Kane County Water Resources Investigations: Interim Report on Geologic Investigations

William S. Dey, B. Brandon Curry, John C. Sieving,
Alec M. Davis, and Curt C. Abert

Illinois State Geological Survey
615 E. Peabody Drive
Champaign, Illinois 61820

Submitted under Contract No. 02-279
to
Kane County, Illinois
Water Resources Department
Paul Schuch, Project Manager
Contract No. 02-279

May 7, 2004
Illinois State Geological Survey
Open File Series 2004-9

Kane County Water Resources Investigations: Interim Report on Geologic Investigations

William S. Dey, B. Brandon Curry, John C. Sieving, Alec M. Davis, and Curt C. Abert

Figures

Tables

Accompanying Maps

EXECUTIVE SUMMARY

This report summarizes the initial efforts of a multi-phase investigation on the water resources of Kane County. The objective this report is to provide baseline information on the geology and hydrogeology of Kane County as part of an assessment of its water resources (Meyer et al., 2002). The emphasis of this report is on Quaternary deposits and shallow bedrock geology.

Kane County has recently undergone tremendous growth. In 1996, the population of Kane County was 370,361 and was projected to grow to about 540,00 by the year 2020 (Kane County, 1996). To sustain this rapid growth, Kane County needs reliable information about its geology and available water resources. Understanding the geology of Kane County is key to effectively evaluating its groundwater resources. The composition, sequence, and geometry of the geologic deposits affect all aspects of hydrogeology. Accurate geologic information is needed to predict sustainable yield from aquifers, estimate rates groundwater and determine areas of greater groundwater recharge, evaluate interactions between surface water and groundwater, and assess the potential impact of surface or near surface activities on groundwater quality.

A conceptual model of the geology of Kane County was developed from the published literature and the expertise of Illinois State Geological Survay (ISGS) geologists working in northeastern Illinois. The conceptual model includes the expected sequence of lithostratigraphic units, mechanisms involved in depositing and modifying those units, and their expected distribution across the county.

A digital geologic database was constructed for the project. The main source of data was existing water well and other geologic boring records at the ISGS. Other geophysical and point source data were incorporated into the database. A limited amount of new geophysical data was collected for the project, and one new stratigraphic test boring was drilled. A subset of wells or borings was selected as the primary wells for use in this study. The locations of these wells were verified, and the location's accuracy was ranked according to the success of the verification method. These stratigraphic assignments were made from geologic logs of primary wells where possible. The stratigraphic assignments were used to generate isopach (thickness) maps or three-dimensional upper and lower surfaces of selected lithostratigraphic units, including all of the major glacial diamicton units. The isopach maps and surfaces were used to create the map products that accompany this report.

Major Quaternary aquifers in Kane County include the St. Charles Aquifer, the Valparaiso Aquifer, the Bloomington Aquifer, and the Kaneville Aquifer. Preliminary mapping efforts have placed portions of the St. Charles and Aurora Bedrock Valleys and the St. Charles Aquifer in new locations. Preliminary results indicate the St. Charles Aquifer is not as continuous as previously mapped, and all of the major aquifers are not as thick as previously mapped. Additionally, the geology of the Valparaiso and Bloomington Aquifers is more complex than previously reported.

Based on the work to date, this report is accompanied by the following products: the *Preliminary Bedrock Geology Map, Kane County*, Illinois (Dey et al., 2005c); the *Preliminary Map of Aquifer Sensitivity to Contamination, Kane County, Illinois* (Dey et al., 2004a); the *Preliminary Map of Major Quaternary Aquifers, Kane County, Illinois* (Dey et al., 2004b); the *Preliminary Three-Dimensional Geologic Model, Kane County, Illinois* (Abert et al., 2004); and *Preliminary Geologic Cross Sections, Kane County, Illinois* (Dey et al., 2004d). All were produced at a scale of 1: 100,000. Revised versions of these maps are scheduled for publication in April 2007. This report presents preliminary results from the geologic investigations and provides a foundation for ongoing three-dimensional geologic modeling and input for potentiometric surface mapping and groundwater flow modeling.

I. INTRODUCTION

Kane County has recently undergone tremendous population growth. The population in Kane County was 370,361 in 1996, and is projected to grow by 30 to 40% by the year 2020 (Kane County, 1996). In anticipation of the need for reliable information on available water resources, the County has contracted with the Illinois State Water Survey (ISWS) and Illinois State Geological Survey (ISGS) to assess its water resources (Meyer et al., 2002). The overall goal of this assessment is to provide Kane County with the scientific basis for developing policies and management strategies for its water resources.

This *Interim Report on Geologic Investigations* is the first installment in a series of reports on the water resources of Kane County. It summarizes the results from the collection and initial analysis of the geologic data. This report provides the basis or framework for all of the other portions of the water resources investigation dealing with geology and groundwater. These include the *Interim Report on Three-Dimensional Geological Modeling*, the *Interim Report on Shallow Aquifer Potentiometric Surface Mapping*, the *Computer Flow Models of Aquifer Systems Used in Kane County and Supporting Hydrologic Database*, the F*inal Report on Geological Investigation*s, and the *Final Report on Groundwater Investigations* (Meyer et al., 2002). These reports and accompanying maps and models are due for delivery to Kane County over the next three years.

The focus of this study was to develop an accurate model of Kane County's geology, with particular emphasis on groundwater resources in the deposits above bedrock. To aid in accurate interpretation of the geology, the study area was defined to extend one township (approximately six miles) beyond all the edges of Kane County (Figure 1) in order to prevent distortion of interpretations near the county line and to aid assessment of hydrogeologic influences coming from outside the county. Although the conceptual model and geologic interpretations extended into adjacent counties, the main effort was inside Kane County, and only map products of the county have been produced.

II. CONCEPTUAL MODEL OF THE GEOLOGY OF KANE COUNTY

A conceptual model was developed for the geology of Kane County and adjacent areas. The conceptual model is a compilation of the understanding of the existing geology and the processes by which it formed. This model is an outgrowth of information from previously published materials, knowledge gained by ISGS staff and colleagues from experience working in Kane County and northeastern Illinois, and efforts from this mapping project. The basic components of the geologic model are the lithostratigraphic units, which are the layers of sediment that occur in a particular position in the succession of materials. Lithostratigraphic units have characteristic physical properties (such as particle-size distribution, color, and moisture content) that are readily observed in the field; the units are extensive enough to justify showing them on maps and cross sections.

The material properties of lithostratigraphic units are important not only in distinguishing the units one from another, but also in dictating how the unit affects the hydrogeology of the region. Some lithostratigraphic units consist primarily of well-sorted, coarse-textured material, such as a sand or gravel deposit. Stratigraphically a sand deposit may be classified as part of the Henry Formation, for example, but the importance of the unit will be how it behaves as an aquifer. The unit's behavior as an aquifer will be controlled by saturation, the texture of the material, its areal extent, and how the thickness varies across its extent. Assignment of a lithostratigraphic designation to a deposit allows mappers to make spatial correlations based on geologic interpretations. In turn, the spatial correlations can be used for hydrogeologic considerations.

For example, the Tiskilwa Formation consists of reddish brown to gray, sandy loam to silt loam diamicton. Diamicton describes a deposit made up of a mixture of particles with a wide range of grain sizes, usually from clay to boulders. Most diamicton of glacial origin in Illinois is matrix-supported, meaning that the larger-sized particles (gravel to boulders) are encased by a mixture of the finer particles (clay, silt, and sand). The Tiskilwa Formation covers a large portion of Kane County. While absent in the southeast, the Tiskilwa is over 200 feet thick in north central Kane County. The presence of a large thickness of glacial diamicton may retard the downward movement of water. The retardation of water movement may hinder the recharge of underlying aquifers while simultaneously providing

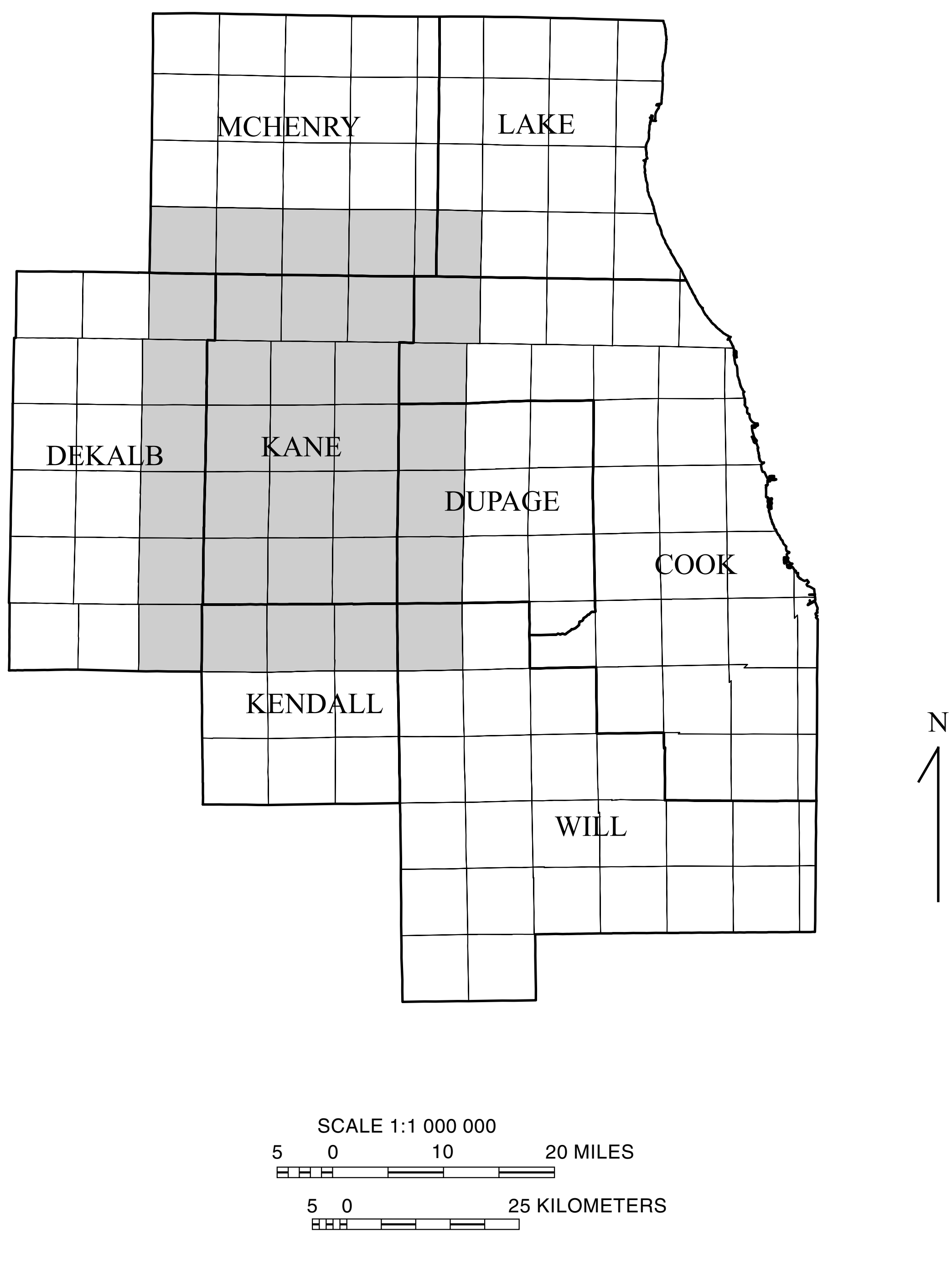

Figure 1 Location of the study area (in gray).

protection to those aquifers from sources of contamination at the ground surface. The distribution, i.e presence or absence, of the unit and its thickness have important hydrogeologic implications along with its material properties.

In addition to understanding the material properties of a unit, it is vital to understanding the processes that placed and shaped each lithostratigraphic unit. Understanding depositional and erosional processes provides insight into where units in a stratigraphic sequence may be present or absent. The conceptual model provided the framework of reference for the development of the map products provided in this report.

A. Previous Studies

The glacial geology of northeastern Illinois was first described by Leverett (1899). From the late 1920s to the 1970s, ISGS scientists and graduate students have periodically mapped the geology of Kane County at scales of 1:62,500 to 1:100,000 (Leighton, 1925; Leighton et al. 1928–1930, Gross, 1969; Gilkeson and Westerman, 1976; Kempton et al., 1977; Masters, 1978; Kemmis, 1978; Wickham, 1979; Wickham et al. 1988). The physical attributes of several glacially deposited units were characterized by partical size distribution, clay mineralogy, clast lithology, and geophysical logging (Hackett and Hughes, 1965; Lund, 1965; Landon and Kempton, 1971; Reed, 1972, 1975; Kemmis, 1981;Wickham et al., 1988). The geology of Kane County was thoroughly investigated during the effort to site the U.S. Department of Energy's Superconducting Super Collider in northeastern Illinois (Kempton et al., 1985, 1986, 1987; Curry et al., 1988; Graese et al., 1988; Vaiden et al., 1988). The focus of the Superconducting Super Collider investigation was the suitability of the bedrock under the region for construction of a tunnel to contain a particle accelerator. As an outgrowth of that investigation, digitized maps at a scale of 1:62,500 were published for bedrock topography (Vaiden and Curry, 1990), drift thickness (Erdmann et al., 1990), stack units to a depth of 15 m (Curry 1990a), Tiskilwa Formation isopach (Curry, 1990b), and other features. Recent hydrogeological investigations in Kane County have used seismic refraction, electrical earth resistivity surveys, test borings, and pumping tests to characterize additionally the glacial sediment and locate groundwater resources (Heigold, 1990; Gilkeson et al., 1987; Larson and Orozco, 1991, 1992; Larson et al., 1991, 1992; Morse and Larson, 1991; Curry et al., 2001).

Today, the ISGS continues to map surficial deposits at a scale of 1:24,000 with funding from county agencies, the U.S. Geological Survey (USGS)-funded StateMap and EdMap programs, and internal sources (Figure 2 and Table 1). EdMap is a part of the National Cooperative Geologic Mapping Program in which the USGS partially funds graduate students to map a quadrangle under the guidance of the student's advisor and with the cooperation and approval of the ISGS. Maps that are completed under the StateMap or EdMap program are available from the USGS (e.g., Stravers et al., 2001). StateMap quadrangles are later published by the ISGS as part of the Illinois Geologic Quadrangle Series [IGQ series]. Some maps currently in production will be published as part of the Illinois Preliminary Geological Map Series [IPGM series] to speed up their availability. For Kane County, IGQ maps of the surficial geology have been completed for the following 7.5-minute USGS topographic quadrangles: Aurora North (Curry, 2001a), Crystal Lake (Curry, 2004), Elburn (Grimley and Curry, 2001a), Geneva (Grimley and Curry, 2001b), and Sugar Grove (Curry et al., 2001). StateMap surficial geology maps that are being put into the IGQ or IGPM format include Elgin (Curry, 1998), Hampshire (Curry, 1999), Maple Park (Grimley, 1999), and Pingree Grove (Grimley, 1998). A surficial geology map of the Big Rock Quadrangle (Straver et al., 2001) was produced as part of the EdMap program.

B. Bedrock Stratigraphy

Nearly horizontal and gently folded Paleozoic sedimentary rocks underlie the Quaternary glacial deposits. The bedrock was deposited approximately 43 to 250 millions years ago (Cambrian to Pennsylvanian in age). Any rocks deposited younger than Silurian have been eroded away. The remaining sedimentary rocks, consisting primarily of dolostone, limestone, sandstone, and shale, are as much as 4,000 feet thick in northeastern Illinois (Willman et al., 1975).

The bedrock strata dip about 10 to 15 feet per mile (0.1 to 0.2) to the southeast, which means that any given stratigraphic unit in the bedrock will be at a higher elevation in the northwest than in the southeast. The most significant structural feature in Kane County is the east–southeast-trending Aurora Syncline. This structure occurs in the southeastern part of the county; the structure dies out to the west in the central part of T. 38 N., R. 8 E. (see Figures 8 and 10 in Graese, 1991). A greater proportion of limestone than dolostone is found in the bedrock in the Aurora Syncline

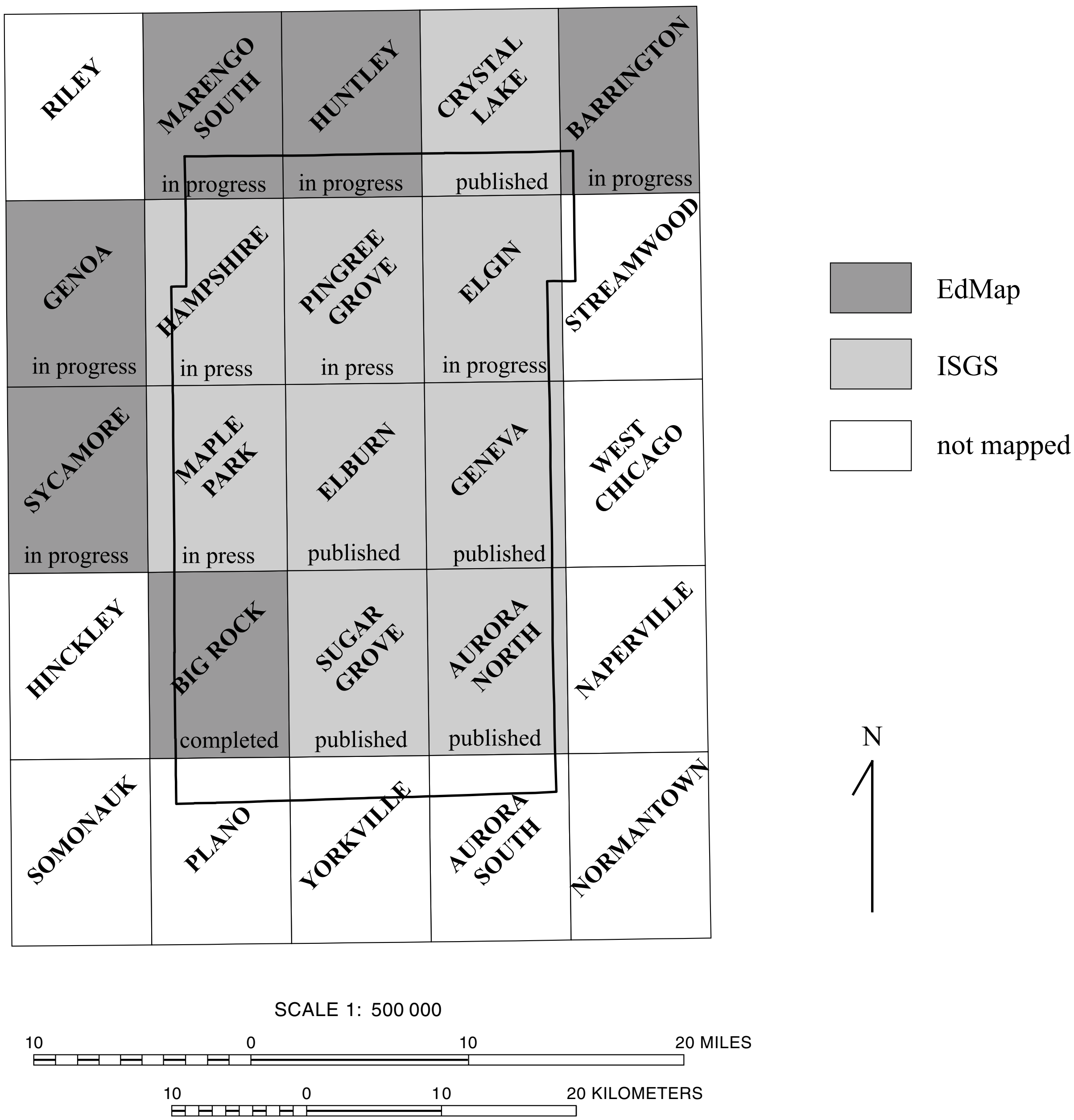

Figure 2 USGS 7.5-minute quadrangles in Kane County and adjoining areas, and the status of associated surficial geology maps and bedrock topography maps.

(see Figure 11 in Graese, 1991).

The Sandwich Fault Zone (SFZ) is located about 5 miles south and west of Kane County. It is a major structural feature in the region with more than 800 feet of near-vertical displacement (Graese et al., 1988). The SFZ is considered to be seismically inactive; no earthquakes with epicenters along this fault zone have been recorded (Heigold, 1972). Also, overlying glacial deposits have not been deformed, indicating that the most recent movement occurred more than 17,000 years ago (Kolata et al., 1978). Although high-resolution seismic data indicate that faulting is not common, normal bedrock faults with no more than about 35 feet of displacement occur in the county (Heigold, 1990). Seismic data will need to be acquired to determine whether significant displacement along other faults associated with the SFZ in Kane County.

Numerous formations and members are recognized in the Paleozoic strata. Most published geologic maps differentiate the following units: (1) Cambrian System (543–490 million years (my) B.P.) (undifferentiated formations, primarily sandstone and dolostone); (2) Ordovician System (490–443 my B.P.): comprising the Prairie du Chien Group (dolostone and sandstone), Ancell Group, including the St. Peter Sandstone (primarily sandstone, some shale and dolostone), Platteville Group (dolostone and limestone), Galena Group (dolostone and limestone) and Maquoketa Group (shale and dolostone, some limestone); and (3) Silurian System (443–417 my B.P.) (undifferentiated forma-

Table 1 Status of 1:24,000 Quadrangle in Kane County and adjacent areas. (IGQ Illinois Geological Quadrangle Series; IPGM Illinois Preliminary Geological Map Series; EdMap published through United States Geological Survey)

Quadrangle	Map Status
Riley	not mapped
Marengo South	EdMap in progress (Stravers, NIU)
Huntley	EdMap in progress (Stravers, NIU)
Crystal Lake	IGQ-in press (Curry); includes bedrock topography and drift thickness
Barrington	EdMap in progress (Stravers, NIU)
Genoa	EdMap in progress (Konen, NIU)
Hampshire	IGQ-in press (Curry)
Pingree Grove	IPGM in press (Gimley)
Elgin	IGQ – in progress (Curry); includes bedrock topography, drift thickness, and aquifer sensitivity
Streamwood	not mapped
Sycamore	EdMap in progress (Konen, NIU)
Maple Park	IPGM – in press (Grimley)
Elburn	IGQ (Grimley and Curry, 2001)
Geneva	IGQ (Grimley and Curry, 2002)
West Chicago	not mapped
Hinckley	not mapped
Big Rock	EdMap (Hibben and Stravers, 2000)

tions composed of dolostone and some limestone). The distribution of these rocks is related to the configuration of the bedrock surface that truncates southeasterly dipping rocks along the Wisconsin Arch.

The Galena and Maquoketa Groups, along with undifferentiated Silurian rock, are the most widespread units at the bedrock surface in Kane County. The bedrock surface represents a major unconformity that separates bedrock that is hundreds of millions of years old from glacial deposits that are only hundreds to tens of thousands of years old.

Buried valleys in the bedrock surface, like those on the ground surface, expose older rocks with increasing depth. The oldest bedrock at the bedrock surface in Kane County is thickly bedded dolostone of the upper Galena Group. This unit appears in the unnamed bedrock valley that enters Kane County from the southwest near Maple Park and that has been previously reported in the deepest part of the St. Charles Bedrock Valley in southwestern Kane County (Graese et al., 1988). The Galena is composed of nearly pure medium- to fine-grained carbonate rocks, both dolostone and limestone. The Galena also contains chert nodules and shaly zones, but these are not as common as in the underlying Platteville. The average thickness of the Galena is about 180 feet beneath Kane County (Graese et al., 1988). There is about 250 feet of relief on the upper surface of the Galena Group, which ranges in elevation from about 400 feet above mean sea level (msl) in the southeast to about 650 feet above msl in northwest Kane County (Graese et al., 1988).

Above the Galena Group is the Maquoketa Group, composed of shale, thinly bedded dolostone, and minor amounts of limestone. The regionally important formations of the Maquoketa include, in ascending order, the Scales Shale, Ft. Atkinson Limestone, Brainard Formation, and Neda Formation (Kolata and Graese, 1983). These formations are not recognized in Kane County, however. Instead, Graese (1991) identified two sequences composed of a basal shale that becomes increasingly carbonate rich, due to two distinct shoaling cycles in the depositional environment. The full thickness of the Maquoketa Group in eastern Kane County is about 210 feet (Graese, 1991).

The youngest bedrock in the county, covering about half the bedrock surface, is dolostone of Silurian age. The Silurian units that have been identified in eastern Kane County include the Wilhelmi, Elwood, Kankakee, and Joliet Formations. The Wilhelmi is a dolomitic siltstone and shale that occurs in channels in the upper surface of the Maquoketa Group. The Wilhelmi is not more than 20 feet thick in Kane County (Graese, 1991). The Elwood, Kankakee, and Joliet units are composed of thin to medium-thick beds of dolostone; the Elwood also contains abundant nodules and interbeds of chert. The Silurian dolostone is more than 100 feet thick in eastern and southeastern Kane County (Figure 3); here the Joliet dolomite likely occurs, but in the absence of the distinctive green bentonite beds of the Brandon Bridge Member, the Joliet is difficult to differentiate from the otherwise similar Kankakee dolomite (Graese, 1991).

C. Bedrock Topography

The bedrock surface has been mapped statewide by Herzog et al. (1994) and in Kane County by Gilkeson and Westerman (1976), Wickham (1979), Wickham et al. (1988), and Vaiden and Curry (1990). The scale of these maps is 1:62,500 (1 inch on the map represents 1 mile on the ground) or smaller (i.e., less detailed). Bedrock topography maps published at a scale of 1:24,000 are also available for the Aurora North (Curry, 2001a) and Sugar Grove Quadrangles (Curry, 2001c). The earlier maps delineated several bedrock valleys, including the main valley in the region, the St. Charles Bedrock Valley, and its tributaries, including the Aurora, Elgin, and Elburn Bedrock Valleys (Curry and Seaber, 1990; Figure 4). These maps indicate that the elevation of the bedrock surface is less than 500 feet above msl at the bottom of the St. Charles Bedrock Valley in southwestern Kane County and more than 825 feet above msl on the uplands to the northwest (Figure 3). Maps of the bedrock surface topography are useful guides for locating the deepest parts of bedrock valleys (Curry and Seaber, 1990). Not only do the bedrock valleys contain sand and gravel aquifers, but they also are places where groundwater flowing from the bedrock may recharge groundwater in the drift (Gilkeson et al., 1987). Existing data, however, are not adequate for most areas to pinpoint the location of the deepest parts of bedrock valleys.

The majority of the valley segments in of the bedrock surface were likely first formed by flowing water prior to the Pleistocene glaciations. Later, the glaciers and the associated meltwater modified the bedrock topography. Valleys were deepened in places, but the largest changes were a scouring or flattening of the uplands. Evidence for glacial erosion includes the boulder-sized fragments of the underlying rock incorporated in the glacial diamicton. Additional

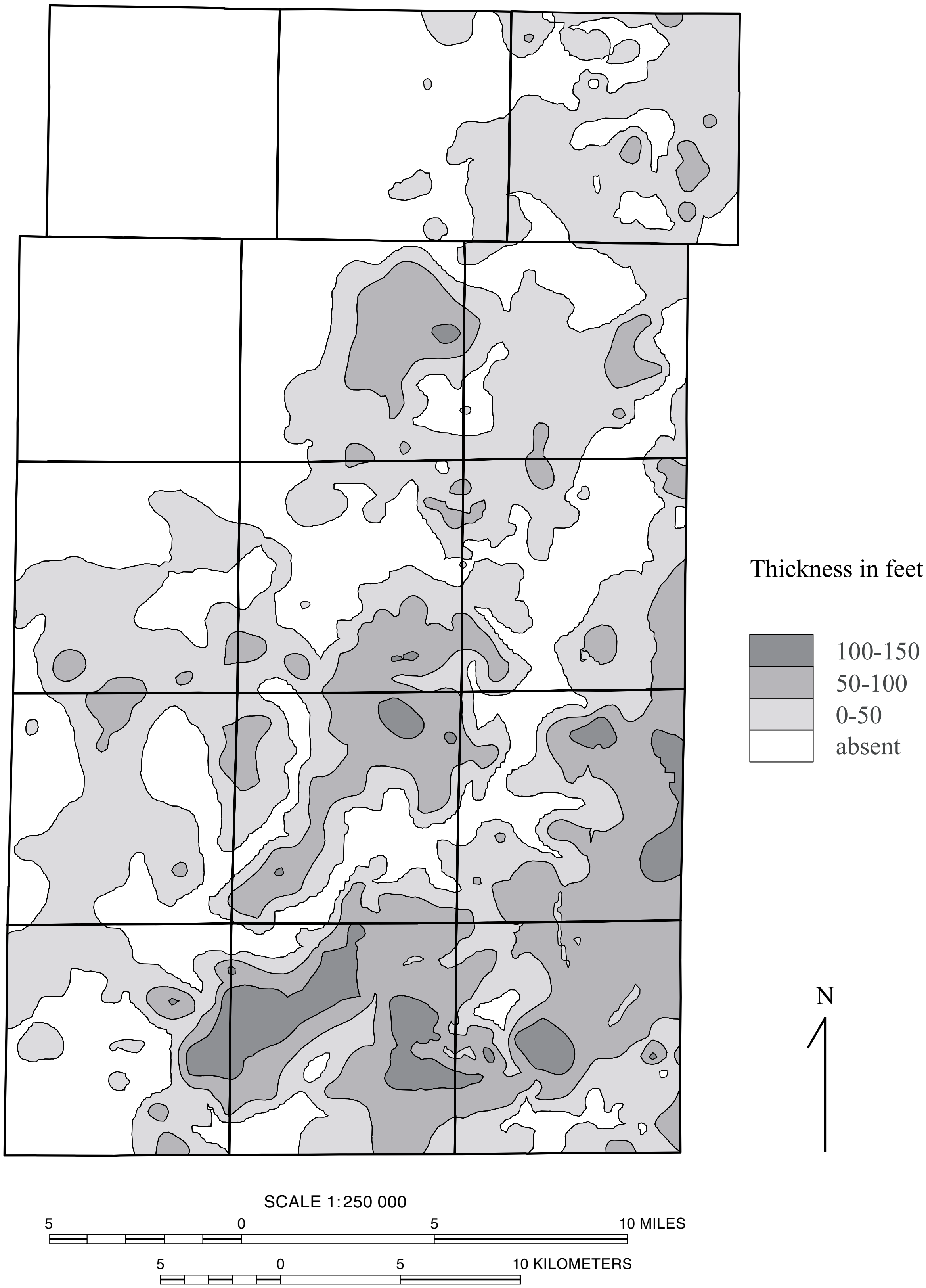

Figure 3 Isopach (thickness map) of Silurian dolomite formations.

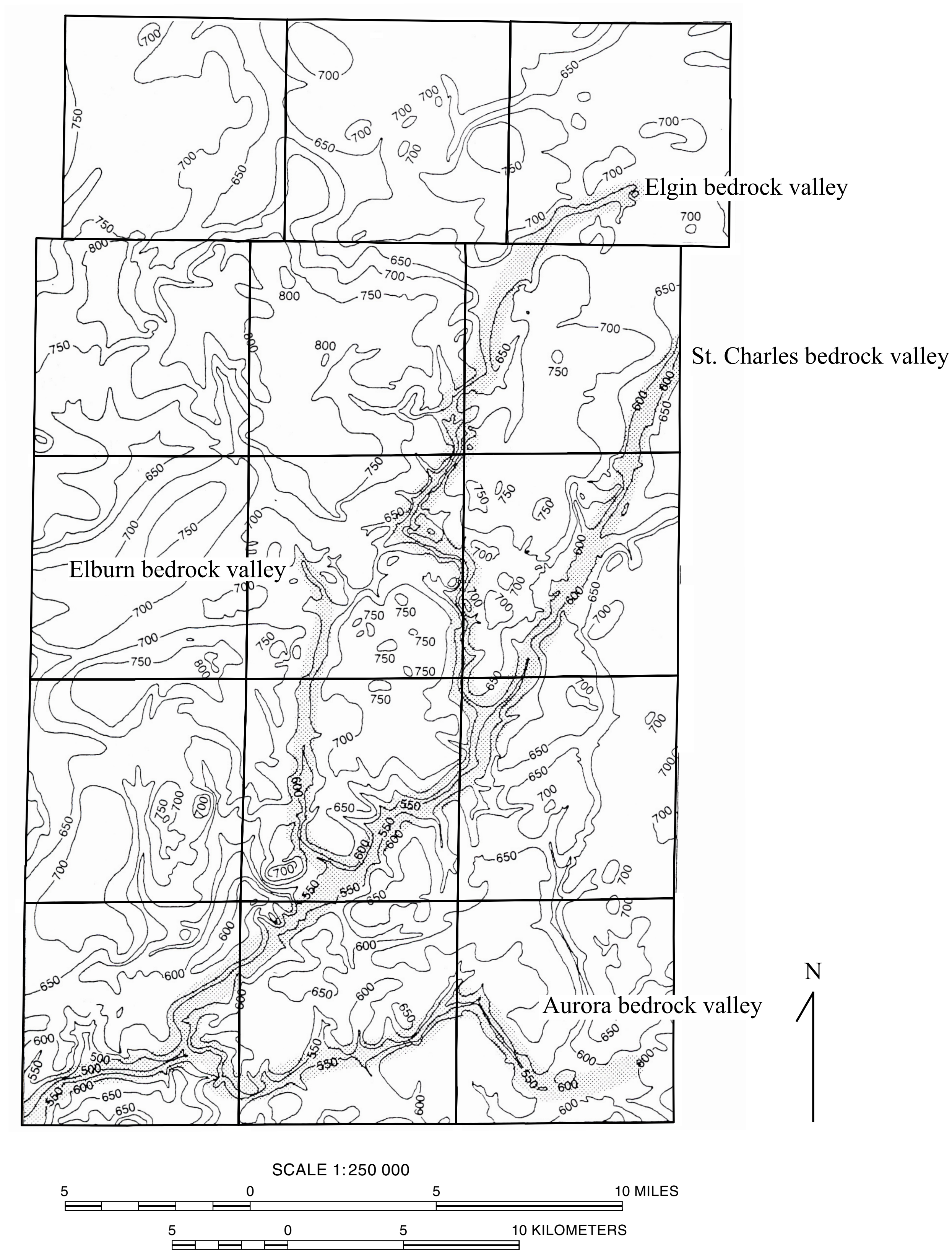

Figure 4 Bedrock topography of Kane County. A stippled pattern indicates the major bedrock valleys (from Curry and Seaber, 1990).

evidence for glacial erosion is the polished and striated bedrock surfaces exposed in many quarries on the Big Rock, Aurora North, Elgin, and Geneva Quadrangles (Graese et al., 1988; Curry 2001b). The rock at and just below the bedrock surface may be fresh or weathered. Where the rock is fresh, it commonly is found to be polished and striated by the passage of debris held in the glacial ice. In most places, however, the rock is fractured, weathered, and oxidized (manifested by orange to orange-brown stains and coatings in the upper 3 to 20 feet of bedrock). Where present, these secondary openings (fractures) typically are saturated with groundwater. The uppermost fractured dolomite bedrock is an important regional aquifer called the Upper Bedrock Aquigroup (Visocky et al. 1985).

Cross-valley topographic profiles of the modern ground surface and the buried bedrock surface across the St. Charles and Aurora Bedrock Valleys and the modern Fox River show similar relief of about 150 feet. The buried valley width varies from less than 2,000 feet to more than 3,000 feet. The Aurora Bedrock Valley has the steepest known valley side slopes of about 13 (Curry, 2001c). The gradient of the St. Charles Valley channel bottom is about 0.0006 feet per mile (Curry and Seaber, 1990).

D. Drift Thickness

Glacial drift is more than 350 feet thick beneath the Marengo Moraine in northern Kane County and more than 200 feet thick above some reaches of the St. Charles Bedrock Valley. Bedrock is locally exposed along the Fox River and a few of its tributaries (Figure 5). Drift is thickest beneath moraines and other high standing glacial landforms such as kames, or above bedrock valleys, especially in the northern half of Kane County. Drift is thinnest in southern Kane County along the major surface drainageways.

E. Glacial Geology

Continental glaciers, associated lakes, and meltwater streams deposited most of the unlithified surficial material in Kane County. Along with the shallow bedrock, these sediments form the framework for the conceptual model used in the mapping for this report. The surficial deposits include Paleozoic bedrock, composed primarily of dolostone and shale, that is exposed along many reaches of the Fox River and the lower reaches of its tributaries.

The first glaciers arrived in Kane County more than 500,000 years ago (Killey, 1998), although there are no known deposits of this age recognized in Kane County. The oldest preserved glacial deposits found in this area were deposited during the Illinois Episode from about 180,000 to 130,00 years ago (Curry and Pavich, 1996); the youngest glacial sediments were deposited during the Wisconsin Episode (Figure 6 and Table 2) from about 23,500 to 15,000 radiocarbon years ago (Hansel and Johnson, 1996; Killey, 1998 ; Curry et al., 1999). During this time, the Lake Michigan Lobe, a south-flowing tongue of the Laurentide Ice Sheet, formed numerous subdued ridges with hummocky topography (Figure 7). Movement of the Lake Michigan Lobe (Figure 8) was complex and, at times, sublobes formed distinctive tracts of moraines. The sublobes melted back and readvanced several times during the last glaciation; each moraine represents the deposits formed during a readvance. As the glacier formed the moraines, meltwater carried and deposited sand and gravel outwash atop, below, and through the glacier, as well as along drainageways beyond the moraines. In some low areas, meltwater deposited fine-grained lake sediments.

Wisconsin Episode deposits constitute distinctive landforms in the study area; several moraines and morainal complexes were mapped by Willman and Frye (1970) and later modified somewhat by Hansel and Johnson (1996; Figure 8). The moraines mark the limits of several glacial advances, and are used for reference on shaded relief maps that aid in delineating significant events in the glacial history of Kane County. In northeastern Illinois, moraines with ridge crests that parallel the modern shore of Lake Michigan were formed when the Lake Michigan Lobe flowed from the Lake Michigan basin unimpeded by interaction with other major lobes of the Laurentide Ice Sheet. The Marengo and Minooka Moraines fit this category (Figure 8). Moraines that have ridge crests that are not parallel to the modern shore of Lake Michigan were formed, in large part, when the west-flowing Huron-Erie Lobe and southeast-flowing Green Bay Lobe interacted with the Lake Michigan Lobe (Wickham et al., 1988) including the Bloomington Morainic System and the Elburn Complex (Figure 8). Moraines in Illinois that were affected by interaction of the Lake Michigan Lobe with the Green Bay Lobe are associated with the Harvard Sublobe (Willman and Frye 1970; Johnson and Hansel 1989) including the Woodstock Moraine in northeasternmost Kane County (Figure 8).

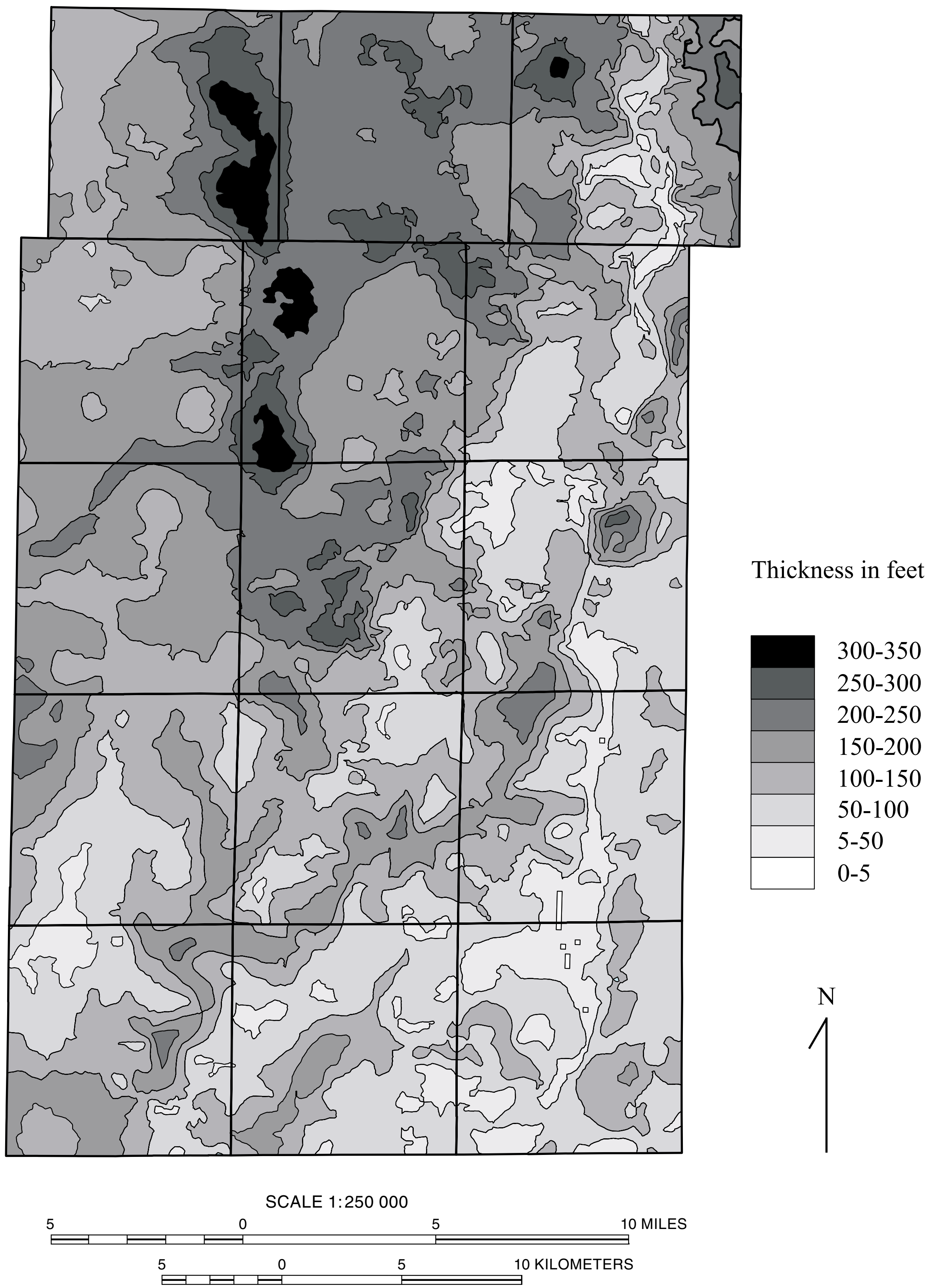

Figure 5 Drift thickness map of Kane County.

Material Description	Unit	Interpretation
	HUDSON EPISODE (~ 12,500 years B.P. to present)	
Peat and muck (black and brown); interbedded sand, silty clay (gray) and marl (white to light gray).	Grayslake Peat gr	Decomposed wetland vegetation and sediment in depressions and on toe slopes
Sand and gravel; well-sorted sand, and lenses of peat, grading laterally to silt and clay.	Cahokia Formation c	Floodplain alluvium along rivers and streams
	HUDSON AND WISCONSIN EPISODES (~ 55,000 years B.P. to present)	
Silt, clay, and fine sand; layered to massive; gray to brown.	Equality Formation e	Lake deposits in kettles and some valleys tributary to the Fox River.
	WISCONSIN EPISODE (~12,500 - 75,000 years B.P.)	
Silt and clay at ground surface; upper foot or so organic-rich in most places; contains abundant soil structures, burrows, roots, etc.	Peoria Silt p	Windblown fines (loess) modified by modern soil processes
Sand and gravel, or sand; contains lenses of silt and clay, or diamicton	Henry Formation h	Channelized proglacial outwash, proglacial outwash deposited in deltas and alluvial fans as outwash plains downslope of glacial margins, or kames.
Diamicton; sandy loam to loam; dolomite-rich; yellowish brown; includes lenses and layers of sand and gravel	Haeger Member, Lemont Formation lh	Till and debris flow deposits associated with the Woodstock Moraine
Diamicton; silty clay, silty clay loam, and clay; gray, oxidizing to yellowish brown; includes layers of sand and gravel, silt, and silty clay	Yorkville Member, Lemont Formation ly	Till and debris flow deposits associated with the St. Charles and Minooka moraines
Diamicton; sandy loam, loam, and silt loam; gray to grayish brown, oxidizing to yellowish brown to brown; includes common layers of sand and gravel or silt and sorted sediment	Batestown Member, Lemont Formation lb	Till and debris flow deposits associated with the Elburn Complex, Farm Ridge, and Arlington moraines
Diamicton; clay loam to loam with lenses of sand and gravel, or sand; reddish brown, oxidizing to brown	Tiskilwa Formation t	Till and debris flow deposits forming the Marengo Moraine and Bloomington Morainic System
	ALTON SUBEPISODE, WISCONSIN EPISODE (~ 55,000 to 24,500 years B.P.)	
Silt and clay; organic-rich, black to brown; leached of carbonate minerals; contains wood fragments	Robein Member, Roxana Silt rr	Deposits accreted in low-lying areas; patchy distribution
	ILLINOIS EPISODE (~ 200,000 to 130,000 years B.P.)	
Diamicton; sandy loam to loam, reddish brown, pinkish brown, and brown; bouldery in places, with abundant lenses and layers of sand and gravel	Glasford Formation g	Till, debris flow deposits, outwash, lake sediment
	PALEOZOIC ERA (~570 to 225 million years ago)	
Dolomite; microcrystalline; cherty in places (Kankakee and Joliet Fms.), shaly, fossiliferous dolomite, shale, and thin beds of vuggy dolomite (Maquoketa Group)	Kankakee and Joliet Formations; Maquoketa Group Pz	Bedrock

Figure 6 Stratigraphic framework of the glacial drift and shallow bedrock in Kane County.

Table 2 Relative percentage of particle-size distribution, clay mineral data, blow count, and moisture content data for several lithostratigraphic units (from Curry et al., 1999).

	Relative percentage				Relative percentage							
	Total Gravel	< 2 mm (%) Sand	Silt	Clay	Expandable clay minerals	Illite	Kaolinite plus chlorite	Counts/second Calcite	Dolomite	Diffraction intensity index	Blow counts	Moisture content (%)
Peoria Silt												
Mean	0.9	8.5	62.9	28.6	78	16.4	5.6	2	8	1.9	12	21.7
Standard deviation	1.3	6.8	7.6	5.9	11.7	10.4	1.8	15	28	0.7	8	4.8
Maximum	4	26	81.2	36	92	47	9	20	47	3.9	32	28.1
Minimum	0	1	48	17.5	45	5	3	0	0	1.1	3	12.5
Number of samples	12	12	12	12	14	14	14	14	14	14	15	11
Yorkville Member, Lemont Formation Minooka Moraine												
Mean	5.2	10.5	47	42.5	4	77	19	26	50	2.6	32	17.2
Standard deviation	5.9	6.3	9.3	8.1	3.5	1.8	1.9	9.5	13.2	0.3	20	2.6
Number of samples	341	380	380	380	94	94	94	94	94	94	267	381
St. Charles Moraine												
Mean	4	8.6	36.3	55.1	3	79	18	22	44	2.9	38	20.1
Standard deviation	5.6	6.4	6.7	8.9	1.2	2.2	2.4	10.5	15.2	0.4	18	3.3
Number of samples	210	227	227	227	34	34	34	34	34	34	245	245
Batestown Member, Lemont Formation Silt loam diamicton facies												
Mean	16.6	32.5	42.5	25	8.7	76.6	14.7	19	36	4.1	20	14.7
Standard deviation	14.6	8.2	5.7	7.4	2.8	5.9	4.8	13	17	1.9	9	2.1
Maximum	51.9	46.9	52.4	34.8	14	86.5	21	54	62	8.1	36	19.1
Minimum	5.4	19.2	28.3	10.9	4	67.5	7	0	0	2.1	7	12.6
Number of samples	11	11	11	11	12	12	12	11	12	12	13	6
Loam diamicton facies												
Mean	10.2	39.3	40.9	19.8	17.2	67.9	14.9	21	58	3.6	19	13.3
Standard deviation	9.7	11.2	9.7	6	15.3	14.4	5	13	38	1.8	12	2.6
Maximum	49	70.4	65.4	29	76	88	24	41	180	9.4	50	21.5
Minimum	0	15.6	25.6	4	1.5	15	6	0	0	1.1	4	10
Number of samples	23	23	23	23	22	22	22	19	22	22	23	18
Tiskilwa Formation diamicton												
Mean	7	33.8	39.1	26.7	13	64.6	22	47	69	2.1	65	10.8
Standard deviation	5.2	5	4.7	4.9	3.8	3.4	2.9	25	20	0.5	78	1.3
Maximum	46	51.8	65.6	41	28	78	31	335	155	5.1	600	15.1
Minimum	0	5.4	26	7.7	3	56	13	10	17	1.1	8	7.7
Number of samples	202	202	202	202	202	202	202	202	202	202	202	202
Glasford Formation diamicton												
Mean	11.1	39.9	36.4	23.7	14.2	67.3	18.5	42	79	3.1	110	10.2
Standard deviation	10.9	12.5	6.7	9.4	10.3	11.7	4.8	16	23	3.3	173	2.9
Maximum	57.3	62	50	48	73	92	26	80	160	26	1,200	18.2
Minimum	0	2	16	11	1.5	18	6	10	32	1.4	22	4.4
Number of samples	63	65	65	65	68	68	68	68	69	69	58	55

Figure 7 Shaded relief map of Kane County (from McGarry, 2000).

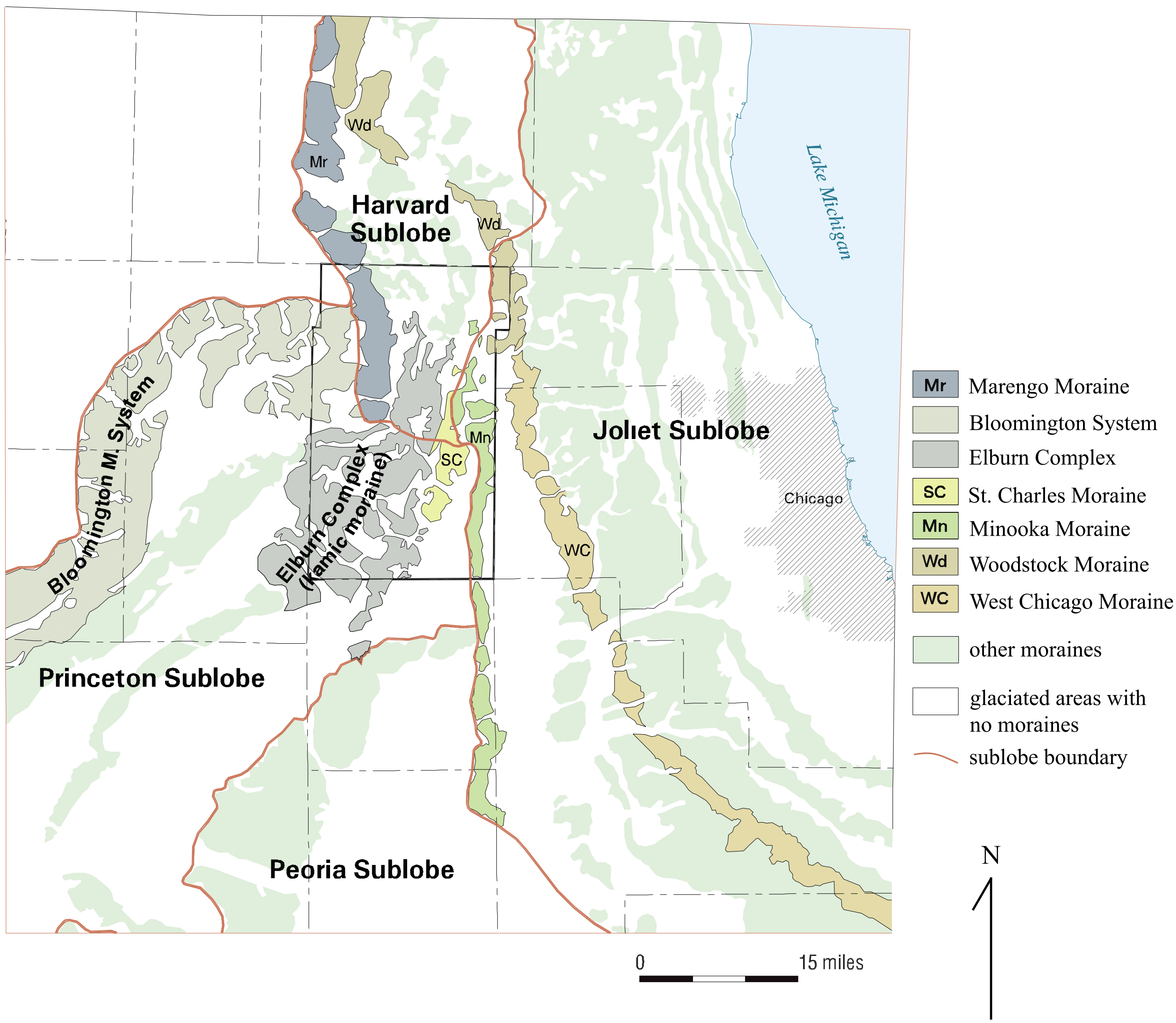

Figure 8 Wisconsin Episode moraines in northeastern Illinois. Moraines, shown in blue and green, were formed near the terminus of glacial ice during various positions of the Lake Michigan Lobe. Glacial ice advanced in a westerly and southwesterly direction into Illinois from the Lake Michigan basin. The older moraines of this figure occur generally to the west and the younger moraines to the east. On this map, modified from Willman and Frye (1970) and Hansel and Johnson (1996), Kane County is outlined in black.

The following discussion is based largely on ISGS geologic mapping (Figure 9), interpretation of surficial or buried landforms, sedimentological studies at natural and man-made outcrops, and radiocarbon ages. Before discussing the glacial history, it is useful to classify glacial landscapes in terms of their genesis and associated sediment assemblages. The glaciated landscape of northeastern Illinois is subdivided here into five generalized landscape-sediment assemblages including (1) lakes and lake plains, (2) outwash plains, (3) drainageways, (4) stream valleys, and (5) moraines. The topographic expressions of these assemblages are easily seen on shaded relief maps of land surface (Figure 7). Lake plains and lakes are underlain by deposits of fine-grained sediment, marl (dense, fine-textured lacustrine deposits of clay and calcium carbonate), mapped as Equality Formation, or peat, mapped as Grayslake Peat (Figures 6 and 10). Several processes may lead to the genesis of lake basins, including differential melting of debris-poor and debris-rich ice (Clayton, 1964) or damming of valleys by glacial ice, or outwash. Outwash plains are underlain by deposits of sand and gravel (Henry Formation) deposited in front of glacial margins such as the one that formed beside the Woodstock and St. Charles Moraines (Figure 8). Originally eroded by meltwater, drainageways are generally underlain by two kinds of alluvium: sand and gravel outwash (Henry Formation) of glacial times, and finer alluvium (Cahokia Formation) of underfit postglacial streams (streams that appear too small to have eroded the valley they occupy). The character of the drainageway sediment assemblage changes along the course of the river system depending on variables such as distance from the meltwater source or depth to bedrock. The Fox River valley is an outstanding example of a glacial drainageway. In many places, drainageways have incised deeply into the surrounding uplands, forming relatively steep slopes (Figure 7). Valleys occupied by modern streams are floored by alluvium deposited by the streams, the character of which changes dramatically as the stream approaches its confluence with the master trunk stream. In Kane County, the master trunk stream is the Fox River. Near their mouths, stream valleys tributary to the Fox River are underlain by thick deposits of coarse- to fine-grained alluvium and peat (Cahokia Formation). These deposits thin rapidly upstream toward the stream's headwaters. Near their headwaters, many streams have formed wide floodplains by lateral migration and beveling of the underlying glacial sediment, but there may be little, if any, alluvium. Moraines formed when glacial margins were relatively stable and are composed of diamicton, with interbedded lenses and sheets of sand and gravel (Figure 11). If formed during a period of ice stabilization, the internal sediment architecture of some moraines may be simple and may be composed of one kind of diamicton. Examples of such moraines include the Marengo and Minooka Moraines (Figure 8). Other moraines, such as the St. Charles Moraine, are more complex. This moraine, which was formed when the ice margin retreated from and readvanced to about the same location at different times, is composed of three lithologically distinctive diamicton units, described below, along with interbeds of sand and gravel. Diamicton forming moraines of the last glaciation include units of the Wedron Group (Figure 6.) such as the Tiskilwa Formation and the Yorkville Member of the Lemont Formation.

F. Quaternary History

Illinois Episode (200,000 to 125,000 Before Present [B.P.]) The oldest known glacial deposits in Kane County were laid down during the Illinois Episode. Although not formally defined like the Wisconsin Episode in Hansel and Johnson (1996), the Illinois Episode is refered to as the time when the Glasford Formation was deposited (Figure 6). Glasford Formation deposits are defined by being modified by the Sangamon Geosol, described below. Although members of the Glasford Formation have been traced into western Kane County (e.g., Curry et al., 1988), for the purpose of county-wide mapping, these units are not differentiated . For the same reason, we have included the capping layer of Illinois Episode sand and gravel (Pearl Formation) and weathered sand and gravel (Berry Formation) with the Glasford Formation.

Sangamon Episode (125,000 to 55,000 B.P.) The last interglacial period, known as the Sangamon Episode, was marked by weathering and the formation of the Sangamon Geosol. In some places, the weathering occurred in slope deposits and alluvium; the new sediment is known as the Berry Clay Member of the Glasford Formation. Soil development probably occurred under several climatic regimes and vegetation types ranging from prairies to deciduous forests (Curry and Baker, 2000). A poorly drained facies of the Sangamon Geosol is exposed at the Feltes Sand and Gravel Pit just north and west of the intersection of Route 47 and Main Street (Curry et al., 1999).

Athens Subepisode, Wisconsin Episode (55,000 to 25,000 yr B.P.) Prior to invasion by ice during the last glaciation, northern Illinois was covered with lakes and open spruce forests (Meyers and King, 1985). In Kane County, less than 3 feet of medium silt and fine silt-rich loess were deposited. Loess is a widespread deposit of silt and clay that mantles most of the landscape of Illinois. The loess was deposited by the wind; the source of the sediment

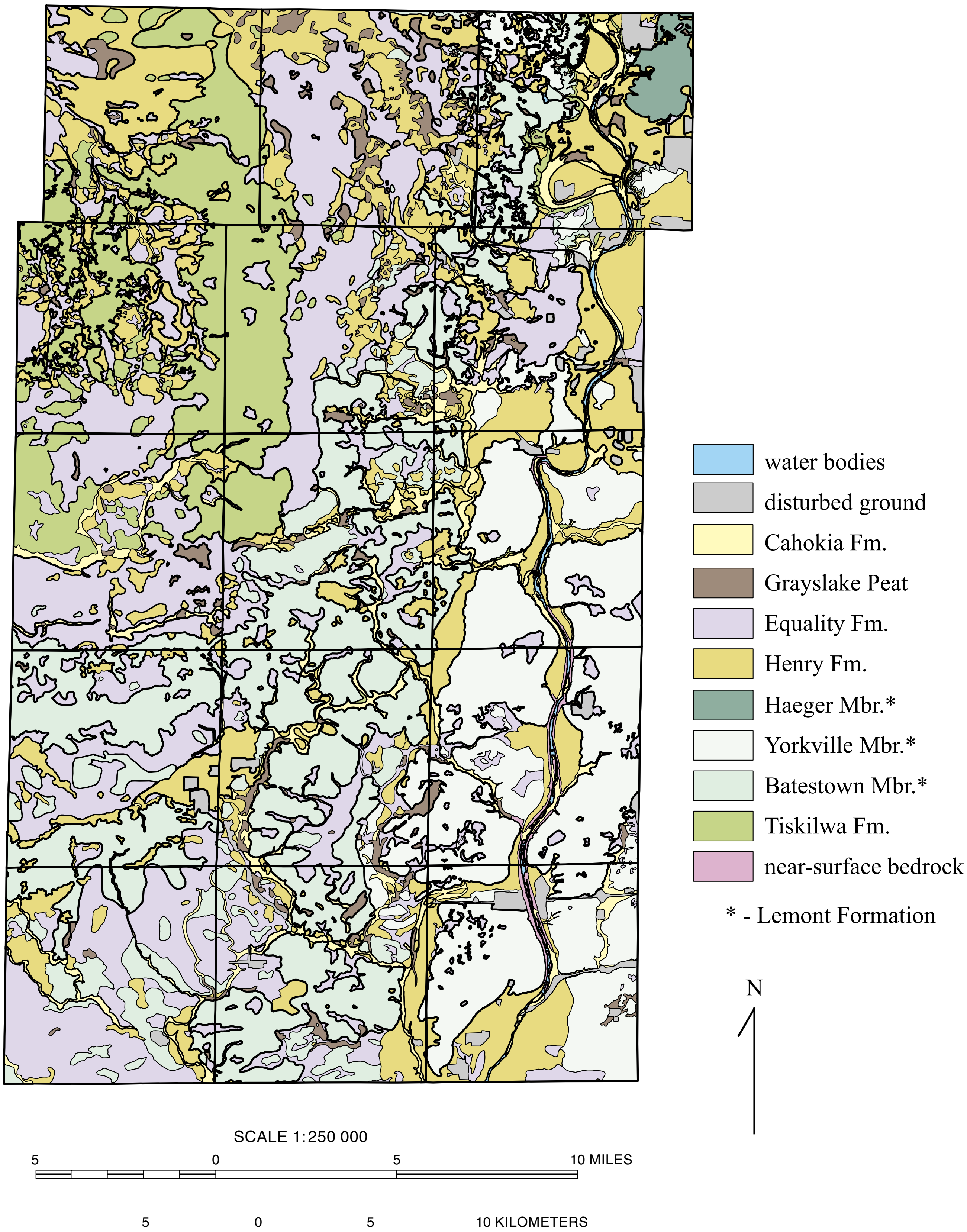

Figure 9 Surficial geology map of Kane County.

was the unvegetated alluvium in major glacial sluiceways such as the valley of the Mississippi River. The loess has been weathered throughout its thickness and is called the Robein Member of the Roxana Silt (Figure 6). The oldest Wisconsin Episode loess was extensively incorporated into the upper Sangamon Geosol through the burrowing of insects and small mammals. The youngest loess usually contains abundant organic matter and, in some cases, stumps of spruce trees and their roots (Curry et al., 1999).

Marengo Phase, Michigan Subepisode (25,000 to 22,500 yr B.P.) The earliest glacial deposits of the last glaciation (Michigan Subepisode) include near-glacial lacustrine sediment and outwash. These sediments were overridden during the Marengo Phase by the westward-flowing Harvard Sublobe (Figure 8), which deposited diamicton and sorted sediment of the Tiskilwa Formation (Figure 6). The Marengo Moraine was formed during this phase (Figure 12). Shelby Phase, Michigan Subepisode (22,500 to 18,000 yr B.P.) After the Marengo Moraine was formed, the Princeton Sublobe (Figure 8) flowed northwestward into Kane County, depositing additional Tiskilwa Formation, and forming the Bloomington Morainic System (Figure 12).

Putnam Phase, Michigan Subepisode (18,000 to 17,500 yr B.P.) After melting back to eastern Kane County, the Princeton and Harvard Sublobes readvanced and coalesced in central Kane County. A large, proglacial lake formed, Glacial Lake Pingree (Figure 13), which was dammed by the Marengo Moraine and Bloomington Morainic System to the west and south and by glacial ice to the east and north (Curry et al., 1999). Landforms attributed to stagnant ice (such as the Kaneville esker (Lukert and Winters, 1965), its related delta, and the kames known as Johnson's Mound and Bald Knob) also formed in Kane County during the Putnam Phase (Figure 13). The stagnant-ice features and deposits contrast with the active-ice morainic ridges typical of those formed during the earlier Shelby and Marengo Phases and later Livingston Phase. Glacial diamicton and intercalated (where a relatively thin stratum of one character alternates between thicker strata of another character) sorted sediment deposited during the Putnam Phase are called the Batestown Member of the Lemont Formation (Figure 6).

Livingston Phase, Michigan Subepisode (17,500 to 16,000 yr B.P.) After the Princeton and Harvard Sublobes retreated to near the modern-day Fox River, the Joliet Sublobe (Figure 8) readvanced to the position of the St. Charles Moraine (Figure 14) during the early Livingston Phase. During the early part of this phase, Nelson Lake formed, and ice-marginal streams deposited valley-train sand and gravel west of the St. Charles Moraine. Diamicton deposited during the Livingston Phase is called the Yorkville Member of the Lemont Formation (Figure 6). South of Valley View, the Fox River valley began to form as an ice-marginal stream when the ice retreated and formed the Minooka Moraine (Figure 15) during the latter part of the Livingston Phase. During this time, a fan delta and fossiliferous lacustrine sediments were deposited in a low area on the St. Charles Moraine at the Fox River Stone Quarry near South Elgin. During the late Livingston Phase, the ice margin retreated to as far east as about the West Chicago Moraine, east of Kane County (Curry et al., 1999).

Woodstock Phase, Michigan Subepisode (16,000 to 15,500 yr B.P.) During the Woodstock Phase, the Joliet Sublobe formed the Woodstock Moraine (Figure 8), the lower part of the West Chicago Moraine, and associated outwash plains in northeastern Kane County (Figure 16). Large volumes of meltwater modified the landscape, both eroding channels and depositing dolostone-rich outwash (Figure 16). The valley of the Fox River north of Valley View formed during this phase, as well as the large abandoned meander scar at Sleepy Hollow north of Elgin, large strath terraces and gravelly point bars, and several channels that cut across the Minooka Moraine and St. Charles Moraine (Figure 16). The Equality Formation (Figures 6 and 9) was deposited in slack water lakes formed behind outwash dams at the mouths of valleys tributary to the Fox River. Woodstock Phase deposits include glacigenic diamicton of the Haeger Member of the Lemont Formation and associated sand and gravel of the Henry Formation (Figure 6).

Late glacial phases (15,500 to 14,000 yr B.P.) Following the Woodstock Phase, the ice margin retreated rapidly to near the Milwaukee area during the Milwaukee Phase (15,500 to 15,000 yr B.P.) (Hansel and Johnson, 1992). The final glacial advance that directly affected Kane County occurred during the Crown Point Phase (15,000 to 14,000 yrs B.P.) when the Joliet Sublobe readvanced to just east of Kane County and deposited the Wadsworth Formation and formed the Valparaiso Morainic System (Hansel and Johnson, 1992). Although little glacial sedimentation occurred during the Crown Point Phase in Kane County, much meltwater flowed down the Fox River valley as the ice melted in eastern McHenry County and Lake County.

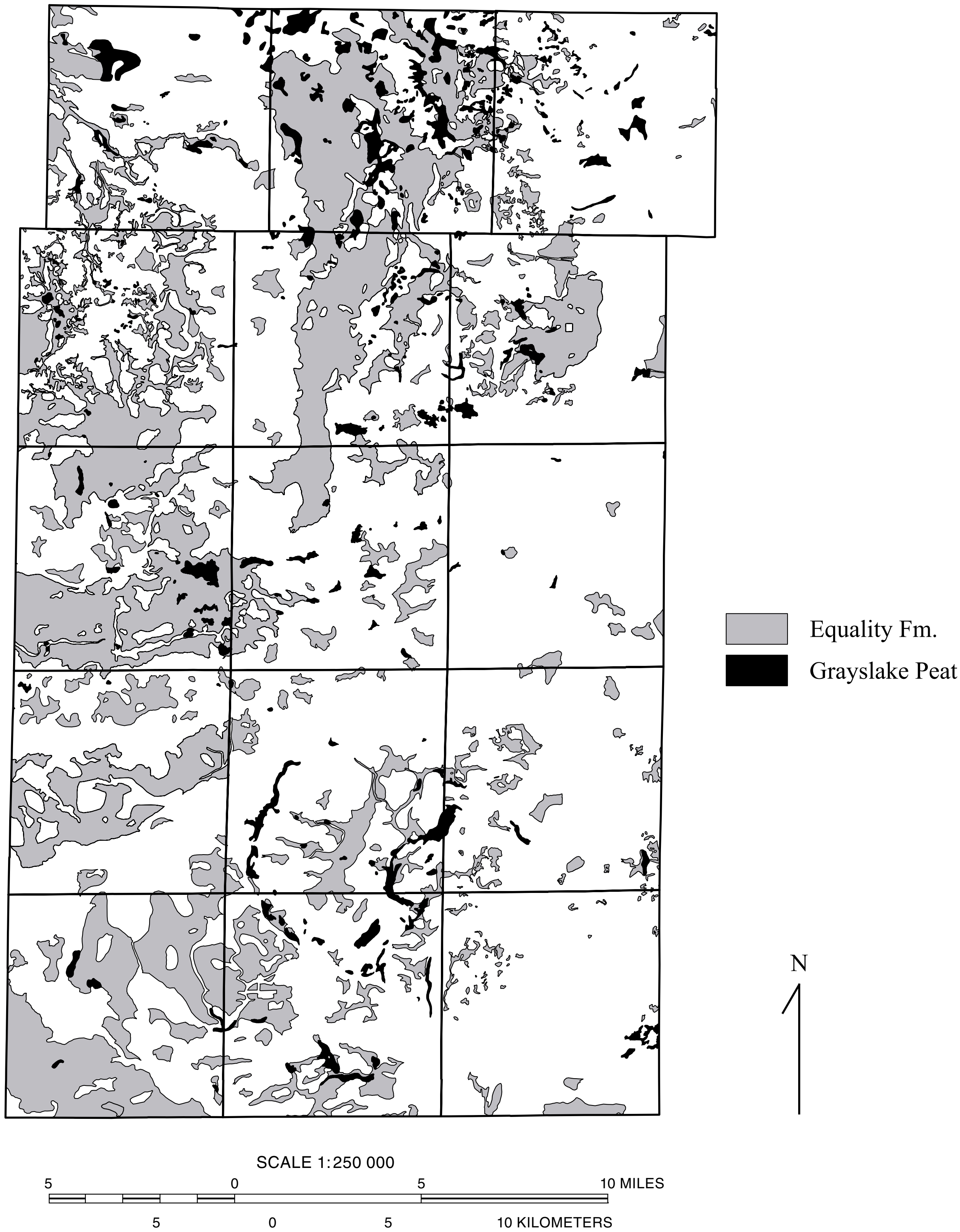

Figure 10 Distribution map of surficial silt, clay, and organic lake sediment known as Equality Formation and distribution of the Grayslake Peat.

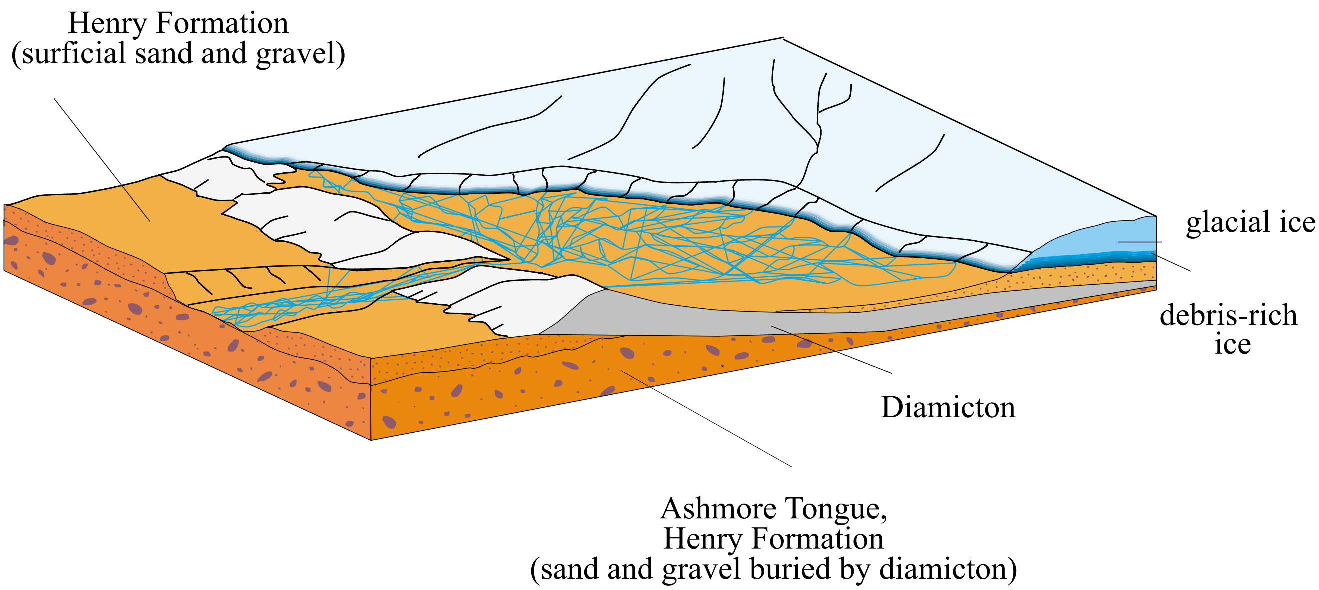

Figure 11 Conceptual model of sediments deposited near glacier margin during ice retreat (from Curry et al., 1997)

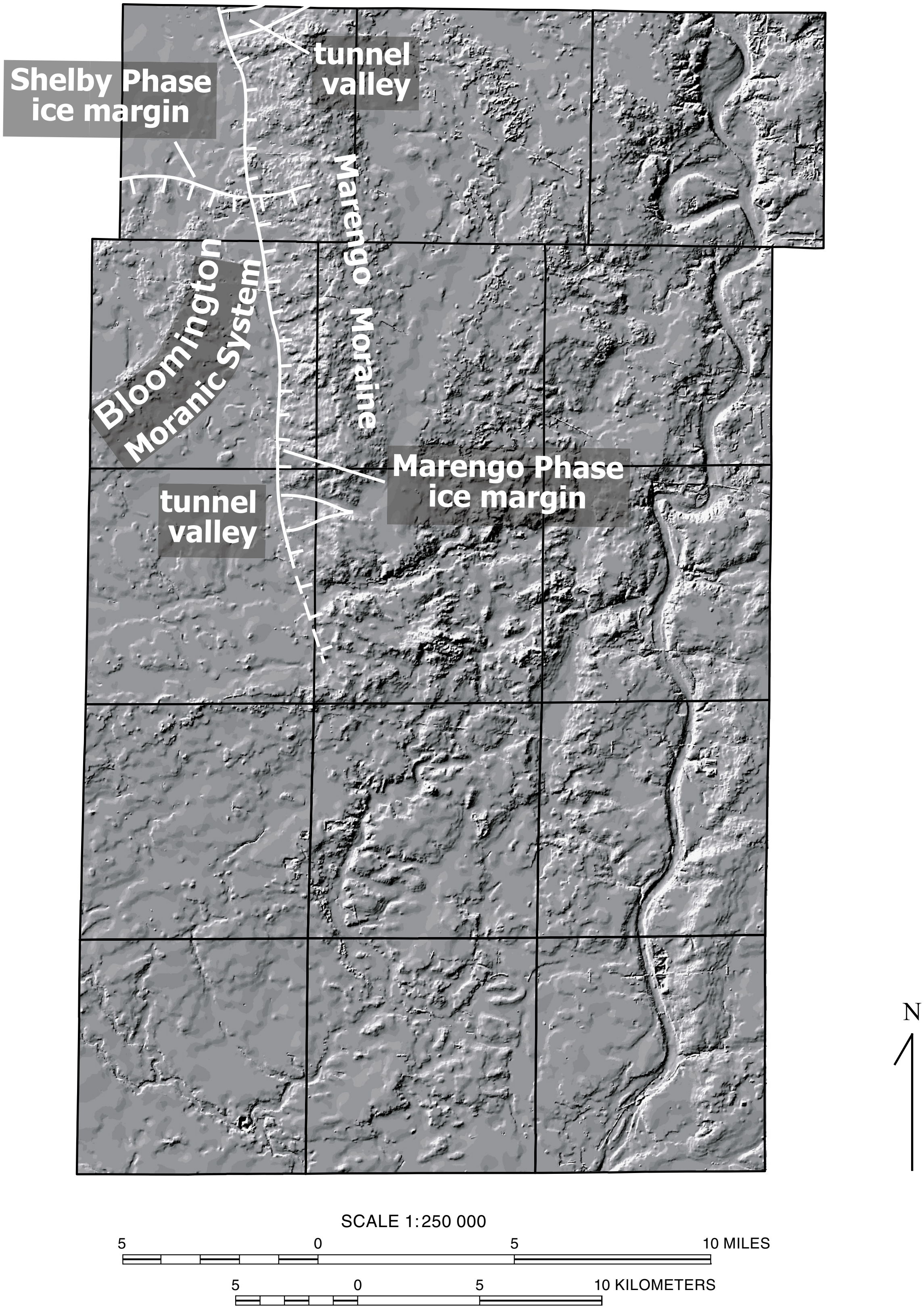

Figure 12 Maximum extent of ice margin during the Marengo and Shelby Phases and location of the tunnel valley, Marengo Moraine, and Bloomington Moranic System (from Curry et al., 1999).

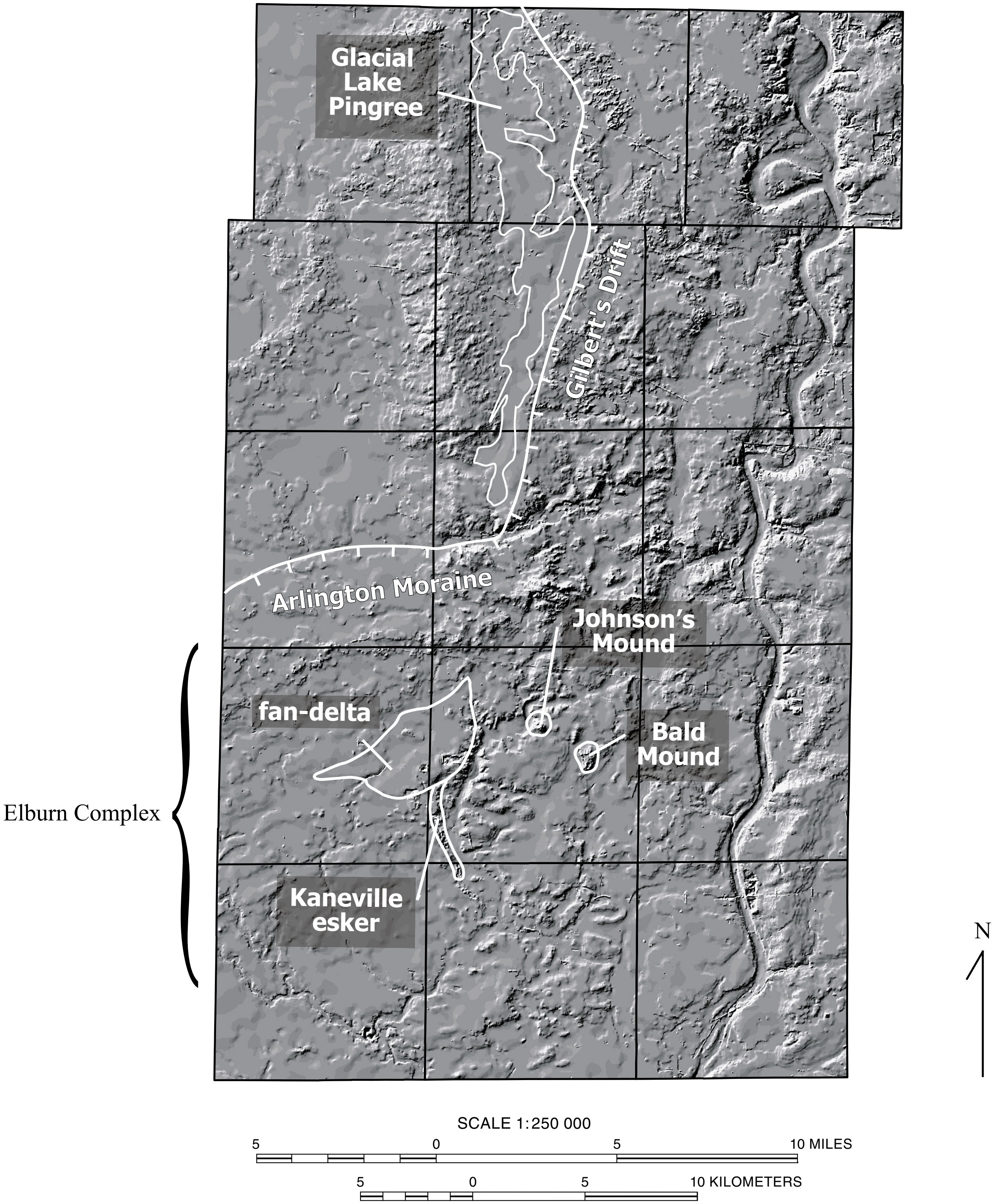

Figure 13 Maximum extent of ice margin during the Putnam Phase and features formed during the Putnam Phase (from Curry et al., 1999).

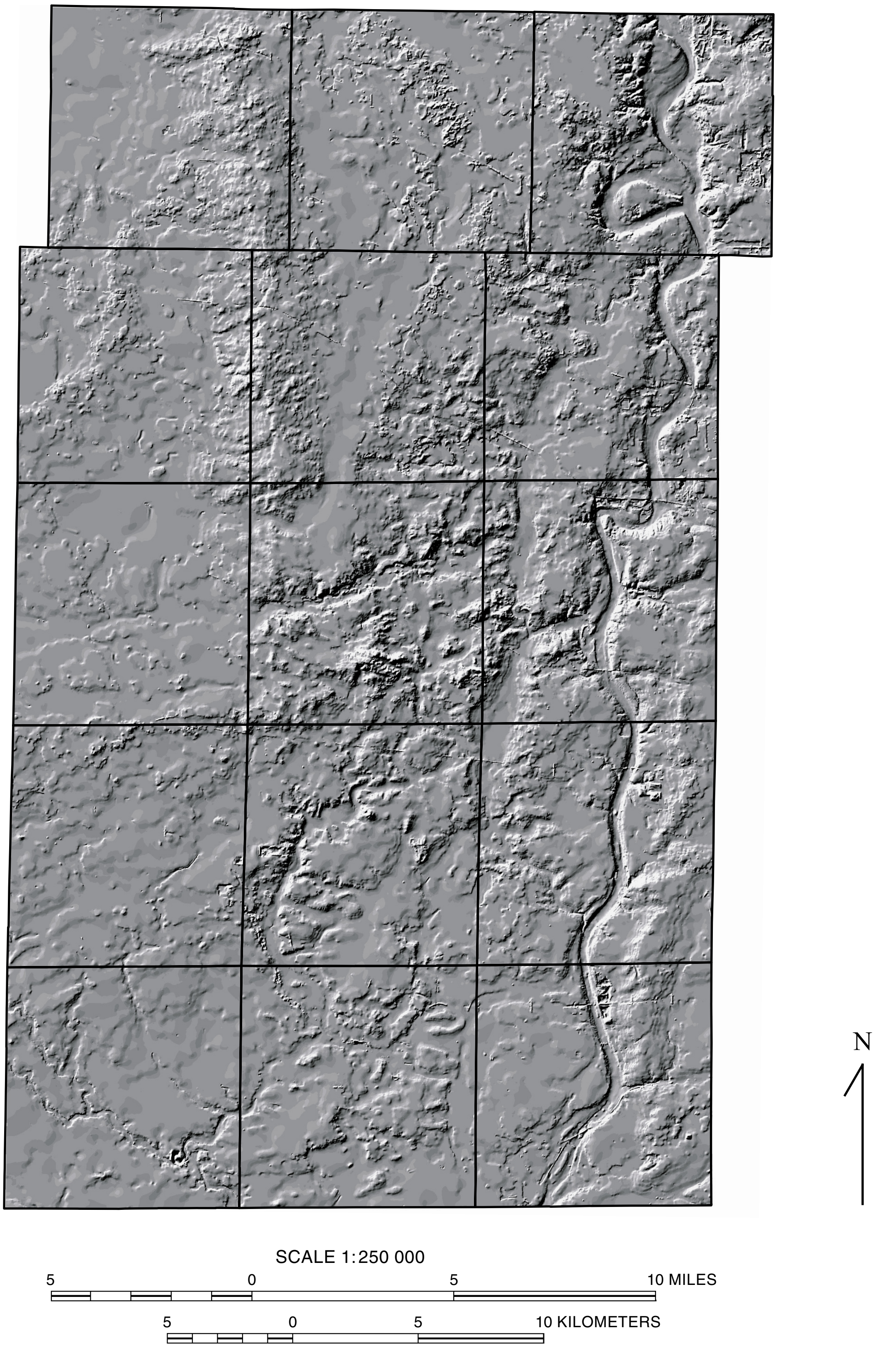

Figure 14 Maximum extent of glacial ice and ice-marginal drainage during formation of the St. Charles Moraine during the early Livingston Phase (from Curry et al., 1999).

Figure 15 Maximum extent of glacial ice and fan-delta near South Elgin (from Curry et al., 1999).

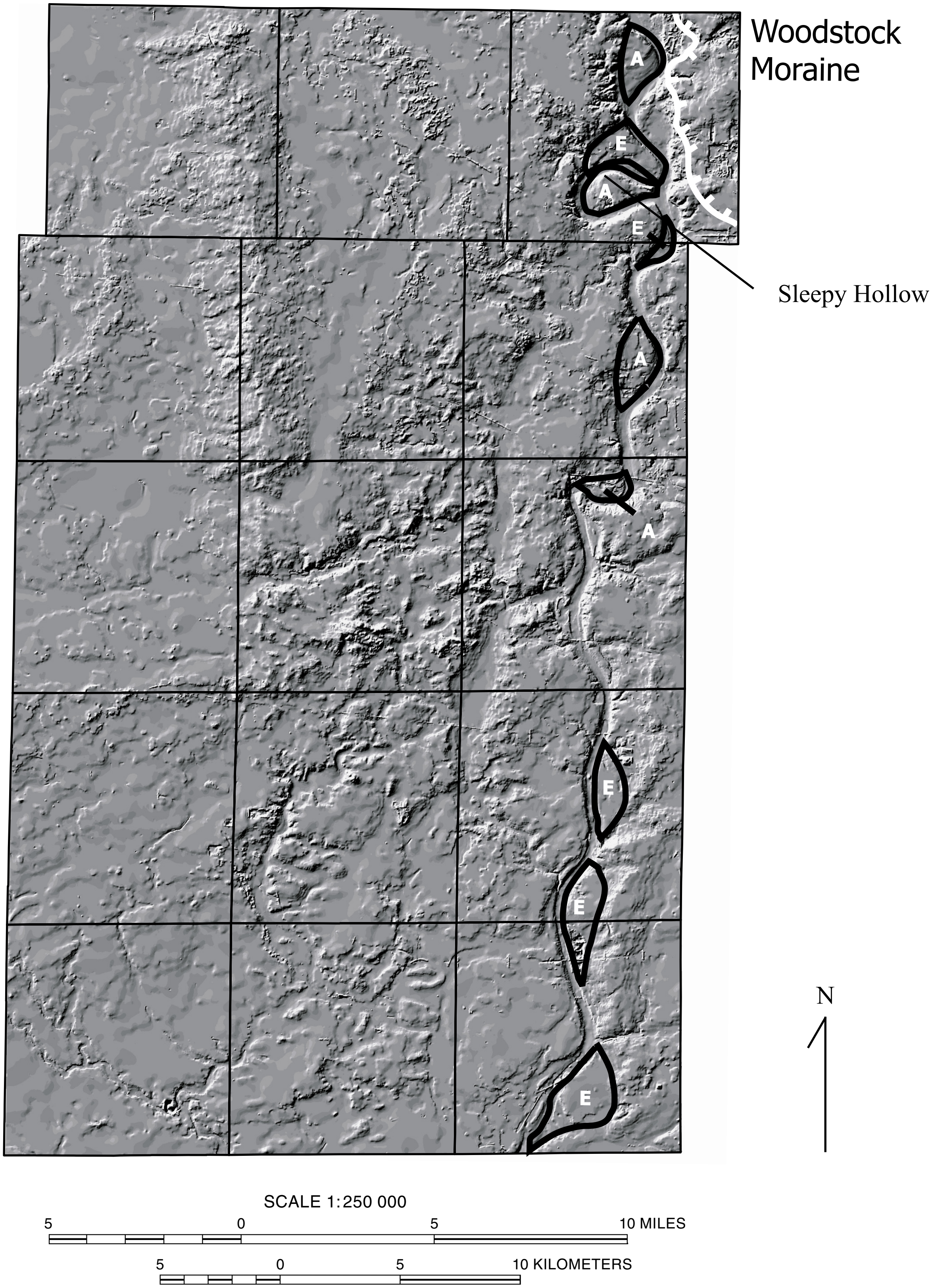

Figure 16 Maximum extent of glacial ice in northeastern Kane County during the Woodstock Phase and terraces formed primarily by aggradation (A) or erosion (E) along the Fox River valley (from Curry et al., 1999).

Postglacial episode (14,000 yr B.P. to the present). The landscape of Kane County has not been modified much since the glaciers left the area about 14,000 yr B.P. Since resistant bedrock occurs in the middle and lower reaches of the Fox River, there has been little vertical incision by flowing water. The most significant change was the deposition of a 2- to 4-foot mantle of silty clay loess, known as the Peoria Silt (Figure 6) from about 14,000 to 13,000 yr B.P. The mantle is continuous across the landscape except in wetlands, lakes, rivers, and most floodplains. Another important change in the landscape was the formation of lakes in depressions. With time, the lakes filled in with sediment eroded from the sides of the depressions, biogenic inputs of organic matter and carbonate also helped to fill the lakes. Most basins in Kane County overflowed, and with the development of overflow channels and infilling with organic matter, most depressions became wetlands or shallow lakes fringed by wetlands.

III. METHODS

A. Data Acquisition and Management

Records of water well and other boring on file at the ISGS were the main source of data for this study. The ISGS Geological Records Unit keeps these records on file in paper format and have entered the location and other data from nearly all of these records into a digital database. A search was made of the ISGS database to identify all well and boring records in the study area. All of these records were downloaded to a project database, created in Microsoft Access®. The initial search yielded 18,833 boring records. A manual search also was conducted of all paper records in the ISGS GRU for information on borings in the study area missing from the on-line database. Records for 2,735 additional borings were identified, added to the project database, and copied to the main ISGS well database. Subsequent searches of the Oracle database yielded another 6,326 records for recently drilled water wells and other borings, mostly added to the ISGS well database since the project began. Field descriptions of outcrops in the study area have been added to the database with associated locational information. The current total number of point data records in the project database is 27,904.

To ensure the quality of the data used in the geologic investigation, a simple ranking system was used to characterize the usefulness of each boring record with regard to geologic content (correctness and completeness of the data, with emphasis on Quaternary materials) and location. Outcrops and the lithologic logs from stratigraphic, structural, and bridge borings described by geologist or engineers provide the most accurate, precise, and complete geologic records. Reliability of the description may be enhanced by cores, sample sets, or geophysical logs from the hole. Sample sets are the washed cuttings (drilling residue brought up with the drilling fluid, usually a thick drilling mud) collected during drilling by the drillers and saved for more detailed description or analysis. The ISGS keeps a repository of sample sets collected from across the state in its Geological Samples Library. Written logs from water well borings vary greatly in their usefulness to geologic mapping. Some drillers provide high-quality, thorough descriptions of the materials encountered during drilling. Other descriptions on well logs are vague or contain colloquial terms. For example, the reddish brown loam diamicton of the Tiskilwa Formation may be described in a high quality description as “hard red sandy clay with boulders,” or may be generalized as “clay” or “drift.” Some records may only be useful for identifying the top of the bedrock surface. As with stratigraphic borings, the reliability of a water well log is greatly enhanced when a geophysical log has been made of the hole or when a sample set is available.

The data quality of each boring or well record was ranked on a scale from one to five. Stratigraphic borings accompanied by geophysical logs or sample sets were rated the highest at five. Stratigraphic borings alone were ranked four, as were detailed water well records accompanied by geophysical logs or sample set. Structural or bridge borings were ranked four, even though they generally are less than 50 feet deep. Detailed water well records alone were ranked three. Water well records with limited data were ranked two. Boring records that contained illogical or unintelligible information were ranked one.

Of the boring records, 8,300 from the original database search were found to be incomplete. The records contained location, owner, and driller information, but the geologic description had not been entered into the ISGS well database. The missing information is being entered into the project database from the paper records as time allows; 5,800 of these have been completed to date. These data are being incorporated into the ISGS well database.

A manageable data set was developed that could effectively be used to map the county at 1:100,00. The initial goal was to have in the primary data set a minimum of one well per quarter section across the study area. The records in the project database were searched to identify the highest ranked data quality boring per quarter section. All records were visually inspected either in paper format or through the database interface. Equally ranked wells were compared to identify wells with the most potentially useful information. Preference was given to wells with more detailed description of geologic materials, wells penetrating to bedrock, and wells with addresses listed for the well in addition to an address for the well owner. The well addresses were for verifying the location of the wells. Results are shown in Table 3 of the rankings for primary wells in both the county and the entire study area. Identifying one primary well per quarter section was not always possible in the less densely populated rural areas or in urban areas dependent on municipal water supplies. Where one well per quarter section was not available for a given section, other wells elsewhere in the section were selected, if available, to bring the total to at least four primary wells. In some locations, because of an abundance of high quality borings, more than four wells per section were selected as primary wells. Two primary wells per quarter section were sometimes chosen when a shallow but high-quality record, such as an engineering bridge boring, was available for use with a second, lower-quality record that reached bedrock. Table 4 shows the number of primary wells per quarter section in the county and study area. One or zero primary wells were selected in 6% of the sections. This occurred mostly in the western portion of the county. A total of 4,092 borings were designated primary wells in the study area.

Table 3 Ranking of geologic data quality of primary wells.

Data quality	Kane County	Entire study area
5	90	115
4	236	371
3	1459	3190
2	171	374
1	11	17

Table 4 Primary well distribution as number of sections containing listed number of wells.

Number of primary wells primary wells per section	Sections in Kane County	Entire study area
0	52	134
1	79	211
2	102	245
3	81	217
4	80	181
5	53	108
6	21	47
7	18	45
8	12	18
9	11	12
10	8	12
>10	23	30

The boring records of the primary wells in the project database are being compared against paper copies of the paper records in the ISGS Geological Record Unit's files. Comparisons are made for information given in the descriptive log of the geology, legal description of the well location, well owner, address of well owner, and address of the well, when given. Of the 662 wells checked to date, 8 had some discrepancies in the geologic descriptions; commonly depths of materials had been mistyped. There were 30 cases where the well or owner's address had not been entered or had been entered incorrectly. Corrections were made to the project database using information from the paper record. Further checking of these records is ongoing.

B. Verification of Well Locations

Ultimately, the usefulness of a boring or well record depends on the material descriptions it contains. However, this information is of limited use if it cannot be placed in its proper geographic context. The accuracy of the reported location of borings or well records is crucial to the usefulness of the descriptive log. A detailed geologic boring is of limited use if its location (both on the land surface and its elevation above sea level) is incorrect or uncertain. All borings in the project database have some locational information. All records have Public Land Survey locational information (i.e., township, range, section, and subsection identifiers). When correct, these data permit the well to be located within a 10-acre area. However, the elevation of that well can vary greatly over a 10-acre area, especially in areas of hilly terrain. A relatively small change in elevation can drastically alter the interpretation of the record. Accurate locations for well and boring drill sites are essential for accurate geologic mapping.

Many water well boring records lack reliable elevation information. To maintain consistency and accuracy, the elevations of wells within the study area have been estimated using a 10-m digital elevation model (DEM) provided to us by the Kane County Planning Division (2001). The accuracy of the DEM allows us to be confident about the elevation to ± 2 feet For areas outside Kane County, we utilized a 30-m DEM, with a vertical accuracy of ± 5 feet. In Kane County, it is likely that the accuracy of our surface elevation estimates are dependent upon the accuracy of the location than accuracy of the DEM data.

Wells were verified at different levels of certainty. Some wells were verified in the office using a plat book to simply determine if the landowner listed on the boring record matched the land owner listed on the plat for the location given in the record. This method increases confidence that the well is in the location listed on the log. Lots shown in plat books vary from a few acres to several hundred acres. Examination of the original logs or permits sometimes provided additional location information. The type of log and the year in which the drilling took place are considered. Water wells for residential use are generally located in close proximity to a residence. Engineering borings are mostly located near major structures that might require detailed subsurface information, such as buildings, bridge foundations, or interstate overpasses. Plat books commonly include these major structures as well as residences. Knowing when a well or boring was drilled allowed examination of plat books for the appropriate year, thereby narrowing down potential locations for the drill site. Historical aerial photographs from the appropriate years were used on rare occasions to narrow the search. Some older logs (pre-1960s) included notes or maps from the driller to explain site locations with unusual circumstances, such as no address. In some instances, the type of well suggested that less confidence be given to the location of a drill site. Agricultural irrigation wells, for example, could potentially be located within exceptionally large areas.

A higher level of confidence was gained by matching the well owner and address on the log to a specific lot, address, or house. This verification was accomplished through methods as simple as reading a name on a mailbox or by using any database that lists landowners by street address. Local phone books were obtained for most of the study area and were used to compare the names and address from well logs to those of current residents. Most libraries keep historical city directories, which can record names and addresses back into the 1800s. Both MapQuest (http://www.mapquest.com/) and Terrafly (http://www.terrafly.com/) were used for verifying well locations. Another reliable source for locational information is tax parcel records. Most county supervisors of assessment have computerized files of parcel information for tax purposes. These files include names, addresses, legal descriptions, and parcel information for current and past years for anyone who pays property taxes. Some property cards include lists of assets associated with a parcel and some have a photograph of the site. Residents of subdivisions without access to a municipal water supply drill individual wells or may develop one community well. These wells can be located with a great deal of confidence by searching tax record databases by subdivision name and lot number.

The most accurate method is field verification, where a well was physically inspected in the field to verify its location and confirm a match to the boring record. The well is then plotted on a topographic map or its location is recorded using a global positioning system (GPS). Field verification may involve site interviews with property owners, neighbors, or local officials. In smaller communities it is not uncommon to find a local resident who knows a great deal about the community and its residents, including where local or municipal water wells are located. Because field verification is labor intensive, this method was reserved for primary wells.
If a primary well could not be verified either through office or field efforts, the project database was searched for other nearby wells to replace it. The newly selected well would then have its location verified.

For this study, wells were ranked according to the reliability of their location. Well locations field verified by a reliable individual were ranked five. A rank of four was assigned to well locations verified by matching the well owner's name as recorded on the well record with a given house or street address. A well location verified by matching a well owner's name from the record with a given parcel of land was ranked three. Unverified wells were ranked two. Wells having unintelligible or questionable location information were ranked one.

Each well was initially ranked two unless the record indicated that the well location had previously been verified by an ISGS staff member. If previously verified, a ranking was given to match the verification method. An extended effort was made to field verify all primary wells for the project. Successful field verification resulted in a change in the well's location ranking to five and in some cases a corrected location in the project database either from GPS reading or corrected plotting on topographic maps. The old location information was retained in the database for reference but with a comment that it was incorrect. Table 5 summarizes the locational quality rankings of primary wells. Field verification of the well locations was successful for 58% of the primary wells in Kane County, whereas 42% of the primary well locations in the study area were field verified.

Table 5 Ranking of location quality of primary wells.

Location quality	Kane County	Entire study area
5	1,144	1,691
4	376	961
3	214	900
2	230	505
1	3	12

C. Lithostratigraphic Assignments

Lithostratigraphic assignments to recognized Quaternary units were made based on the geologic information in the descriptive log of the primary wells and by using the conceptual model, published stratigraphic interpretations, and the professional judgement of geologists working on the project. A review was made of wells with existing stratigraphic interpretations made by ISGS personnel (Landon and Kempton, 1971; Kemmis, 1981; Wickham et al., 1988; Kempton et al., 1985, 1986, 1987; Curry et al., 1988; Graese et al., 1988; Vaiden et al., 1988; Heigold, 1990; Gilkeson et al., 1987; Larson and Orozco, 1991; 1992; Larson et al., 1991, 1992; Morse and Larson, 1991; Curry et al., 2001) and cross sections from recently published maps (Curry, 1998, 1999, 2001a; Curry, 2004; Grimley and Curry, 2001a, b; Curry et al., 2001; Grimley, 1998, 1999). Due to the high data quality ranking, most of these wells had already been selected as primary wells. Descriptions of the geology in other primary wells were compared with established lithostratigraphic interpretations in nearby wells. In some cases, but not all, lateral correlation of one or more lithostratigraphic units between wells was possible. The extent of each glacial advance recognized in our conceptual model also limited which units were expected at any location. Curry and Grimley's unpublished preliminary 1:100,000-scale Surficial Geology Map of Kane County (Figure 9) depicts which geologic unit is at land's surface beneath the Peoria Silt. Peoria Silt is the uppermost geologic unit over most of the state, so it is not shown. The map was produced by making a mosaic of published and preliminary 1:24,000 and 1:100,000 geologic maps (Figure 2) and by interpreting some areas in southernmost Kane County. For this project, the map was extended to cover the entire study area by incorporating the surficial geology map of McHenry County (Curry et al., 1997) and unpublished surficial geologic mapping work done by Berg for the Superconducting Super Collider study (Graese et al., 1988). With the uppermost stratigraphic unit defined at a point, all units younger than the defined unit must be absent, and only older units can be present below the uppermost unit. All primary wells in the project database were examined, and lithostratigraphic assignments were made where possible (Figure 17). Without sufficient cause to make a stratigraphic assignment to a well, materials were left unassigned. Table 6 shows the number of lithostratigraphic assignments per primary well. A large number of assignments may imply complex geology, whereas a low number implies a simpler geologic succession or a location where geologists were unable to completely define the sequence of units present. The number of assignments made for selected lithostratigraphic units is shown in Table 7. A small number of assignments mostly reflects the limited areal extent of a unit in the county. For example, the Haeger Member occurs only in a small area in northeastern Kane County. The larger number of assignments of the upper boundaries of units reflects the fact that some wells did not fully penetrate that unit.

Similarly, bedrock lithostratigraphic assignments were made by camparison with earlier work done by ISGS staff (Graese, unpublished data; Kolata and Graese, 1983; Kempton et al. 1985, 1986, 1987; Curry et al., 1988; Vaiden et al., 1988). The emphasis in choosing primary wells was on quality of description of Quaternary deposits. Many of the boring records with existing stratigraphic interpretation of bedrock units were not chosen as primary wells. These wells were matched to wells in the project database using the sample set number, legal description of each well's location, and owner's name, when provided. Once matched to a well already in the project database, the bedrock lithostratigraphic assignments were added to the well record. Additionally, identification of the uppermost bedrock unit in primary wells was made by project staff where possible. Other than the primary wells, no effort was made to verify the locations of these wells. The great depth and thickness of the units involved make variations in the horizontal or vertical position of the boring much less important than when mapping Quaternary units, which tend to be shallower and thinner. Bedrock lithostratigraphic assignments were simplified into five major units: undifferentiated Silurian formations, the Maquoketa Group, the Galena-Platteville Groups, the Ancell Group and the undifferentiated Cambrian formation.

D. Lithostratigraphic Surfaces and Isopach Maps

To create a digital three-dimensional model of the succession of geologic materials of Kane County, we used the assignments made to primary wells of the contacts between the major Quaternary lithostratigraphic units in the study area. A map of the elevation of a contact (e.g., the top) of a particular lithostratigraphic unit constitutes a surface in the model. Each stratigraphic unit requires the definition of its upper and lower bounding surfaces. The lowermost unit, the Glasford Formation, has the top of the bedrock as its lower bounding surface. Upper and lower surfaces were defined for other major units, which included the diamictons of the Tiskilwa Formation and the Batestown, Yorkville, and Haeger Members of the Lemont Formation. With the exception of the bedrock units, none of these lithostratigraphic units occur continuously across the county. Hence, the three-dimensional maps of the bounding surfaces for each Quaternary unit are not continuous across the county; the absence of a surface in an area indicates that the unit was not described in the primary well data in that area. In addition, isopach maps of the thickness of the sand and gravel units that occur bewteen each diamicton units were created.

Data sets were built for each of the surfaces. Each data set contained the location coordinates (x and y), and elevation values (z) for each point defining the top or bottom of a lithostratigraphic unit in each boring record. The final data set for each unit is simply a list of locations and elevations of the upper and lower bounding surface of the unit where it is present as well as the locations of known absence of a unit.

Each surface was created using Surfer® (Golden Software Inc., 2002) with an interpolation algorithm, in our case kriging, which takes as an input a set of coordinates (x, y) and an elevation at those points (z) defined in the data set. The interpolation uses spatial trends in the data to establish values between data points. The resulting output is an evenly spaced grid of values representing the elevation of the surface. A node spacing of 1/8 mile was used on the output grids. Each node is not located precisely where the primary wells were located; hence, the elevation of the modeled surface may not be exactly the same as what is indicated in the primary well record.

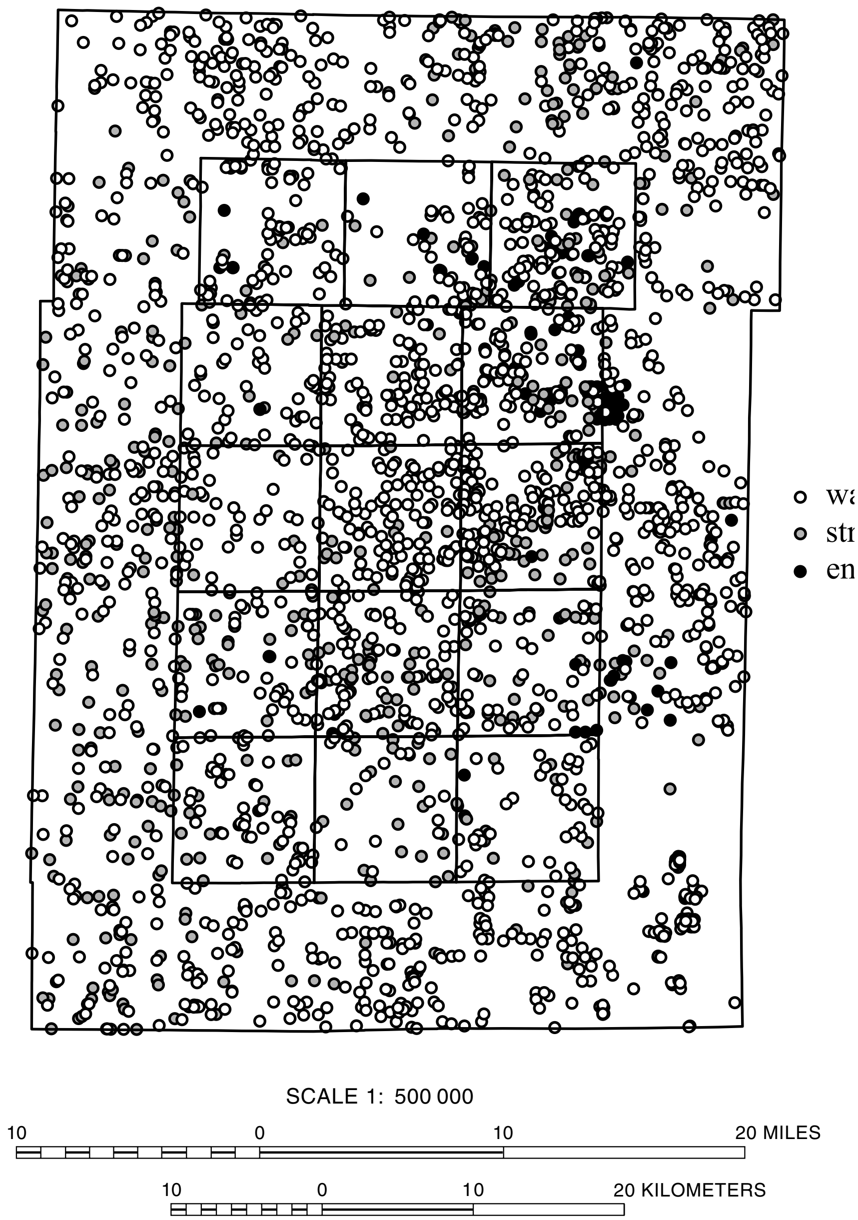

Figure 17 Distribution of primary wells used to generate lithostratigraphic surfaces.

Table 6 Number of lithostratigraphic assignments per primary well.

Assignments per well	Kane County	Entire study area
0	121	169
1	262	634
2	177	519
3	211	575
4	361	691
5	321	618
6	226	383
7	139	248
8	89	144
9	38	60
10	16	19
11	4	6
12	2	3

Table 7 Number of primary wells with lithostratigraphic assignments representing select units (d, diamicton lithology of the stratigraphic unit listed).

Lithostratigraphic unit	Kane County	Study area
Top of Haeger Member (d)	7	178
Bottom of Haeger Member (d)	6	183
Top of Yorkville Member (d)	366	748
Bottom of Yorkville Member (d)	284	591
Top of Batestown Member (d)	746	1,138
Bottom of Batestown Member (d)	718	1,077

The bedrock surface is different from the other surfaces in that its features, in our conceptual model, were shaped primarily by flowing water. Using a special algorithm for the interpolation of elevations that favors creation of water drainage features (topogrid http://support.esri.com/), we were able to create a topographic surface for the bedrock that has continuous valleys and other features that are more geologically plausible than the results of a simple point-to-point interpolation of the data that was used in creating the other grids. This surface was created independent of the bedrock lithology.

In addition to the surfaces of the units mentioned above, thickness grids of each of the major sand units were created using the kriging algorithm. A data set containing information on the absence or presence and thickness was used instead of elevation to generate a grid of thickness for each major unit of the Henry Formation and a composite of Glasford Formation sand and gravels. The latter is of somewhat limited use, as these sands do not always form a continuous unit and may represent distinct aquifers separated by thick layers of fine-textured material that is much less porous and permiable than the aquifer. This phenomenon will be addressed in future three-dimensional geologic modeling efforts.

After completing the model Quaternary units, an upper surface for each major bedrock unit was generated using the same kriging method as for the Quaternary units. Each surface was truncated using the bedrock topographic surface. This procedure produced a map showing the subcrop of the bedrock units.

Having completed the initial gridding of the surfaces, constraints were established to force the grids to follow certain logical and geological rules. For example, the top of the any glacial deposit cannot be above the ground surface, nor can the base be below the bedrock surface. In addition, the deposit must be above all older units and below younger units. Establishing and enforcing such constraints ensures that each surface has a reasonable shape and position in space in agreement with the conceptual model.

Working from the bottom upward, the bedrock surface was constructed first. It also had more points defined in its data set than did the Quaternary units. The upper surface of the undifferentiated Glasford Formation was constructed next. The bedrock surface defined the bottom surface of the Glasford Formation and was used to truncate that surface where bedrock ascends above the Glasford surface (i.e., in areas where the Glasford is absent). The surface of the bottom of the Tiskilwa Formation was constructed next. It was compared to the upper surface of the Glasford Formation. The comparison showed where there was void space or overlap between the surfaces. At locations where they overlapped, new stratigraphic assignments were made to correct the discrepancies . The void space between the surfaces was compared to a thickness grid of the Ashmore Tongue of the Henry Formation, which underlies the Tiskilwa diamicton. In general the comparison was very good; where discrepancies occurred, a geologist's judgment was used in adjusting previous stratigraphic assignments or in making new assignments to correct each case. Following each round of new stratigraphic assignments, new surfaces were generated for each unit. The comparison process was repeated until the two surface conformed. In this way, working from the bottom up, each surface was modified to conform to those above and below it. Also, the surfaces were tested against the conceptual model.

Although the surfaces or grids themselves are two-dimensional data sets, they represent three-dimensional surfaces that can be used to create three-dimensional models and derivative maps based on the gridded properties, such as the aquifer sensitivity map (described below). Isopach maps, for example, are simply contour maps of unit thicknesses, which can be easily obtained by subtracting the elevation grid for the bottom of a unit from the elevation grid of the top of that unit.

Lithostratigraphic surfaces and isopach maps represent the basic geologic maps of Kane County. To make this basic geologic information more useful, a series of derivative maps were produced, which can be used directly as planning tools. These include a *Preliminary Map of Aquifer Sensitivity to Contamination, Kane County, Illinois* (Dey et al, 2004a), a *Preliminary Map of Major Quaternary Aquifers, Kane County, Illinois* (Dey et al., 2004b), a *Preliminary Bedrock Geology Map, Kane County, Illinois* (Dey et al., 2004c), a *Preliminary Three-dimensional Model of the Geology, Kane County* (Abert et al., 2004), and *Preliminary Geologic Cross Sections, Kane County, Illinois* (Dey et al., 2004d). Although the primary geologic maps were created for the entire study area, the derivative maps cover only Kane County.

Details of how individual surfaces and isopach maps were used to construct each derivative map product are included in the following descriptions of each map.

IV. LITHOSTRATIGRAPHIC UNITS AND PRIMARY GEOLOGIC MAPS

The methods described in the preceding section were used to translate the lithostratigraphic units from the conceptual model to a physical three-dimensional geologic model, where the units have lateral and vertical mapped dimensions. Descriptions and isopach maps are presented to communicate the properties, distribution, and relationships of the major lithostratigraphic units.

Geologists map geologic materials as lithostratigraphic units having unique physical properties (such as color and particle-size distribution) that occur at a specific level in the succession of sediment layers. For deposits of the last glaciation, a special distinction is made based on grain-size sorting. Deposits composed of similarlysized grains (i.e., well-sorted sediment) are classified with the Mason Group; deposits composed of a wide rsnge of grain size classes (i.e., diamicton) are classified with the Wedron Group (Hansel and Johnson, 1996). Regionally important layers of sand and gravel or fine-grained sediment that is classified as part of the Mason Group but occur between named lithostratigraphic units of the Wedron Group are named stratigraphic tongues, such as the Beverly Tongue of the Henry Formation (Figure 18). Sand and gravel layers that are mappable at 1:100,000, but are not necessarily of regional extent, are unnamed tongues of the Henry Formation.

"Diamicton" describes a deposit made up of a mixture of particles with a wide range of grain sizes, commonly ranging from clay to boulders. Most diamicton of glacial origin in Illinois is matrix-supported, meaning that the larger sized particles (gravel to boulders) are not in contact with one another and are encased in a matrix composed of the finer particles (clay, silt, and sand). In Illinois, moraines are commonly formed of diamicton with a lithology that contrasts with the diamictons that form adjacent moraines of different ages. The most commonly used lithological criteria to differentiate among diamicton units include the color, the particle-size-distribution of the <2 mm matrix, and the clay mineral composition (Wickham et al., 1988). Table 2 provides basic statistics (mean, maximum, and minimum values) for particle size distribution and clay minerals. Quaternary geologists use textural terms such as "loam" and "clay loam" to describe the particle-size distribution of the matrix; the terms are based on the soil texture classification of the US Department of Agriculture (Buol et al., 1980).

Glasford Formation, undifferentiated, This unit includes the oldest Quaternary deposits in Kane County. The Glasford is the surficial unit (below a mantle of loess) in the northwestern corner of project study area. Glasford Formation is found throughout most of north, west , and central Kane County, and is thickest where it fills buried bedrock valleys (Figure 19). The most important criteria for identifying these deposits are that they occur below the Robein Member of the Roxana Silt or have evidence of soil weathering (usually ascribed to development of the Sangamon Geosol) where buried by younger glacial deposits. The Glasford Formation is observed in many quarries in the county, including the Feltes Sand and Gravel Pit (Curry et al., 1999). The Glasford is composed of diamicton (till and debris flow deposits, mostly the former), sand and gravel, and uniform silt and clay.

Although they are not differentiated, Glasford Formation diamicton comprises several lithologic units with varying physical attributes. For example, at the Feltes Sand and Gravel Pit, Glasford Formation diamicton is yellow-brown, coarse-textured, and associated with thick, bouldery sand and gravel. In other areas of the county, the Glasford Formation is a finer-grained diamicton associated with silty lake sediment. Additional information is necessary to confidently map the distribution of these distinct lithologies in Kane County. Part of the difficulty in mapping the Glasford units is that they generally occur far below ground surface beneath youger deposts (and, hence, are difficult and expensive to sample).

Robein Member, Roxana Silt A distinct unit composed of black to very dark brown, leached silt loam with wood fragments, the Robein Member occurs throughout the county above the Glasford Formation sediment. Generally less than 3 feet thick, this layer has been traced throughout northeastern Illinois, where it may also be compact peat, soupy muck, or stratified organic-rich silt as much as 28 feet thick (Kempton et al., 1987). Interpreted to be a buried soil originally formed in loess, this unit ranges in age from about 55,000 to about 23,500 yr B.P. (Curry, 1989; Curry et al., 1999; Curry and Pavich, 1996) and is correlated with the Robein Member of the Roxana Silt. Slow degradation of the organic matter has occurred, resulting in local buildups of methane in the county (e.g., Lily Lake).

Wedron Group Predominantly glacially deposited diamicton interbedded with lenses of sand and gravel, the Wedron Group overlies the Glasford Formation and Robein Silt. The very poorly sorted sediment of the Wedron Group contrasts with the better sorted sediment (sand, sand and gravel, gravel, silt, or clay) of the Mason Group, discussed separately below (Figure 18).

Tiskilwa Formation This unit forms the Bloomington and Marengo Moraines (Figure 8), and is as much as 270 feet thick (Figure 20). Elsewhere in Kane County, it constitutes a significant proportion of the glacial drift, especially in north-central and central Kane County. The Tiskilwa is largely absent in the southeast (Figure 20). The Tiskilwa overlies the Robein Member of the Roxana Silt and sorted units of the Mason Group, including silt and clay of the Peddicord Tongue (Equality Formation) and sand and gravel of the Ashmore Tongue (Henry Formation) (Figure 21). The Tiskilwa Formation is composed primarily of reddish brown clay loam to loam diamicton with channel-shaped bodies and stringers of sand and gravel, sand, as well as silt and clay. Locally, a basal stratified facies occurs that is

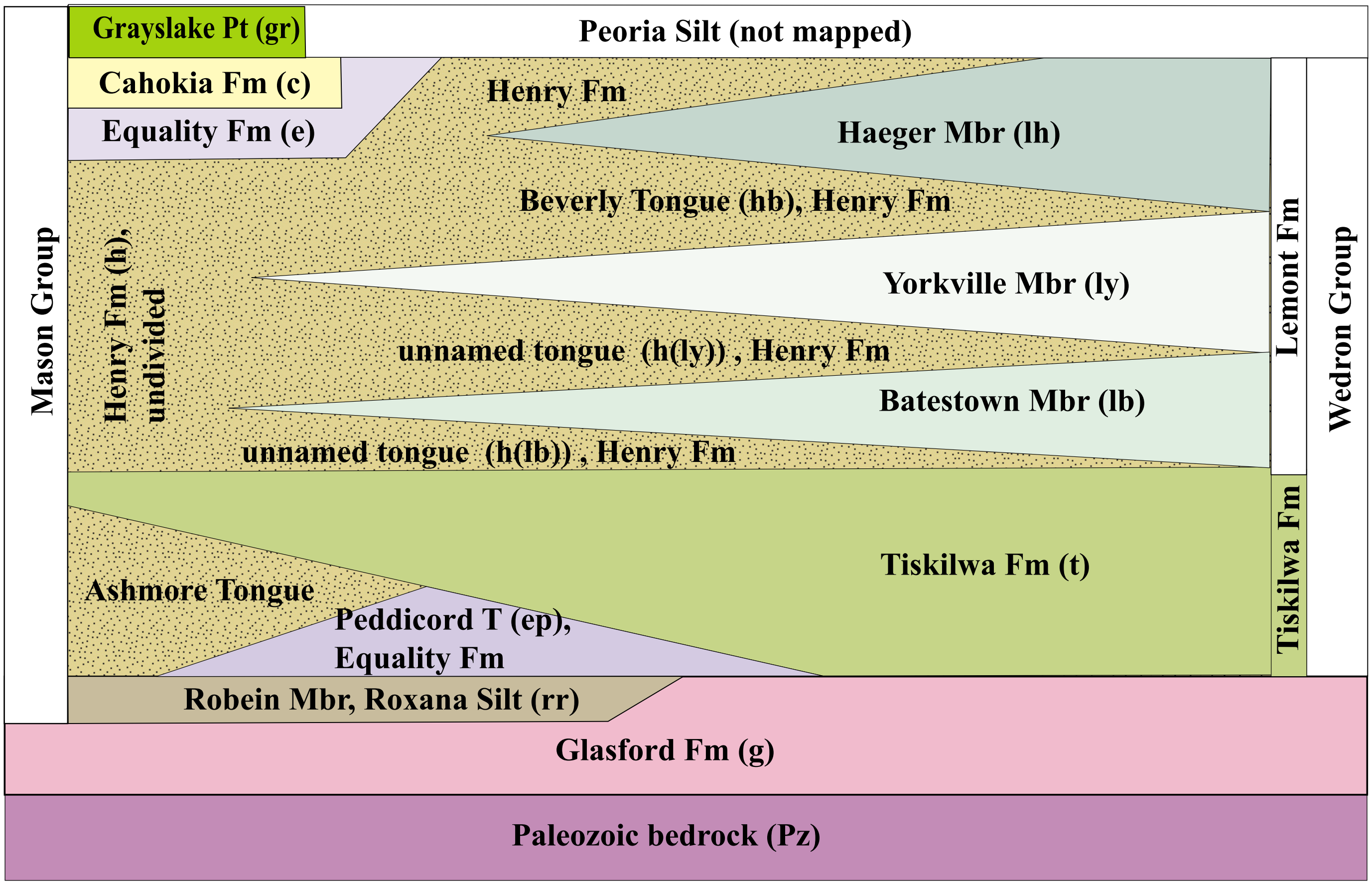

Figure 18 Schematic diagram showing lateral and vertical relationships between Mason Group units and diamictons of the Wedron Group (modified from Curry et al., 1999).

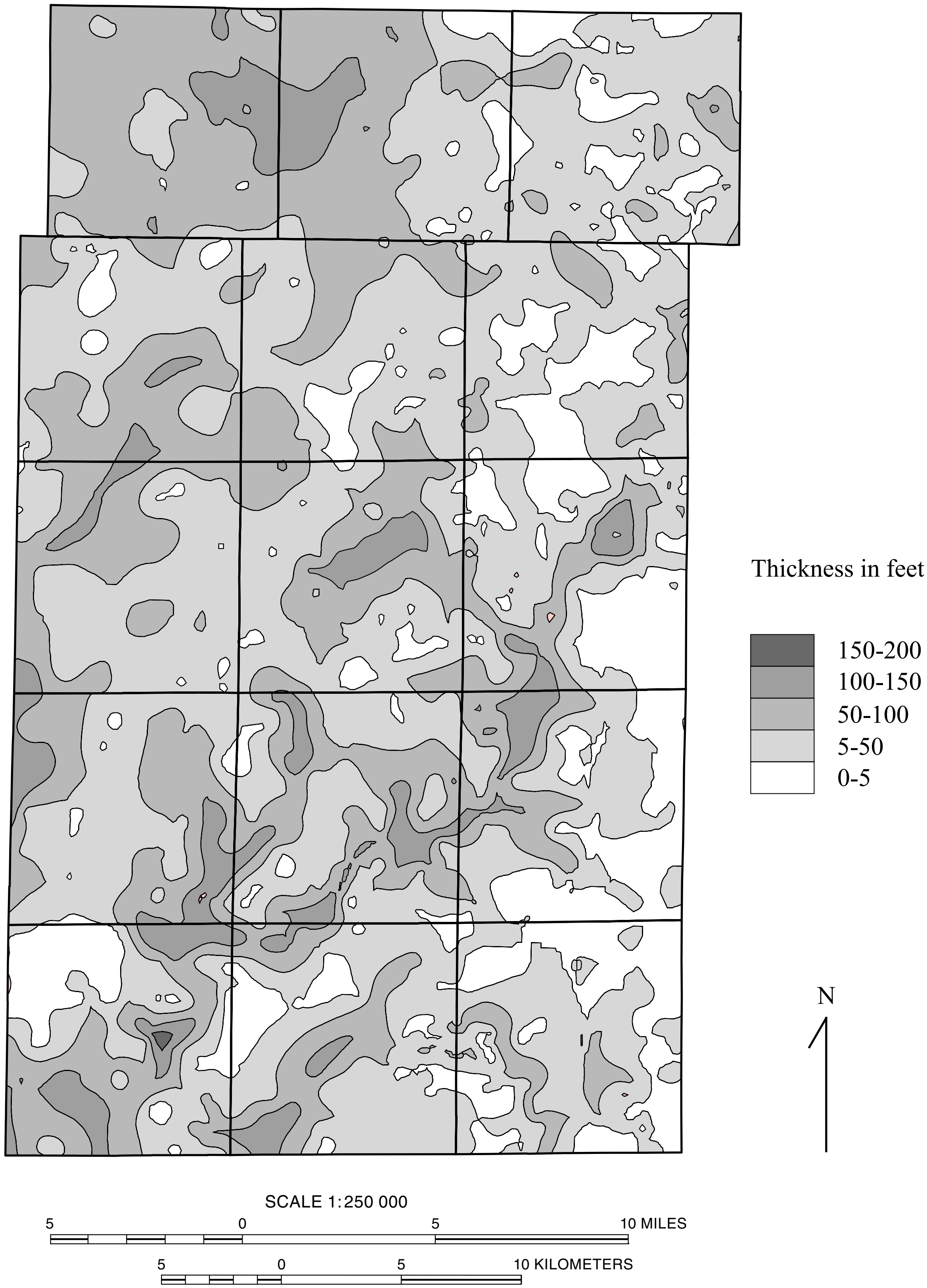

Figure 19 Isopach (thickness) map of combined deposits (diamicton, silt and clay, sand and gravel) of the Glasford Formation in Kane County.

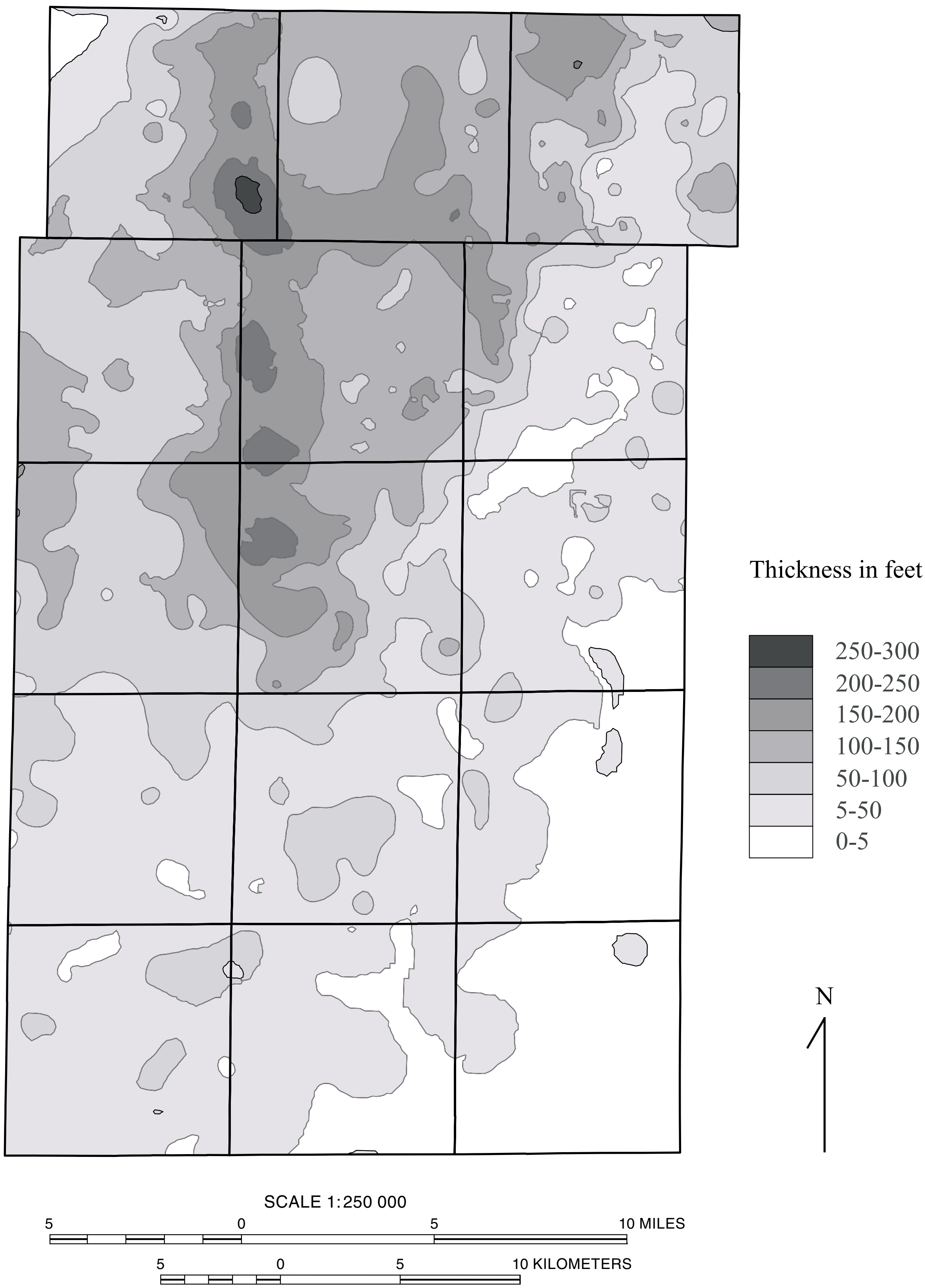

Figure 20 Isopach (thickness) map of diamicton of the Tiskilwa Formation in Kane County.

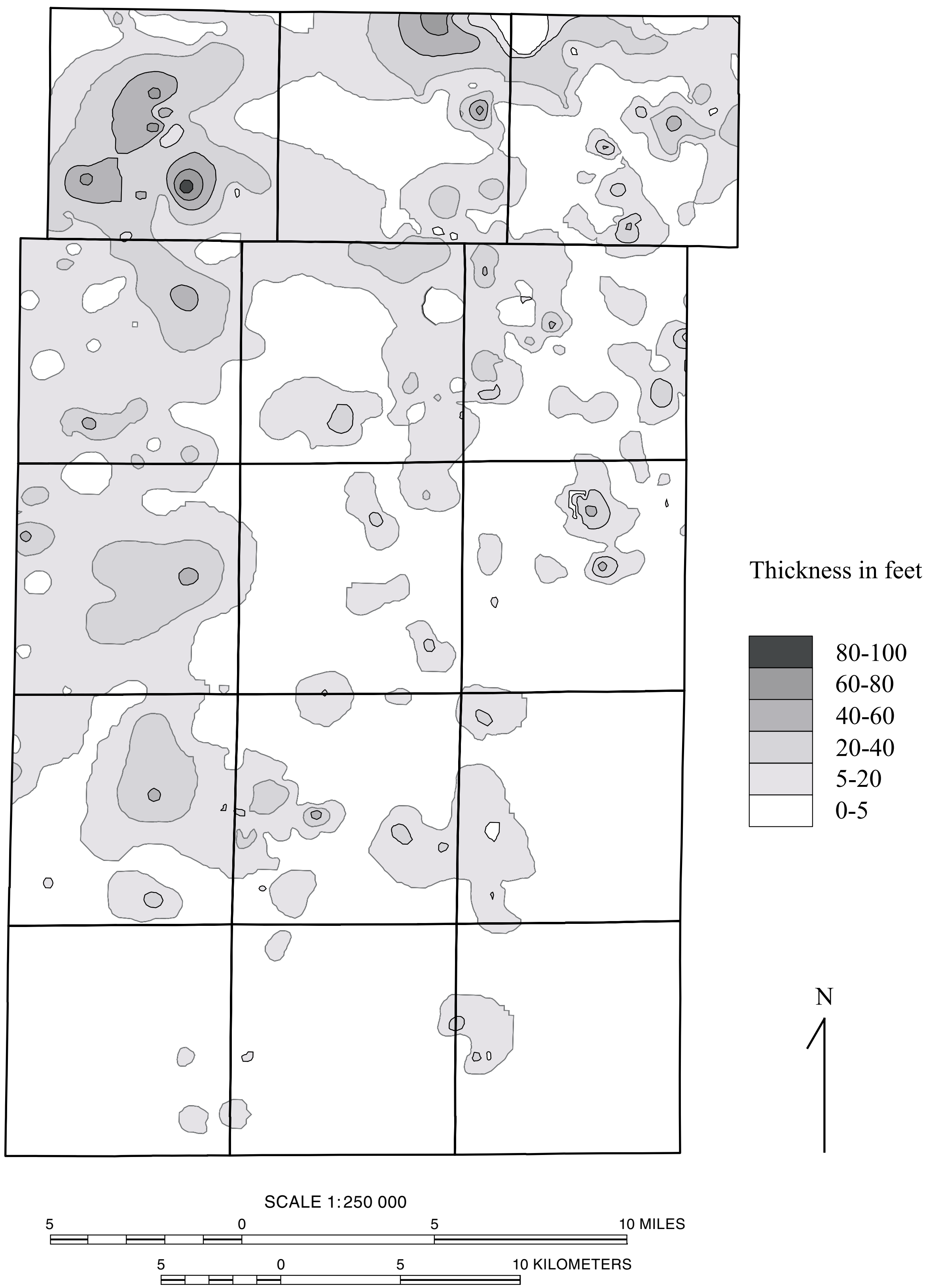

Figure 21 Isopach (thickness) map of proglacial sand and gravel associated with the Tiskilwa Formation known as the Ashmore Tongue of the Henry Formation.

composed of mostly subhorizontal beds of sorted sediment interbedded with layers of very hard diamicton. In the stratified facies, occasional deformed and truncated channel-shaped bodies, in addition to inclusions of organic silt with sheared, polished, and striated surfaces attest to deposition in an active ice environment. At the Fox River Stone Quarry, prolate pebbles have strong preferred orientations in both facies of diamicton, suggesting deposition as subglacial till deposited beneath active ice. The diagnostic characteristics of Tiskilwa diamicton are that it is harder, redder, and thicker than the other units of the last glaciation and its stratigraphic position.

Batestown Member (Lemont Formation) The Batestown forms the upper diamicton of the Arlington Moraine, Elburn Complex, and Gilbert's Drift (Figure 13). Overlying the reddish brown diamicton of the Tiskilwa Formation, the Batestown is a uniform to stratified (layered) loam to silt loam diamicton containing abundant interbeds of sand and gravel or sand. The loam diamicton facies tends to be brown and uniform and occurs primarily west of the Marengo Moraine. The silt loam diamicton facies tends to be somewhat browner than the loam facies and occurs primarily in south and central Kane County. The Batestown Member diamicton is as thick as 90 feet in Kane County (Figure 22) and is associated with sand and gravel as thick as 80 feet throughout the county (Figure 23). Other large landforms formed of Batestown-associated sand and gravel include Johnson's Mound (a kame) and Bald Mound (a mined-out kame; Figure 13). This sand and gravel was named the Wasco facies of the Henry Formation (Grimley and Curry, 2001a) but is treated in this report as sand and gravel associated with the Batestown Member. At the Fox River Stone Company, prolate pebbles yield strong preferred orientations indicating the local diamicton is subglacial till that was deposited beneath active ice (Curry et al., 1999).

Both facies of the Batestown Member at the Fox River Stone Quarry are associated with abundant lenses, layers, and channel-shaped bodies of clay-poor sediment. This material ranges in texture from very poorly sorted, clast-supported sandy loam diamicton to well-sorted, cross-bedded fine to coarse sand. In the layered facies, channel-shaped deposits with coarser sediment are often small (the largest general dimensions are 2 to 3 feet thick, 5 to 10 feet wide). Some drape over large clasts. Tabular beds of cross-bedded, finer-grained sands may be continuous across as much as 50 feet. In 1987, a channel-shaped body of well-sorted, uniform medium sand that was about 500 feet long and 30 feet thick was observed in an anomalously thick section of layered silt loam diamicton. The sand body had a flat base and concave-upward upper surface. This sand body is interpreted to represent a large R-channel, which, in modern glacial environments, forms in ice-walled channels that collapse and deform as the ice melts (Drewry, 1986). Other smaller R-channel deposits have been observed in the layered Batestown diamicton, which we interpret to be a melt-out till (Curry et al., 1999).

The diagnostic characteristics of Batestown diamicton include its stratigraphic position; association with the Elburn Complex, Arlington Moraine, and Gilbert's Drift; its softness (especially compared to Tiskilwa diamicton); high sand content; and abundant interbeds of sorted sediment.

Yorkville Member (Lemont Formation) This unit forms the St. Charles and Minooka Moraines (Figure 14) where it is as much as 100 feet thick (Figure 24). Unweathered Yorkville diamicton is gray diamicton with a matrix texture that varies from clay to loam diamicton. Typically, the upper part of the Yorkville Member in Kane County is weathered, and oxidizes yellow brown in the upper 10 to 15 feet. Three textural facies of the Yorkville Member are recognized at Fermi Accelerator Laboratory, including lower clay, middle loam, and upper silty clay units (Landon and Kempton, 1971; Kemmis, 1978; Curry, 1991). The St. Charles Moraine tends to be formed of the clay diamicton facies; the Minooka Moraine is typically formed of the silty clay facies. The loam facies is associated with abundant channels of sand and gravel. Both the clay and silty clay facies typically contain fewer boulder to cobble-sized clasts than do the other diamictons of the last glaciation. At the Fox River Stone Quarry, prolate pebbles have strong preferred orientation indicating deposition in a subglacial environment under active ice (Curry et al., 1999). The 0.004-mm fraction contains from about 75% to 80% illite, which is 5 to 10% higher than other diamictons in the succession. Channel-shaped bodies of sand and gravel occur in Yorkville diamicton; aside from the loam facies, they are less common than in the other diamicton units (Figure 25). The diagnostic characteristics of Yorkville diamicton include its stratigraphic position and association with the St. Charles and Minooka Moraines, high clay content, and gray color.

Haeger Member (Lemont Formation) This unit forms the Woodstock Moraine, which just clips the northeastern corner of Kane County (Figure 16 and Figure 26). The Haeger is associated with thick sand and gravel deposits.

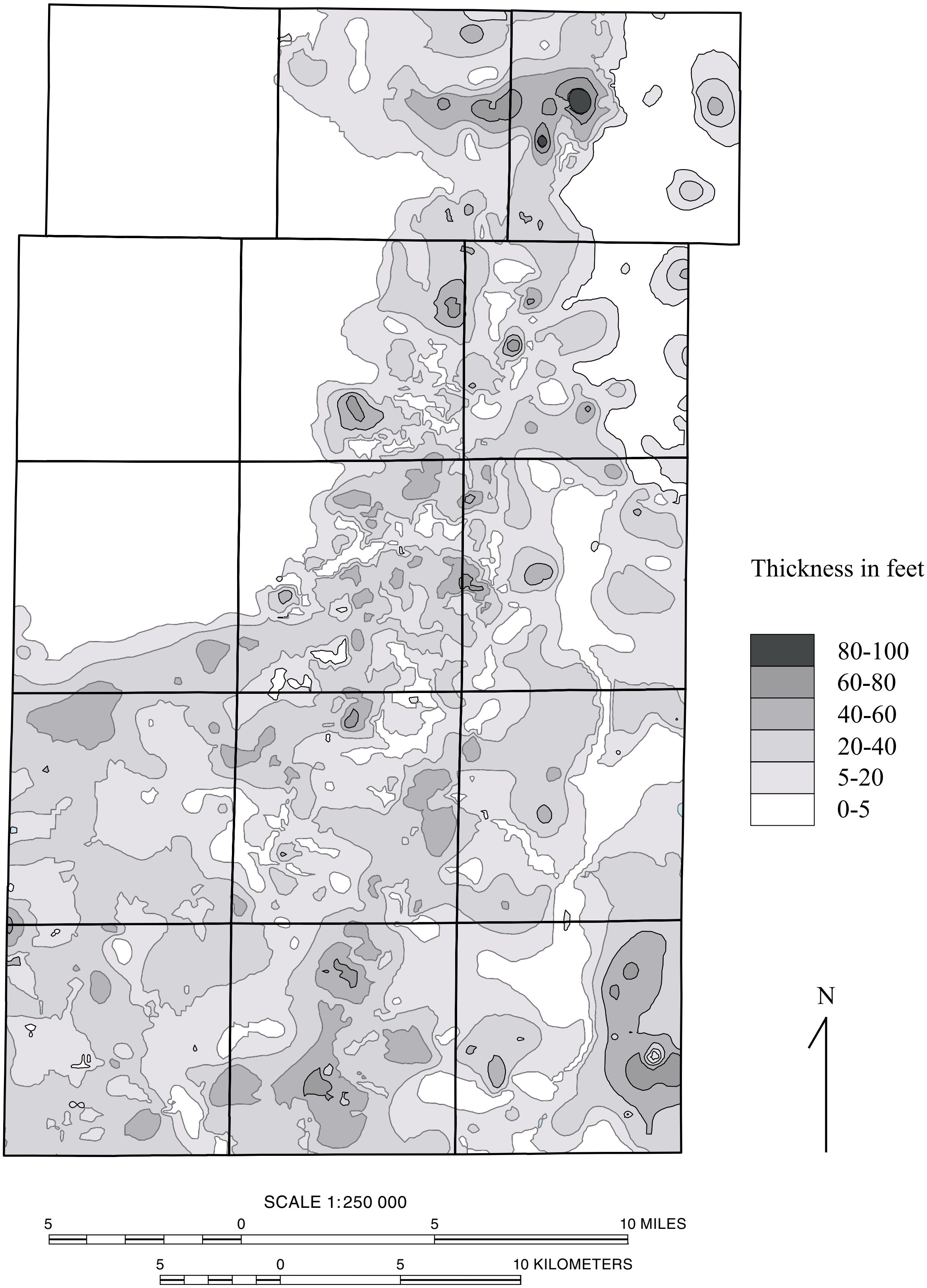

Figure 22 Isopach (thickness) map of diamicton of the Batestown Member, Lemont Formation, in Kane County.

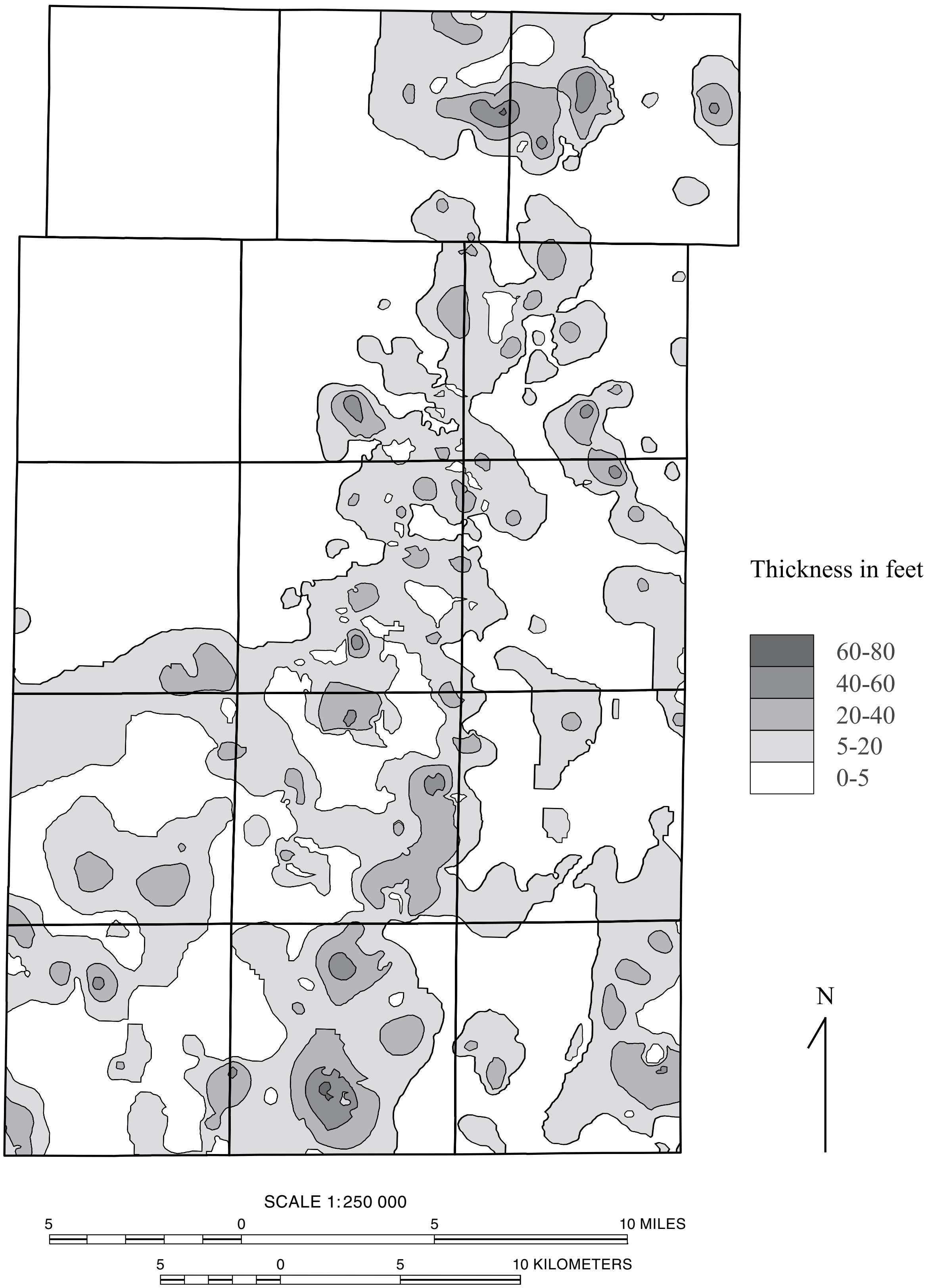

Figure 23 Isopach (thickness) map of basal sand and gravel associated with the Batestown Member, Lemont Formation, in Kane County.

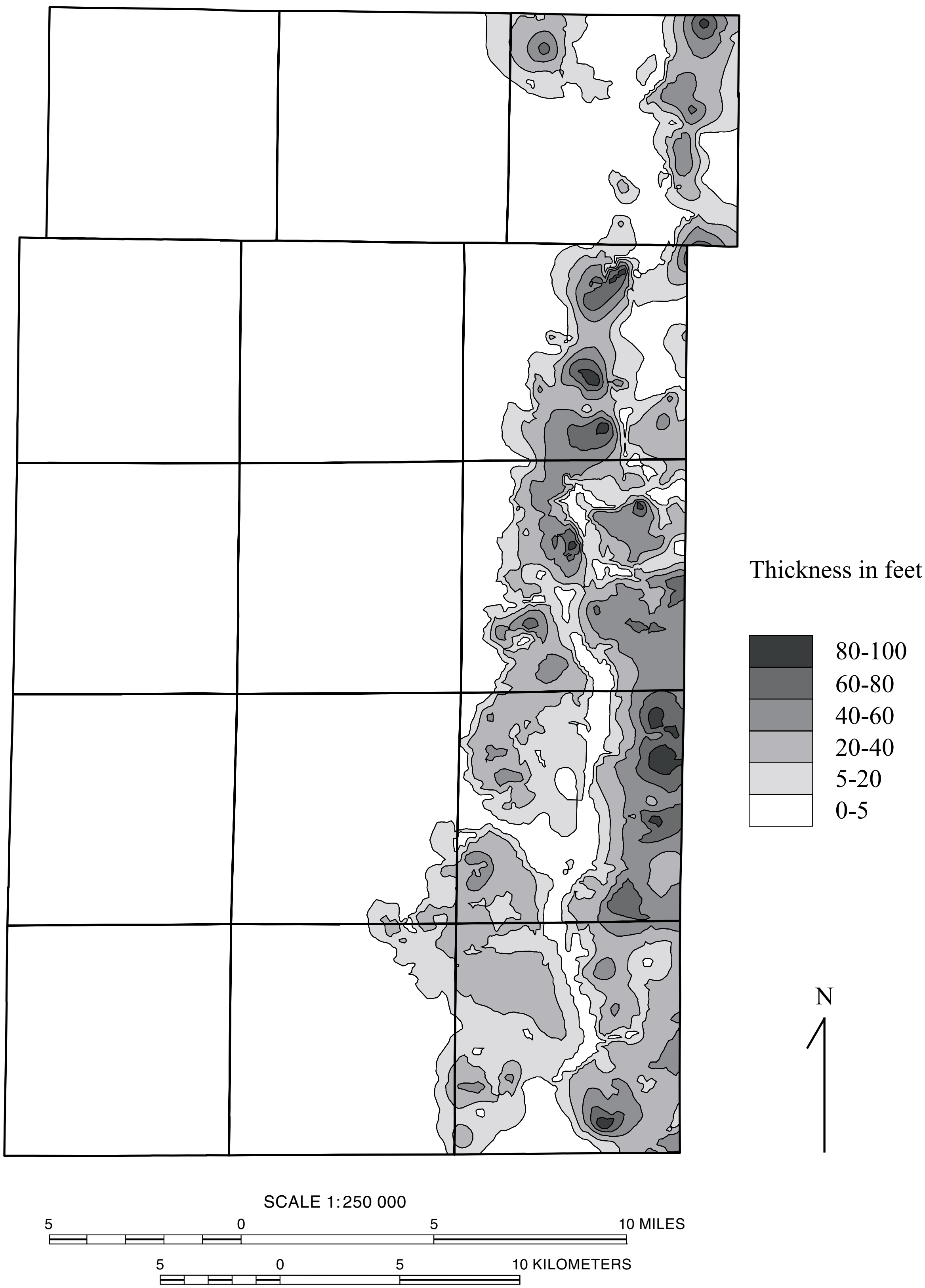

Figure 24 Isopach (thickness) map of diamicton of the Yorkville Member, Lemont Formation, in Kane County.

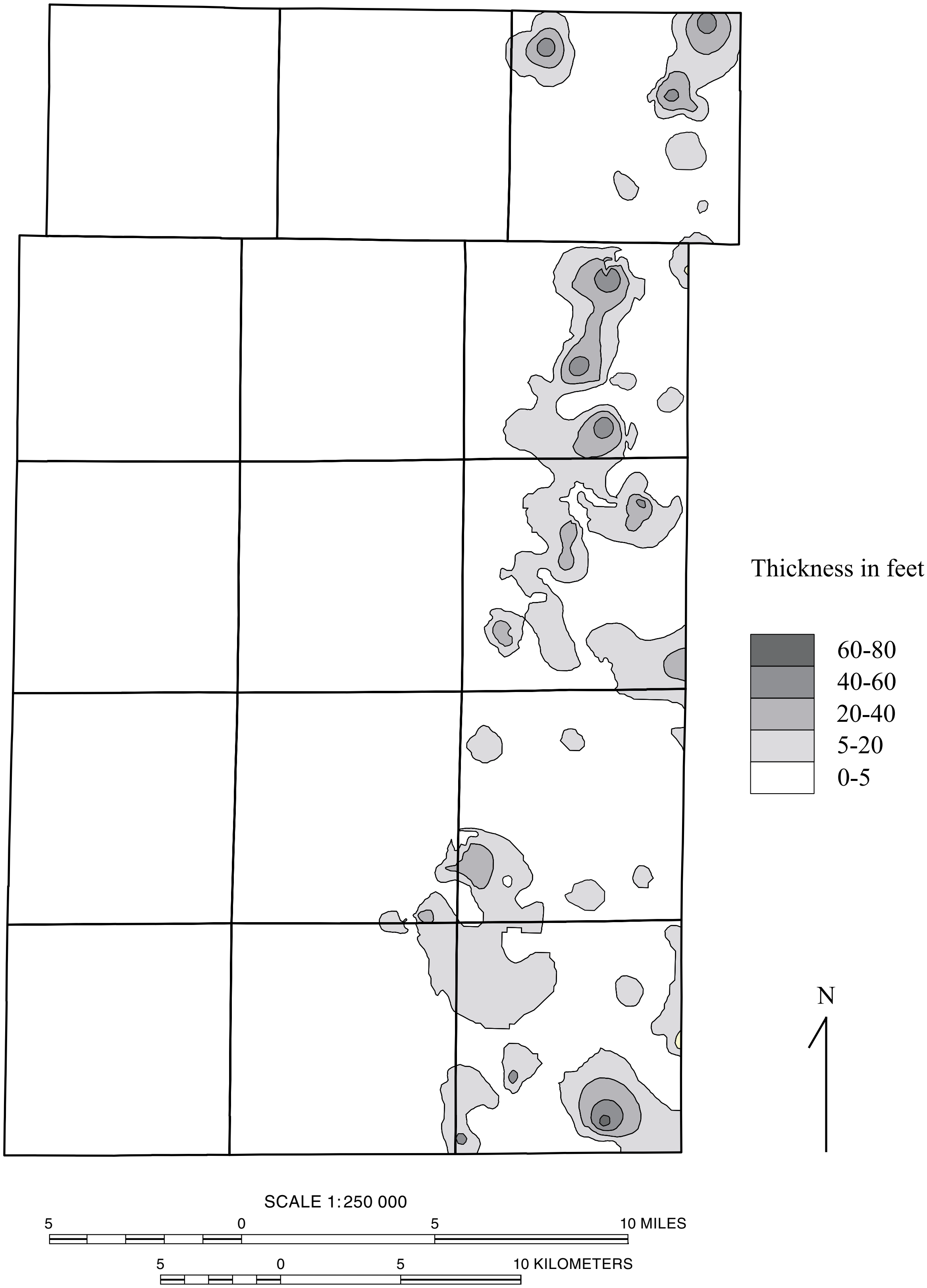

Figure 25 Isopach (thickness) map of basal sand and gravel associated with theYorkville Member, Lemont Formation, in Kane County.

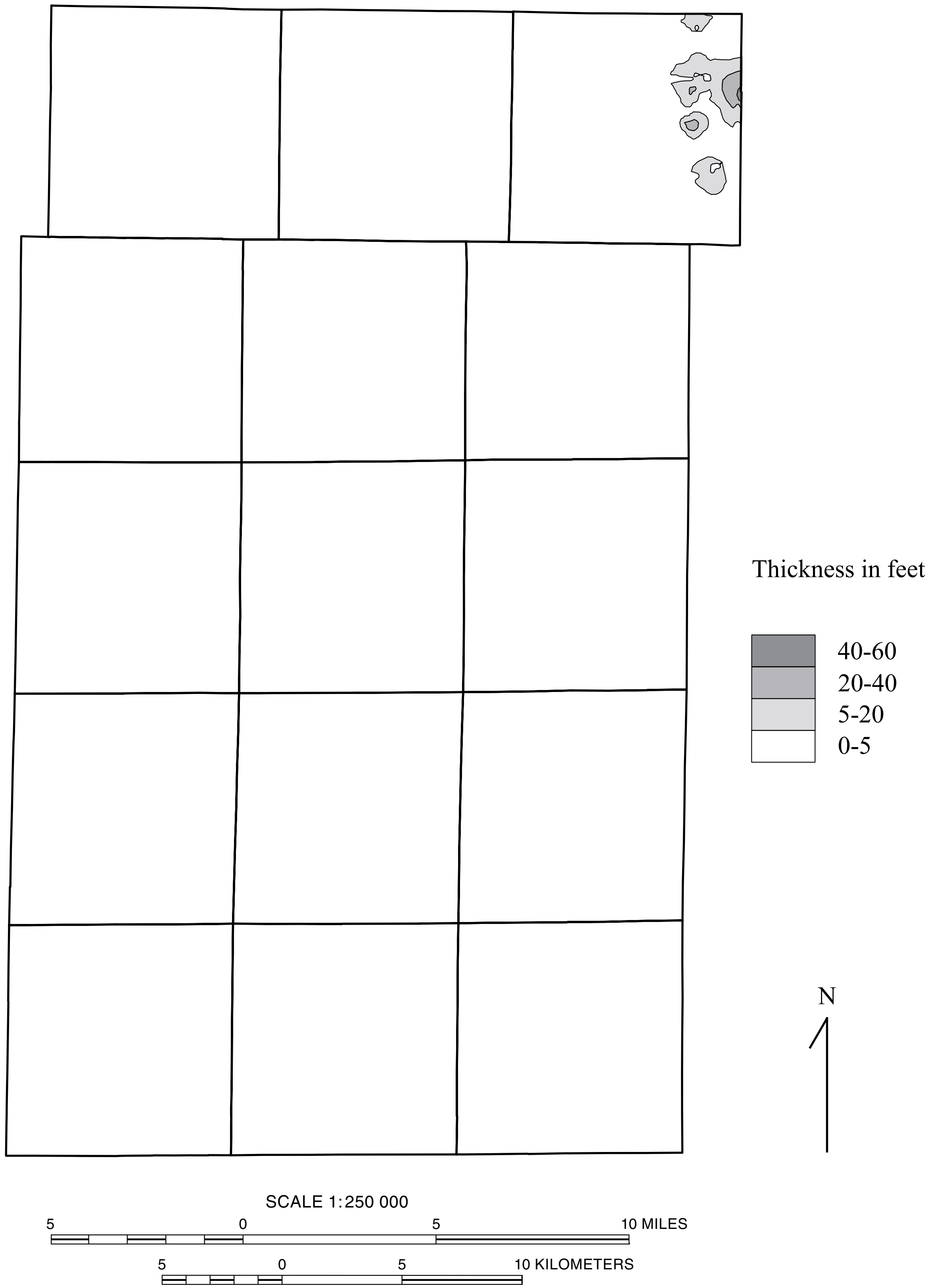

Figure 26 Isopach (thickness) map of diamicton of the Haeger Member, Lemont Formation, in Kane County.

Where buried by Haeger diamicton, the sand and gravel is known as the Beverly Tongue (Figure 27); where it occurs as a surficial deposit (even though the deposit can be shown to be associated with Haeger diamicton), the sand and gravel is known as the Henry Formation. The Haeger Member is sandy loam diamicton with abundant, discontinuous lenses of sand and gravel and thin beds of silt and clay (Curry et al., 1997). Clasts composed of brownish yellow to yellow dolostone dominate the lithology of both the diamicton of the Haeger Member and the sand and gravel of the Beverly Tongue. Just north of Kane County, the Woodstock Moraine swings to the west; as a result, the Haeger Member constitutes much of the surficial diamicton in McHenry County.

Wadsworth Formation This unit forms the West Chicago Moraine to the north and east of Kane County. The thickness of the Wadsworth may be greater than 100 feet in the study area. The lithology of the Wadsworth diamicton is virtually indistinguishable from the Yorkville Member (Schmitt, 1985). Hence, its distinguishing chararcteristics are its occurrence as the surficial diamicton forming the West Chicago Moraine and Valparaiso Morainic System. The Wadsworth Formation also occurs above the sandy and dolomite-rich Haeger Member and Beverly Tongue described above.

Mason Group In contrast to the very poorly sorted diamicton of the Wedron Group, the Mason Group consists of better sorted sediment, including poorly sorted sand and gravel and well-sorted sand of the Henry Formation, to well-sorted silt and clay of the Equality Formation and Peoria Silt. Stratigraphic "tongues" are regionally extensive layers that occur below unique Wedron units. For example, the Beverly Tongue of the Henry Formation is a regionally extensive deposit of sand and gravel that occurs below the Haeger Member (Figure 18).

Henry Formation This unit is primarily sand and gravel, with fewer layers of silt and clay, and diamicton. There are three primary landscape-sediment assemblages in which Henry sand and gravel is found: (1) kames, (2) stream valleys, and (3) alluvial fans. Kamic Henry Formation has been mapped as the Wasco Member of the Henry Formation by Grimley and Curry (2001a,b). Attaining thicknesses of 100 feet in the Campton Hills, the bedding of the kamic sand and gravel is, in places, deformed by collapse. The Wasco facies contains abundant silt, both in the matrix of the sand and gravel and as discrete beds.

Compared to the irregular, mapped distribution of the Wasco Member, Henry Formation along streams and rivers occurs in long, linear deposits. The deposits are too thin and narrow to appear at the 1:100,000 scale of the isopach map of the Henry Formation (Figure 28). Conceptually, sand and gravel that was deposited by meltwater is known as the Henry Formation, whereas sand and gravel deposited by the flowing water of postglacial time is part of the Cahokia Formation. The distinction is not always easy to make based on the materials alone, because postglacial sand and gravel may simply be reworked outwash. The mapped distribution of Henry and Cahokia Formations sand and gravel is determined largely by landscape position; materials found in the active floodplain are considered Cahokia Formation, and sand and gravel occurring above the floodplain are mapped as Henry Formation. Henry Formation occurring in terraces along the Fox River is typically less than 20 feet thick. The Henry Formation in this landscape position is a common location for spring discharge.

Sand and gravel that occurs in alluvial fans tends to be thicker, cleaner (i.e., contains less clay and silt), and more widespread than the other two types. Such alluvial fan deposits are common west and south of the Woodstock Moraine in northeastern Kane County (Figure 28; Hansel et al., 1985; Curry, 2004). Cobb and Fraser (1981) mapped facies of the sand and gravel deposits west of the Woodstock Moraine in Crystal Lake, just north of McHenry County. There, they determined that alluvial fan deposits within about a 1/4 mile of the ancient ice margin tend to be chaotically bedded with common channel fills composed of sandy diamicton. Cobb and Fraser (1981) named this assemblage the proximal facies. Sand and gravel from about 1/4 to 2 miles away from the ancient ice margin tended to be horizontally bedded or had broad, shallow channels with relatively clean sand with some gravelly and cobbly beds. This was named the medial facies. Deposits further away from the ancient ice margin included silty lake deposits (the distal facies). In Kane County, deposits of the medial facies are commonly exposed in sand and gravel pits. Discharge down the Fox River appears to have precluded the deposition of distal facies material in Kane County.

There are two stratigraphic tongues of the Henry Formation recognized in Kane County: the Ashmore Tongue (everywhere buried by diamicton of the Tiskilwa Formation; Figure 21) and the Beverly Tongue (associated with the Haeger Member, Lemont Formation; Figure 27). The distribution of the Ashmore Tongue is irregular with a maxi-

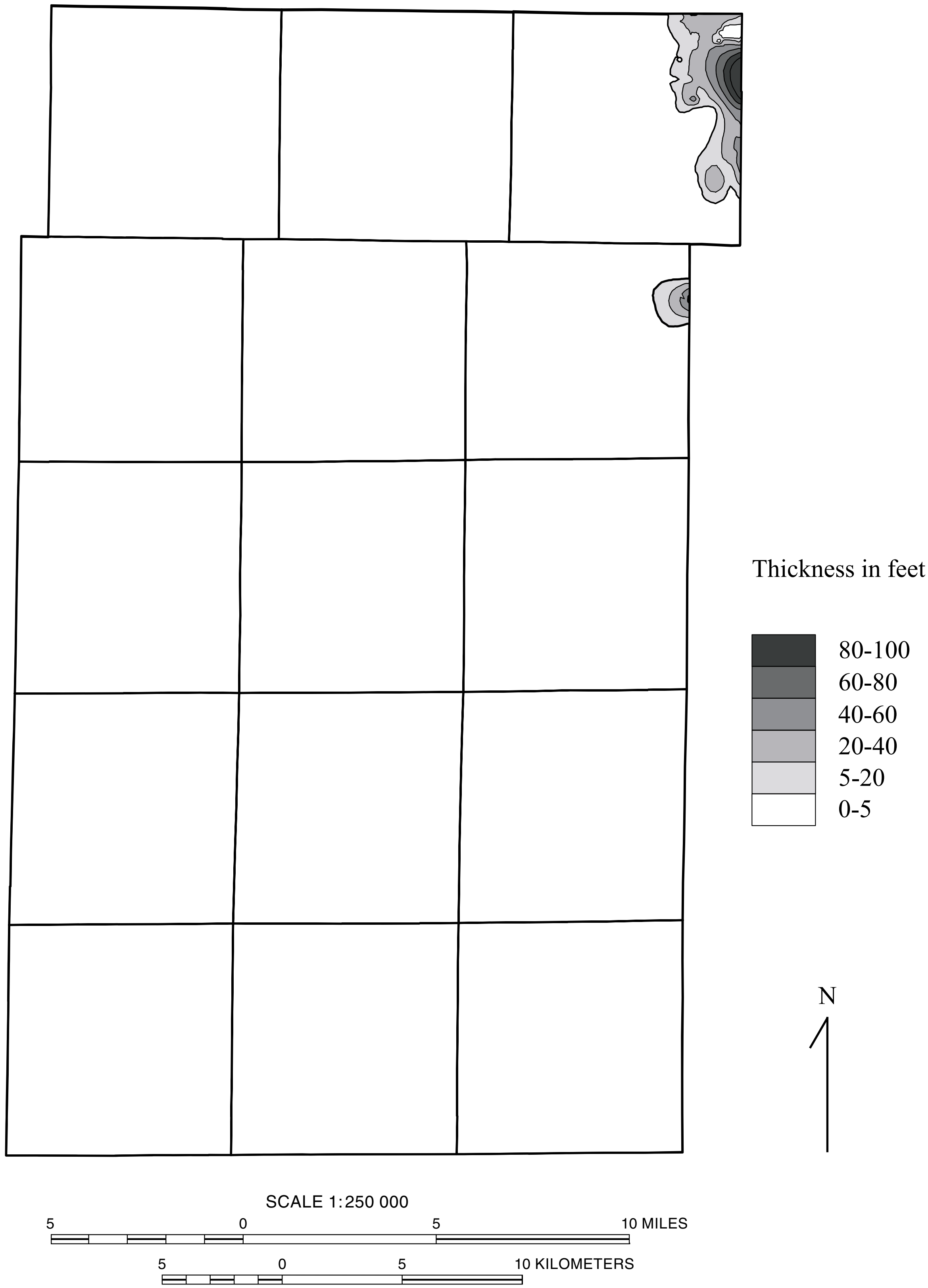

Figure 27 Isopach (thickness) map of proglacial sand and gravel associated with the Haeger Formation known as the Beverly Tongue of the Henry Formation.

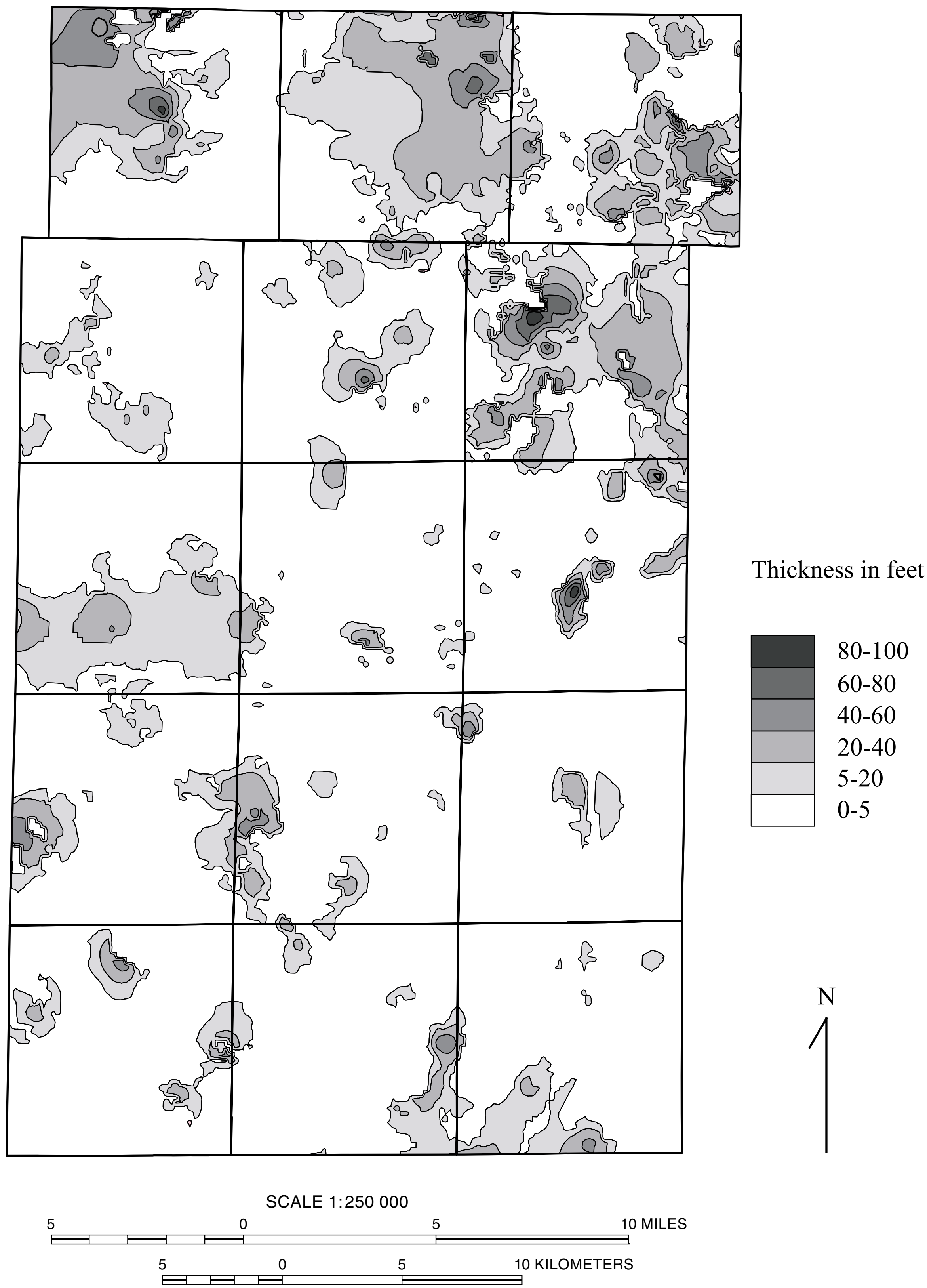

Figure 28 Isopach (thickness) map of surficial sand and gravel of the Henry Formation.

mum thickness of about 70 feet in the Hampshire area. The Beverly Tongue is thicker, more widely distributed in northeast Illinois, and closer to ground surface than the Ashmore Tongue. The maximum thickness of the Beverly Tongue is about 90 feet in northeastern Kane County.

Equality Formation This silt, clay, and fine sand that was deposited in quiet water under both glacial and postglacial conditions. Although the distribution of surficial lake sediment is widespread throughout Kane County, the thickness rarely exceeds 10 feet (Figure 10). Equality Formation associated with glacial lake deposits usually contains less organic matter and more interbeds of sand than postglacial material. The deposits of lake sediment associated with Glacial Lake Pingree are as much as about 20 feet thick (Grimley, 1998). The total thickness of lake sediment below Nelson Lake, the largest natural lake in Kane County, is about 43 feet. Of that, the lower 10 feet was deposited during glacial time as evidenced by the low organic matter content (<5%). The upper 33 feet was deposited during postglacial time and contains 20 to 60% organic matter and 20 to 40% biogenic calcite (snail shells and other fossils; Curry et al., 2001).

Postglacial deposits In Kane County, postglacial deposits include Peoria Silt, Grayslake Peat, and the Cahokia Formation. Their distribution in the county has been interpreted from soil mapping by the Natural Resource Conservation Service (Goddard, 1979), lithologic logs of structural borings, and topographic interpretations.

Peoria Silt This unit forms a 2- to 4-foot thick mantle across the uplands of Kane County. The silt and clay of the Peoria, originally derived from late glacial dust storms, has been modified considerably by the Modern Soil. In particular, bioturbation (the burrowing action of insects, crayfish, and small mammals) has mixed the silt and clay of the Peoria Silt with underlying sediment. Hence, in some places, Peoria Silt includes a non-eolian component such as coarse sand and gravel. Because of its ubiquity, we have not mapped the distribution of Peoria Silt across Kane County. In fact, the surficial geology map should be considered the geology of the ground surface with the Peoria Silt stripped off.

Grayslake Peat This unit is composed of peat in varying stages of decomposition, marl, and well-sorted sand. The thickest known peat in Kane County (about 40 feet) occurs in southeastern Aurora. In many wetlands, the sediment succession from top to bottom includes sapric muck 1 to 2 feet thick of the Grayslake Peat, fibric peat 2 to 6 feet thick of the Grayslake Peat, marl 1 to 4 feet thick of the Grayslake Peat, and fossiliferous silt and clay 1 to 30 feet thick of the Equality Formation (Figure 10). With water contents in many places exceeding 100 to 200%, naturally occurring peat is a highly compressible soil. It also tends to occur in very poorly drained areas. Hence, in most urban and agricultural settings, the drainage and character of the Grayslake Peat has been altered by either installing tile within the peat itself or by adding shallow tiles and burying them with local fill.

Cahokia Formation This unit includes the deposits of streams and rivers and is composed of all lithologies listed above, including sand and gravel, silt and clay, peat, and diamicton. Sand and gravel tend to be the dominant lithologies, especially in the channels of active streams and rivers. Away from past and present channels, the sediment fines to silt and clay. The upper 3 feet of the Cahokia Formation is generally riddled with biopores of crayfish, worms, and roots, both living and rotting. At the tributary mouths of streams entering the Fox River, the Cahokia Formation may reach thicknesses of more than 30 feet. In other areas, especially at the headwaters of smaller streams, the alluvium is generally less than 3 feet thick or is missing. Thick sand of the Cahokia Formation was combined with surficial deposits of the Henry Formation for the preliminary maps produced for this report.

IIV. PRELIMINARY MAP PRODUCTS

The lithostratigraphic surfaces and isopach maps produced for this report are primary geologic maps of Kane County. To make the geologic information more useful, a set of derivative maps was produced, which can be used directly as planning tools. These include a *Preliminary Bedrock Geology Map, Kane County, Illinois* (Dey et al., 2004c), a *Preliminary Map of Aquifer Sensitivity to Contamination, Kane County, Illinois* (Dey et al, 2004a), a *Preliminary Map of Major Quaternary Aquifers, Kane County, Illinois* (Dey et al., 2004b), *Preliminary Three-dimensional Geologic Model, Kane County, Illinois* (Abert et al., 2004), and *Preliminary Geologic Cross Sections, Kane County, Illinois* (Dey et al., 2004d).Although the primary geologic maps were created for the entire study area, deriviative maps cover only Kane County.

A. Aquifer Sensitivity

An aquifer sensitivity map is a representation of the potential vulnerability of aquifers in an area to contamination from sources of contaminants at or near the surface. The U.S. Environmental Protection Agency (1993) defines aquifer sensitivity/contamination potential as

> "a measure of the ease with which a contaminant applied on or near the land surface can migrate to an aquifer. It is a function of the intrinsic characteristics of both the geologic materials [constituting] the aquifer as well as the overlying saturated and unsaturated material. It is independent of land use and the types of contaminant introduced."

The method for classifying aquifer sensitivity used in producing the *Preliminary Map of Aquifer Sensitivity to Contamination, Kane County, Illinois* (Dey et al., 2004a) was based on the mapping system developed by Berg (2001). The system uses depth to and thickness of the uppermost aquifer or aquifer material and relative permeability of overlying material to assign a classification rating. Aquifers are defined as geologic materials that are saturated and sufficiently permeable to yield economic quantities of water to wells or springs (Fetter, 1994). In Kane County, shallow aquifers are generally composed of unlithified, well-sorted sand and gravel deposits or bedrock units of fractured carbonates. For this map, sand and gravel deposits were defined as aquifers in areas where the units were greater than 5 feet thick and extended over at least a square mile of area. Carbonate bedrock of Silurian age was defined as an aquifer where it was the uppermost bedrock unit and greater than 15 feet thick. The Silurian rock tends to be heavily fractured at the surface (Graese et al., 1988). Geologic materials that would be classified as aquifer, but are above the water table and therefore not saturated, were grouped with aquifers in the interpretation for this map. Glacial diamicton (an unsorted mixture of gravel, sand, silt, and clay commonly called "till"), windblown silt (loess), peat, silty and clayey river and lake sediment, shale and unfractured carbonate bedrock are not considered aquifers because they are generally fine-grained and have limited potential to yield water to a well.

Aquifer vulnerability is assumed to decrease with depth. Studies in Minnesota (Klaseus et al., 1989) and Iowa (Libra et al., 1993) found a decrease in agricultural chemicals in water samples collected at a depth of greater than 100 feet. Schock et al. (1992) found that depth to uppermost aquifer is useful for predicting the occurrence of agricultural chemicals in drilled wells in rural Illinois using depth intervals of less than 50 feet and greater than 50 feet. In a subsequent study, Mehnert et al. (2003) found that depth to uppermost aquifer is useful for predicting the occurrence of agricultural chemicals in monitoring wells in rural Illinois, using intervals of less less than 20 feet, 20 to50 feet, and greater than 50 feet.

Thicker aquifers provide a greater groundwater resource than thinner aquifers, potentially yielding more water and being utilized by more people. The importance of protection from contamination theoretically increases with aquifer thickness. Thus, vulnerability increases with aquifer thickness. Following Berg's (2001) recommendation, aquifer thickness intervals used were 5 to 20 feet (or 15 to 20 feet for fractured carbonate), 20 to 50 feet, and greater than 50 feet.

The isopach map of each coarse-textured lithostratigraphic unit mapped in Kane County (Figures 21, 23, 25, 27, and 28) and the Silurian formations (Figure 4) were contoured using the thickness intervals given above. Maps depicting depth to the upper surface of each aquifer were made by subtracting the elevation of the surface of the unit from the land surface. These maps were contoured to Berg's (2001) depth-to-aquifer categories. The depth-to-aquifer map of each unit was combined with the aquifer thickness map of that unit, individual aquifer sensitivities maps were created for each unit, again in accordance with Berg (2001). The final aquifer sensitivity map was generated by combining the individual sensitivity maps of each unit such that the stratigraphically uppermost unit is shown on the map.

The isopach map of the Haeger Member (Figure 26) was used to delineate where it is at the land surface. The Haeger Member is a sandy loam diamicton with abundant, discontinuous lenses of sand and gravel, and thin beds of silt and clay (Curry et al., 1997). The Haeger member is not uniformly coarse enough to be considered an aquifer. Its presence over an aquifer does not offer the same protection from contamination as an equal thickness of a finer-grained diamicton. Although the Haeger diamicton is treated as non-aquifer material for this aquifer sensitivity map, its presence at the land surface is uniquely noted because of the lower potential protection it offers underlying aquifers.

The aquifer sensitivity classification rates sequences from Map Unit A to Map Unit E in order of decreasing sensitivity to aquifers becoming contaminated.

Map Unit A: High Potential for Aquifer Contamination Map Unit A is defined as areas with sand and gravel or high-permeability bedrock aquifers greater than 20 feet thick and where the upper surface of the aquifer is within 20 feet of the land surface. Map Unit A is classified as an area of high aquifer sensitivity. It is most prevalent in southern and northwestern Kane County and along the Fox River where the drift is thin. In these areas, contaminants from any source can move rapidly through the sand and gravel deposits to wells or nearby streams. Land use practices should be very conservative in all areas mapped as Map Unit A.

Map Unit A1. Aquifers are greater than 50 feet thick within 5 feet of the land surface. Small patches of Map Unit A1 occur throughout the county. Notable occurrences are found north of Hampshire (as part of a large alluvial fan extending west of the Marengo Moraine and north of the Bloomington Morainic System), south of Sugar Grove and near the village of Udina (as part of the Elburn Complex), and along reaches of the Fox River between St. Charles and North Aurora (where glacial drift is thin and fractured dolomite is at or very near ground surface).

*Map Unit A2***.** Sand and gravel deposits more than 50 feet thick and between 5 and 20 feet below ground surface. This map unit is not very common in Kane County.

Map Unit A3. Sand and gravel deposits between 20 to 50 feet thick occur at the land surface. Because of their similar definitions, the distribution of Map Unit A3 is in areas where Map Unit A1 is also mapped. Map Unit A3t also is common in southern and north-central Kane County.

Map Unit A4. Aquifers are between 20 and 50 feet thick between 5 and 20 feet below the land surface. Map Unit A4 is much more common than similarly defined Map Unit A2. It is common in areas where there are surficial lake and peat deposits associated with Glacial Lake Pingree, and in the alluvial fan complex north and west of Hampshire. Large areas of Map Unit A4 also occur in southern Kane County associated with the Elburn Complex.

Map Unit B: Moderately High Potential for Aquifer Contamination Map Unit B is defined where aquifers are within 20 of the land surface and sand and gravel aquifers are between 5 and 20 feet thick or high-permeability bedrock aquifers are between 15 and 20 feet thick. Groundwater remains very sensitive to contamination because of the minimal barrier of diamicton or silt and clay.

*Map Unit B1***.** Aquifers less than 20 feet thick are within 5 feet of the land surface. This unit occurs in patches throughout the county. Notable occurrences include along the Kaneville Esker along Route 47 north of Sugar Grove and in outwash terraces along the Fox River.

Map Unit B2. Aquifers less than 20 feet thick are between 5 and 20 feet below the land surface. This unit is more continuous than Map Unit B1 and, in many places, connect isolated patches of Map Unit B1. Map Unit B2 is most common in the Elburn Complex and in northeastern Kane County.

Map Unit C: Moderate Potential for Aquifer Contamination In Map Unit C areas, aquifers are buried by 20- to 50-foot-thick, fine-grained deposits, including all diamicton units and silt and clay of the Equality Formation. The mantle of fine-grained material offers moderate protection for underlying aquifers from waste spreading or septic systems. Again, Schock et al. (1992) reported that pesticide and nitrate detections in Illinois were significantly fewer where aquifers were buried by 20 to 50 feet than where aquifers were shallower.

*Map Unit C1***.** Constitutes aquifers greater than 50 feet thick buried by 20 to 50 feet of fine-grained material. Map Unit C1 occurs in isolated patches in vicinity of Carpentersville, North Aurora, Aurora, Wasco, and Hampshire.

Map Unit C2. Aquifers are between 20 to 50 feet thick and are buried by 20 to 50 feet of fine-grained material. This unit is widespread in the Elburn Complex and St. Charles Moraine.

Map Unit C3. Sand and gravel aquifers are between 5 and 20 feet thick and bedrock aquifers between 15 and 20 feet thick that are buried by 20 to 50 feet of fine-grained material. Again, these units are widespread in the Elburn Complex and St. Charles Moraine.

Map Unit D: Moderately Low Potential for Aquifer Contamination The probability that groundwater will become contaminated is moderately low in places where sand and gravel aquifers are buried by fine-grained deposits 50 to 100 feet thick. In Kane County, such areas occur below moraines.

Map Unit D1. Aquifers are more than 50 feet thick and are buried by 50 to 100 feet of fine-grained material. The largest mapped areas of Map Unit D1 occur near Virgil, Hampshire, Sugar Grove, and Aurora.

Map Units D2. Aquifers are between 20 to 50 feet thick and are buried by 20 to 50 feet of fine-grained material. These units are widespread in the Bloomington Morainic System, Elburn Complex, and the Minooka and St. Charles Moraines.

Map Units D3. Sand and gravel are aquifers between 5 and 20 feet thick and bedrock aquifers between 15 and 20 feet thick that are buried by 20 to 50 feet of fine-grained material. These units have a similar distribution to Map Unit D2.

Map Unit E: Low Potential for Aquifer Contamination Map Unit E occurs in places where diamicton, lacustrine silt and clay or shale is more than 100 feet thick. Discontinuous lenses of sand and gravel may occur in the diamicton, but they typically are not aquifers. The large area mapped as Map Unit E is associated with the Marengo Moraine and, to a lesser degree, the Bloomington Morainic System. Isolated patches of this unit occur throughout the rest of the county.

Overprint Pattern: Sandy Diamicton (Haeger) at Land Surface A stippled overprint pattern shows where the Haeger diamicton is at the land surface. Overprinted Map Units have a higher potential of sensitivity to contamination than the same map unit in areas without the stipple overprint pattern. The Haeger diamicton only occurs in northeast Kane County east of the Fox River.

Application Kane County's 2020 *Land Resource Management Plan* (Kane County, 1996) recognized the vulnerability of the county's water resources to contamination. Fifteen policies for water-resources management are articulated in the plan (p. 58), the first of which addresses protecting the county's groundwater resources. The Preliminary Map of Aquifer Sensitivity to Contamination, Kane County, Illinois (Dey et al., 2004c) is a useful tool for county-wide planning. It should be used as a guide in decisions that have a potential to negatively impact groundwater. The map is based on generalized textural properties and assumptions about hydraulic characteristics of geologic materials and hydraulic gradients, but not results from water quality or groundwater flow analysis. It is not suitable for site specific work or a substitute for detailed investigations. The map should not be enlarged.

B. Major Quaternary Aquifers

In Illinois, major aquifers are defined as "geologic units (sand and gravel, or fractured and/or permeable bedrock) capable of yielding at least 300 liters of water per minute [80 gpm] to wells completed in them (a designation consistent with the Water Use Act of 1983)" (Berg et al., 1989). Quaternary aquifers in Kane County are thick sand and gravel deposits. At this preliminary stage of the project, it is impossible to accurately predict yield from any aquifer. The *Preliminary Map of Major Quaternary Aquifers, Kane County, Illinois* (Dey et al., 2004b) depicts the location of large contiguous sand and gravel deposits that may reasonably have the potential to meet the definition of major aquifer. The mapped aquifers are greater than 50 feet thick at some point and several square miles in extent. Boundaries were described where the mapped thickness of the aquifer became less than 20 feet thick. The 20 foot thickness was chosen to conform to the aquifer sensitivity standard established by Berg (2001) and used in producing the *Preliminary Map of Aquifer Sensitivity to Contamination, Kane County, Illinois* (Dey et al., 2004a).

Following the descriptions of Curry and Seaber (1990), Vaiden and Curry (1990) mapped four Quaternary aquifers with potential for development as public water supplies in Kane County:

1. The St. Charles Aquifer located in the St. Charles Bedrock Valley in eastern and southern Kane County. It is composed of sand and gravel of the Ashmore Tongue of the Henry Formation and Glasford Formation.
2. The Valparaiso Aquifer located in northeast Kane County immediately below the ground surface. It is composed of surficial sand and gravel of the Henry Formation and sand and gravel of the Beverly Tongue of the Henry Formation and Haeger Member of the Lemont Formation. While Curry and Seaber (1990) included the Haeger diamicton in their definition of this aquifer, but we omitted it from the preliminary mapping, because little is known about its hydraulic properties.
3. The Bloomington Aquifer located west of the Marengo Moraine in northwestern Kane County. It consists of surficial sand and gravel of the Henry Formation and sand and gravel of the Ashmore Tongue of the Henry Formation.
4. The Kaneville Aquifer Member of the Elburn Aquiformation, located discontinuously across Kane County. It is composed of surficial sand and gravel of the Henry Formation, and sand and gravel deposits associated with the Batestown and Yorkville Members of the Lemont Formation.

The Preliminary Map of Major Quaternary Aquifers, Kane County, Illinois (Dey et al., 2004b) was constructed by compiling appropriate individual isopach maps for each of the major sand and gravel units in the study area.

The St. Charles Aquifer was delineated by combining isopach maps of the Ashmore Tongue of the Henry Formation with the isopach map of the sand and gravel deposits of the Glasford Formation. The combined thicknesses were superimposed on the bedrock topography map. The St. Charles Aquifer was identified as the thick sands in the vicinity of the St. Charles Bedrock Valley. Similar associations were made with the Elburn and Montgomery Bedrock Valleys as well as the unnamed bedrock valley entering western Kane County near Maple Park. Areas where these units are greater than 20 feet thick are shown in the Figure 29. Dashed lines indicate probable areas of occurrence based on interpolated geometry of the bedrock valleys but unsubstantiated by boring records. Additional aquifers were identified with the same lithostratigraphic composition as the St. Charles Aquife, but are not associated with prominent bedrock valleys (Figure 30). These are listed as unnamed aquifers on the accompanying map (Dey et al., 2004b)

The Valparaiso Aquifer is the combined thickness of surficial deposits and the Beverly Tongue of Henry Formation (Figure 31). The thickness should be considered conservative since the overlying Haeger diamicton may have aquifer-like hydraulic properties. Also, our mapping indicates the presence of aquifers in the bounded area related to other units, including the Batestown Member of the Lemont Formation and Tiskilwa Formations. Forthcoming three-dimensional geologic modeling and groundwater flow modeling should clarify the interconnectivity of these units and the applicability of the Haeger diamicton as an aquifer.

The Bloomington Aquifer was delineated by combining isopach maps of the surficial deposits of the Henry Formation and the Ashmore Tongue of the Henry Formation (Figure 32). In the eastern portion of the aquifer, the surficial sands and gravels are separated from the Ashmore Tongue by greater than 100 feet of Tiskilwa diamicton. In the west, the Tiskilwa diamicton is absent, and the sand and gravel form a single unit. The aquifer is underlain by greater than 20 feet of sand and gravel of the Glasford Formation but is usually separated by greater than 20 feet of diamicton of the Glasford Formation. Where the aquifer extends into DeKalb County, the Glasford sands may be hydraulicly connected to the Bloomington Aquifer. As with the Valparaiso Aquifer, ongoing investigations should clarify any connection between these aquifers.

The Kaneville Aquifer Member of the Elburn Aquiformation, as mapped by Vaiden and Curry (1990), occurred in isolated patches across the county. It is composed of surficial deposits of the Henry Formation and sand and gravel deposits associated with the Batestown and Yorkville Members of the Lemont Formation (Figure 33). We omitted areas mapped as part of the Valparaiso or Bloomington Aquifers. Connectivity between the three units will be examined in next year's three-dimensional modeling. The three-dimensional modeling will also assess where the Kaneville Aquifer has significant hydraulic connection with the St. Charles Aquifer and other underlying aquifers. Estimates of these areas are shown on the map. These areas were delineated where the fine-textured material separating the two aquifers was less than three feet thick or absent.

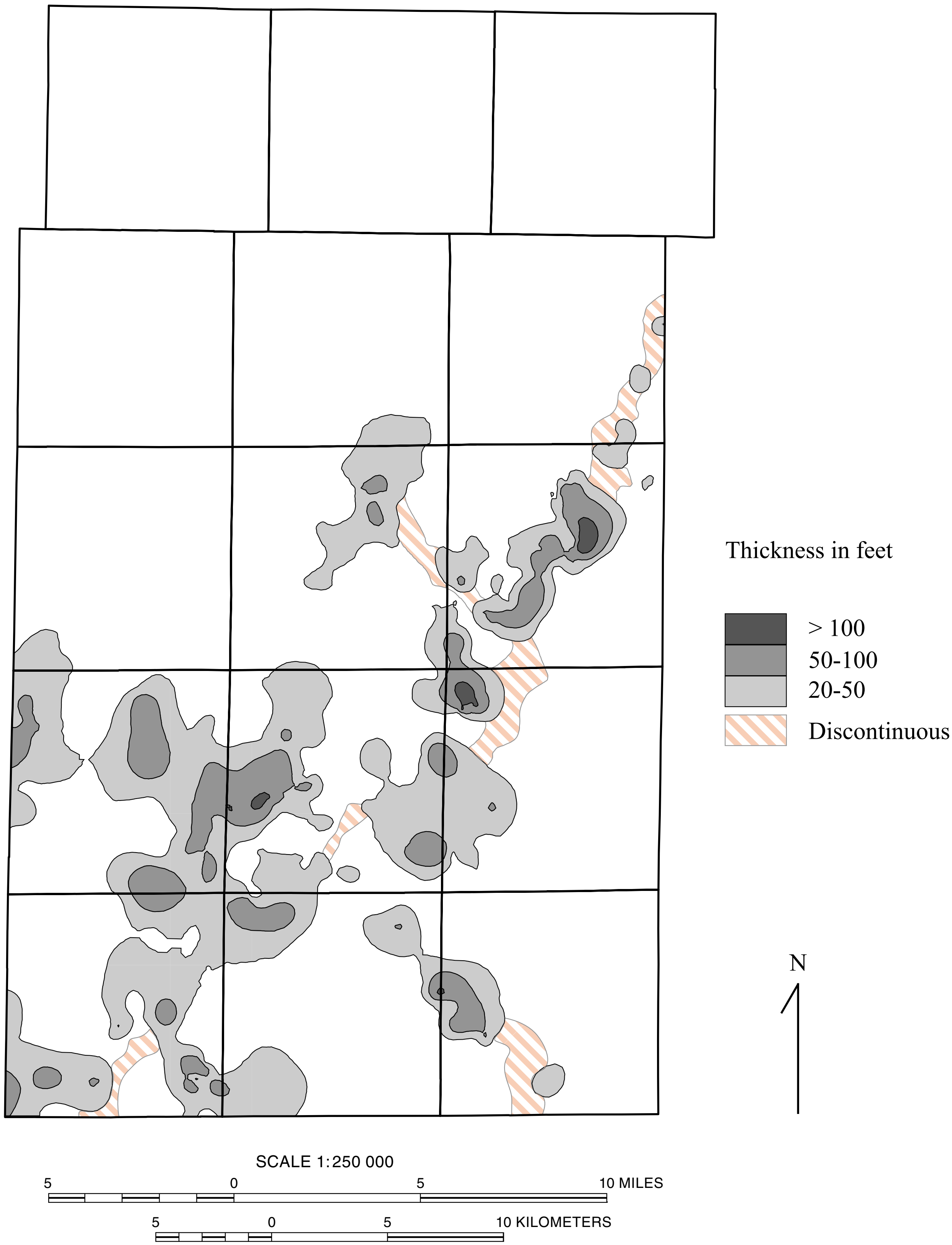

Figure 29 Distribution and thickness of St. Charles Aquifer in Kane County.

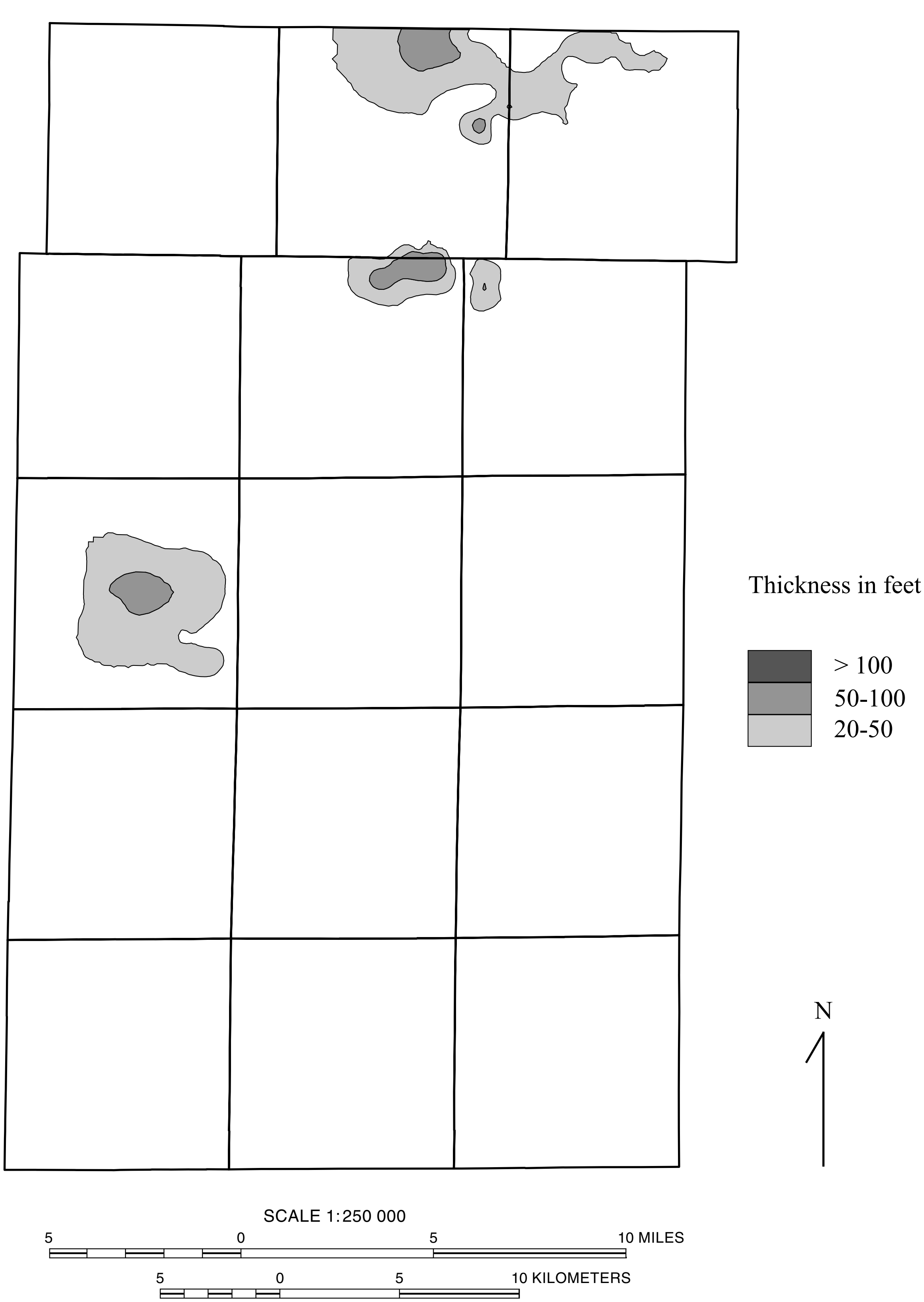

Figure 30 Distribution and thickness of unnamed aquifers stratigraphically associated with the St. Charles Aquifer in Kane County.

Figure 31 Distribution and thickness of the Valparaiso Aquifer in Kane County.

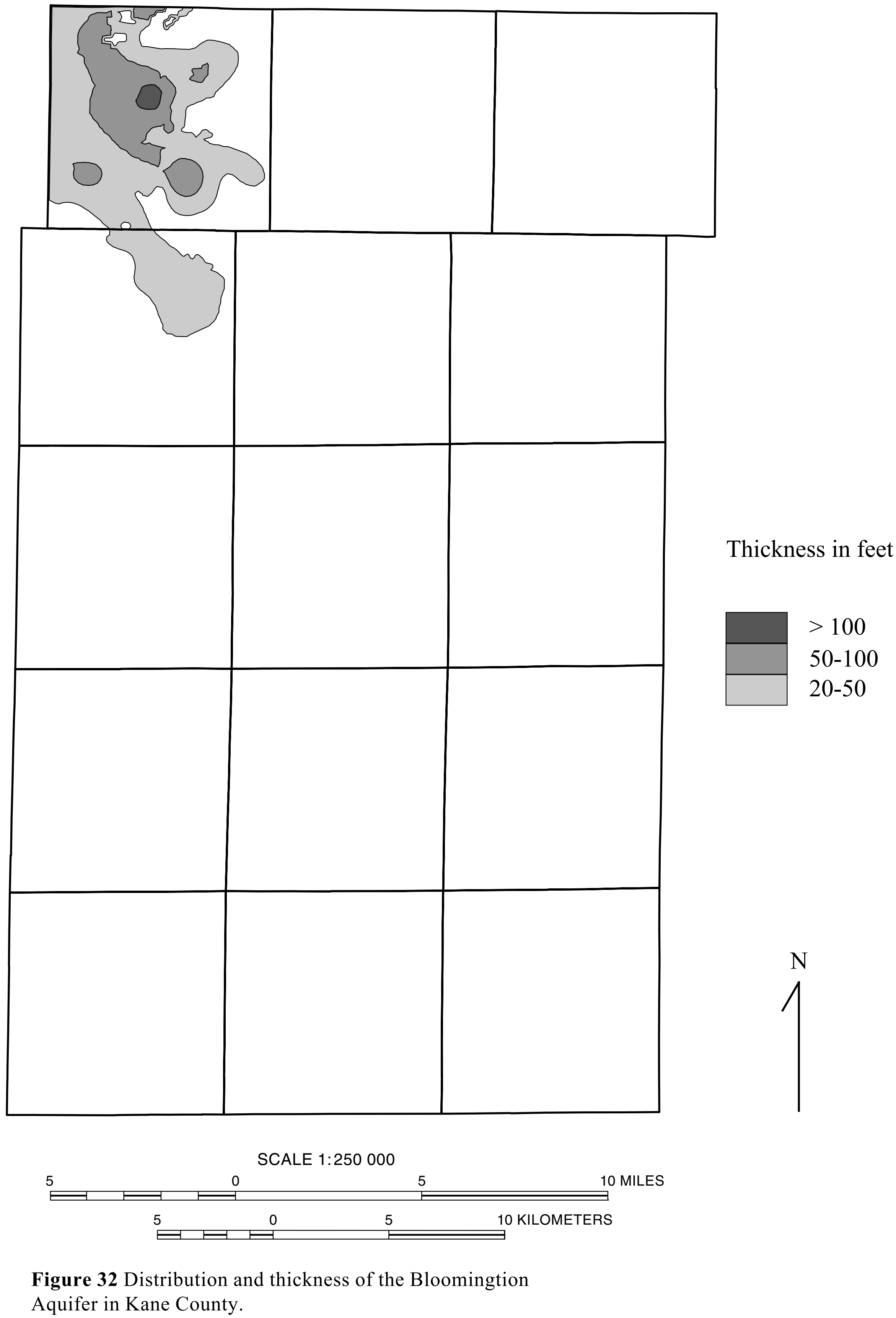

Figure 32 Distribution and thickness of the Bloomingtion Aquifer in Kane County.

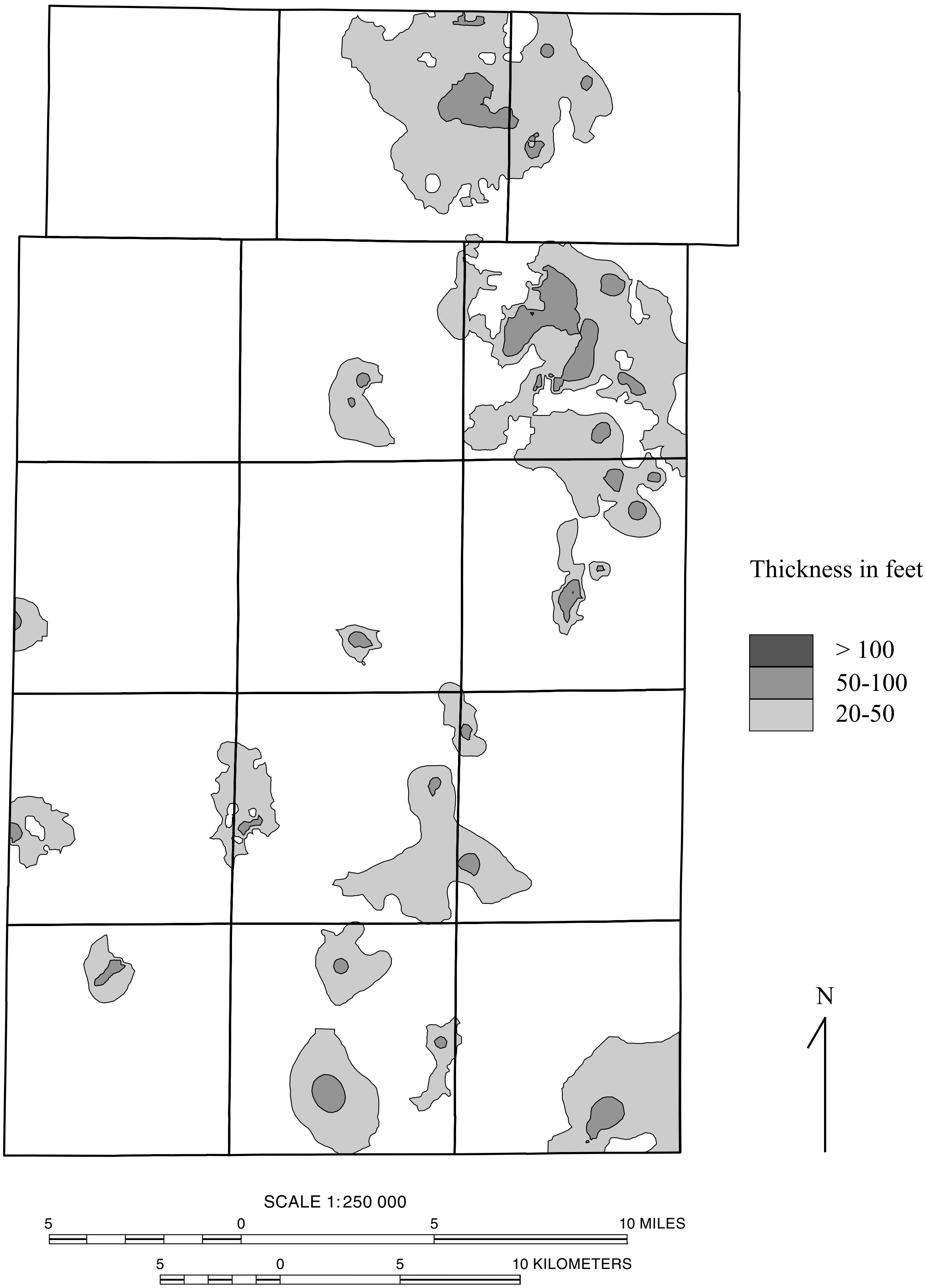

Figure 33 Distribution and thickness of the Kaneville Aquifer in Kane County.

In general, all of the mapped aquifers are thinner than mapped by Vaiden and Curry (1990) and Curry and Seaber (1990). The mapped thickness of the individual aquifers are based on the published definition and thickness of lithostratigraphic units mentioned. Preliminary results indicate that other sand and gravel units, not included in the aquifer's definition, underlie and may connect to either the Bloomington or Valparaiso Aquifers.

Application The Preliminary Map of Major Quaternary Aquifers, Kane County, Illinois (Dey et al., 2004b) is useful for county scale planning. Three-dimensional geologic modeling and groundwater flow modeling will undoubtedly change the delineations and possibly definitions of the specific aquifers shown on the map. Groundwater modeling should provide estimates of the sustainable yield from these aquifers.

C. Bedrock Geology

Information on the topography of the bedrock surface and composition of the uppermost bedrock unit were combined to produce The Preliminary Bedrock Geology Map, Kane County, Illinois (Dey et al., 2004c). The topographic map of the bedrock surface was compiled with data from field observations and primary wells in the project. The elevation of the bedrock surface and location of the deepest parts of buried bedrock valleys also were estimated using seismic refraction methods (Heigold, 1990). Bedrock surface elevation estimates from seismic refraction data are generally within 20 feet of the actual bedrock surface elevation as determined by subsequent test drilling (Gilkeson et al., 1987; Curry and Seaber, 1990). Because of this greater uncertainty, not all available seismic reflection data were used in constructing the map. It was used to fill in areas of sparse data. To construct the map, 5,142 data points were used (Figure 34). Of these data points, 3,469 were primary wells and 188 were seismic reflection data points from previous publications (Heigold, 1990; Larson et al., 1991). Additional seismic reflection data were collected in August 2002 along Merril, Dugan, and Wheeler Roads near Sugar Grove, resulting in 1,485 closely spaced data points. This was complemented by drilling a test hole adjacent to Merril Road in Hannaford Woods Forest Preserve.

As described above, the bedrock topographic surface was created using an algorithm for the interpolation of elevations that favors creation of water drainage features (topogrid http://support.esri.com/). The resulting map has continuous valleys and other features that are more geologically plausible than the results of a simple point-to-point interpolation of the data that was used in creating the other lithostratigraphic surfaces. The surface was further adjusted using insight of the authors. The bedrock surface of the study area was then cropped to the county boundaries (Figure 35).

Major changes from previously published maps include the course of the St. Charles Bedrock Valley in the vicinity of Sugar Grove. Also, the confluence of the St. Charles and Aurora Bedrock Valley has been moved to the south, outside of Kane County.

The bedrock lithstratigraphic map was created largely from previous lithostratigraphic assignments made by ISGS staff (Graese, unpublished data; Kolata and Graese, 1983; Kempton et al. 87a,b, Curry et al., 1988, Vaiden et al., 1988). Stratigraphic assignments were simplified into five units: undifferentiated Silurian formations, the Maquoketa Group, the Galena-Platteville Groups, the Ancell Group and the undifferentiated Cambrian formation. The reported uppermost occurrences of each unit were used to produce a surface defining the upper extent of that unit. The surface of each unit was truncated using our bedrock topography map, removing the presence of units or lowering their upper surface across the study area. The upper surface of a subsequent lower unit defines the bottom of each unit. Although not depicted on the map, this process produced a distribution and thickness for each bedrock unit in the study area. A map of the uppermost bedrock unit was created for the entire study area boundary and then was cropped to the county boundaries (Figure 36). Figure 37 shows the distribution of data points used in creating the bedrock lithology map

Application The map can be used to identify the lithology of the uppermost bedrock units across the county and the location of major bedrock valleys. Both uses are important to delineating groundwater resources. For example, the St. Charles Aquifer is defined, in part, by association with bedrock valleys. Also, the map displays where the upper most bedrock unit is an aquifer as in the case of the Silurian Formation. The data distribution used to construct the bedrock lithostratigraphy map (Figure 37) is much sparser than the data distribution used in making the bedrock topography map (Figure 34) or in mapping the distribution of quaternary deposits (Figure 17). We did not map facies in the Maquoketa Group identified by Graese (1991). As with all maps at 1:100,000, the map should not be used as

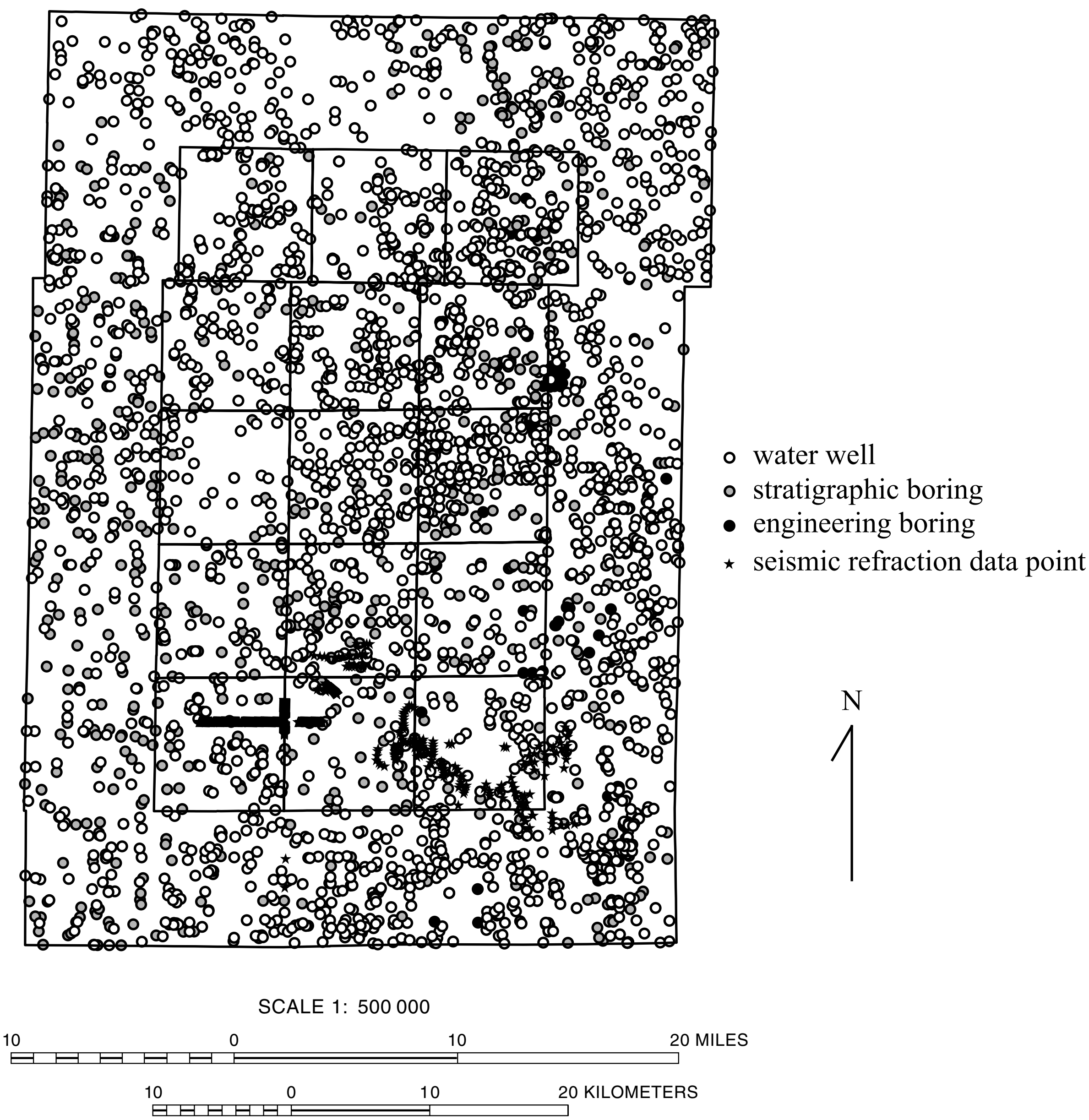

Figure 34 Distribution of data points used to generate bedrock topographic surface.

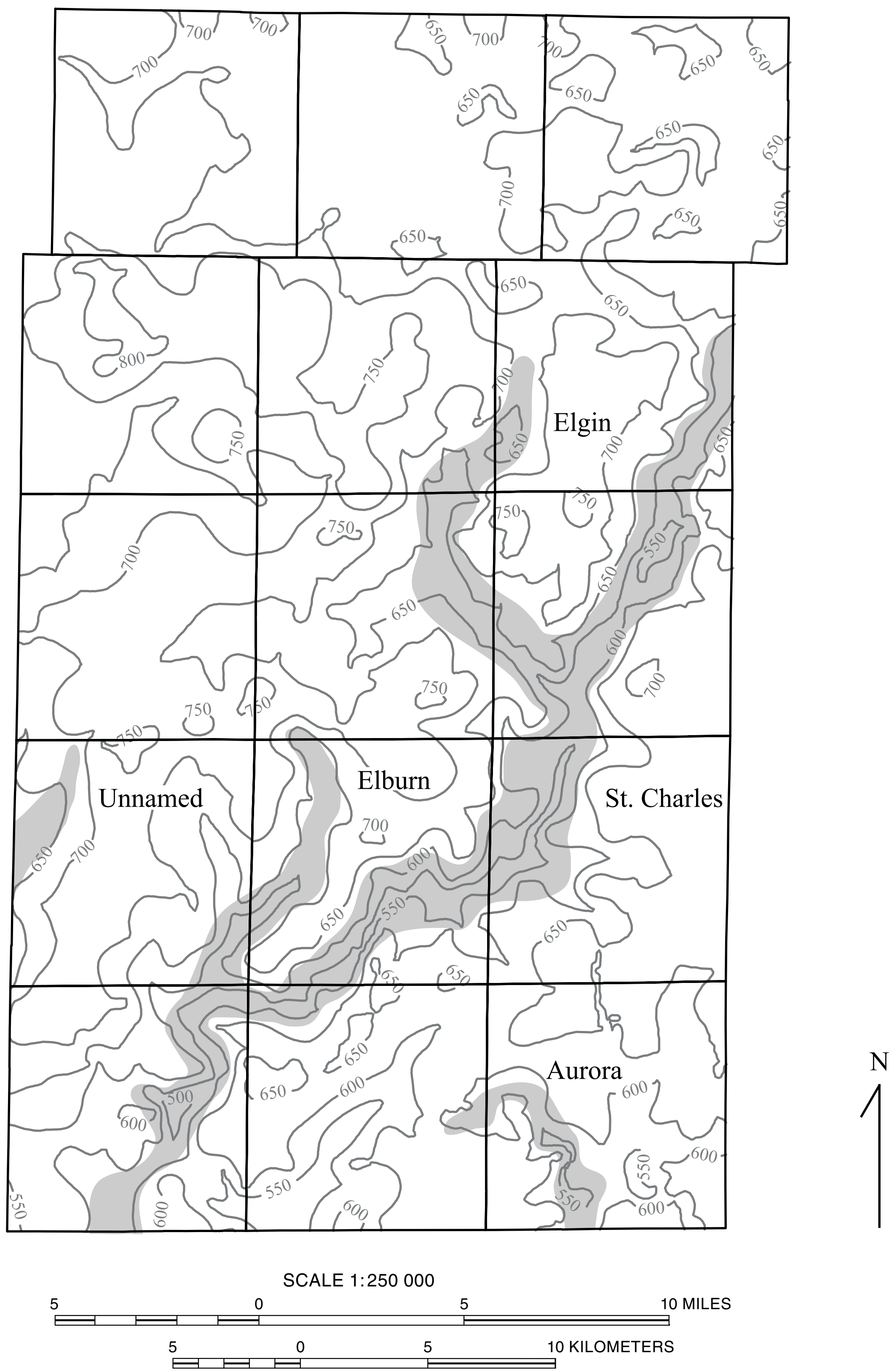

Figure 35 Bedrock topography of Kane County (shading indicates major bedrock valleys).

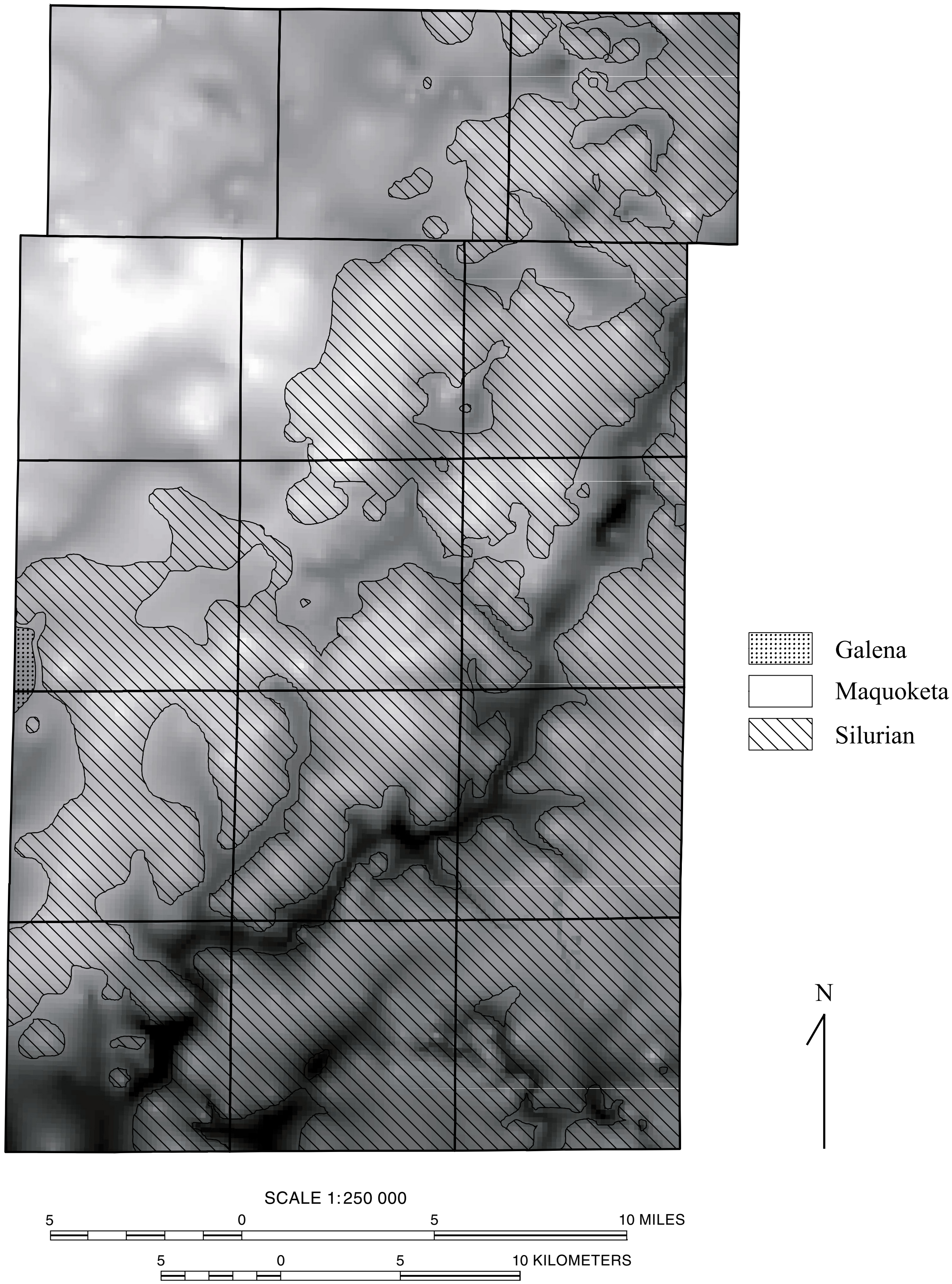

Figure 36 Shaded relief map of the bedrock surface with the subcrop pattern of the major stratigraphic bedrock units.

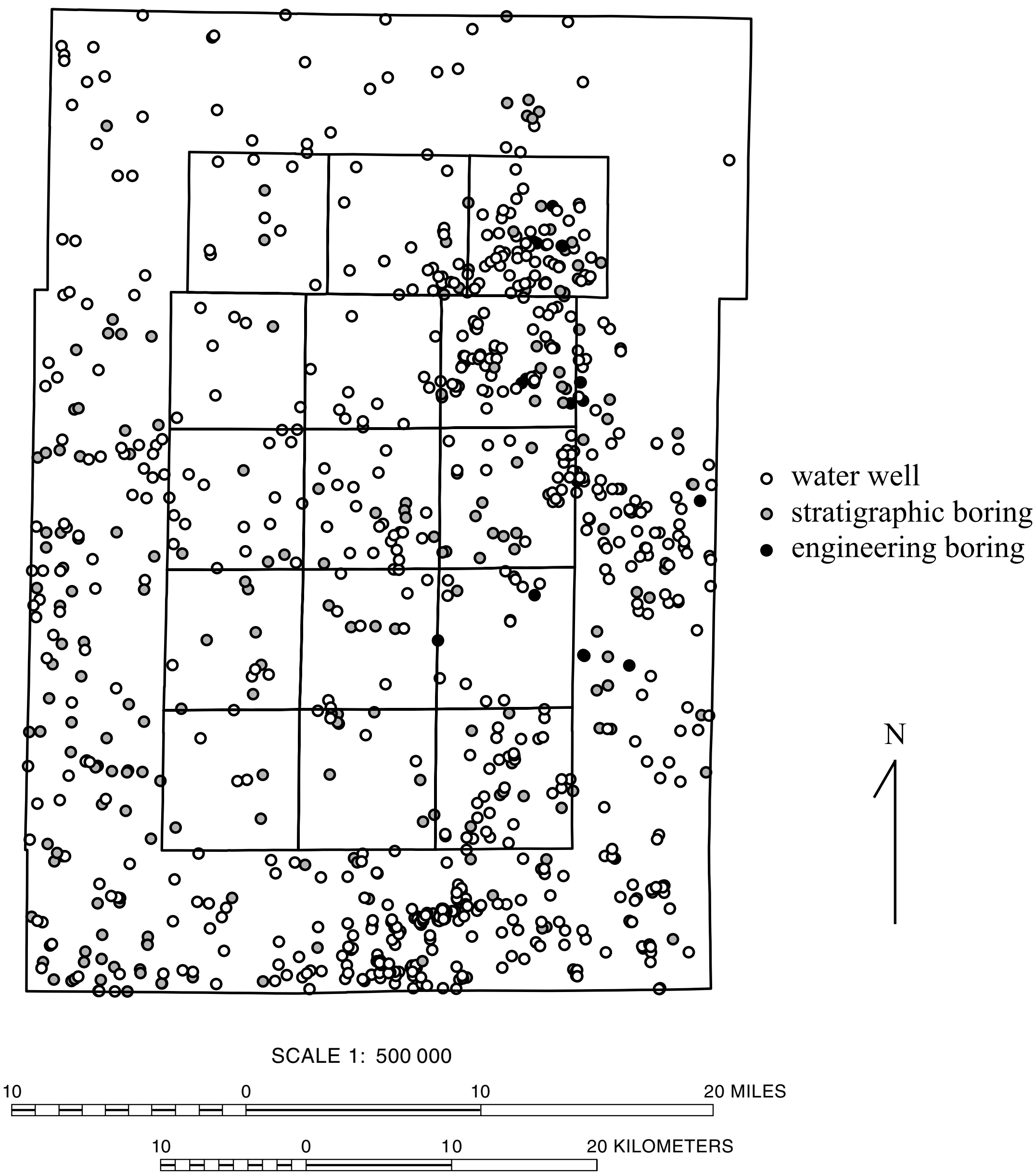

Figure 37 Distribution of borings used to generate bedrock lithostratigraphy map.

a substitute for site- specific work. In addition, work toward producing the final version of this map (due April 2007) will include effort to better delineate the course of the St. Charles, Elgin, and Aurora Bedrock Valleys and the intersection of the Elburn and St. Charles Bedrock Valleys (Figure 35).

D. Three-dimensional Geologic Model

We originally proposed to produce a stack-unit map or other three-dimensional representation of Kane County for this report (Meyer et al., 2002). A draft stack-unit map of Kane County was produced using a simplified version of the lithostratigraphy presented in the conceptual model. The resulting map possessed very limited potential for any application in an area with geology as complex as Kane County. Instead a *Preliminary Three-Dimensional Model, Kane County* (Abert et al., 2004) was produced. The lithostratigraphic surfaces created to produce the other map products were imported into 3-D modeling software (Earth Vision, Dynamic Graphics Inc.). The surfaces were combined to produce a three-dimensional model, similar to those produced for other ISGS publications (Abert et al, 2000; Abert, 2001). The software allowed the mappers to see the relationships between geologic units and make adjustments, where geologic units occurred out of accordance with the conceptual model. The images presented in Plate 4 were created by separating each lithostratigraphic unit from the three-dimensional model and displaying them in a consistent projection.

Application The preliminary model is the basis for ongoing work towards the ***Interim Report on Three-Dimensional Modeling*** due in April 2005 and will be shared with ISWS for use in completing the ***Interim Report on Shallow Aquifer Potentiometric Surface Mapping***, and the report on ***Computer Flow Models of Aquifer Systems Used in Kane County and Supporting Hydrologic Database***.

The Preliminary Three-dimensional Geologic Model, Kane County, Illinois (Abert et al., 2004) provides a visual representation of the geology of the county accessible to individuals with limited geologic background. It allows visualization of the individual stratigraphic layers and how they relate to one another. Its usefulness can be described as more educational than regulatory.

E. Geologic Cross Sections

Geologic cross sections are two-dimensional representations of geologic material present in a vertical plane passing through a portion of the Earth's surface. They offer an image of the distribution and thickness of the geologic units present, usually along a straight line in the geographic area of interest, or are on a line drawn through a series of points across that area. Traditionally, the points are borings or outcrops where the mappers are highly confident of their geologic interpretation.

The cross sections accompanying this report (Dey et al., 2004d) were created by taking east-west and north-south slices through the three-dimensional model mentioned in the previous section (Abert et al., 2004). Each cross section was carefully inspected, and corrections were made in areas where the modeling process did not adequately capture the mappers' interpretation. Instead of presenting selected profiles of the highest quality data, the cross sections show the overall results of the preliminary mapping effort. Figure 38 shows where the cross sections pass through the county.

Application The cross sections can be considered a supplement to the Preliminary Three-dimensional Geologic Model, Kane County, Illinois (Abert et al., 2004). The cross sections provide a visual representation of the geology of the county along the cross section lines through the county. The cross sections also allow visualization of the individual stratigraphic layers and how they relate to one another. Like the model, the usefulness of the cross sections is more educational than regulatory.

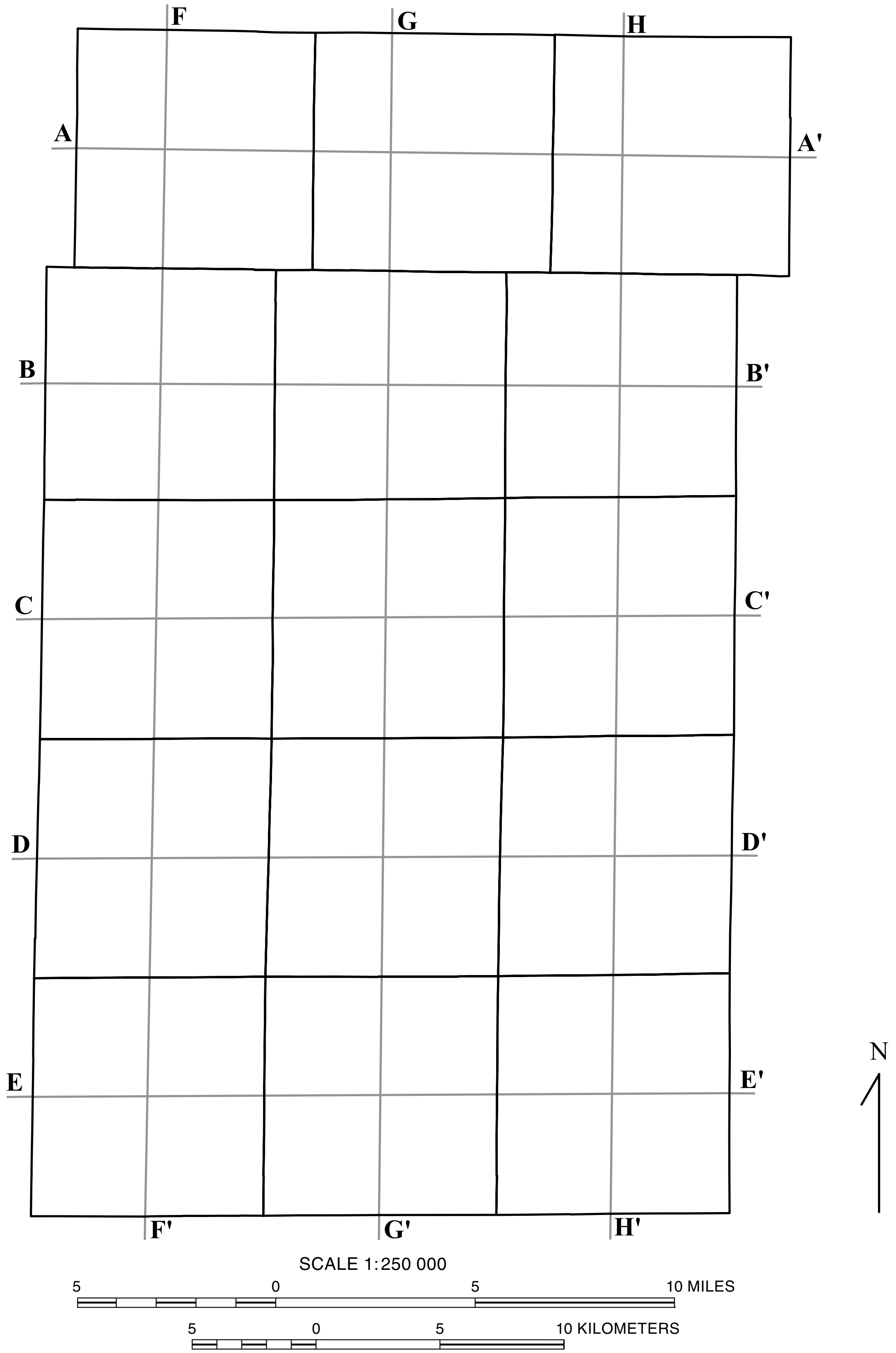

Figure 38 Cross section lines for Kane County.

V. SUMMARY AND FUTURE PLANS

A conceptual model was developed for the geology of Kane County and vicinity based on the body of published materials and the experience of ISGS geologists working in northeastern Illinois. A project database was constructed containing 27,904 water well and boring records from the ISGS and other point data. All wells were ranked for quality of the geologic information, and a subset of 4,092 wells was selected to be used as primary wells in the mapping effort. The goal was to have one primary well per quarter section across the study area. Primary wells had their locations verified and were assigned location quality rankings based on the success of verification (Table 5) . Where possible, lithostratigraphic assignments were made to primary wells based on the geologic information in their record using the conceptual model, published stratigraphic interpretations and professional judgement of geologists working on the project (Table 6 and Figure 17). These assignments were used to create surfaces of select lithostratigraphic units. The surfaces were checked and corrected for conformation to the conceptual model and one another. The surfaces were used to create the map products accompanying this report; the *Preliminary Bedrock Geology Map of Kane County, Illinois* (Dey et al., 2004c); the *Preliminary Map of Aquifer Sensitivity, Kane County, Illinois* (Dey et al., 2004a); the *Preliminary Map of Major Quaternary Aquifers, Kane County, Illinois* (Dey et al., 2004b); and the *Preliminary Three-dimensional Geologic Model, Kane County, Illinois* (Abert et al., 2004). The three-dimensional model was used to create the *Preliminary Geologic Cross Sections, Kane County, Illinois* (Dey et al., 2004d).

The work documented in this report provides the foundation for ongoing research into the Water-Resources Investigations for Kane County (Meyer et al., 2002). Work has begun on research to be summarized in the ***Interim Report on Three-Dimensional Modeling,*** due in April 2005. That report will be accompanied by revised bedrock topography, shallow bedrock lithology, and a thickness of the major Quaternary aquifers developed from the modeling.

During the next year, we plan to gather more water well records from recently drilled wells and finish entering missing records into the project database. We will correlate as many water wells as possible from the ISWS project database, with a emphasis on the wells used in their synoptic measurements. Where appropriate, the number of priority wells will be increased, and additional stratigraphic assignments will be made.

We plan on adding information on hydraulic properties of geologic materials to the project database as that information becomes available. The ISGS is conducting a related study to create a statewide database of hydraulic conductivity values from Quaternary units in Illinois. Although that study is independent of the Kane County investigation, the data gained may be used to improve the quality of products produced for Kane County. Existing hydrologic data are being compiled from consultant reports on file with the Illinois Environmental Protection Agency (IEPA). Compilation of data is being accomplished on a county-by-county basis, concentrating initially in predominately urbanized counties and proceeding to more rural areas of the state. One of the first counties from which data is being compiled is Kane County. The data include location information, values of hydraulic conductivity, the type of material in which the source well is screened, and accompanying data used to calculate hydraulic conductivity, such as slug test data. The quality of each hydraulic conductivity value is ranked according to the quality and availability of source data.

We have planned additional seismic surveys in southern Kane County to further map the location of the St. Charles and Aurora Bedrock Valleys. We plan to drill at least two additional stratigraphic borings in southern Kane County to correlate with the seismic work. We have scheduled collecting down-hole gamma ray logs several private, domestic wells to help delineate the distribution and thickness of the Ashmore Tongue in northwestern Kane County.

Findings from this report are being shared with ISWS for use in completing the ***Interim Report on Shallow Aquifer Potentiometric Surface Mapping***, the ***Computer Flow Models of Aquifer Systems Used in Kane County and Supporting Hydrologic Database***. Results from both of these studies will be used to refine our geologic model and will contribute to the ***Final Report on Geological Investigations*** due in April 2007. The final report will be accompanied by finalized versions of the preliminary maps, presented in this report.

ACKNOWLEDGMENTS

This study was funded by Kane County and administrated through Paul Schuch of the Kane County Water Resource Department. Several staff members at the Illinois State Geological Survey participated in this project. Mary Mushrush and Don Keefer helped with the database. Meghan Ward performed a large portion of the field verification of wells. Denise Sieving, Meghan Ward, Jill Baty, and Queenie Tsui entered and checked many well records. Andre Pugin, Tim Larson, and Steve Sargent performed the seismic survey in southern Kane County. Jane Domier, Dan Byers, Jill Baty, and Melony Barrett assisted with graphics and map layout. Ed Mehnert, Beverly Herzog, Jonathan Goodwin, Cheryl Nimz, Dick Berg, and Joel Steinfeldt provided essential and insightful review comments. Bianca Pedersen of Northern Illinois University assisted with data compilation and interpretation. Scott Meyer, Illinois State Water Survey, provided valuable insight and encouragement.

REFERENCES

Abert, C.C., 2000, Three-dimensional geological mapping of the Villa Grove Quadrangle, Douglas County, Illinois, Proceedings, Digital Mapping Techniques ‘00 Workshop, May 17–20, 2000, Lexington, KY: Reston, Virginia, U.S. Geological Survey, Open File Report 00-325, p.125–129.

Abert, C.C., 2001, Geographic Information System and computer modeling: Support, methodology and application to geologic mapping, *in* Z. Lasemi and R.C. Berg, eds., Three-dimensional geological mapping: A pilot program for resource and environmental assessment in the Villa Grove Quadrangle, Douglas County, Illinois, Illinois State Geological Survey, Bulletin 106, p. 12–15.

Abert, C.C., W.S. Dey, A.M. Davis, B.B. Curry, and J.C. Sieving, 2004, Preliminary Three-dimensional Model, Kane County, Illinois: Illinois State Geological Survey, Illinois Preliminary Geological Map, IPGM-Kane-3D, 1: 100,000.

Berg, R.C., 2001, Aquifer sensitivity classification for Illinois using depth to uppermost aquifer material and thickness: Illinois State Geological Survey, Circular 560, 14 p.

Berg, R.C., H.A. Wehrmann, and J.M. Shafer, 1989, Geological and hydrological factors for siting hazardous or low-level radioactive waste disposal facilities: Illinois State Geological Survey, Circular 546, p. 7.

Buol, S.W., F.D. Hole, and R.J. McCracken, 1980, Soil genesis and classification: Ames, Iowa, The Iowa State Press, 404 p.

Clayton, L., 1964, Karst topography on stagnant glaciers: Journal of Glaciology, v. 5, 107–112.

Cobb, J.C., and G.S. Fraser, 1981, Application of sedimentology to development of sand and gravel resources in McHenry and Kane counties, northeastern Illinois: Illinois State Geological Survey, Illinois Mineral Notes 82, 17 p.

Curry B.B., 2004 (in press), Surficial geology map, Crystal Lake Quadrangle, Kane and McHenry Counties, Illinois: Illinois State Geological Survey, Illinois Geological Quadrangle Map IGQ-Crystal Lake-SG, 1:24,000

Curry, B.B., 1989, Absence of Altonian glaciation in Illinois: Quaternary Research, v. 31, p. 1–13.

Curry, B.B., 1990a, Distribution and thickness of the Tiskilwa Till in Kane County: Illinois State Geological Survey, Open File Series 1990-2g, 1:62,500.

Curry, B.B., 1990b, Stack unit map (to 50 ft) of Kane County: Illinois State Geological Survey, Open File Series 1990-2i, 1:62,500.

Curry, B.B., 1991, Statistical evaluation of common geotechnical parameters of glacial drift units at Fermi National Accelerator Laboratory, Batavia, Illinois: Proceedings, 34th Annual Meeting, Association of Engineering Geologists, Sept. 29–Oct. 4, 1991, Chicago, IL, p. 258.

Curry, B.B., 1998, Quaternary geology map, Elgin Quadrangle, Kane and Cook Counties, Illinois: Illinois State Geological Survey, 1:24,000. (Available from the U.S. Geological Survey, Reston, Virginia.)

Curry, B.B., 1999, Quaternary geology map, Hampshire Quadrangle, Kane and De Kalb Counties, Illinois: Illinois State Geological Survey, 1:24,000. (Available from the U.S. Geological Survey, Reston, Virginia.)

Curry, B.B., 2001a, Surficial geology map, Aurora North Quadrangle, Kane and DuPage Counties, Illinois: Illinois State Geological Survey, Illinois Geological Quadrangle Map IGQ-Aurora North-SG, 1:24,000.

Curry, B.B., 2001b, Topographic map of the bedrock surface, Aurora North Quadrangle, Kane and DuPage Counties, Illinois: Illinois State Geological Survey, Illinois Geological Quadrangle Map IGQ-Aurora North-BT, 1:24,000.

Curry, B.B., 2001c, Topographic map of the bedrock surface, Sugar Grove Quadrangle, Kane County, Illinois: Illinois State Geological Survey, Illinois Geological Quadrangle Map IGQ-Sugar Grove-BT, 1:24,000.

Curry, B.B., and R.G. Baker, 2000, Paleohydrology, vegetation, and climate during the last interglaciation (Sangamon Episode) in south-central Illinois: Palaeogeography, Palaeoclimatology, and Palaeoecology 155(1–2): 59–81.

Curry, B.B., R.C. Berg, and R.C. Vaiden, 1997, Geologic mapping for environmental planning, McHenry County, Illinois: Illinois State Geological Survey, Circular 559, 79 p. with four plates.

Curry, B.B., W.S. Dey, E.C. Grimm, S.L. Sargent, and S.A. Kuzin, 2001, Investigation of the geology, hydrology, water balance, paleovegetation, and paleohydrology of Nelson Lake Marsh: Unpublished contract report to the Kane County Forest Preserve, Geneva, Illinois.

Curry, B.B., A.M. Graese, M. Hasek, R.C. Vaiden, R.A. Bauer, J.P. Kempton, D. Schumacher, K.A. Norton, and W.G. Dixon, Jr., 1988, Geological-geotechnical studies for siting the Superconducting Super Collider in Illinois: Results of the 1986 test drilling program: Illinois State Geological Survey, Environmental Geology Notes 122, 108 p.

Curry, B.B., D.A. Grimley, and T.H. Larson, 2001, Surficial geology map, Sugar Grove Quadrangle, Kane County, Illinois: Illinois State Geological Survey, Illinois Geological Quadrangle Map IGQ- Sugar Grove-SG, 1:24,000.

Curry, B.B., D.A. Grimley, and J.A. Stravers, 1999, Quaternary geology, geomorphology, and climatic history of Kane County, Illinois: Illinois State Geological Survey, Guidebook 28, 40 p.

Curry, B.B., and M.J. Pavich, 1996, Absence of glaciation in Illinois during marine isotope stages 3 through 5: Quaternary Research 31:19–26.

Curry, B.B., and P.R. Seaber, 1990, Hydrogeology of shallow groundwater resources, Kane County, Illinois: Illinois State Geological Survey, Contract/Grant Report 1990–1, 37 p.

Dey, W.S., A.M. Davis, B.B. Curry, and J.C. Sieving, 2004c, Preliminary bedrock geology map, Kane County, Illinois: Illinois State Geological Survey, Illinois Preliminary Geologic Map, IPGM-Kane-BG, 1:100,000.

Dey, W.S., A.M. Davis, B.B. Curry, and J.C. Sieving, 2004b, Preliminary map of major Quaternary aquifers, Kane County, Illinois: Illinois State Geological Survey, Illinois Preliminary Geologic Map, IPGM-Kane-QA, 1:

100,000.

Dey, W.S., A.M. Davis, B.B. Curry, and J.C. Sieving, 2004d, Preliminary geologic cross sections, Kane County, Illinois: Illinois State Geological Survey, Illinois Preliminary Geologic Map, IPGM-Kane-CS, 1:100,000.

Dey, W.S., A.M. Davis, J.C. Sieving, and B.B. Curry, 2004a, Preliminary map of aquifer sensitivity to contamination, Kane County, Illinois: Illinois State Geological Survey, Illinois Preliminary Geologic Map, IPGM-Kane-AS, 1: 100,000.

Drewry, D., 1986, Glacial geologic processes: London, Edward Arnold, 276 p.

Dynamic Graphics Inc., 1997, EarthVision®. user's guide 5.0: Alameda, California, Dynamic Graphics Inc., v. 1, various paginations.

Erdmann, A., R.C. Vaiden, and B.B. Curry, 1990, Drift thickness of Kane County, Illinois: Illinois State Geological Survey, Open File Series (OFS)-1990c; map, 1:62,500.

Fetter C.W., 1994, Applied hydrogeology: Upper Saddle River, New Jersey, Prentice Hall, 691 p.

Gilkeson, R. H., S.S. McFadden, D.E. Laymon, and A.P. Visocky,1987, Hydrogeologic evaluation of groundwater resources in buried bedrock valleys, northeastern Illinois: Proceedings of the Focus Conference on Midwestern Ground Water Issues, National Water Well Association.

Gilkeson, R.H., and A.A. Westerman, 1976, Geology for planning in northeastern Illinois, II, Geology for planning in Kane County: Illinois State Geological Survey, Open File Series 1976-2, 43 p.

Goddard, T.M.,1979, Soil survey of Kane County, Illinois: Illinois Agricultural Experimental Station, Soil Report No.109.

Graese, A.M.,1991, Facies analysis of the Ordovician Maquoketa Group and adjacent strata in Kane County, northeastern Illinois: Illinois State Geological Survey, Circular 547, 36 p.

Graese, A.M., R.A. Bauer, B.B. Curry, R.C. Vaiden, W.G. Dixon, Jr., and J.P. Kempton, 1988, Geological-geotechnical studies for siting the SSC in Illinois: Regional summary: Illinois State Geological Survey, Environmental Geology Notes 123, 100 p.

Grimley, D.A., 1998, Quaternary geology map, Pingree Grove Quadrangle, Kane County, Illinois: Illinois State Geological Survey, 1:24,000. (Available from the U.S. Geological Survey, Reston, Virginia.)

Grimley, D.A.,1999, Quaternary geology map, Maple Park Quadrangle, Kane and De Kalb Counties, Illinois: Illinois State Geological Survey, 1:24,000. (Available from the Geological Survey, Reston, Virginia.)

Grimley, D.A., and B.B. Curry, 2001a, Surficial geology map, Elburn Quadrangle, Kane County, Illinois: Illinois State Geological Survey, Illinois Geological Quadrangle Map IGQ-Elburn-SG, 1:24,000.

Grimley, D.A., and B.B. Curry, 2001b, Surficial geology map, Geneva Quadrangle, Kane County, Illinois: Illinois State Geological Survey, Illinois Geological Quadrangle Map IGQ-Geneva-SG, 1:24,000.

Gross, D.L., 1969, Glacial geology of Kane County, Illinois: University of Illinois at Urbana-Champaign, Ph.D. dissertation, 211 p.

Hackett, J.E., and G.M. Hughes, 1965, Controlled drilling program in northeastern Illinois: Illinois State Geological Survey, Environmental Geology Notes 1, 5 p.

Hansel, A.K., and W.H. Johnson, 1992, Fluctuations of the Lake Michigan Lobe during the late Wisconsin Subepisode: Sveriges Geologiska Undersökning, Series Ca 81, p. 133–144.

Hansel, A.K., and W.H. Johnson,1996, Wedron and Mason Groups: Lithostratigraphic reclassification of deposits of the Wisconsin Episode, Lake Michigan Lobe area:. Illinois State Geological Survey, Bulletin 104, 116 p.

Hansel, A.K., J.M. Masters, and B.J. Socha, 1985, The Beverly section, in W.H. Johnson, A.K. Hansel, B.J. Socha, L.R. Follmer, and J.M. Masters, Depositional environments and correlation problems of the Wedron Formation (Wisconsinan) in northeastern Illinois: Illinois State Geological Survey, Guidebook 16, p. 53–70.

Heigold, P.C., 1990, Seismic reflection and seismic refraction surveying in northeastern Illinois: Illinois State Geological Survey, Environmental Geology Notes 136, 52 p.

Heigold, P.C., 1972, Notes on the earthquake of September 15, 1972 in northern Illinois: Illinois State Geological Survey, Environmental Geology Notes 59, 15 p.

Herzog, B.L., B.J. Stiff, C.A. Chenoweth, K.L. Warner, J.B. Sieverling, and C. Avery, 1994, Buried bedrock surface of Illinois. U.S. Geological Survey and Illinois State Geological Survey, Illinois Map 5, 1:500,000.

Johnson, W.H., and A.K. Hansel, 1989, Age, stratigraphic position, and significance of the Lemont drift, northeastern Illinois: Journal of Geology, v. 97, p. 301–318.

Kane County, 1996, 2020 Land Resource Management Plan: Geneva, Illinois, Kane County Development Department, 125 p

Kane County Planning Division, Development Department, 2001, Topographic map of Kane County, 2-foot contours, digital data obtained from Tim Mescher.

Kemmis, T.J., 1978, Properties and origin of the Yorkville Till Member at the National Accelerator Laboratory Site, northeast Illinois: University of Illinois at Urbana- Champaign, M.S. thesis, 331 p.

Kemmis, T.J., 1981, Importance of the regulation process to certain properties of basal tills deposited by the Laurentide Ice Sheet in Iowa and Illinois, U.S.A.: Annals of Glaciology, v. 2, p. 147–152.

Kempton, J.P., R.A. Bauer, B.B. Curry, W.G. Dixon, Jr., A.M. Graese, D.R. Kolata, P.C. Reed, M.L. Sargent, and R.C. Vaiden, 1986, Geological-geotechnical studies for siting the Superconducting Super Collider in Illinois—Results of the fall 1984 test drilling program: Illinois State Geological Survey, Environmental Geology Notes 117, 102 p.

Kempton, J.P., R.A. Bauer, B.B. Curry, W.G. Dixon, Jr., A.M. Graese, P.C. Reed, and R.C. Vaiden, 1987, Geological-geotechnical studies for siting the Superconducting Super Collider in Illinois—Results of the spring 1985 test drilling program: Illinois State Geological Survey, Environmental Geology Notes 120, 88 p.

Kempton, J.P., J.E. Bogner, and K. Cartwright, 1977, Geology for planning in northeastern Illinois, VIII, Regional summary: Illinois State Geological Survey, Open File Series 1997-2, 84 p.

Kempton, J.P., R.C. Vaiden, D.R. Kolata, P.B. DuMontelle, M.M. Killey, and R.A. Bauer, 1985, Geological-geotechnical studies for siting the Superconducting Super Collider in Illinois— Preliminary Geological Feasibility Report: Illinois State Geological Survey, Environmental Geology Notes 111, 63 p.

Killey, M.M., 1998, Illinois' Ice Age legacy: Illinois State Geological Survey, GeoScience Education Series 14, 66 p.

Klaseus, T.G., G.C. Buzicky, and E.C. Schneider, 1989, Pesticides and groundwater: Surveys of selected Minnesota wells: Minnesota Department of Public Health and Minnesota Department of Agriculture, Minneapolis, 95 p.

Kolata, D.R., and A.M. Graese, 1983, Lithostratigraphy and depositional environments of the Maquoketa Group (Ordovician) in northern Illinois: Illinois State Geological Survey, Circular 528, 49 p.

Landon, R.A., and J.P. Kempton, 1971, Stratigraphy of the glacial deposits at the National Accelerator Laboratory Site, Batavia, Illinois: Illinois State Geological Survey, Circular 456, 21 p.

Larson, T.H., S.S. McFadden, and R.H. Gilkeson, 1991, Hydrogeology of shallow groundwater resources, Aurora and Vicinity, Kane County, Illinois: Illinois State Geological Survey, Open File Series 1991-12, 19 p.

Larson, T.H., S.S. McFadden, and R.H. Gilkeson, 1992, Hydrogeology of shallow groundwater resources, Geneva-Batavia Township, Kane County, Illinois: Illinois State Geological Survey, Open File Series 1992-5, 15 p.

Larson, T.H., and P.G. Orozco, 1991, Results of a shallow seismic refraction survey near the Village of North Aurora, Illinois: Illinois State Geological Survey, Open File Series 1991-15, 17 p.

Larson, T.H., and P.G. Orozco, 1992, Results of a shallow seismic refraction survey near Gilberts in Kane County, Illinois: Illinois State Geological Survey, Open File Series 1992-11, 27 p.

Leighton, M.M., 1925, The glacial history of the Elgin region: Illinois Academy of Science Transactions, v. 17, p. 65–71.

Leighton, M.M., P. MacClintock, L.E. Workman, and W.E. Powers, 1928–1930, Geology and mineral resources of the Barrington, Elgin and Geneva Quadrangles: Illinois State Geological Survey, Manuscript 252, 207 p.

Leverett, R., 1899, The Illinois Glacial Lobe: Reston, Virginia, U.S. Geological Survey, Monograph 38, 817 p.

Libra, R.D., et al., 1993, The Iowa state-wide rural well-water survey: June 1991, Repeat Sampling of the 10% Subset: Des Moines, Iowa, Iowa Department of Natural Resources, Technical Information Series 26, 30 p.

Lukert, M.T., and H.A. Winters, 1965, The Kaneville esker, Kane County, Illinois: Illinois Academy of Sciences, Transactions 58: 3–10.

Lund, C.R., 1965, Data from controlled drilling program in Kane, Kendall, and DeKalb Counties, Illinois: Illinois State Geological Survey, Environmental Geology Notes 6, 56 p.

Masters, J.M., 1978, Sand and gravel and peat resources in northeastern Illinois: Illinois State Geological Survey, Circular 503, 11 p.

McGarry, C.S., 2000, Shaded relief of Kane County, Illinois [map]: Illinois State Geological Survey, Open File Series OFS-2000-6, 1:62,500.

Meyer, S.C., D.D. Walker, S.M. McConkey, W.S. Dey, B.B. Curry, C.C. Abert, and E.M. Abert, 2002, Water-resources investigations for Kane County, Illinois: Illinois State Water Survey and Illinois State Geological Survey, proposal to Kane County Development Department, 55 p.

Meyers, R.L., and J.E. King, 1985, Wisconsin interstadial vegetation of northern Illinois: Illinois State Geological Survey Guidebook 19, p. 75–86.

Morse, W.J., and T.H. Larson, 1991, Hydrogeology of Shallow Groundwater Resources in the Vicinity of St. Charles, Kane County, Illinois: Illinois State Geological Survey, Open File Series, 1991-13, 12 p.

Munsell Soil Color Charts, 1998: Baltimore, Maryland, Kollmorgen Instruments.

Reed, P.C., 1972, Data from controlled drilling program in Du Page, Kane, and Kendall Counties, Illinois: Illinois State Geological Survey, Environmental Geology Notes 53, 42 p.

Reed, P.C., 1975, Data from controlled drilling program in Kane County, Illinois: Illinois State Geological Survey, Environmental Geology Notes 75, 38 p.

Schmitt, J.W., 1985, Glacial stratigraphy of northwestern Cook County: Chicago, Illinois, Northeastern Illinois University, 212 p.

Schock, S.C., E. Mehnert, M.E. Caughey, G.B. Dreher, W.S. Wilson, C. Ray, S.F.J. Chou, J. Valkenburg, J.M. Gosar, J.R. Karny, and M.L. Barnhardt, 1992, Pilot study: Agricultural chemicals in rural private wells in Illinois: Illinois State Water Survey and Illinois State Geological Survey, Cooperative Groundwater Report 14, 80 p.

U.S. Environmental Protection Agency, 1993, Ground water resource assessment: Washington, DC, U.S. Environmental Protection Agency Office of Ground Water and Drinking Water, EPA 813-R-93-003, 232 p.

Vaiden, R.C., and B.B. Curry, 1990, Bedrock topography of Kane County: Illinois State Geological Survey, Open File Series 1990-2b 1:62,500.

Vaiden, R.C., M.J. Hasek, C.R. Gendron, B.B. Curry, A.M. Graese, and R.A. Bauer, 1988, Geological-geotechnical studies for siting the Superconducting Super Collider in Illinois—Results of drilling large-diameter test holes in 1986: Illinois State Geological Survey, Environmental Geology Notes 124, 58 p.

Visocky, A.P., M.G. Sherrill, and K. Cartwright, 1985, Geology, hydrogeology, and water quality of the Cambrian and Ordovician systems in northern Illinois: Illinois State Water Survey and Illinois State Geological Survey, Cooperative Goundwater Report 10, 136. p.

Wickham, S.S., 1979, The Tiskilwa Till Member, Wedron Formation—A regional study in northeastern Illinois: Urbana-Champaign, University of Illinois, M.S. thesis, 227 p.

Wickham, S.S., W.H. Johnson, and H.D. Glass, 1988, Regional geology of the Tiskilwa Till Member, Wedron Formation, Northeastern Illinois: Illinois State Geological Survey, Circular 543, 35 p.

Willman, H.B. E. Atherton, T.C. Bushbach, C. Collinson, J.C. Frye, M.E. Hopkins, J.A. Lineback, and J.A. Simon, 1975, Handbook of Illinois stratigraphy. Illinois State Geological Survey, Bulletin 95, 261 p.

Willman, H.B., and J.C. Frye,1970, Pleistocene stratigraphy of Illinois: Illinois State Geological Survey, Bulletin 94, 204 p.