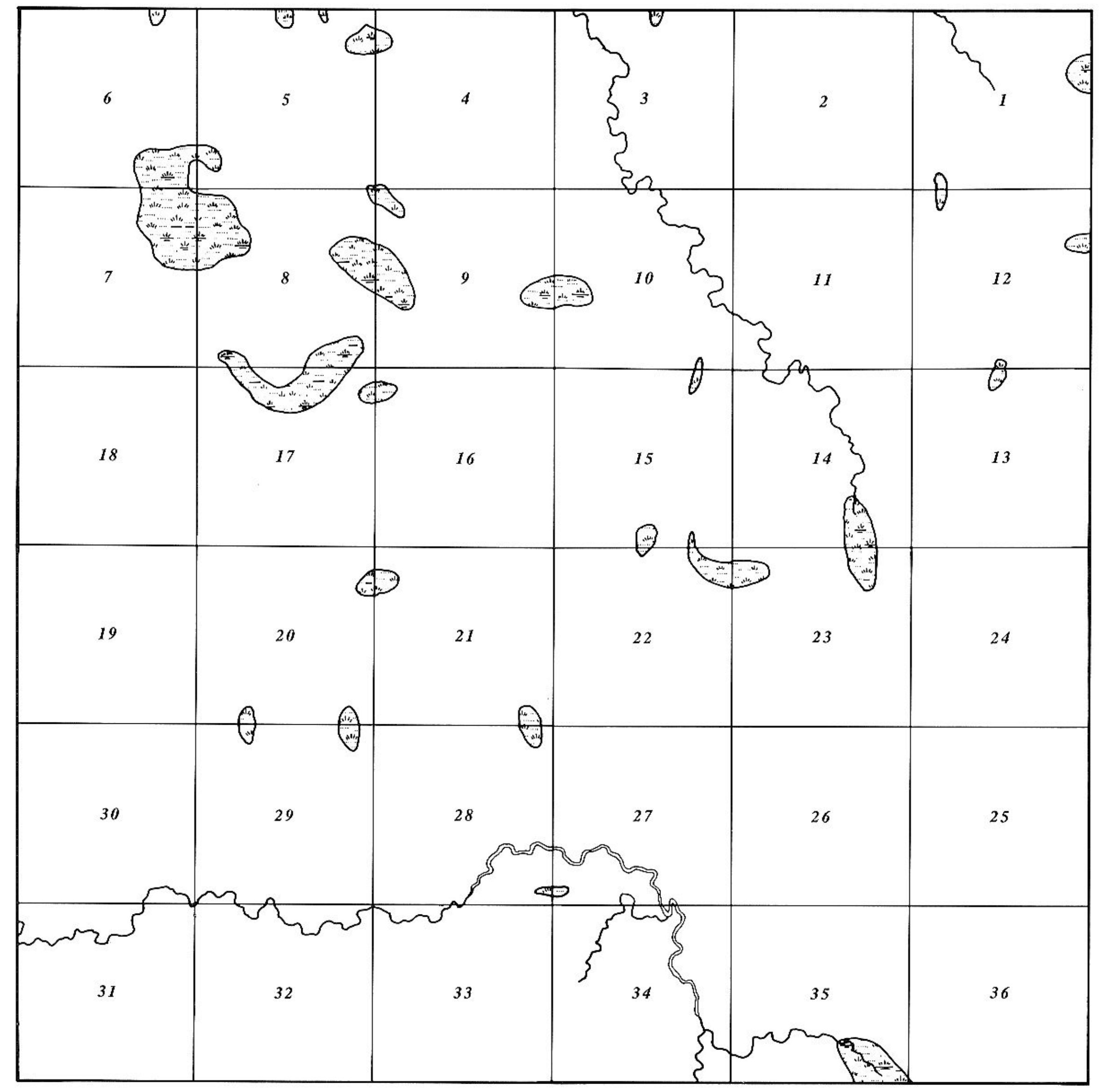


LOCATION DIAGRAM



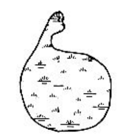
T. 105 N. R. 24 W.

GENERAL LAND SURVEY MAP

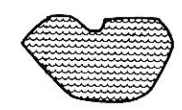


SCALE: 1 : 64,000 1 inch = 1 mile

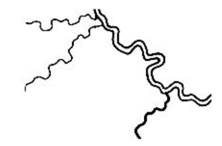
EXPLANATION



Wetland (Marsh, Slough)



Open Water (Lake, Pond)



Riverine (River, Stream)

EXPLANATION
Surface Water Hydrology Map

Minor Watershed Boundary

Ditchshed Boundary

Lakeshed Boundary

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Tile Drainage Ditch (Arrow points in direction of flow)

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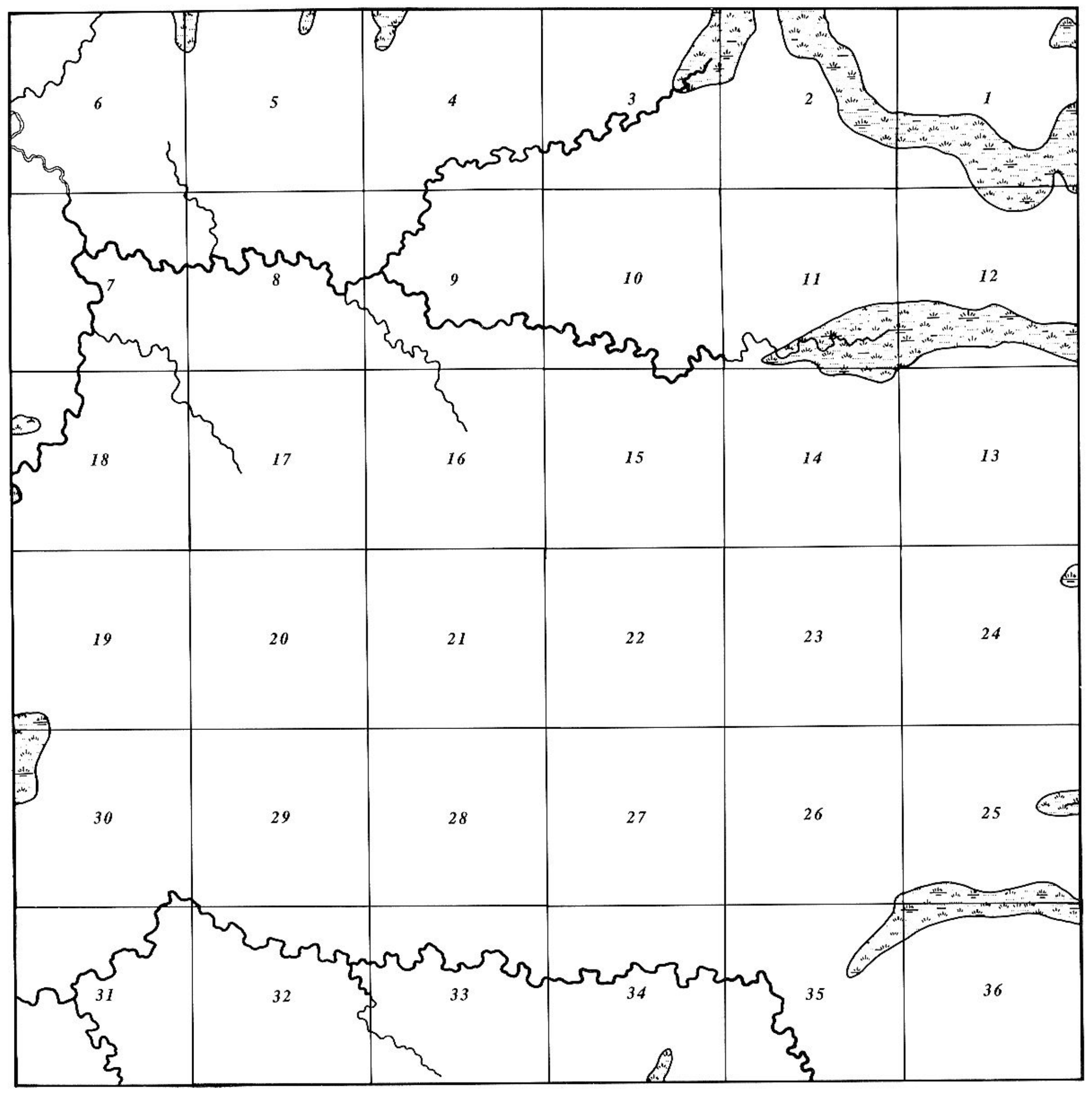
Forested Wetlands (NWI Palustrine: Forested)

T. 106 N. R. 22 W.

SURFACE WATER HYDROLOGY MAP

GENERAL LAND SURVEY MAP



SCALE: 1 : 64,000 1 inch = 1 mile

EXPLANATION

Wetland (Marsh, Slough)

Open Water (Lake, Pond)

Riverine (River, Stream)

EXPLANATION
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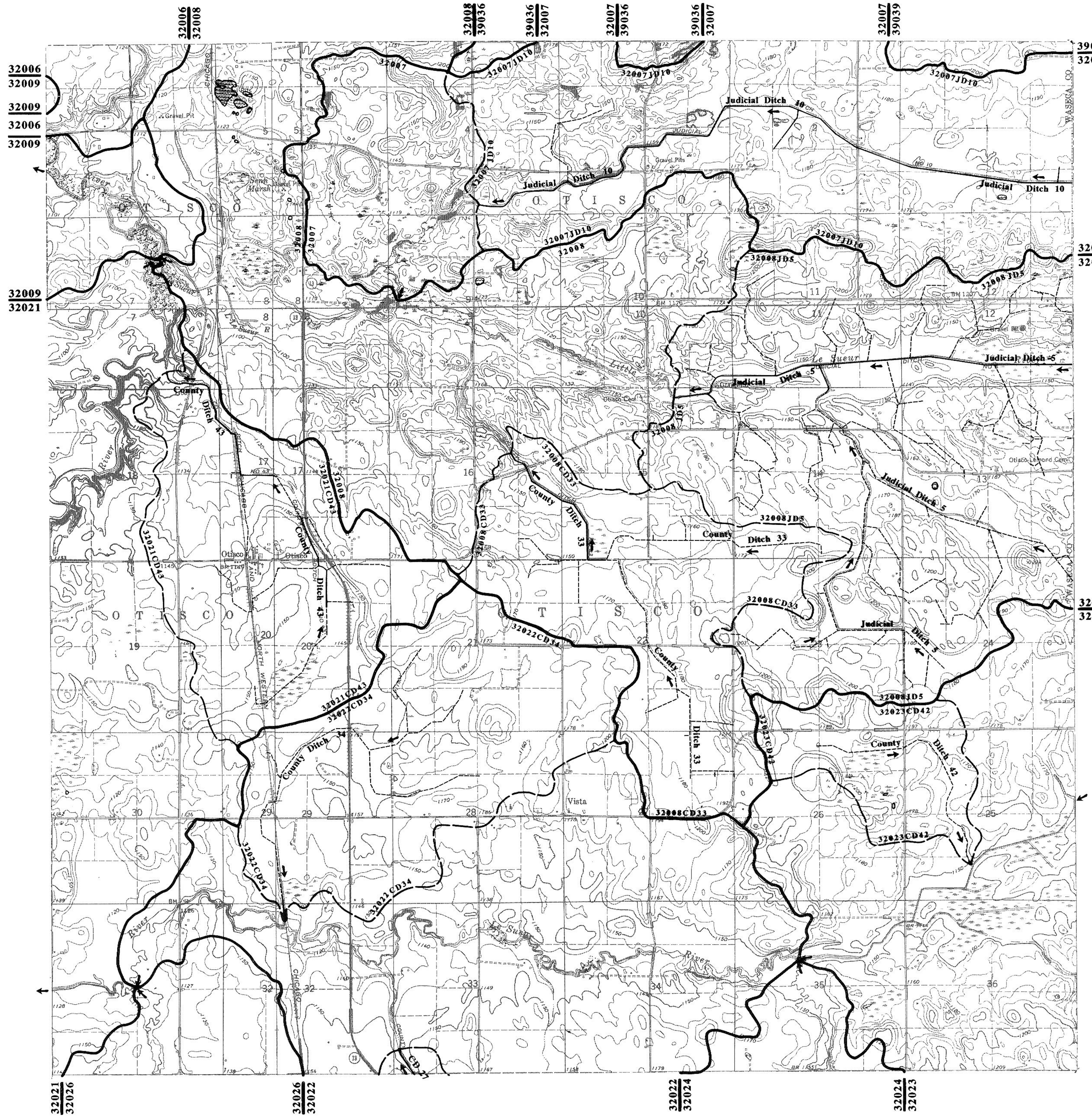
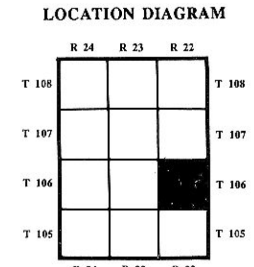


LOCATION DIAGRAM



SCALE 1:32,000

1 .5 0 1 MILE

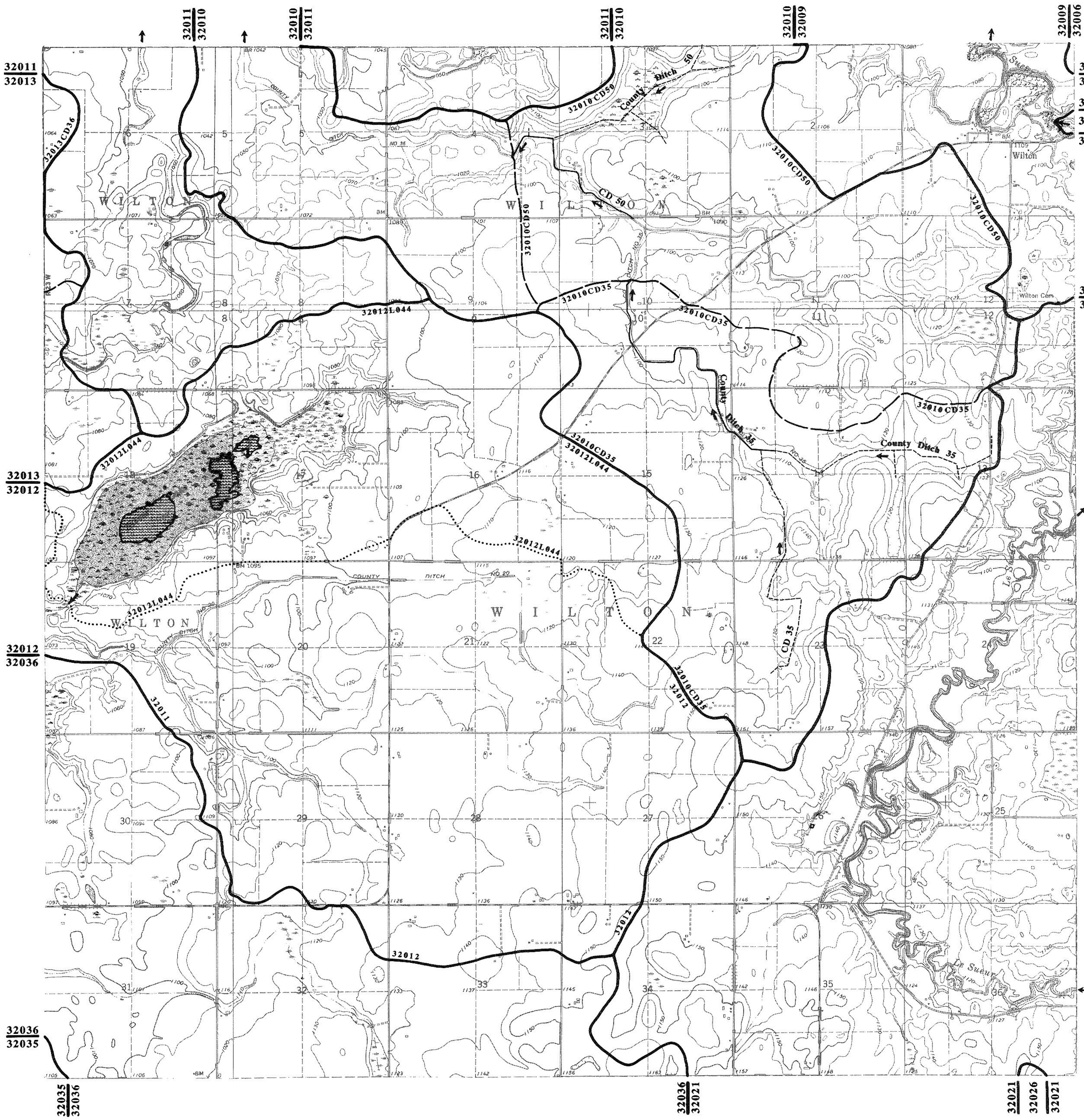
1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 .5 0 1 KILOMETRE

N

SURFACE WATER HYDROLOGY MAP

T. 106 N. R. 23 W.



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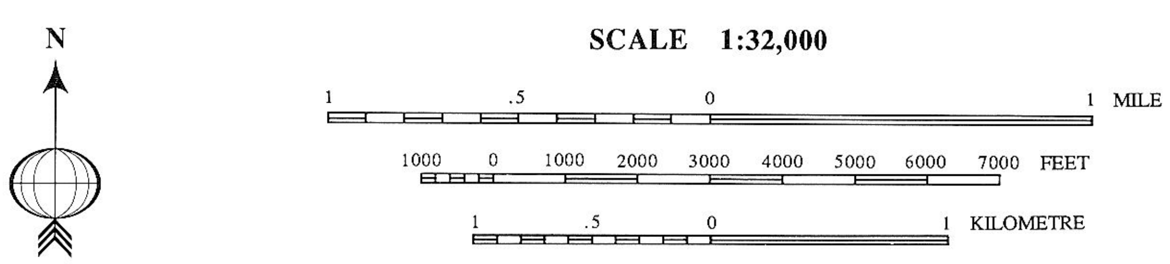
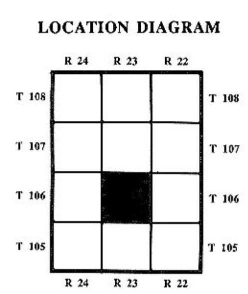
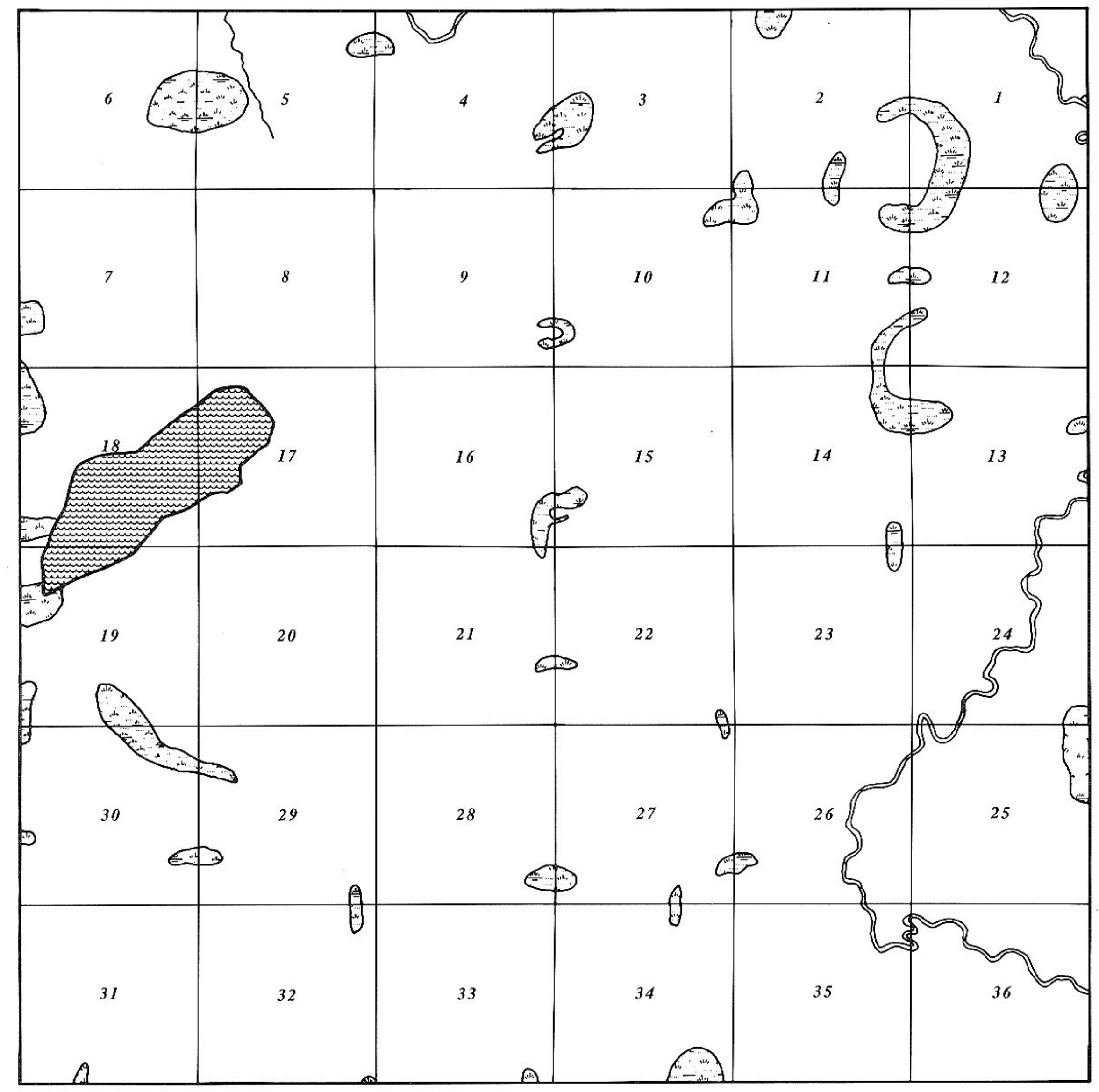




GENERAL LAND SURVEY MAP



SCALE: 1 : 64,000 1 inch = 1 mile

EXPLANATION

Wetland (Marsh, Slough)

Open Water (Lake, Pond)

Riverine (River, Stream)

EXPLANATION
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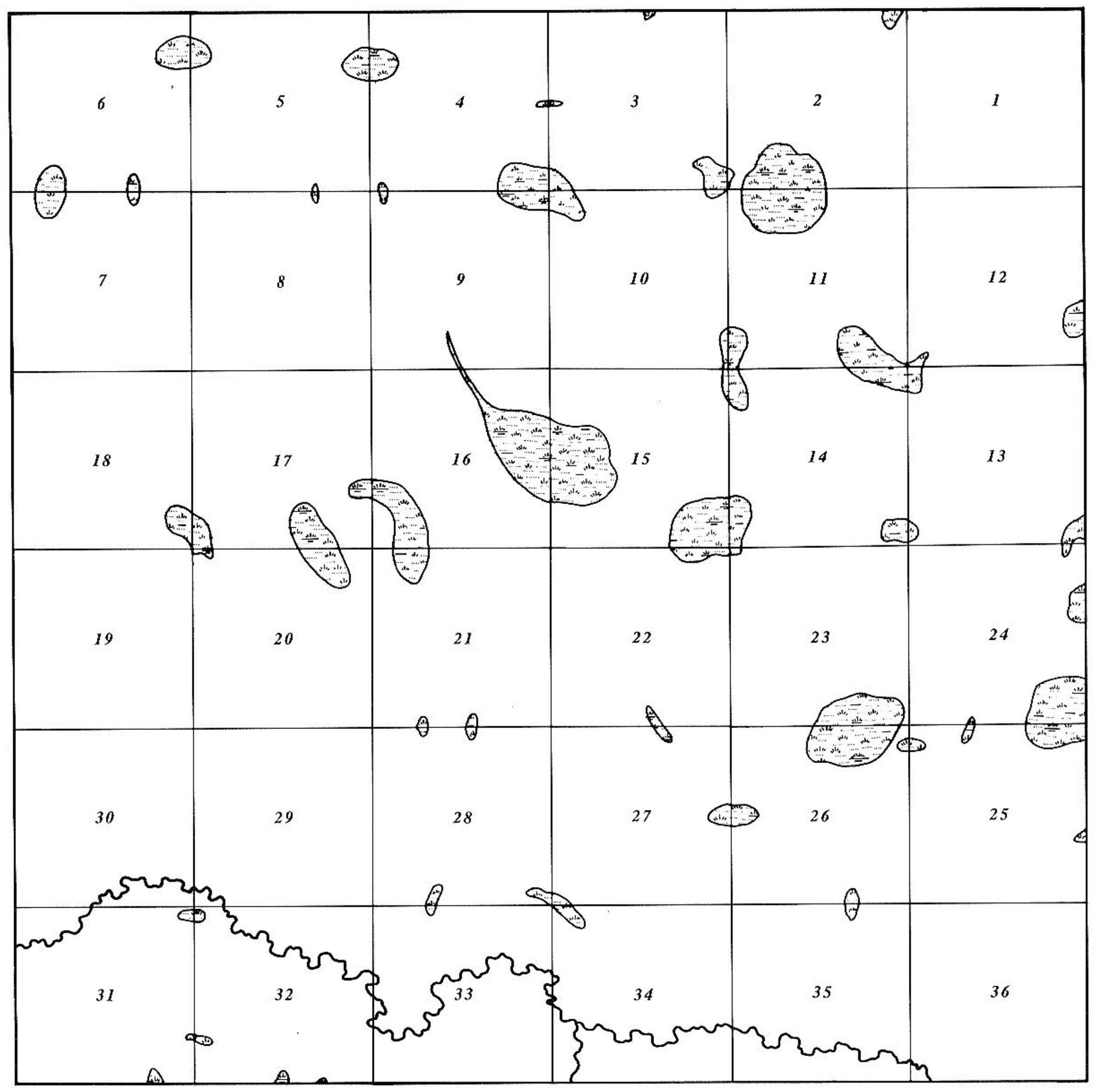
T. 106 N. R. 24 W.

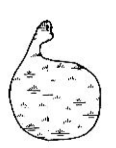
SURFACE WATER HYDROLOGY MAP

GENERAL LAND SURVEY MAP



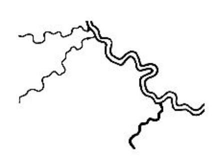
SCALE: 1 : 64,000 1 inch = 1 mile

EXPLANATION

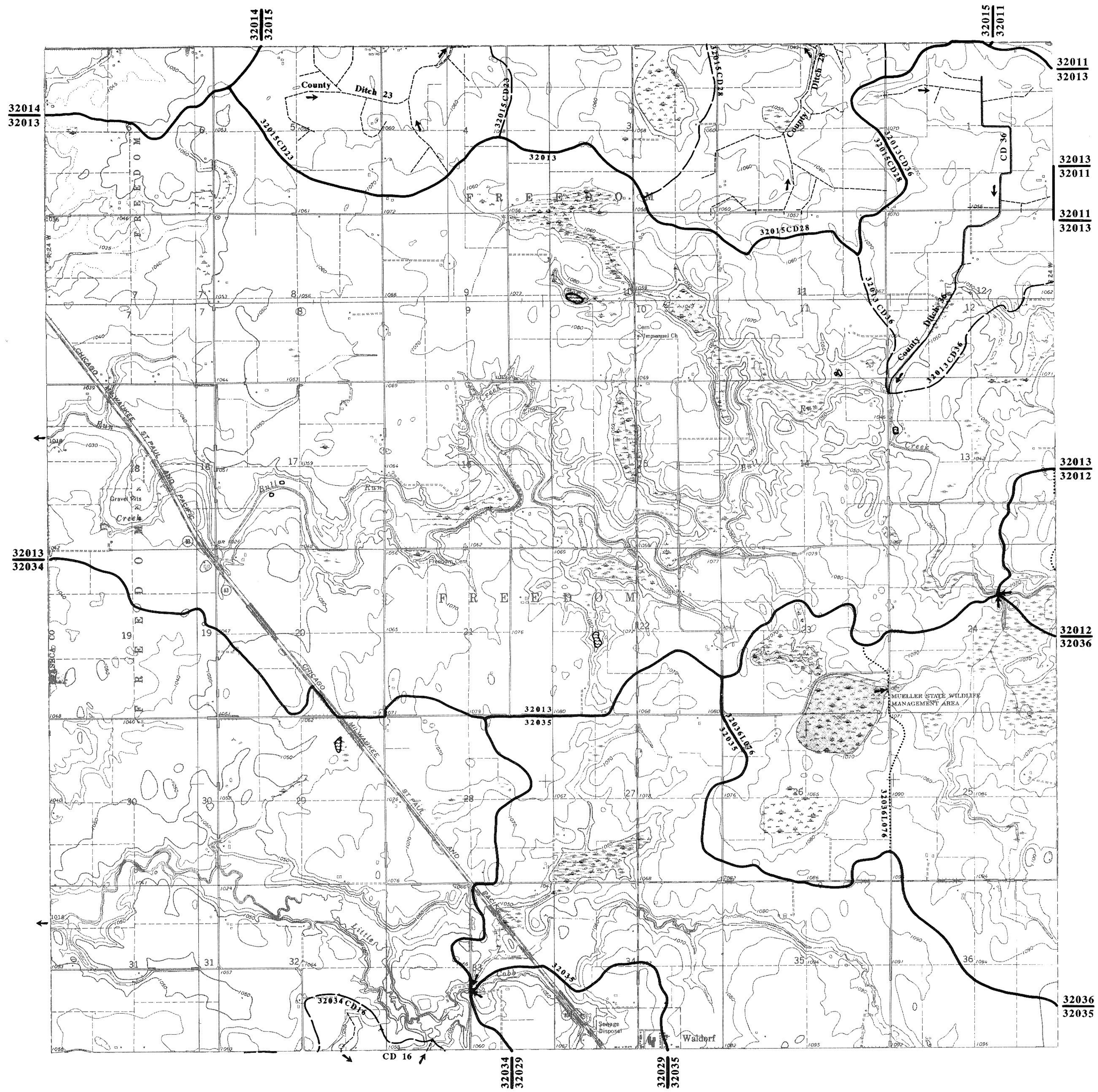


Wetland
(Marsh, Slough)

Open Water
(Lake, Pond)



Riverine
(River, Stream)

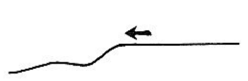


EXPLANATION
Surface Water Hydrology Map

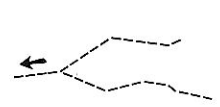
Minor Watershed Boundary

Ditchshed Boundary

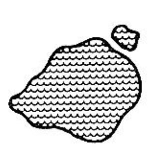
Lakeshed Boundary



Open Drainage Ditch
(Arrow points in direction of flow)

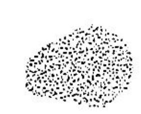


Tile Drainage Ditch
(Arrow points in direction of flow)

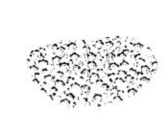


Open Water
(NWI Lacustrine: Limnetic and Littoral
Palustrine: Unconsolidated Bottom
and Aquatic Bed)

Emergent Wetlands
(NWI Palustrine: Emergent)

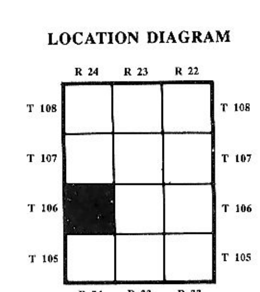


Shrub Wetlands
(NWI Palustrine: Scrub-Shrub)



Forested Wetlands
(NWI Palustrine: Forested)

LOCATION DIAGRAM



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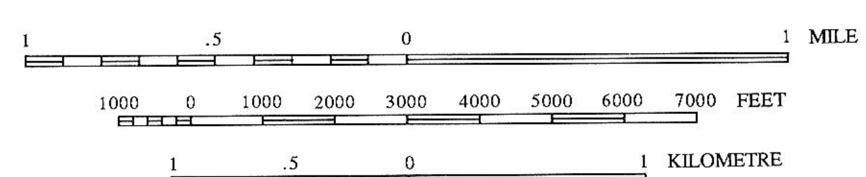
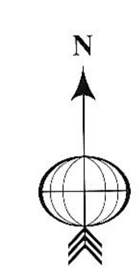
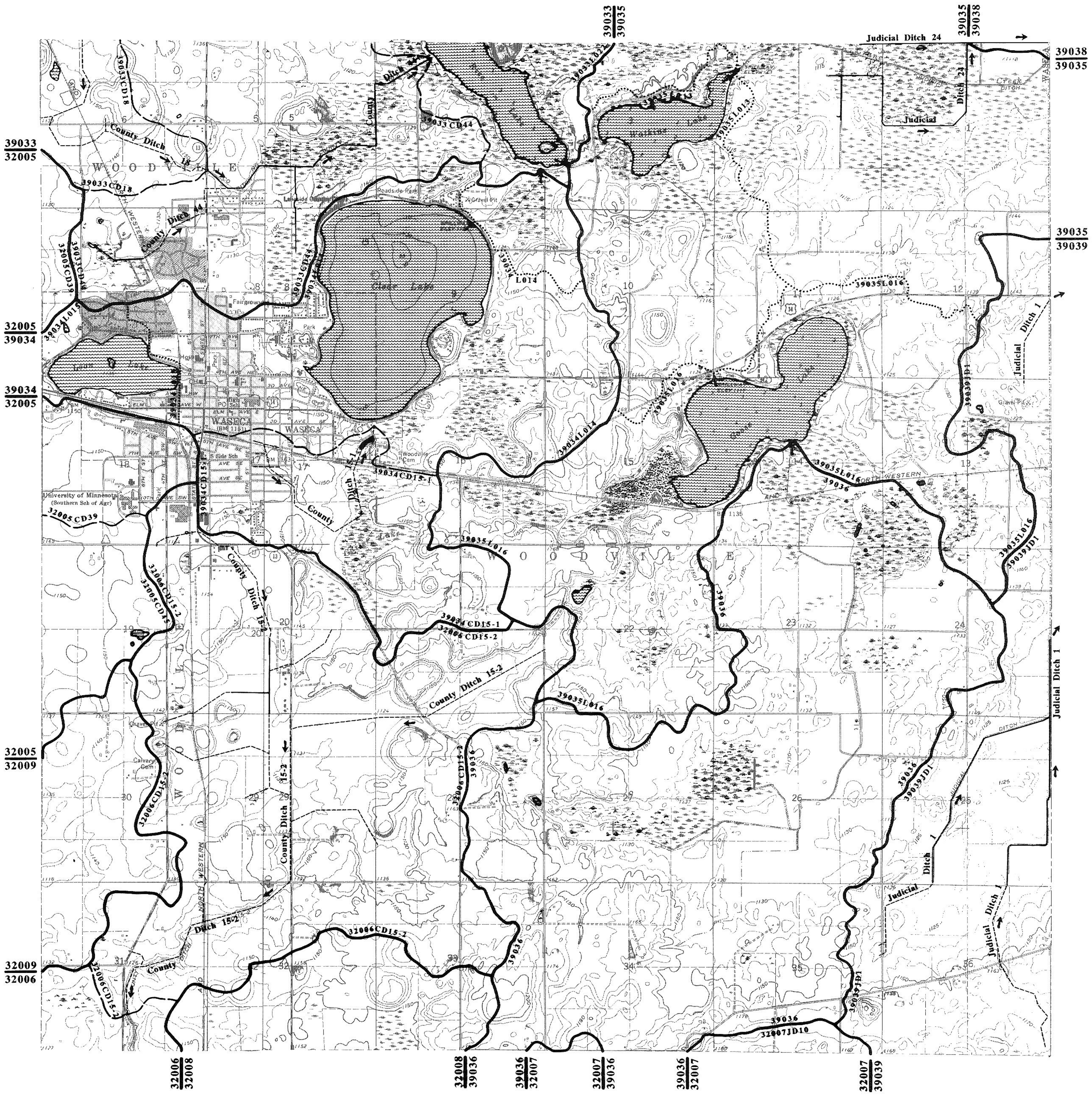


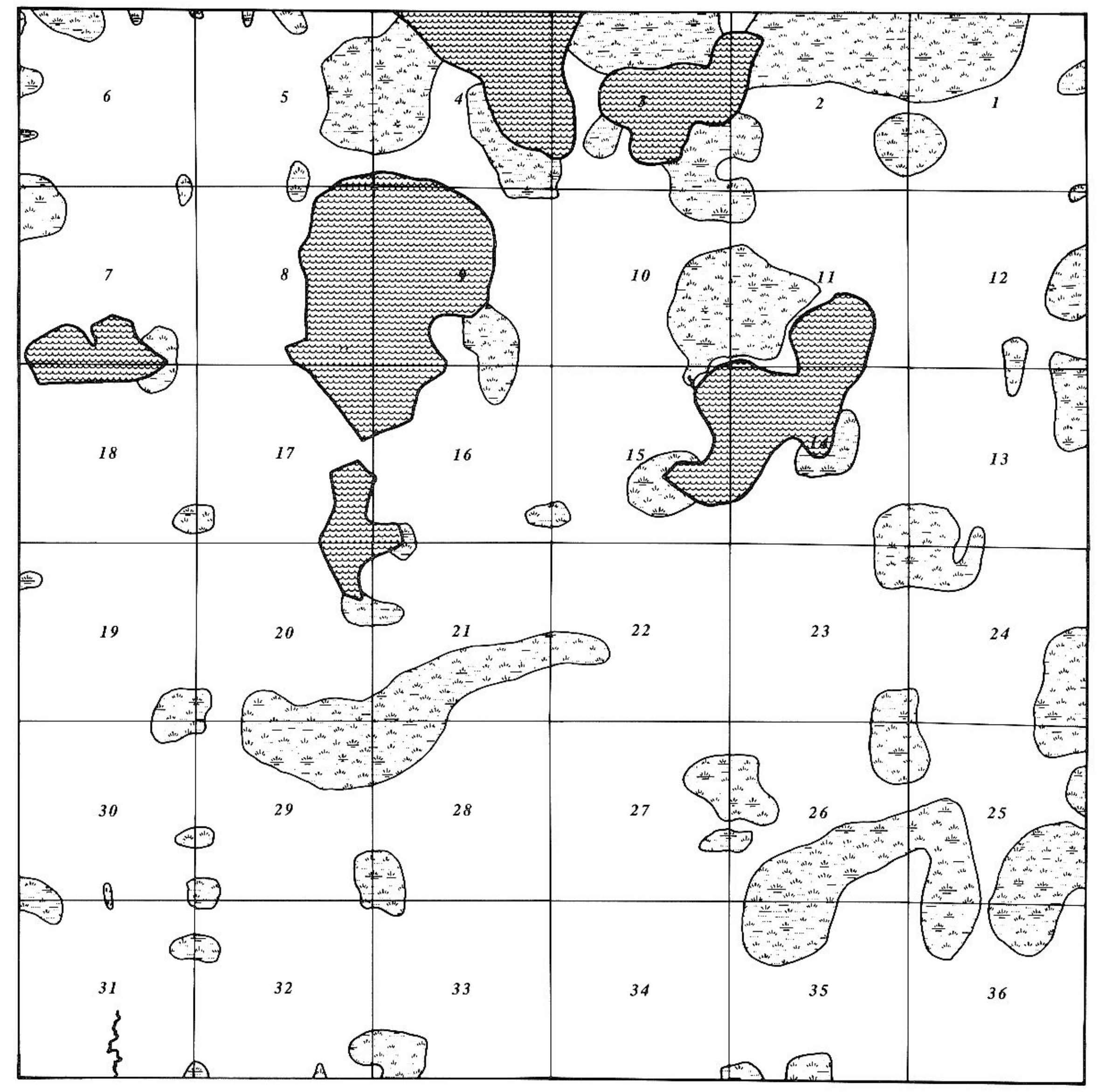


SURFACE WATER HYDROLOGY MAP

T. 107 N. R. 22 W.



GENERAL LAND SURVEY MAP



SCALE: 1 : 64,000 1 inch = 1 mile

EXPLANATION

Wetland (Marsh, Slough)

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EXPLANATION
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N

SCALE 1:32,000

1 .5 0 1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 .5 0 1 KILOMETRE

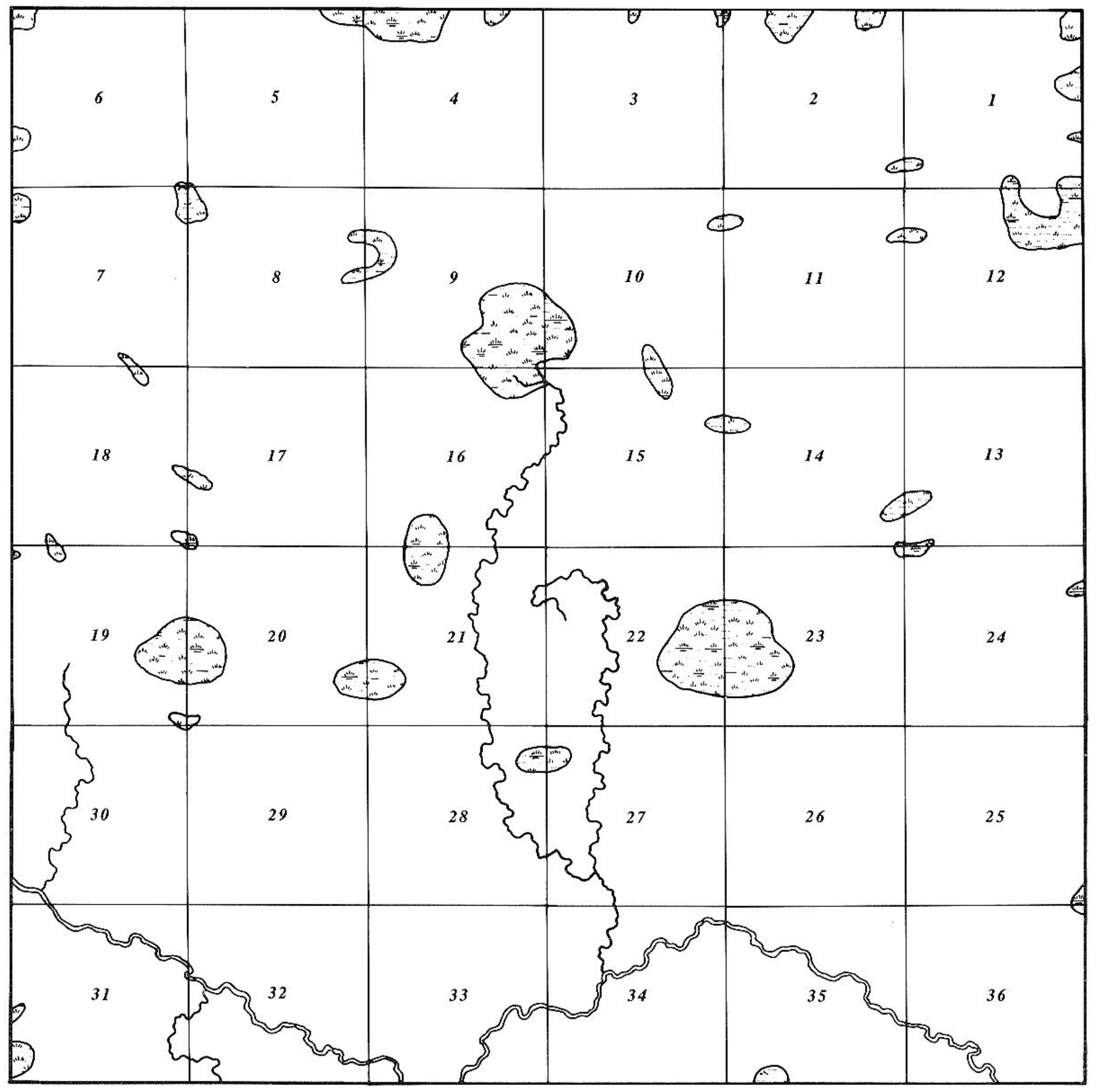
LOCATION DIAGRAM

R 24 R 23 R 22

T 108 T 107 T 106 T 105

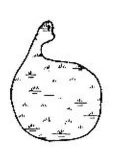
T. 107 N. R. 23 W.

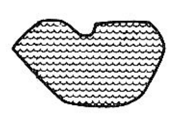
GENERAL LAND SURVEY MAP

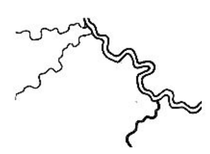


SCALE: 1 : 64,000 1 inch = 1 mile

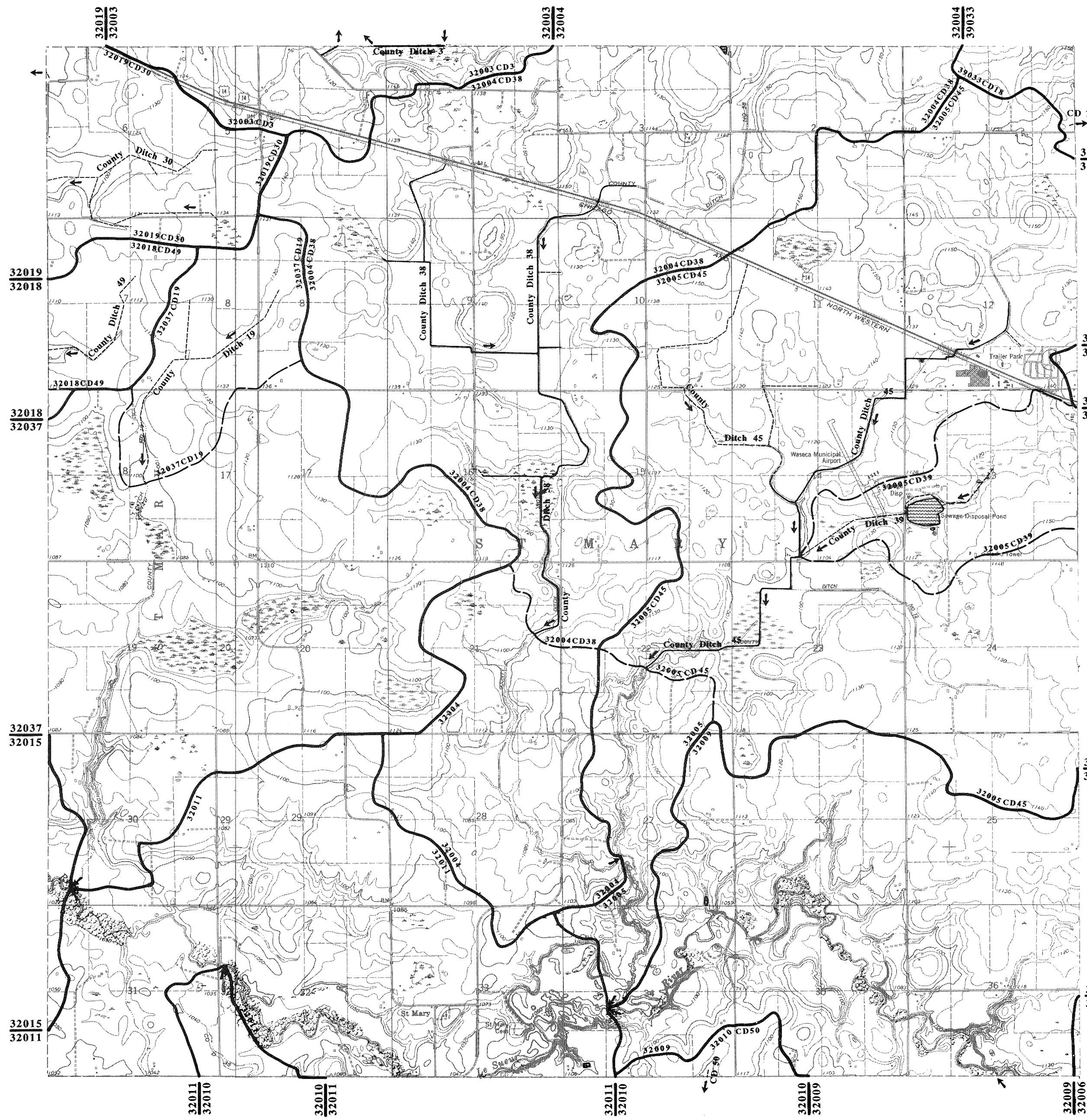
EXPLANATION


Wetland (Marsh, Slough)


Open Water (Lake, Pond)


Riverine (River, Stream)

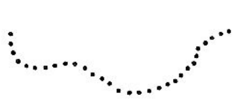
SURFACE WATER HYDROLOGY MAP



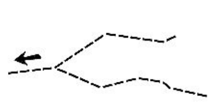
EXPLANATION
Surface Water Hydrology Map

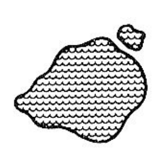

Minor Watershed Boundary


Ditchshed Boundary


Lakeshed Boundary


Open Drainage Ditch (Arrow points in direction of flow)


Tile Drainage Ditch (Arrow points in direction of flow)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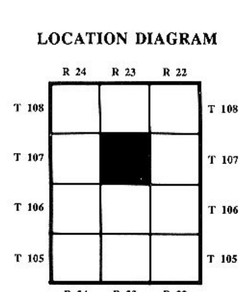

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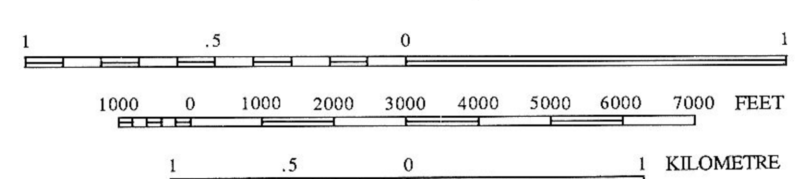
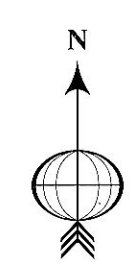
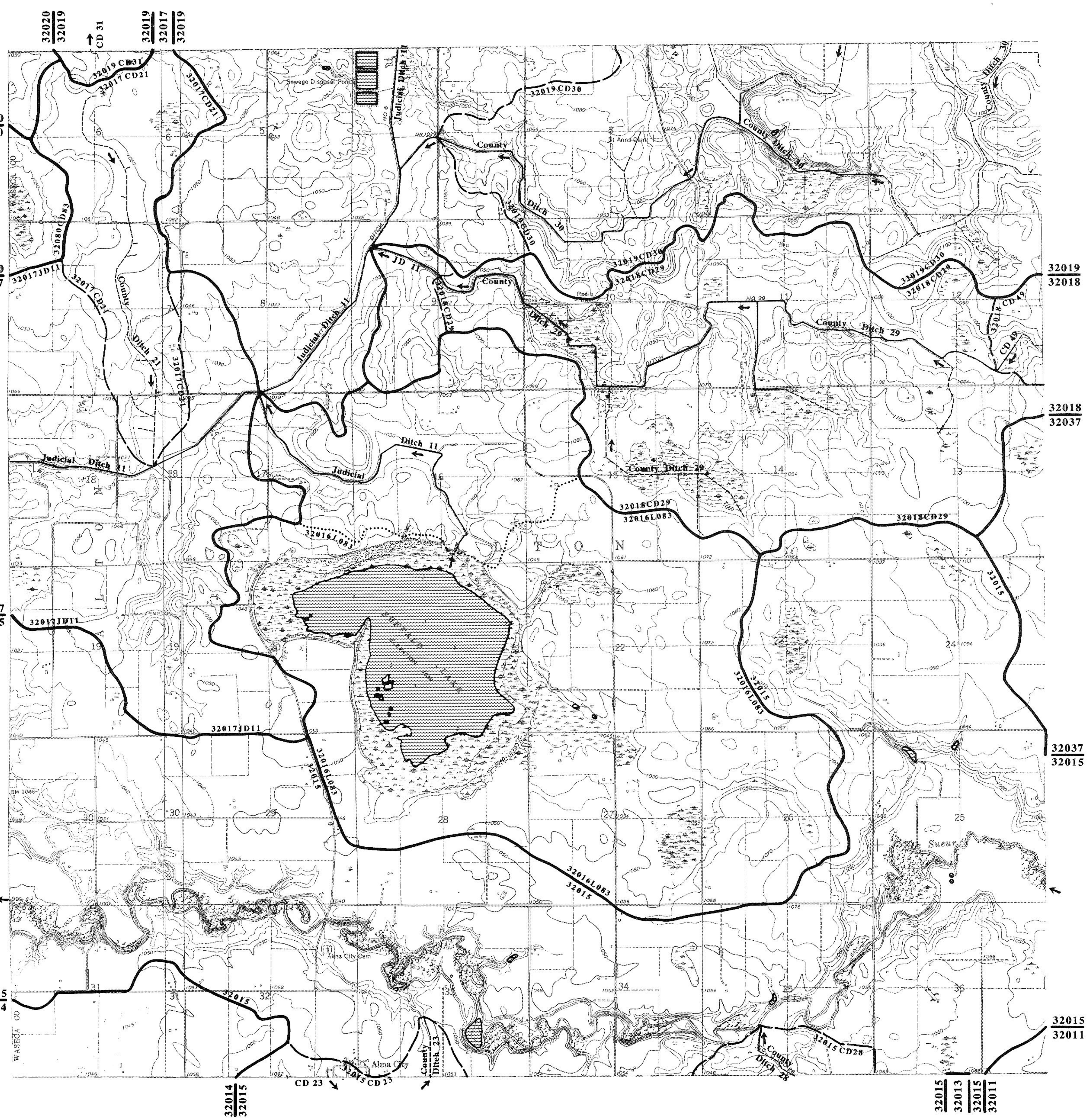




SURFACE WATER HYDROLOGY MAP

T. 107 N. R. 24 W.



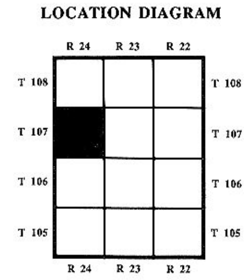
SCALE 1:32,000

1 .5 0 1 MILE

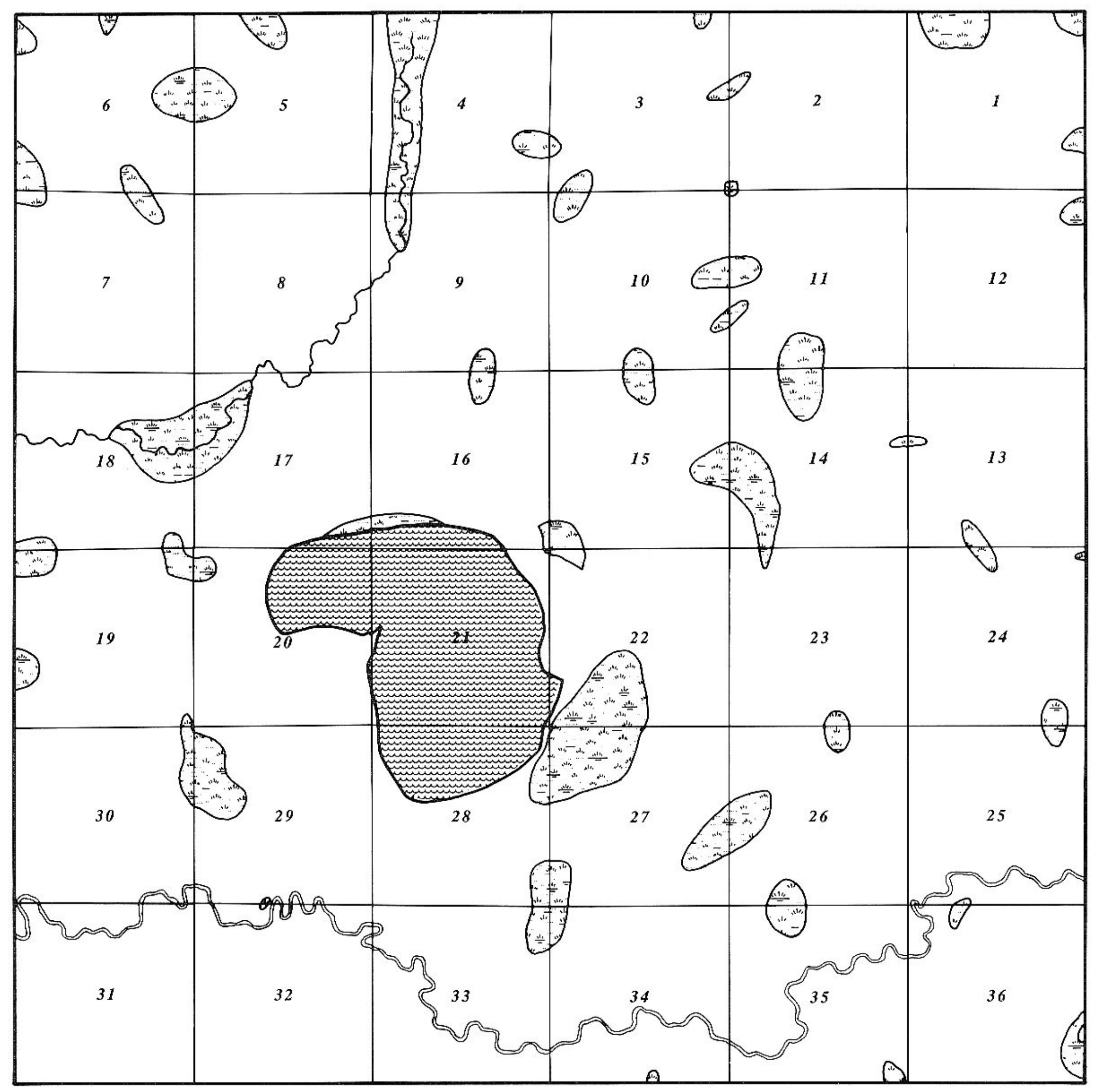
1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 .5 0 1 KILOMETRE

LOCATION DIAGRAM



GENERAL LAND SURVEY MAP



SCALE: 1 : 64,000 1 inch = 1 mile

EXPLANATION

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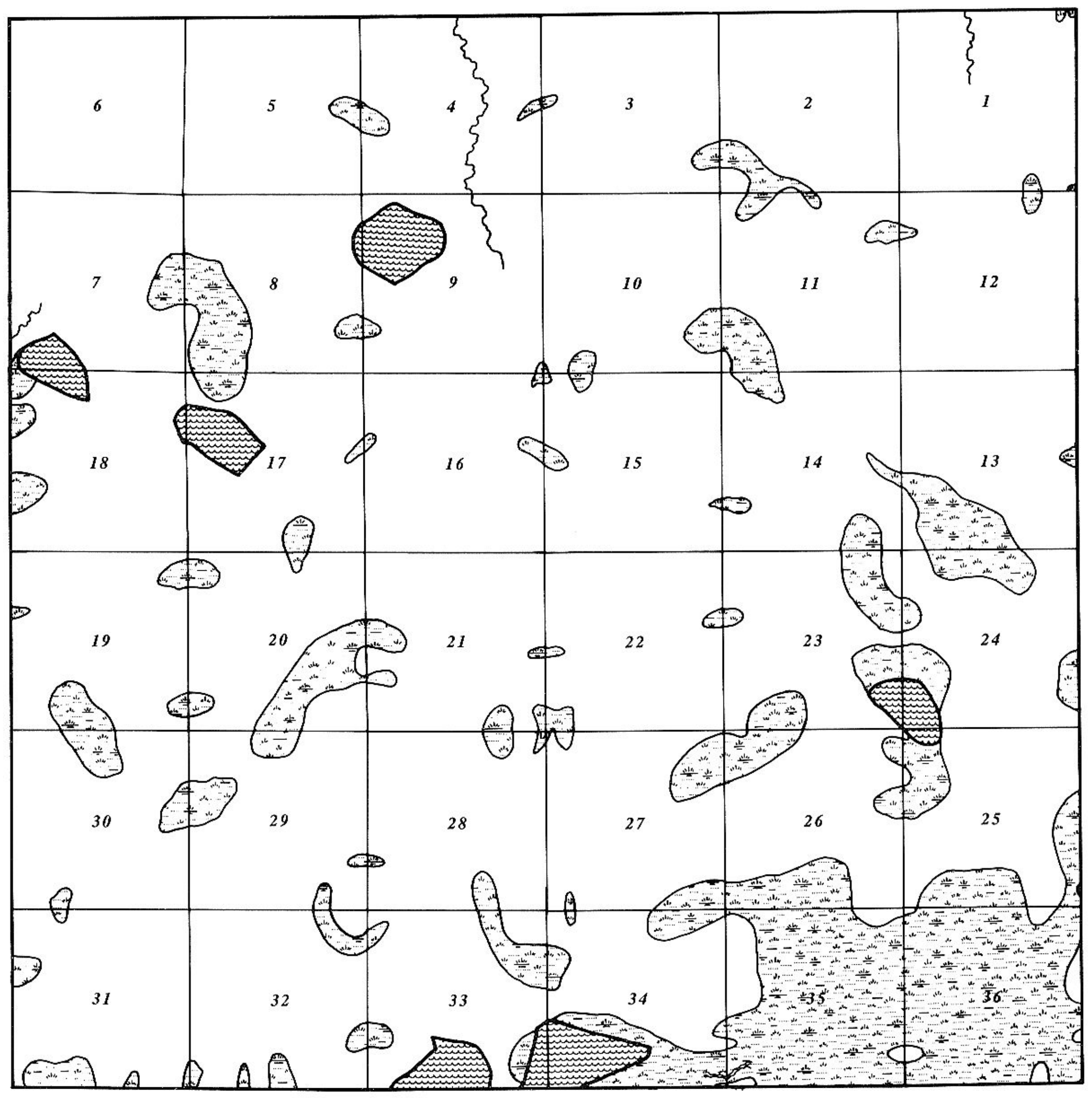
T. 108 N. R. 22 W.

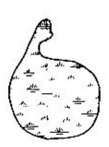
SURFACE WATER HYDROLOGY MAP

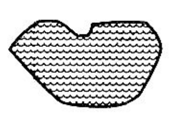
GENERAL LAND SURVEY MAP

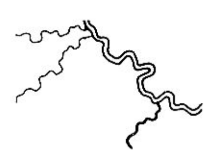


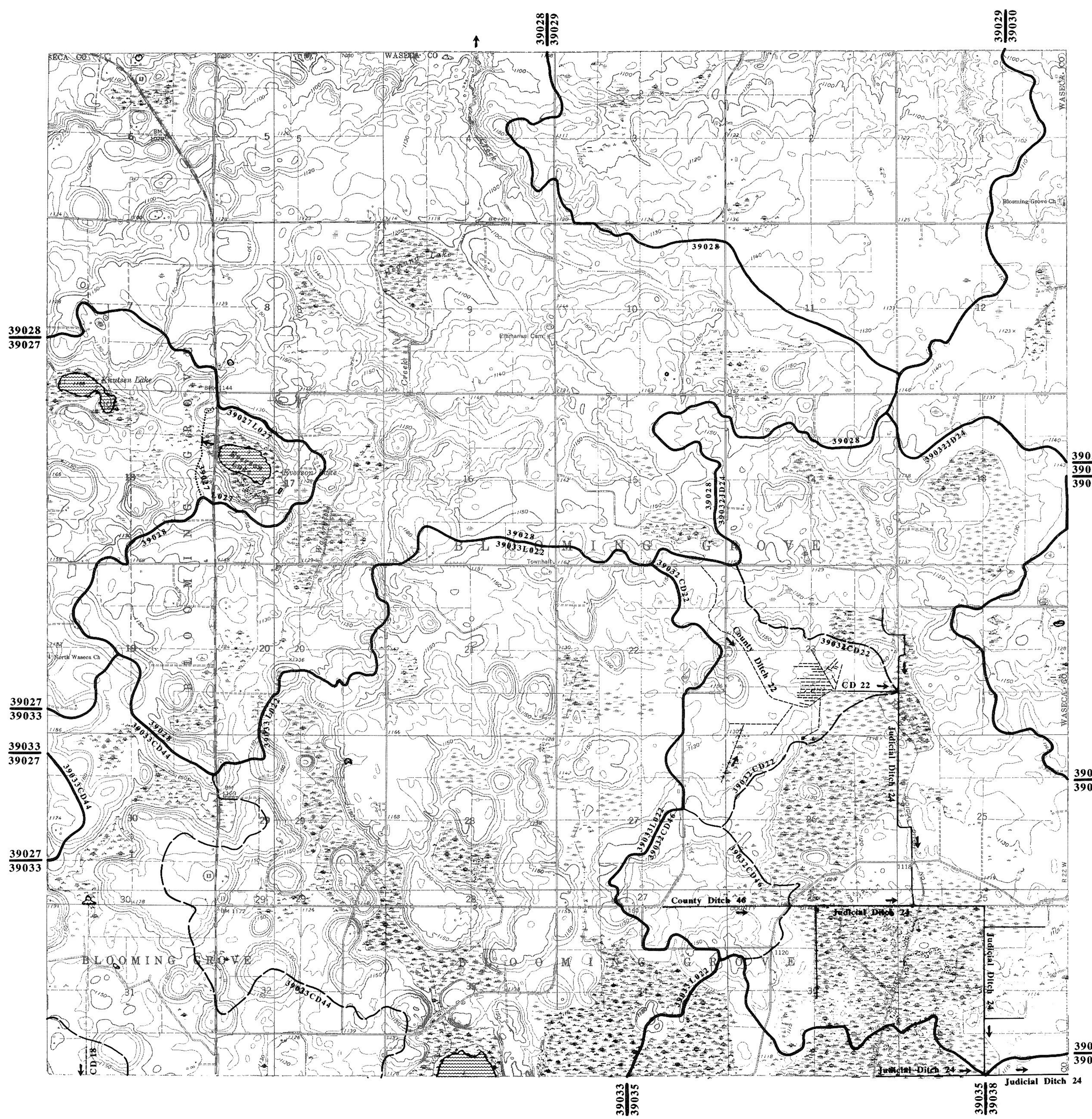
SCALE: 1 : 64,000 1 inch = 1 mile

EXPLANATION


Wetland
(Marsh, Slough)

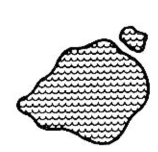

Open Water
(Lake, Pond)


Riverine
(River, Stream)

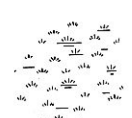


EXPLANATION
Surface Water Hydrology Map


Minor Watershed Boundary


Open Water
(NWI Lacustrine: Limnetic and Littoral
Palustrine: Unconsolidated Bottom
and Aquatic Bed)

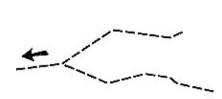

Ditchshed Boundary


Emergent Wetlands
(NWI Palustrine: Emergent)

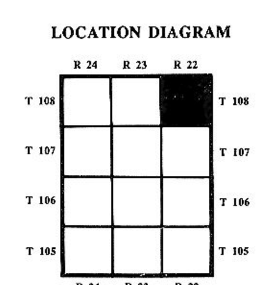

Lakeshed Boundary


Open Drainage Ditch
(Arrow points in direction of flow)

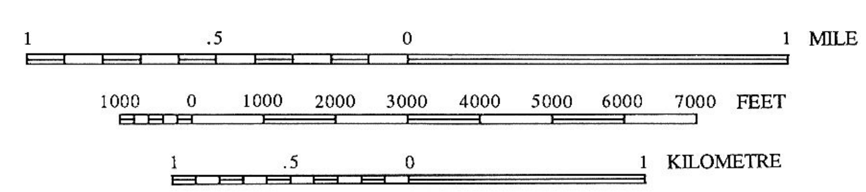

Shrub Wetlands
(NWI Palustrine: Scrub-Shrub)

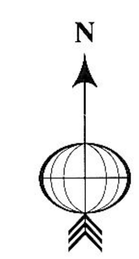

Tile Drainage Ditch
(Arrow points in direction of flow)


Forested Wetlands
(NWI Palustrine: Forested)



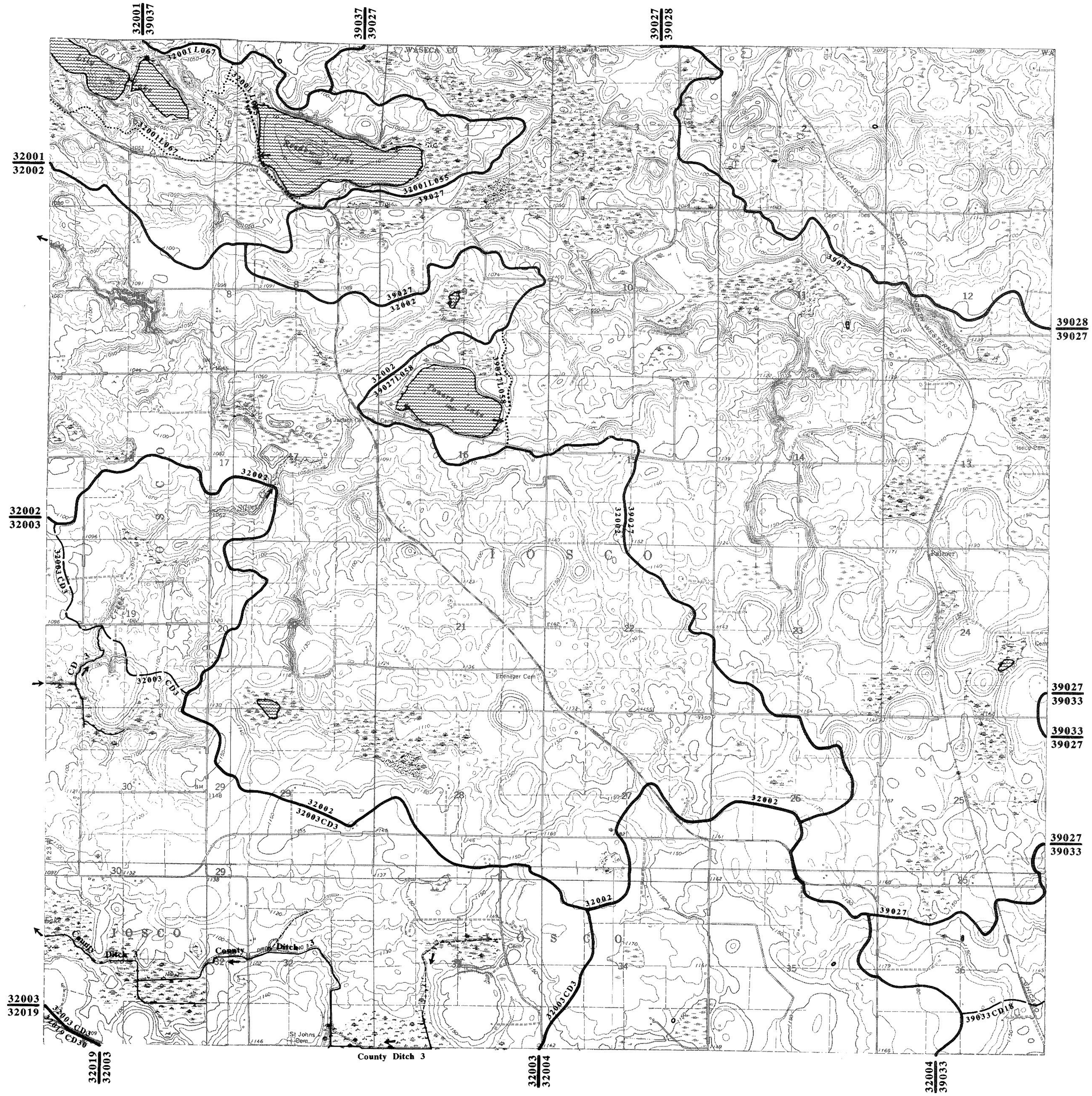
SCALE 1:32,000



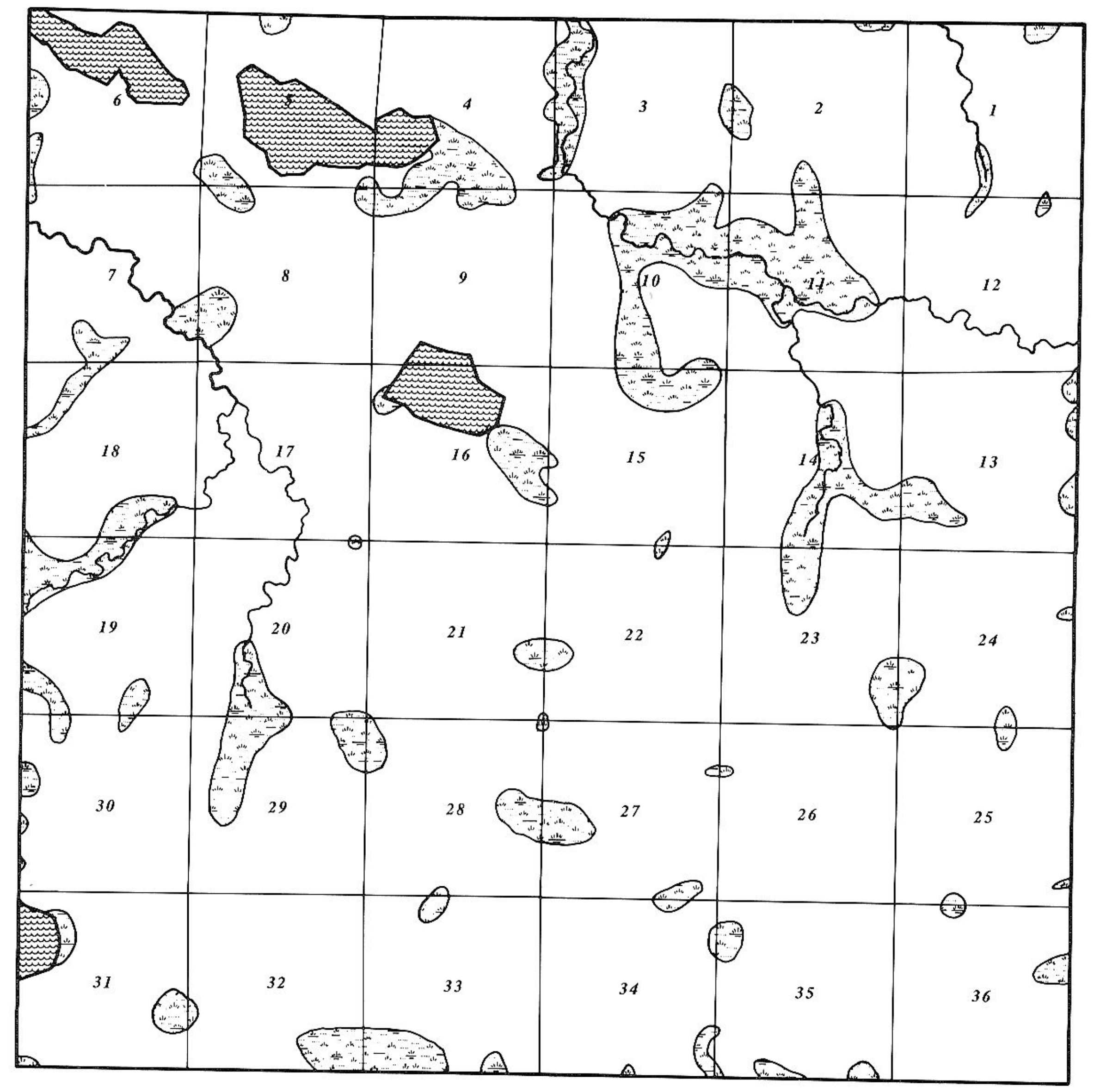


SURFACE WATER HYDROLOGY MAP

T. 108 N. R. 23 W.



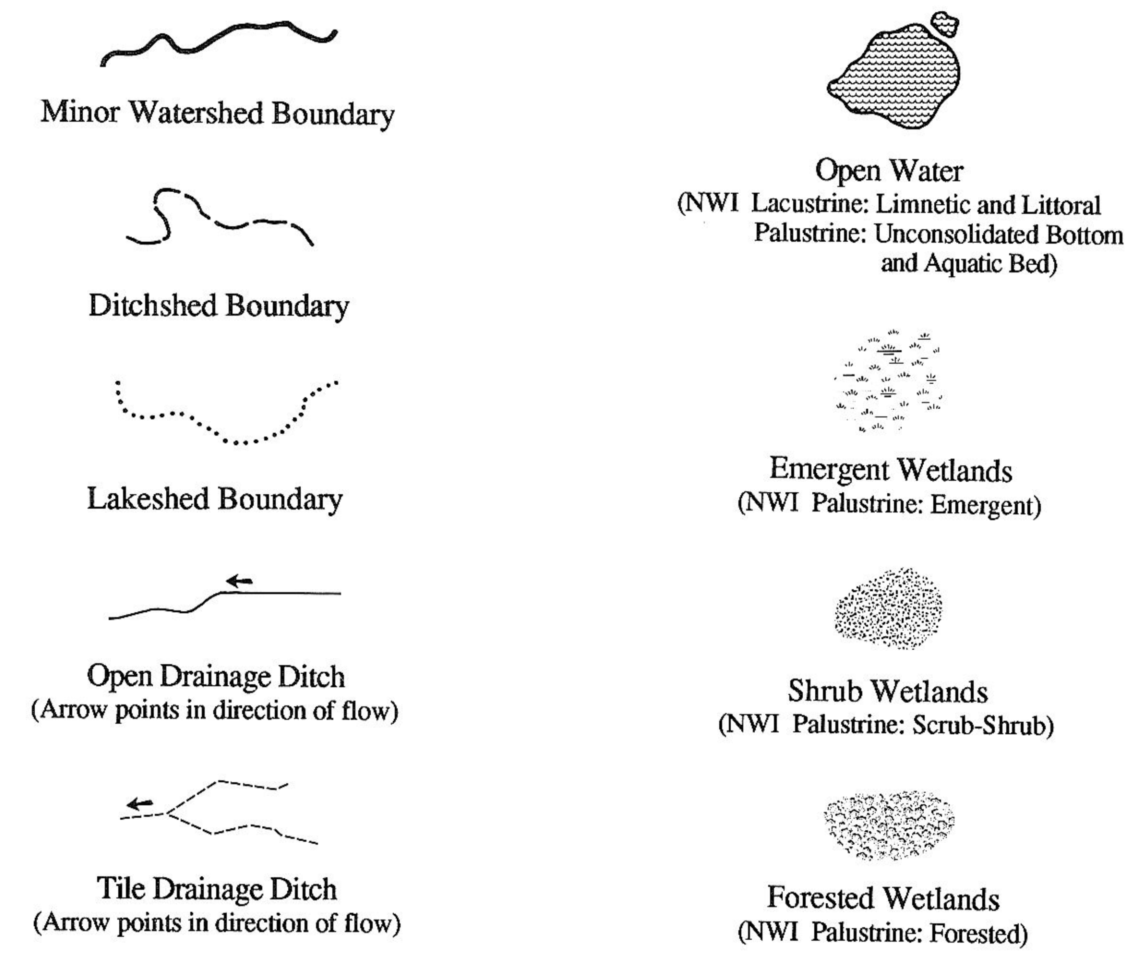
GENERAL LAND SURVEY MAP

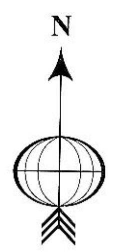


SCALE: 1 : 64,000 1 inch = 1 mile

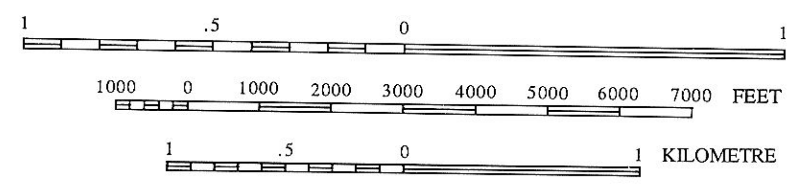
EXPLANATION

EXPLANATION
Surface Water Hydrology Map

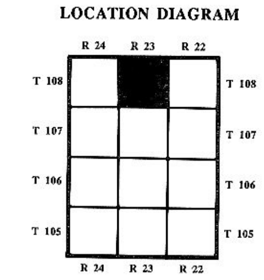




SCALE 1:32,000

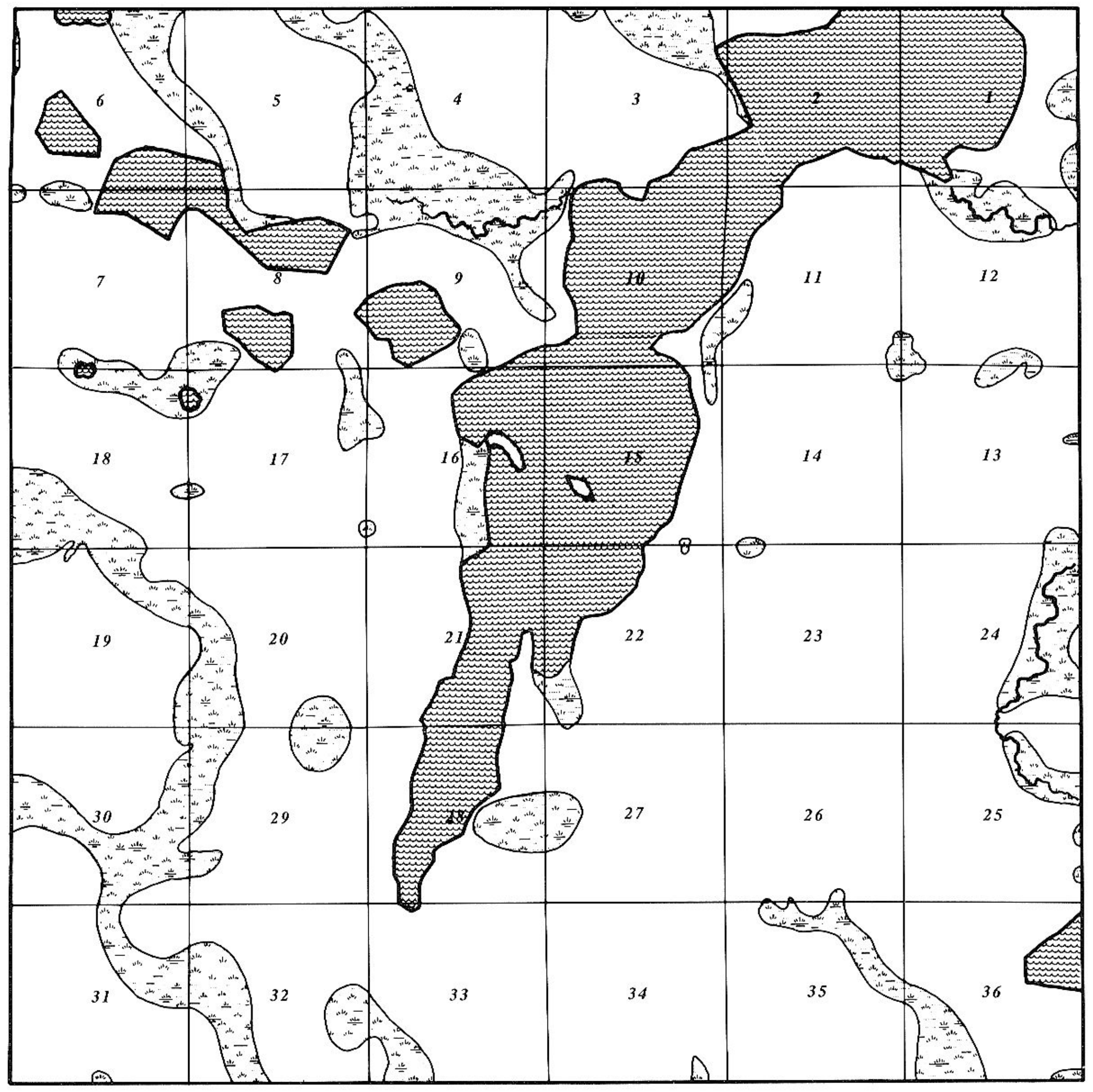


LOCATION DIAGRAM



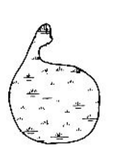
T. 108 N. R. 24 W.

GENERAL LAND SURVEY MAP

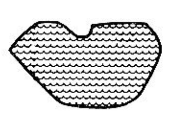


SCALE: 1 : 64,000 1 inch = 1 mile

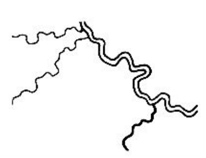
EXPLANATION



Wetland
(Marsh, Slough)

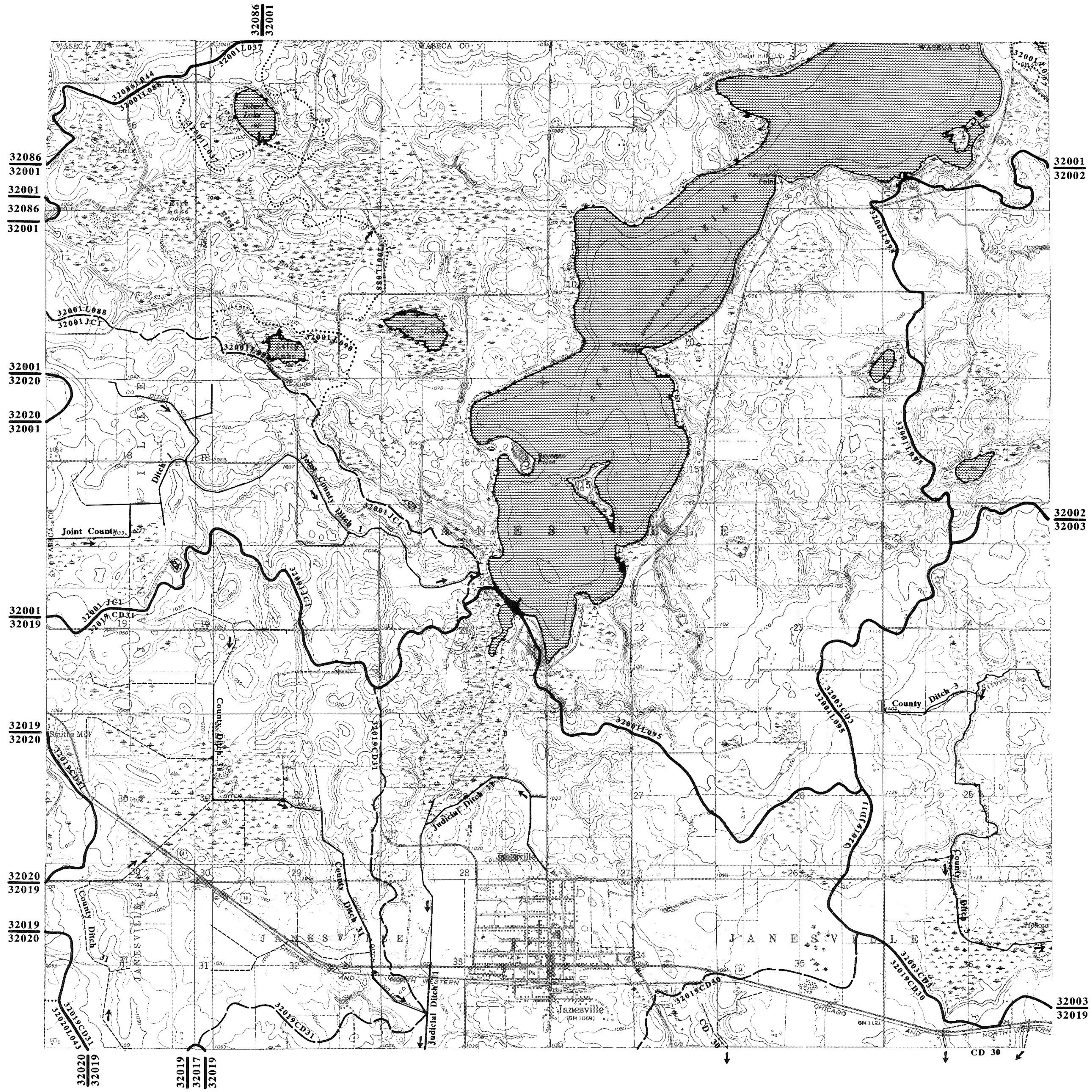


Open Water
(Lake, Pond)



Riverine
(River, Stream)

SURFACE WATER HYDROLOGY MAP

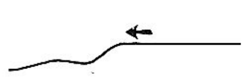


EXPLANATION
Surface Water Hydrology Map

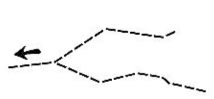
Minor Watershed Boundary

Ditchshed Boundary

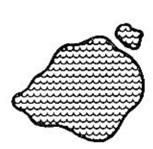
Lakeshed Boundary



Open Drainage Ditch
(Arrow points in direction of flow)



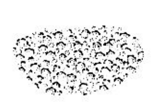
Tile Drainage Ditch
(Arrow points in direction of flow)



Open Water
(NWI Lacustrine: Limnetic and Littoral
Palustrine: Unconsolidated Bottom
and Aquatic Bed)

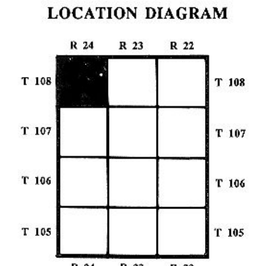
Emergent Wetlands
(NWI Palustrine: Emergent)

Shrub Wetlands
(NWI Palustrine: Scrub-Shrub)



Forested Wetlands
(NWI Palustrine: Forested)

LOCATION DIAGRAM



SCALE 1:32,000

1 .5 0 1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 .5 0 1 KILOMETRE

N