HYDROGEOLOGIC ENVIRONMENTS ALONG THE FOX RIVER VALLEY IN KANE COUNTY, ILLINOIS

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ABSTRACT

The hydrogeologic environment of the Fox River in eastern Kane County is affected by various shallow aquifers in the glacial drift and shallow bedrock. Use of these shallow aquifers and the Fox River for public water supply is increasing. Development of shallow aquifers in the area could reduce groundwater discharge to the Fox River, affecting the quantity and quality of base flow. Geologic maps of the shallow aquifers presented in this paper provide a basis for interpreting the relationship of these aquifers to the Fox River.

The elevation of the bedrock surface varies along the Fox River, ranging from about 480 feet above mean sea level on the floors of buried bedrock valleys to 760 feet on bedrock uplands. Silurian dolomite bedrock in the upland areas is at the same elevation as the Fox River from Aurora north to St. Charles, from South Elgin north to the southern area of Elgin, and in local areas near Carpentersville. The shallow bedrock may be hydraulically connected with the Fox River in these uplands.

Sand and gravel aquifers in the glacial drift are present both as valley fill deposits of the St. Charles aquifer and as areally extensive deposits of the Valparaiso aquifer and the Kaneville aquifer member of the Elburn aquiformation covering bedrock uplands. The St. Charles aquifer is generally isolated from the Fox River by units of low permeability. An important exception occurs north of St. Charles, where the St. Charles aquifer discharges into the river and contributes to its base flow. The Valparaiso aquifer is located in the northern part of the area where it is highly productive. The Valparaiso and Kaneville aquifer members may also contribute to the base flow.

The regional maps prepared for this report should prove useful in identifying areas for further detailed study. Additional site-specific data will be needed if the maps are used for purposes other than the regional hydrogeological assessment for which they were intended.

INTRODUCTION

Aquifers in the Cambrian and Ordovician sandstones, known as the Midwest and Basal Bedrock Aquigroups (Visocky et al. 1985), are highly used sources of drinking water in Kane County, Illinois. Concerns over high concentrations of naturally occurring radium and barium (Gilkeson et al. 1984) and extensive drawdown in the aquifers (Sasman et al. 1982) have led to a search for additional sources of supply. Alternative water resources in Kane County are being evaluated by the Illinois State Geological Survey (ISGS) and Illinois State Water Survey (ISWS). Possible alternative sources of water include (1) the shallow sand and gravel aquifers within the Prairie Aquigroup, (2) fractured dolomite in the Upper Bedrock Aquigroup, and (3) the Fox River. In the future, less water will probably be withdrawn from the Midwest and Basal Bedrock Aquigroups and more water will be withdrawn from the Prairie and Upper Bedrock Aquigroups and the Fox River.

This shift may impact the Fox River, especially during periods of low flow. Withdrawals from the shallow aquifers that are hydraulically connected with the Fox River may reduce the groundwater discharged to the river from the aquifers. Conversely, withdrawal of groundwater from aquifers not hydraulically connected with the Fox River may increase the low-flow discharge rate of the river if treated effluent discharges are added to the flow. Some aquifers in the Prairie and Upper Bedrock Aquigroups are hydraulically connected with the Fox River, whereas others are separated from the river by clay-rich glacial till, glaciolacustrine deposits, or alluvium with low permeability. Although the Midwest and Basal Bedrock Aquigroups are not hydraulically connected with the Fox River in Kane County, water pumped from these aquifers currently adds to the flow of the river in the form of effluent discharges from sewage treatment plants.

This investigation of the relationships between the Prairie and Upper Bedrock Aquigroups and the Fox River is connected with other ongoing and recent water resource studies conducted in Kane County. The regional water resources of Kane County were documented by Curry and Seaber (1990). The investigation for the site proposed for the Superconducting Super Collider added hydrogeologic data for the region (Graese et al. 1988).

Four phases are involved in this investigation of the hydrologic environments along the Fox River Valley. The results of the second phase—mapping glacial materials and bedrock along the Fox River Valley and defining aquifers in the Prairie Aquigroup and Upper Bedrock Aquigroup—are included in this report. The ISWS completed the first phase, which involved the study of the variation in base-flow accretions along the Fox River, aspects of the low-flow regime, water quality, and the effects of changes in water supply sources (Broeren and Singh 1987). Phase three, quantitative definition of the hydraulic interaction of the sand and gravel aquifers with the Fox River, and phase four, impacts of various scenarios of shallow groundwater use and river water withdrawals, are also to be reported by the ISWS.

The objectives of this ISGS phase of the study were to (1) map the bedrock surface elevation and shallow bedrock lithology of a corridor along the Fox River, (2) identify the extent of aquifers in the Prairie Aquigroup and their relationship to the Fox River, and (3) suggest the relationship between aquifers in the Upper Bedrock Aquigroup and the Fox River. The study area extends from T38N, R8E, to T42N, R8E in a corridor along the Fox River, 4 to 5 miles wide (fig. 1).

The regional maps prepared for this report should prove useful in identifying areas for detailed study. If the maps are to be used for purposes other than the regional hydrogeological assessment for which they were intended, additional site-specific data will be needed. Additional studies including aquifer testing and flow modeling are needed to define the hydrologic relations among the aquifers mapped in this study and their relationships to the Fox River.

METHODOLOGY

Well records, surficial geophysical surveys, and existing literature and maps provided information on the glacial drift and bedrock surface and lithology. In addition to existing well records, test wells drilled for the regional Kane County project and the SSC siting project were sources of detailed data. The maps and general conclusions in this report are derived from Graese et al. (1988) and Curry and Seaber (1990). We have included specific and recent information relevant to the Fox River corridor and revised the maps accordingly.

Well Records

Records from well logs on file at the ISGS were used in the study. Well logs, recorded at the time of drilling, document the location of a well and geologic materials encountered during drilling. Well records consisted of both private and municipal wells. Well locations described in the logs from private wells are commonly inaccurate or missing. Private well locations verified at the Kane County Permit Office provided information on bedrock depth and lithology, and the thickness and lithology of the glacial drift. In most cases, the reliability of descriptions of glacial drift lithology is adequate to poor, but the depth to bedrock is sufficiently reliable for this study. Records of wells with unverified locations provided general information in areas of sparse data coverage. Records of municipal wells for the cities of Montgomery, Aurora, Elgin, St. Charles, and Geneva provided detailed and reliable data on the lithologic units. Published sources of well records in Kane County include Lund (1965), Reed (1975), Woller and Sanderson (1978), Kempton et al. (1985), Kempton et al. (1987a and b), Curry et al. (1988), and Vaiden et al. (1988). Well locations from all these sources are shown on figure 1.

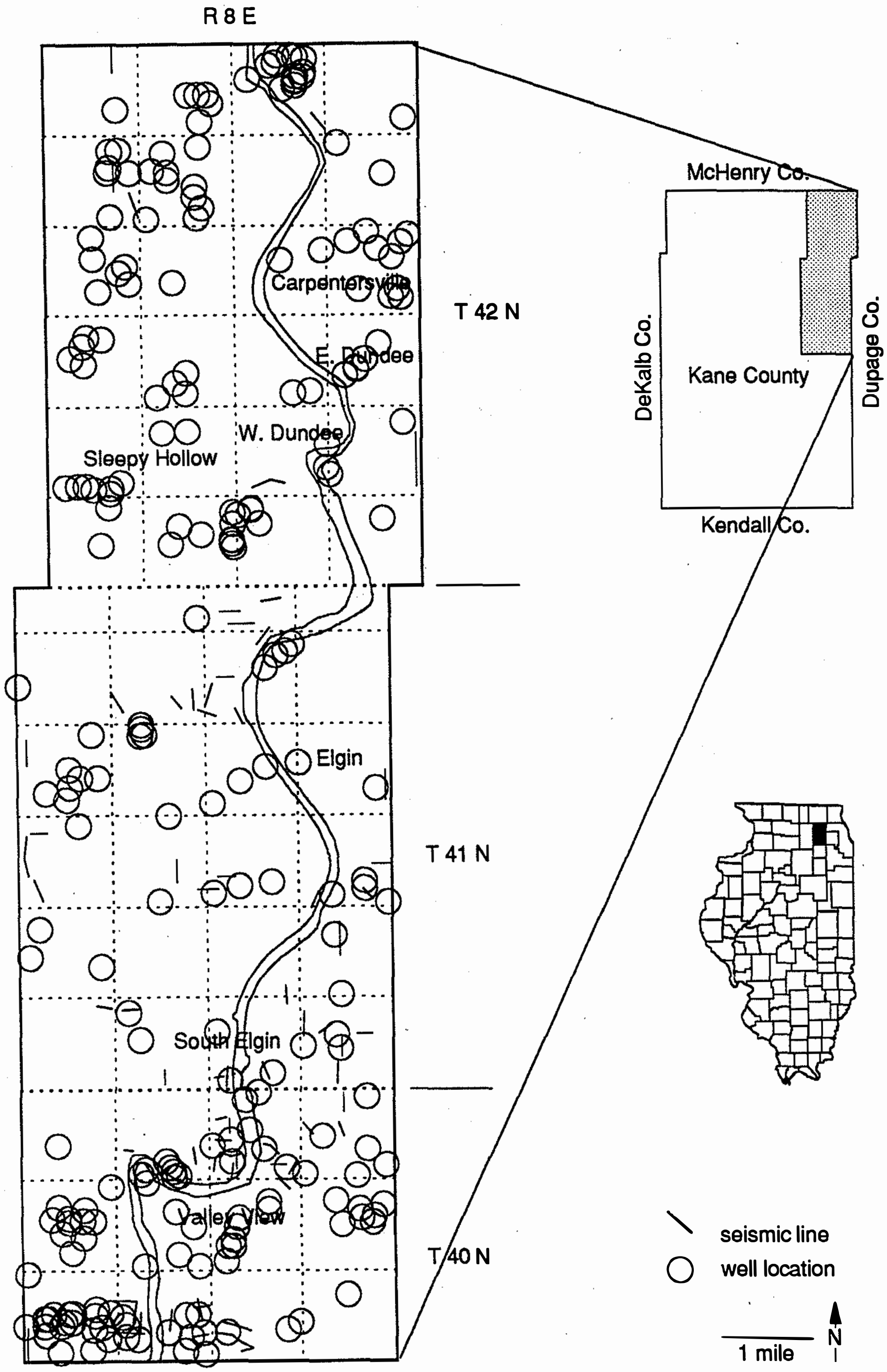

Figure 1 Location of the study area in Illinois. Northern part is above, southern part is on following page. Symbols show locations of wells and seismic lines used as data in this report.

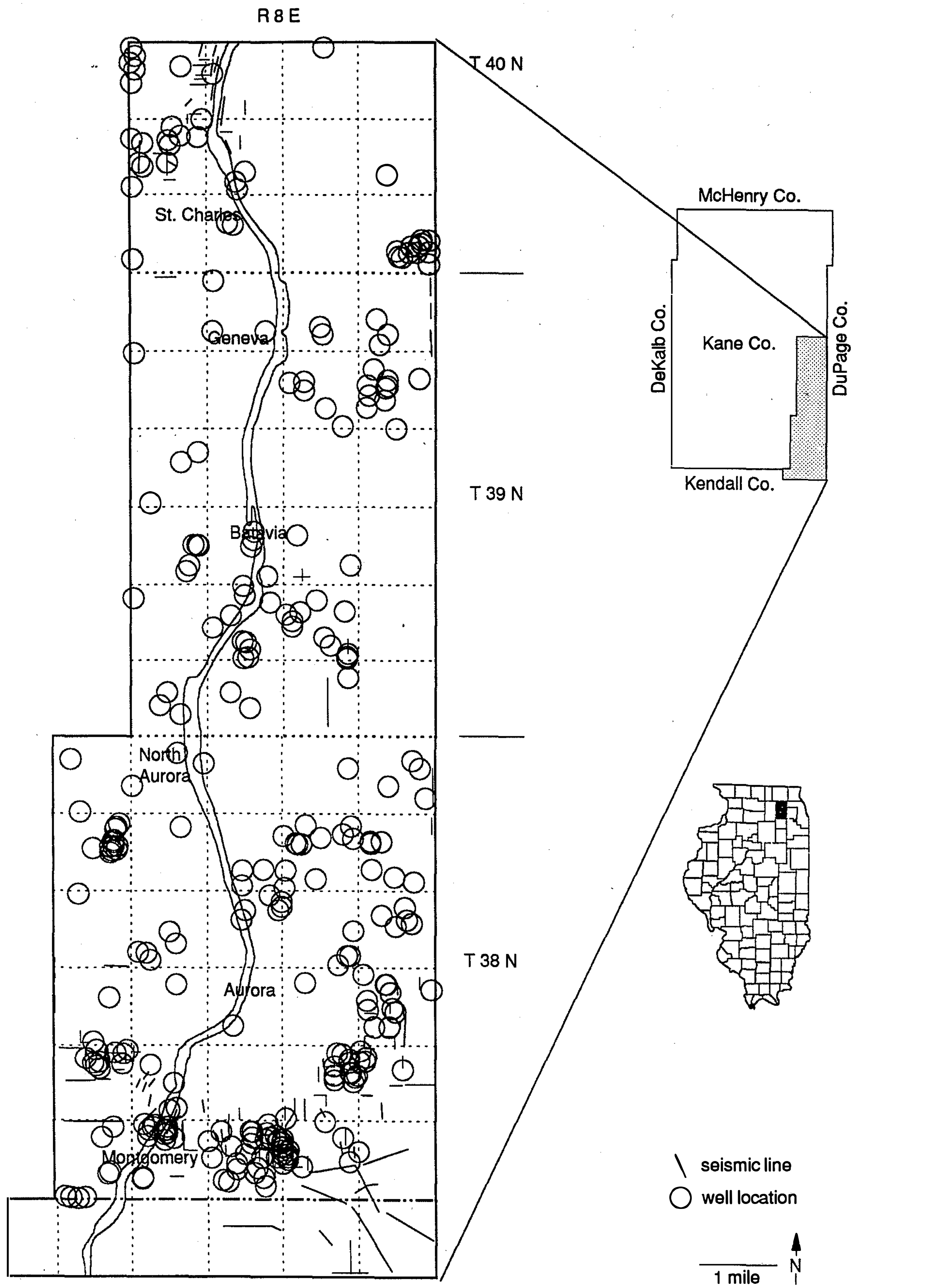

Figure 1 *continued.*

Surficial Geophysical Surveys

Seismic refraction, a surficial geophysical method, was used for mapping of bedrock topography. The locations of seismic surveys in the study area are shown on figure 1. In this procedure, seismic energy traveling through the ground is refracted back to ground surface from the interface between glacial sediments and the bedrock. A buried explosive charge or a weight-drop system provided the energy source to produce seismic waves. Reversed profile seismic data were gathered using a 24-channel signal enhancement seismograph. Geophones were spaced 50 or 100 feet apart along 650 or 1300 foot-long lines, respectively, depending on the thickness of the glacial drift and seismic velocities of the materials. Field data were automatically processed using a modified version of the ray tracing program SIPT-1 (Scott et al. 1972). The SIPT-1 program corrects for irregular surface terrain along the seismic profile and also calculates the depth to bedrock beneath each geophone.

Anomalously great depths to bedrock are calculated from the seismic refraction method in areas where thick sand and gravel deposits are overlain by thick, clay-rich glacial till (Zohdy et al. 1974). Because the sand and gravel layer has a lower seismic velocity than both the overlying till and underlying bedrock, the error in calculated depth is proportional to the thickness of the sand layer and always results in greater calculated depths to bedrock than actually exist. These anomalies are caused by buried sand and gravel, and thus are potential targets for further groundwater resource evaluation.

A second surficial geophysical method, electrical earth resistivity, was used to determine the texture of the glacial sediments. Sand and gravel units have a higher resistivity than finer-grained glacial till in freshwater environments and can be easily identified by this method. Identification is difficult, however, where the sand and gravel deposits are thin or deeply buried (McGinnis and Kempton 1961). Thickness determinations are not possible where the bedrock and overlying glacial deposits have similar resistivities, such as a fine-grained glacial till underlain by a shale, or coarse sand and gravel underlain by dolomite. Therefore, resistivity data were primarily used in conjunction with seismic refraction to identify sand and gravel deposits within the glacial drift.

Test Drilling

Test holes for new municipal water sources were drilled in areas identified as favorable by the geophysical surveys. Test drilling identified aquifer materials, assisted in stratigraphic correlation, and provided information for the design of an aquifer test and production well. Test drilling was done for the cities of Montgomery, Aurora, Geneva, St. Charles, Elgin, and Batavia (Curry and Seaber 1990).

Other test drilling in Kane County, including the area covered by this study, was previously conducted for siting of the SSC. Continuous cores of the bedrock sequence and discontinuous cores of the glacial sequence were collected and suites of geophysical logs were run. Results of this drilling were reported in Kempton et al. (1987a and b), Curry et al. (1988), and Vaiden et al. (1988).

GEOLOGY OF THE FOX RIVER VALLEY

Stratigraphy

The geology of the area includes Precambrian crystalline basement rocks, Paleozoic indurated sedimentary rocks, and Quaternary uncemented sediments. In northern Illinois, the Paleozoic history from 600 million to 245 million years ago is represented by rocks of marine origin (fig. 2) with a maximum thickness of 4,000 feet (Kempton et al. 1985). The Paleozoic rocks in the area are overlain by up to 200 feet of Quaternary sediments.

Bedrock The Paleozoic rocks most significant to the shallow groundwater resources in the area are the Ordovician Maquoketa Group (Kolata and Graese 1983) and the Silurian Kankakee and Elwood Formations (Willman 1973) (fig. 3). The deeper aquifers in the area are beyond the scope of this study, but are discussed in Visocky et al. (1985).

The Maquoketa Group is composed of shale, argillaceous dolomite and limestone, and interbeds of shale and dolomite. This group is present at the bedrock surface in buried bedrock valleys beneath the study area. The regionally important formations of the Maquoketa in the region include, in ascending order, the Scales Shale, Ft. Atkinson Limestone, Brainard Formation, and Neda Formation, but these cannot be readily differentiated in Kane County (Graese et al. 1988). Here, the Maquoketa consists of two sequences composed of basal shales that become increasingly carbonate rich.

The Elwood and Kankakee Formations are composed of thin to medium-thick beds of dolomite; the Kankakee also contains abundant nodules and interbeds of chert. Because the lithology of these units is similar, they are not differentiated in this report.

Quaternary deposits Stratigraphic classification of Quaternary deposits is illustrated on figure 4a. Quaternary sediments consist of glacial till, glacial outwash, glaciolacustrine (lakebed) materials, and eolian (windblown) sediments, and recent deposits along steep slopes and floodplains (Curry and Seaber 1990). The distribution of the surficial drift units is shown on figure 4b. These deposits are the product of a variety of depositional environments associated with major glacial advances and retreats during the period approximately 1.6 million to 14,000 years ago. Successive glacial advances modified the sediments deposited by earlier events and further complicated the geometry of the various units. Since the retreat of the most recent glaciers, glacial deposits have also been modified by erosion. This last process occurred predominantly in fluvial environments such as the present Fox River valley.

The oldest glacial drift identified in Kane County is Illinoian; it may correlate to the Glasford Formation near Rockford in Boone and Winnebago Counties (Berg et al. 1985). Illinoian deposits are covered by Sangamonian and early to middle Wisconsinan colluvium composed of Berry Clay, Robein Silt (Curry 1989, fig 4a), and other organic-carbon-rich silty deposits that have been modified by soil formation. Although these sediments may be as much as 25 feet thick in Kane County, they are more commonly thin or absent (Curry and Seaber 1990).

The late Wisconsinan Wedron Formation and the related Henry and Equality Formations (Willman and Frye 1970) cover the Robein Silt. The bulk of the late Wisconsinan deposits belong to the Wedron Formation; its representative members in Kane County are in ascending order, the Tiskilwa, Malden, Yorkville, and Haeger Till Members (fig. 4a). Till members consist of diamicton (poorly sorted sediment deposited directly or indirectly by glacial ice) interlayered with outwash (well-sorted sand and gravel deposited by glacial meltwater). The Yorkville Till Member is the predominant surficial deposit in the Fox River corridor; the Haeger is present at the surface in the far northeast portion of the area; the Malden and the Tiskilwa are present in the subsurface.

The Henry Formation consists of sand and gravel; its distribution and thickness are relatively well known because of its importance as an aggregate resource (Masters 1978). The Henry is a common surficial deposit in the northern half of the study area.

The Equality Formation is composed of stratified to massive sand, silt, and clay associated with sedimentation in lakes; it occurs in several parts of the study area, usually west of the Fox River. Generally, this formation is less than 20 feet thick, but may be as much as 45 feet thick (Curry and Seaber 1990).

ERA	SYSTEM	Group	FORMATION (thickness in feet)	GRAPHIC COLUMN (not to scale)	DESCRIPTION	Aqui-group
CENOZOIC	QUATERNARY		(0-350)		silt and loess peat and muck sand and gravel diamicton (clay, silt, sand, gravel, and boulders; commonly till)	Prairie
PALEOZOIC	SILURIAN		Joliet-Kankakee (0-50)		dolomite, fine-grained, cherty	Upper Bedrock
			Elwood (0-30)			
			Wilhelmi (0-20)			
	ORDOVICIAN	Maquoketa	(0-210)		shale, argillaceous dolomite and limestone	
		Galena	(155-185)		dolomite, some limestone, fine- to medium-grained, slightly cherty	Midwest Bedrock
		Platteville	(140-150)			
		Ancell	Glenwood-St. Peter (60-520)		sandstone, white, fine- to medium-grained,sandy	
		Prairie du Chien	(0-400)		dolomite, sandstone	
	CAMBRIAN		Eminence (20-150)		dolomite, fine to medium grained, sandy	
			Potosi (90-225)		dolomite, fine grained, trace sand and glauconite	
			Franconia (75-150)		sandstone, fine-grained, glauconitic; green and red shale	
			Ironton-Galesville (155-220)		sandstone, fine- to medium-grained, dolomitic	
			Eau Claire (350-450)		sandstone, fine grained, glauconitic; siltstone, shale, and dolomite	Basal Bedrock
			Mt. Simon (1400-2600)		sandstone, white, coarse grained, poorly sorted	
PRECAMBRIAN (13,000+)					granite	Crystal-line

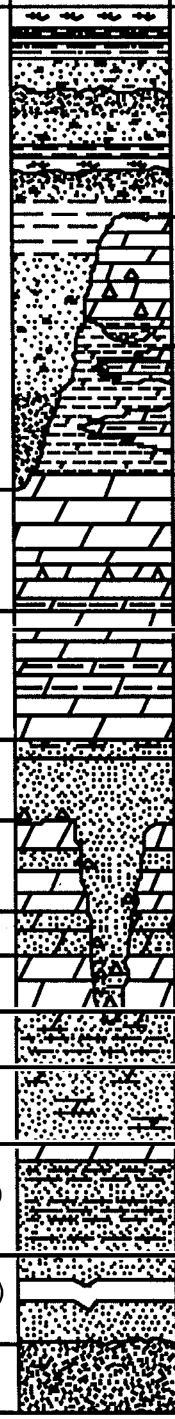

Figure 2 Stratigraphy of rocks underlying eastern Kane County.

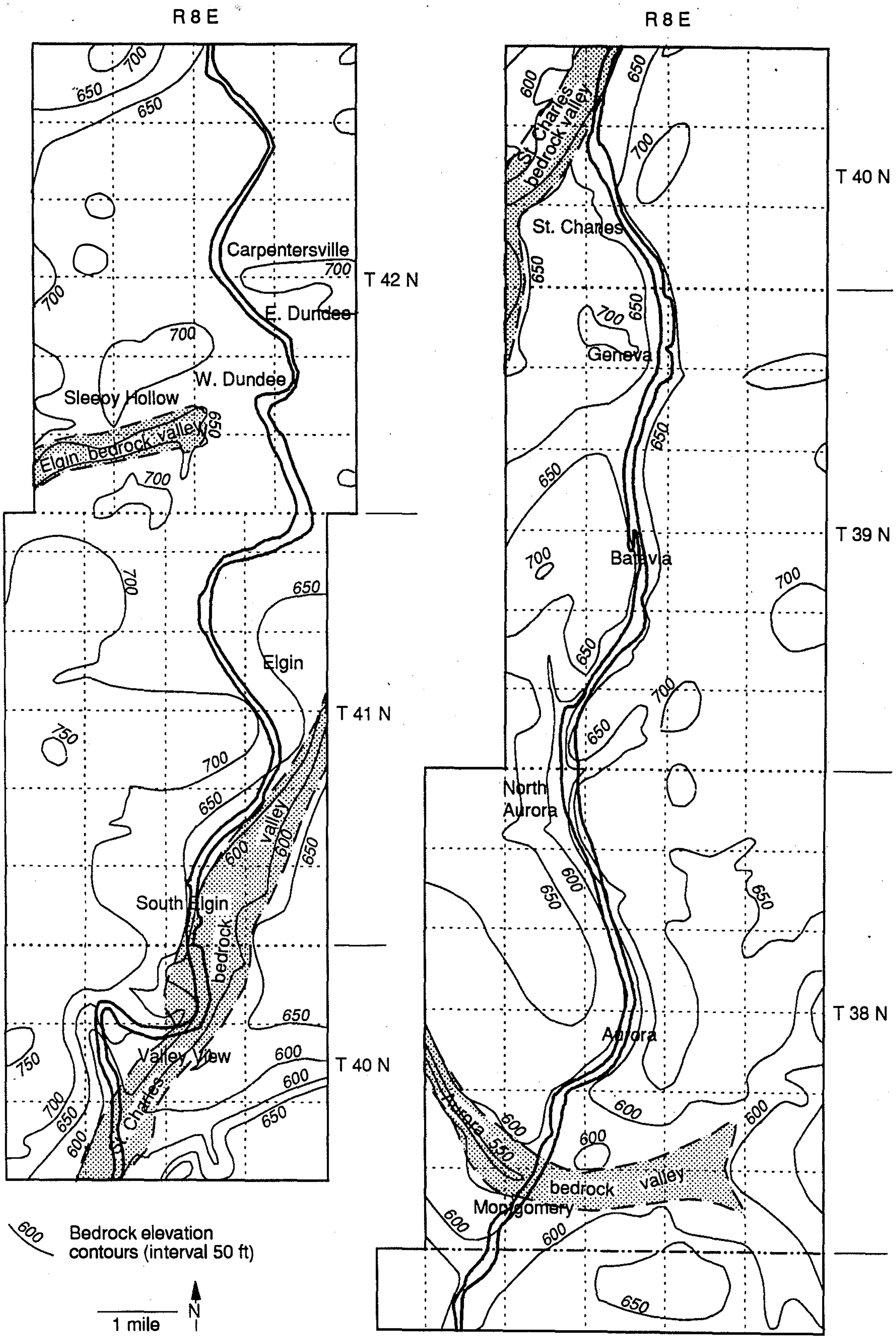

Figure 3 Areal geology of the bedrock surface.

Other minor deposits occur in the study area. Richland Loess mantles the upland landscape, but is generally less than 2 feet thick and has not been included on the maps for this report. Holocene deposits are also thin, and occur along drainage ways, such as in the Fox River valley (Cahokia Alluvium) and in shallow or drained wetlands (Grayslake Peat, fig. 4b).

Bedrock Surface Topography

The bedrock surface of the state was mapped by Horberg (1950), and in Kane County by Graese et al. (1988) and Curry and Seaber (1990). The bedrock surface map in this report (fig. 5) was modified from Curry and Seaber (1990). The bedrock surface is characterized by bedrock uplands dissected by narrow valleys that trend north-south or east-west (Kempton et al. 1985). The buried bedrock surface typically does not follow the present day topography, which is related to Pleistocene glaciation. The bedrock valleys represent a previous drainage system developed prior to glaciation. These ancient valleys were extensively modified and eventually buried by processes related to glacial activity. Elevation of the bedrock surface near the Fox River varies from 480 feet above msl in a buried bedrock valley west of Batavia, to 760 feet on the upland in the northwest corner of T40N, R8E.

Near the Fox River in Kane County, the St. Charles bedrock valley (called the Newark Bedrock Valley in some previous reports) is the major pre-Pleistocene drainage feature of the bedrock surface (fig. 5). The bedrock valley enters the Fox River corridor from the east outside of Elgin. It passes beneath the Fox River near Valley View and exits the area southwest of Geneva. Typical elevations of the deepest portions of the St. Charles bedrock valley are less than 550 feet.

Two major tributaries to the St. Charles bedrock valley occur in the study area. The Aurora bedrock valley enters the corridor in the northern portion of Montgomery and extends westward beyond Aurora (fig. 5). Beneath the Fox River in Montgomery, the floor of the Aurora bedrock valley has an elevation of 575 feet. The Elgin bedrock valley has its head northwest of Elgin and joins the St. Charles bedrock valley west of St. Charles; elevation of this valley floor is about 650 feet.

The elevation of the bedrock surface beneath the Fox River corridor ranges from about 700 to 750 feet. Bedrock in upland areas is exposed along the Fox River from just north of St. Charles to south of Montgomery, except where dissected by the Aurora bedrock valley. The bedrock valley floors are generally composed of Maquoketa Group shale and dolomite, whereas the surface of the upland is composed of Silurian dolomite of the Kankakee and Elwood Formations (fig. 3).

Glacial Drift Thickness

Variations of glacial drift thickness are the result of bedrock topography, glacial landforms such as moraines, and erosion in postglacial environments. The glacial drift in the study area is up to 200 feet thick in the St. Charles bedrock valley. Formation of glacial moraines resulted in thick drift which may not be associated with bedrock topography. Moraines formed at locations where ice margins remained relatively stable over long periods of time, and where ridges of glacial materials were deposited. An example of this occurs west of Carpentersville in the northern part of the study area, where drift thickness locally exceeds 250 ft above a relatively flat bedrock surface. Another example occurs east of North Aurora and Batavia, where drift thickness varies from 50 to 100 ft above flat bedrock uplands.

Erosion also controls drift thickness, particularly along the Fox River. Erosion of glacial materials occurred during the formation of the Fox River valley, resulting in relatively thin drift along the course of the river. Bedrock exposures occur along the Fox River where a combination of high bedrock elevations and erosion along the river has resulted in removal of

System	Series	Stage	Formation / Member	Graphic Column	Genetic Interpretation of Materials and Description
QUATERNARY	HOLOCENE		Cahokia Alluvium		Alluvium — sand, silt, and clay deposited by streams
			Grayslake Peat		Peat and muck, often interbedded with silt and clay
	PLEISTOCENE	WISCONSINAN	Equality Fm		Lake deposits — stratified silty clay and sand
			Henry Fm		Outwash — sand and gravel
			Wedron Fm: Haeger		Till — yellowish brown loam; extensive, thick basal sand and gravel
			Wedron Fm: Yorkville		Till — yellowish brown to gray silty clay loam*
			Wedron Fm: Malden	Not Exposed At Ground Surface	Till — yellowish brown to brownish gray loam to clay; extensive basal sand and gravel west of the Fox River*
			Wedron Fm: Tiskilwa		Till — pinkish brown to grayish brown clay loam*
		SANGAMONIAN	Robein Silt		Buried soil developed into alluvium, colluvium or bog deposits — organic rich silt, sand and clay.
			Berry Clay		Accretion-gley — colluvium
			Pearl Fm		Outwash — sand and gravel
		ILLINOIAN	Glasford Fm: Esmond		Till — gray silty loam
			Glasford Fm: Herbert		Till — pink sandy loam; extensive basal sand and gravel

d — disturbed (quarries, sand and gravel pits)

* till interbedded with sand and gravel

Figure 4a Stratigraphy of glacial drift (Prairie Aquigroup) underlying eastern Kane County.

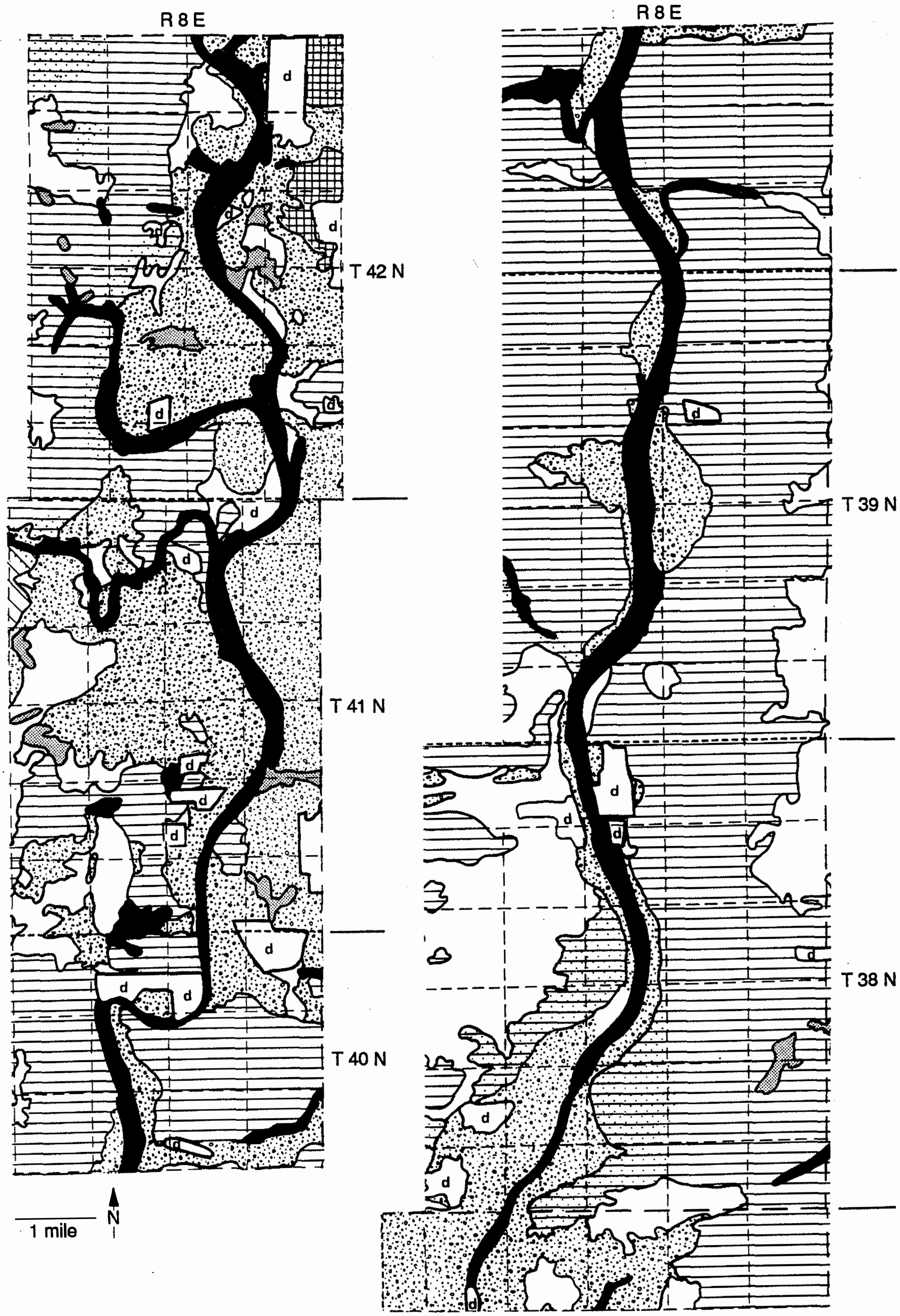

Figure 4b Surficial drift map of the Fox River corridor.

all the drift. Erosion along the Fox River also has hydrologic significance for drift-filled bedrock valleys because in some cases the Fox River has cut through overlying tills and into sand and gravel deposits within the bedrock valleys. This interconnection affects the hydraulic relationship of the Fox River with the shallow aquifers, and will be discussed in a following section. Locations where the Fox River crosses buried bedrock valleys are shown on figure 5.

HYDROGEOLOGY ALONG THE FOX RIVER VALLEY

Hydrostratigraphy

Visocky et al. (1985) formally defined the two major shallow hydrostratigraphic units in northern Illinois as the Upper Bedrock Aquigroup and the Prairie Aquigroup. Although no formal hydrostratigraphic classification of subunits within these aquigroups now exists, Curry and Seaber (1990) defined informal subunits for the Prairie Aquigroup in Kane County. For consistency, we have maintained their terminology as a working model of the local hydrostratigraphy. Table 1 shows how the hydrostratigraphic units used in this report compare with the terminology used previously for drift aquifers.

Upper Bedrock Aquigroup

The Upper Bedrock Aquigroup consists of local and intermediate flow systems in indurated sediments with open hydraulic connection with the glacial drift that composes the Prairie Aquigroup. In Kane County, the aquigroup consists of rocks of Ordovician and Silurian age.

The most significant and productive part of the aquigroup is composed of Kankakee and Elwood Formation dolomites, informally known as the "dolomite aquifer" or "shallow dolomite aquifer" (figs. 2 and 3). This aquifer sustains pumping rates as great as 100 to 200 gpm (Visocky et al. 1985). Within the study area, where Silurian rocks thin to the west, the Maquoketa Group occurs at the bedrock surface. Where the Maquoketa Group rocks are predominantly shale, the Upper Bedrock Aquigroup is much less productive. The hydrogeology and yields of these units are discussed in detail by Csallany and Walton (1963). Packer test data for these units are presented in Kempton et al. (1987a and b) and summarized in Curry et al. (1988).

Prairie Aquigroup

Prairie Aquigroup deposits are Quaternary in age; most date from late Pleistocene deposits of Illinoian and Wisconsinan age. In Kane County, the Prairie Aquigroup has local and

Table 1 Comparison of classifications of drift aquifers used in Kane County

McFadden et al. (1989)	Schicht et al. (1976)	Graese et al. (1988)	Curry and Seaber (1990) and this report
			Prairie Aquigroup:
Upper sand and gravel aquifer	Surficial sand and gravel aquifer	Surficial drift aquifer	Valparaiso aquifer Kaneville aquifer of Elburn aquiformation
	Interbedded sand and gravel aquifer	Basal drift aquifer	Bloomington aquifer
Lower sand and gravel aquifer	Basal sand and gravel aquifer	Buried drift aquifer	St. Charles aquifer

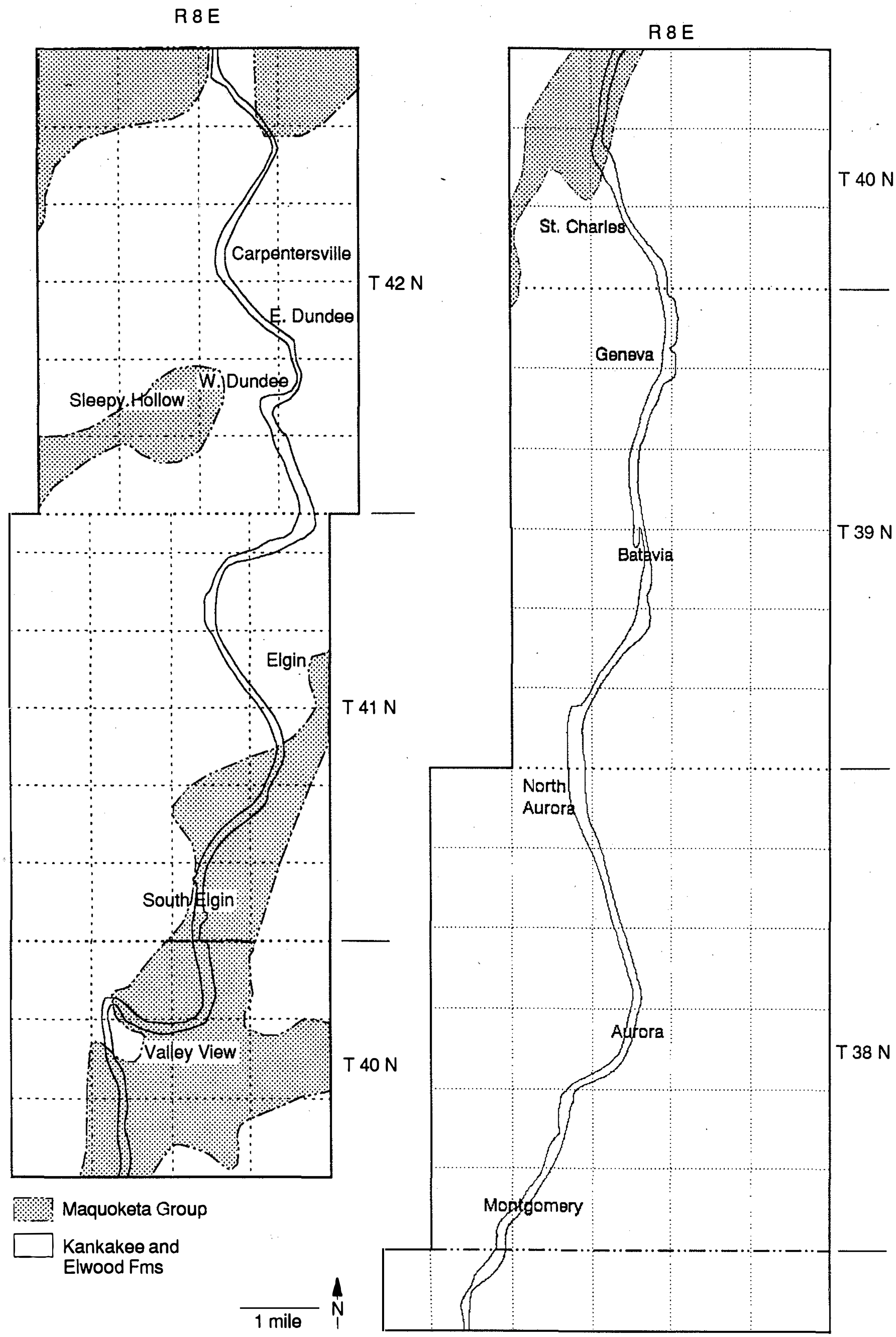

Figure 5 Elevation of the bedrock surface.

intermediate flow systems in uncemented geologic materials consisting of glacial drift, alluvium, and other sediments. The aquifers are confined locally by fine-grained sediments. Recharge to the system is mainly from local precipitation. Of the six hydrostratigraphic units informally recognized by Curry and Seaber (1990) in Kane County (Table 2), five are current contributors to base flow along the Fox River corridor. The distribution of the three major aquifers is shown on figure 6. The vertical relation of these aquifers and associated aquitards is illustrated on a series of cross sections (figs. 7 a-d). Figures 7a, b, and c are drawn at three locations within the corridor. Figure 7d extends the length of the corridor. This last cross section only approximates the geometry of the valley. The actual valley geometry varies considerably depending on lateral proximity to the river.

St. Charles aquifer The St. Charles aquifer is composed chiefly of sand and gravel of the Wedron and the Glasford Formations. It occurs primarily within the buried St. Charles bedrock valley and tributaries where it exceeds 100 feet in thickness west of Geneva. The distribution of the St. Charles aquifer is shown on figure 6. Because of the complex relationship between diamicton and outwash, the boundary of the sand and gravel within the St. Charles aquifer as shown on figure 6 is only approximate.

Marengo aquitard The Marengo aquitard is chiefly made up of diamicton (till) of the Tiskilwa Till Member of the Wedron Formation (Wickham et al. 1988) and the Herbert Till Member of the Glasford Formation (Graese, et al. 1988). The aquitard covers the St. Charles aquifer in much of the northern and extreme southern sections of the study area. The relationship between aquitard and aquifer is illustrated on figure 7a in the Montgomery area and on figure 7d, which extends the length of the corridor.

The Marengo aquitard has a field-measured hydraulic conductivity on the order of 10^{-6} to 10^{-8} cm/sec (Jennings 1987). Materials with such low hydraulic conductivities restrict the flow of water and contaminants. Where the Marengo aquitard occurs above the St. Charles aquifer, well yields within the aquifer may be reduced. However, the presence of the overlying aquitard provides the underlying aquifer some protection from surface contamination. Relatively small bodies of sand and gravel have occasionally been found in the Marengo aquitard, but these supply only small amounts of groundwater (Graese et al. 1988).

Kaneville aquifer member, Elburn aquiformation The Elburn aquiformation, underlying most of central and south-central Kane County, is primarily an aquitard composed mainly of diamicton with some lacustrine deposits; it also contains related bodies of sand and gravel outwash that can be considered aquifers. In the Fox River corridor, the Elburn aquiformation is composed chiefly of the silty clay loam diamicton of the Yorkville Till Member and the clay to loam diamicton of the Malden Till Member. Both till members belong to the Wedron Formation. Portions of the Elburn may also be part of the Henry Formation. The Kaneville aquifer member of the Elburn aquiformation represents the ice-contact and outwash sand and gravel sequences of these units (fig. 6). The Elburn aquiformation primarily occupies the upland portions of the area and occasionally overlies portions of the St. Charles aquifer (fig. 6).

Table 2 Informal hydrostratigraphic hierarchy in Kane County (modified from Curry and Seaber 1990)

Aquigroup	Aquiformation	Aquimember
Prairie	Valparaiso aquifer	
	Elburn aquiformation	Kaneville aquifer member
	Bloomington aquifer	
	Pingree Grove aquiformation	
	Marengo aquitard	
	St. Charles aquifer	

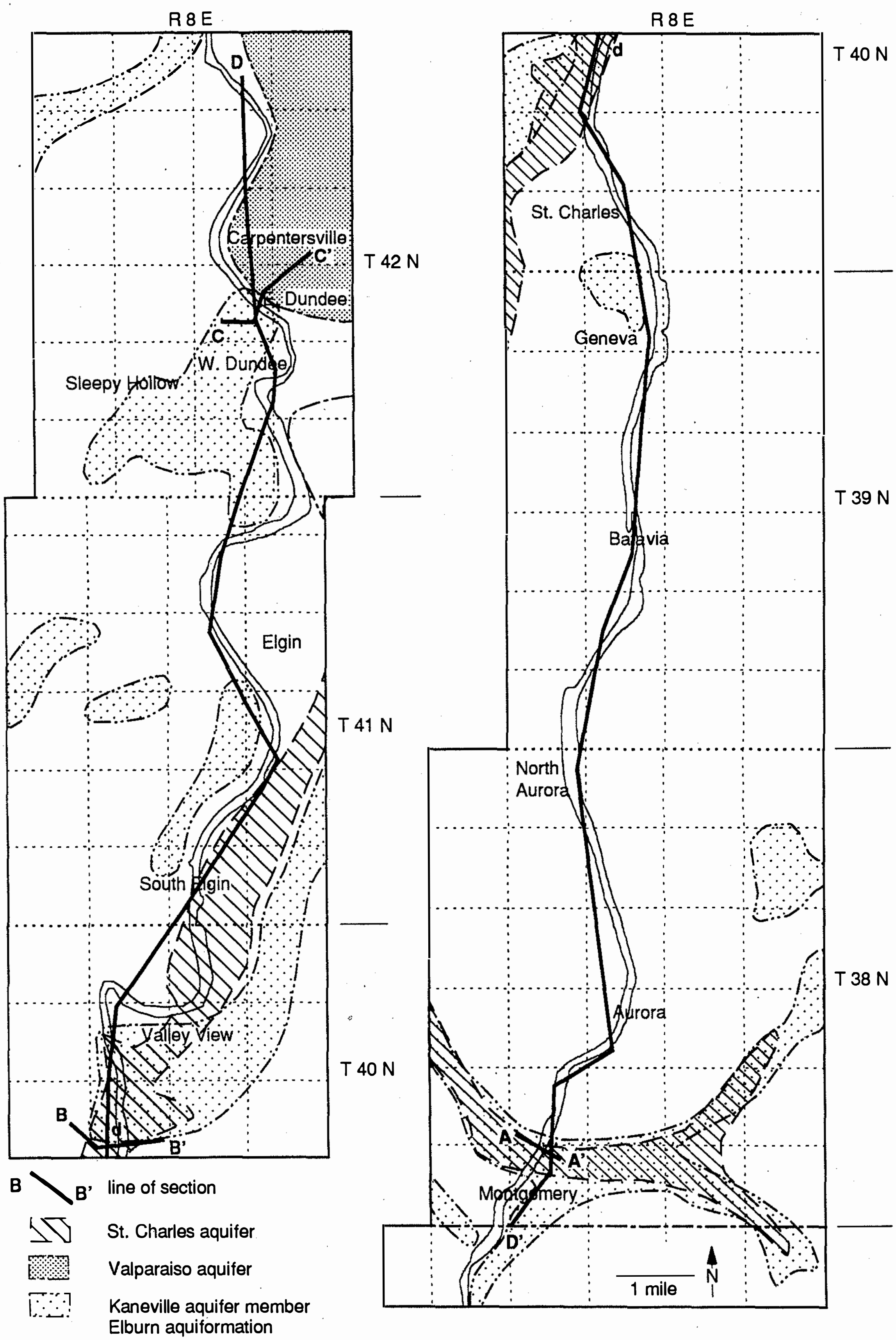

Figure 6 Major aquifers of the Prairie Aquigroup within the Fox River corridor.

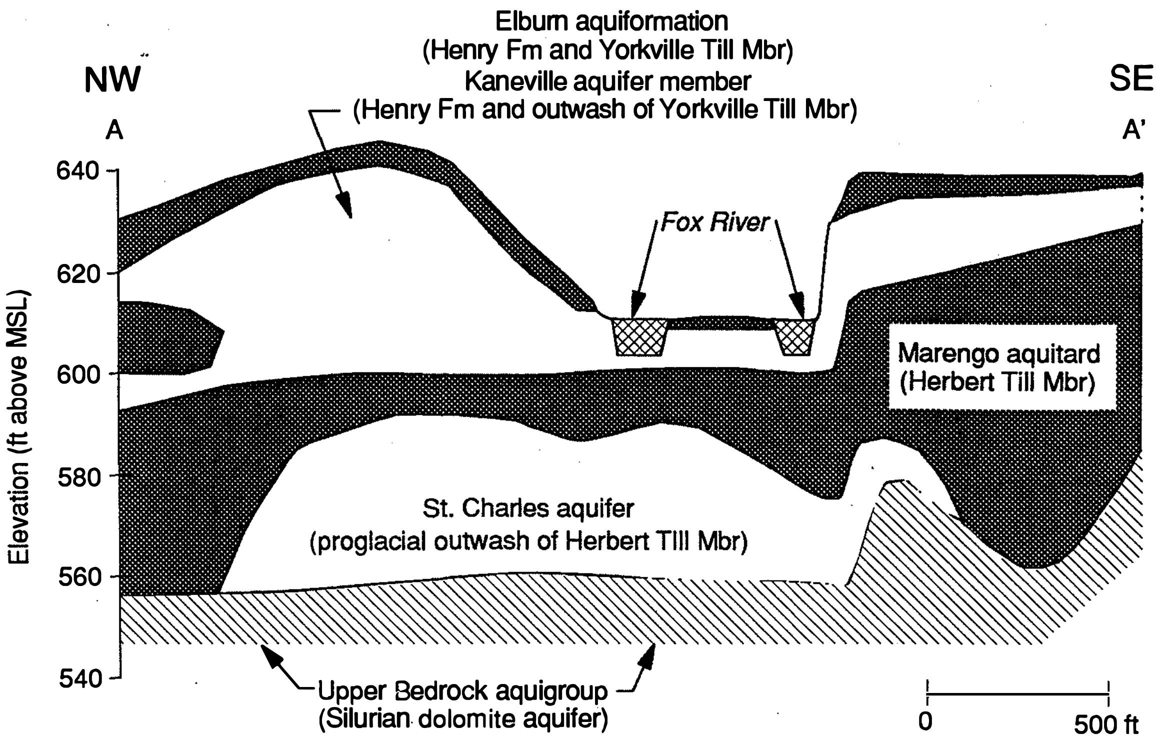

Figure 7a Cross section of the Fox River valley in the Montgomery area.

At most of the locations where the Kaneville aquifer member and St. Charles aquifer overlap, they are separated by the Marengo aquitard (fig. 7a). At some locations, however, the Marengo aquitard is missing and the two aquifers are mapped together (fig. 7b). The combined thickness of the two aquifers exceeds 100 feet north of St. Charles (figs. 7b and d). The top of the Kaneville aquifer member occurs at depths of 10 feet or less in many locations. Groundwater protection is an environmentally important concern in these areas, because the aquifer may be susceptible to contamination from surface sources.

Valparaiso aquifer Although not extensive in the study area, the Valparaiso aquifer is a productive drift aquifer in northeastern Illinois (Curry and Seaber 1990). The Valparaiso aquifer is composed of outwash of the Henry Formation and Haeger Till Member of the Wedron Formation. It occurs immediately below ground surface in the northeastern corner of the study area (figs. 6, 7c, and 7d).

Pingree Grove aquiformation This unit is composed of stratified sands, silt, clay, marl, and peat. It is often associated with drained or existing lakes and bogs, and may be dissected by rivers and streams. The Pingree Grove aquiformation is composed of the Equality Formation, Grayslake Peat, and Cahokia Alluvium (Curry and Seaber 1990). As a wetland area, this unit is an environmentally important resource, and is found at several locations in the study area such as Mooseheart Lake, Peck Lake, and Nelson Lake. We did not consider it an aquifer in this area, however, and did not included it in this investigation.

The cross sections of figure 7 illustrate some of the complexities of the hydrogeologic relationships. Section A-A' (fig. 7a), located at the Fox River in Montgomery, shows the Aurora bedrock valley where it crosses under the Fox River. The St. Charles aquifer partially fills the

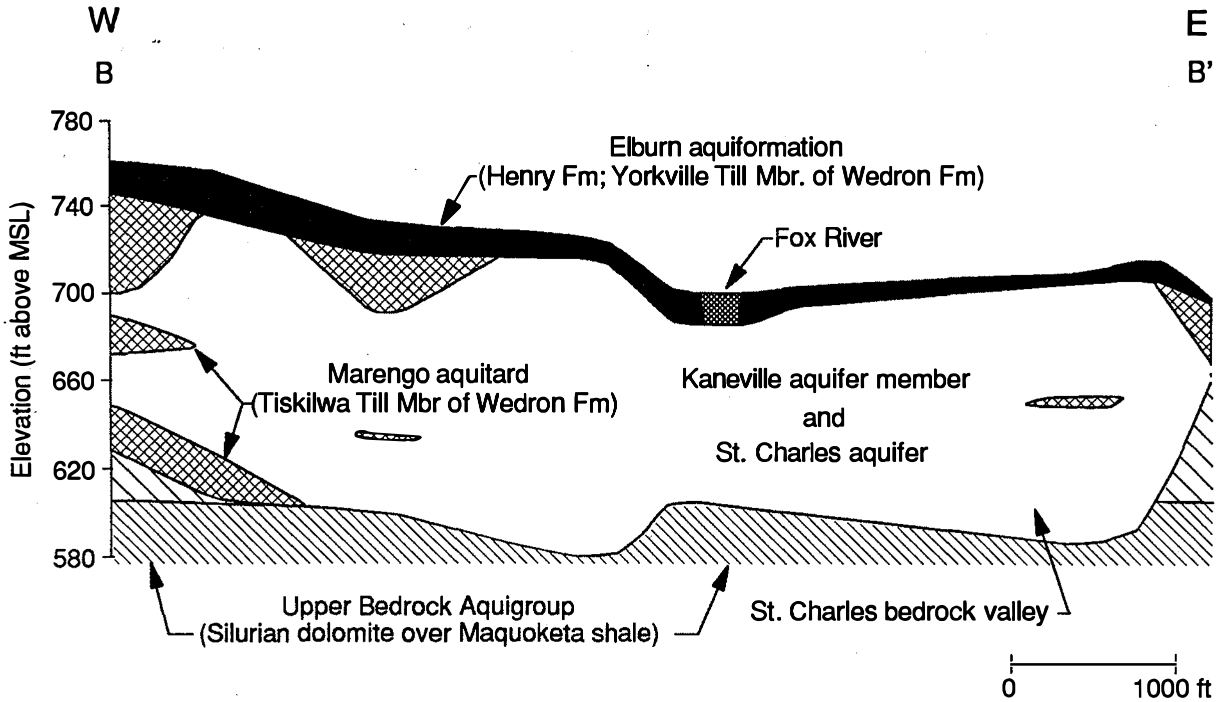

Figure 7b Cross section of the Fox River valley north of St. Charles.

bedrock valley. The Marengo aquitard fills the rest of the bedrock valley and separates the St. Charles aquifer from the Kaneville aquifer member that lies above. The Fox River has eroded into the Elburn aquiformation, but the St. Charles aquifer is still separated from the river by 10 to 20 feet of the Marengo aquitard. As the bedrock elevations rise and the drift thins toward the valley walls, the St. Charles aquifer pinches out leaving the Marengo aquitard in direct contact with bedrock.

Figure 7b, a cross sectional view farther north where the St. Charles bedrock valley crosses beneath the Fox River valley, shows a contrasting relationship. At this point, the main channel of the St. Charles bedrock valley crosses beneath the Fox River and the Kaneville aquifer member directly overlies the St. Charles aquifer, forming one continuous aquifer with a combined thickness of more than 100 feet. The Fox River flows over this aquifer. In the northern portion of the study area, the St. Charles aquifer is less extensive, but in this area the Kaneville aquifer member and the Valparaiso aquifer form thick aquifers (figs. 6 and 7c). In the Carpentersville and East Dundee areas, the southwest margin of the Valparaiso aquifer borders the alluvial and outwash deposits within the Fox River valley. On figure 7c, the valley-fill materials are assigned to the Kaneville aquifer member because they are distinctly different from deposits of the St. Charles aquifer that occur south of Elgin. An arbitrary boundary has been drawn between the Valparaiso aquifer and the Kaneville aquifer member on figure 7c; however, the two aquifers are connected hydraulically and, in places, are also connected hydraulically with the Fox River.

Figure 7d shows a longitudinal cross section along the Fox River in Kane County, and illustrates the range of hydrogeologic environments. Glacial drift as much as 140 feet thick fills the bedrock between St. Charles and Elgin. The St. Charles aquifer generally fills the base of the bedrock valleys and is commonly overlain by the Marengo aquitard. Elsewhere, a similar relationship is found between the Kaneville aquifer member and unnamed aquitards of the Elburn aquiformation.

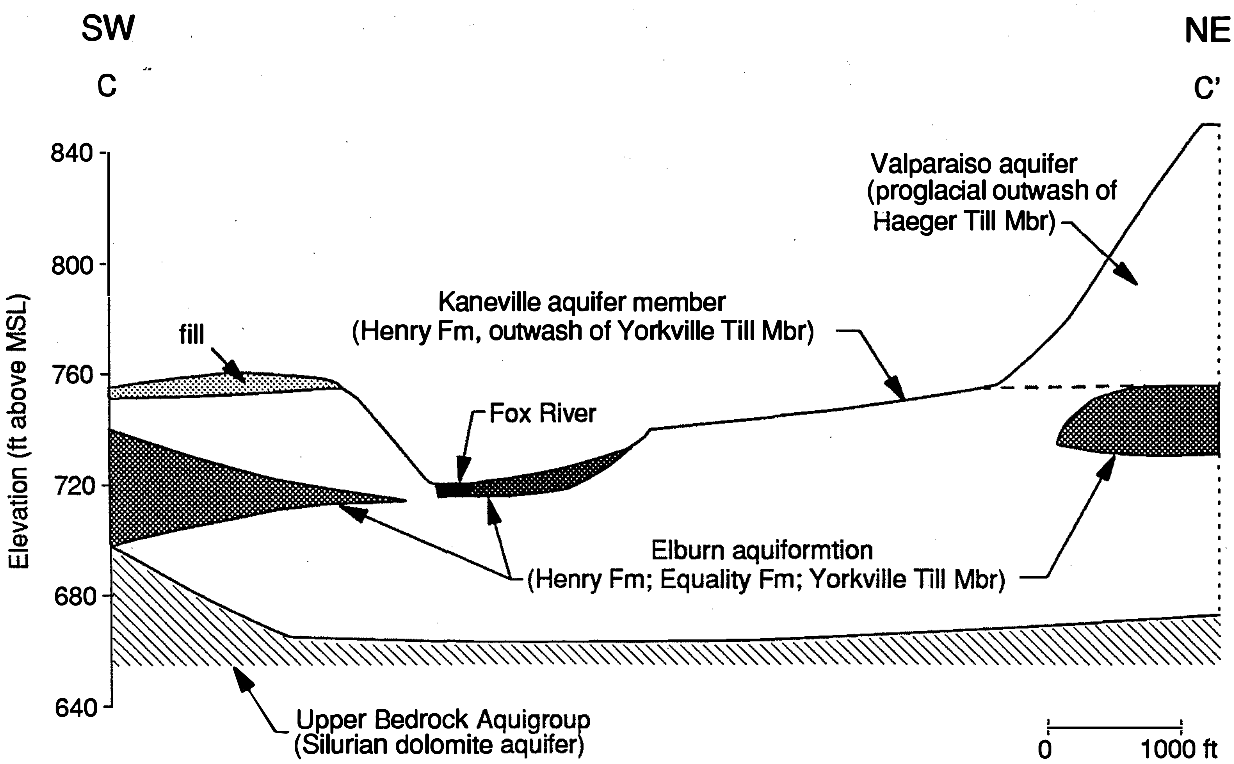

Figure 7c Cross section of the Fox River valley in the Dundee-Carpentersville area.

In general, thickness of the Prairie Aquigroup aquifers increases with total drift thickness (fig. 7d). Drift is relatively thin outside of buried bedrock valleys in the southern two-thirds of the area. South of South Elgin, the Kaneville aquifer member is commonly less than 30 feet thick. Local exceptions occur southwest of Montgomery, northeast of Aurora, northwest of Geneva, and southwest of Valley View in association with the St. Charles bedrock valley; the Kaneville aquifer member is up to 80 feet thick in these areas. North of South Elgin the Kaneville aquifer member thickens even though it is not associated with the buried bedrock valleys (fig. 7d). Areas where the Valparaiso aquifer is 50 to 150 feet thick occur in East Dundee, in eastern Carpentersville and in the extreme northeastern corner of the study area. The distribution and thickness of aquifers (figs. 6 and 7) were determined from well records and resistivity profiles. However, the maps should be interpreted as general conditions that could be encountered within the defined areas. Because of the variability of the extent and thickness of glacial deposits, lack of reliable data for some areas, and uneven distribution of data, it is possible that local conditions will vary from those described in these figures.

HYDROGEOLOGIC ENVIRONMENTS ALONG THE FOX RIVER VALLEY

A variety of hydrogeologic environments along the Fox River in Kane County affects the relationship of surface water and groundwater. Broeren and Singh (1987) found that some sections of the Fox River in Kane County gained base flow while other sections lost flow. The losses are not necessarily an indication that sections of the Fox River lose water to shallow aquifers, but that the net natural and artificial gains to flow unaccounted for in the water budget analysis are exceeded by the unquantified net losses to flow. Net gains to flow include groundwater discharge, flow from tributaries and discharges by man; net losses to flow include groundwater recharge, evaporation, and consumptive withdrawals by man. Under natural conditions, in an environment such as northeastern Illinois, shallow groundwater generally discharges to surface streams. If there are withdrawals from aquifers hydraulically connected with surface streams, drawdowns in the aquifers may be of sufficient magnitude to reverse the

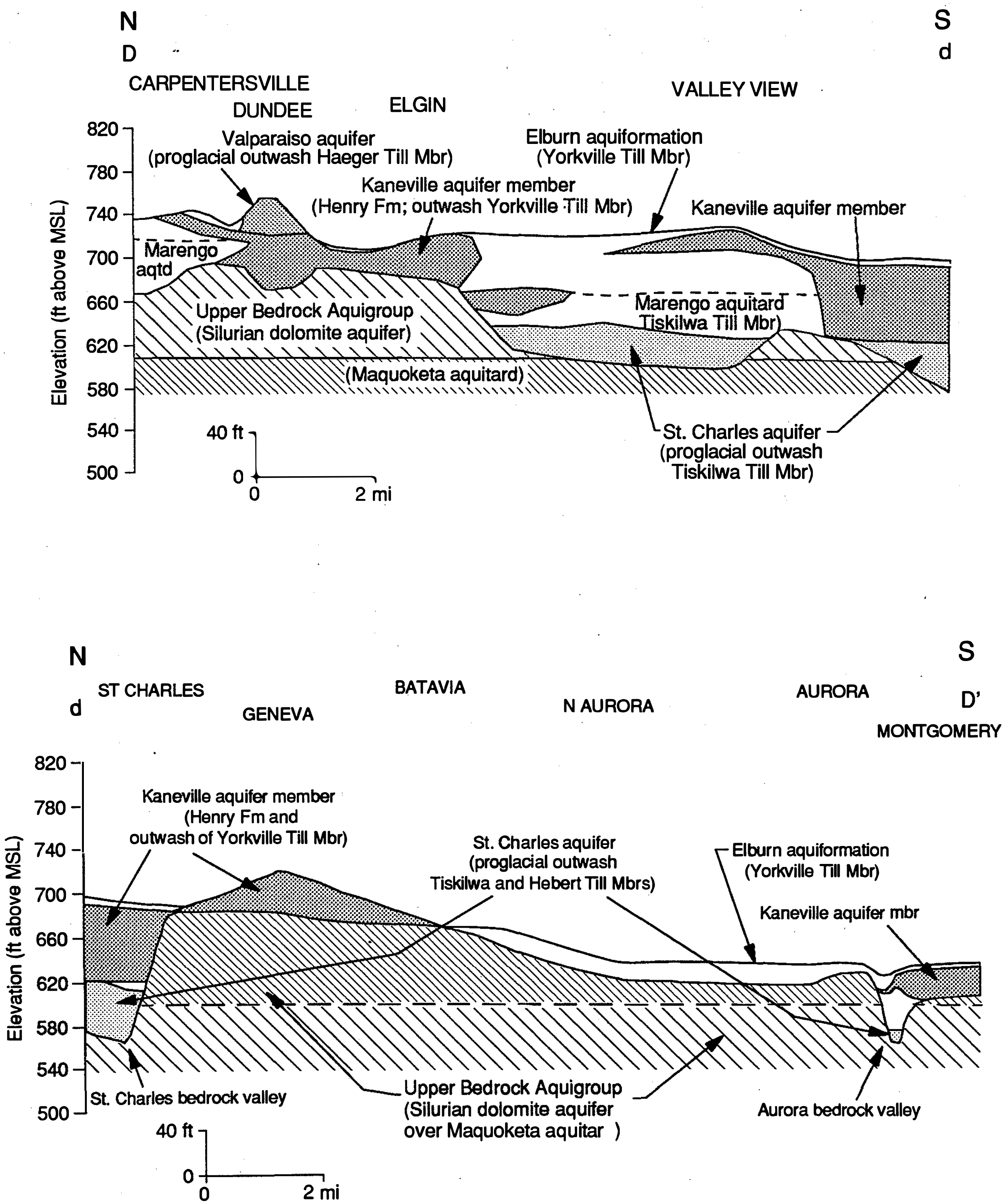

Figure 7d Longitudinal cross section of the Fox River valley from north of Carpentersville to south of Montgomery.

natural head relationships favoring groundwater discharge to streams. Discharge patterns are modified on a seasonal basis by bank storage. A limited amount of discharge from storage occurs during low flow, however it has no effect on the long-term base flow of the Fox River.

A major purpose of this study and its companion (Broeren and Singh 1987) is to identify those aquifers that can be developed with possible beneficial effects, and those that may have detrimental effects on Fox River base flow. A minimum base flow is required to maintain water quality. Development of aquifers not hydraulically connected with the Fox River can increase flow in the river because of treated wastewater discharge. Conversely, water pumped from aquifers connected with the Fox River may reduce groundwater discharge and have a detrimental effect on the water quality of base flow.

Aquifers Not Hydraulically Connected with the Fox River

Aquifers that have limited hydraulic connection with the Fox River are those aquifers, whether shallow or deep, that are isolated from the river by relatively thick aquitards. The Basal and Midwest Bedrock Aquigroups (fig. 2), which have historically been the major source of public water supply in Kane County, are effectively isolated from the Fox River by thick aquitards in the Galena and lower Maquoketa Groups (fig. 2). Use of these aquifers has had a beneficial effect on flow in the Fox River, because treated waste water discharged to the river contains a large percentage of water from these aquifers. Because of declining water levels and increasing concern over water quality (high radium concentrations and, in some areas, high barium and salinity levels), use of the deep aquifers has been declining. This trend will likely continue as use of shallow aquifers and surface water increases.

The Upper Bedrock Aquigroup (fig. 2) is locally capable of producing water in sufficient quantities for public supply. The permeability of aquifers in the aquigroup depends on fracture development, which is a local condition. However, the shallow dolomite can be productive locally, sustaining pumping rates as great as 100 to 200 gpm (Visocky, et al. 1985).

In several areas of the Fox River valley, the Marengo aquitard and aquitards in the Elburn aquiformation separate the river and the bedrock. In these areas, aquifers in the Upper Bedrock Aquigroup can be assumed to be hydraulically isolated from the Fox River. These areas are (fig.1): from the Kane-Kendall county line to south Aurora; from St. Charles to South Elgin; from Elgin to West Dundee; and from Carpentersville north to the Kane-McHenry county line.

Aquifers in the Prairie Aquigroup are complex in their geometry and hydraulic interconnection. Although extensive test drilling and aquifer testing are needed to evaluate hydrologic relationships in detail, the general relationships with the Fox River and the Upper Bedrock Aquigroup are shown on figure 7d. At most locations, the St. Charles aquifer is isolated from the ground surface and the Fox River by the Marengo aquitard (fig. 7a, 7d). By contrast, the Kaneville aquifer member generally is interconnected with the Fox River and supplies some portion of the river's base flow. An exception is the Kaneville aquifer near Montgomery. Although figure 7a shows the Fox River cut into the aquifer, tests performed at this location demonstrate that the aquifer is not hydraulically connected with the river (Gilkeson, et al. 1987, McFadden et al. 1989). Fine-grained bottom sediments in the Fox River (Pingree Grove aquiformation) probably isolate the two hydraulic systems from each other.

Aquifers Hydraulically Connected with the Fox River

Aquifer mapping and a small number of aquifer tests in the study area demonstrate hydraulic interconnection of several shallow aquifers with the Fox River. Included in this group are aquifers in both the Upper Bedrock and Prairie Aquigroup.

In areas of high bedrock elevation, the Fox River has eroded through the glacial drift and into the upper bedrock units. In these areas, the fractured dolomite, where it is present, discharges water into the Fox River. It is not possible, with the data currently available, to quantify this discharge, although it is likely to be highly variable and dependent in part on fractures in the dolomite and base level of the Fox River. These areas include: Aurora north to St. Charles; South Elgin north to the southern area of Elgin; and local areas in southern Carpentersville (fig. 5).

The St. Charles aquifer is generally isolated from the Fox River; a hydrologically important exception occurs in the St. Charles bedrock valley north of St. Charles (figs. 6, 7b, and 7d) where the St. Charles aquifer is probably continuous with the Kaneville aquifer member, forming a single, thick sequence of permeable materials. An aquifer test performed at St. Charles Well No.10 on the west bank of the Fox River indicated hydraulic interconnection of the river and the aquifer (Visocky, personal communication, 1988). Broeren and Singh (1987, p. 19 and Table 12, p. 29) found the reach of the Fox River between West Dundee and St. Charles to be the only section of the river in Kane County to be gaining flow. Their conclusion, that this reach of the river may have a higher base flow accretion than the other reaches, is supported by the work of this report, which demonstrates interconnection of the Fox River with the extensive St. Charles aquifer in the St. Charles bedrock valley. It is probable that the combination of the St. Charles aquifer and Kaneville aquifer member at this location discharges more groundwater to the Fox River than any other aquifer in Kane County.

The Kaneville aquifer member and the Valparaiso aquifer may also contribute to the base flow of the Fox River, especially north of Elgin where the glacial sediments are generally thicker. The Valparaiso aquifer is a valuable source of water for East and West Dundee and Carpentersville. Although the Valparaiso aquifer might be expected to contribute significantly to the base flow of the Fox River, Broeren and Singh (1987, Table 12, p. 29 and p. 32-33) found that the reach of the river north of Kane County and West Dundee was losing flow. They suggested that withdrawals of groundwater in the area have reduced the base flow contribution of the aquifer. However, most of the wells in East and West Dundee and Carpentersville are not located near the river. The impact of withdrawals on gradients and flow direction in the Prairie Aquigroup aquifers is not well known and is a subject for additional investigation. Another possibility is that fine-grained sediments in the riverbed may effectively limit groundwater discharge. A third possibility is that the river flow equation of the Broren and Singh (1987) study may have included incomplete terms.

FINDINGS

Summary

Hydrogeologic environments along the Fox River valley in Kane County were mapped using well records, surficial geophysical methods, and borehole logging (figs. 6, 7a-7d). The purpose of the study was to identify shallow aquifers which may be contributing to the base flow of the Fox River through discharge of groundwater into the river.

A minimum base flow is needed to maintain water quality, a primary consideration, as use of the Fox River as a public water supply is expected to increase. Public water suppliers in eastern Kane County have traditionally relied on aquifers in the Basal and Midwest Bedrock Aquigroups, but use of these sources has been affected by overpumping and water quality problems. Alternative sources now being developed include shallow aquifers in the Upper Bedrock and Prairie Aquigroups as well as the Fox River. Concern that development of these shallow aquifers will reduce the groundwater contribution to the Fox River base flow prompted this study. However, water produced from aquifers not hydraulically connected with the Fox River could add to the base flow through the pathway of treated wastewater discharge.

Conclusions

Five conclusions resulted from this study.

- Shallow aquifers are numerous along the Fox River in Kane County both in the shallow bedrock and glacial drift. The shallow bedrock aquifer consists of fractured limestone and dolomite in the Upper Bedrock Aquigroup (fig. 3). Glacial drift sand and gravel aquifers (fig. 6) are present within buried bedrock valleys (St. Charles aquifer) and in deposits covering the bedrock uplands (Kaneville aquifer member of the Elburn aquiformation and the Valparaiso aquifer).

- Aquifers in the Upper Bedrock Aquigroup may be hydraulically connected with the Fox River in areas of bedrock highs where the glacial drift is thin or absent. These areas are: Aurora north to St. Charles; South Elgin north to the southern area of Elgin; and local areas in southern Carpentersville.

- The St. Charles aquifer is generally isolated from the Fox River by the Marengo aquitard except where the Marengo aquitard is absent (fig. 7d). The St. Charles aquifer in the St. Charles bedrock valley is potentially the most productive aquifer in the Prairie Aquigroup in Kane County, and apparently contributes to the base flow of the Fox River where it crosses under the river north of St. Charles (fig. 6).

- The Valparaiso aquifer is thick and forms a productive shallow aquifer north of Elgin, particularly in the area of East and West Dundee and Carpentersville (figs. 6, 7c, 7d). This aquifer may be hydraulically connected with the Fox River and may contribute to the base flow. Withdrawals in the area may already affect the quantity of groundwater discharged to the river.

- Shallow aquifers which may not to be hydraulically connected with the Fox River are (fig. 7d): the bedrock aquifers in the Upper Bedrock Aquigroup where it is deeply buried by glacial drift units of low permeability (Kane-Kendall County line north to south Aurora, St. Charles to South Elgin, Elgin to West Dundee, Carpentersville to the Kane-McHenry County line); the St. Charles aquifer where it is overlain by the Marengo aquitard; the Kaneville aquifer member and Valparaiso aquifer where they are isolated from the Fox River by fine-grained bottom sediments in the riverbed.

Recommendations

It is recommended that additional studies be performed in those aquifers which have been found to be potentially contributing to the base flow of the Fox River. Such studies would include test drilling, aquifer testing, and flow modeling to quantitatively define the relationship of shallow aquifers and the Fox River. Completion of these studies would permit an economic analysis of the impacts of withdrawals of groundwater from shallow aquifers on the base flow quantity and quality of the Fox River.

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