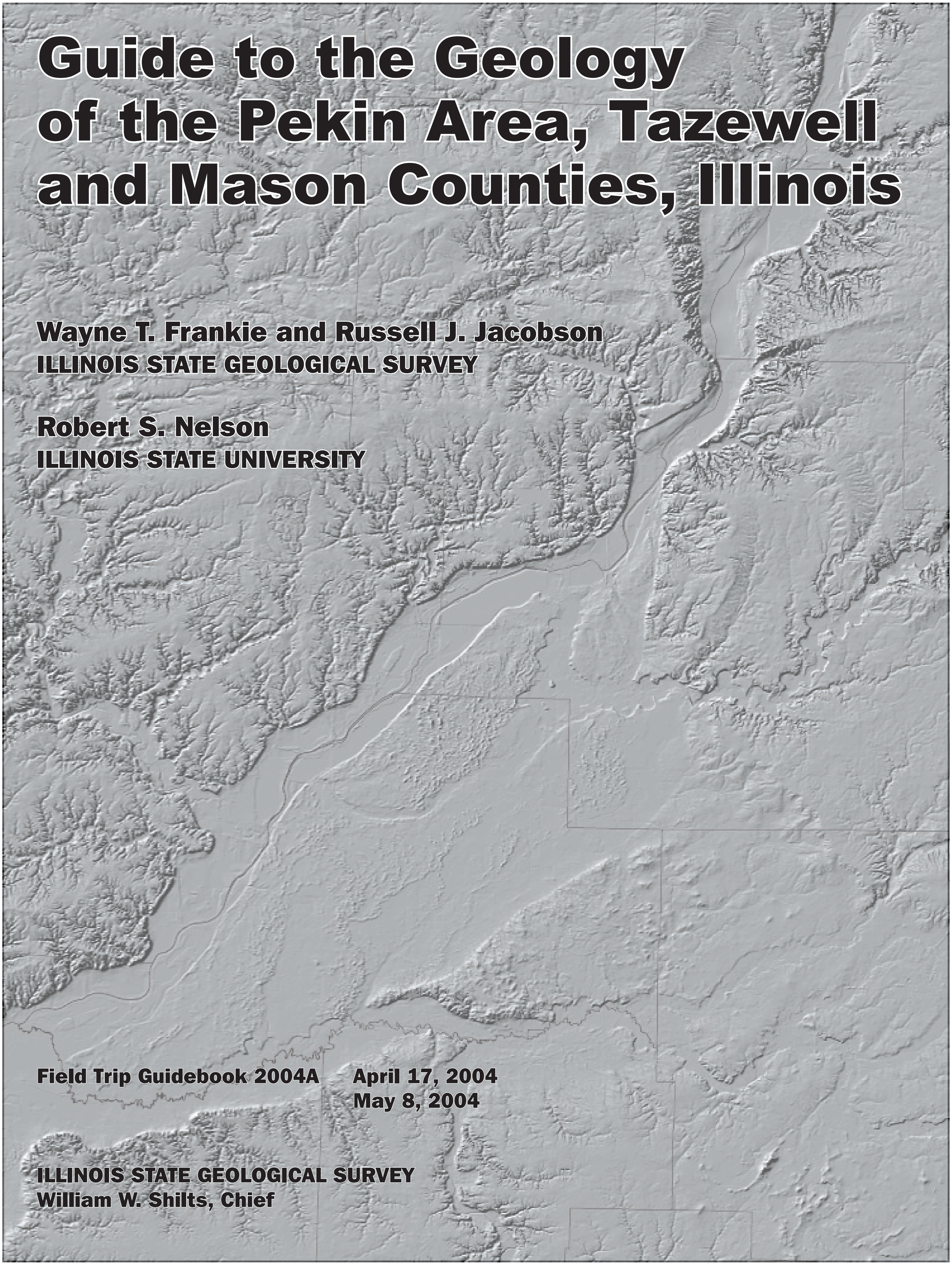
Guide to the Geology of the Pekin Area, Tazewell and Mason Counties, Illinois

Wayne T. Frankie and Russell J. Jacobson
ILLINOIS STATE GEOLOGICAL SURVEY

Robert S. Nelson
ILLINOIS STATE UNIVERSITY



Field Trip Guidebook 2004A **April 17, 2004**
May 8, 2004

ILLINOIS STATE GEOLOGICAL SURVEY
William W. Shilts, Chief

Cover photo: *Surface topography surrounding Tazewell and Mason Counties (Luman et al. 2003).*

Geological Science Field Trips The Illinois State Geological Survey (ISGS) conducts four tours each year to acquaint the public with the rocks, mineral resources, and landscapes of various regions of the state and the geological processes that have led to their origin. Each trip is an all-day excursion through one or more Illinois counties. Frequent stops are made to explore interesting phenomena, explain the processes that shape our environment, discuss principles of earth science, and collect rocks and fossils. People of all ages and interests are welcome. The trips are especially helpful to teachers who prepare earth science units. Grade school students are welcome, but each must be accompanied by a parent or guardian. High school science classes should be supervised by at least one adult for each ten students. Preregistration is required.

A list of guidebooks of earlier field trips for planning class tours and private outings may be obtained by contacting the Geoscience Outreach Coordinator, Illinois State Geological Survey, Natural Resources Building, 615 East Peabody Drive, Champaign, IL 61820-6964. Telephone: (217) 244-2427 or 333-4747. This information is on the ISGS home page: http://www.isgs.uiuc.edu.

Nine USGS 7.5-Minute Quadrangle maps (Delavan North, Duck Island, Forest City, Glasford, Manito, Marquette Heights, Pekin, South Pekin, and Topeka) provide coverage for this field trip area.

This field guide is divided into four sections. The first section serves as an introduction to the geology of Central Illinois and in particular Tazewell and Mason Counties and the area south of Pekin, Illinois. The second section is a road log for the trip, and the third section provides detailed stop descriptions. The final section is an appendix that includes supplementary materials that are important to the field trip area.

ILLINOIS DEPARTMENT OF NATURAL RESOURCES

ISGS Illinois State Geological Survey

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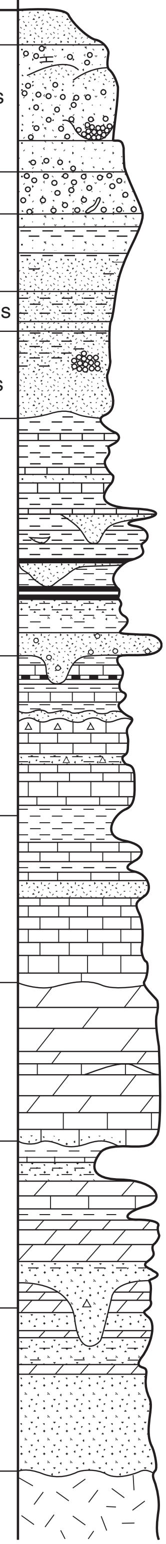
CONTENTS

Era		Period or System and Thickness	Epoch	Age (years ago)	General Types of Rocks
CENOZOIC "Recent Life"	Age of Mammals		Holocene	10,000	Recent; alluvium in river valleys
		uater nary 0–500′	Pleistocene Glacial Age	1.8 m	Glacial till, glacial outwash, gravel, sand, silt, lake deposits of clay and silt; wind deposits of loess and sand dunes. Deposits cover nearly all of state except northwest corner and southern tip
			Pliocene	5.3 m 33.7 m	Chert gravel, present in northern, southern, and western Illinois
		Tertiary 0–500′	Eocene	54.8 m	Mostly micaceous sand with some silt and clay; present only in southern Illinois
			Paleocene	65 m	Mostly clay, little sand; present only in southern Illinois
MESOZOIC "Middle Life"	Age of Reptiles	Cretaceous 0–300′		144 m 290 m	Mostly sand, some thin beds of clay, and, locally, gravel; present only in southern and western Illinois
PALEOZOIC "Ancient Life"	Age of Amphibians and Early Plants	Pennsylvanian 0–3,000′ ("Coal Measures")		323 m	Largely shale and sandstone with beds of coal, limestone, and clay
		Mississippian 0–3,500′		354 m	Black and gray shale at base, middle zone of thick limestone that grades to siltstone chert, and shale; upper zone of interbedded sandstone, shale, and limestone
	Age of ishes	Devonian 0–1,500′		417 m	Thick limestone, minor sandstones, and shales; largely chert and cherty limestone in southern Illinois; black shale at top
	Age of Invertebrates	Silurian 0–1,000′		443 m	Principally dolomite and limestone
		Ordovician 500–2,000′		490 m	Largely dolomite and limestone but contains sandstone, shale, and siltstone formations
		Cambrian 1,500–3,000′		543 m	Chiefly sandstones with some dolomite and shale; exposed only in small areas in north-central Illinois
		Precambrian			Igneous and metamorphic rocks; known in Illinois only from deep wells



Generalized geologic column showing succession of rocks in Illinois.

INTRODUCTION

This geological science field trip will acquaint you with the geology[1], landscape, and mineral resources for part of Tazewell and Mason Counties, Illinois. Pekin is located in the north-central portion of Illinois along the Illinois River about 160 miles southwest of Chicago, nearly 170 miles north-northeast of St. Louis, and about 300 miles north of Cairo.

Tazewell County, originally a part of Sangamon County, was established on January 31, 1827. The county is named for Lyttelton Waller Tazewell, an eminent Virginia and U.S. Senator at the time the county was named. The first Tazewell County encompassed parts of present-day DeWitt, Livingston, Logan, Mason, McLean, and Woodford Counties. The present Tazewell County boundaries were not established until 1841.

Tazewell County has the distinction of having the first white settlement in Illinois. In January 1680, Robert Cavalier, sieur de la Salle (a.k.a. La Salle)—accompanied by Father Louis Hennepin, Henry de Tonti, and about thirty other explorers—landed their canoes on the eastern bank of the Illinois River and built Fort Creve Coeur (or Crevecoeur) just below Peoria Lake in Section 1 of Pekin Township. Thus, the French flag was the first to fly over the area, but the fort was abandoned just a few months after it was built. Today, the junction of Interstates 474 and Illinois Route 29 are within a mile of the site.

Mason County, originally part of Tazewell County, was established on January 20, 1841. The county is named for Mason County, Kentucky, and was chosen because of the influence of settlers from Mason County, Kentucky.

GEOLOGIC FRAMEWORK

Precambrian Era (3.8 bya to 543 mya)

Through several billion years of geologic time, the area surrounding Tazewell and Mason Counties, like the rest of present-day Illinois, has undergone many changes (see generalized geologic column, facing page). The oldest rocks beneath the field trip area belong to the ancient Precambrian basement complex. These ancient rocks consist mostly of granitic and rhyolitic igneous rocks and possibly metamorphic, crystalline rocks formed about 1.5 to 1.0 billion years ago. The depth to the Precambrian rocks within Tazewell and Mason Counties ranges from 4,400 feet to 5,050 feet.

From about 1 billion to about 0.6 million years ago, these Precambrian rocks were exposed at Earth's surface. During this long period, the rocks were deeply weathered and eroded and formed a barren landscape that was probably quite similar to the topography of the present Missouri Ozarks.

There is no rock record in Illinois that represents the long interval of weathering and erosion that lasted from the formation of the Precambrian rocks until the first Cambrian age sediments accumulated. This interval of weathering and erosion is almost as long as the time from the beginning of the Cambrian Period to the present.

Because geologists cannot see the Precambrian basement rocks in Illinois except as cuttings and cores from boreholes, various other techniques, such as measurements of Earth's gravitational and magnetic fields and seismic exploration, are used to map the regional characteristics of the basement complex.

Paleozoic Era (543 mya to 248 mya)

During the latter part of the Precambrian Era, and continuing until the Late Cambrian, the movement of crustal plates (plate tectonics) began to rip apart the North American continent, forming rift valleys in southernmost Illinois (fig. 1). These rift valleys were initially filled with sands and gravels that were shed from the adjacent uplands. About 520 million years ago in the late Cambrian Period

[1] Terms in italics (except for Latin names) are defined in the glossary at the back of the guidebook. Also, please note: although all present localities have only recently appeared within the geologic time frame, the present names of places and geologic features are used because they provide clear reference points for describing the ancient landscape.

of the Paleozoic Era, rifting stopped, and the hilly Precambrian landscape began to sink slowly on a broad regional scale, allowing the invasion of a shallow sea from the south and southwest. These continual tectonic movements caused repeated invasions and withdrawals of the seas across the region.

During the following 270 million years of the Paleozoic Era, the area that is now called the Illinois Basin (fig. 1) continued to accumulate sediments that were deposited in the shallow seas that repeatedly covered this subsiding basin. The region continued to sink until at least 20,000 feet of sedimentary strata were deposited in the deepest part of the basin, located in southeastern Illinois and western Kentucky. At various times during this era, the seas withdrew, and deposits were weathered and eroded, resulting in gaps in the sedimentary record in Illinois.

Near the close of the Mississippian Period, gentle arching of the rocks in eastern Illinois initiated the development of the LaSalle Anticlinorium (fig.1). This complex structure contains domes, anticlines, and synclines superimposed on it. Further arching continued through the Pennsylvanian Period. Because the youngest Pennsylvanian strata are absent from the area of the anticlinorium (either because they were not deposited or because they were eroded), we cannot determine just when folding ceased—perhaps by the end of the Pennsylvanian or during the Permian Period a little later, near the close of the Paleozoic Era.

The Paleozoic Era rocks (compacted and hardened sediments) constitute the bedrock. In the field trip area, bedrock strata range in age from more than 520 million years (the Cambrian Period) to less than 320 million years old (the Pennsylvanian Period). In central Illinois, older, generally deeper bedrocks are mainly composed of limestone, dolomite, shale, and sandstone (fig. 2).

In the field trip area, just below a cover of glacial deposits, younger, Pennsylvanian age bedrock strata consist of shale, siltstone, sandstone, limestone, coal, and underclay that were deposited as sediments in shallow seas and swamps between about 323 and 290 million years ago. Some of

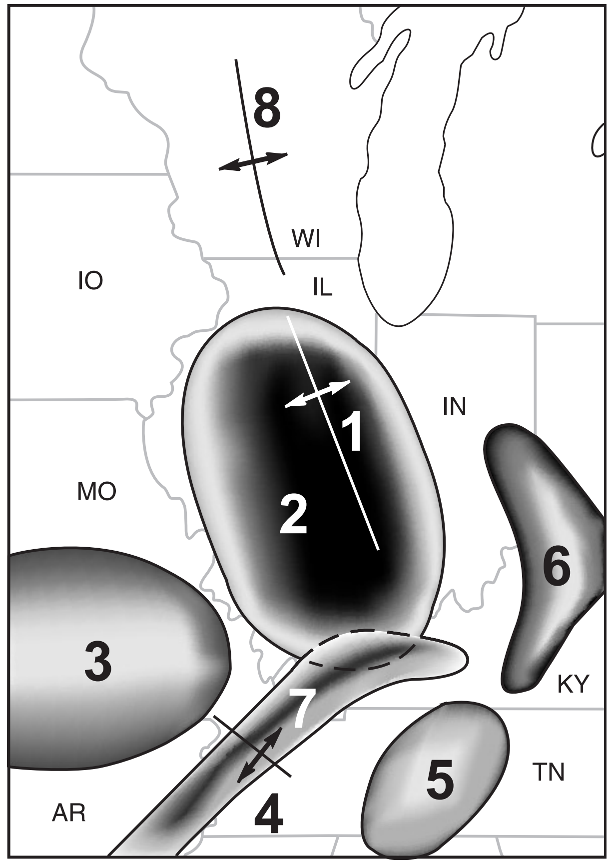


Figure 1 Location of some of the major structures in the Illinois region: (1) La Salle Anticlinorium, (2) Illinois Basin, (3) Ozark Dome, (4) Pascola Arch, (5) Nashville Dome, (6) Cincinnati Arch, (7) Rough Creek Graben–Reelfoot Rift, and (8) Wisconsin Arch.

these rocks are exposed in scattered road cuts and stream cuts, immediately north and west of the field trip area. Some of these exposures were visited during the 1995 ISGS field trip (Frankie et al. 1995). The Pennsylvanian strata increase in total thickness from less than 200 feet in western Tazewell and Mason Counties, to more than 400 feet in eastern Tazewell County, to more than 600 feet in eastern Mason County.

The field trip area is underlain by as much as 5,000 feet of Paleozoic sedimentary rocks. Figure 2 shows the succession of rock strata a drill bit would penetrate in this area if the rock record were complete and all the strata were present.

Stratigraphic Units and Contacts Sedimentary rock commonly occurs in units called formations.

AGE		ROCK UNITS	
SYSTEM	SERIES	FORMATION	MATERIALS
PENNSYLVANIAN	HOLOCENE	Grayslake Peat	peat and muck, interbedded with silt and clay
	PLEISTOCENE	Peoria Silt Equality Formation Henry Formation	loess, windblown silt and clay lake deposits, stratified silty clay and sand outwash, sand and gravel
	DESMOINESIAN	Shelburn Formation Carbondale Formation	shale, sandstone, limestone, clay, coal shale, sandstone, coal, clay, limestone
	ATOKAN	Tradewater Formation	sandstone, shale, clay, coal limestone sandstone, clay, shale
MISSISSIPPIAN	VALMEYERAN	St. Louis Limestone Salem Limestone Warsaw Shale Keokuk Limestone Burlington Limestone Meppen Limestone	limestone limestone, shale shale, limestone limestone limestone limestone, dolomite
	KINDERHOOKIAN	Chouteau Limestone Hannibal Shale Glen Park Limestone	limestone shale, siltstone limestone, oolite
DEVONIAN	UPPER	Louisiana Limestone Saverton Shale Grassy Creek Shale Sweetland Creek Shale Sylamore Sandstone	limestone shale, gray shale, black shale, gray sandstone
SILURIAN	NIAGARAN	Joliet Dolomite	dolomite
	ALEXANDRIAN	Kankakee Dolomite Edgewood Dolomite	dolomite dolomite
ORDOVICIAN	CINCINNATIAN	Brainard Shale Fort Atkinson Limestone Scales Shale	shale, limestone, siltstone limestone, dolomite, shale shale, limestone
	CHAMPLAINIAN	Galena Group Platteville Group St. Peter Sandstone	dolomite limestone limestone, dolomite sandstone
	CANADIAN	Shakopee Dolomite	dolomite, sandstone, shale

Figure 2 Generalized stratigraphic column of the rock formations in the field trip area (modified from Willman 1973).

A formation is a body of rock that has a distinctive set of characteristics and easily recognizable top and bottom boundaries. It is also thick enough to be readily traceable in the field and sufficiently widespread to be represented on a map. Most formation names are derived from geographic names and predominant rock types, for example, St. Peter Sandstone or Scales Shale. When no single rock type is characteristic, the word “formation” becomes a part of the name (for example, Carbondale Formation). A group, for example, the Galena Group or the Maquoketa Group, consists of vertically adjacent formations having many similarities. A member, or bed, is a subdivision of a formation that is too thin to be classified as a formation or that has minor characteristics setting it apart from the rest of the formation.

Many formations have conformable contacts—that is, no significant interruption in deposition occurred as one formation was succeeded by another (fig. 2). In some instances, even though the composition and appearance of the rocks change significantly at the contact between two formations, the fossils in the rocks and the relationships between the rocks at the contact indicate that deposition was virtually continuous. In contrast, in other places, the top of the lower formation was at least partially eroded before the next formation was deposited. In these instances, fossils and other evidence indicate a significant age difference between the lower unit and the overlying unit. This type of contact is called an unconformity. Unconformities occur throughout the Paleozoic rock record and are shown as wavy lines in the generalized stratigraphic column (fig. 2). The geologic map (fig. 3) shows the distribution of the rock systems of the various geologic time periods as they would appear if all of the glacial, windblown, and surface materials were removed.

Mesozoic Era 248 mya to 65 mya)

During the Mesozoic Era, the rise of the Pascola Arch (figs. 1 and 4) in southeastern Missouri, northeastern Arkansas, and western Tennessee by uplifting strata in southern Illinois produced a structural barrier, helping to form the Illinois Basin's present asymmetrical, spoon-shaped configuration (fig. 5).

Younger rocks of the latest Pennsylvanian and perhaps the Permian (the youngest rock systems of the Paleozoic) might have once covered the southern and northern portions of Illinois. Mesozoic and Cenozoic rocks (see the generalized geologic column at the front of the guidebook) might also have been present here.

During the more than 240 million years after the end of the Paleozoic Era and before the onset of glaciation 1 to 2 million years ago, several thousands of feet of strata may have been eroded. Nearly all traces of any post-Pennsylvanian bedrock that may have been present in Illinois were removed. During this extended period of erosion, deep valleys were carved into the gently tilted bedrock formations (fig. 6).

The Pekin field trip area is in the north-central flank of the Illinois Basin in an area where very few large structural features have been identified (fig. 4). The closest large-scale structural feature is the Glasford Structure located in the southern portion of Peoria County (Buschbach and Ryan 1963). Several small-scale anticlines and synclines with a general east-west orientation have been identified in Peoria County north of Glasford (Nelson 1995).

GLACIAL HISTORY OF ILLINOIS

Pleistocene Epoch

During the past 1.8 million to 2 million years, during the Pleistocene Epoch of the Quaternary Period (also known as the Ice Age), much of northern North America was repeatedly covered by huge glaciers as a result of climate cooling. The advances of these continental ice masses into the central lowland of the United States altered the landscape across much of the Midwest. The topography of the bedrock surface throughout much of Illinois is largely hidden from view by glacial deposits except along the major streams and in the driftless areas of northwestern and southern Illinois (fig. 7).

During the early part of the Pleistocene Epoch, glaciers advanced out of their centers of ice

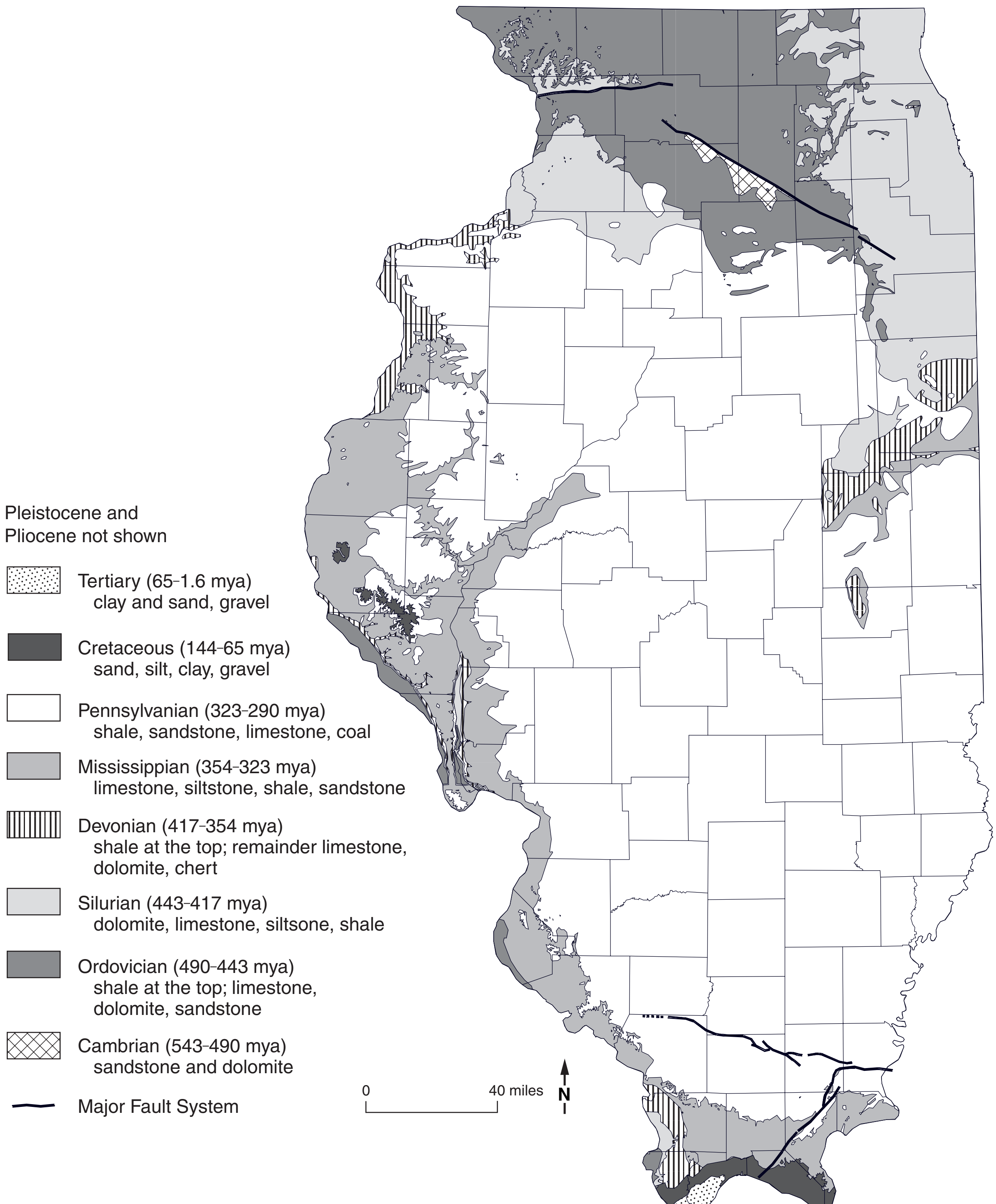


Figure 3 Bedrock geology beneath the surficial deposits in Illinois.

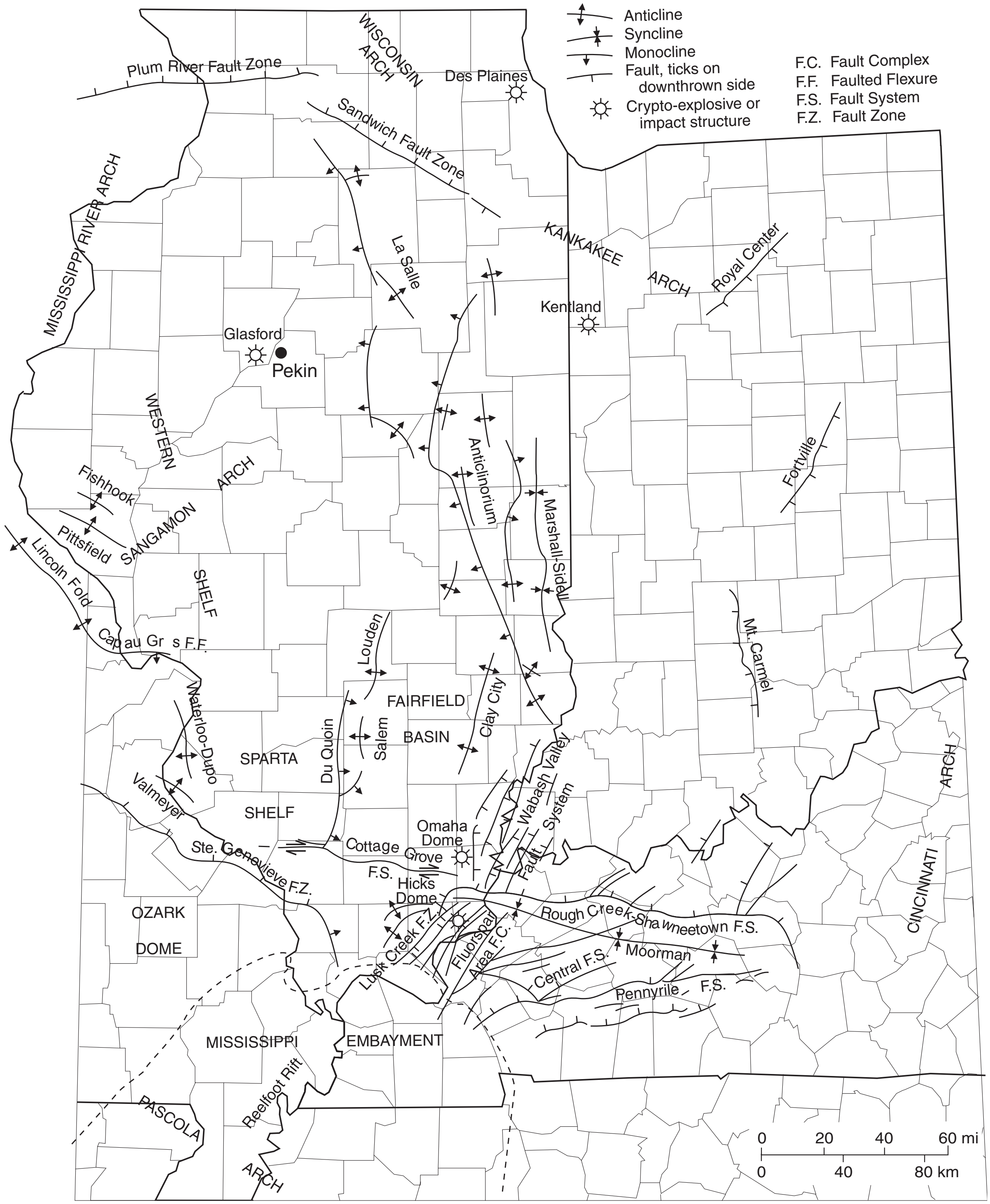


Figure 4 Structural features of Illinois (modified from Buschbach and Kolata 1991).

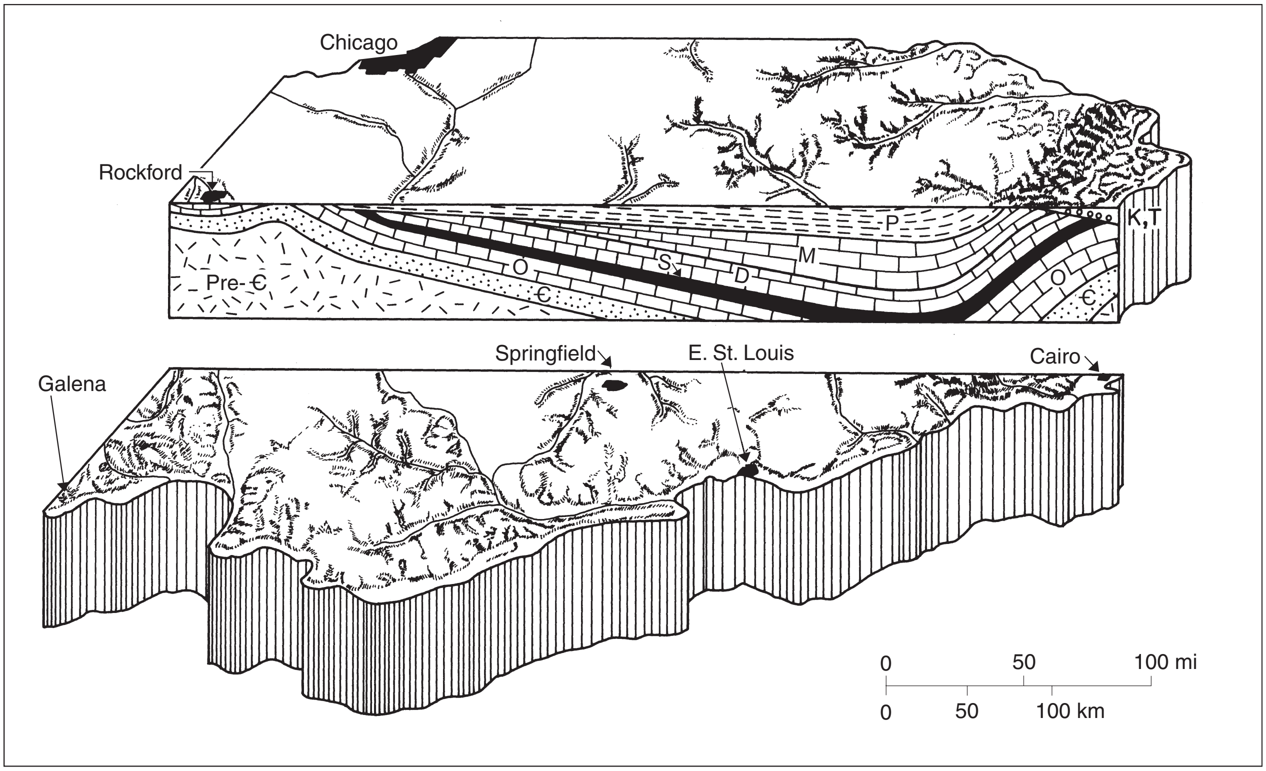


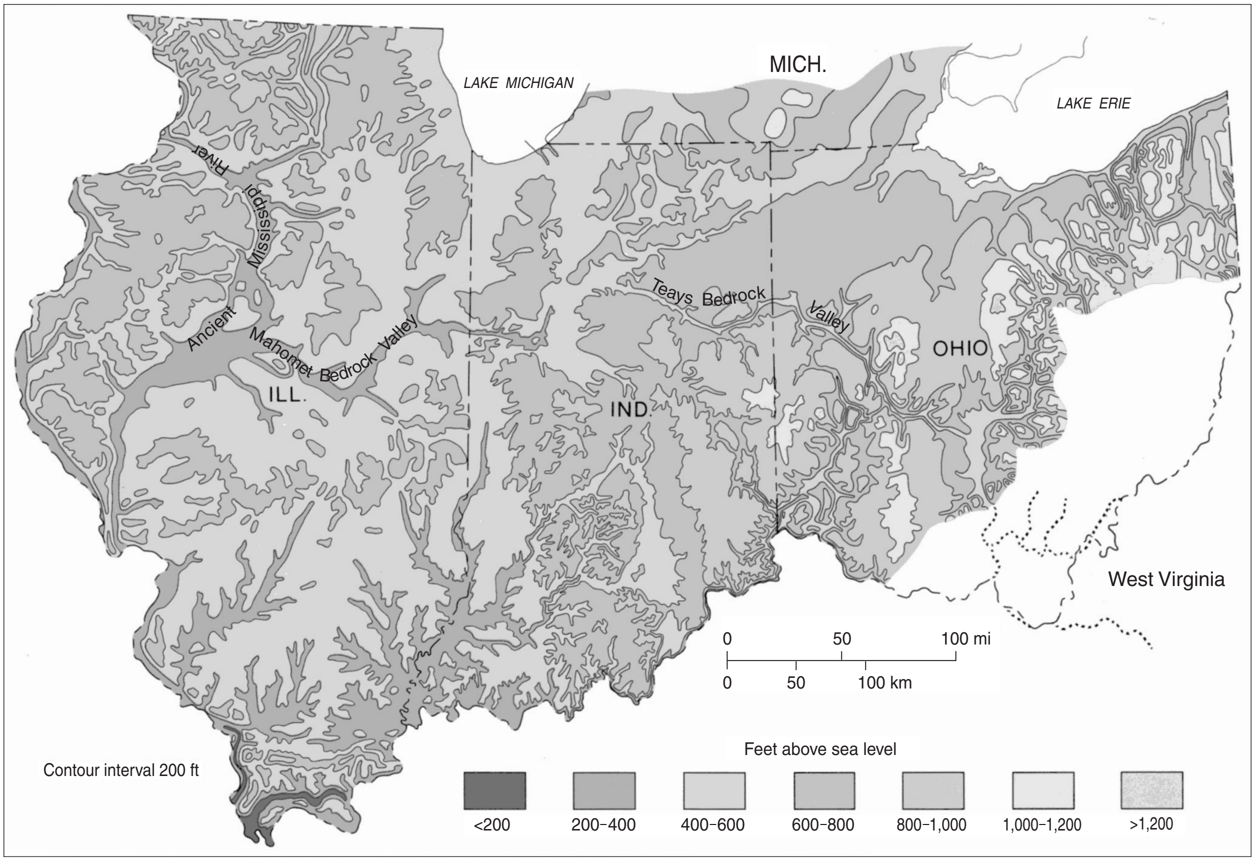
Figure 5 Stylized north-south cross section shows the structure of the Illinois Basin. To show detail, the thickness of the sedimentary rocks has been greatly exaggerated and younger, unconsolidated surface deposits have been eliminated. The oldest rocks are Precambrian (Pre-Є) granites. They form a depression filled with layers of sedimentary rocks of various ages: Cambrian (Є), Ordovician (O), Silurian (S), Devonian (D), Mississippian (M), Pennsylvanian (P), Cretaceous (K), and Tertiary (T). Scale is approximate.

accumulation both east and west of the Hudson Bay area in Canada. As they advanced, the glaciers carried along rock debris incorporated into the ice. The material was dropped out as the ice melted. Prior to glaciation, as just noted, an extensive system of bedrock valleys was deeply entrenched in the bedrock surface of the Illinois Basin. As glaciation began, the ancient streams changed from erosion to deposition and the bedrock valleys were filled from the large volumes of transported glacial sediments that built up in the channels. Later, during the Ice Age, the repeated advances and melting back of additional continental glaciers scoured and scraped the bedrock surface, but no evidence indicates that the early fills in the preglacial valleys were ever completely flushed from their channels by succeeding meltwater. Glacial erosion modified all of the bedrock surfaces in Illinois. The final melting of the glaciers left behind the non-lithified deposits in which our modern Holocene soil has developed.

The number and timing of these early episodes of glaciation are uncertain and are therefore unnamed, but, because they precede the first named episode, the Illinois Episode (Hansel and Johnson 1996) of glaciation, they are called simply pre-Illinois glacial episodes (figs. 8a and b, 9, and 10). The pre-Illinois glacial episodes ended about 425,000 years ago.

A long interglacial episode, called the Yarmouth, followed and lasted approximately 125,000 years (figs. 9 and 10). Deep soil formation (Yarmouth Geosol) took place during that long interval. On generally poorly drained areas, fine silts and clays slowly accumulated (accreted) in shallow, wet depressions and formed what are called accretion-gleys. Accretion-gleys are characterized by dark gray to black, massive, and dense gleyed clays.

The Illinois Episode of glaciation began approximately 300,000 years ago and lasted for about



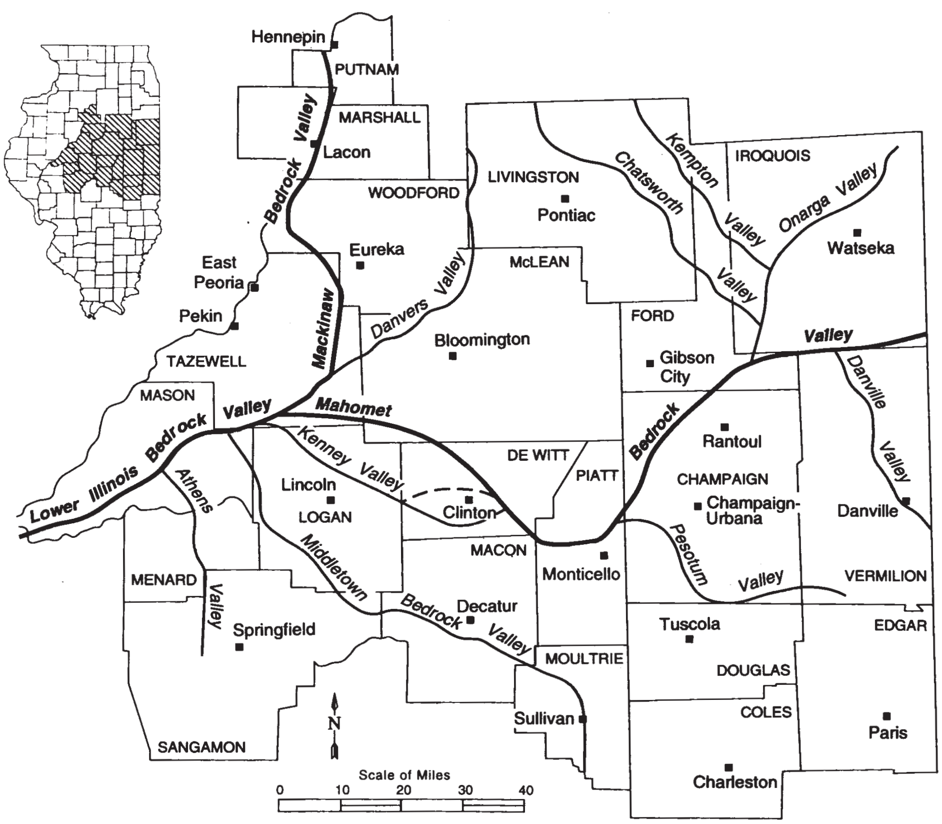


Figure 6 Bedrock valley systems from Ohio to Illinois (modified from Larson et al. 2003).

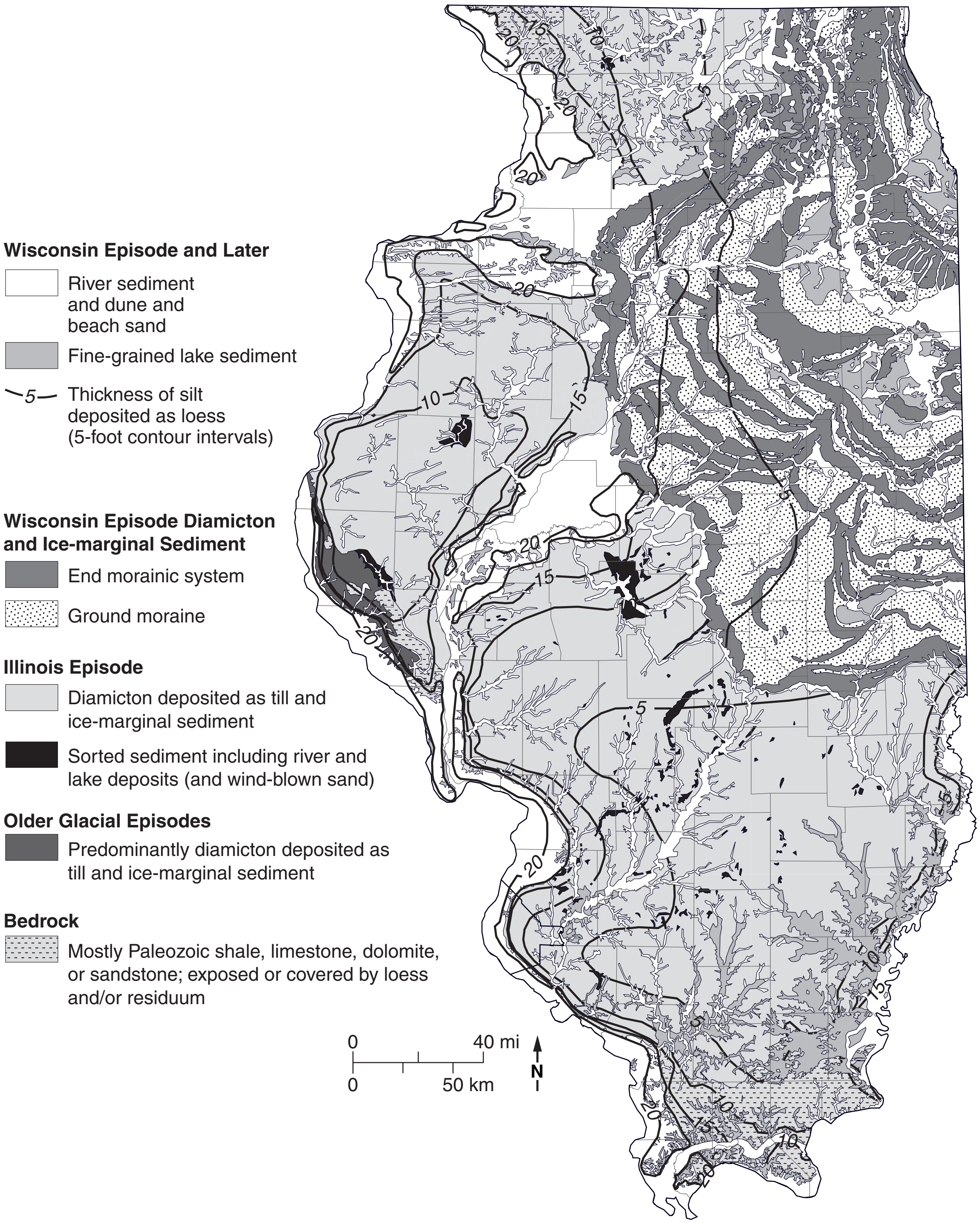


Figure 7 Generalized map of glacial deposits in Illinois (modified from Willman and Frye 1970).

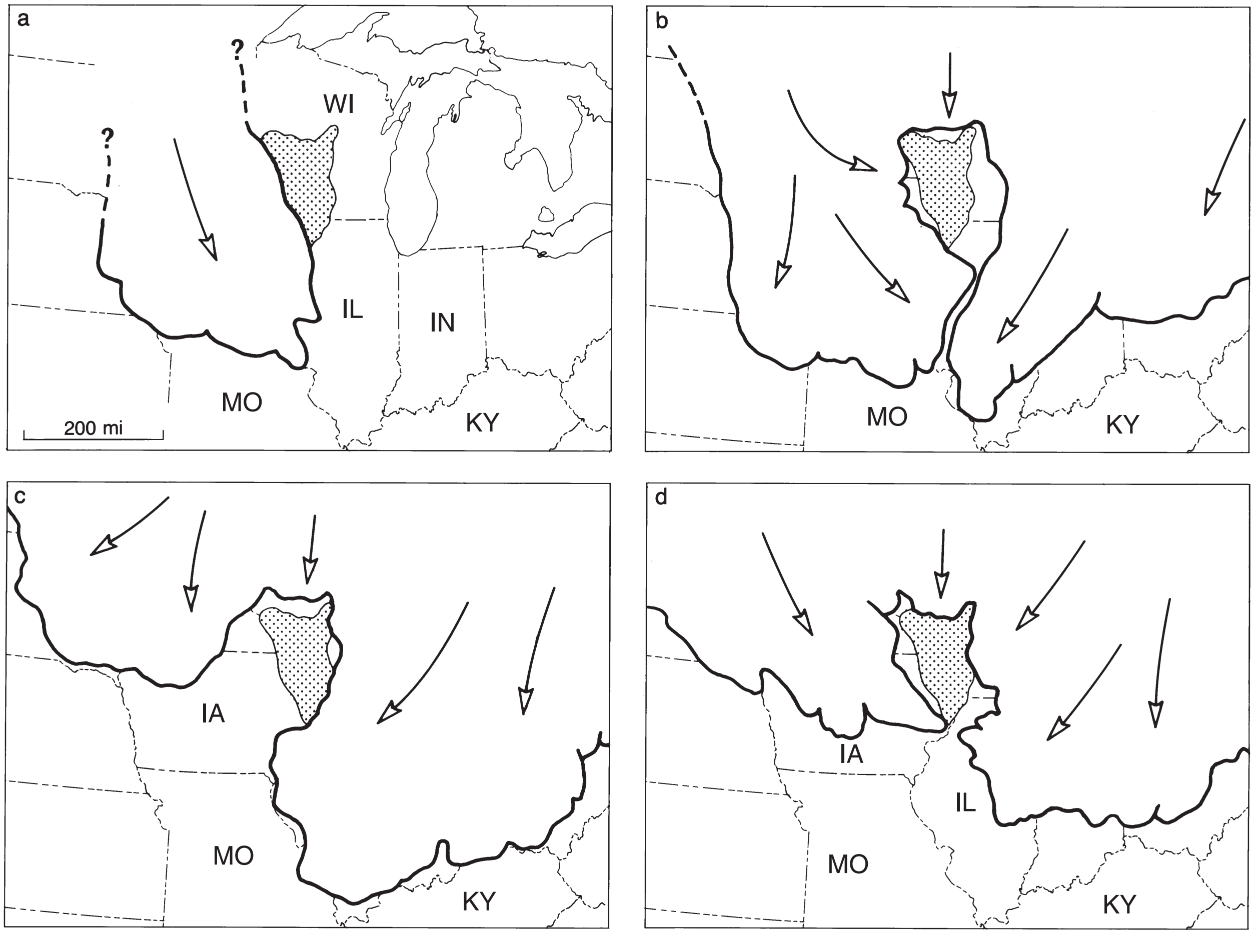


Figure 8 Maximum extent of (a) early pre-Illinois glacial episode (1,000,000 ± years ago); Driftless Area shown by stippled pattern; arrow indicates direction of ice movement; (b) late pre-Illinois glacial episode (600,000 ± years ago); (c) Illinois Glacial Episode (250,000 ± years ago); (d) late Wisconsin Glacial Episode (22,000 years ago).

175,000 years. During this episode, ice advanced three times into Illinois (figs. 9 and 10). The North American continental glaciers reached their southernmost position south of Marion in northern Johnson County. During the first advance, Illinois Episode ice reached westward across Illinois and into Iowa, south of the Driftless Area (fig. 8c).

Another long interglacial interval, called the Sangamon (figs. 9 and 10), followed the Illinois Episode and lasted about 50,000 years. The Sangamon Geosol developed during this time. The Sangamon Geosol exhibits both well-drained and poorly drained soil profiles; although accretion-gleys are not as pronounced as they are in the Yarmouth Soil, their occurrence is common across the Sangamon landscape, and they are easily identified by the same characteristics as the Yarmouth accretion-gleys.

About 75,000 years ago, the Wisconsin Episode of glaciation began (figs. 8d, 9, and 10). Ice from the early and middle parts of this episode did not reach into Illinois. Late Wisconsin ice did advance across northeastern Illinois beginning about 25,000 years ago, but did not reach southern or western Illinois (figs. 7, 8d, and 9). The maximum thickness of the later Wisconsin Episode glaciers was about 2,000 feet in the Lake Michigan Basin, but only about 700 feet over most of the Illinois land surface (Clark et al. 1988). The last of these glaciers melted from northeastern Illinois about 13,500 years before present (B.P.).

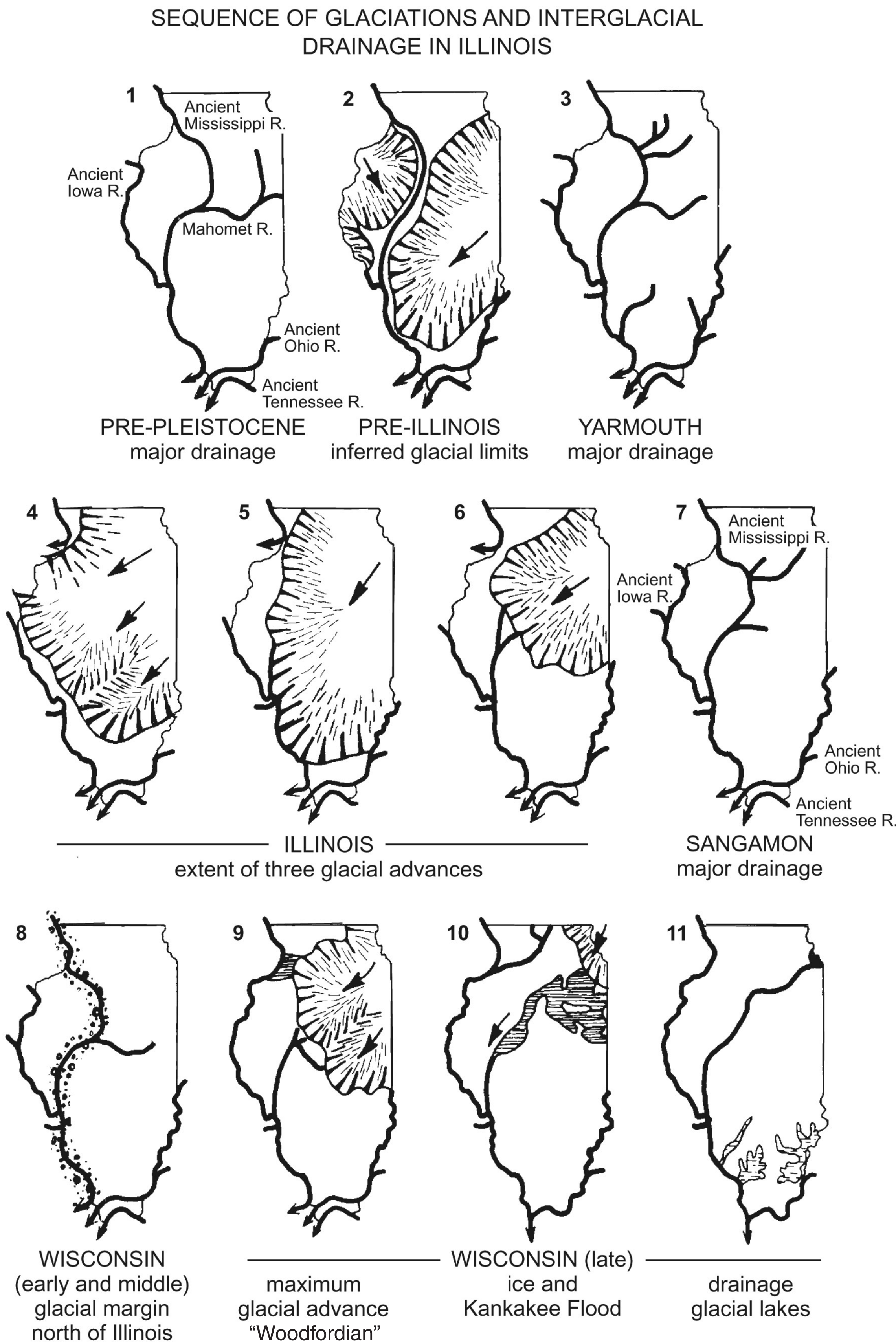


Figure 9 Sequence of glaciations and interglacial drainage patterns in Illinois (modified from Willman and Frey 1970).

Years before present	Time-distance diagram Interglacial and glacial episodes	Sediment record	Dominant climate conditions Dominant land-forming and soil-forming events
HOLOCENE	interglacial episode	River, lake, wind, and slope deposits.	Warm; stable landscape conditions. Formation of modern soil; running water, lake, wind, and slope processes.
10,000	WISCONSIN (late) glacial episode; glacial ice	Till and ice-marginal deposits; outwash and glacial lake deposits; loess. **6**	Cold; unstable landscape conditions. Glacial deposition, erosion, and land-forming processes (e.g., formation of end moraines, outwash plains, valley trains, proglacial lakes, kettles), plus running water, lake, wind, and slope processes.
25,000	WISCONSIN (early and middle) glacial margin north of Illinois	Loess; river, lake, and slope deposits. **5**	Cool; stable. Weathering, soil formation (Farmdale Soil and minor soils); wind and running water processes.
75,000	SANGAMON interglacial episode	River, lake, wind, and slope deposits. **4**	Warm; stable. Weathering, soil formation (Sangamon Geosol); running water, lake, wind, and slope processes.
125,000	ILLINOIS glacial episode	Till and ice-marginal deposits; outwash and glacial lake deposits; loess. **3**	Cold; unstable. Glacial deposition, erosion, and land-forming processes, plus proglacial running water, lake, wind, and slope processes; possible minor soil formation.
300,000	YARMOUTH interglacial episode	River, lake, wind, and slope deposits. **2**	Warm; stable. Long weathering interval with deep soil formation (Yarmouth Geosol); running water, lake, wind, and slope processes.
425,000	? PRE-ILLINOIS glacial and ? interglacial episodes	Till and ice-marginal deposits; outwash and glacial lake deposits; loess plus nonglacial river, lake, wind, and slope deposits. **1**	Alternating stable and unstable intervals of uncertain duration. Glacial deposition, erosion, and land-forming processes, plus proglacial and interglacial running water, lake, wind, and slope processes; interglacial weathering and soil formation.
1,600,000 and older			

PLEISTOCENE EPOCH (not to scale)

NW source — NE source

Figure 10 Timetable illustrating the glacial and interglacial events, sediment record, and dominant climate conditions of the Ice Age in Illinois (modified from Killey 1998).

In general, the glacial deposits in the field trip area consist primarily of (1) till —pebbly clay, silt, and sand, deposited directly from melting glaciers; (2) outwash—mostly sand and gravel, deposited by rapidly flowing meltwater rivers; (3) lacustrine deposits—silt and clay that settled out in quiet-water lakes and ponds; and (4) loess—windblown sand and silt.

Wisconsin Episode moraines were deposited in Illinois from approximately 25,000 to 13,500 years ago (figs. 7 and 11). These moraines were formed along the edge of the ice when the rate of ice advance was approximately equal to the melting rate, depositing large arc-like ridges of till in northeastern Illinois. Although Illinois Episode glaciers probably built morainic ridges similar to those of the later Wisconsin Episode glaciers, the Illinois Episode moraines apparently were not as numerous and have been exposed to weathering and erosion for approximately 280,000 years longer than their younger Wisconsin Episode counterparts. For these reasons, younger Wisconsin Episode features dominate.

This field trip area is located along the western edge of the late Wisconsin Episode Shelbyville Moraine, the earliest moraine of the Woodfordian Substage that was deposited about 25,000 years ago.

Outwash deposits of silt, sand, and gravel were dumped along the major river valleys during all of the glacial episodes. When these deposits dried out during the winters, strong prevailing winds from the west (the westerlies) winnowed out the finer materials, such as fine sand and silt, and carried them eastward across the terrain. The fine-grained, windblown silts form a deposit called loess. These deposits were laid down by the wind during all of the glacial episodes, from the earliest pre-Illinois glacial episode (approximately 1.8 million years ago) to the last glacial episode, the Wisconsin Episode (which occurred approximately 25,000 to 13,500 years ago).

These windblown silts blanket the landscape and compose the parent materials for our modern Holocene soils. Fresh loess exposures are generally yellowish brown. In general, loess thickness decreases to the east. The loess, which covers most of Illinois, is up to 15 feet thick along the Illinois River Valley in Tazewell and Mason Counties and is more than 50 feet thick in some localities along the east edge of the Mississippi River valley. Erosion has completely removed the loess in scattered areas.

REGIONAL DRAINAGE

Some time after the deposition of the Pennsylvanian age strata, the entire central area of the United States was slowly lifted above sea level, and a drainage network of streams began to form. In the Pekin area, the ancient buried bedrock drainage network includes the Mahomet Valley, Mackinaw Valley, Danvers Valley, and the Ancestral Mississippi River valley (figs. 6 and 12). Because of the irregular bedrock surface and erosion, glacial drift is unevenly distributed across Tazewell and Mason Counties. The Ancient Mahomet-Teays (Mahomet in Illinois) was a major river that drained the western flank of the Appalachian Mountains in West Virginia and flowed westward across Ohio, Indiana, and into central Illinois (fig. 6). In central Illinois, it was joined by the Ancestral Mississippi River. The Ancestral Mississippi River, headed in Minnesota, followed the course of the modern Mississippi from its headwaters to near Savanna, Illinois, flowed eastward to near Hennepin, and then flowed southward to join the Ancestral Mahomet River southeast of Pekin in southeastern Tazewell County (fig. 12). The combined rivers flowed southwestward along what is now the lower Illinois River valley.

The present surface topography within the field trip area reflects the landforms left after the melting of the last continental glacier and subsequent weathering and erosion. The principal topographic features include the relatively high morainal ridges that trend generally northwest-southeast, modern low elevation stream valleys that trend generally northeast-southwest, and river terraces (abandoned floodplains) within the modern Illinois and Mackinaw River valleys.

The two major bedrock valley systems in central Illinois—the Mahomet system from the east, and the Ancient Mississippi system from the north—

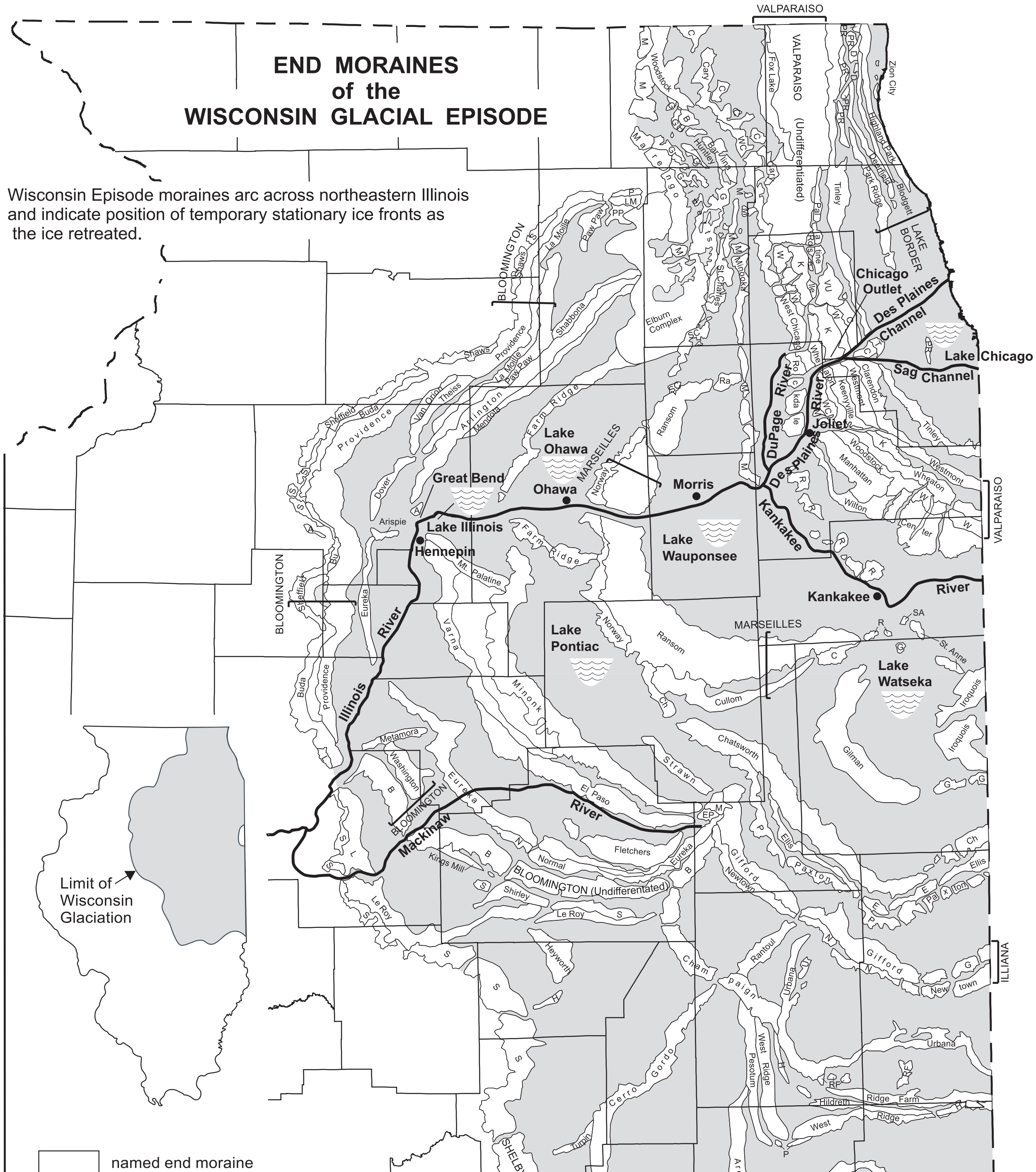


Figure 11 Areal distribution of Wisconsin Glacial Episode moraines of the Wedron Group (modified from Hansel and Johnson 1996).

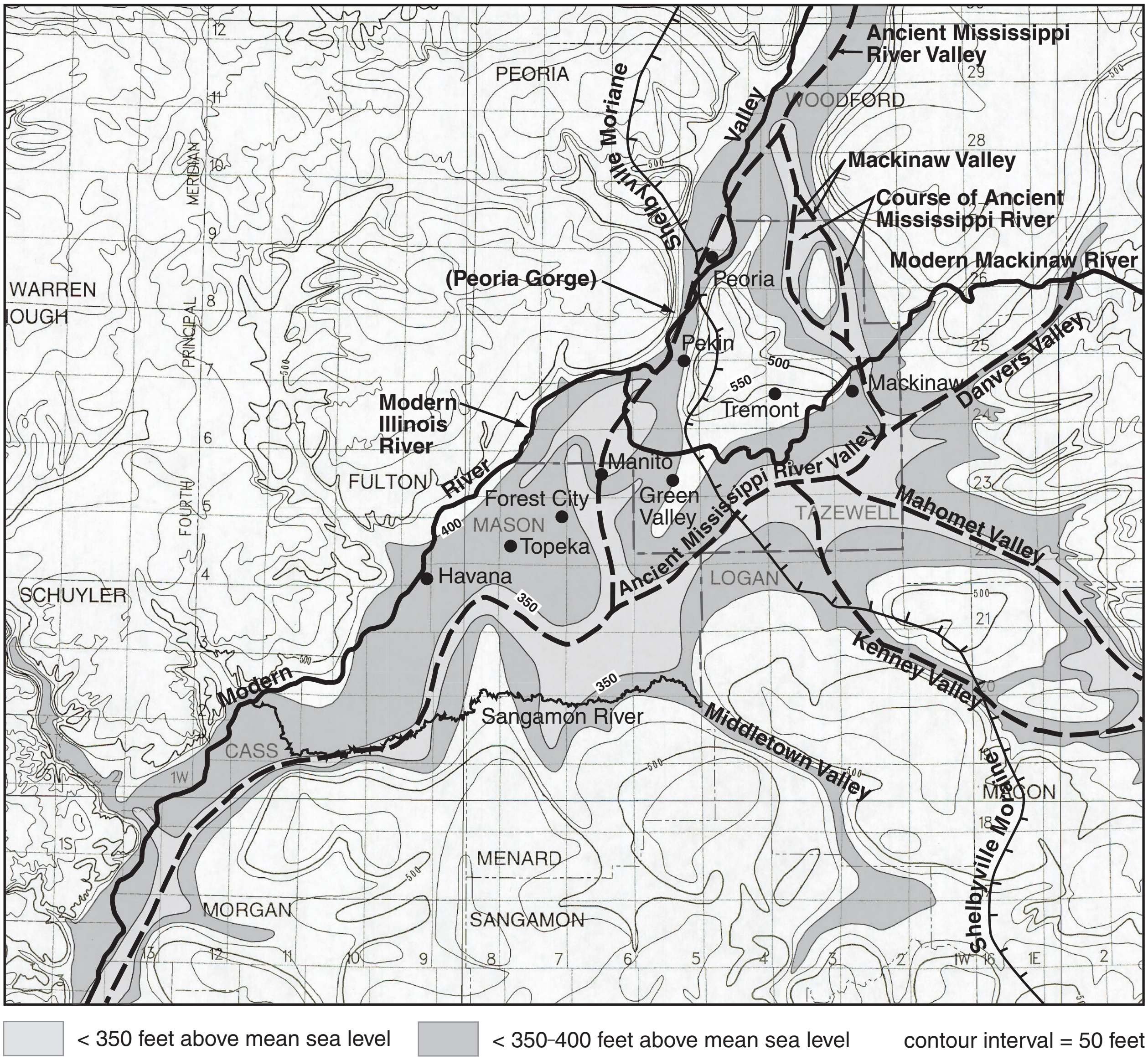


Figure 12 Junction of buried bedrock valleys within the field trip area, with the western limit of the Wisconsin age Shelbyville Moraine, extent of Mahomet-Sankoty aquifer, and position of modern Illinois, Mackinaw, and Sangamon Rivers identified (base map modified from Herzog et al. 1994).

converged in Tazewell County. The onset of the pre-Illinois glacial episode profoundly changed the landscape of the bedrock surface of east-central Illinois by disrupting drainage paths and by initially deepening the existing bedrock valleys through erosion from the surges of meltwater and later partially filling them with coarse sands and gravels. Later glaciation ultimately filled and buried the preglacial bedrock valleys. Deposits left by the glacial advances and retreats of the Illinois and Wisconsin Glacial Episodes filled these channels with additional deposits of unlithified gravels, sands, silts, and clays (water and ice-laid deposits). Near the convergence of the Mahomet and Mackinaw Bedrock Valleys, the extensive basal sands and gravels of the Mahomet and Sankoty Sands of the Banner Formation are overlain by additional layers of sands and gravels, glacial till, and/or lacustrine sediments. These upper sand and gravel deposits represent important aquifers or saturated bodies of earth materials that can yield sufficient groundwater to wells. The main aquifer in the field trip area is the Mahomet-Sankoty aquifer, which lies within the base of the Mahomet and Mackinaw Bedrock Valleys.

Horberg (1946, 1950) was one of the first to map the general shape of the Mahomet and Mackinaw bedrock valleys in this region on his benchmark bedrock topography map. He later defined the Mahomet Sand in the Mahomet Valley and the Sankoty Sand in the Mackinaw Valley (Horberg 1953). The Mahomet and Sankoty Sands are members of the pre-Illinois Episode, Banner Formation.

As the Wisconsin glacier advanced into the area from the north and east, meltwater streams carried tremendous amounts of sand and gravel into where the Ancient Mahomet Valley and Ancestral Mississippi Valley merged. This outwash was deposited as a large alluvial fan that spread westward from the position of the early Shelbyville Moraine and later Le Roy Moraine.

Torrents The last glacier advanced to Peoria and blocked the Ancestral Mississippi River valley north of its junction with the Mahomet Valley (figs. 11 and 12), which produced a large lake that filled part of the Ancestral Mississippi River valley until the lake overflowed and cut a new valley around the edge of the glacier (the Peoria Gorge). The modern Illinois River flows through this valley at Peoria. The Shelbyville Moraine reached Peoria about 20,000 years ago. It had reached the area of the Big Bend at Hennepin, where it had diverted the Ancient Mississippi River westward approximately 5,000 years earlier (Willman 1973, Hansel and Johnson 1996).

This overflow event released a spectacular flow of "energy" in the form of water from the lake. As the torrent from the overflow cut down through the Pennsylvanian strata, coal and other bedrock materials were incorporated into the coarse sediments that choked the valley just below the point of release. Some of the lake sediments (laminated clays and silty clays) that had accumulated in the blocked river valley were ripped from the lake floor and tumbled with sand and gravel to produce armored mud balls. These armored mud balls were deposited in the coarse sediment. These pro-glacial lake deposits are mapped as the Equality Formation.

Further upstream, along what is now the upper Illinois River valley, above the "Big Bend" at Hennepin and between LaSalle and Lake Michigan, several later episodes of massive flooding occurred as lakes that had formed behind moraines overtopped and breached the moraines. These large floods, collectively called the Kankakee Torrents, reworked the sediments and formed large sand and gravel bars (called valley train deposits) that were oriented along the direction of stream flow. These outwash deposits spread out over the large preexisting alluvial fans within the modern Mackinaw Valley from Pekin south toward Havana and west to the Shelbyville Moraine, forming a second alluvial fan. The coarser deposits concentrated along the Ancestral Mississippi River valley. However, as the floodwater rose and spread out over the already existing alluvial fan deposits of the Mackinaw Valley, large volumes of sand were deposited.

During the flooding events of the Kankakee Torrents, erosion was followed by deposition, generally of coarser materials forming the basal deposits, followed by finer-grained sands, silts, and finally clays during the waning stages of the floods. Wind reworked the finer sediments on the alluvial fan.

Much of the silt and clay was blown away to become part of the Richland Loess that forms a thin blanket over the most recent glacial tills to the east. The sand was mobilized to form sand dunes. The dunes within this area form the type section for the Parkland Sand.

The combined actions of the Illinois and Mackinaw Rivers cut away at the alluvial fan and the sand dunes, producing three terrace levels. The highest level is the Manito Terrace. There are abundant sand dunes on the Manito Terrace. The middle level is the Havana Terrace, which has scattered, small sand dunes. The lowest terrace is the Bath Terrace, where sand dunes have been removed by the Mackinaw River as it meandered within its valley. See Stop 2 for a detailed discussion of the development of these terraces.

The Mackinaw River has cut a broad, shallow valley into the alluvial sands, gravels, and overlying sand dunes. Its course is typical of rivers building deltaic alluvial fans in that the direction of flow in the lower reaches changes over time in response to changes in sediment load, compaction, and distance to its discharge point (confluence with the Illinois River). The lower Mackinaw actually flows north (opposite direction to flow of the master stream) to join the Illinois River instead of directly west as is expected. The Ancestral lower Mackinaw used to flow to the south toward Havana.

GEOMORPHOLOGY

Physiography

The Pekin field trip area is located at the junction of the Springfield Plain, the Galesburg Plain, and the Bloomington Ridged plain, all divisions of the Till Plains Section, Central Lowland Physiographic Province (Horberg 1950)(fig. 13). This area is covered with a variety of glacial landforms

Drainage

In the Tazewell County portion of this field trip area, drainage is to the west toward the Illinois River. Major tributaries to the Illinois River from the east include Lost Creek and the Mackinaw River. Most streams in the field trip area have medium to high gradients (bottom slopes) where they are actively eroding into the western sides of the Woodfordian Moraines and have low gradients where they enter into the floodplain of the Illinois river. The modern course of the Illinois River follows the Ancestral Mississippi River valley.

NATURAL RESOURCES

Mineral Production

The only economic minerals currently mined in Tazewell and Mason Counties are sands and gravels from glacial outwash deposits. Sand dunes are currently being mined in Mason County. Peat was previously mined in both counties near Manito from 1905 to 1954. Coal seams more than three feet thick and relatively thick underclay units within the sequence of Pennsylvanian age rocks in the field trip area have been commercially exploited. Three major coal units have been mined: the Colchester Coal at Banner, the Springfield Coal at Pekin (see road log, and route maps for locations of some of the mines located in Pekin), and the Herrin Coal at Buckhart. Although no coal mines are currently active, Tazewell County cumulative production equals 17,633,802 tons. The Lakeside Coal Company, Lakeside Mine was the last active mine in Tazewell County, closing in 1956. Just north of Pekin, the Pennsylvanian shales and underclays were previously mined for making bricks and drainage tile.

Groundwater

Groundwater is a mineral resource frequently overlooked in assessments of an area's natural resource potential, yet this mineral resource is essential for orderly economic and community development. More than 48% of the state's 11 million citizens and 97% of those who live in rural areas depend on groundwater for their water supply. Groundwater is derived from underground formations called aquifers. The water-yielding capacity of an aquifer can only be evaluated by constructing wells into it. After construction, the wells are pumped to determine the quality and quantity of groundwater available for use.

Because thick glacial deposits occur in the field trip area, sand and gravel deposits are common throughout most of the county. The Mahomet, Mackinaw, and other bedrock valleys contain thick deposits of unconsolidated materials that include

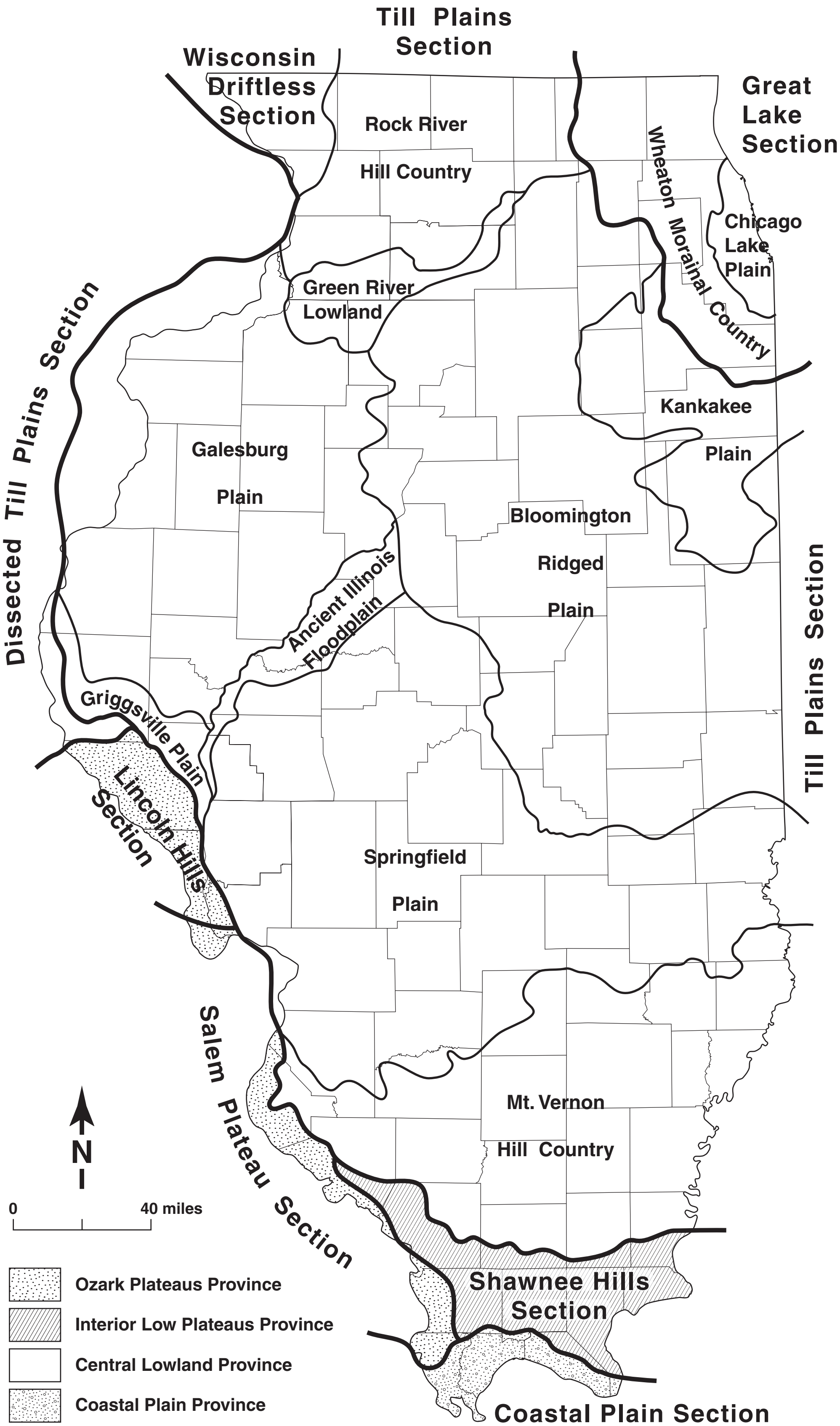


Figure 13 Physiographic divisions of Illinois (modified from Leighton et al. 1948).

thick basal sand and gravel and other intermediate zones. These sand and gravel deposits yield vast amounts of water for industrial and municipal water supplies. The Mahomet-Sankoty aquifer underlies western Tazewell and northern Mason Counties. Over 1,400 agricultural center-pivot irrigation systems are scattered throughout these two counties where numerous specialty crops are grown. As a result, this area is known as the Imperial Valley of Illinois.

Natural Areas

Descriptions of the natural areas within the field trip area are adapted from brochures produced by the Illinois Department of Natural Resources.

Sand Ridge State Forest (fig. 14) lies southwest of Peoria. Its 7,500 acres contain oak, hickory, pine, open fields, grasslands, and sand prairies. The area is the result of a prehistoric dry period when more desert-like conditions existed. Today it supports plants and animals more associated with the Southwest than Illinois: badgers, pocket gophers, and prickly pear cactus. The endangered silvery bladderpod is found only here and in Nebraska and Montana. The area is an important nesting habitat for some increasingly rare neo-tropical migratory birds, such as the ovenbird, indigo bunting, veery, and scarlet tanager.

Spring Lake Fish and Wildlife Area (fig. 15) is located in Tazewell County, 25 miles southwest of Peoria on the east side of the Illinois River. Total acreage is 1,946; the lake covers 1,285 acres with 18 miles of shoreline. Overlooked by a large sandstone bluff, Spring Lake is a long, narrow lake created by a meander of the Illinois River. Lake level was raised by dike construction in the late 1950s, increasing the lake to nearly twice its former size, inundating another lake known as Sewell Lake.

Early residents of the area were mound-building Native American tribes, including the Peoria, Kaskaskia, Cahokia, Tamaroa, and Michigamie, who were eventually driven out by white settlers around 1830. At that time, the lake became a feeder-type waterway, joined to the commercial developments along the Illinois River by a backwater slough. Dike construction in 1903 made boat access from the lake to the river impossible. A marine railway was constructed by the Spring Lake Drainage and Levee District, but legend has it that the railway was used only once. It eventually fell into disrepair and was abandoned.

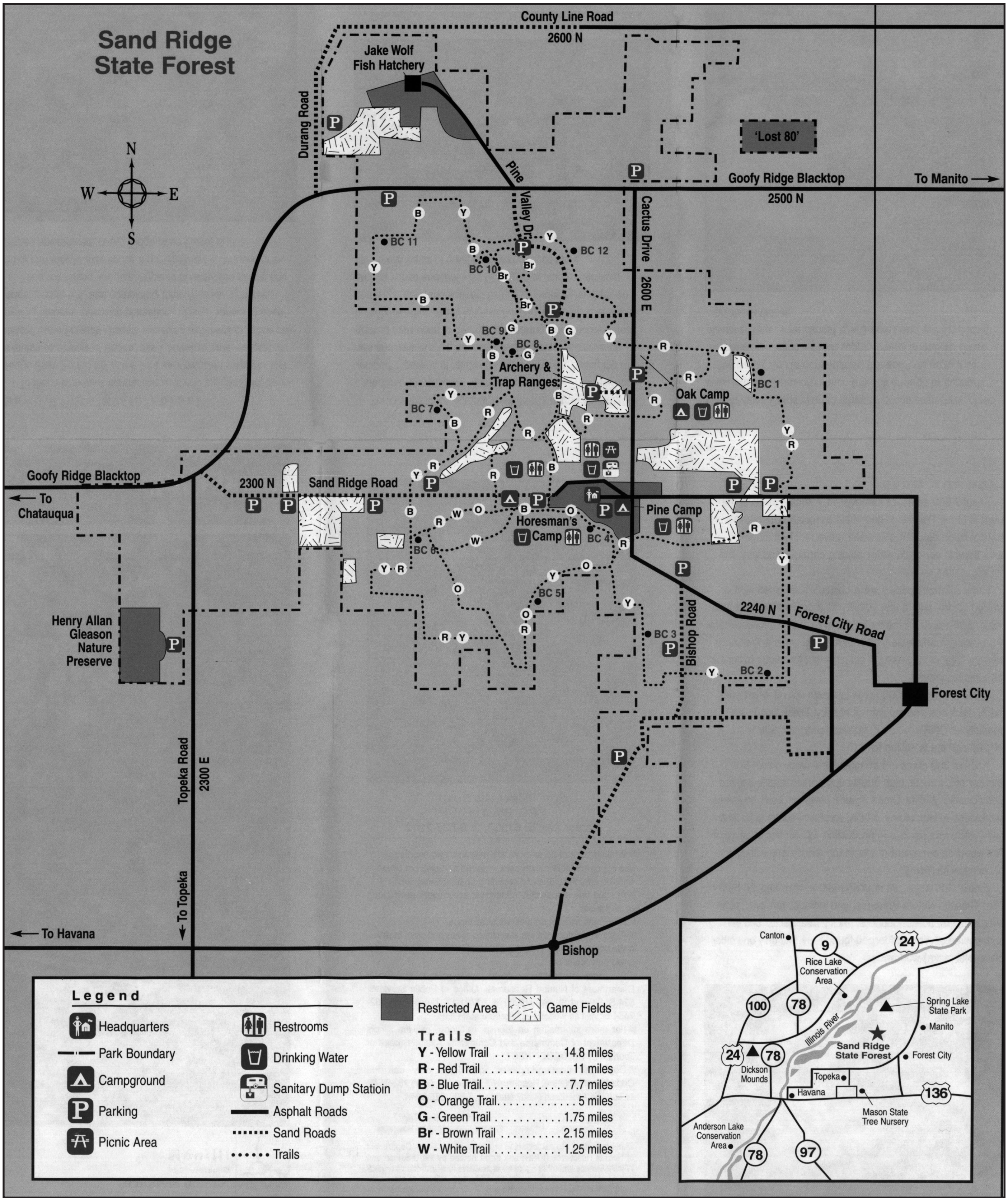


Figure 14 Sand Ridge State Forest (modified from Illinois Department of Natural Resources 2000).

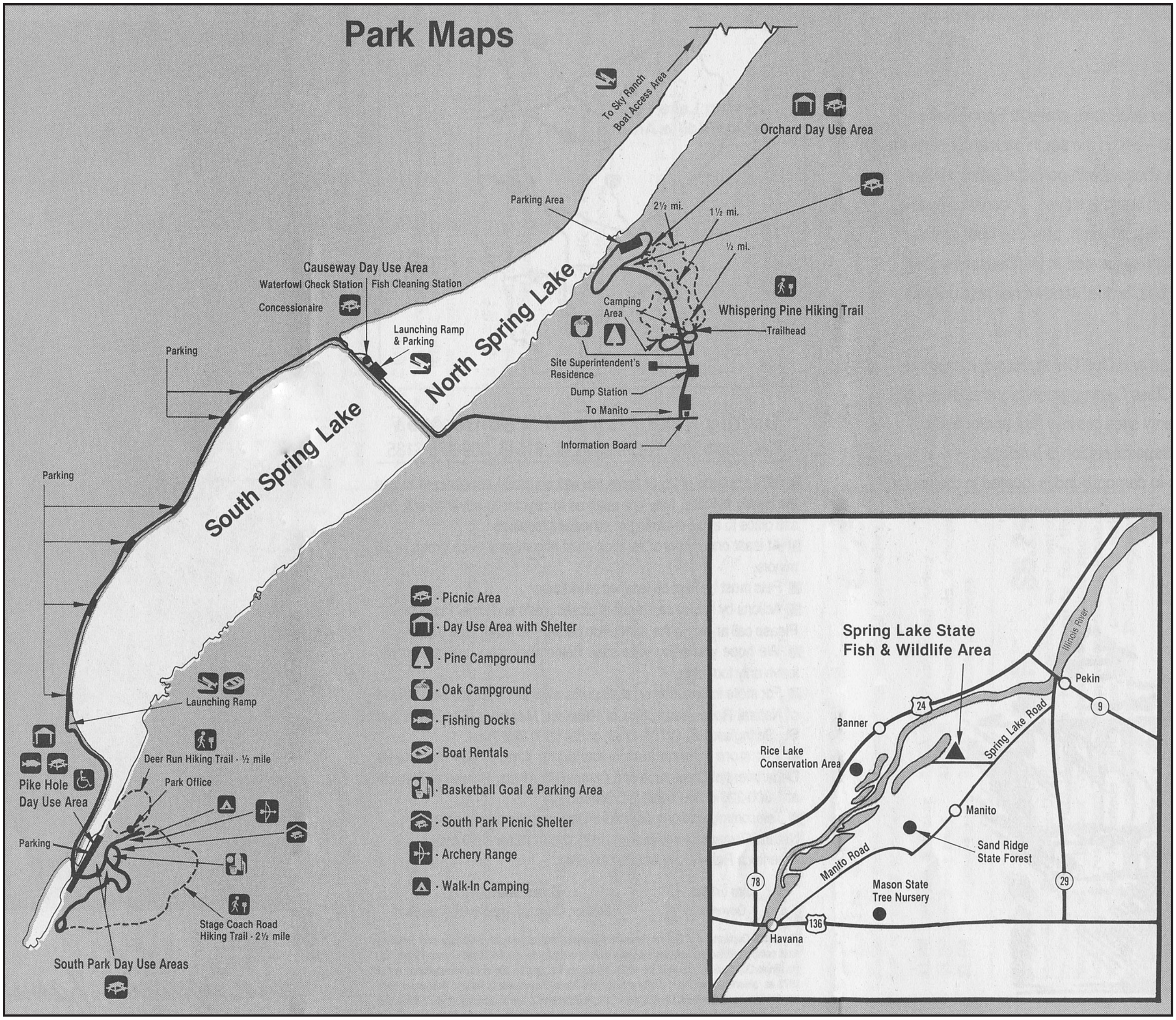


Figure 15 Spring Lake Fish and Wildlife Area (modified from Illinois Department of Natural Resources 1995).

GUIDE TO THE ROUTE

We will start the field trip at the gazebo in Mineral Springs Park, Pekin (NE, NE, Sec. 2, T24N, R5W, 3rd P.M., Pekin 7.5-minute Quadrangle, Tazewell County). Mileage will start at the dugout parking lot. Set your odometer to 0.0.

You must travel in the caravan. Please drive with headlights on while in the caravan. Drive safely but stay as close as you can to the car in front of you. Please obey all traffic signs. If the road crossing is protected by an Illinois State Geological Survey (ISGS) vehicle with flashing lights and flags, please obey the signals of the ISGS staff directing traffic. When we stop, park as close as possible to the car in front of you, and turn off your lights.

Private property Some stops on the field trip are on private property. The owners have graciously given us permission to visit on the day of the field trip only. Please conduct yourselves as guests and obey all instructions from the trip leaders. So that we may be welcome to return on future field trips, follow these simple rules of courtesy:

- Do not litter the area.
- Do not climb on fences.
- Leave all gates as you found them.
- Treat *public* property as if you were the owner—which you are!
- Stay off all mining equipment.
- Parents must closely supervise their children at all times.

When using this booklet for another field trip with your students, a youth group, or family, remember that *you must get permission from property owners or their agents before entering private property*. No trespassing, please.

Nine USGS 7.5-minute Quadrangle maps (Delavan North, Duck Island, Forest City, Glasford, Manito, Marquette Heights, Pekin, South Pekin, and Topeka) provide coverage for this field trip area.

START: Gazebo, Mineral Springs Park, Pekin Park District (NE, NE, Sec. 2, T24N, R5W, 3rd P.M., Pekin 7.5-minute Quadrangle, Tazewell County. Mileage will start at the dugout parking lot. Set your odometer to 0.0.

Miles to next point	Miles from start	
0.0	0.0	Set your odometer to 0.0. Exit the parking lot and turn right onto Pavilion Drive.
0.15	0.15	STOP (four-way). Intersection of Pavilion Drive and Royal Avenue. CONTINUE AHEAD. Pavilion Drive becomes Sycamore Street.
0.15	0.3	STOP (two-way). Intersection of Broadway Street and Sycamore Street. TURN RIGHT (east) onto Broadway.

0.5	0.8	STOP LIGHT (intersection of Broadway Street and Parkway Drive). CONTINUE AHEAD (east). Abandoned Pekin Coal Company, Pekin Mine. The mine is located to the north in Sec. 36, T25N, R5W (see route map for location). This mine was a shaft mine in the Springfield Coal, which had an average thickness of 56 inches at a depth of approximately 100 feet. The mine was operated between 1939 and 1953 under the Pekin Coal Company and produced 978,022 tons of coal. ISGS mine records indicate that prior to 1939 it was operated as the David Grant Coal Company from 1915 to 1936 and under the name Fred Schaefer from 1936 to 1938. No production figures were reported. The Louis Grant and Son Coal Company is located to the south in Sec. 1, T24N, R5W (see route map for location). The Springfield Coal in this mine was found at an average depth of 95 feet but was reported as running from 90 to 100 feet deep with an average thickness of 58 inches. This mine produced 289,050 tons from 1891 to 1910 as the Grant 2 mine. This mine also operated under the names of Grant Bros. Coal and Ice and Grant and Son Coal Co. This mine operated as the Ubben Coal Company, Mine No. 1 from 1911 to 1938, producing 906,415 tons. Total reported production from this mine was 1,195,465 tons.
0.7	1.5	Parkview Golf Course on the right.
0.05	1.55	CAUTION: Four-lane road narrows to two-lane road.
0.05	1.6	Regal Coal Company. Abandoned shaft is located 360 feet to the south in Sec. 6, T24N, R4W (see route map for location). The Springfield Coal averages 56 inches thick at a depth of 205 feet. Total production of coal from 1905 to 1925 was more than 237,000 tons. In addition, the abandoned Tazewell County Coal Co., Tazewell Mine is located to the south in Sec. 6, T24N, R4W (see route map for location). This mine was a shaft mine in the Springfield Coal, with an average thickness of 56 inches at a depth of approximately 160 feet. The mine was operated between 1901 and 1925 and produced 2,089,332 tons of coal.
0.7	2.3	Pass three T-intersections from the left (Pin Oak Road, Reuter Lane, and Country Club Drive). CONTINUE AHEAD.
0.3	2.6	T-intersection from the right (California Road). CONTINUE AHEAD.
0.25	2.85	Prepare to turn right.
0.15	3.0	STOP LIGHT (intersection of Veterans Drive on the right and California Road on the left). TURN RIGHT.
0.5	3.5	Pass under power transmission lines.
0.6	4.1	Crossroad intersection (Allentown Road). CONTINUE AHEAD.

1.0	5.1	STOP LIGHT (intersection of Court Street/Route 9 and Veterans Drive). CONTINUE AHEAD.
0.2	5.3	STOP LIGHT (entrance to mall). CONTINUE AHEAD. Road curves to the right after the stop light and becomes Mall Road.
0.5	5.8	T-intersection from the left (Towerline Road/17000E and Mall Road/15000N). TURN LEFT. Road parallels power line on the right.
0.5	6.3	T-intersection from the left (VFW Road/14500N). CONTINUE AHEAD.
0.3	6.6	Cross under the east-west transmission power line. Road a makes slight jog before and after the power line.
0.7	7.3	On the right, note the trees that were snapped off and damaged by the June 2003 tornado on the right.
0.5	7.8	Crossroad intersection (Red Shale Hill Road/13000N). CONTINUE AHEAD. The abandoned N.C. Hawley Coal Mine is located west of this intersection (see route map). This shaft mine operated between 1878 and 1896, producing 16,789 tons from the Springfield Coal at a depth of 90 feet.
0.9	8.7	T-intersection from the left (unnamed road with flashing yellow light). CONTINUE AHEAD.
0.2	8.9	Cross Lost Creek.
0.2	9.1	T-intersection from the right (Furrow Road/11700N). CONTINUE AHEAD. The crest of the Shelbyville and Le Roy Moraines is to the left. The road is crossing part of the outer edge of the Shelbyville Moraine. The view to the southwest is the Mackinaw River Valley.
0.75	9.85	STOP (four-way). Crossroad intersection (Towerline Road/17000E and Townline Road/11000N). CONTINUE AHEAD. The area to the left has been dissected by erosion that has developed along the outer slope of the Shelbyville Moraine (see route map). Drainage is to the west.
0.65	10.5	T-intersection from the right (Christmas Tree Road/10250N and Towerline Road/17000E). CONTINUE AHEAD. The small hill (elevation 600 feet) at this intersection is an erosional outlier of the Shelbyville Moraine (see route map). This hill marks the furthest southwest advance of the Wisconsin Episode glacier.
0.4	10.9	T-intersection from the right (Straub Road/10000N). CONTINUE AHEAD. Road begins its descent into the Mackinaw Valley. Great view of the flat-lying floodplain to the right and left. The north- and south-facing bluffs define the valley carved by the Mackinaw River.
0.7	11.6	Cross the Mackinaw River. Notice the extensive flat-lying floodplain terraces along the road. The river bed of the Mackinaw contains gravel bars and is very sandy. The

		Mackinaw River has breached (cut through) the Shelbyville and Le Roy Moraines approximately 2 miles upstream from the bridge. Note the close spacing between contours along the Mackinaw River as it flows between Sec. 16 and 21, T23N, R4W (see route map).
0.8	12.4	Entrance to the R.A. Cullinan and Sons Goeken Sand and Gravel Pit on the left, now abandoned.
0.1	12.5	Road begins its ascent out of Mackinaw Valley.
0.4	12.9	Crossroad intersection (Cedar Bluff Road to the left and Goeken Road to the right/ 8000N). TURN RIGHT onto Goeken Road (heading west). Road is now traversing a high-level terrace along the Mackinaw River.
0.2	13.1	Center pivot-point irrigation system on the left. The irrigation system is manufactured by Zimmatic.
0.2	13.3	Road curves to the right.
0.3	13.6	Road begins its descent onto the Bath Terrace. Old abandoned sand and gravel pit to the left.
0.05	13.65	Exposure of loess on the right.
0.1	13.75	Road is traversing the Bath Terrace, which forms the modern Mackinaw River flood-plain.
0.25	14.0	T-intersection from the left (Worner Road/16000E). CONTINUE AHEAD. Drainage ditches on the right and left. Center pivot-point irrigation systems on the right and left.
0.5	14.5	Cross abandoned railroad grade.
0.2	14.7	Abandoned sand and gravel pit along the bluff to the left.
0.3	15.0	CAUTION: Cross single-track railroad (Illinois Central). UNGUARDED (no lights or guard gates). Mackinaw River is to the right.
0.45	15.45	CAUTION: Cross another single-track railroad (Chicago and North Western). UN-GUARDED (no lights or guard gates). Prepare to stop.
0.05	15.5	STOP (one-way). Crossroad intersection (Goeken Road/8250N and Illinois Route 29/14500E). TURN LEFT onto Illinois Route 29. Cross a small drainage ditch and prepare to turn right.
0.2	15.7	T-intersection from the right (Hickory Grove Road/8000N). TURN RIGHT. The Ha-vana Terrace is to the left. You are driving on the Bath Terrace.

2.05	17.75	STOP (one-way). T-intersection (Hickory Grove Road/8000N and Wagonseller Road/12500E). TURN RIGHT. Old sand and gravel pits from small mining operations are on the left, along the base of the bluff (see route map).
0.45	18.2	T-intersection from the left (Weir Road/8500N). TURN LEFT. Center pivot-point irrigation systems on the right and left.
1.45	19.65	STOP (one-way). T-intersection from the right (Jacobs Road/11000E). TURN RIGHT. View from the stop sign, directly ahead, is The Mound (elevation 520 feet), to the left is Little Mound (elevation 490 feet), and to the southwest is Hickory Grove Hill (elevation 500 feet) (see route map). Each one of these mounds is an erosional remnant of older and higher terraces that were bypassed by the ancient meandering Mackinaw River as it flowed through this valley. The Mound is part of the Manito Terrace, Little Mound marks the Havana Terrace, and Hickory Grove Hill is the Manito Terrace. The lowest elevations in this area are part of the Bath Terrace.
0.45	20.1	Road curves 90 degrees to the left. Road becomes Warner Road/9000N at the curve. Immediately to the right of the curve is the Mackinaw River. Thus far, the Mackinaw River has been flowing in a generally east-west direction. At this point, the Mackinaw River changes course and begins to flow toward the northwest. The Mound is directly ahead.
0.3	20.4	View to the right: the Mackinaw River has made its turn to the north.
0.45	20.85	T-intersection from the right (Proehl Road/10250E). CONTINUE AHEAD.
0.25	21.1	Cross Breedlove drainage ditch at base of The Mound. The intersection of Meeker and Breedlove drainage ditches is located immediately to the left. The Breedlove and Meeker ditches, along with many others in this area, are man-made drainage ditches constructed for field drainage. On the left, notice the bent over trees from the June 2003 tornado.
0.25	21.35	Cross the crest of The Mound (elevation 520 feet), a Manito Terrace erosional remnant. The bluffs straight ahead form a portion of the Mackinaw River valley and also are part of the Manito Terrace.
0.25	21.6	T-intersection from the right (Schuttler Road/9500E). CONTINUE AHEAD.
0.2	21.8	Power line crosses road. Possible stop, good view of The Mound, Little Mound, and Hickory Grove Hill (see route map).
0.3	22.1	Crossroad intersection (Dinky Ditch Road/9000E). TURN LEFT. After making the turn, Hickory Grove Drainage Ditch is on the right. The Manito Ditch T-intersects with Hickory Grove Ditch on the right.
0.5	22.6	Power line crosses the road. Pull over to the far right side of the road.

STOP 1: Mackinaw River Valley—Terraces, Meanders, and Buried Valleys (NE, NE, SE, Sec.15, T23N, R6W, Manito 7.5-minute Quadrangle, Tazewell County).

This is a great stop for a scenic view. To the right (west), at the base of the bluff, is a large meander scar of the ancient Mackinaw River. The surficial material filling and along the abandoned meander belongs to the Grayslake Peat. The large brick structure in the distance, located just south of the Tazewell/Mason County line, is an abandoned peat and fertilizer processing plant. To the left is a good view of The Mound (elevation 520 feet) and Manito Terrace, Little Mound (elevation 490 feet) and Havana Terrace, and Hickory Grove Hill (elevation 500 feet) and Manito Terrace (see route map). The road is on the Bath Terrace (see route map).

0.0	22.6	Leave Stop 1. CONTINUE AHEAD.
0.2	22.8	T-intersection from the left (Meyers Farm Road). CONTINUE AHEAD. The farm buildings to the left are on top of the Little Mound, an erosional remnant of the Havana Terrace. Hickory Grove Hill, an erosional remnant of the Manito Terrace, is located to the south and slightly to the east.
0.2	23.0	Cross the Tazewell-Mason County line.
0.5	23.5	STOP (two-way). Crossroad intersection (Dinky Ditch Road/9000E and Hickory Grove Road/7500N). TURN RIGHT. There is a good view of abandoned meander scar, peat factories, and bluffs to the right.
0.8	24.3	Enter the community of Manito, population 1,733. Road curves to the left and then back to the right.
0.4	24.7	Pass by four T-intersections, Reagen from the right, East Avenue from the left, North Park Avenue from the right and from the left. CONTINUE AHEAD.
0.1	24.8	STOP (two-way). Intersection (North Harrison Street and East High Street). TURN RIGHT onto North Harrison Street.
0.05	24.85	Road curves to the left. Follow the curve to the left; the road is now East North Street.
0.05	24.9	T-intersection from the left (South Washington Street). CONTINUE AHEAD.
0.1	25.0	Crossroad intersection (Broadway Street and East North Street). The peat factory is located to the right. Follow the farm lane, which is part of Broadway Street. Manito Peat Deposit is located SW, NE, SW, Sec.15, T23N, R6W, Manito 7.5-minute Quadrangle, Tazewell County.
0.05	25.05	CAUTION: Cross railroad tracks (Chicago and Illinois Midland). UNGUARDED. No signal lights or guard gates. Cross the railroad and pass by the T-intersection to the left (North Broadway Street). CONTINUE AHEAD.

0.05	25.1	STOP (two-way). Intersection (Manito Road and West North Street). TURN LEFT. After making the turn, on the right you will see a wood carving, made from a large tree trunk of a Native American (Indian) that was carved in November 2003. Although the historical origin of the name for this city could not be found, Manito, as defined by *Webster's,* is the name given by the Algonquin Indians to a pervading spirit or deity having supernatural powers (good or evil) over the vital forces of nature.
0.8	25.9	T-intersection from the right (East Manito Road/2500N and Manito Road/3030E). CONTINUE AHEAD.
1.0	26.9	T-intersection from the left (2400N). CONTINUE AHEAD.
1.4	28.3	Crossroad intersection (2300N). CONTINUE AHEAD. This intersection is called Union.
0.3	28.6	Sparks Pond State Natural Area on the right. CONTINUE AHEAD. Sparks Pond is a 230-acre tract owned by the Illinois Department of Natural Resources and proposed for registration as a Land and Water Reserve. The proposed reserve contains sand ponds, sand prairie, oak forest, and old fields. The area is included on the Illinois Natural Areas Inventory because it supports populations of the endangered Illinois mud turtle and the threated Illinois chorus frog.
1.0	29.6	Enter Forest City, population 287.
0.4	30.0	Crossroad intersection (Broadway Street). CONTINUE AHEAD. The road to the right leads to the Sand Ridge State Forest.
0.4	30.4	Abandoned Forest City School on the right. Tornado damage is visible just past the school.
0.6	31.0	Crossroad intersection (Dierker Road/2730E and East Manito Road). CONTINUE AHEAD. Large sand dune on the right just past the intersection. The Mason Tazewell Drainage Ditch parallels the road on the left. This drainage ditch is within an old abandoned channel of the Ancient Mackinaw River. Note the elevation contours V upstream within the old channel (see route maps).
0.5	31.5	T-intersection from the right (2680E). CONTINUE AHEAD.
0.4	31.9	Road is crossing old terrace. Notice the difference between soil color in this area and that in the areas covered by sand dunes.
0.9	32.8	Enter the community of Bishop, population less than 225.
0.3	33.1	Crossroad intersection (North Bishop Road/2550E and East Manito Road/2000N). CONTINUE AHEAD. A large dune can be seen on the left.
0.9	34.0	T-intersection from the right (2450E). CONTINUE AHEAD.
1.0	35.0	T-intersection from the left (2350E). CONTINUE AHEAD.

0.5	35.5	T-intersection from the right (Topeka Road/2300E). TURN RIGHT. Sign on the right for Sand Ridge State Forest.
1.75	37.25	Enter Sand Ridge State Forest, and prepare to stop. Notice the broken trees on the left from the June 2003 tornadoes. Two tornadoes passed through this area within a week, providing a raw demonstration of the power of Mother Nature!
0.25	37.5	Entrance to Henry Allen Gleason Nature Preserve on the left. Pull over to the far right side of the road, and park your vehicles. There is a view of a sand pit operation to the right (east), opposite the parking lot.

STOP 2. Henry Allen Gleason Nature Preserve, Sand Ridge State Forest (SE, SE, SE, Sec. 6, T22N, R7W, Duck Island 7.5-minute Quadrangle, Mason County). On the day of the field trip, pull over to the side of the road.

0.0	37.5	Leave Stop 2. CONTINUE AHEAD.
0.25	37.75	T-intersection from the right. TURN RIGHT. Entrance to West Side Sand. Notice tree damage from the June 2003 tornados on the left side of the road. The trees have been snapped like wooden matches.
0.8	38.55	Enter Manito Investment Co. West Side Sand operations.

STOP 3. Manito Investment Co. West Side Sand (SE and SW, SE, Sec. 5, and NE and NW, NE, Sec. 8, T22N, R7W, Duck Island 7.5-minute quadrangle, Mason County). On the day of the field trip, follow the lead vehicle, and obey ISGS staff directing traffic.

0.0	38.55	Leave Stop 3. Retrace the route back to Topeka Road.
0.8	39.35	T-intersection (Topeka Road/2300E). TURN RIGHT.
0.7	40.05	STOP (three-way). Crossroad intersection (Goofy Ridge Road/2300N and Topeka Road/2300E). TURN RIGHT.
0.1	40.15	T-intersection from the right (Sand Ridge Road/2300N). CONTINUE AHEAD. Road to the right will take you to the headquarters for Sand Ridge State Forest.
0.5	40.65	T-intersection from the left (2330N). CONTINUE AHEAD.
0.7	41.35	Good view of large-scale dune topography within Sand Ridge State Forest on the right.
0.7	42.05	T-intersection from the left (Cedar Lake Road/2480N). CONTINUE AHEAD. View to the left of reforested pine trees in the lower portions and oaks higher up on the ridges within Sand Ridge State Forest. Road begins large curve to the right.

0.3	42.35	T-intersection from the left (2400E). CONTINUE AHEAD. The road to the left will take you to Spring Lake State Fish and Wildlife Area.
0.25	42.6	Enter Sand Ridge State Forest.
0.4	43.0	The road cuts through the middle of a large sand dune. Notice sand in the road cut and the prickly pear cactus, typical plants that grow on sand dunes.
0.55	43.55	T-intersection from the left (Fish Hatchery Road/2520E and Goofy Ridge Road/ 2500N). TURN LEFT.
0.9	44.45	Enter Jake Wolf Memorial Fish Hatchery parking lot.

STOP 4: LUNCH: Jake Wolf Memorial Fish Hatchery (SW, NE, Sec. 21, T23N, R7W, Duck Island 7.5-minute Quadrangle, Mason County). On the day of the field trip, follow the lead vehicle and obey ISGS staff directing traffic. We will be using the right side of the parking lot.

0.0	0.0	Leave Stop 4. Reset odometer to 0.0 and retrace the route back to the main entrance on Goofy Ridge Road.
0.9	0.9	STOP (one-way). T-intersection (Fish Hatchery Road/2520E and Goofy Ridge Road/ 2500N). TURN RIGHT.
1.2	2.1	T-intersection from the right (2400E). TURN RIGHT, heading toward Spring Lake State Fish and Wildlife Area.
1.15	3.25	Road curves to the right. At the Tazewell/Mason County line, road is marked as 2600N for Mason County. The abandoned community of Durand was located here.
0.05	3.3	T-intersection from the left (Woodley Road/1200E and Mason Road/8000N). TURN LEFT. Road begins its descent into the Illinois River valley.
0.1	3.4	Old concrete structures on the left are part of an abandoned marine railway that connected Spring Lake to the Illinois River. Possible location of ISGS field station on the left (maybe)!
0.15	3.55	Road curves 90 degrees to the right.
0.1	3.65	Cross drainage ditch for Spring Lake. After crossing the bridge, the drainage ditch is on the right.
0.75	4.4	Y-intersection. TURN RIGHT. Larry's Restaurant and Family Bar is on the left after the turn.
0.1	4.5	Cross the drainage ditch.

0.05	4.55	STOP (one-way). Intersection (State Park Road). TURN LEFT. Road to the right leads to the headquarters for Spring Lake State Fish and Wildlife Area.
0.1	4.65	Scenic Stop: Spring Lake State Fish and Wildlife Area, Spring Lake (NE, NE, NW, Sec.16, T23N, R7W, Duck Island 7.5-minute Quadrangle, Tazewell County). Park in the large parking lot on the right. Possible stop on the day of field trip if time permits. The stop provides a good view of Spring Lake and the bluffs forming the eastern edge of the Illinois River valley.
2.15	6.8	STOP (one-way). Intersection (Spring Lake Road/10400N and State Park Road/ 2800E). TURN RIGHT, crossing Spring Lake Causeway.
0.6	7.4	Road curves 90 degrees to the left, begins its ascent onto the bluffs, and then turns 90 degrees to the right.
0.2	7.6	T-intersection from the right (Tobacco Road/3300E and Spring Lake Road/10000N). CONTINUE AHEAD.
0.2	7.8	T-intersection from the right (unnamed road). Small vineyard to the right owned by Manito Winery. CONTINUE AHEAD.
0.3	8.1	T-intersection from the right (DeSutter Road/3800E and Spring Lake Road/10000N). CONTINUE AHEAD.
0.15	8.25	T-intersection from the right (Evergreen Drive/4000E). CONTINUE AHEAD.
0.25	8.5	Entrance to Spring Lake State Fish and Wildlife Area on the left.
0.3	8.8	Crossroad intersection (Fornoff Road/4500E). CONTINUE AHEAD.
0.7	9.5	T-intersection from the right (Caulkins Road/5200E). CONTINUE AHEAD.
1.4	10.9	Crossroad intersection (Spring Garden Road/6700E). CONTINUE AHEAD.
0.5	11.4	Illinois Department of Natural Resources, Manito Pheasant Habitat is on the right.
0.25	11.65	STOP (two-way). Intersection (Manito Road/7500E and Spring Lake Road/10000N). TURN LEFT. Straight ahead is the community of Parkland. The type section for the Parkland Sand (dune sand) is named after the dune deposits near Parkland.
1.05	12.7	Crossroad intersection (Townline Road/11000N). CONTINUE AHEAD.
1.0	13.7	Crossroad intersection (Airport Road/12000N). CONTINUE AHEAD.
1.05	14.75	Crossroad intersection (Sky Ranch Road/13000N). CONTINUE AHEAD. Enter the community of Talbott, population less than 225. The road starts to make a 90-degree curve to the right, immediately north of Talbott.

0.75	15.5	T-intersection from the right (Alice Calkins Road/7800E). CONTINUE AHEAD.
0.5	16.0	Manito Prairie Nature Preserve on the left. The Manito Praire Nature Preserve is owned by the Illinois Department of Natural Resources. The 19.6 acres was dedicated in December 1985. Manito Prairie is located on a sand and gravel terrace above the Illinois River floodplain. The bulk of the terrace was formed during the post-glacial period of the Wisconsin glaciation with some sand deposition occurring later. This preserve is the last remaining area in Illinois containing high-quality gravel hill prairie and sand prairie that represents the Illinois River Section of the Illinois River and Mississippi River Sand Area Natural Division. Dry-mesic forest and successional field communities also occur at the site. Over 200 species of vascular plants have been observed within the preserve. Two of the prairie species, Tennessee milk vetch and kitten-tails, are rare. Franklin's ground squirrel is one of the more unusual mammals. Current management practices include prescribed burning, brush cutting, fencing, and monitoring rare species.
0.4	16.4	T-intersection from the left (Bass Road/8500E). CONTINUE AHEAD.
0.45	16.85	T-intersection from the right (Herrman Road/9000E and Manito Road/14000N). CONTINUE AHEAD.
0.75	17.6	T-intersection from the left (Schumm Road/9075E). Entrance to Lowry sand and gravel pit on the right. TURN RIGHT.

STOP 5: R.A. Cullinan and Sons Inc. Lowry Pit (NW, NE, Sec. 23, T24N, R6W, 3rd P.M., Pekin 7.5-minute Quadrangle, Tazewell County). On the day of the field trip, follow the lead vehicle, and obey ISGS staff directing traffic.

0.0	17.6	Leave Stop 5. Exit pit and TURN RIGHT onto Manito Road/14000N.
0.3	17.9	Road curves 45 degrees to the left. Angled intersection on the right (Sap Road/10100E). Follow Manito Road.
0.45	18.35	Cross Mackinaw River. Notice that there is a levee on the west side, but not on the east side of the river, because there are two different elevations of floodplains along the Mackinaw River, the east side is slightly higher and represents an older terrace than the west side.
1.2	19.55	T-intersection from the right (Garman Road/11400E/ and Manito Road/15000N). TURN RIGHT.

0.25	19.8	Entrance to Cornick Sand and Gravel Pit on the left. TURN LEFT.

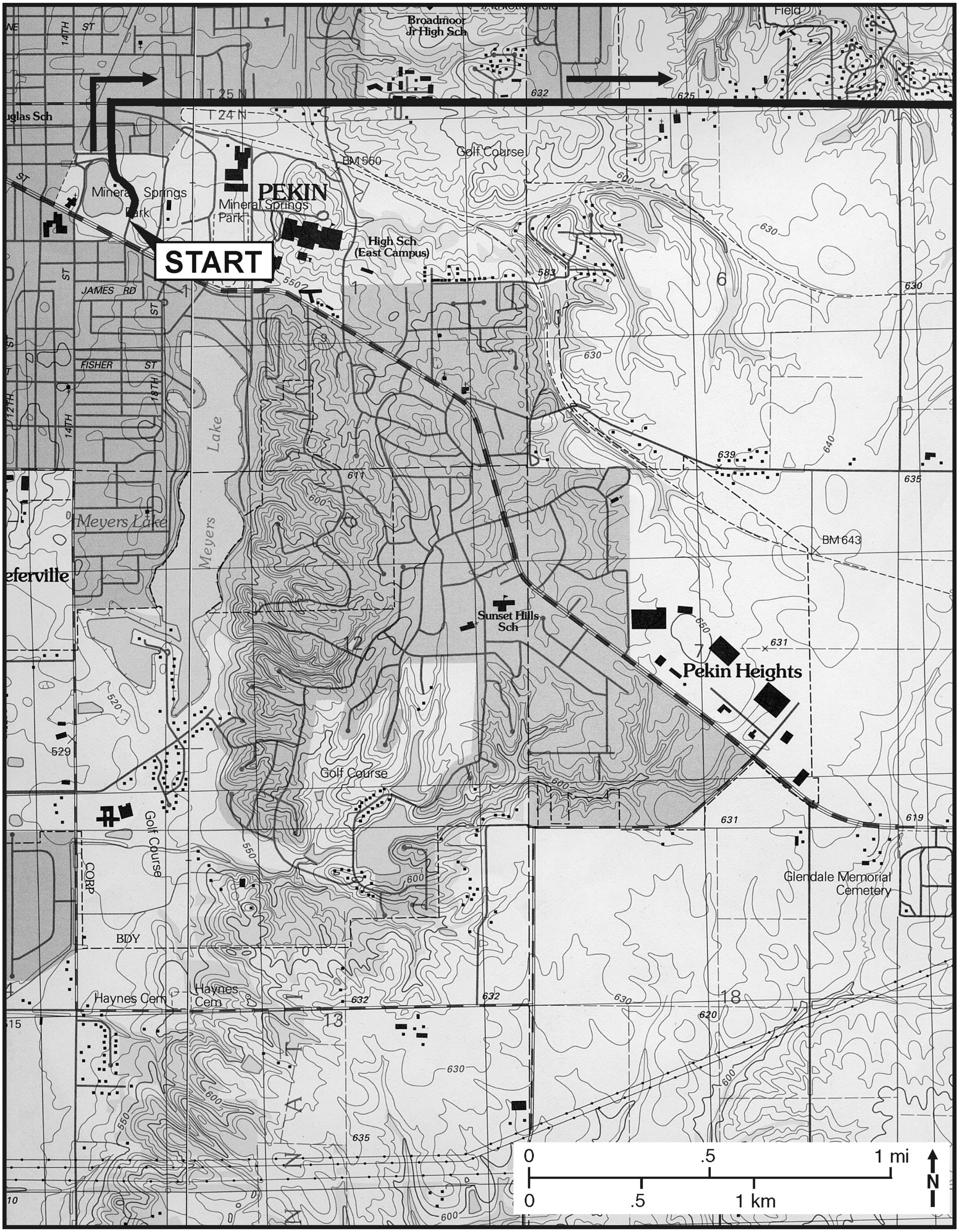
STOP 6: Cornick Sand and Gravel Pit (NE, Sec. 18, T24N, R5W, 3rd P.M., Pekin 7.5-Minute Quadrangle, Tazewell County). On the day of the field trip, follow the lead vehicle and obey ISGS staff directing traffic.

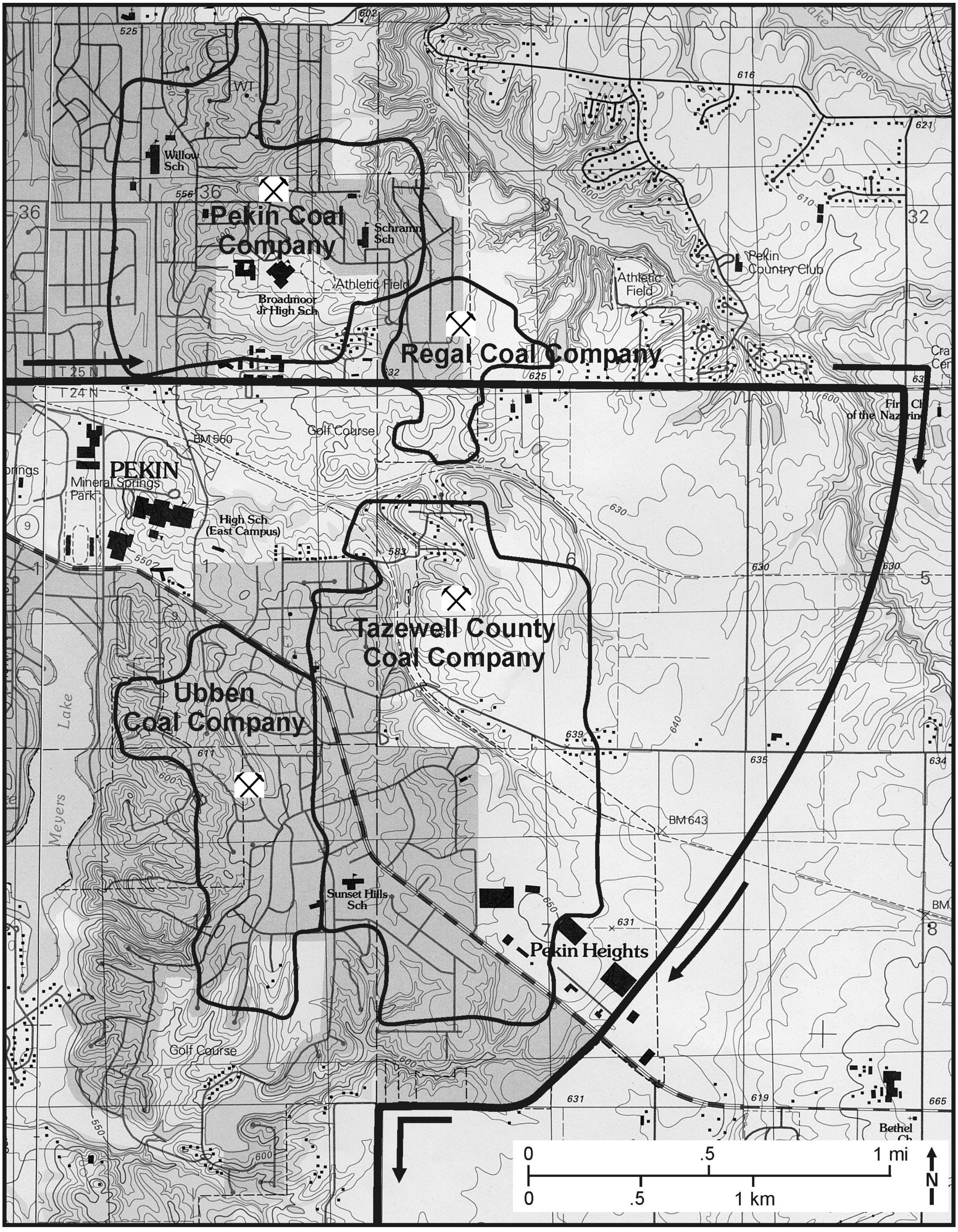
End of Field Trip. Have a Safe Journey Home!

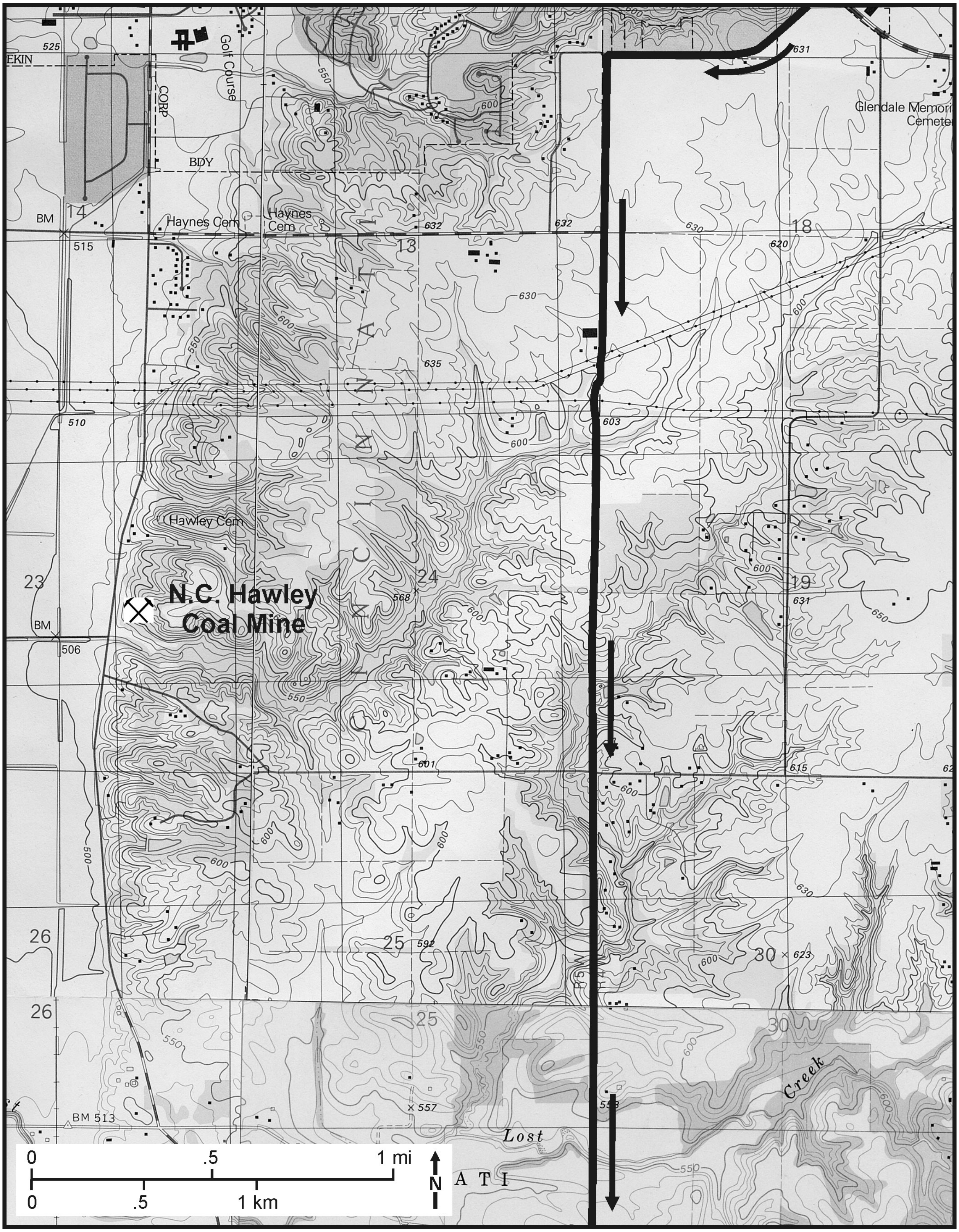
Join us this fall for another exciting and fun-filled adventure. The following road log will take you back to civilization.

Retrace the route back to Manito Road, and turn right onto Illinois Route 29. If you turn left (north) onto Illinois Route 29, you will head toward Pekin. If you turn right (south), you will head toward Green Valley.

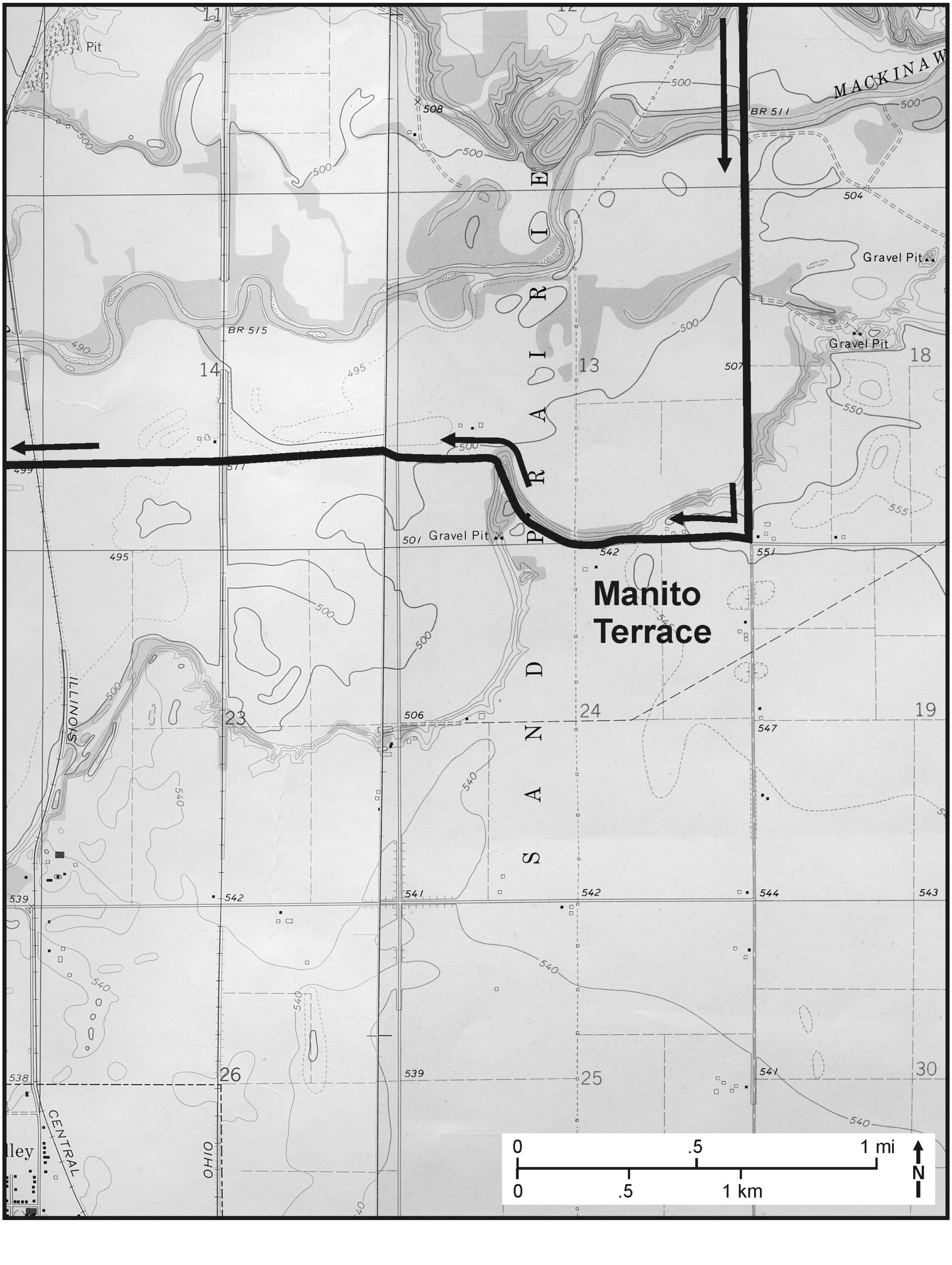
0.0	0.0	Intersection of Garman and Manito Roads. TURN RIGHT.
0.7	0.7	Cross the old channel of Mackinaw River.
1.0	1.7	Cross over railroad and Pekin Energy on the left. Pekin Energy is one of the largest producers of ethanol in the country and the main supplier of ethanol to BP Amoco.
0.6	2.3	Pass under railroad through the narrow viaduct.
0.1	2.4	STOP LIGHT. Intersection of Manito Road and Illinois Route 29. Directly across from the stop light is the Pekin Federal Correctional Institution, U.S. Department of Justice, Federal Bureau of Prisons.

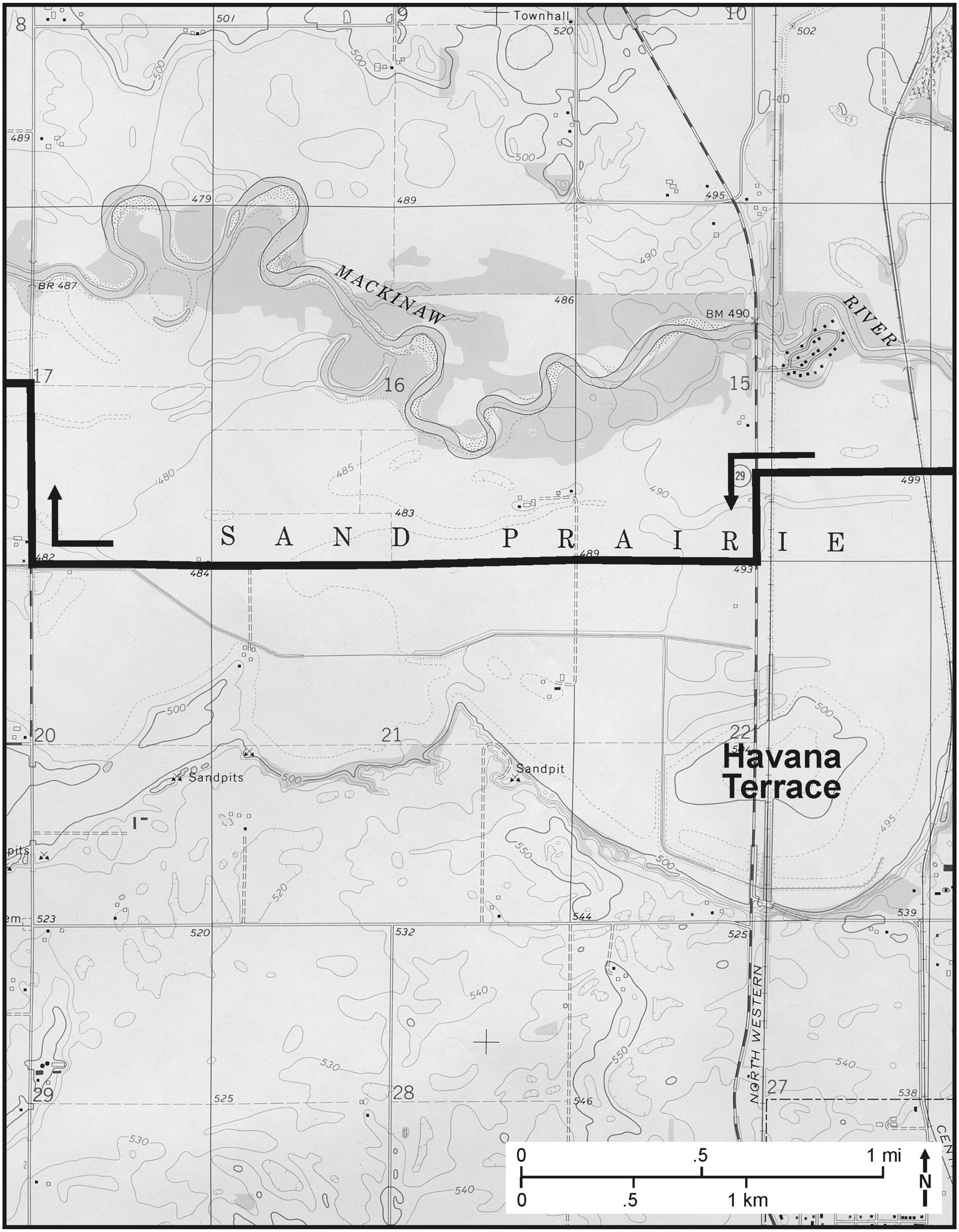

START
PEKIN
Mineral Springs Park
High Sch (East Campus)
Broadmoor Jr High Sch
Golf Course
T 25 N
T 24 N
BM 550
JAMES RD
FISHER ST
Meyers Lake
Sunset Hills Sch
Pekin Heights
BM 643
Glendale Memorial Cemetery
Haynes Cem
CORP
BDY
0 .5 1 mi
0 .5 1 km
N

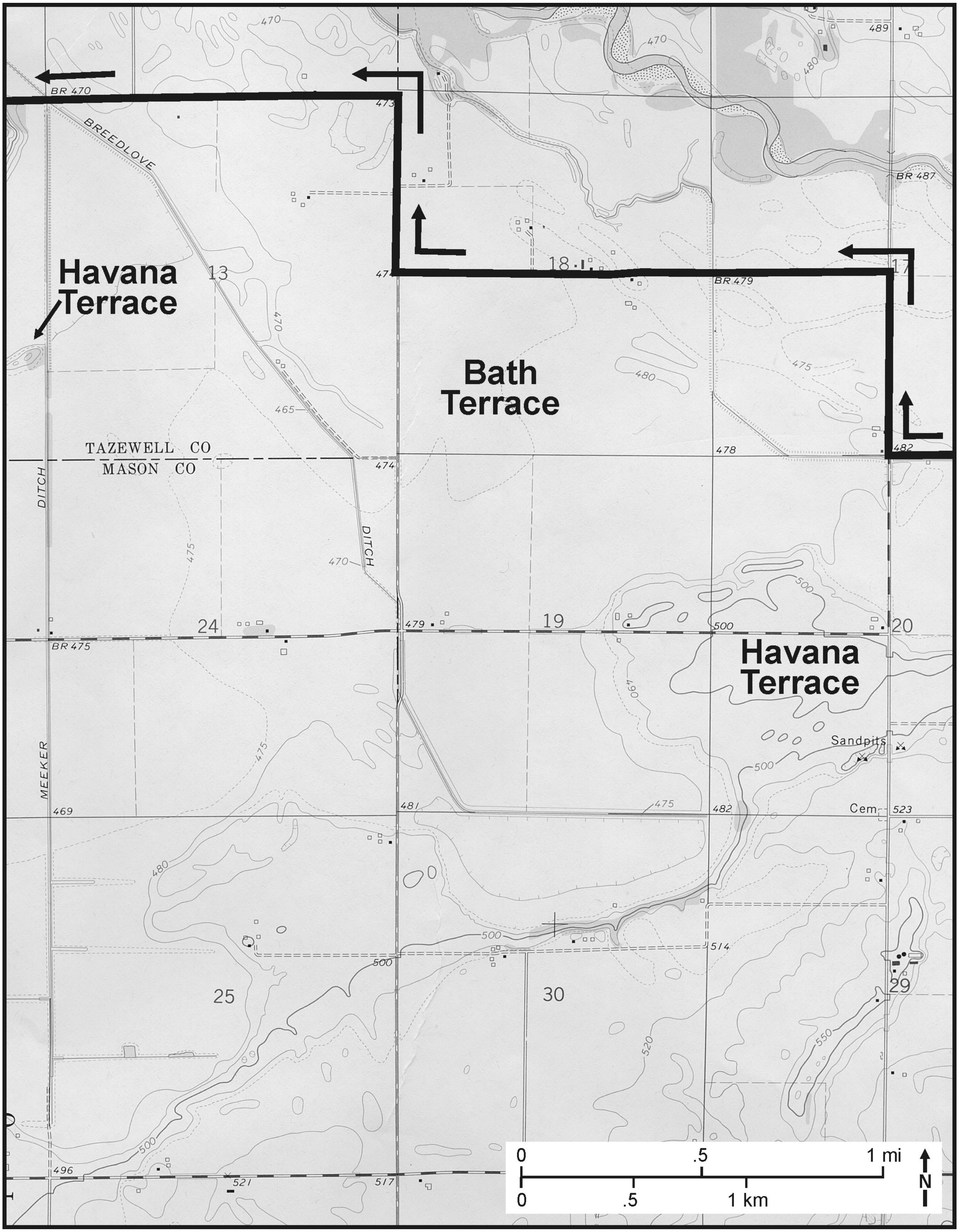

Pekin Coal Company
Regal Coal Company
Tazewell County Coal Company
Ubben Coal Company
Willow Sch
Schramm Sch
Broadmoor Jr High Sch
Athletic Field
Pekin Country Club
PEKIN
Mineral Springs Park
High Sch (East Campus)
Golf Course
Sunset Hills Sch
Pekin Heights
Meyers Lake
BM 550
BM 643
T 25 N
T 24 N
0
.5
1 mi
1 km
N

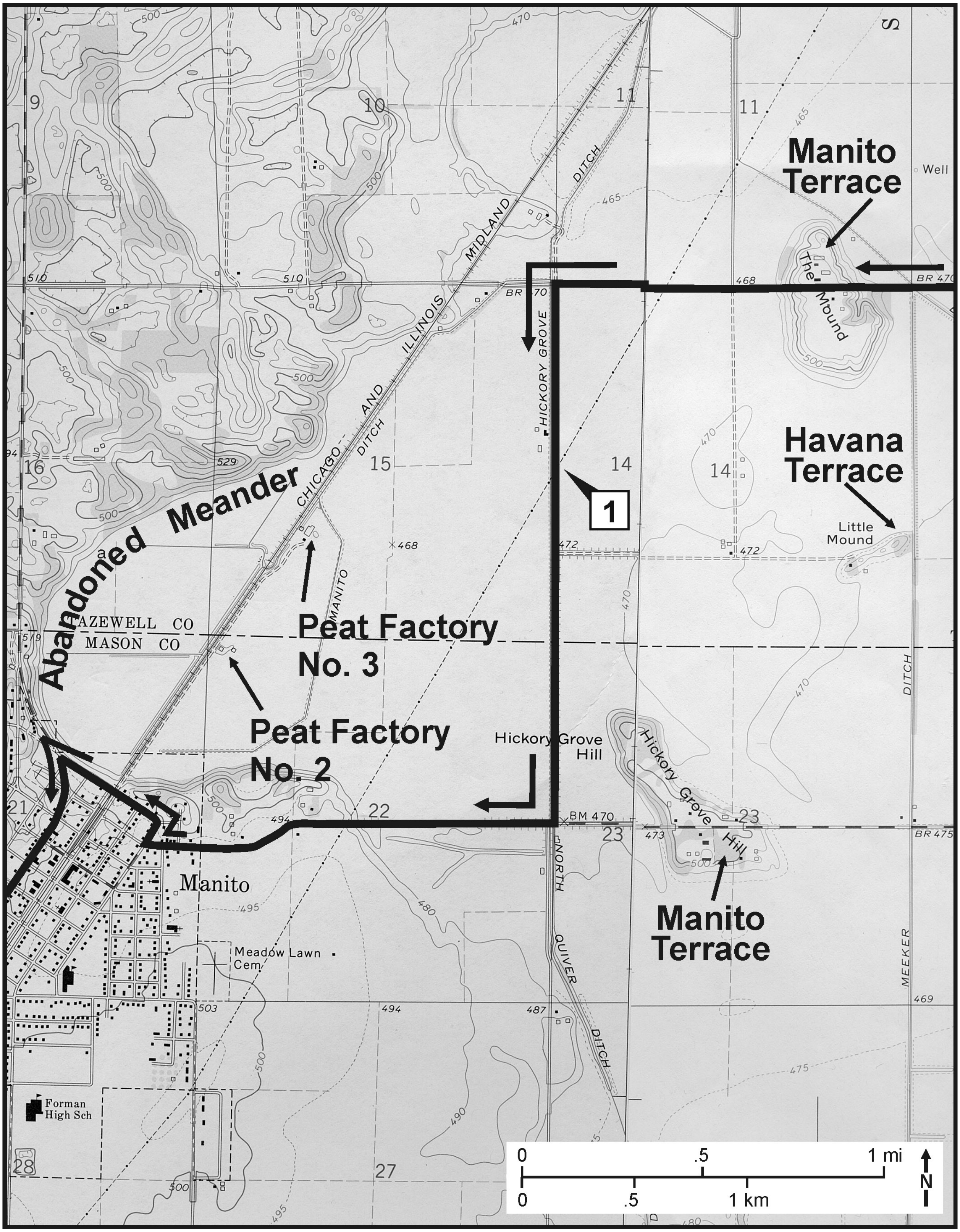

N.C. Hawley
Coal Mine
Hawley Cem
Haynes Cem
Haynes Cem
Golf Course
CORP
BDY
Glendale Memori
Cemeter
BM
515
BM
506
510
525
632
632
630
620
635
603
600
631
615
601
592
623
557
550
500
14
13
18
23
24
19
25
26
26
25
30
30
BM 513
Lost
Creek
0
.5
1 mi
0
.5
1 km
N

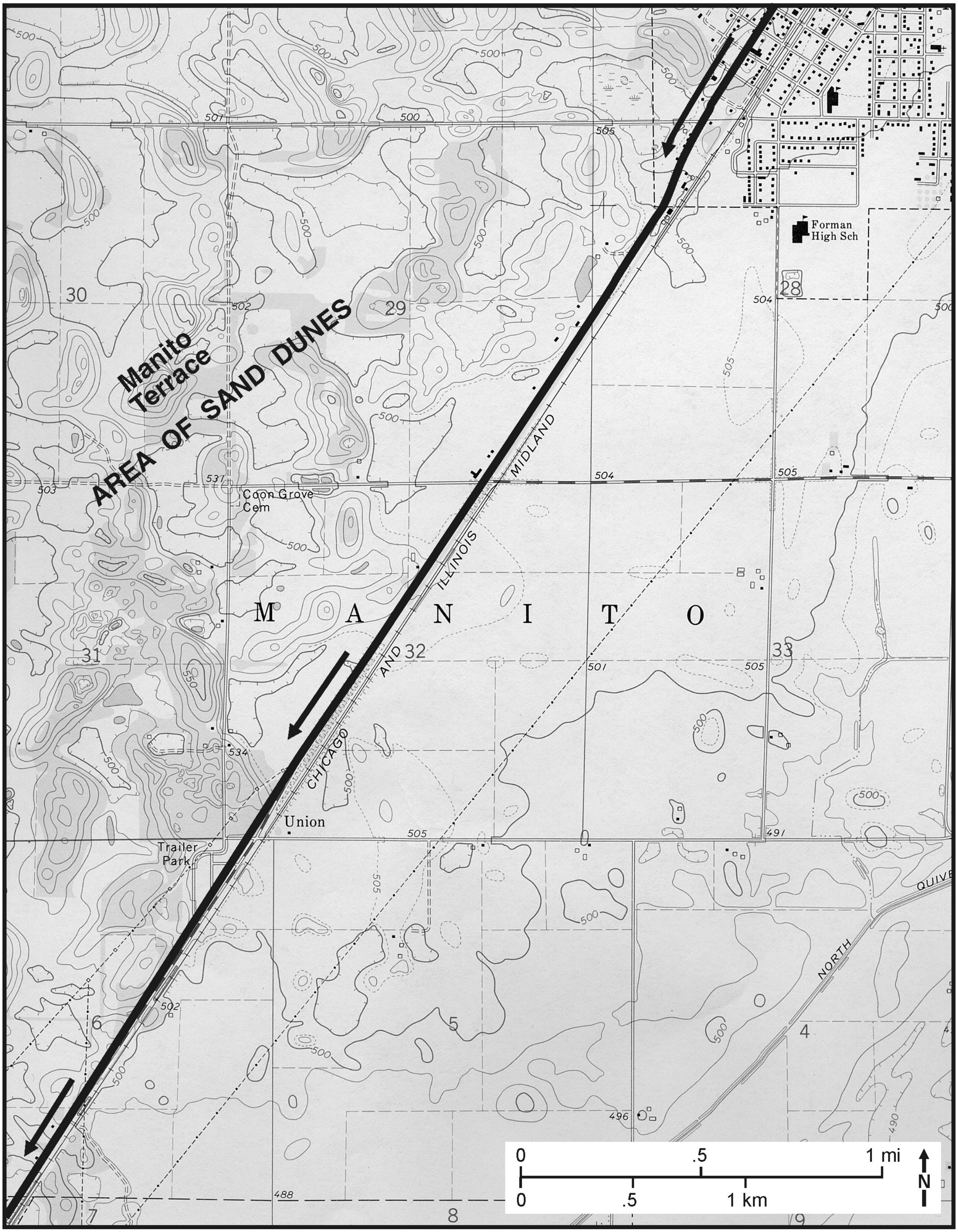
BM 513
557
Lost
Creek
CINCINNATI
533
Woodrow
Cem
520
550
35
36
576
31
650
600
510
OHIO
AND
MOBILE
GULF
531
530
548
560
590
627
580
1
2
6
603
570
568
BM 533
600
571
607
587
567
11
12
7
552
MACKINAW
500
BR 511
508
504
Gravel Pit
0
.5
1 mi
0
.5
1 km
N

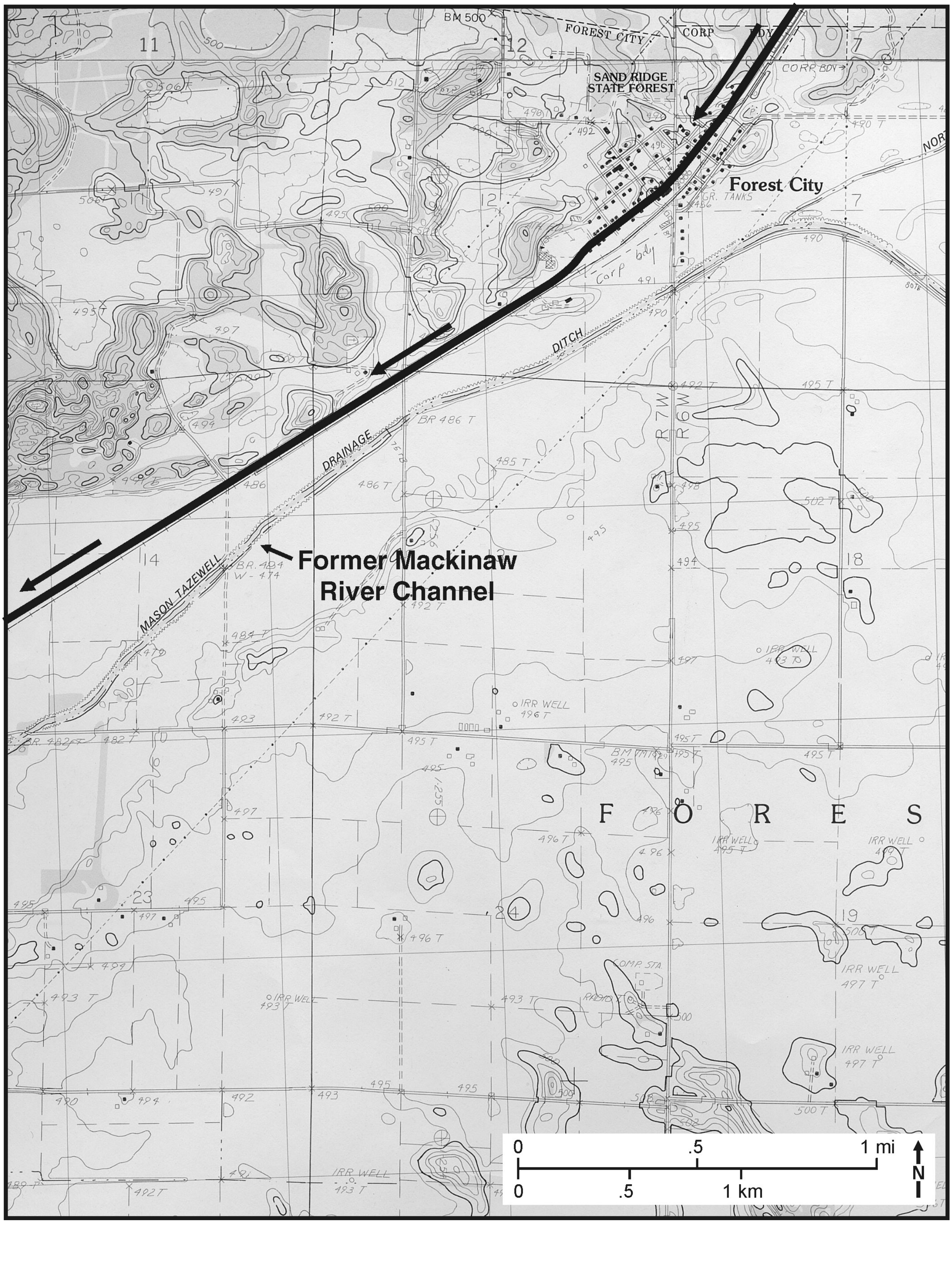

Manito
Terrace
S A N D P R A I R I E
MACKINAW
Gravel Pit
Pit
BR 511
BR 515
ILLINOIS
CENTRAL
OHIO
0 .5 1 mi
0 .5 1 km
N

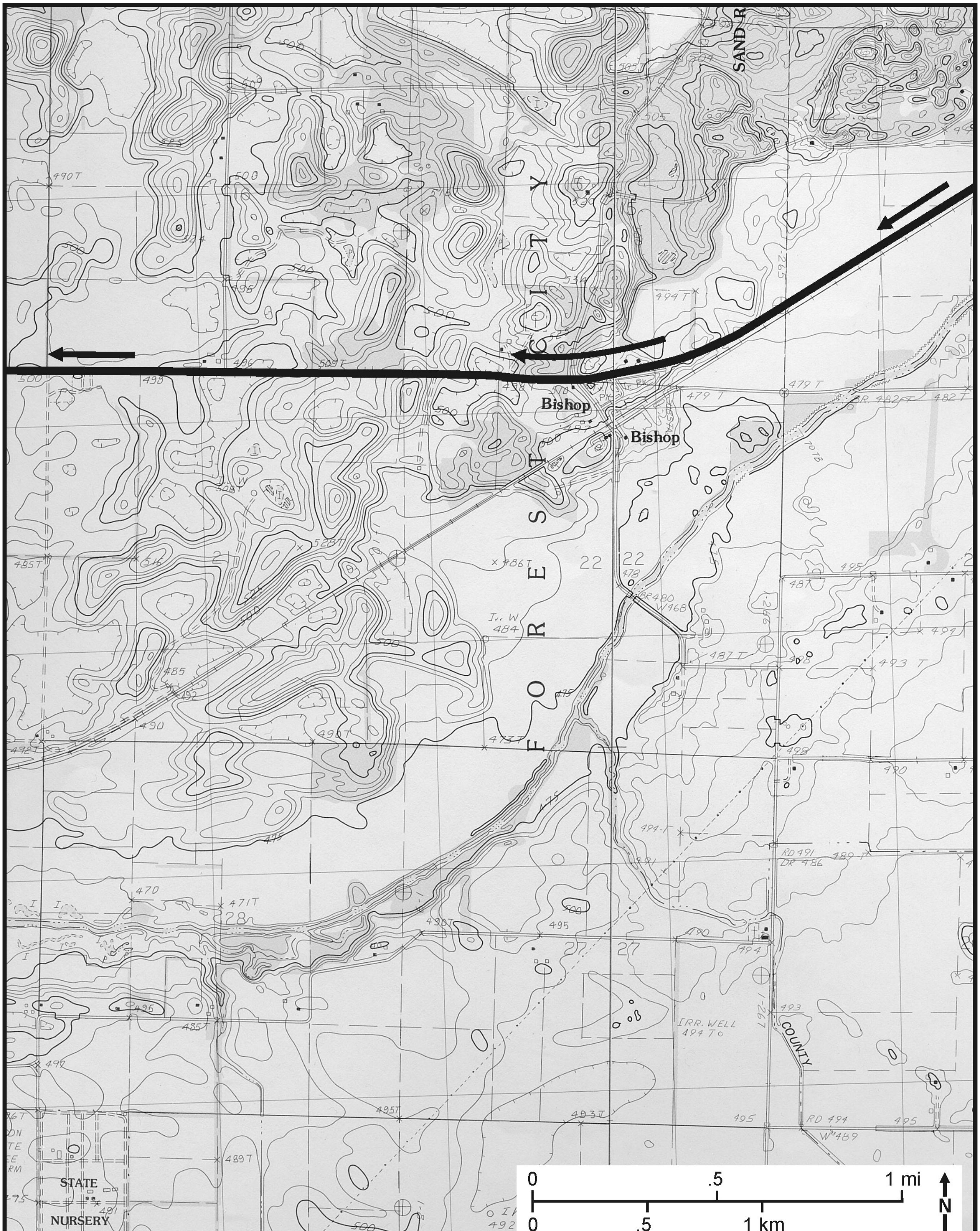

Townhall
MACKINAW
RIVER
BM 490
SAND PRAIRIE
Sandpits
Sandpit
Havana
Terrace
NORTH WESTERN
0
.5
1 mi
0
.5
1 km
N

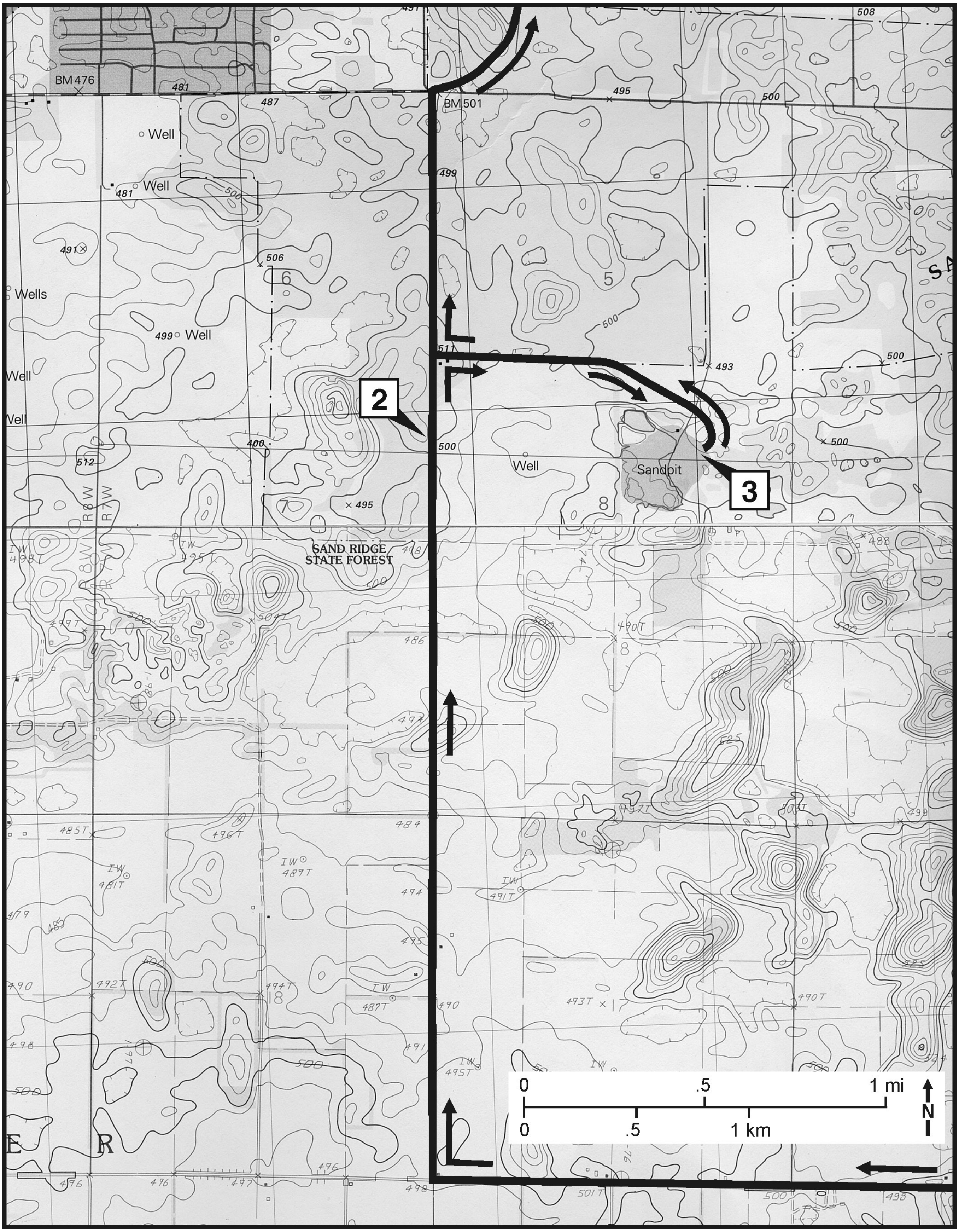

Havana
Terrace
Bath
Terrace
Havana
Terrace
BR 470
BREEDLOVE
TAZEWELL CO
MASON CO
DITCH
DITCH
MEEKER
BR 479
BR 487
BR 475
Sandpits
Cem
13
18
17
24
19
20
25
30
29
0
.5
1 mi
0
.5
1 km
N

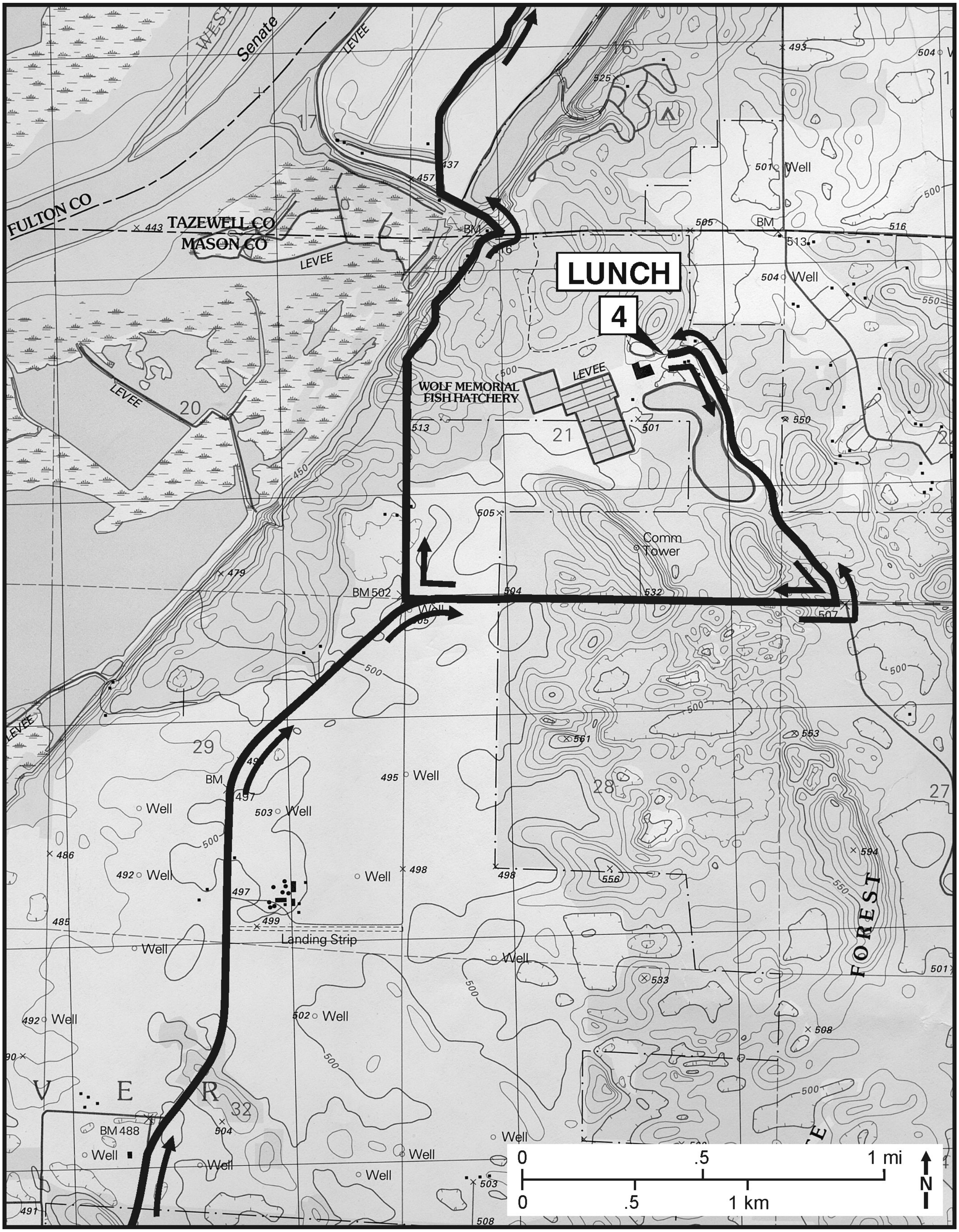

Manito Terrace
Havana Terrace
Little Mound
The Mound
Well
Abandoned Meander
Peat Factory No. 3
Peat Factory No. 2
Hickory Grove Hill
Hickory Grove Hill
Manito Terrace
1
CHICAGO AND ILLINOIS MIDLAND
MIDLAND DITCH
HICKORY GROVE
MANITO DITCH
NORTH QUIVER DITCH
MEEKER DITCH
TAZEWELL CO
MASON CO
Manito
Meadow Lawn Cem
Forman High Sch
BR 470
BM 470
BR 475
0 .5 1 mi
0 .5 1 km
N

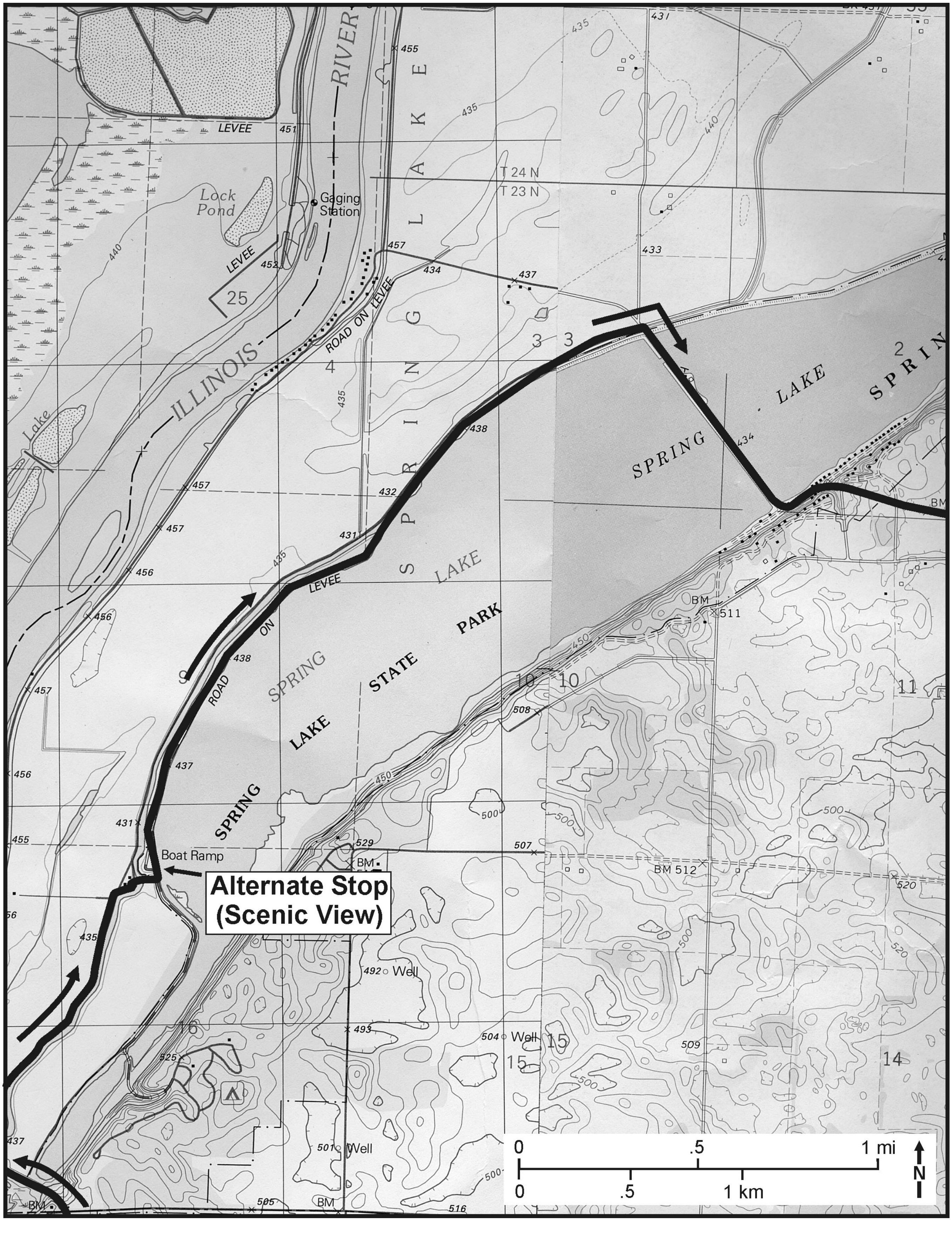

Manito Terrace
AREA OF SAND DUNES
M A N I T O
Forman High Sch
Coon Grove Cem
Union
Trailer Park
CHICAGO AND ILLINOIS MIDLAND
NORTH QUIVE
0 .5 1 mi
0 .5 1 km
N

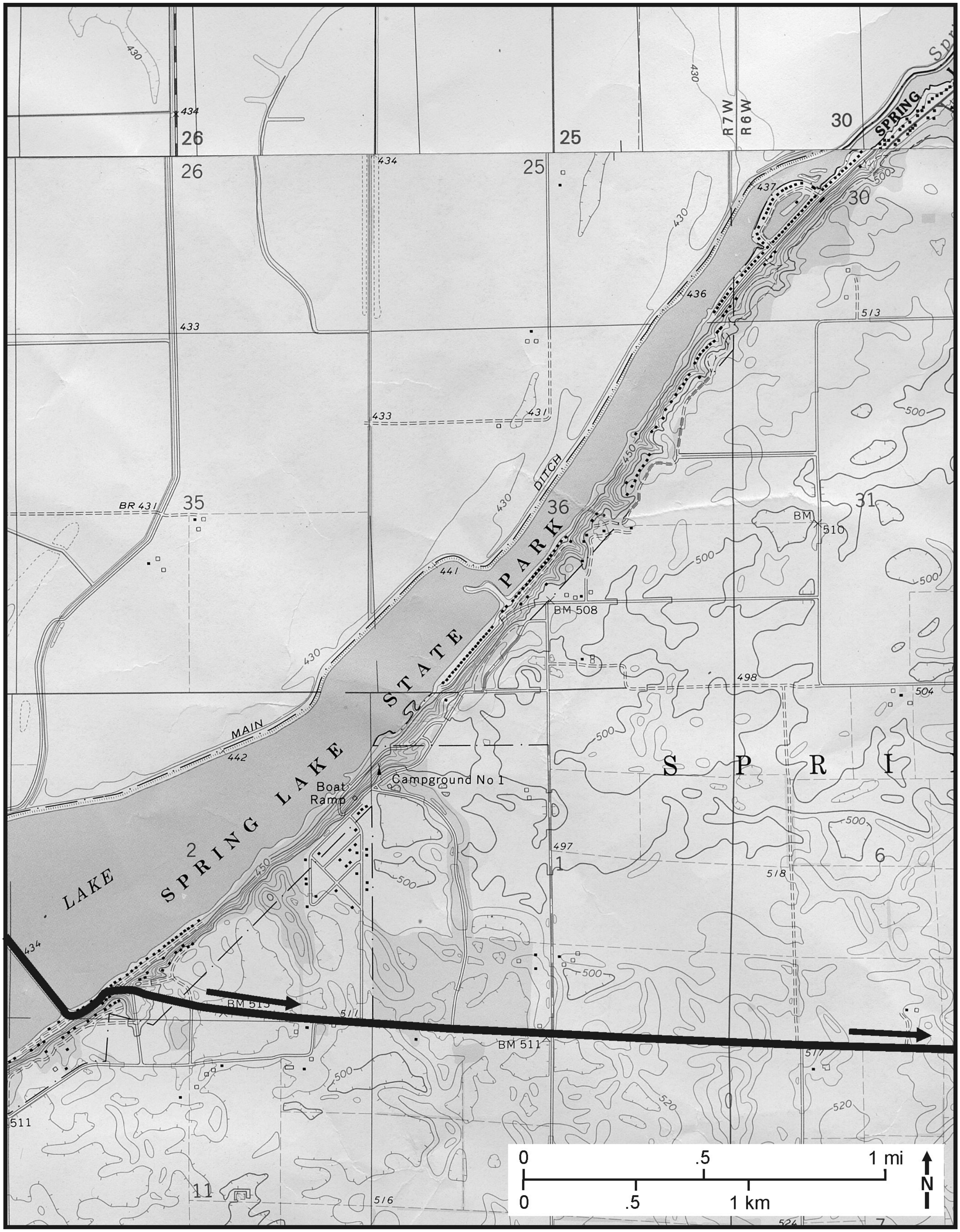

Forest City
SAND RIDGE
STATE FOREST
Former Mackinaw
River Channel
MASON TAZEWELL
DRAINAGE
DITCH
FOREST CITY
CORP
F O R E S
0
.5
1 mi
0
.5
1 km
N

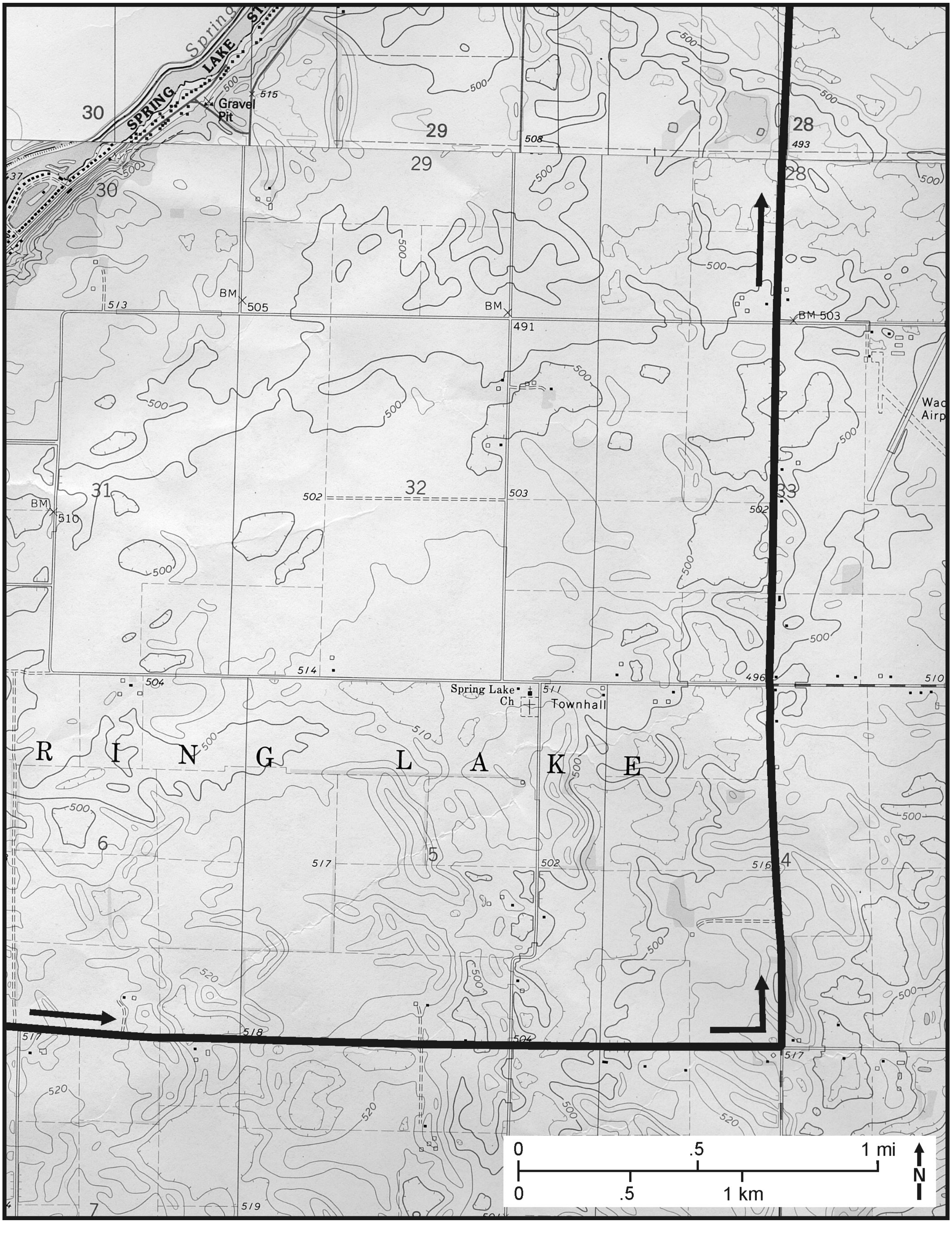

Bishop
Bishop
STATE
NURSERY
COUNTY
0
.5
1 mi
0
.5
1 km
N


BM 476
481
487
BM 501
495
500
508
Well
481
Well
491
506
6
5
Wells
499
Well
Well
Well
511
493
2
500
400
500
Well
Sandpit
3
512
R8W
R7W
495
8
7
SAND RIDGE
STATE FOREST
0
.5
1 mi
0
.5
1 km
N
E
R


LUNCH
4
WOLF MEMORIAL FISH HATCHERY
TAZEWELL CO
MASON CO
FULTON CO
Senate
LEVEE
Comm Tower
Landing Strip
FOREST
Well
0 .5 1 mi
0 .5 1 km
N

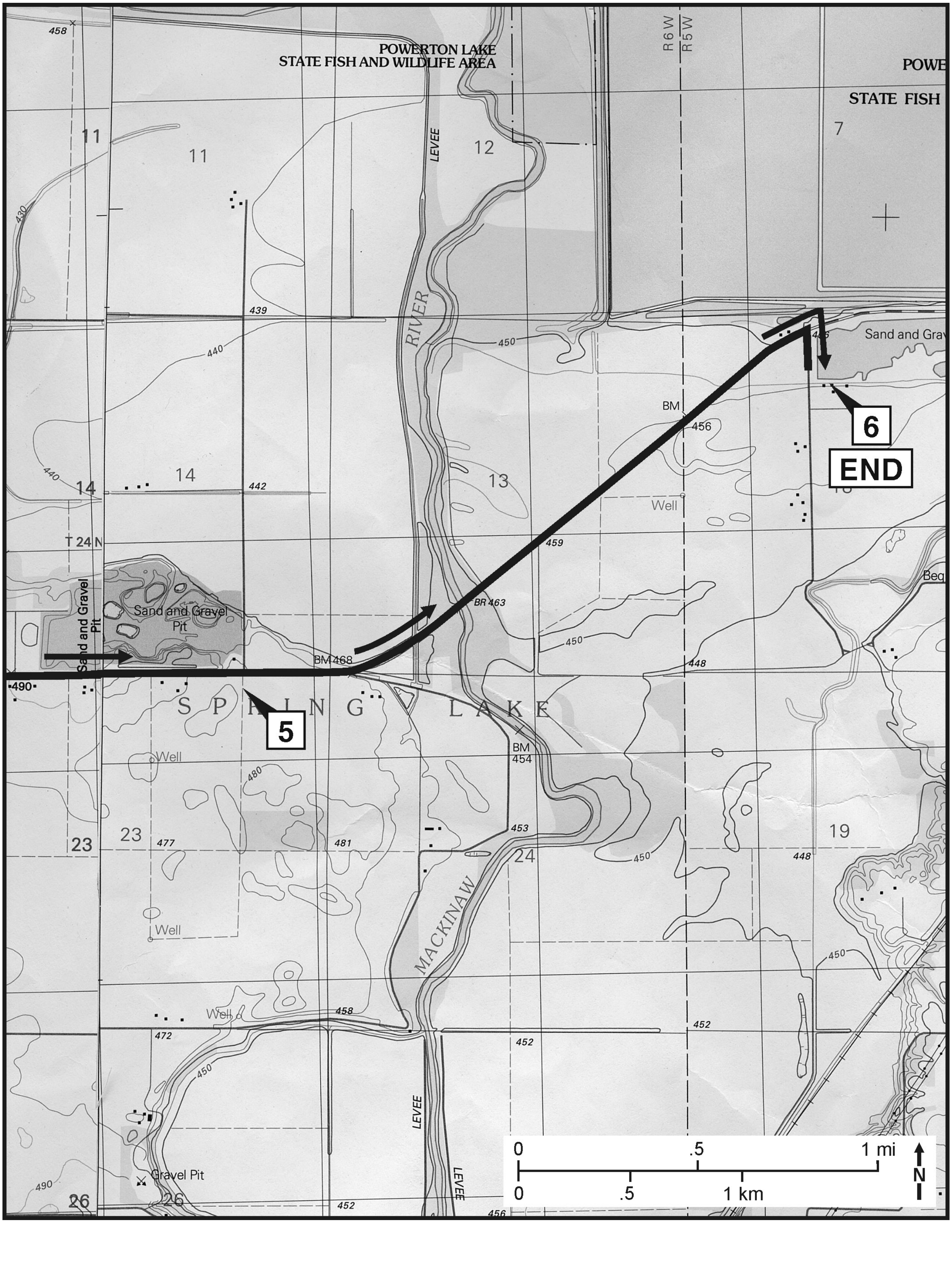

Alternate Stop
(Scenic View)
Boat Ramp
ILLINOIS
RIVER
LEVEE
Lock
Pond
Gaging
Station
ROAD ON LEVEE
SPRING LAKE
SPRING LAKE STATE PARK
T 24 N
T 23 N
Well
BM
0
.5
1 mi
0
.5
1 km
N


SPRING LAKE STATE PARK
SPRING LAKE
LAKE
SPRING
DITCH
MAIN
Boat Ramp
Campground No 1
BM 508
BM 510
BM 513
BM 511
R7W
R6W
S P R I
0 .5 1 mi
0 .5 1 km
N



SPRING LAKE
Gravel Pit
Spring Lake Ch
Townhall
R I N G L A K E
BM 505
BM 491
BM 503
BM 510
0 .5 1 mi
0 .5 1 km
N


LEVEE
DITCH
Gravel Pit
Sand and Gravel Pit
Sand and Pit
Talbott
Spring Lake Sch
BM 486
BM
T 24 N
Well
0 .5 1 mi
0 .5 1 km
N



POWERTON LAKE
STATE FISH AND WILDLIFE AREA
POWE
STATE FISH
R 6 W
R 5 W
LEVEE
RIVER
MACKINAW
SPRING LAKE
T 24 N
Sand and Gravel Pit
Sand and Gravel Pit
Sand and Grav
Gravel Pit
Well
BM 468
BR 463
BM 456
BM 454
5
6
END
0
.5
1 mi
1 km
N

STOP DESCRIPTIONS

STOP 1: Mackinaw River Valley—Terraces, Meanders, and Buried Valleys (NE, NE, SE, Sec.15, T23N, R6W, Manito 7.5-minute Quadrangle, Tazewell County).

To the right (west), at the base of the bluff, is a large meander scar of the Ancient Mackinaw River. The surficial material filling and along the abandoned meander belongs to the Grayslake Peat. The large brick structure in the distance, located just south of the Tazewell/Mason County line, is the abandoned Weidmar Chemical Company peat and fertilizer processing plant. To the left (east) is a good view of The Mound, a Manito Terrace (fig.16), Little Mound, a Havana Terrace, and Hickory Grove Hill, a Manito Terrace. The road is on the Bath Terrace (see route map).

Terrace Development

Glacial outwash flood deposits (called valley train deposits) formed an alluvial fan extending from Peoria to Beardstown and from the Illinois River eastward to the front of the Shelbyville Moraine. These alluvial fan deposits are classified as the Wisconsin age Henry Formation and are described as sands and gravels that were transported by meltwater. These flood deposits are collectively known as the Kankakee Torrents (see Introduction for a description).

There are three distinct terraces within the Mackinaw Valley: the Manito Terrace, the Havana Terrace, and the Bath Terrace. These terraces are defined mainly on the basis of elevation and, secondarily, by the type of sediments within or the presence of loess or sand deposits on the top of the terrace. In general, the terraces have been mapped by some investigators as either high or low terraces.

High terraces (Manito and Havana Terraces) consist largely of medium- and coarse-grained sand

Figure 16 View of The Mound (elevation 520 feet), a Manito Terrace within the Mackinaw Valley (photo by R.J. Jacobson).

and pebbly sand, overlain by fine- to medium-grained dune sand. Low terrace (Bath and Beardstown Terraces) remnants are largely pebbly sand, but in places they contain fine sandy gravel and are generally coarser than the high terraces. Coarser gravel occurs in the low terraces near Pekin. The low terraces overlie older, sandier deposits in some areas (Willman 1973).

The sediments that make up the terraces are formed from alluvial fans deposited by different flooding events of the Kankakee Torrents. The maximum thickness of the individual terraces is about 100 feet, thinning to the east toward the uplands (Shelbyville Moraine), but generally 40 to 50 feet thick (Hunter 1966).

The Manito Terrace (elevation 500 to 520 feet) was formed by the Mackinaw River cutting through deposits from an early event in the Kankakee Torrents. The Havana Terrace (elevation 475 to 495 feet) was formed by the Mackinaw River cutting through deposits from a late event in the Kankakee Torrents. The Bath Terrace (elevation 460 to 470 feet) was formed by the Mackinaw River cutting through deposits from the Lake Chicago flood (a later flood, but still considered a part of the Kankakee Torrents (Wanless 1957, Hunter 1966, Willman 1973).

As the Mackinaw River meandered back and forth across the alluvial fan deposits, it continually cut deeper into the sediments. This process of meandering and downcutting creates natural floodplains parallel to the present course of the river. At different times, certain floodplains within the Mackinaw River valley were preserved as the Mackinaw River continued downcutting through the sediments. As new floodplains were formed at lower elevations in response to increased downcutting, the older floodplains became abandoned. Geologists call these abandoned floodplains terraces (fig. 17). The study of these terraces helps recreate the history of the formation of the Mackinaw Valley.

The basal or lower deposits within the Mackinaw Valley consist of a combination of outwash sands and gravels from the Shelbyville, LeRoy, and Bloomington Moraines located to the east and sands and gravels from the Kankakee Torrents that flowed along the path of the present Illinois River valley. The upper Manito Terrace deposits are overlain by finer-grained sediments consisting of windblown sands that form the sand dunes and the finer-grained silts and clays that make up the loess deposits. Further to the west, as you will see later on today, the top of the Manito Terrace is covered with sand dunes "as thick as ticks on a hound dog."

Grayslake Peat

The Grayslake Peat deposits are geologically classified as Pleistocene to Holocene in age. Recent radiocarbon dating from this site by the ISGS radiocarbon lab is 4,100 ± 70 years BP, which classifies the peat as Holocene in age. The Grayslake Peat is described as peat, muck, and marl. These dominantly organic deposits are interbedded with silt and clay in some places. These deposits are mostly found in glacial lake basins and on floodplains of major rivers (Willman and Frey 1970). The Grayslake Peat deposits began to form during the Woodfordian time (Pleistocene) and have continued to accumulate plant remains to the present in areas that have not been drained (Willman 1973). The Grayslake Peat deposits within the Manito area occur in abandoned stream channels (meanders) within an abandoned valley cut by the Mackinaw River. The Mackinaw River used to flow to the southwest where it joined the Illinois River south of Buzzville.

A review of the literature found only small bits and pieces of information on the peat deposits and historical mining operations for the peat deposits at Manito.

The Weidmer Chemical Company began to mine the peat deposit near Manito in 1905, and mining continued until 1954 by the Weidmer Chemical Company. The peat was used as a stock for the manufacturing of fertilizer, was sold as a packing material to protect merchandise during shipping, and was used for horticultural purposes. The peat was used as packing material for plants, fruit, vegetables, eggs, fish bait, and fragile materials (Hester and Lamar 1969). The remains of the Weidmer Chemical processing plant is a large red brick structure located at the center of SW, Sec.15,

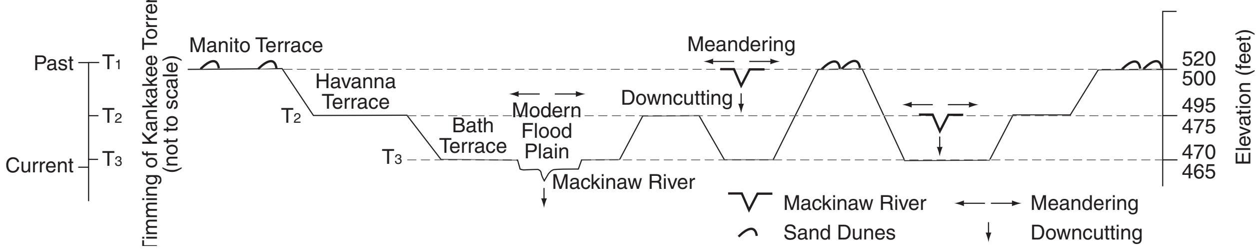


Figure 17 Diagrammatic cross section of terrace (T) developments within the Modern Mackinaw Valley, illustrating the meandering and downcutting of the Mackinaw River through alluvial fans deposited by different events of the Kankakee Torrents.

T23N, R6W. Early peat digging operations were situated a short distance northeast of Manito, but the last production was in the NE, SE, Sec. 26, and NW, SW, Sec. 25, T23N, R6W. Locally the peat operation was known as the "dirt factory." These peat deposits may have also been operated under the name Springfield Filler and Fertilizer Company (personal communication, H. Daniel Willet).

There were three different factories built for processing the peat at Manito. The first factory was located on the top of the bluffs on the south side of the deposit. The second factory was located in the northwest corner of Sec. 21, toward the middle of the field near where a white barn stands today. The third factory is in the large red brick buildings near the north end of the field. The third factory was equipped with four kilns to dry the peat. The remains of the kilns are within the large red brick building. The first two factories were destroyed by fire (personal communication, H. Daniel Willet).

A small-scale railroad (reported to be called the Dinky Railroad, personal communication, H. Daniel Willet) ran from the northwest to the southeast. This railroad is shown on the 1942 Manito and 1942 Delavan 15-minute Quadrangles. This small railroad spur ran from the third factory (the large red brick buildings) toward the southwest to another abandoned meander, located in Sec. 25 and 26 of T23N, R6W (fig. 18). This railroad crossed the current intersection of Dinkey Ditch Road and Hickory Grove Road. These two abandoned meanders are located on the west and east sides of the old Mackinaw River valley.

The following information was obtained from several resources with only slight modifications in order to maintain the historical context of these earlier reports. From Soper and Osborn (1922) came this description:

> A large peat deposit occupies an abandoned meander in parts of Sec. 15, 16, 21, and 22 in T23N, R6W. The eastern part of the deposit (east of the railroad) is 120 acres in area, averages 5 feet in thickness, and has a potential yield approximately 120,00 short tons of air-dried peat. The upper layers consist of the remains of grasses and milkweed. The peat was described as largely black and plastic. The lower layers are so thoroughly decomposed that plant remains are difficult to identify. Five test holes were bored into the peat, and the thickness ranged between 3 and 9 feet (exact location of the holes was not given). Combining the descriptions of the five test holes, the deposit is characterized as brown, fibrous peat in the upper layers to black plastic peat at the bottom underlain by sand. Although this deposit cannot be recommended as a source of fuel, the peat is especially suitable for direct use as a fertilizer or for a nitrogenous ingredient of commercial fertilizers. The western part of the deposit (west of the railroad) is about 240 acres in area and 3 feet in average thickness and contains the equivalent of about 144,000 short tons of air-dried muck. The living vegetation is similar to that in the eastern part, and the muck is black and plastic and is underlain by clay and sand. Three test borings were done (exact location of holes was not given) and, according to analysis, the muck seems to be well adapted for use as a nitrogenous fertilizer.

The following description is from Hester and Lamar (1967):

Location: NE, SE, NE, Sec. 21, T23N, R6W.

Soil, black (humus)	1.5 feet
Peat, medium-brown, coarse-textured, fibrous, with much material probably derived from wood	3 feet
Silt, gray-brown, rich in organic matter at top, many small mollusk shells or pieces	2 feet

The following descriptions are summarized from ISGS field notes (a combination of personal interviews with residents and field observations) dated 1931.

> The field notes reported the existence of Manito Chemical Company (most likely the Weidmer Chemical Company). The factory was built by William E. Hill. The peat deposit was reported to be 4 to 7 feet thick and over 6,000 to 7,000 acres located northeast of Manito. The peat was used as a base for fertilizer because of its high nitrogen content. It was used by Armour and Swift to combine with animal refuse for fertilizer and for greenhouses, etc.; the peat addition keeps soil from caking. Peat locally is very marly and contains abundant gastropods. Peat description: the wood looks coniferous, stumps etc. look like cedar, white, red, or tamarack-brown woody peat with abundant tree remains.

The following description is from 1931 ISGS field notes.

Location: SW, Sec. 15, T23N, R6W.

Peat	6 to 8 feet
Clay, blue sticky "gumbo," sometimes some sand above it	0 to 3 feet
Sand "quick," quite fine, whitish green, non-calcareous	1 to 1.6 feet
Gravel	16 to 18 feet

From *The Story of the Soil* (Hopkins 1910):

> A favorite filler is dried peat, which is taken from some of the peat bogs, as at Manito, Illinois, and shipped in train loads to the fertilizer factories. The peat is not considered worth hauling onto the land in Illinois, even where the farmers can get it for nothing; but it contains some organic nitrogen, and, by the addition of a little potassium salt, the agent is enabled to call the product a "complete" fertilizer.

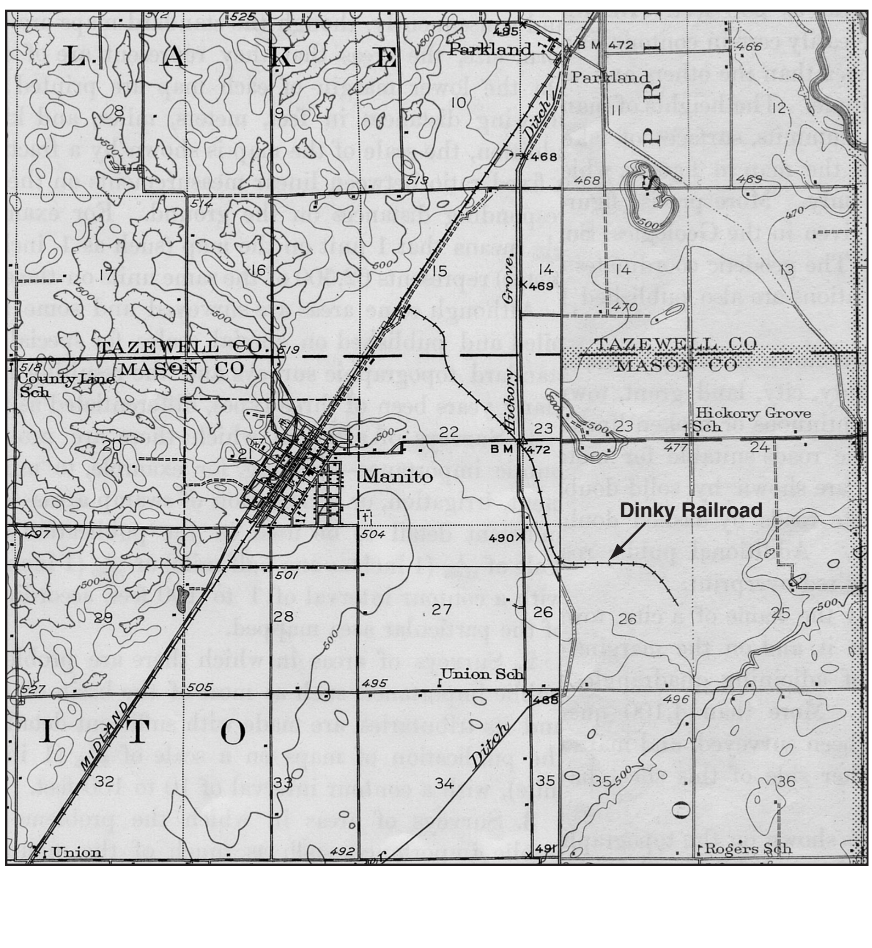


Figure 18 Location of the Dinky railroad connecting the Grayslake Peat deposits within two abandoned meanders, along the east and west sides of an abandoned course of the Mackinaw River (from the 1942 U.S. Geological Survey Manito and 1942 Delavan 15-minute Quadrangles).

The Grayslake Peat is the geological name assigned to this deposit, which is different from the name used by soil scientists. The soil classification name for these deposits is the Palms Muck and Hougton Muck, both containing over 70% organic matter (Soil Survey of Mason County 1995 and the Soil Survey of Tazewell County 1996). The soil survey defines muck as dark-colored, finely divided, well-decomposed soil material. A total of 1,836 acres containing the Palms Muck and Hougton Muck soils, as calculated from the soil surveys for Mason and Tazewell Counties. The historical accounts of 6,000 to 7,000 acres of peat in the Manito area are suspect. However, the draining of the area and subsequent exposure to air, coupled with cultivation of the peat deposits for more than 50 years, may have led to the alteration of some of the peat deposits by microbial decomposition of plant material, especially at or near the surface above the level of the groundwater table.

Peat Formation

Normally, when plants die, their remains are quickly consumed by organisms and decomposed by microbial activity. In wetlands, however, organic matter can accumulate faster than it can be broken down, especially by oxygen-dependent organisms and processes. The remains of roots, stems, and leaves from the vegetation that was growing during peat formation are often visible when peat is examined.

Two key factors, water and nutrient availability, determine the type of plants that are found in wetlands and the type of peat formed. Peat deposits form in upland areas where rainfall controls peat growth and in lowland areas where surface drainage and groundwater are more important, as with the peat deposits near Manito. Peat-forming wetlands that are dependent on rainfall are often nutrient-poor (ombrotrophic), whereas drainage-dependent (rheotrophic) wetlands receive nutrients from both flooding events and rainfall. Peat also can form in coastal salt marshes. In all cases, peat-forming wetlands have a self-sustaining and significant effect on local drainage patterns.

Ancient Bedrock Valleys

At Stop 1, you are standing approximately 115 feet above the junction of the buried bedrock valleys of the Ancestral Mississippi River and the Ancient Mahomet and Mackinaw Rivers. The Mahomet-Sankoty Sands occur in the deepest part of the Mahomet and Mackinaw Bedrock Valleys. These basal sands are up to 100 feet thick and form the most important aquifer within Central Illinois. (See the Introduction for a discussion on the formation of these ancient bedrock valleys.)

Irrigation

All along the route to Stop 1, you passed by several irrigation systems scattered throughout the Mackinaw Valley. These center-pivot irrigation systems are an important part of the agriculture economy of this area.

Irrigation is the controlled application of water for agricultural purposes through man-made systems to supply water requirements not satisfied by rainfall. Crop irrigation is vital throughout the world in order to provide its ever-growing populations with enough food.

Many different irrigation methods are used worldwide. The center-pivot automated sprinkler system of irrigation is achieved by automatically rotating the sprinkler pipe or boom, supplying water to the sprinkler heads or nozzles in a radial pattern from the center of the field to be irrigated. Water is delivered to the center or pivot point of the system (water from wells completed into the Mahomet-Sankoty aquifer in this area). The pipe is supported above the crop by towers at fixed spacings and propelled by pneumatic, mechanical, hydraulic, or electric power on wheels or skids in fixed circular paths at uniform angular speeds. Water is applied at a uniform rate by a progressive increase of nozzle size from the pivot to the end of the line. The depth of water applied is determined by the rate of travel of the system. Single units are ordinarily about 1,250 to 1,300 feet long and irrigate about a 130-acre circular area (http://ga.water.usgs.gov/edu/irquicklook.html).

STOP 2: Henry Allan Gleason Nature Preserve, Sand Ridge State Forest (SE, SE, SE, Sec. 6, T22N, R7W, Duck Island 7.5-minute Quadrangle, Mason County).

The Henry Allan Gleason Nature Preserve represents a unique type of habitat that occurs along the Illinois River from Pekin to Havana. During your visit to this prairie, whether spring, summer, fall, or winter, you may derive pleasure in investigating the diversity of plants, animals, birds, and even insects. Consider each of the seasons as an opportunity to participate in what may be described as a living outdoor play. As with all plays, the stage must be set before the play begins. The preparation of this "stage"—or habitat—is the geological foundation, built through the processes of weathering, erosion, transportation, and deposition. Rivers, streams, and landscapes are the product of flowing water and land use activities and also, most important, a product of the geologic foundation and landforms on which they evolved.

The top of Devils Neck sand dune provides a great overlook into the Illinois River Valley (fig. 19). See Stop 3 for a discussion on the formation of sand dunes. Because the sand and associated soils are very well drained, this area has flora and fauna that are unusual for Illinois. Prickly pear cactus is the most distinct natural plant in the area. The Henry Allan Gleason Nature Preserve contains two distinct habitats:

1. Sand prairie is found on coarse-textured soils, such as sand, loamy sand, and sandy loam. Sand prairies form on sandy outwash plains, and lake plains and range in soil moisture characteristics. The communities within the sand prairie include dry, dry-mesic, mesic, wet-mesic, and wet sand prairies.

Figure 19 Russ Jacobson standing on top of Devil's Neck sand dune at Henry Allan Gleason Nature Preserve at Stop 2 (photo by W.T. Frankie).

2. Dry sand prairie, which occurs on the crest of sand dune formations, are characterized by grasses less than 3 feet tall. Soil is formed in rapidly drained, deep sand deposits with no dark A horizon. Definitions are from the Critical Trends Assessment Program, *Lower Sangamon River Area Assessment* (2001).

Henry Allan Gleason Nature Preserve

Located within the Sand Ridge State Forest, the preserve contains sand prairie, dunes, and blowouts characteristic of the Illinois River Section of the Illinois River and Mississippi River Sand Natural Division. These dry communities support rare and unusual plants, such as silvery bladderpod, prickly pear cactus, porcupine grass, and spiderwort. Badger, pocket gopher, lark sparrow, six-lined racerunner (a lizard), and regal fritillary (a butterfly) are some of the more unusual animals that occur here. One of the unique features at Henry Allan Gleason Preserve is a 60-foot stabilized sand dune historically and locally known as the "Devil's Tower" or "Devils Neck." A large blowout is located at the top of the dune. Management practices occurring at the preserve include prescribed burning and habitat enhancement. The preceding was modified from information from the Illinois Nature Preserves Commission Web site (http://www.dnr.state.il.us/ INPC/Directory/Sitefiles/Area5/GLEMA.htm).

This 110-acre nature preserve is owned and managed by the Illinois Department of Natural Resources. It was dedicated in October 1970. For further information, contact the Site Superintendent, Sand Ridge State Forest, Forest City, IL 61532 (309/597-2260) or Illinois Department of Natural Resources, Natural Heritage Biologist, Sangchris Lake State Park, R.R. #1, Rochester, IL 62563 (217/498-9208).

The University of Illinois at Urbana-Champaign and Eastern Illinois University have recently received a grant to conduct a study on the population and viability of the endangered silvery bladderpod at the Henry Allan Gleason Nature Preserve in Mason County. (Contact: Janice Coons, 217/333-8505). The preserve is the only location in the state where the silvery bladderpod is found. The closest habitat outside of Illinois is northwestern Nebraska and Montana. The silvery bladderpod (the *Lesquerella ludoviciana*) blooms in May, producing small four-petaled yellow flowers (Post 2001).

Three species of the prickly pear cactus occur in Illinois, *Opunita humifusa* (the eastern prickly pear; most widespread), *Opuntia fragilis* (the little prickly pear), and *Opuntia macrorhiza* (the plains prickly pear; "*Opuntia* with the big roots") (Koelling 1996, an excellent article on the prickly pear cactus in Illinois). Be careful when examining the prickly pear cactus. It's not the large spines that give us grief, but the glochids, the very tiny barbed hairs located at the base of each spine. When the glochids attack the human skin they can be . . . painful! The large yellow flower of the prickly pear, in my opinion, is one of the most beautiful natural blooms in Illinois. I agree with Koelling (1996): "If you have seen one prickly pear you have seen them all" is definitely not true.

From Billy Lowe, Site Superintendent at Sand Ridge State Forest:

> Beginning in 1903, Henry Allan Gleason (after whom the park is named) and Chester A. Hart began a study of the plant and insect communities that inhabit the windblown sand deposits of Illinois. Their work resulted in a classic publication, *On the Biology of the Sand Areas of Illinois.* Gleason would take a train to a certain point and then walk to what is now the H. A. Gleason State Natural Area (Nature Preserve [NP]). At this time (1903), Gleason stated that the sand regions were the only areas of natural vegetation left in the state where thousands of acres of virgin prairie still remained untouched by the plow (Hart and Gleason 1907). In 1907, Hart and Gleason estimated that there were 179,200 acres or 700 square kilometers of sand vegetation in Tazewell, Mason, Cass, and Morgan Counties. Today, only 172 acres of recognized high-quality sand prairie remain within those counties (Illinois Natural Heritage Database 2003).

STOP 3: Manito Investment Co. West Side Sand (SE and SW, SE, Sec. 5, and NE and NW, NE, Sec. 8, T22N, R7W, Duck Island 7.5-minute quadrangle, Mason County) (fig. 20).

West Side Sand is owned by Manito Investment Company, 22285 N. County Road, 2300 E, Topeka, IL 61567. The company has produced, in the past, a number of different products, including foundry sand (primarily for Caterpillar). They also produced glass sand for Hillsboro Glass Company in Montgomery County until Hillsboro Glass went out of business in 1997. They have also produced blasting sand and fill sand.

Their main customer is Caterpillar, which uses the sand as foundry sand (molding sand) for the casting of metal parts. The Caterpillar foundry casts the cylinder blocks, cylinder heads, cylinder liners, and manifolds of each Caterpillar diesel engine. Foundry sand primarily consists of clean, uniformly sized, high-quality silica sand or lake sand that is bonded to form molds for ferrous and nonferrous metal castings. The iron and steel industries account for approximately 95% of foundry sand used for castings.

The most common casting process used in the foundry industry is the green sand cast system. Virtually all sand cast molds for iron castings are of the green sand type. Green sand and green sand molds are not green in color. The term “green sand” refers to the moisture content of the mixture. Green sand consists of high-quality silica sand, about 10% bentonite clay (as the binder), 2 to 5% water, and about 5% sea coal (a carbonaceous mold additive to improve casting finish). The type of metal being cast determines which additives and what gradation of sand is used. The green sand used in the process constitutes upwards of 90% of the molding materials used (personal communication, American Foundry Society).

A casting is a metal part formed by pouring molten metal into a sand mold or metal die. The mold or die comprises two halves that, when mated together, form a cavity into which the molten metal is poured. The mold or die forms the external surface of the casting. If an internal cavity is required in the casting, a core is placed inside the mold cavity. After the metal solidifies, the mold is broken, the cores are removed, and the part is readied for finishing operations. The sand is then remolded and used again.

Operations began in 1983 at West Side Sand, which currently mines approximately 140,000 tons per year and sells 70,000 tons per year. The balance is rejected because it does not meet specifications. The average thickness of the sand is 25 feet, and the company owns 500 acres.

Mining operations use a hydraulic mining technique: water is ejected under high pressure (sometimes several hundred pounds of pressure) from a swivel nozzle that is mounted on a stand. The pressurized water stream is aimed at a dune bank, washing it down into a small holding pond. From this point, the sand slurry is pumped through a pipeline to the Hydrosizers, which use water to separate the sand using differences in specific gravity. This is a sink-float process—the heavy materials sink and the light ones float. The product is sent to the stockpiles via a slurry through pipes. The sand is then fed to the dryers with front end loaders. The dryers are rotary kilns and use natural gas to dry the sand. The product is then sent to the screen house, where any coarse material is separated. The finished product is then sent to the silos where it awaits shipment by truck. No mining occurs during the winter months, because the water freezes. Start-up is usually the first of April or possibly the latter part of March.

Sand Dunes

The dune sand was deposited during the Wisconsin Glacial Episode and is classified as the Parkland Sand, a facies of the Henry Formation. This sand consists of well-sorted fine- and medium-grained sand (Willman 1973, Hansel and Johnson 1996). Sand dunes are abundant in the area between Pekin and Havana. These dunes are reworked glacial outwash and alluvium associated with the Kankakee Torrents. Most of the dunes are rather old, but some have moved out of the lowland area onto the Shelbyville Moraine.

The largest area and the thickest deposits of dune sand in Illinois occur on the terrace that extends from Pekin southwest through the Havana District nearly to Beardstown. The dune sand is largely quartz but contains about 20% feldspar, 1 to 2% other minerals, and 1 to 2% clay. Much of the sand is stained light yellow by iron oxide and is generally non-calcareous (Willman 1973).

From their distribution and asymmetrical profiles (steeper on the southeast), as well as the barchan shapes of some dunes (crescent-shaped dunes with tapering ends pointing southeast), it is apparent that the dunes were formed by wind blowing dominantly from the northwest (Willman 1973). Many dunes are 20 to 40 feet high but may be underlain by as much as 100 feet of dune sand, although the maximum is generally less than 50 feet.

Sieve analyses of over 100 samples of sand from dunes over the entire dune field indicate that the sand is moderately well sorted, but coarser sand is present on the windward side of the dune, and finer sand is present of the leeward side of individual dunes. There is no statistically significant difference in grain sizes between dunes located in different parts of the dune field, which indicates that the sand is locally derived everywhere in the dune field rather than blown from a single source area. Hand auger boring encountered gravel at shallow depths (1 to 10 feet) below ground level in the inter-dune areas to the east, where several dunes are on top of large gravel bars produced during the Kankakee Torrents.

Figure 20 Skip Nelson looking at eolian crossbeds in sand dune deposits at Manito Investment Company West Side Sand at Stop 3 (photo by Russ Jacobson).

STOP 4: LUNCH: Jake Wolf Memorial Fish Hatchery (SW, NE, Sec. 21, T23N, R7W, Duck Island 7.5-minute Quadrangle, Mason County).

Why is this facility located here? The decision to place the hatchery here was largely based on the geology. The facility is located on top of the Mahomet-Sankoty aquifer and is capable of maintaining its requirement of a plentiful supply of good quality water.

Ten water wells are located within the adjoining Sand Ridges State Forest. Normal withdrawal is 1,500 gallons per minute with a peak withdrawal of 4,500 gallons per minute. Wells 5, 6, 7, 8, and a pumping station are located along Pine Valley Road, which is located directly across from the entrance to the fish hatchery. One problem to contend with is the naturally occurring nitrogen gas in the water, which is caused by the rapid recharge rate from rainwater, which picks up the nitrogen from the atmosphere.

The following was submitted by Steve Krueger at Jake Wolf Memorial Fish Hatchery.

Completed in 1982, Jake Wolf Memorial Hatchery is the largest of Illinois' four hatcheries. Located five miles west of Manito in Mason County, the hatchery is within the 7,280-acre Sand Ridge State Forest. Originally called Sand Ridge Hatchery, it was renamed in 1985 in honor of the late Jacob John "Jake" Wolf, former Deputy Director of Conservation.

The Jake Wolf hatchery is unique in that it simultaneously rears 16 species of fish using both "intensive" and "extensive" culture techniques. Intensive culture mainly uses prepared feed for the fish and maintains environmental quality with the use of a single pass flow of water through the tanks. This method allows the rearing of large numbers of fish in a small area and results in a more predictable production. Extensive culture uses natural food in a pond (such as plankton and minnows) to produce fingerling fish. The species reared include chinook and coho salmon, rainbow, brown and steelhead trout, northern pike, muskie, walleye, striped bass, striped bass hybrids, smallmouth and largemouth bass, channel catfish, bluegill and redear sunfish and crappie. These fish are shipped statewide to stock state- and public-owned lakes, three reservoirs, streams, Lake Michigan, and private ponds. Fish production during the last ten years has averaged 35 million fish.

The hatchery complex includes a 36,000-square foot building that includes a visitor center, offices, well water aeration towers and headboxes, culture tanks, spawn tanks, and incubation facilities. Additional elements include a 22-acre solar pond that uses solar energy to heat the 54-degree well water for fish production; raceways for production, brooding, and quarantine purposes; plastic-lined rearing ponds; and a waste treatment system.

The original eight wells that supply water for fish production are located approximately one mile southeast of the hatchery building. These wells are spaced approximately 500 feet from one another along a forest roadway. Each of the wells is equipped with an Allis-Chalmers vertical turbine pump with two to four stages. Their depths range from 98 to 110 feet, and the screen diameters are either 12 or 16 inches. All the screens are 40 feet in length, except for well 4, which has a 30-foot screen. Rated pump capacities range from 400 to 1,200 gallons per minute. Two additional 1,500 gallon per minute wells were installed in 1990 and are located approximately three miles from the hatchery by the Sand Ridge State Forest headquarters.

Located on the upper level of the hatchery, the Visitor's Center has several overlooks to view the different stages of fish production. Other attractions include an antique fishing tackle display containing over 200 artifacts, a "Harvesting the River" exhibit depicting life on the Illinois River during the late 1800s and early 1900s, and several live and static fish displays. Tours of the hatchery are available seven days a week at 10:00 a.m. and 2:00 p.m. Large groups and school groups are welcome. For tour information and reservations, please call

(309/968-7531) the Jake Wolf Memorial Fish Hatchery, 25410 North Fish Hatchery Road, Topeka, IL 61567.

A fish production calendar may be obtained from the Illinois Department of Natural Resource Web site (http://dnr.state.il.us/lands/Education/interprt/jwolf.htm).

The following drillers log description was obtained from the well records library at the ISGS.

Water well # 0W-1 in the NW, NW, Sec. 21, T23N, R7W, located northwest of the fish hatchery, was drilled on October 3, 1975, for the Illinois Conservation Department. The well was completed with 2-inch pipe set to 119 feet, with the bottom 40 feet of the pipe slotted. The static water level was 77.7 feet.

Driller's log description	
Loose brown fine-medium sand	20 feet
Brown fine to coarse sand with occasional clay seam	3 feet
Fine sand to small gravel	24 feet
Fine sand to coarse gravel	9 feet
Fine to coarse sand some gravel intermixed	31 feet
Soft gray shale	8 feet
Gray shale with coal seams	5 feet
Total depth	130 feet

STOP 5: R.A. Cullinan and Sons Inc. Lowry Pit (NW, NE, Sec. 23, T24N, R6W, 3rd P.M., Pekin 7.5-minute Quadrangle, Tazewell County).

The stop is an exposure of the sand and gravel deposits of the Havana Terrace at the R.A. Cullinan and Sons Inc. Lowry Pit. This sand and gravel pit was opened in fall 2003. Production is estimated to be initially 200,000 tons per year increasing to 300,000 tons per year.

Stop 5 presents an excellent opportunity to examine the depositional features of sediments from the Kankakee Torrents. The sets of cross-bedded sands and gravels, with a west to southwest dip, tell an interesting story of Wisconsin Glacial Episode activity in the area. When the pulse of the Woodfordian glacier that was responsible for the Shelbyville and Bloomington Morainic Systems advanced into the area (roughly 20,000 years ago) from the northeast, it developed meltwater streams that carried tremendous amounts of sand and gravel into the areas of the Ancestral Mahomet River and Ancestral Mississippi River (fig. 12). This outwash was deposited as a large alluvial fan (sometimes referred to as the Bloomington outwash fan) that spread westward from the position of the Shelbyville and LeRoy Moraines.

As later pulses of the Woodfordian glacier advanced and retreated (roughly during the period of 18,000 to 13,500 years ago), a series of large lakes formed behind the terminal moraines left by preceding pulses of ice. During this time, there appear to have been several episodes of massive flooding as these moraine dams between LaSalle and Lake Michigan were breached (fig. 11). These large floods are collectively called the Kankakee Torrents (Wanless 1957, Willman and Frye 1970). These torrents of water reworked a significant portion of the sediments of the outwash fan and created large sand and gravel bars on the upper part of this fan that were oriented along the direction of stream flow. Many of the broad terraces along the Illinois River valley (the Manito, Havana, and Bath, for example) indicate various erosional surfaces that developed at different times during the various episodes of the Kankakee Torrents.

The fluvial glacial outwash deposits in nearly all exposures (such as this stop) show long foreset beds of sand and gravel dipping uniformly west to southwest down the valley (fig. 21). Studies by Wanless (1957) show that the original surface of this valley train dips to the southwest from an elevation of about 640 feet near the edge of the Shelbyville Moraine to about 485 feet near Beardstown. The sediments in this outwash fan, including the sediments that were later deposited by the Kankakee Torrents, collectively are termed the Mackinaw Member of the Henry Formation (Willman and Frye 1970). The Mackinaw Member is defined as sand and gravel that is generally well sorted and well bedded, deposited in valleys, and mostly glacial outwash in former valley trains and terrace remnants of former valley trains.

The flooding caused by the periodic release of water from these lakes was substantial during several periods, leading to a torrent that cut down through the unconsolidated morainic and outwash sediments to Pennsylvanian bedrock. As a result, coal and other bedrock materials were incorporated into the very coarse sediments that choked the valley just below the point of release. These torrents also ripped up some of the lake sediments (laminated clayey silts) that had accumulated in the blocked river valley. As these sediments were ripped from the lake floor, they were tumbled with sand and gravel to produce armored mud balls. These armored mud balls were deposited in the coarse sediment.

The clay-bedded lake sediments belong to the Equality Formation. The Equality formation occurs 10 to 20 feet above the floodplain north of Peoria along the Illinois River valley. These sediments were deposited in slack water lakes that formed behind moraines and in the tributary val-

Figure 21 R.A. Cullinan and Sons Inc. Lowry Pit at Stop 5. Skip Nelson points at contact between two bed sets of cross bedding in the high wall. The dip in these beds points in the direction (southern) that the water was flowing during the deposition of the fluvial outwash (photo by W.T. Frankie).

leys during high-water stages in the Illinois Valley (Willman 1973).

As we examine the sediments in this sand and gravel pit we should be able to find some of the many armored clay balls (of varying size coming from the upper part of the exposure). In addition, some rather large blocks of local Pennsylvanian bedrock are present from time to time, testifying to the power unleashed during some of these large floods. At the next stop, we will actually be able to collect some of the many pieces of local bedrock and glacial outwash rocks (many from much farther north in Canada). The next stop also has a larger amount of the large ripped up bedrock blocks (some approaching automobile size) that we also will be able to examine.

Henry Formation in Western Tazewell County

There are five facies in the upper part of the Mackinaw Member of the Henry Formation. The oldest facies (facies 1) consists of clean, quartz sand with a few scattered, well-rounded pebbles. This facies exhibits a uniform planar cross-bedding in which the foresets dip about 35 degrees. This facies is interpreted as valley train outwash from the advancing Woodfordian glacier that deposited the Shelbyville Moraine. The facies is overlain by facies 2. Facies 2 consists of sand, granules, pebbles, and cobbles with scour and fill cross-beds. Coal, black shale, and armored mudballs are abundant. The coal and black shale clasts give the facies a distinctive dark color. This facies marks the cutting of the Peoria Gorge and destruction of lakes trapped by the moraine. Facies 3 consists of plane-bedded sand and fine gravel deposited during the waning of the outburst event. The fourth facies consists of poorly bedded deposits of silt, clay, fine sand and local peat. This facies is normal overbank alluvium. The fifth facies consists of the largest cobbles and boulders along with some armored mudballs. This facies marks the Kankakee Torrents.

The R.A. Cullinan and Sons Inc. Hurley Sand and Gravel Pit is located across the road (SE NE SW SE, Sec. 14, T24N, R6W, 3rd P.M., Tazewell County; Pekin 7.5-minute Quadrangle), north of the Lowry pit. During a visit in 1995, a sand dune was exposed near the top of the north facing highwall. The material in this sand dune is the same as the sand dunes within the Henry Allan Gleason Nature Preserve. Shortly after deposition of the sand and gravel bars by the torrents, wind reworked the finer sediments from the alluvial fan and the reworked bars. Much of the silt and clay was blown away to become part of the Richland Loess that forms a thin blanket over the most recent glacial tills to the east. The sand was mobilized to form the sand dunes we have been seeing throughout much of the day. This sand is termed by geologists who study Pleistocene sediments the Parkland Sand, and the location of the type section for this geologic unit is 5 miles west of the town for which it was named—Parkland in Tazewell County, a small town about 3 miles northeast of Manito.

STOP 6. Cornick Sand and Gravel Pit (NE, Sec. 18, T24N, R5W, 3rd P.M., Pekin 7.5-Minute Quadrangle, Tazewell County).

Stop 6 presents an opportunity for you to examine varied gravel and boulders in sediments of the Bath Terrace and collect rocks and minerals at the Cornick Sand and Gravel Pit, Cornick Concrete Products Company (fig. 22).

Production is 250,000 to 300,000 tons per year. As of December 4, 2003, the yearly production was 314,883 tons. The average price of product is $5.00 per ton. Experience at this operation has shown that the overall deposit has more gravel at the west end of the pit and more sand at the east end of the pit. The deposits are underlain by a blue shale at the west end of the pit, and a coal underlies the deposits at the east end of the pit. An interesting term that is used by operators is “boney,” which means more rocks in the material they are mining.

Figure 22 Preparation plant at Cornick Sand and Gravel Pit at Stop 6 (photo by W.T. Frankie).

The bag plant produces a variety of bagged products. Their biggest customer is Menards. Production is currently equal to 3 million bags per year, or 15,000 bags per day, which is approximately 400 tons per day. Products include mason sand, sand tubes for use as weight in vehicles during the winter, and bagged Portland cement, to which is added a small amount of fly ash.

We have several purposes for visiting this sand and gravel pit. First, we want to examine close at hand some of the large ripped up bedrock boulders from the Kankakee Torrents. This operation encounters a relatively large number of these boulders. Try to imagine the force behind the water that could lead to immense blocks such as these being ripped up and deposited downstream in these sand and gravel bars.

Second, Stop 6 affords us a good opportunity to examine and collect a large number of different types of rocks that were deposited in the alluvial fan and torrent sediments now being mined in this pit. There are many different types of igneous and metamorphic rocks, for example, that were undoubtedly brought from the north by Wisconsinan glaciation and eventually deposited in these outwash sediments as the glaciers melted. In addition, there are many small pieces and very large blocks of local Pennsylvanian bedrock that were deposited during the phases of the Kankakee Torrents, including limestone, coal, and black shale. Some of the large blocks of coal are mined from the coal that directly underlies a portion of the pit. Some of the limestones and black shales are quite fossiliferous and good for fossil collecting. Finally there are also a large number of the armored mudballs in the same spoil piles, and you should be able to examine these close at hand.

Third, at this operation we will take some time to examine the equipment utilized in this sand and gravel operation. There are a number of pieces of equipment present that allow the company to sort the sediments into the precise sizes they need in order to meet product specifications of their customers. You may have never thought about how that gravel in your driveway was actually mined or what that sand in your children's sandbox went through before you purchased it at your local hardware store.

The deposit mined here averages 50 feet thick and is overlain by 2 to 3 feet of topsoil and underlain by Pennsylvanian-age coal and shale bedrock. The glacial sediments include an upper sand that is 7 to 12 feet thick and grades downward into sand and gravel, which is underlain by 30 to 35 feet of coarse sand and gravel.

Rocks and minerals found within the sand and gravel deposits along the Illinois River (modified from Hunter 1966) include these:

- Dolomite
- Limestone
- Weathered carbonates
- Chert
- Shale
- Sandstone and siltstone
- Ironstone concretions
- Gabbro
- Granite
- Rhyolite
- Quartzite
- Gneiss
- Schist
- Graywacke
- Cemented gravel
- Armored clay balls
- Coal
- Quartz
- Jasper
- Agate
- Pyrite

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GLOSSARY

The following definitions are adapted in total or in part from several sources. The principal source is R.L. Bates and J.A Jackson, eds., 1987, *Glossary of Geology*, 3rd ed.: Alexandria, Virginia, American Geological Institute, 788 p.

ablation Separation and removal of rock material and formation of deposits, especially by wind action or the washing away of loose and soluble materials.

accretion The gradual or imperceptible increase or extension of land by natural forces acting over a long period of time.

accretion-gley A gley soil built by accretion.

age An interval of geologic time; a division of an epoch.

aggraded Built up by deposition.

aggrading stream A stream that is actively depositing sediment in its channel or floodplain because it is being supplied with more load than it can transport.

alluviated valley One that has been at least partially filled with sand, silt, and mud by flowing water.

alluvium A general term for clay, silt, sand, gravel, or similar unconsolidated sorted or semisorted sediment deposited during comparatively recent time by a stream or other body of running water.

angular unconformity The name of the contact when the beds below the unconformity are tilted and eroded prior to deposition of overlying beds.

anticline A convex-upward rock fold in which strata have been bent into an arch; the strata on either side of the core of the arch are inclined in opposite directions away from the axis or crest; the core contains older rocks than does the perimeter of the structure.

anticlinorium A complex structure having smaller structures, such as domes, anticlines, and synclines superimposed on its broad upwarp.

aquifer A geologic formation that is water-bearing and that transmits water from one point to another.

arenite A relatively clean quartz sandstone that is well sorted and contains less than 10% argillaceous material.

argillaceous Said of rock or sediment that contains, or is composed of, clay-sized particles or clay minerals.

barchan The most common type of sand dune. It is an isolated crescent-shaped dune lying crosswise to the direction of the wind, with a gently sloping side facing the wind and a steep concave slope on the leeward side. This type of dune forms on a flat, hard surface where the sand supply is limited and the wind is constant and of moderate speed.

base level Lower limit of erosion of the land's surface by running water. Controlled locally and temporarily by the water level of stream mouths emptying into lakes, or more generally and semipermanently by the level of the ocean (mean sea level).

basement complex The suite of mostly crystalline igneous and/or metamorphic rocks that generally underlies the sedimentary rock sequence.

basin A topographic or structural low area that generally receives thicker deposits of sediments than adjacent areas; the low areas tend to sink more readily, partly because of the weight of the thicker sediments; the term also denotes an area of relatively deep water adjacent to shallow-water shelf areas.

bed A naturally occurring layer of earth material of relatively greater horizontal than vertical extent that is characterized by physical properties different from those of overlying and underlying materials. It also is the ground upon which any body of water rests or has rested, or the land covered by the waters of a stream, lake, or ocean; the bottom of a stream channel.

bedrock The solid rock (sedimentary, igneous, or metamorphic) that underlies the unconsolidated (non-indurated) surface materials (for example, soil, sand, gravel, glacial till).

bedrock valley A drainageway eroded into the solid bedrock beneath the surface materials. It may be completely filled with unconsolidated (non-indurated) materials and hidden from view.

biota All living organisms of an area; plants and animals considered together.

braided stream A low-gradient, low-volume stream flowing through an intricate network of interlacing shallow channels that repeatedly merge and divide and are separated from one another by branch islands or channel bars. Such a stream may be incapable of carrying all of its load. Most streams that receive more sediment load than they can carry become braided.

calcarenite Describes a limestone composed of more or less worn fragments of shells or pieces of older limestone. The particles are generally sand-sized.

calcareous Said of a rock containing some calcium carbonate ($CaCO_3$), but composed mostly of something else (synonym: limey).

calcining The heating of calcite or limestone to its temperature of dissociation so that it loses its carbon dioxide; also applied to the heating of gypsum to drive off its water of crystallization to make plaster of Paris.

calcite A common rock-forming mineral consisting of $CaCO_3$; it may be white, colorless, or pale shades of gray, yellow, and blue; it has perfect rhombohedral cleavage, appears vitreous, and has a hardness of 3 on the Mohs scale; it effervesces (fizzes) readily in cold dilute hydrochloric acid. It is the principal constituent of limestone.

cap rock The top layer of rock.

chert Silicon dioxide (SiO_2); a compact, massive rock composed of minute particles of quartz and/or chalcedony; it is similar to flint, but lighter in color.

clastic Said of rocks composed of particles of other rocks or minerals, including broken organic hard parts as well as rock substances of any sort, transported and deposited by wind, water, ice, or gravity.

claypan (soil) A heavy, dense subsurface soil layer that owes its hardness and relative imperviousness to higher clay content than that of the overlying material.

closure The difference in altitude between the crest of a dome or anticline and the lowest structural or elevation contour that completely surrounds it.

columnar section A graphic representation, in the form of one or more vertical columns, of the vertical succession and stratigraphic relations of rock units in a region.

conformable Said of strata deposited one upon another without interruption in accumulation of sediment; beds parallel.

cuesta A ridge with a gentle slope on one side and a steep slope on the other.

delta A low, nearly flat, alluvial land form deposited at or near the mouth of a river where it enters a body of standing water; commonly a triangular or fan-shaped plain extending beyond the general trend of a coastline.

detritus Loose rock and mineral material produced by mechanical disintegration and removed from its place of origin by wind, water, gravity, or ice; also, fine particles of organic matter, such as plant debris.

disconformity An unconformity marked by a distinct erosion-produced irregular, uneven surface of appreciable relief between parallel strata below and above the break; sometimes represents a considerable time interval of nondeposition.

dolomite A mineral, calcium-magnesium carbonate ($Ca,Mg(CO_3)_2$); also the name applied to sedimentary rocks composed largely of the mineral. It is white, colorless, or tinged yellow, brown, pink, or gray; has perfect rhombohedral cleavage; appears pearly to vitreous; and effervesces feebly in cold dilute hydrochloric acid.

dome A general term for any smoothly rounded landform or rock mass that roughtly resembles the dome of a building.

drift All rock material transported by a glacier and deposited either directly by the ice or reworked and deposited by meltwater streams and/or the wind.

driftless area A 10,000-square mile area in northeastern Iowa, southwestern Wisconsin, and northwestern Illinois where the absence of glacial drift suggests that the area may not have been glaciated.

earthquake Ground displacement associated with the sudden release of slowly accumulated stress in the lithosphere.

end moraine A ridge or series of ridges formed by accumulations of drift built up along the outer margin of an actively flowing glacier at any given time; a moraine that has been deposited at the lower or outer end of a glacier.

en echelon Said of geologic features that are in an overlying or staggered arrangement, for example, faults.

epoch An interval of geologic time; a division of a period (for example, Pleistocene Epoch).

era The unit of geologic time that is next in magnitude beneath an eon; it consists of two or more periods (for example, Paleozoic Era).

erratic A rock fragment carried by glacial ice and deposited far from its point of origin.

escarpment A long, more or less continuous cliff or steep slope facing in one general direction; it generally marks the outcrop of a resistant layer of rocks or the exposed plane of a fault that has moved recently.

esker An elongated ridge of sand and gravel that was deposited by a subglacial or englacial stream flowing between ice walls or in an ice tunnel and left behind by a melting glacier.

evaporite A nonclastic sedimentary rock composed primarily of minerals produced from a saline solution as a result of extensive or total evaporation of the solvent (for example, gypsum, anhydrite, rock salt, primary dolomite, and various nitrates and borates).

fault A fracture surface or zone of fractures in earth materials along which there has been vertical and/or horizontal displacement or movement of the strata on opposite sides relative to one another.

flaggy Said of rock that tends to split into layers of suitable thickness for use as flagstone.

floodplain The surface or strip of relatively smooth land adjacent to a stream channel produced by the stream's erosion and deposition actions; the area covered with water when the stream overflows its banks at times of high water; it is built of alluvium carried by the stream during floods and deposited in the sluggish water beyond the influence of the swiftest current.

fluvial Of or pertaining to a river or rivers.

flux A substance used to remove impurities from steel. Flux combines with the impurities in the steel to form a compound that has a lower melting point and density than steel. This compound tends to float to the top and can be easily poured off and separated from the molten steel.

formation The basic rock unit, one distinctive enough to be readily recognizable in the field and widespread and thick enough to be plotted on a map. It describes the strata, such as limestone, sandstone, shale, or combinations of these and other rock types. Formations have formal names, such as Joliet Formation or St. Louis Limestone (formation), generally derived from the geographic localities where the unit was first recognized and described.

fossil Any remains or traces of a once-living plant or animal preserved in rocks (arbitrarily excludes recent remains); any evidence of ancient life. Also used to refer to any object that existed in the geologic past and for which evidence remains (for example, a fossil waterfall)

fragipan A dense subsurface layer of soil whose hardness and relatively slow permeability to water are chiefly due to extreme compactness rather than to high clay content (as in claypan) or cementation (as in hardpan).

friable Said of a rock or mineral that crumbles naturally or is easily broken, pulverized, or reduced to powder, such as a soft and poorly cemented sandstone.

geest An alluvial material that is not of recent origin lying on the surface.

geology The study of the planet Earth that is concerned with its origin, composition, and form, its evolution and history, and the processes that acted (and act) upon the Earth to control its historic and present forms.

geophysics Study of the Earth with quantitative physical methods. Application of the principles of physics to the study of the Earth, especially its interior.

glaciation A collective term for the geologic processes of glacial activity, including erosion and deposition, and the resulting effects of such action on the Earth's surface.

glacier A large, slow-moving mass of ice formed on land by the compaction and recrystallization of snow.

gley horizon A soil developed under conditions of poor drainage that reduced iron and other elemental contents and results in gray to black, dense materials.

gob pile A heap of mine refuse left on the surface.

graben An elongate, relatively depressed crustal unit or block that is bounded by faults on its long sides.

gradient A part of a surface feature of the Earth that slopes upward or downward; the angle of slope, as of a stream channel or of a land surface, generally expressed by a ratio of height versus distance, a percentage or an angular measure from the horizontal.

gypsum A widely distributed mineral consisting of hydrous calcium sulfate ($CaSO_4 \cdot 2H_2O$). Gypsum is soft (hardness of 2 on the Mohs scale); white or colorless when pure but commonly has tints of gray, red, yellow, blue or brown. Gypsum is used as a retarder in portland cement and in making plaster of Paris.

hiatus A gap in the sedimentary record.

horst An elongate, relatively uplifted crustal unit or block that is bounded by faults on its long sides.

igneous Said of a rock or mineral that solidified from molten or partly molten material (that is, from magma).

indurated Said of compact rock or soil hardened by the action of pressure, cementation, and, especially, heat.

joint A fracture or crack in rocks along which there has been no movement of the opposing sides (*see also* fault).

karst Collective term for the land forms and subterranean features found in areas with relatively thin soils underlain by limestone or other soluble rocks; characterized by many sinkholes separated by steep ridges or irregular hills. Tunnels and caves formed by dissolution of the bedrock by groundwater honeycomb the subsurface. Named for the region around Karst in the Dinaric Alps of Croatia where such features were first recognized and described.

lacustrine Produced by or belonging to a lake.

Laurasia A protocontinent of the northern hemisphere, corresponding to Gondwana in the southern hemisphere, from which the present continents of the

Northern Hemisphere have been derived by separation and continental displacement. The supercontinent from which both were derived is Pangea. Laurasia included most of North America, Greenland, and most of Eurasia, excluding India. The main zone of separation was in the North Atlantic, with a branch in Hudson Bay; geologic features on opposite sides of these zones are very similar.

lava Molten, fluid rock that is extruded onto the surface of the Earth through a volcano or fissure. Also the solid rock formed when the lava has cooled.

limestone A sedimentary rock consisting primarily of calcium carbonate (the mineral calcite). Limestone is generally formed by accumulation, mostly in place or with only short transport, of the shells of marine animals, but it may also form by direct chemical precipitation from solution in hot springs or caves and, in some instances, in the ocean.

lithify To change to stone, or to petrify; especially to consolidate from a loose sediment to a solid rock.

lithology The description of rocks on the basis of their color, structure, mineral composition, and grain size; the physical character of a rock.

local relief The vertical difference in elevation between the highest and lowest points of a land surface within a specified horizontal distance or in a limited area.

loess A homogeneous, unstratified accumulation of silt-sized material deposited by the wind.

magma Naturally occurring molten rock material generated within Earth and capable of intrusion into surrounding rocks or extrusion onto the Earth's surface. When extruded on the surface it is called lava. The material from which igneous rocks form through cooling, crystallization, and related processes.

meander One of a series of somewhat regular, sharp, sinuous curves, bends, loops, or turns produced by a stream, particularly in its lower course where it swings from side to side across its valley bottom.

meander scars Crescent-shaped swales and gentle ridges along a river's floodplain that mark the positions of abandoned parts of a meandering river's channel. They are generally filled in with sediments and vegetation and are most easily seen in aerial photographs.

metamorphic rock Any rock derived from pre-existing rocks by mineralogical, chemical, and structural changes, essentially in the solid state, in response to marked changes in temperature, pressure, shearing stress, and chemical environment at depth in Earth's crust (for example, gneisses, schists, marbles, and quartzites)

mineral A naturally formed chemical element or compound having a definite chemical composition, an ordered internal arrangement of its atoms, and characteristic crystal form and physical properties.

monolith (a) A piece of unfractured bedrock, generally more than a few meters across. (b) A large upstanding mass of rock.

moraine A mound, ridge, or other distinct accumulation of glacial drift, predominantly till, deposited in a variety of topographic land forms that are independent of control by the surface on which the drift lies (*see also* end moraine).

morphology The scientific study of form and of the structures and development that influence form; term used in most sciences.

natural gamma log One of several kinds of measurements of rock characteristics taken by lowering instruments into cased or uncased, air- or water-filled boreholes. Elevated natural gamma radiation levels in a rock generally indicate the presence of clay minerals.

nickpoint A place with an abrupt inflection in a stream profile, generally formed by the presence of a rock layer resistant to erosion; also, a sharp angle cut by currents at base of a cliff.

nonconformity An unconformity resulting from deposition of sedimentary strata on massive crystalline rock.

nonlithified Said of unconsolidated materials.

normal fault A fault in which the hanging wall appears to have moved downward relative to the footwall.

Opunita A genus containing prickly pear species, including *Opunita humifusa, Opuntia macrorhiza,* and *Opuntia fragilis,* all of which occur in Illinois.

outwash Stratified glacially derived sediment (clay, silt, sand, and gravel) deposited by meltwater streams in channels, deltas, outwash plains, glacial lakes, and on floodplains.

outwash plain The surface of a broad body of outwash formed in front of a glacier.

overburden The upper part of a sedimentary deposit, compressing and consolidating the material below.

oxbow lake A crescent-shaped lake in an abandoned bend of a river channel. A precursor of a meander scar.

paha A low, elongated, rounded glacial ridge or hill consisting mainly of drift, rock, or windblown sand, silt, or clay but capped with a thick cover of loess.

palisades A picturesque extended rock cliff or line of bold cliffs, rising precipitously from the margin of a stream or lake.

Pangea The supercontinent that existed from 300 to 200 million years ago. It combined most of the continental crust of the Earth, from which the present continents were derived by fragmentation and movement away from each other by means of plate tectonics. During an intermediate stage of the fragmentation, between the existence of Pangea and that of the present widely separated continents, Pangea was split into two large fragments, Laurasia on the north and Gondwana in the southern hemisphere.

ped Any naturally formed unit of soil structure (for example, granule, block, crumb, or aggregate).

peneplain A land surface of regional scope worn down by erosion to a nearly flat or broadly undulating plain.

perched groundwater Unconfined groundwater separated from an underlying body of groundwater by an unsaturated zone.

perched water table The water table of a body of perched groundwater.

period An interval of geologic time; a division of an era (for example, Cambrian, Jurassic, and Tertiary).

physiographic province (or division) (a) A region, all parts of which are similar in geologic structure and climate and which has consequently had a unified geologic history. (b) A region whose pattern of relief features or landforms differs significantly from that of adjacent regions.

physiography The study and classification of the surface features of Earth on the basis of similarities in geologic structure and the history of geologic changes.

point bar A low arcuate ridge of sand and gravel developed on the inside of a stream meander by accumulation of sediment as the stream channel migrates toward the outer bank.

radioactivity logs Any of several types of geophysical measurements taken in boreholes using either the natural radioactivity in the rocks or the effects of radiation on the rocks to determine the lithology or other characteristics of the rocks in the walls of the borehole (for example, natural gamma radiation log; neutron density log).

relief (a) A term used loosely for the actual physical shape, configuration, or general uneveness of a part of Earth's surface, considered with reference to variations of height and slope or to irregularities of the land surface; the elevations or differences in elevation, considered collectively, of a land surface (frequently confused with topography). (b) The vertical difference in elevation between the hilltops or mountain summits and the lowlands or valleys of a given regional extent. Formed in places where the forces of plate tectonics are beginning to split a continent (for example, east African rift valley).

rift (a) A narrow cleft, fissure, or other opening in rock made by cracking or splitting; (b) a long, narrow continental trough that is bounded by normal faults—a graben of regional extent.

riprap A layer of large, durable fragments of broken rock, specially selected and graded, thrown together irregularly or fitted together to prevent erosion by waves or currents and to preserve the shape of a surface, slope, or underlying structure.

rubble bars A loose mass of angular rock fragments, commonly overlying outcropping rock.

sediment Solid fragmental matter, either inorganic or organic, that originates from weathering of rocks and is transported and deposited by air, water, or ice or that is accumulated by other natural agents, such as chemical precipitation from solution or secretion from organisms. When deposited, sediment generally forms layers of loose, unconsolidated material (for example, sand, gravel, silt, mud, till, loess, and alluvium).

sedimentary rock A rock resulting from the consolidation of loose sediment that has accumulated in layers (for example, sandstone, siltstone, mudstone, and limestone).

shoaling Said of an ocean or lake bottom that becomes progressively shallower as a shoreline is approached. The shoaling of the ocean bottom causes waves to rise in height and break as they approach the shore.

silt A rock fragment or detrital particle smaller than a very fine sand grain and larger than coarse clay, having a diameter in the range of 4 to 62 microns; the upper size limit is approximately the smallest size that can be distinguished with the unaided eye.

sinkhole Any closed depression in the land surface formed as a result of the collapse of the underlying soil or bedrock into a cavity. Sinkholes are common in areas where bedrock is near the surface and susceptible to dissolution by infiltrating surface water. Sinkhole is synonymous with "doline," a term used extensively in Europe. The essential component of a hydrologically active sinkhole is a drain that allows any water that flows into the sinkhole to flow out the bottom into an underground conduit.

slip-off slope Long, low, gentle slope on the inside of a stream meander. The slope on which the sand that forms point bars is deposited.

stage, substage Geologic time-rock units; the strata formed during an age or subage, respectively. Generally applied to glacial episodes (for example, Woodfordian Substage of the Wisconsinan Stage).

strata Layers of sedimentary rock, visually separable from other layers above and below; beds.

stratigraphic unit A stratum or body of strata recognized as a unit in the classification of the rocks of Earth's crust with respect to any specific rock character, property, or attribute or for any purpose such as description, mapping, and correlation.

stratigraphy The study, definition, and description of major and minor natural divisions of rocks, particularly the study of their form, arrangement, geographic distribution, chronologic succession, naming or classification, correlation, and mutual relationships of rock strata.

stratum A tabular or sheet-like mass, or a single, distinct layer of material of any thickness, separable from other layers above and below by a discrete change in character of the material, a sharp physical break, or both. The term is generally applied to sedimentary rocks but could be applied to any tabular body of rock (*see also* bed).

subage A small interval of geologic time; a division of an age.

syncline A convex-downward fold in which the strata have been bent to form a trough; the strata on either side of the core of the trough are inclined in opposite directions toward the axis of the fold; the core area of the fold contains the youngest rocks (*see also* anticline).

system A fundamental geologic rock unit of worldwide significance; the strata of a system are those deposited during a period of geologic time (for example, rocks formed during the Pennsylvanian Period are included in the Pennsylvanian System).

tectonic Pertaining to the global forces that cause folding and faulting of the Earth's crust; also used to classify or describe features or structures formed by the action of those forces.

tectonics The branch of geology dealing with the broad architecture of the upper (outer) part of Earth; that is, the major structural or deformational features, their origins, historical evolution, and relations to one another. It is similar to structural geology, but generally deals with larger features such as whole mountain ranges or continents.

temperature-resistance log A borehole log, run only in water-filled boreholes, that measures the water temperature and the quality of groundwater in the well.

terrace A long, narrow, relatively level or gently inclined surface bounded on one side by a steeper descending slope and along the other by a steeper ascending slope; a large bench or steplike ledge breaking the continuity of a slope. A terrace commonly occurs along the margin and above the level of a body of water, marking a former water level.

till Nonlithified, nonsorted, unstratified drift deposited by and underneath a glacier and consisting of a heterogenous mixture of different sizes and kinds of rock fragments.

till plain The undulating surface of low relief in an area underlain by ground moraine.

topography The natural or physical surface features of a region, considered collectively as to form; the features revealed by the contour lines of a map.

unconformable Said of strata that do not succeed the underlying rocks in immediate order of age or in parallel position. A general term applied to any strata deposited directly upon older rocks after an interruption in sedimentation, with or without any deformation and/or erosion of the older rocks.

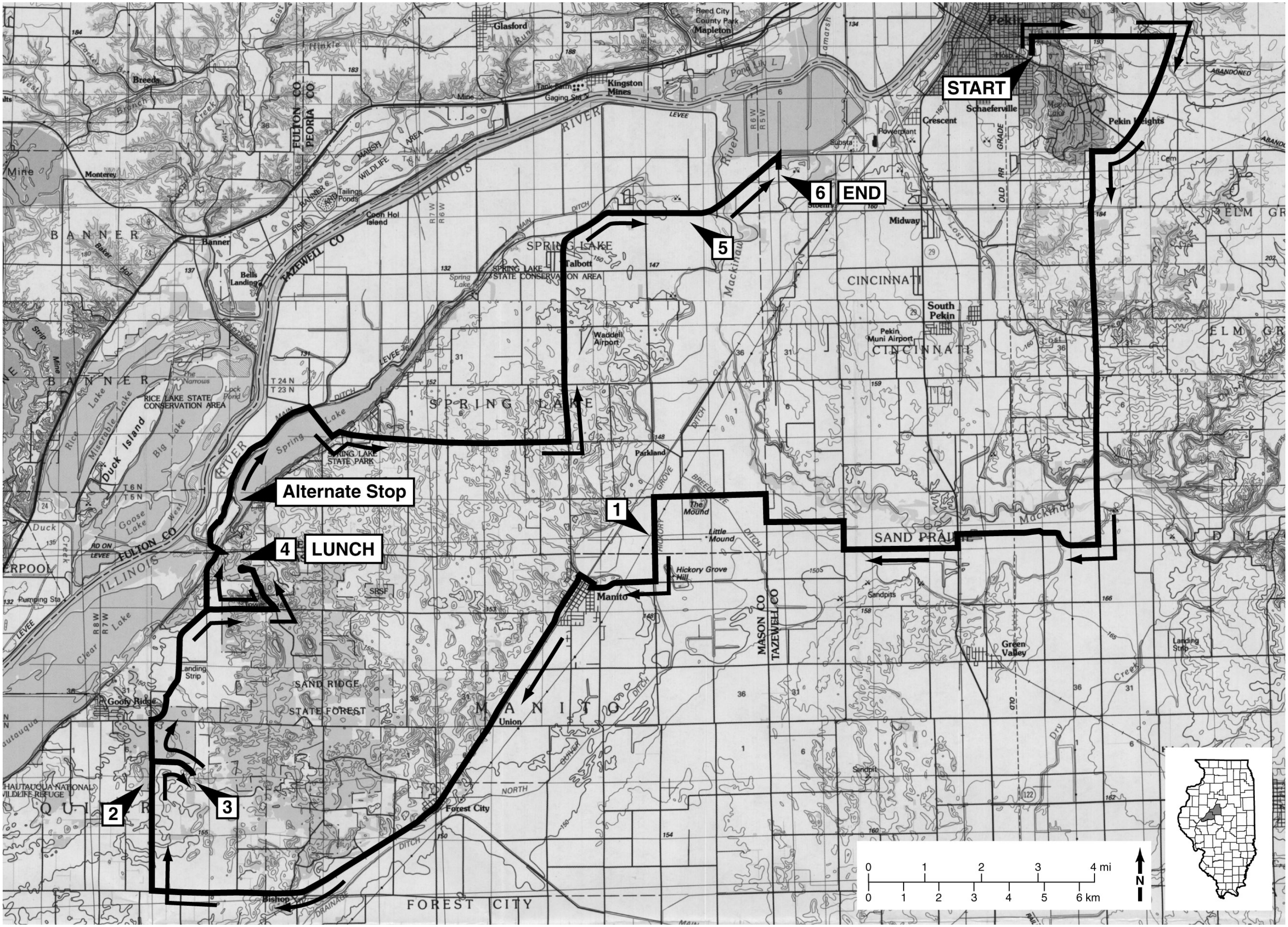
unconformity A substantial break or gap in the geologic record where a rock unit is overlain by another that is not next in stratigraphic successsion.

underfit stream A misfit stream that appears to be too small to have eroded the valley in which it flows. It is a common result of drainage changes effected by stream capture, by glaciers, or by climate variations.

valley train The accumulation of outwash deposited by rivers in their valleys downstream from a glacier.

water table The point in a well or opening in the Earth where groundwater begins. It generally marks the top of the zone where the pores in the surrounding rocks are fully saturated with water.

weathering The group of processes, both chemical and physical, whereby rocks exposed to the weather change in character and decay and finally crumble into soil.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SPRING LAKE STATE PARK
Talbott
Waddell Airport
Parkland
The Mound
Little Mound
Hickory Grove Hill
Manito
Union
MANITO
Forest City
FOREST CITY
Bishop
SAND RIDGE STATE FOREST
Goofy Ridge
CHAUTAUQUA NATIONAL WILDLIFE REFUGE
Green Valley
Sandpits
Kingston Mines
Glasford
Mapleton
Reed City County Park
Banner
BANNER
Bells Landing
Breeds
Monterey
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