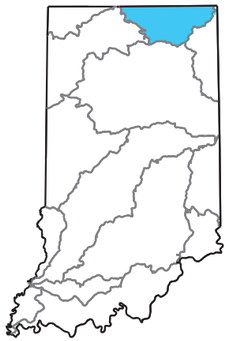


ST. JOSEPH RIVER BASIN

By Kathleen K. Fowler

General Description

The St. Joseph River basin, which encompasses an area of 1,699 mi^2 in northeastern Indiana, is part of the St. Lawrence drainage system. The basin includes all of Lagrange County, most of Elkhart, Steuben, and Noble Counties, and parts of St. Joseph, Kosciusko, and Dekalb Counties. The St. Joseph River flows into Indiana in Elkhart County and flows out of the State in St. Joseph County. Major cities within the basin are South Bend, Mishawaka, Elkhart, Goshen, Kendallville, and Angola (fig. 18).

Previous Studies

Studies of the ground-water resources of the St. Joseph River basin have been published since the late 1890's. Leverett (1899) compiled a report on the wells of northern Indiana that was used as a reference for many years. Capps (1910) produced one of the first investigations of the quantity, quality, and distribution of ground water in north-central Indiana. A summary of ground-water sources and occurrence for each county of the State was compiled by Harrell (1935). Klaer and Stallman (1948), Stallman and Klaer (1950), and Rosenshein and Hunn (1962) described ground-water resources of the South Bend area, Noble County, and St. Joseph County. The geohydrology and ground-water potential of St. Joseph County was also described by Hunn and Rosenshein (1969). Pettijohn (1968) provided data on the occurrence, availability, and chemical quality of ground water in the St. Joseph River basin as part of a comprehensive report of the ground-water resources of Indiana. Marie (1975) studied the water-supply potential of the aquifers in the South Bend area. Reussow and Rohne (1975) compiled three plates describing the availability, distribution, quality, and use of water in the St. Joseph River basin. The ground-water resources and quality of northwestern Elkhart County were evaluated by Imbrigiotta and Martin (1981). Bailey and others (1985) and Lindgren and others (1985) described local hydrologic systems in the St. Joseph River basin and modeled the effects of agricultural irrigation on those local systems. Crompton and others (1986) reviewed the hydrologic data-collection network in the St. Joseph River basin. Peters (1987) and Peters and Renn (1988) described the effects of agricultural irrigation on the water resources of the St. Joseph River basin. Ground-water and surface-water availability, distribution, quality, and use in the St. Joseph River basin were described by the Indiana Department of Natural Resources (1987).

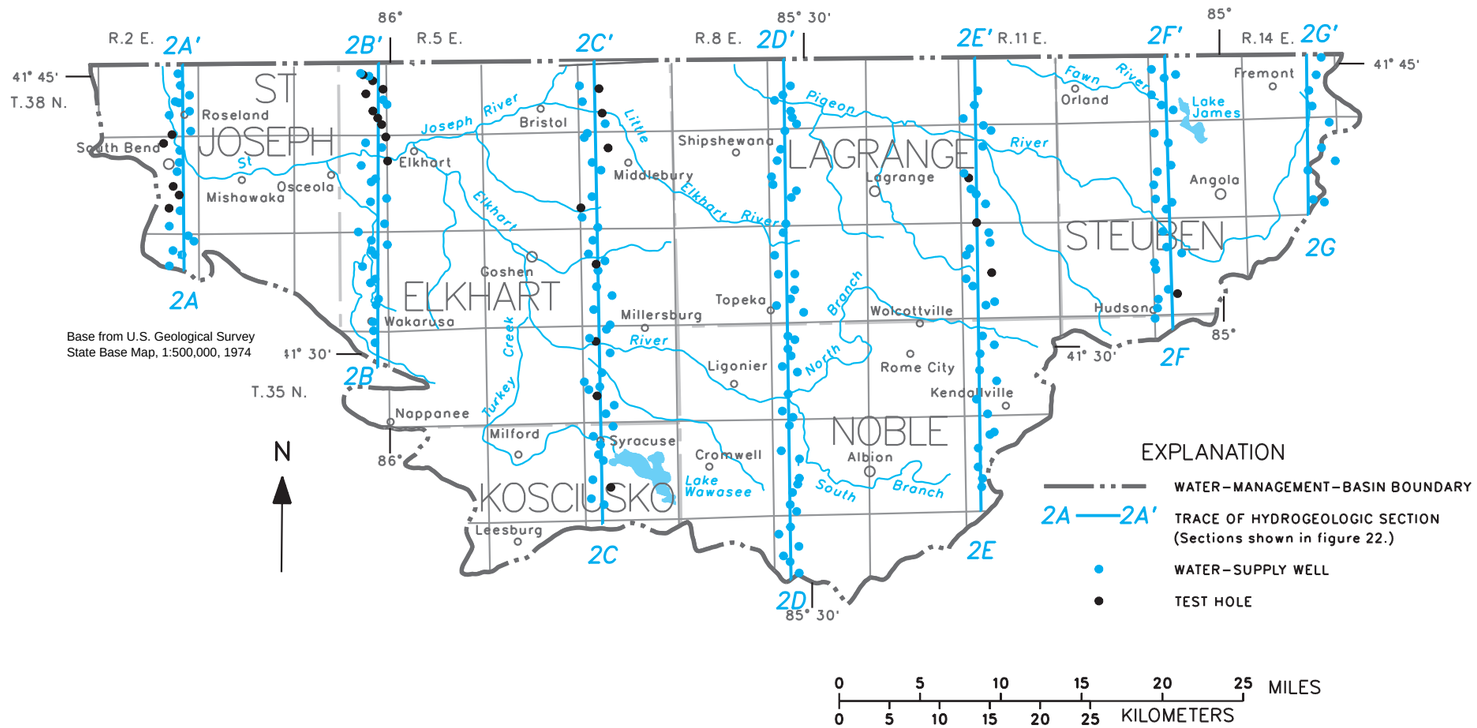


Figure 18. Location of section lines and wells plotted in the St. Joseph River basin.

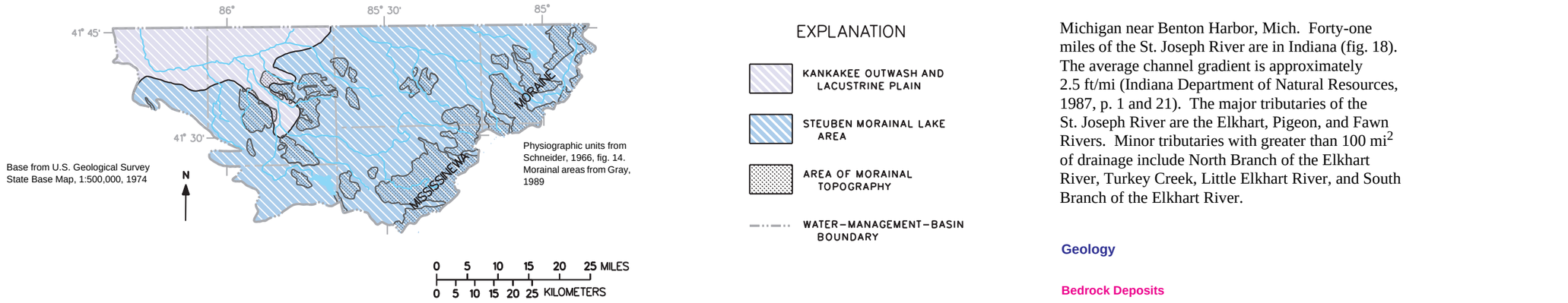


Figure 19. Physiographic units and moraines in the St. Joseph River basin.

Physiography

The St. Joseph River basin is part of the Northern Moraine and Lake Region physiographic area as described by Malott (1922, p. 112) and Schneider (1966, p. 42). This region has been divided into five physiographic units. Two units, the Kankakee Outwash and Lacustrine Plain and the Steuben Morainal Lake Area, compose the St. Joseph River basin (fig. 19).

The topography of the basin is variable; land-surface altitudes range from 700 ft near South Bend to 1,100 ft north of Angola. The Kankakee Outwash and Lacustrine Plain, recently described as the Kankakee Lowlands (Indiana Department of Natural Resources, 1987, p. 12), lies in the northwestern part of the basin and extends into eastern Illinois and southwestern Michigan. Prior to the glacial retreat from the Great Lakes drainage basin, the St. Joseph River drained southwest to the Kankakee River. After the St. Lawrence River became free of ice, the St. Joseph River drainage was captured and drainage direction reversed downstream of South Bend.

Much of this area is a poorly drained, level plain covered by fine-grained alluvium and underlain by thick outwash sand and gravel. Much of the sand and gravel was deposited in the form of broad valley trains and outwash plains by glacial meltwaters at several different times during the late Wisconsin glaciation (Schneider, 1966, p. 52). Sand transported by the wind, and formed into dunes, overlies the outwash in parts of this area.

The Morainal Lake Area, located south and east of the Kankakee Outwash and Lacustrine Plain, has a more complex physiography. Glacial and post-glacial activity have produced the present landforms. Some of the glacial landforms include: knob-and-kettle topography (which forms basins for the many lakes and peat bogs characteristic of northeastern Indiana), kames (composed of ice-contact sand and gravel deposits), meltwater channels, small lake plains, and dunes (Schneider, 1966, p. 52-53). The Maxinkuckee Moraine and the Packerton Moraine (fig. 3) near the southwestern and southern edges of the basin have traditionally been recognized as the major uplands formed by the recession of the Saginaw Lobe (fig. 8). Recent evidence indicates that the Maxinkuckee Moraine was formed by the recession of the Lake Michigan Lobe (fig. 8) and that the Packerton Moraine is a recessional feature of the Erie Lobe (Bleuer and Melhorn, 1989, p. 44). The Mississinewa Moraine (fig. 19), located along the southeastern border of the basin, was formed by the recession of the Erie Lobe (fig. 8). These and other morainic uplands (fig. 19) are composed of unsorted material in a clay matrix. The lowlands between moraines are remnants of meltwater channels and are composed of thick sand and gravel deposits (Crompton and others, 1986, p. 7). Local relief of 100 to 150 ft is common; relief in areas of kame deposits can be as much as 200 ft.

Surface-Water Hydrology

The St. Joseph River drains 1,699 mi^2 in Indiana and 2,586 mi^2 in southern Michigan. The river begins in a morainal area near Hillsdale, Mich., flows generally to the southwest, then to the north through South Bend, Ind., and empties into Lake Michigan near Benton Harbor, Mich. Forty-one miles of the St. Joseph River are in Indiana (fig. 18). The average channel gradient is approximately 2.5 ft/mi (Indiana Department of Natural Resources, 1987, p. 1 and 21). The major tributaries of the St. Joseph River are the Elkhart, Pigeon, and Fawn Rivers. Minor tributaries with greater than 100 mi^2 of drainage include North Branch of the Elkhart River, Turkey Creek, Little Elkhart River, and South Branch of the Elkhart River.

Geology

Bedrock Deposits

Four thousand feet of sandstones, siltstones, shales, limestones, and dolomites of Cambrian, Ordovician, Silurian and Devonian ages overlie Precambrian igneous and metamorphic basement rocks in the St. Joseph River basin. Paleozoic shale and limestone are present at the bedrock surface throughout the St. Joseph River basin in Indiana (fig. 20). A gently rolling bedrock surface is interspersed with a few entrenched, preglacial valleys. Bedrock is overlain by thick glacial drift throughout the basin. Bedrock formations dip northeast into the Michigan Basin (fig. 4) at approximately 30 ft/mi (Indiana Department of Natural Resources, 1987, p. 15).

Devonian carbonate rocks of the Muscatatuck Group are present at the bedrock surface in relatively small areas in Kosciusko and Noble Counties in the extreme southern part of the basin (fig. 20). The Devonian carbonate rocks and underlying Silurian carbonate rocks form a 400 to 900 ft thick carbonate rock sequence (Bassett and Hasenmueller, 1978 and 1979). Overlying the carbonate rock is the Antrim Shale of Devonian age. The Antrim Shale is present at the bedrock surface in the southern part of the basin. This shale is typically brownish-black and noncalcareous. Thickness of the Antrim Shale ranges from 0 to greater than 220 ft in the St. Joseph River basin. The Ellsworth Shale of Late Devonian and Early Mississippian age overlies the Antrim Shale, and is present at the bedrock surface in the western

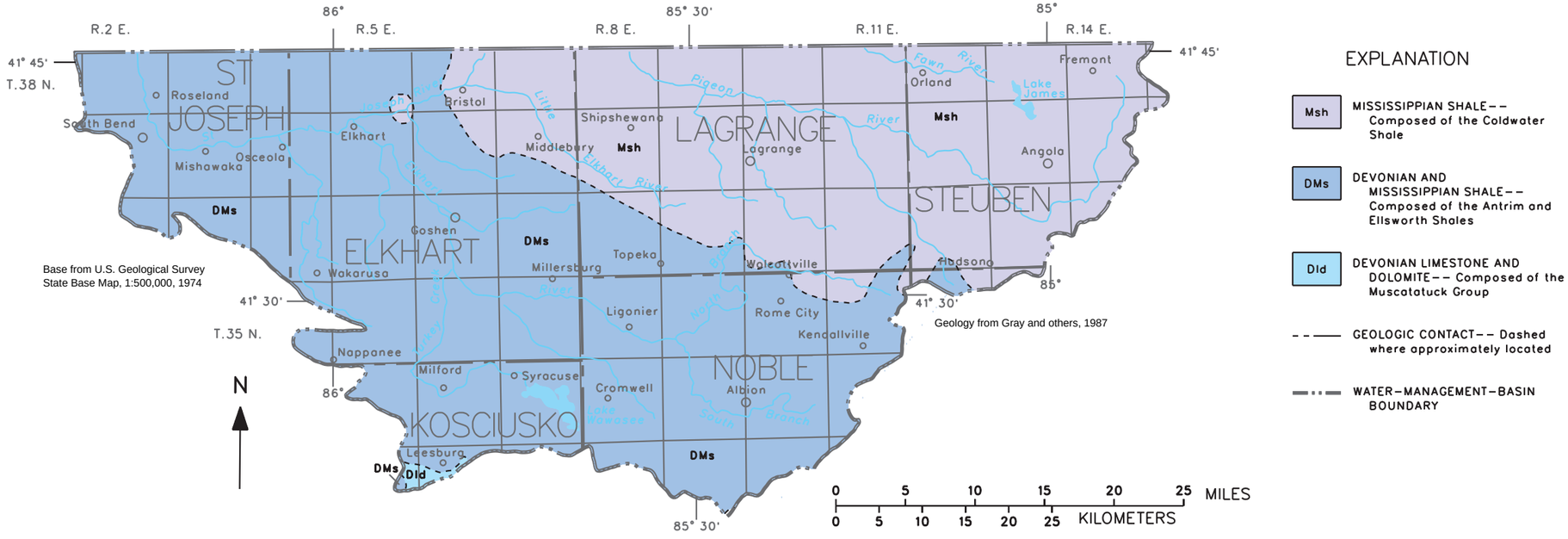


Figure 20. Bedrock geology of the St. Joseph River basin.

part of the basin. The lower part of the formation consists of alternating layers of gray-green shale and brownish-black shale. The upper part is a grayish-green shale that contains limestone and dolomite lenses. The Ellsworth Shale ranges in thickness from less than 40 ft to greater than 200 ft. The Coldwater Shale of Early Mississippian age is present in the northeastern part of the basin. It is predominantly a gray to greenish-gray, slightly silty shale with red shale stringers in the lower part. Thickness ranges up to 500 ft. (See Shaver and others, 1986.)

Unconsolidated Deposits

The St. Joseph River basin is covered by thick, unconsolidated glacial deposits (fig. 21). These deposits are the result of several glacial periods, but predominately the Wisconsinan glaciation (fig. 8) and the subsequent recessions of the Saginaw, Erie, and Lake Michigan Lobes (Schneider, 1966, p. 53; Bleuer, 1989, p. 44). Most of the sediments deposited in the St. Joseph River basin are from the ice advances of the Saginaw and the Erie Lobes of about 15,000 years ago (Wayne, 1966, p. 35).

Although, the thickness of the drift in this basin ranges from 100 ft to 500 ft, thicknesses of 200 ft to 400 ft are typical (Reussow and Rohne, 1975) (fig. 21). Drift thickness generally increases from west to east. The sand and gravel units within the drift were deposited as broad outwash plains or channels beyond the melting ice front, as kame and esker deposits within the ice sheet, and as lenticular masses within the morainal deposits of glacial till (Pettijohn, 1968, p. 7). These sand and gravel units within the drift are the major aquifers of the basin.

Aquifer Types

Seven hydrogeologic sections 2A–2A′ to 2G–2G′ (fig. 22), were produced for this atlas to show the general hydrostratigraphy of the St. Joseph River basin. Locations of the sections are shown in figure 18. All hydrogeologic sections are oriented from south to north and were drawn at intervals of 8 to 12 mi. The seven hydrogeologic sections of the St. Joseph River basin have a combined length of 148 mi and were produced from the logs of 213 water-supply and test wells. The average density of logged wells plotted along the section lines is 1.4 wells per mile.

The St. Joseph River basin is an area of highly variable and complex glacial deposits. The sand and gravel sequences of the unconsolidated deposits, which form the major aquifer systems in the basin, were laid down by the advances of as many as three ice sheets. These deposits are variable in extent and thickness and are widespread over the entire area. The major types of unconsolidated aquifers are the surficial sands and gravels and the buried sands and gravels of the northern and central parts of the basin. Other unconsolidated aquifers are the discontinuous lenses of sand and gravel distributed across the central and southern parts of the basin. Buried preglacial bedrock valleys, where they are filled with sand and gravel, are small but significant aquifers along the Indiana-Michigan State line. In the St. Joseph River basin, ground-water flow in the unconsolidated aquifers is generally toward the St. Joseph River and its tributaries. The four aquifer types mapped in the St. Joseph River basin (fig. 23) are summarized in table 4. The table includes range of thickness, range of yields, and aquifer names commonly used by other authors.

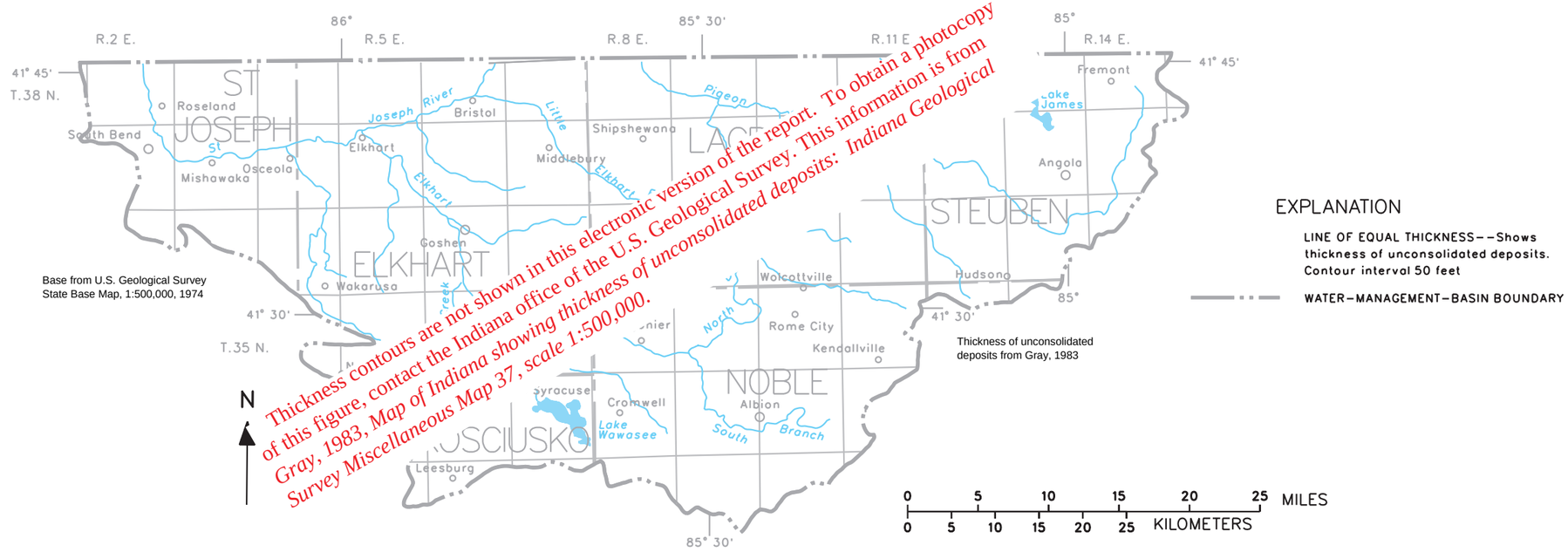


Figure 21. Thickness of unconsolidated deposits in the St. Joseph River basin.

Unconsolidated Aquifers

Surficial Sand and Gravel Aquifers

Surficial sand and gravel aquifers are present in approximately half of the basin (fig. 23) and are shown in all seven hydrogeologic sections (fig. 22). The surficial sand and gravel aquifers consist mostly of outwash, outwash-fan deposits, isolated hills and ridges of ice-contact stratified drift, and Holocene alluvium (Gray, 1989). Thicknesses are generally greatest in the north and east and in the vicinity of buried bedrock valleys. Thicknesses of surficial sand and gravel aquifers range from a few feet in section 2C–2C′, T. 37 N. (fig. 22), to 160 ft in section 2B–2B′, T. 37 N. (fig. 22). Precipitation is the principal source of recharge to the surficial sand and gravel aquifers.

Buried Sand and Gravel Aquifers

Most of the buried sand and gravel aquifers are composed of outwash-related material. They are found in more than one-third of the basin, but they are predominantly in the northeastern and central parts of the basin, as seen in section 2C–2C′, Tps. 35 and 37 N., eastward to section 2G–2G′ (fig. 22). Small areas of buried sand and gravel are shown at the southern end of section 2A–2A′ (fig. 22). Much of the buried sand and gravel aquifer lies beneath the surficial sand and gravel aquifer. A clay layer of variable thickness separates these two aquifers.

Sand and Gravel Within Buried Preglacial Bedrock Valleys

Buried preglacial bedrock valleys are located in two areas of the basin. The far northern parts of sections 2B–2B′ and 2D–2D′, T. 38 N., (fig. 22) show the depths and thicknesses of parts of these valleys. This aquifer type does not cover a large area of the basin, but it is a locally significant aquifer. The bedrock valley is filled with sand and gravel in some areas, and with nonaquifer material in other areas (section 2B–2B′, fig. 22). The buried valleys filled by thick sequences of sand and gravel can produce as much as 2,000 gal/min (Pettijohn, 1968, p. 8). The buried bedrock valley beneath the Pigeon River in section 2D–2D′ (fig. 22) is filled mostly with nonaquifer material.

Discontinuous Sand and Gravel Aquifers

Discontinuous sand and gravel aquifers underlie approximately half of the basin. This aquifer type, which is present across the central one-third and southern boundaries of the basin, is shown in hydrogeologic sections 2B–2B′ to 2G–2G′ (fig. 22). In general, this is an area of loam till and morainal topography (Gray, 1989). The discontinuous lenses of sand and gravel are variable in size but are typically thin and used locally for domestic and agricultural wells. In some areas, however, individual zones can be as thick as 60 ft, as shown in section 2E–2E′, T. 34 N. (fig. 22).

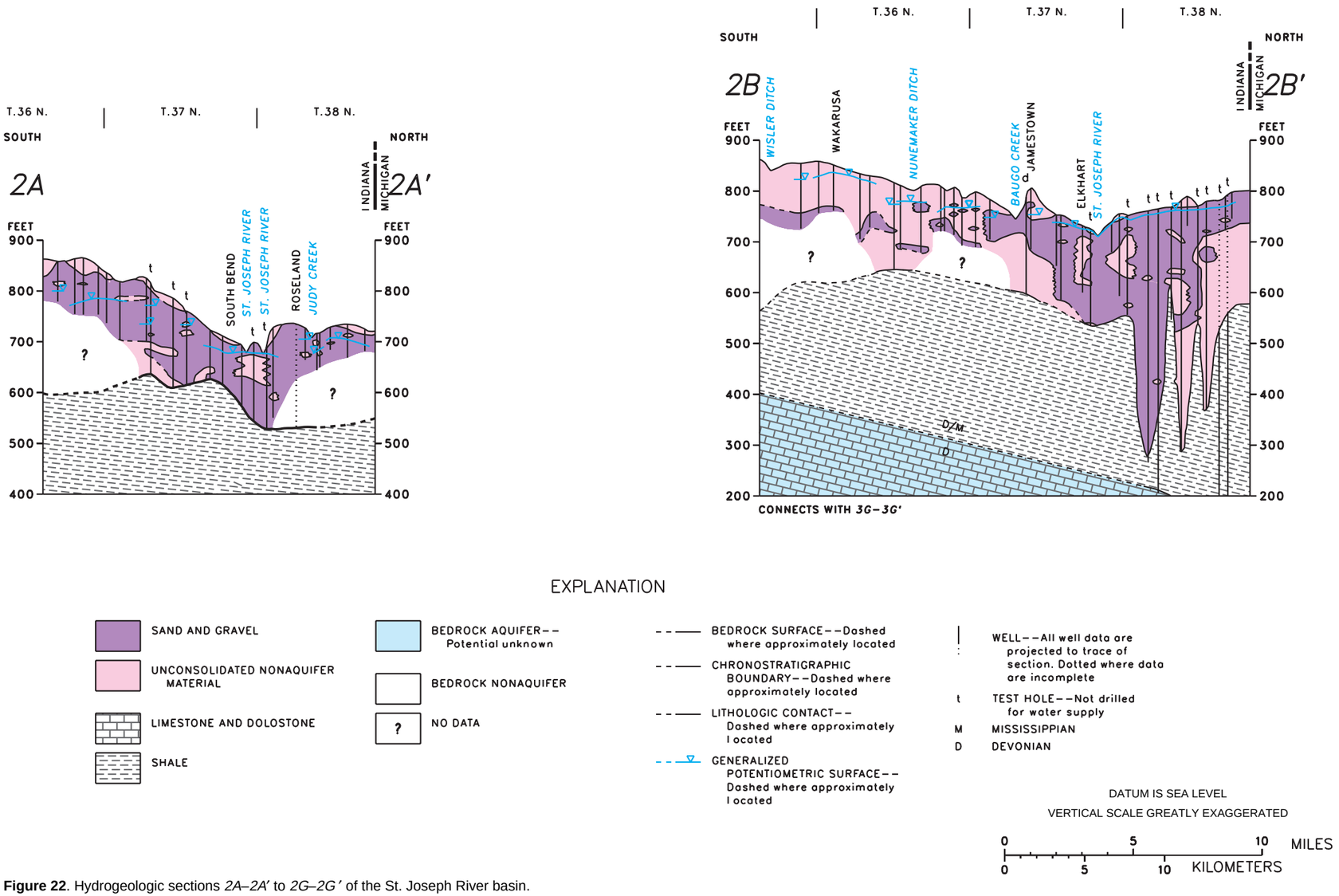
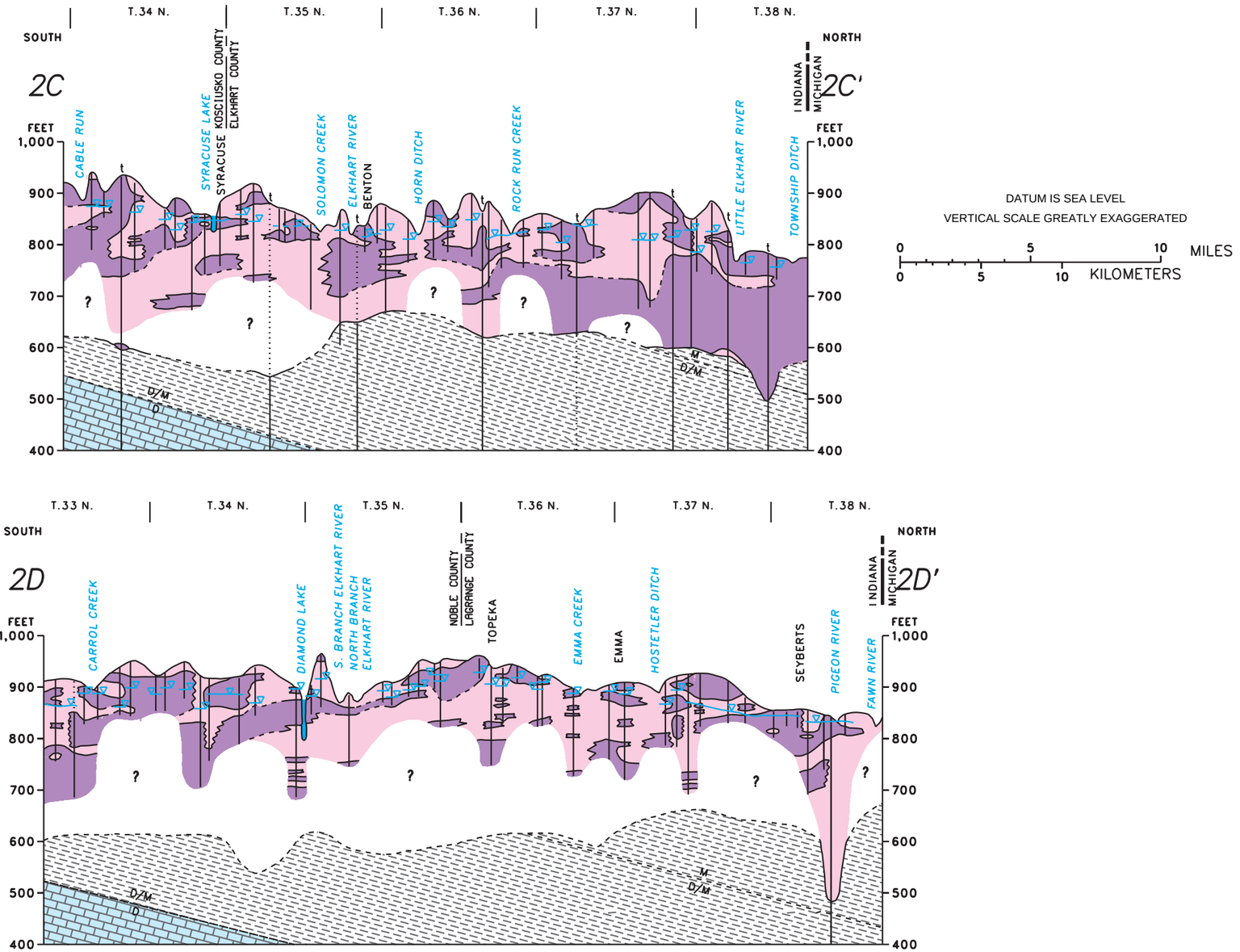


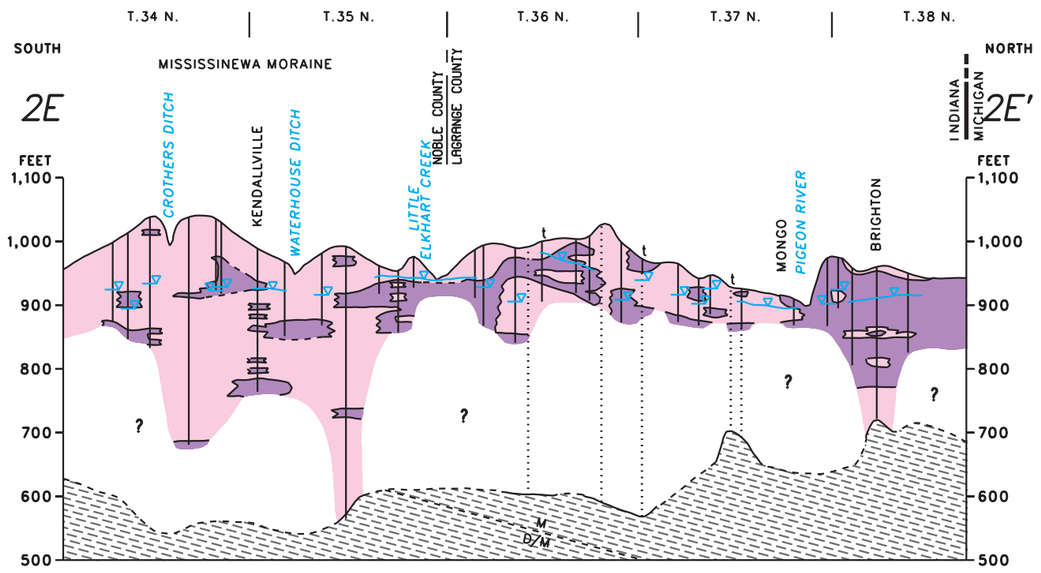
Figure 22. Hydrogeologic sections *2A–2A′* to *2G–2G′* of the St. Joseph River basin.

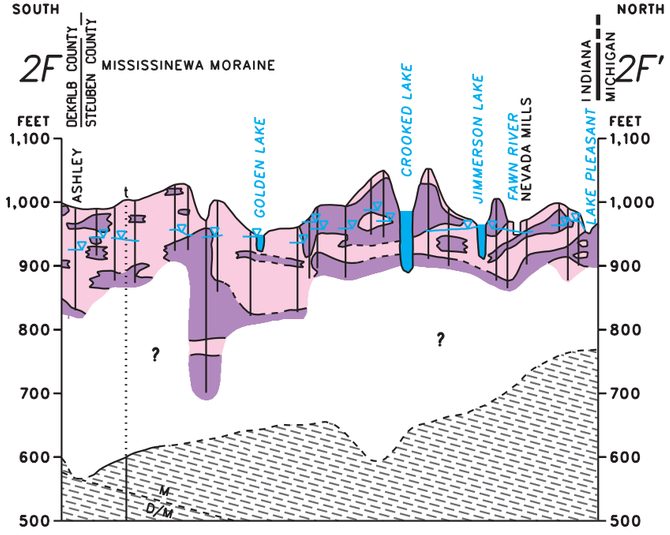
Figure 22. Hydrogeologic sections *2A–2A′* to *2G–2G′* of the St. Joseph River basin—Continued.



DATUM IS SEA LEVEL
VERTICAL SCALE GREATLY EXAGGERATED

0 5 10 MILES
0 5 10 KILOMETERS


T.34 N.
T.35 N.
T.36 N.
T.37 N.
T.38 N.
SOUTH
NORTH
2E
2E'
MISSISSINEWA MORAINE
CROTHERS DITCH
KENDALLVILLE
WATERHOUSE DITCH
LITTLE ELKHART CREEK
NOBLE COUNTY
LAGRANGE COUNTY
MONGO
PIGEON RIVER
BRIGHTON
INDIANA
MICHIGAN
FEET
1,100
1,000
900
800
700
600
500
?
t
M
D/M


T.36 N.
T.37 N.
T.38 N.
SOUTH
NORTH
2F
2F'
MISSISSINEWA MORAINE
DEKALB COUNTY
STEUBEN COUNTY
ASHLEY
GOLDEN LAKE
CROOKED LAKE
JIMMERSON LAKE
FAWN RIVER
NEVADA MILLS
LAKE PLEASANT
INDIANA
MICHIGAN
FEET
1,100
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t
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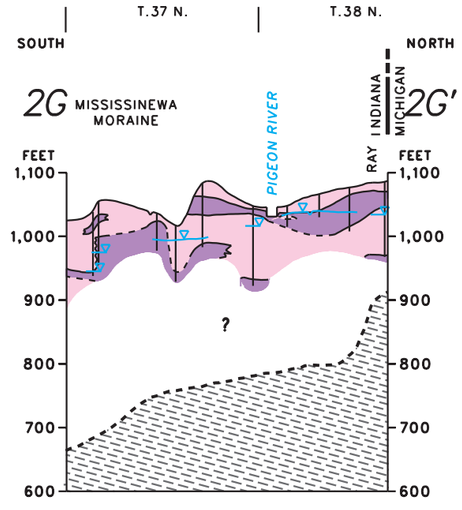
T.37 N.
T.38 N.
SOUTH
NORTH
2G
2G'
MISSISSINEWA MORAINE
PIGEON RIVER
RAY
INDIANA
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FEET
1,100
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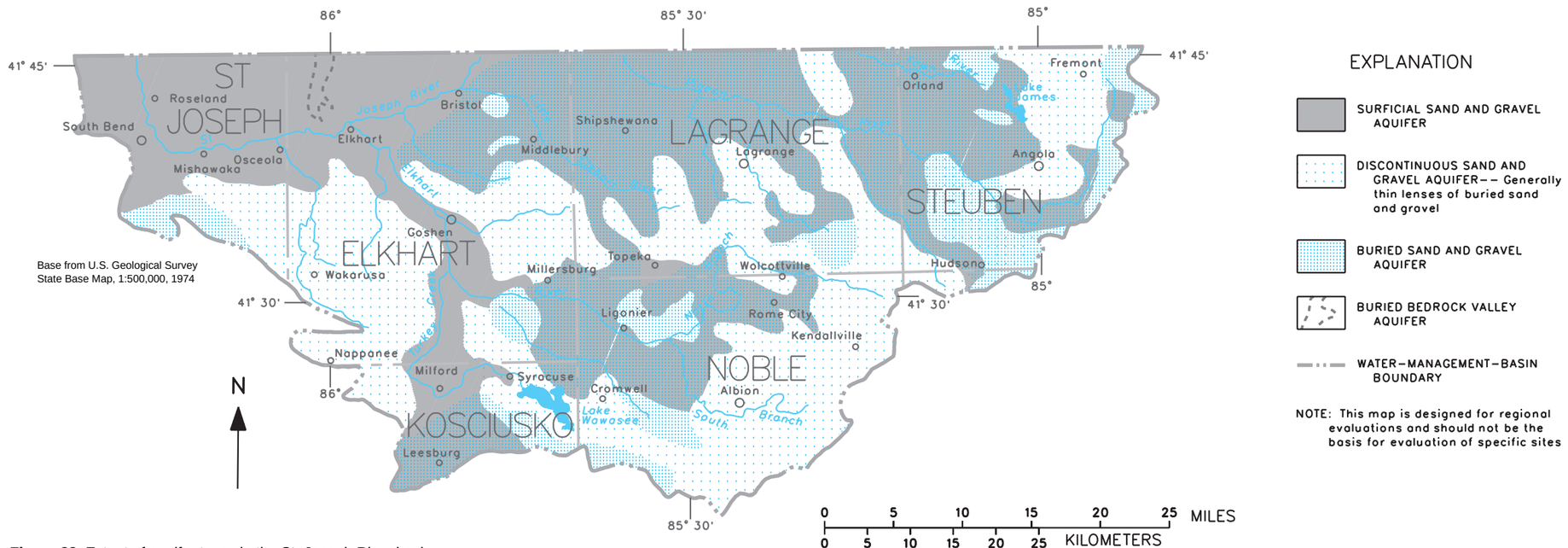

Figure 23. Extent of aquifer types in the St. Joseph River basin.

Bedrock Aquifers

There are several potential bedrock aquifers in the St. Joseph River basin. However, in over half of the area the potential bedrock aquifers are more than 300 ft below the land surface. Therefore, aquifers in the unconsolidated drift are more accessible, as well as adequate for all uses. Bedrock aquifers are not shown on the aquifer map (fig. 23) for the St. Joseph River basin.

The Silurian and Devonian carbonate rock sequence has the greatest potential as a bedrock source of ground water (Gray, 1973). At present, the carbonate bedrock is not used as a source of ground water because of the relative abundance of aquifers in the glacial drift. The other bedrock unit with aquifer potential, the Coldwater Shale of Mississippian age, is at the bedrock surface in the northeastern part of the basin (fig. 20). Isolated pockets of sandstone within this unit have a potential for domestic or light-industrial water supply (Gray, 1973).

Summary

The St. Joseph River basin encompasses 1,699 mi^2 in northeastern Indiana. The basin is composed of two physiographic units: the Kankakee Outwash and Lacustrine Plain and the Steuben Morainal Lake Area. The gently rolling bedrock surface of the basin is composed of shale and limestone. The entire basin is overlain by drift. This unconsolidated drift was deposited during the advances and retreats of Wisconsinan and older glaciations. The glacial drift generally thickens from west to east.

Four unconsolidated aquifer types are present in the St. Joseph River basin. The primary aquifer types are the surficial sands and gravels of the northern one-third and central parts of the basin and the buried sands and gravels of the northern and central parts. Minor aquifer types include the buried preglacial bedrock valleys along the Indiana-Michigan State line and the discontinuous sand and gravel aquifer material across the central one-third and southern boundary of the basin.

Potential bedrock aquifers are not mapped in the St. Joseph River basin because of their great depth and infrequent use. The Silurian and Devonian carbonate rocks have the greatest potential as a bedrock ground-water source. Sandstone deposits within the Coldwater shale in the northeast part of the basin are also potential bedrock aquifers.

Table 4. Characteristics of aquifer types in the St. Joseph River basin
[<, less than; locations of aquifer types shown in fig. 23]

Aquifer type	Thickness (feet)	Range of yield (gallons per minute)	Common names
Surficial sand and gravel	0-160	[1,2]25-2,000	St. Joseph and Tributary Valley, Howe Outwash, and Hilltop Aquifer Systems[2]; Valley train and outwash plain deposits[1]; Unit 3[1]
Buried sand and gravel	5- 90	25-1,000	Natural Lakes and Moraine, Howe Outwash, St. Joseph, Topeka, and Kendallville Aquifer Systems[2]
Sand and gravel in buried bedrock valley	20-480	[1,2]100-2,000	St. Joseph Aquifer System[2]; Preglacial valley deposits[3]
Discontinuous sand and gravel	<5- 80	[1,2]20- 600	Nappanee, Kendallville, and Natural Lakes and Moraine Aquifer Systems[2]; Unit 2[1]

[1]Hunn and Rosenshein, 1969.
[2]Indiana Department of Natural Resources, 1987.
[3]Pettijohn, 1968.

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