MAJOR AQUIFERS IN GLACIAL DRIFT NEAR MATTOON, ILLINOIS*

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Subsurface Pleistocene studies near Mattoon recently conducted by the Illinois State Geological Survey have revealed the probable origin and nature of occurrence of two gravel aquifers of major importance. The report describes a veneer of sand and gravel which rests on the Sangamon interglacial surface over a wide area north of the Shelbyville moraine which here marks the maximum stage of Wisconsin glaciation. A second, more restricted but more favorable aquifer of Shelbyville age lies immediately south of the Shelbyville terminus and extends from the ground surface to the top of Illinoian drift. The relationships of these gravel aquifers to the Cerro Gordo and Shelbyville moraines, to the undulations of the Sangamon surface, and to the topography of the top of the bedrock are described. The investigation is expected to lead to the discovery of unknown aquifer deposits of similar genesis in areas of similar geologic conditions.

Introduction. — Geological and geophysical studies of the gravel aquifers near Mattoon have been conducted by the State Geological Survey at intermittent periods for many years. The older surveys have been directed principally toward the location of the areas most favorable for well field construction. The present investigation, largely a subsurface study by the records of 114 drift borings, has been designed toward not only descriptive geology but an insight into the physical development of the Mattoon aquifers. It is hoped that this insight will lead toward a better understanding of the groundwater available to Mattoon, its industries and hinterland farms, and lead also toward the discovery of other still unknown aquifer deposits of similar rank lying in areas of similar Pleistocene history.

General setting.—The one hundred and ninety-two square miles of the Mattoon investigation lie entirely in southwestern Coles county and include Townships 12 and 13 north, Ranges 7 and 8 east, and the north four section tiers of Township 11 north, Range 7 and 8 east. The terrain is largely rolling to nearly level upland prairie, shedding drainage west into the Kaskaskia, south into the Little Wabash, and east into the Embarrass systems. Relief is only 165 feet, with elevations ranging from about 620 feet on the Kaskaskia River in the northwest area and the Little Wabash River in the southwest area to about 785 feet on the highest crest of the Shelbyville moraine (fig. 2) near the southwest

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corner of T.12 N., R.8 E. Mattoon, with a population estimated at more than 18,000, lies on the gentle north or backslope of the Shelbyville moraine in the south-central area.

As in most of east-central Illinois, the glacial drift near Mattoon rests on the shales, thin limestones, sandstones, and coals of the Pennsylvanian system. Bedrock here is exposed at very restricted locations along the Kaskaskia valley north of the Cerro Gordo moraine (figs. 2 and 3). Everywhere else drift, with estimated thicknesses up to approximately 220 feet in southwestern T.12 N., R. 7 E., buries the bedrock surface and completely obscures its topography. Drift of Illinoian age is capped with younger Wisconsin deposits associated with the Shelbyville and Cerro Gordo ice lobes (Leighton, Ekblaw, Horberg, 1948, p. 22) of Tazewell age. Each of these drift mantles shows surface expression, the Illinoian as a nearly level till plain beyond the influence of Wisconsin ice, the Shelbyville as a prominent moraine, and the Cerro Gordo as a more gentle moraine and till plain in the far north portion of the Mattoon area.

FIG. 1.—Index map showing location of the area of investigation near Mattoon, Illinois.

The bedrock surface.—The buried bedrock surface of the Mattoon area is principally interfluve between the pre-glacial Embarrass (Horberg, 1950, p. 84) and Middletown (Horberg, 1950, p. 73) drainage systems. The shallow sags in the bedrock topography in the northeast portion of the area were apparently courses tributary to the great Embarrass bedrock valley which trends southerly in the eastern part of Coles County. The more prominent bedrock valleys of the Mattoon area appear to trend westward and northwestward as part of the buried Middletown valley which in turn is in confluence with the ancient course of the Mississippi River in eastern Mason County. Although Illinoian drift to a great degree obscured the subdued topography of the top of the bedrock, the southernmost of the west-trending bedrock valleys appears to have influenced the building of a Wisconsin gravel aquifer, and probably influences the hydrologic characteristics of that aquifer.

Illinoian drift.—For the most part the bedrock near Mattoon is mantled

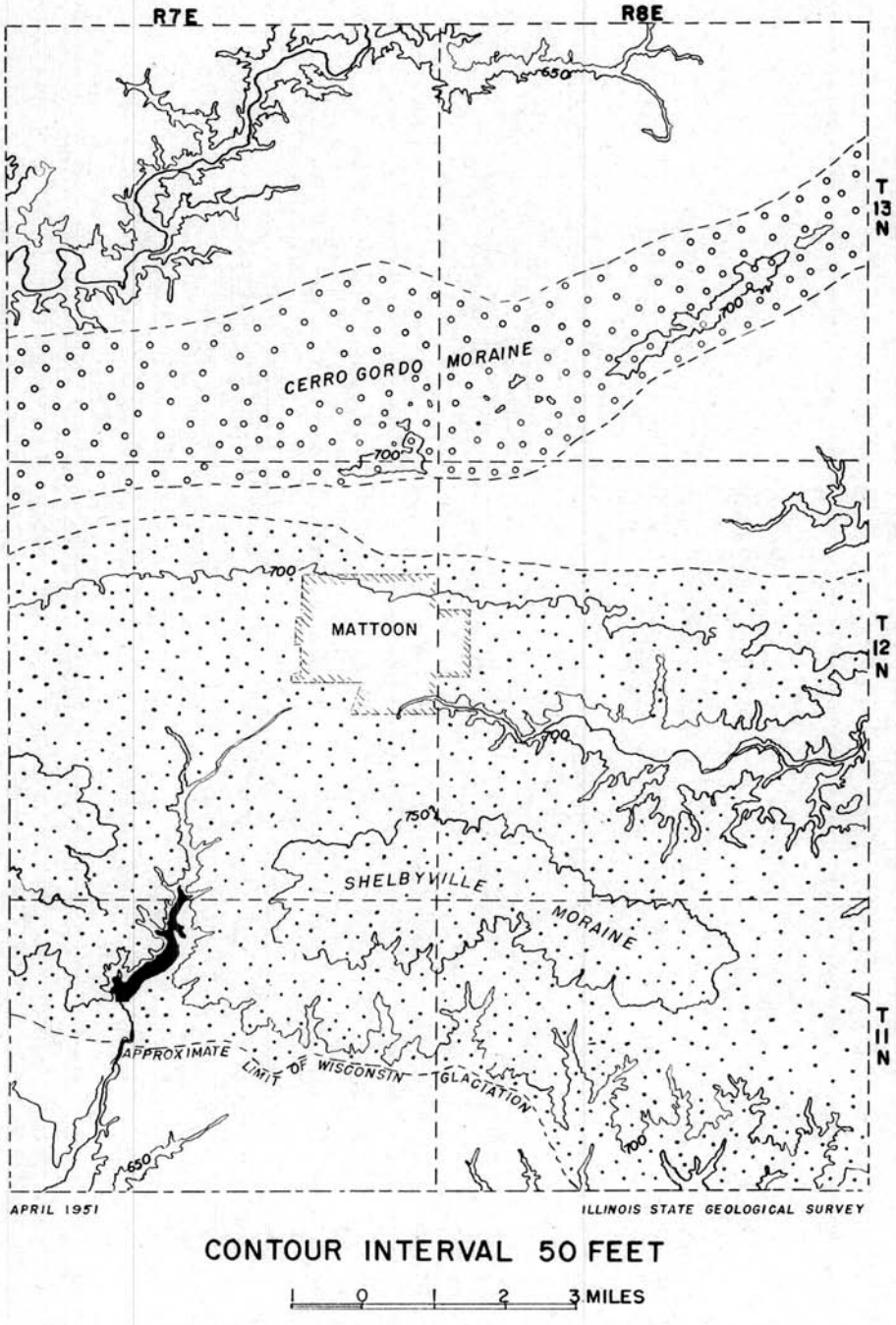

FIG. 2.—Surface contour and moraine configuration map.

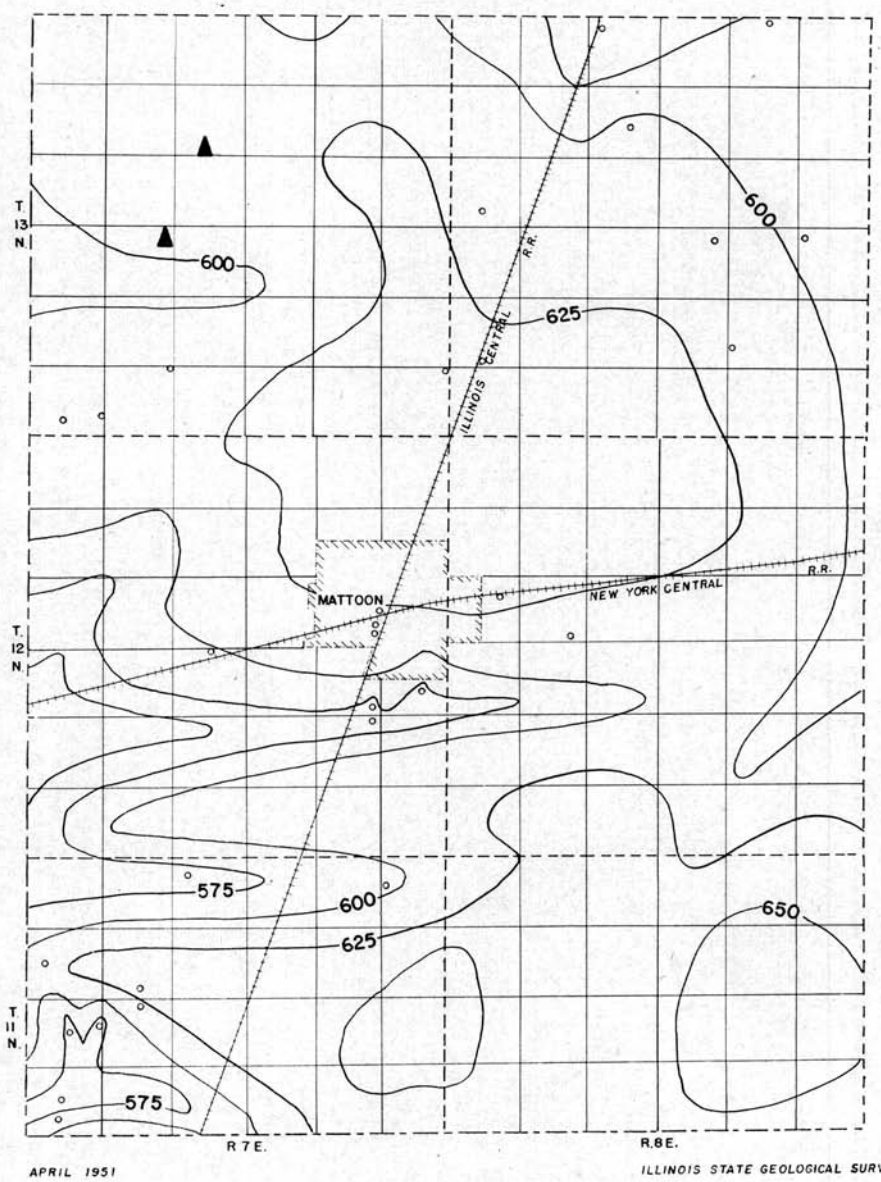

Fig. 3.—Buried bedrock surface contour map.

with Illinoian drift. Two exceptions are noted: (1) Reliable samples from a 1944 Mattoon City test hole located NE. SE. NE. sec. 18, T.11 N., R. 7 E., indicate that the basal material is a fine to coarse silty sand with an abundance of humus and most likely represents a Yarmouth interglacial alluvial deposit. No convincing evidence of Kansan drift has been noted in this subsurface investigation. (2) Three borings in T.11 N., R. 7 E., penetrated to the bedrock without apparently cutting pre-Wisconsin material. These suggest that Sangamon erosion denuded the bedrock at numerous though probably restricted locations principally along Sangamon drainage systems and in localities where Illinoian drift was originally thin. Inasmuch as the top of Illinoian drift appears to have been a gently undulating plain, at an average elevation of about 625 feet, the greater Illinoian drift thicknesses occur generally over the depressions of the bedrock surface. The greatest Illinoian drift thickness in the Mattoon area is estimated to be about 90 feet where a low bedrock surface is overlain by a relatively high Sangamon surface in sec. 19, T.12 N., R.8 E.

Illinoian drift over wide areas here is exclusively a grey or grey-green calcareous clay till which lacks the sandy character typical of Illinoian drift in most of Champaign County. The upper 5 to 10 feet of Illinoian till shows clearly by representative samples the weathering during the Sangamon interglacial period. The general textural homogeneity of the Illinoian drift lends no support to the possibility of multiple Illinoian glaciation, although this fact by no means precludes such a history.

Aquifer material in Illinoian drift, though very uncommon near Mattoon, may be extremely important in its influence on the hydrology of Wisconsin gravels immediately south of the Shelbyville moraine. In sec. 18, T.11 N., R.7 E., pre-Wisconsin sand deposits are as thick as 45 feet and occupy there a well-developed valley of the bedrock surface, drift boring number 4, fig. 4. The nature of this pre-Wisconsin sand is unknown, but the deposit is very likely restricted to the bedrock valley in which it lies, and probably trends westward in conformity with the valley configuration. Samples from boring number 4 suggest that this sand is silty to very silty and may not in itself be an important direct source of groundwater.

Sangamon soil.—Well drillers in the Mattoon area are familiar with the "peat" which rests largely on Illinoian till. It is this remarkably preserved soil section that has provided an excellent horizon marker here.

The excellence of the Sangamon interglacial soil development as a marker near Mattoon has enabled the use of driller's logs where they might otherwise be of little value in geological Pleistocene interpretation. Unusual preservation of Sangamon loam here through the overrunning of the later Wisconsin glacier is probably due to the equally unusual nature of the advance of the Shelbyville ice.

Shelbyville ice progression and the spreading of gravel veneer.—The progression of Shelbyville ice into the Mattoon area early in Tazewell

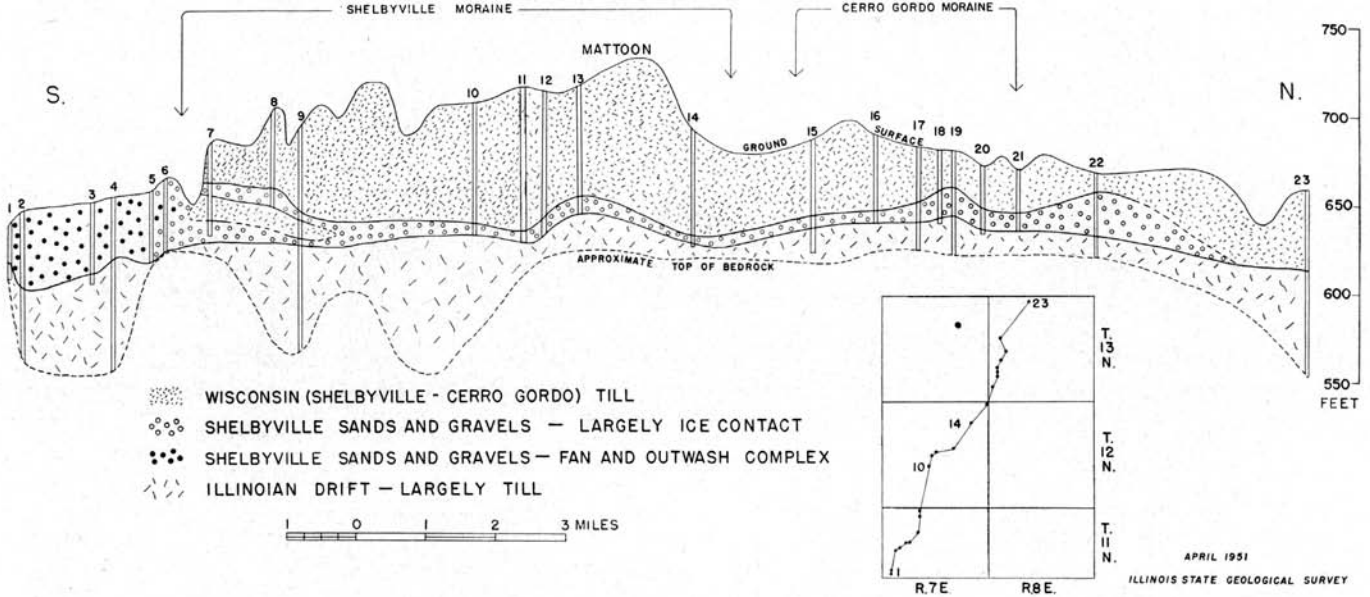

FIG. 4.—South-north cross section of the glacial drift, showing the relationships of the aquifer deposits to each other and to older and younger tills.

time, with a southwesterly lobate axis, began the key period of aquifer building. Subsurface data throughout the area show that a widespread veneer of gravel and sand was laid directly on the Sangamon soil by strong pro-glacial fluvial activity. Figure 4 illustrates the persistence with which these coarse Shelbyville clastics were spread, apparently without much regard for the hills and dales of the Illinoian (or Sangamon) surface. The adaptability of the gravel veneer to the topography indicates that the veneer was spread either subglacially under hydrostatic pressure or as ice-contact accumulation along the advancing zone of strong periglacial fluvial activity. Deposits of outwash origin distant from the glacier mass would concentrate in the existing sags of the Illinoian drift surface with very thin deposition, if any, on the topographic highs. The wide occurrence of the gravel veneer here apparently eliminates the possibility of subglacial origin, leaving the likelihood of ice-contact origin.

Fan and outwash complex.— Shelbyville ice appears to have reached the north portion of T.11 N., R.7 E., about 5 miles south of the present city of Mattoon, without great mechanical change. Here, however, ice-front progression ceased and deterioration of the front probably paced the movement of ice into the terminus area. During this part of the Shelbyville time began the building of a complex fan and outwash deposit immediately south of the glacier terminus near secs. 17, 18, 19, and 20, T.11 N., R.7 E., south of the present Lake Mattoon. Sands of this complex accumulated first in the sag in the Illinoian drift surface (which is apparently the reflection of a partially obscured bedrock valley).

The present valley of the Little Wabash River cuts deeply into the Shelbyville moraine (fig. 2) directly behind the Shelbyville fan and outwash complex and may represent the course of a subglacial or superglacial torrent from which a portion of the complex would have been derived. Periglacial deposits here originating from an ice-fed torrent would likely have spread as an alluvial fan close to the stream's emergence from the ice mass. Such fan-type gravels would combine with earlier and later outwash gravels to form an aquifer deposit similar to the complex found in secs. 17, 18, 19, and 20, T.11 N., R.7 E.

Borings 7, 8 and 9 of fig. 4 show the occurrence of a till bed five to ten feet in thickness intercalated between gravels near the south edge of the Shelbyville moraine. This till zone may have been the result of a minor northward retreat of the ice front a distance of about two miles. The momentary ice front control by ablation may then have been lost by reinvasion to a position nearly equal to the former Shelbyville terminus, spreading as it progressed a second gravel veneer, shown on fig. 4.

The second invasion renewed the building of the fan and outwash complex beyond the limit of Wisconsin glaciation. Subsequent till deposition resulted in the prominent Shelbyville moraine which is the landmark of the Mattoon region. Fluvial deposits of sand and gravel associated with the final recessional

stage of the Shelbyville ice front are very rare or absent within the till near Mattoon. Although the extent of the final retreat of the Shelbyville ice front is not known, ice of this stage of Tazewell glaciation must have ablated at least 50 miles, as Shelbyville drift in central Champaign County exhibits a young soil profile, but little or no leaching.

Cerro Gordo lobate ice. — Post-Shelbyville glaciation in the Mattoon area is believed to include only the development of the more restricted Cerro Gordo lobe, with an axis similar in direction to that of the earlier Shelbyville lobe. Perhaps, because of meager fluvial activity or because of lack of coarse clastic load, the Cerro Gordo glacier failed to spread before it the gravel veneer which Shelbyville ice spread with such uniformity. Drilling above the Shelbyville drift in and north of the Cerro Gordo moraine has revealed no more than widely scattered thin sands of limited groundwater resources. Cerro Gordo ice near Mattoon reached its maximum in extreme northern T.12 N., R.7 and 8 E., about one mile north of the city (fig. 2). The till sheet deposited by the Cerro Gordo ice rests on older Shelbyville till. The horizon between the two tills should be recognizable from sample study on the basis of weathering on the top of the buried Shelbyville till and on the basis of pre-Cerro Gordo soil development. The subsurface distinction of the Cerro Gordo and Shelbyville tills, however, has not been made in the area of this investigation for lack of suitable sample cuttings in the key area of Cerro Gordo overlap. Illinois State Geological Survey files contain sample study records which show that pre-Cerro Gordo soil has been identified at many well sites in Douglas and Champaign counties, north of the Mattoon area.

Geo-hydrology of the aquifers.— Despite the uniformity of thickness of the Shelbyville gravel veneer north of the Shelbyville moraine, the textural composition of the aquifer shows great variation from place to place. The veneer exhibits over wide areas a three- to ten-foot bed of very fine sand at the base of the aquifer, directly above Sangamon soil. Where this fine sand composes the entire thickness of the Shelbyville veneer, well construction even for domestic groundwater is difficult. Borings in the veneer not restricted to any given locality commonly exhibit a bed of clean, very coarse gravel with a thickness up to fifteen feet intercalated between beds of less well sorted silty sand and gravel. It is the very coarse gravel deposit which yields abundant groundwater at scattered sites through the Mattoon area, although even the poorly sorted sand and gravel, where the coarse material is missing, yields more than adequate domestic groundwater supplies.

Far more favorable than the gravel veneer north of the Shelbyville moraine is the gravel aquifer of the fan and outwash complex in the area of secs. 17, 18, 19, and 20, T.11 N., R.7 E., largely south of the limit of Wisconsin glaciation. The veneer and the complex gravel formations are distinct both geologically and by hydrologic characteristics and are being considered here as two aquifers. The fan and outwash complex has a number of

geologic features which encourage favorable groundwater yields:

(1.) The sand and gravel complex of Shelbyville age extends from the ground surface to the top of the Illinoian drift with thicknesses up to 65 feet. These thicknesses are due to the well-defined sag in the Illinoian drift surface previously described. No such thicknesses of gravel are known in the Shelbyville veneer to the north.

(2.) The fan and outwash complex in a number of test-holes in T.11 N., R.7 E., has two or more zones of clean, very coarse gravel with combined thicknesses of twenty feet or more.

(3.) The complex is in hydrologic contact with the buried Shelbyville gravel veneer on the north, thereby facilitating groundwater recharge.

The complex is probably also in hydrologic contact with Illinoian gravels occupying the bedrock valley which directly underlies part of the complex area. Borings here have encountered an upper Illinoian till deposit which, if continuous, might effectively seal the deep gravels from recharge of the shallower gravel complex. Where erosion of the upper Illinoian till may have exposed deep Illinoian gravels during Sangamon time, Illinoian and Wisconsin gravels may be in direct contact. Inasmuch as the deeper Illinoian gravels are believed to be generally silty and limited in permeability, wells in the complex area will probably be constructed in the clean Shelbyville gravels, even though these are relatively shallow and widely exposed.

City of Mattoon well field construction.—Mattoon wells are concentrated in two areas, the Dorans field near sec. 30, T.12 N., R.8 E., and the Southwest field near sec. 18, T.11 N., R.7 E. City wells constructed prior to 1944 were located largely in the Dorans area. These penetrate to depths of 40 to 70 feet and tap groundwater in the Shelbyville gravel veneer. The Dorans wells have never shown capacities adequate for the demands of a city the size of Mattoon. By 1935 Lake Mattoon was supplying the city with the major portion of its water needs. Limited surface inflow in the summer of 1944, caused by rainfall deficiencies recorded by the United States Weather Bureau in the months of May, June, and July of that year, lowered surface storage to an alarming level. Geophysical exploration was conducted by the State Geological Survey for the purpose of discovering, if possible, groundwater aquifers more prolific than that at the old Dorans field. Electrical earth resistivity exploration delineated in 1944 the very favorable gravels in the area of secs. 17, 18, 19, and 20, T.11 N., R.9 E., described in this study as the Shelbyville fan and outwash complex.

Lake Mattoon still furnishes the major portion of water requirements at Mattoon though limited pumping of the Dorans well field continues. However, the construction of wells in the Southwest area, since 1944, which penetrate the most prolific deposit near Mattoon, safeguards the city's supplies against future low water levels of Lake Mattoon. Furthermore, industries which can lo-

cate in the vicinity of the Shelbyville fan and outwash complex will be assured of a source of abundant groundwater available for independent development. This favorable situation exists at very few industrial sites in this region.

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